Souvenir & Abstracts

IPS (NZ)
Meet-2017

National Symposium

on

Ecologically Sustainable Plant Disease Management under Diversified Farming Situation

November 13-14, 2017

at

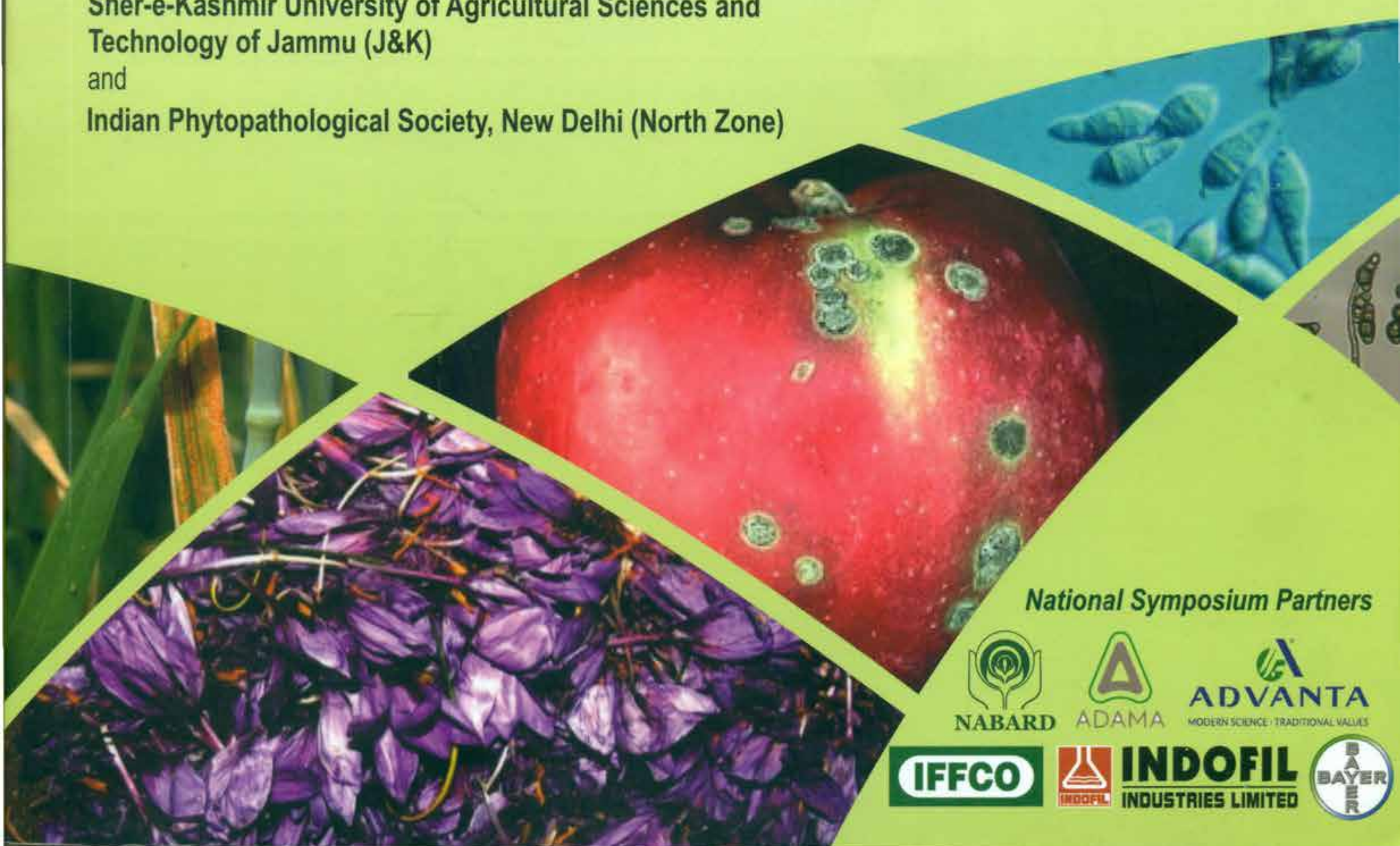
SKUAST-Jammu, Main Campus, Chatha (J&K)

Organized by:

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (J&K)

and

Indian Phytopathological Society, New Delhi (North Zone)



National Symposium Partners

NABARD ADAMA ADVANTA MODERN SCIENCE · TRADITIONAL VALUES

IFFCO INDOFIL INDUSTRIES LIMITED BAYER

About SKUAST of Jammu (J&K)

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) came into existence on 20th September, 1999 following the amendment in Sher-e-Kashmir University of Agricultural Sciences and Technology Act, 1982, through the State Legislature. The establishment of SKUAST of Jammu has in its background aspirations, commitment and missionary zeal to cater the needs of Jammu Division situated between 305 m to 5000 m above mean sea level (MSL) with low altitude subtropical, mid to high altitude intermediate zone and alpine-type geo-climatic areas through advances in research, education and extension in the field of agriculture.

SKUAST-Jammu is a multi-campus university having three well established faculties, with its headquarters located at main campus, Chatha, Jammu. The Faculty of Veterinary Sciences and Animal Husbandry located at R.S. Pura has eighteen (18) divisions and offers BVSc. & A.H., M.V.Sc. and Ph.D. degree programmes in Veterinary Sciences and Animal Husbandry streams. The Faculty of Basic Sciences has four (4) divisions and runs programmes of M.Sc. and Ph.D.

The Faculty of Agriculture (FOA) located at Main Campus Chatha has thirteen (13) divisions and one (01) School of Biotechnology and offers degree programmes namely, B.Sc. (Hons.), B.Sc. (Hons.) Biotechnology, M.Sc. (Agriculture streams), MBA (Agribusiness), M.Sc. (Biotechnology), Ph.D. (Agriculture streams) and Ph.D. (Biotechnology)

There are thirteen Research Stations/Sub-Stations including Seed Processing Facility, Centre for Organic Agriculture and two Advanced Centres namely, Advanced Centre for Horticulture Research & Advanced Centre for Rainfed Agriculture etc. working with the mandate to capitulate the research programme for the University through identification of researchable issues of regional and national importance. There are seven KVKs under the administrative control of the University, located in different agro-climatic zones of Jammu region for catering the location-specific needs of the farming community.

The main Campus of the university is at Chatha, Jammu. The total land in possession of the university (including research stations/sub-stations and KVKs) is 460.98 ha. Among major infrastructural facilities, the University has a hi-tech structure for conducting research on protected cultivation, a well-furnished library with collection of quality books related to agriculture and allied subjects, periodicals, national and international journals etc., and six Experimental Learning units out of which four (Mushroom Cultivation, Plant Clinic and High Tech Nursery horticultural crops and Productive Insects) are established in the Faculty of Agriculture and two (Poultry Production and Dairy Production) are established in Faculty of Veterinary Sciences and Animal Husbandry, R.S. Pura.

The technical information and production recommendations of the faculties of the University are being disseminated through the publications and print material in form of pamphlets, leaflet and posters.

The University is committed to bring development of the region and prosperity of the farmers through the expansion of proven and profitable technologies in the field of agriculture and animal sciences.

INDIAN PHYTOPATHOLOGICAL SOCIETY

About the Society

The Indian Phytopathological Society (IPS) is a professional forum for promoting the cause of Phytopathology. It is the third largest society of plant pathologists in the world. The Society was established in February 28, 1947 at the Indian Agricultural Research Institute, New Delhi by Dr. B.B. Mundkur, an eminent Plant Pathologist.

The IPS is working for diverse global community of scientists that provides credible and beneficial information related to plant health; advocates and participates in the exchange of knowledge with the public, policy makers, and the larger scientific community; and promotes and provides opportunities for scientific communication, career preparation and professional development for its members

It provides a forum to the scientists to interact on important issues of Plant Pathological research, education and extension. The society organizes National and International conferences, symposia and seminars on major topics of Plant Pathology. At present, the Society has approximately 2000 member.

Objectives

- To advance the cause of Mycology and Plant Pathology in India.
- To encourage and promote Mycological and Plant Pathological study and research in the country.
- To disseminate the knowledge of Mycology and Plant Pathology.
- To facilitate close association among members and other scientific workers in India and abroad.

Executive Council

The Executive Council is the policy decision making body consisting of **25** members and meets at least twice a year

President	President Elect will succeed	1 year
President Elect	Elected by General Body	1 year
Secretary	Elected by General Body	3 year
Joint Secretary	Elected by General Body	3 year
Treasurer	Elected by General Body	3 year
Chief Editor	Elected by the EC members	3 year
Sr. Editor (02)	Nominated by the Chief Editor	3 year
Zonal President & Councillor (One from each Zone)	Elected by the members of the respective Zone	1 year
Ex-officio	Head, Division of Plant Pathology, IARI, New Delhi 110012	

Zonal Chapters

The Society has Eight Zonal Chapters each one having its Zonal President and Councillor elected every year. Apart from Delhi and U.P. each Zone comprises of several states the, details of which are as follows:

ZONE	**STATES**
Delhi Zone	Delhi
Northern Zone	Haryana, Punjab, Chandigarh, Himachal Pradesh, Jammu and Kashmir
Mid-Eastern Zone	Uttar Pradesh and Uttaranchal
Eastern Zone	Bihar, Jharkhand, West Bengal, Orissa, Andaman and Nicobar Island
Central Zone	Madhya Pradesh, Chhatisgarh, Rajasthan and Andhra Pradesh
Western Zone	Maharashtra, Gujarat
Southern Zone	Tamil Nadu, Karnataka, Kerela, Goa and Pondicherry
North-Eastern Zone	Assam, Meghalaya, Arunachal Pradesh, Manipur, Mizorum, Tripura, Nagaland and Sikkim

Publication

The Society publishes its official organ "Indian Phytopathology" a leading plant pathology research journal, which deals with the disciplines of Mycology, Fungal Pathology, Bacteriology, Virology, Phytopathology and Nematology. The journal is a focus and strength for our society. The journal is published quarterly in March, June, September, and December. So far, the society has published the journal for over 64 years. The journal also publishes the abstracts of the papers presented in Zonal Meetings.

Awards/Contests

The Society has instituted 15 lecture awards named after distinguished Plant Pathologists to recognize their contribution in the field of Plant Pathology and Mycology. These award lectures are presented at the Annual Meeting of the Society every year.

The Society regularly honors individuals who have made significant contributions to the science of plant pathology through several prestigious awards presented at the Annual Meeting. The Society also offers student members monetary travel awards providing opportunities for professional experience and enrichment.

1. Mundkur Memorial Lecture Award
2. Jeersannidhi Award Lecture
3. Prof. S.N. Dasgupta Memorial Lecture
4. Prof. M.S. Pavgi Award Lecture
5. K.C. Mehta and Manoranjan Mitra Award
6. A.P. Misra Life Time Achievement Award
7. Prof. M.K. Patel Memorial Young Scientist Award
8. Prof. J.F. Dastur Memorial Lecture Award
9. Prof. J.P. Verma Memorial Lecture Award
10. Prof. A.K. Sarbhoy Memorial Lecture Award
11. Sharda C. Lele Memorial Award
12. Dr. S.P.Raychaudhuri Memorial Lecture Series
13. IPS Recognition Award
14. S. Sinha Memorial Award
15. Fellow of Indian Phytopathological Society (FPSI)

Contests

Besides the awards mentioned about, the Society also organizes several award contests.

1. Prof. M.J. Narasimhan Academic Merit Award Contest
2. K.P.V. Menon Best Poster Paper
3. M.J. Narasimhan Best Research Paper
4. IPS travel sponsorship for young scientists
5. APS Travel sponsorship for young scientists

Meetings, Symposia & Conferences

The Society organizes symposia and seminars for better understanding of plan t pathological problems of national interest at its Annual Meetings every year. The Society is pioneer in organizing International Symposia in field of Plant Pathology. So far, five International Conferences have been organized. The Society also organizes regular symposia to discuss plant pathological problems of Zonal importance as well as workshops, lectures, etc., by eminent plant pathologists from within the country and abroad throughout the country through its Zonal Chapters. The Annual Meeting is the Society's premier event, attracting some 400-500 participants a year. The latest advances approaches in the field of plant pathology are presented and attendees have the opportunity to participate in symposia and discussion sessions, view hundreds of technical posters, present research results, attend special events, learn about new products and services, and connect with others who share their interests. National Symposium gives members the opportunity to meet with colleagues to exchange ideas, and share information. Special Symposia and lecture to discuss important plant pathological problems of national interest are organized at the annual general body meeting of the society. Some topics of special significance to the discipline are also taken up for the panel discussions.

Executive Council 2017

President
Dr. B.N. Chakraborty
NBU, Siliguri, WB

President Elect
Dr. R.N. Pandey
AAU, Anand, Gujarat

Secretary
Dr. Dinesh Singh
IARI, New Delhi

Joint Secretary
Dr. Robin Gogoi
IARI, New Delhi

Treasurer
Dr. Vaibhav Kr. Singh
IARI, New Delhi

Chief Editor
Dr. M. Anandaraj
Bangalore, Karnataka

Senior Editor
Dr. S.C. Dubey
NBPGR, New Delhi

Senior Editor
Dr. V.K. Baranwal
IARI, New Delhi

Ex-officio
Dr. Rashmi Aggarwal
IARI, New Delhi

Advisory Board : A.J. Gibbs, Australia; C. Manoharachary, India; Dean W. Gabriel, USA; Krishna V. Subbarao, USA; M.N. Khare, India; M.S. Swaminathan, India; R.D. Wilcoxson, USA; S.M. Paul Khurana, India; William E. Fry, USA

Honorary Fellows : A.N. Mukhopadhyay, India; A.S. Summanwar, India; Anupam Varma, India; C.D. Mayee, India; Dilip K. Lakshman, USA; J.P. Tewari, Canada; M.R.S. Iyengar, India; R.D. Wilcoxson, USA; R.S. Singh, India; S.S. Chahal, India

Zonal Chapters

Zonal President (CZ)	:	Dr. Om Gupta, JNKVV, Jabalpur, Madhya Pradesh
Zonal Councillor (CZ)	:	Dr. Pramod Kr. Gupta, Krishi Vigyan Kendra (JNKVV, Jalbapur), Balaghat, Madhya Pradesh
Zonal President (DZ)	:	Dr. Atul Kumar, ICAR-Indian Agricultural Research Institute, New Delhi
Zonal Councillor (DZ)	:	Dr. Bishnu M. Bashyal, ICAR-Indian Agricultural Research Institute, New Delhi
Zonal President (EZ)	:	Dr. Srikanta Das, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal
Zonal Councillor (EZ)	:	Dr. Subrata Dutta, Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, West Bengal
Zonal President (MEZ)	:	Dr. K.P. Singh, GBPUAT, Pantnagar, Uttarakhand
Zonal Councillor (MEZ)	:	Dr. A.K. Tewari, GBPUAT, Pantnagar, Uttarakhand
Zonal President (NZ)	:	Dr. Shahid Ahamad, SKUAST, Jammu, J & K
Zonal Councillor (NZ)	:	Dr. S.K. Singh, SKUAST, Jammu, J & K
Zonal President (NEZ)	:	Dr. Narendra Prakash, ICAR Research Complex for NEH Region, Manipur Centre, Imphal
Zonal Councillor (NEZ)	:	Dr. Susheel Kr. Sharma, ICAR Research Complex for NEH Region, Manipur Centre, Imphal
Zonal President (SZ)	:	Dr. V. Devappa, University of Horticulture Science, Bengaluru, Karnataka
Zonal Councillor (SZ)	:	Dr. B. Anjaneya Reddy, University of Horticulture Science, Bengaluru, Karnataka
Zonal President (WZ)	:	Dr. S.S. Mane, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra
Zonal Councillor (WZ)	:	Dr. M.V. Totawar, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra

(CZ: Central Zone; DZ: Delhi Zone; EZ: Eastern Zone; MEZ: Mid Eastern Zone; NZ: Northern Zone; NEZ: North Eastern Zone; SZ: Southern Zone; WZ: Western Zone)

CONTENTS

Plant Protection Practices in Organic Farming

Shahid Ahamad, Jag Paul Sharma and S.K. Singh
Directorate of Research, Sher-e-Kashmir University of Agriculture Science & Technology-Jammu
Email: shahid_2056@yahoo.co.in

As a matter of fact, the organic farming and organic consumable products have become matter of concern in wake of reports of pesticides residues above permissible limits in several samples of fruit, vegetables and crop products. Liberal use of synthetic fertilizers and pesticides has increased the yield but has deteriorated quality and nutritional value of the products. Consumption of such products has led to the emergence of many minor diseases and disorders into major ones, mention may be made of Diabetes, cancers and cardio-vascular problems. Moreover, these human health problems have been linked with agricultural system producing them. Adverse ecological effects of chemical based agriculture have been reported from all corners of the world.

All these concerns demand for research, refinement and popularization of an agricultural production system that can sustain ecology and provides products of standard that take care of human health as well.

Priority of crops to be organically produced

- Plant produce eaten raw: fruits, salad vegetables, garnishing spices, herbs to be used in cosmetics and herbal preparations, seed spices
- Plant produce consumed as whole without peeling: leafy vegetables, okra
- Plant produce consumed after peeling or shelling: cucurbits, pulses and cereals
- Scenario of organic farming in India

The agriculture was by default organic before the advent of inorganic fertilizers and chemical pesticides. Over the time, the use of these synthetic inputs has come to the level of causing a concern to the environment and human health. Consequently, it is felt necessary to advocate the use of the age-old practice of organic farming not only to ensure uncontaminated food production but also to sustain the agriculture by keeping the land in a healthy condition. To make organic farming successful, it is essential that eco-friendly technologies, which can maintain or increase the agricultural productivity, have to be developed and made available to the farmers.

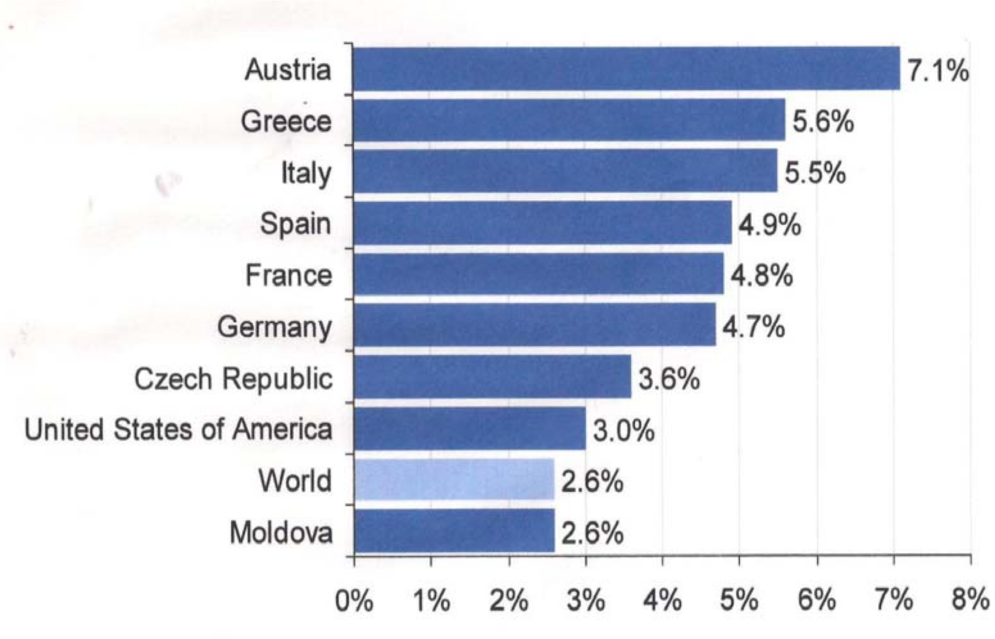


Fig. 1: Top ten countries with highest share of organic agricultural land
Source: FIBL & IFOAM Survey 2011, based on national data; shares calculated with FAOSTAT data

Scenario of organic farming in India

The agriculture was by default organic before the advent of inorganic fertilizers and chemical pesticides. Over the time, the use of these synthetic inputs has come to the level of causing a concern to the environment and human health. Consequently, it is felt necessary to advocate the use of the age-old practice of organic farming not only to ensure uncontaminated food production but also to sustain the agriculture by keeping the land in a healthy condition. To make organic farming successful, it is essential that eco-friendly technologies, which can maintain or increase the agricultural productivity, have to be developed and made available to the farmers.

In India, about 528,171 ha area is under organic farming including certified and land under organic conversion with 44,926 number of certified organic farms. This accounts for about 0.3% of total agricultural land. Indian organic farming industry is estimated at US$ 78 million and is almost entirely export oriented. According to Agricultural and Processed Food Products Export Development Authority (APEDA), a nodal agency involved in promoting Indian organic agriculture, about 585,970 ton of organic products worth of Rs. 301 million are being exported from India. Growing awareness, increasing market demand, increasing inclination of farmers to go organic and growing institutional support have resulted in more than 200% growth in certified area during the last two years.

Table 1: Status of organic farming in India

Total Area under organic farming	528,171.00 ha
Area under organic conversion certified organic farms	44,926.00 ha
Total production	585970.00 mt
Total quantity exported	19456.00 mt
Value of total export	Rs. 301.24 m
Number of Farmers	141904.00

Source: APEDA, 2006-07

Integrated Pest Management (IPM)

1. Field hygiene/Sanitation:
   a) The heavily infected plant parts should be burnt.
   b) Insects and their egg clusters and larval stages can be physically collected & destroyed.
   c) Dropped and decaying fruit should be removed & put in the center of the compost heap.
   d) Over-grown weeds should be slashed and used in compost making.
2. Trap crops should be raised.
3. Light traps should be used to monitor and control insects.

Fruit fly in Cucurbita trap, highly damaging fruits in cucurbitaceous crop

Fruit fly damaged Pumpkin

4. Use below mentioned bio-control agents:

S.No.	Biological Agents	Pest	Crop
1.	*Trichogramma brassiliensis;* 1.0 cc/ac. once in 10 days	*Heliothis* sp	Tomato
2.	*Trichogramma chilonis;* 2 cc/ac once in 15 days	Fruit Borer	Vegetables
3.	Nuclear Polyhedrosis Virus (NPV); 100-200 LE/ac	*Spodoptera* sp & *Heliothis* sp	Vegetables
4.	*Chrysoperla* Sp; 500/ha	Prudenia, Caterpillars, White flies, thrips, aphids	Vegetables

5. Herbal extracts

Herbal extracts should be used only as a final remedy only after utilizing & practicing all the above said methods. One should try to use only the locally available weeds or those that are grown as life fence for making herbal extracts. If enough materials are not available in and around the garden, then materials can be collected from other areas.

Basic important procedures to be followed while preparing the herbal extracts are:

a) Macerate and grind the plant material to a pulp state.

b) Soak the pulped material in at least 60-70% of the final volume of spray solution.

c) Soak it for 3-5 days, filter, make up the spray volume with water and spray.

d) To avoid soaking it for 3-4 days, soak it at least for overnight and then heat it to a bearable warmth (60-70°C) for an hour by stirring. After this dilute it to the required final volume of spray solution, filter, allow to cool & spray.

e) Use at least 2-3 different materials at a time to prepare the herbal extract.

f) Change the combination of the materials every time.

g) Use 2-3% of herbal extract (combination of 2-3 different materials) while the pest attack is at early stage. Increase the dosage upto 5-6% if the attack is very severe.

Commonly available plants that can be used for making herbal extracts are as follows:

Sr.No.	Common Name	Botanical Name	Useful Plant Parts
1	Neem	*Azadirachta indica*	Neem Cake
2	Pungam	*Pongamia glabra* *Pongamia pinnata*	Leaf & flower
3	Notchi	*Vitex nugunda*	Leaf & flower
4	Nithia Kalyani	*Catharanus rosea*	Whole plant
5	Unni	*Lantana camera*	Leaf & flower
6	Devils Trumpet	*Datura Metal*	Leaf, fruit, flower
7	Yellow Nelliam	*Nerium thevetifolia*	Flower, fruit, root
8	Aruku	*Calatropis gigantea*	Leaf, tender stem, flower
9	Siria Nangai	*Andrographis paniculata*	Whole plant
10	Parthenium	*Parthenium* sp	Plant before flowering
11	Adathoda	*Adathoda vasica*	Leaf
12	Tobacco	*Nicotiana tobaccum*	Dried leaf, plant waste, stem waste
13	Chevanthi	*Crysanthemum cinerrifolia*	Flower
14	Thumbai	*Lucus aspera*	Flower, leaf, tender stem
15	Tobacco Plant (weed)	*Lobilia* sp	Whole plant
16	Ginger	*Zingiber officinale*	Rhizome
17	Etti	*Strychnos nuvomica*	Seeds
18	Turmeric	*Curcuma longa*	Rhizome
19		*Artemesia* ________ *Artemesia vulgaris*	Tender shoots & leaves
20	Papaya	*Carica papaya*	Leaf, tender stem

By continuous practice & observation one can develop many different combinations with the locally available material for different pest attack. Meanwhile already tried and verified combinations are as follows:

Sr.No.	Herbal Combinations	Pest
a.	*Vitex nugundo* (2%) + Neem Kernel Cake (1%)	Thrips
b.	*Vitex nugundo* (2%) + *Calatropips gigantia* (2%)	Aphids
c.	Neem Kernel Cake (3%)	Leaf eating caterpillar
d.	*Nerium thevitifolia* (2%) + *Vitex nugundo* (2%)	Fruit borers
e.	*Andrographis panaculata* (*Siria nangai*) (1%) + Neem cake (1%)	Fruit borers & Stem borers
f.	*Parthenium* sp (3%) + *Vinca rosea* (1%)	Thrips
g.	*Lantana camera* (2.5%) + *Nerium thevitifolia* (1%)	Aphids

h.	*Calatropis gigantia* (2%) + *Lucas aspera* (1%)	Leaf eating caterpillar
i.	*Nicotiana tobaccum* (1%) + *Vitex nugundo* (1%)	Leaf roller
j.	*Calatropis gigantia* (1%) + *Nerium thevitifolia* (1%)	Leaf roller
k.	*Gingiber officianale* (3%)	Thrips & Aphids
l.	Papaya (3%)	Leaf eating caterpillar
m.	*Occimum* sp (Tulasi) (3%)	Caterpillars & Spotted leaf beetles
n.	Soak Turmeric 1kg in 10 lt of Cow urine for two days & then dilute it to 100 lt for an acre of crop	Caterpillars and Aphids

Another method is soaking the pulped material in cow urine (10% of the final volume of spray solution) for 15-20 days by burying the mud pot containing the materials in a compost heap. Then dilute it as 1:9 with water, filter & spray.

h) Integrated Disease Management (IDM)

1. Field Sanitation- The diseased plants should be collected and dump in covered pit at the early stages of any disease spreading.
2. Control the vectors by IPM.
3. Spray BD 501 on Moon opposite to Saturn days every month.
4. Dress the seeds with CPP manure slurry - will help to overcome seed borne & soil borne pathogen attack.
5. Dip the roots of the seedlings in with CPP manure slurry to reduce root rot & collar rot diseases.
6. Spray CPP manure as foliar (1.5kg/ac/50 lt water) cone in a month for annuals and once in two months for perennials against leaf rot, leaf blight, fruit rot, sheath blight & sheath rot (as prophylactic and also as a foliar nutrition).
7. Spray 2% well fermented buttermilk - Mix 2 lt of well fermented curd (6-7 days) in 98 lt of water and after thorough mixing & potentising by 10-15 minutes of clockwise & anti-clockwise stirring.

Severe infestation of Yellow Rust of Wheat at OFRC, Chatha

Wheat crop after spray of Bio-pesticides, Bacillus subtilis

8. Mixture of Garlic (2%) & Turmeric (1%) can also be sprayed.
9. Use BD 508 - Take 1kg of *Casuarina equisitifolia* or *Equisetium arvense* or *Equisetum ramassisimum* and boil it for 2hrs in 10 lts of water. Leave it for two days, dilute it to 100 lts, filter and spray.
10. Bordeaux mixture- 1.0% can also be sprayed.
11. Use bio-control agents against wilt and rot

Diseases:

a) *Trichoderma viride*- seed treatment @ 10g/kg or *Trichoderma harzianum*- 10 g/lt for spray and 5 kg/ac for basal dressing
b) *Pseduomonas fluoroscens*- 5 g/kg seeds, 3 g/lt for spray and 2-3 kg/acre for basal dressing.

Ecologically Sustainable Management of Apple Diseases in Diversified Farming Situation

J.N. Sharma

Director of Research, Dr. Y. S. Parmar, University of Horticulture and Forestry, Nauni, Solan-173230, H.P., India

Email: jnsharma1960@yahoo.co.in

In India, apple is commercially cultivated in the states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand on an area of 3,12,000 hectares with annual production of 19,15,000 metric tons. It has become the number one commercial fruit crop being cultivated over 1,06,230 hectares with annual production of 4,12,000 metric in Himachal Pradesh. Incidence of diseases is one of the most important factor in lowering the fruit production and they can cause as much as 30-50 percent loss under favourable conditions, if suitable package of practices are not followed. Apart from the lowered fruit quality and yield, certain plant pathogens infecting roots and stems of the trees may cause premature decline of the orchards and death of the bearing trees resulting in total loss. In the earlier years, there have been more reliance on chemical means for their management which has boomeranged thereby necessitating for the ecologically sustainable options for apple disease control. In the present paper, effort will be made to put together the knowledge and information on various aspects of etiology and epidemiology of various diseases inflicting apple for evolving sustainable control strategy. White root rot (*Dematophora necatrix*) and collar rot (*Phytophthora cactorum)* are important soil borne diseases in different agro-climatic conditions and are favoured by clayey soil with poor drainage of the orchards; whereas seedling blight affects the nursery stock and young trees and is particularly severe in well aerated sandy loam soils. Apart from better drainage and resistant root stock, soil drenching with carbendazim (against the white root rot), metalaxyl (against collar rot) and thiram (against seedling blight) is effective in controlling these diseases. Of late, hairy root rot (*Agrobacterium rhizogene*s) and crown gall have become important and responsible for rejection of apple nursery stock up to 40 per cent in some cases. Exemplary biological control of crown gall has been achieved through K 84 strain of non-pathogenic *Agrobacterium radiobacter* in Australia. In India, efforts are in progress to develop a native non-pathogenic strain for controlling crown gall.

More than 13 canker causing fungi affecting tree trunks of apple have been isolated and found responsible for production various cankers in Himachal Pradesh. Cultural practices like mulching, balanced fertilization, irrigation and proper training and pruning of the trees are recommended to avoid canker diseases. Pruning wounds and other unavoidable mechanical injuries should be treated with fungicide based pastes and paints immediately. Affected portion should be scarified and cauterized with blow lamp, followed by copper based or cow dung paste for hastening the healing of the wounds. On apple foliage, scab is the foremost disease and it is prevalent almost in all the apple producing states of India affecting both leaves and fruits. Its incidence is quite high in J&K, Uttarakhand and Arunachal Pradesh. In Himachal Pradesh, extensive work has been done on its epidemiology and management. Computerized automated electronic device Reuter Stokes Predictor has been used effectively for predicting infection periods in monitored scab control. Marssonina blotch appeared in Himachal Pradesh early in 1990s and affected the apple plantation throughout the state covering more than 90 per cent area by 1995 when it caused widespread premature defoliation of the trees. It is caused by *Marssonina coronaria*, a hitherto little known fungal pathogen in India. Its incidence has also been recorded from J&K, Uttarakhand and Arunachal Pradesh. This disease was favoured by excessively humid conditions during fruit development and later stages of apple. As both the above apple pathogens perpetuate in the infected leaf litter, its destruction by raking, collection followed by burning, and urea (5%) spray in the autumn is effective in reducing the disease incidence. Sooty blotch (*Gloeodes pomigena*) and fly speck (*Schizothyrium pomi*) cause black superficial blemishes on apple and pear fruits thereby reducing quality and ultimately the market price of the fruit produce which can be avoided by proper training pruning and using ecofriendly fungicidal treatments.

Similarly, apple is vulnerable to postharvest decay and spoilage by different plant pathogenic fungi. Infection of most of the post-harvest pathogens takes place at harvest, handling and storage. However, some of these like bitter rot, brown rot and core rot infect fruits in the field and develop at a later stage. Proper handling, transit and storage are pivotal in their management apart from pre-harvest fungicide sprays, and dip treatments after harvest. Although, fungicides and other chemicals provide effective control of above apple diseases, an integrated disease management approach is always recommended to ameliorate their adverse effect on the environment and human beings.

Ecofriendly Strategies for Vegetable Disease Management in North Western Himalaya

S.K. Gupta

Department of Plant Pathology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan-173230 (H.P.) India

Email: skguptampp@rediffmail.com

ABSTRACT

India is the second largest producer of vegetables after China. In mid hills, vegetables are generally grown in such a period which is off-season for plains and these are transported to plains where they fetch remunerative prices. During cultivation vegetables are infected with several diseases of fungal, bacterial and viral nature which not only reduce the quantity but also quality of the produce. Chemical fungicides have been used successfully to combat the ravages of these diseases for many years. However, side effects such as ground water pollution, residues on food crops, effect on non-target organisms and the development of resistance to chemicals have drawn attention towards ecofriendly strategies including genetic, cultural and biological control along with minimum use of environment friendly fungicides and resistance inducer chemicals. The cultural practices like sanitation, crop rotation, mulching, soil solarization and soil amendment help in establishing an environment that favours the crop over the pathogen. Reducing plant stress through modification of soil environment promotes good plant health and aides in reducing damage from plant diseases. Cultural practices reduce the initial inoculum of the pathogen (s) in the field besides improving the efficacy of the fungicides applied thus reducing the number of fungicide application. In biological control, bioagents not only reduce the diseases through antagonistic activity but also have plant growth promoting activities like phosphate solublization and siderophore production. Compatibility of antagonists with fungicides further enhances their capability in reducing the disease incidence.

Removal of stalk rot (*Sclerotinia sclerotiorum*) infected leaves at weekly intervals reduces the disease incidence by 50 per cent. Crop rotation i.e. cauliflower -paddy-cauliflower enhances the seed yield of cauliflower by 161 per cent. Pine needle mulch alone and spray applications of copper oxychloride (0.3%) on mulch and foliage was most efficacious in managing buckeye rot of tomato but pine needle mulch impregnated with floor application of copper oxychloride was also quite effective without having residue deposits on fruits with slightly less benefit cost ratio (12.9) compared to foliage application of copper oxychloride (16.7).

In case of Fusarium wilt of pea, soil microflora was isolated for identification of the antagonists. Actinomycete *Streptomyces* sp. (64.17%) and *S. californicus* (59.53%) and fungus *Trichoderma harzianum* (52.53%) showed antagonistic activity under *in vitro* conditions against *Fusarium oxysporum* f.sp. *pisi*. Both actinomycetes were further studied for their plant growth promoting activity (PGPR) and *Streptomyces* sp. was found siderophore producing while *S. californicus* was phosphate solublizing. Besides this *Streptomyces* sp. was also compatible with carbendazim upto 4000 ppm. Under pot culture conditions, seed treatment of pea with carbendazim (0.25) and Streptomyces sp. (0.4%) was found highly effective in reducing the disease incidence to 4 per cent and increasing the nodulation up to 39 per cent as compared to 79 per cent and 14 per cent in control, respectively. When this combination along with soil solarization was evaluated under field conditions, provided maximum disease control and increased the green pod yield. Cold water extracts of *Allium sativum* was found highly effective in the management of pea powdery mildew.

For the management of Phytophthora leaf blight and fruit rot of capsicum through induced resistance, two foliar sprays of Acibenzolar-S-methyl (10μM) was most effective in managing the disease followed by DL-α-amino-n- butyric acid (BABA) (1 mM). Similarly, β- aminobutyric acid (2 mM) was found most effective in managing the buckeye fruit rot of tomato with 85.66 per cent disease reduction over control.

4

Quality and Quantity Frightened Awareness of Dreaded Rice Blast, *Magnaporthe grisea* and IDM for its Combat in Temperate Ecology

Ali Anwar and Mudasir Bhat

Division of Plant Pathology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, J&K-190025, India

Email: zaman04@rediffmail.com

Rice (*Oryza sativa*) was probably first domesticated in the Yangtze River Valley in China. Today, we estimate that rice is the staple food for about 2.4 billion people providing more than 20% of the daily calorie intake. The demand for rice in India is expected to increase to 122 million tonnes by 2020, the reason being that the population has increased by three fold since independence and is still growing at 1.8 per cent per year, even though growth trend has slowed down in almost all the districts. With respect to scenario in the state of J&K, rice is cultivated on an area of 2.56 lakh hectares, whereas, in the temperate zone alone the rice crop occupies an area of 1.4 lakh hectares at present, with a production of 24.6 lakh tones and productivity of 17.4 q per hectare.

The fungal diseases, major yield reducing factors, have been great concern to the sustainable rice production. Blast disease (*Magnaporthe grisea*) has become increasingly important dreaded disease of rice in production constraints. It is considered the principal disease of rice owing to its wide distribution and destructiveness and remains the world's most economically important malaise. The crop is cultivated under hundred percent irrigated and cool night ecology of Kharif (wet) season; but its productivity is declined due to breakdown in the resistance of high rice yielding varieties (Anwar *et al.*, 2003). Blast frequently occurs on coarse grain Kashmiri japonica/indica rice cultivars. Disease severity varies with location, weather, cultivar maturity and the inherent level of partial resistance of cultivars. Virtually avirulence of blast pathogen tends to shift to virulence nature rather than virulence to avirulence in rice crop. Therefore, such variability has made it difficult to point out strategies for selecting rice cultivar that show stable resistance to a blast pathogen in rice growing areas of Kashmir. This fungus also infects other host grasses but specific host range is still contradictory.

Status of blast disease in Kashmir ecology

An intensive survey of paddy growing areas across the Kashmir revealed maximum average disease severity on leaves which was in variable range of 3.7-41.3%. Highest severity occurrence of nodal blast (7.3%) was found in Kulgam followed by Khudwani (5.4%) and Larnoo (3.8%) zones of Anantnag district which is rice bowl of Kashmir. The most destructive phase of blast lesion i.e. neck blast incidence was encountered in every surveyed district in range of 0.9-10.0 percent owing to the prevalence cultivation of primitive local cultivars which are to be vary in susceptibility to the disease. However, in the surveyed zones of district Anantnag, the average severity of neck blast was on higher (3.8%) side in all the wet seasons of years. The incidence of neck blast at the end of the season usually appeared to be related to the amount of leaf blast occurring during the season although in some fields where little leaf blast was observed, there was severe amount of neck blast. Anantnag district consistently suffered with maximum blast disease occurring on leaves, nodes and neck of the crop during consecutive three years (2002-2004) due to highest inoculum load or disease pressure, whereas, least severity of leaf and node blast was measured in the Baramulla but neck blast was determined in Kupwara district which clearly indicated the pathogenic variability.

Hosts and symptoms

Members of the *Magnaporthe grisea* complex can also infect other agriculturally important cereals including wheat, rye, barley, and pearl millet causing diseases called blast disease or blight disease.

Leaf blast

Collar blast

Node blast

Neck blast

Disease Affected Rice Nursery

Leaf blast at tillering stage

Initial symptoms are white to grey-green lesions or spots with darker borders produced on all parts of the shoot, while older lesions are elliptical or spindle-shaped and whitish to gray with necrotic borders. Lesions may enlarge and coalesce to kill the entire leaf. Symptoms are observed on all above-ground parts of the plant. Lesions can be seen on the leaf collar, culm, culm nodes and panicle neck node. Internodal infection of the culm occurs in a banded pattern. Nodal infection causes the culm to break at the infected node (rotten neck). It also affects reproduction by causing the host to produce fewer seeds.

Screening

Diverse pathogenicity in *P. grisea* on rice was first noted by Sasaki (1923) in Japan while its physiological races are known since long. Agriculturally important isolates (mother isolates-MI) developed from different locations in all the districts of Kashmir differed from one another such as those virulent or avirulent on the eight international blast differential hosts (IBD). Various primitive rice cultivars are being cultivated in Kashmir from which blast isolates were virulent. In general, differences among *P. grisea* populations from different agro-ecological systems in Kashmir probably reflect discernation in differential hosts by their reaction. Genotypes were evaluated in uniform blast nursery (UBN) pattern (IRRI, 1979). At Rice Research and Regional Station, Khudwani. That 47 out of 69 genotypes were immune and rated 0 to leaf blast pathogen. All the donors from Brazil (CAN 4125, CNA4136, CNA4150 and CNA4745; Thailand (KHAO-HAO, SEW DAENG and SEW MAE JAN); Philippines (UPL Ri 7) and Ivory coast (IRAT 112) showed immune (0) reaction to leaf and neck blast. The introgression lines IR 78221-19-6-33, IR 78222-20-8-33, IR 78222-20-IA-7 and IR 78222-20-7-50 of IRRI/Hazaribagh also showed immune (0) reaction to both leaf and neck blast pathogen.

Molecular Diagnostic Tools for Detection of Plant Pathogens

Sudheer Kumar
Indian Institute of Wheat and Barley Research, Karnal-132001, Haryana

Introduction

Plant pathogens are invisible foe for cross-boundary trade of agricultural commodities as well as for profitable crop production causing about 20-30% losses annually (Kashyap *et al.* 2017). This can be minimized, and specific treatment can be tailored, if pathogens detected and identified correctly and rapidly. Thus, detection of plant pathogens is very important for successful and effective management. Besides the management it is also important for quarantine, epidemiological and host parasite interaction studies. It is one of the most important strategies for controlling plant diseases to initiate preventive or curative measures. Detection and identification of diseases in crops could be realized via both direct and indirect methods. Direct detection of diseases includes molecular and serological methods that could be used for directly detecting the causal agent or pathogens trough high-throughput analysis to provide accurate identification of the disease/pathogen. On the other hand, indirect methods identify the plant diseases through various parameters such as morphological change, temperature change, transpiration rate change and volatile organic compounds released by infected plants.

Under the changing climatic conditions it is expected in change of host range and geographical distribution of many pathogens for example recent wheat blast outbreak in Bangladesh. Special interest are being taken in the early detection of pathogens in seeds, mother plants and propagative plant material to avoid the introduction and further spreading of new pathogens in a growing area where it is not present yet. For that reason, the availability of fast, sensitive and accurate methods for detection and identification of plant pathogens is necessary to improve decision making in disease management. The early detection and identification of plant pathogens is an integral part of successful disease management.

Moreover, recent trend for globalization in agriculture created even higher demands in various aspects of plant protection. With the advancement of international commerce that practically cancelled the geographic boarders between countries, legislation set most strict rules concerning movement of seed and plant material. Phytosanitary inspections and quarantine regulations became more stringent not only between countries but also within the territories of a country. There certain challenged faced by plant pathologist like identification of healthy propagation material, inspection of planting material for quarantine pathogens, prevention of spread of a pathogen to another country or region, screening of mother plants for certain pathogens, monitoring of resistance phenotypes of a pathogen to certain agrochemincals where the specific detection has great potential. Furthermore, research frontiers have been widened to more detailed and in depth studies of host-parasite interactions, disease resistance, and pathogens population structure (Miller *et al.*, 2009). Thus, the development of methods capable to detect and identify pathogens in plant materials in a fast, accurate and sensitive manner has been necessitated more than ever.

Traditionally, experienced plant pathologists diagnose diseases by observing typical disease symptoms and identify the pathogen by culturing in specialized media. This method is mostly accurate but is time consuming require expertise and experience, and therefore not suitable for rapid disease management practices. During the last decades, the advent of molecular biology offered radical alternatives in the detection and enumeration of plant pathogens. These include the enzyme-linked immunosorbant assay (ELISA), which considerably increased the speed of detected *in vivo*, and DNA-based technologies, such as the polymerase chain reaction (PCR) which enable regions of the pathogen's genome to be amplified several million fold, thus increasing the sensitivity of pathogen detection (Lievens and Thomma, 2005). Furthermore, diagnostic PCR has been greatly improved by the introduction of the second generation PCR, known as the Real time PCR where closed-tube fluorescence detection and quantification during PCR amplification (in real time) is possible eliminating the need for laborious post-PCR sample processing steps which greatly reduces the risk of carryover contamination (Martin *et al.* 2000). Using Real Time PCR, it is possible not only to detect the presence or absence of the target pathogen, but it is also possible to quantify inoculums load in the sample. These methods are only able to identify one to few pathogens simultaneously by multiplexing. Whereas, crops are attacked by many pathogens, often occur in complexes. Therefore, many disease diagnostic applications require simultaneous detection and quantification of several targets. The DNA Microarray technology, originally designed to study gene expression and generate single nucleotide polymorphism (SNP) profiles, is currently a new and emerging pathogen diagnostic technology, which in theory, offers a platform for unlimited multiplexing capability.

Furthermore, electrochemical DNA biosensors have also been widely used in disease diagnosis as they potentially offer high sensitivity, rapid analysis and portability at potentially lower cost than traditional technologies. Several DNA biosensors have been reported in which involve the labelling of PCR products with enzymes, redox active components or nanoparticles to enhance the electrochemical signal (Yola *et al.* 2014; Lau *et al.* 2017). Therefore, nanomaterial-based DNA biosensors can provide a promising platform for the development of rapid, sensitive, specific and portable diagnostic tools for detecting DNA. It is viewed as a technology that fundamentally alters molecular diagnostics. The fast growing databases generated by genomics, biosystematics and nanotechnological research provides unique opportunity for the design of more versatile, high-throughput, sensitive and specific molecular assays which will address the major limitations of the current technologies and benefit plant pathology.

Molecular techniques for detection of plant pathogens

Traditionally, the available detection and diagnostic techniques for plant pathogens have been microscopic observation, isolation, biochemical characterization, serology (mainly through immunofluorescence and Enzyme-Linked Immunosorbent Assay (ELISA) using polyclonal and/or monoclonal antibodies), bioassays and pathogenicity tests. Biological indexing, electron microscopy and some biochemical and staining tests have been used for testing pathogens of the genus *Spiroplasma* and phytoplasmas. For viruses and viroids, biological indexing (using herbaceous and/or woody indicator plants), electrophoresis, electron microscopy and ELISA based techniques have been the choice (López *et al*. 2009). There are currently many molecular methods, which have been used to detect and/or characterize specific fungal, bacterial and viral pathogens in plant material and summarized in following sections.

Molecular hybridization

The use of Southern blot or dot blot hybridization techniques using selected probes from DNA libraries was a strategy for the identification of plant pathogens prior to the introduction of PCR-based methods with greater sensitivity, simplicity and speed. Molecular hybridization-based assays were first utilized in plant pathology to detect *Potato spindle tuber viroid* by Owens and Diener (1981) and later on adapted to plant pathogens detection. Today, the most common molecular hybridization format for the detection of pathogens is non-isotopic dot-blot hybridization using digoxigenin-labelled probes. Babu *et al.* (2007) developed hybridization probe for identification and detection of *Macrophomina phaseolina*. Molecular hybridization can also be applied to the specific detection of amplicons generated after amplification techniques based on PCR, thereby increasing their sensitivity and specificity levels and reducing time when a flow-through system is used.

Fluorescence* in situ *hybridization

Fluorescence *in-situ* hybridization (FISH) combines microscopic observation of bacteria and the specificity of hybridization and is dependent on the hybridization of DNA probes to species-specific regions of bacterial ribosomes. The technique can visualize the precise location of particular DNA or RNA sequences in the cytoplasm, organelles, or nuclei of biological materials. As a result, the technique can detect metabolically active fungi directly in the environment without cultivation when RNA is present. The spatial distribution of growing mycelia on or within colonized substrata can also be investigated (Tsui *et al.* 2011). In theory, FISH can detect single cells but in practice, the detection level is near 10^3 cells/ml of plant extract. There is a high affinity and selectivity of DNA probes because FISH takes place under very stringent hybridization conditions, where a difference of one nucleotide in a 15-20 oligonucleotide probe is sufficient for discrimination. However, this method has some limitations that fungal and substrate inherent autofluorescence, insufficient permeability of cell walls, non-specific binding of probes, and low ribosome contents. Auto-fluorescence of fungi can also lead to false positive fluorescence signals.

Conventional PCR and RT-PCR

The PCR based diagnosis of plant diseases has become very common in laboratory practice. Its advantages (speed, sensitivity, specificity) are far more important than its drawbacks (risk of contamination, sensitivity to inhibitors, complexity, cost), and several modifications to solve these problems have been performed with success. In general, PCR, with all its variants, is currently a basic tool in diagnosis, alone or preferentially in combination with other techniques. As for any target, PCR efficiency for detection of pathogens is based on the primer specificity. Its efficiency is also related to many parameters such as polymerase type, buffer composition and stability, purity and concentration of dNTPs, cycling parameters as well as the characteristics of the starting template. In addition, the quality of the nucleic acid to be amplified is critical. Because PCR can achieve a relatively high sensitivity (1-10^3 cells/ml of plant extract) and good specificity, it is used for routine pathogen detection, although it has been hampered in some cases by a lack of robustness. However, PCR protocols have been developed for many important plant pathogens.

RT-PCR is the “gold standard” molecular method used for the detection of plant viruses due to its high sensitivity and specificity. As the majority of them are RNA viruses, an initial step of reverse transcription that converts single strand RNA to cDNA is necessary for PCR-based molecular amplification. When PCR or RT-PCR is applied routinely for detection purposes, the sensitivity usually afforded tends to be similar to ELISA or hybridization techniques.

Nested PCR

Sensitivity and specificity problems associated with conventional PCR and RT-PCR can be reduced by using nested PCR-based methods, based on two consecutive rounds of amplification. Usually, the products of the first amplification are transferred to another tube before the nested PCR is carried out using one or two internal primers (heminested or nested amplification respectively). The potential of nested-PCR in plant pathology has been already reported, and there are many published examples of its application to bacteria, fungi and viruses detection in plants. Sensitivity is increased by two orders of magnitude reaching about 10^2 bacterial cells/ml of extract. Yang *et al.* (2017) developed a nested PCR method to detection of *P. granati* causal agent of twig blight and crown rot of pomegranate. The primers were designed from ITS sequences and successfully amplified a 450 bp product exclusively from the genomic DNA of *P. granati*. This technique was successfully applied to detect the natural infection of *P. granati* in the pomegranate fruit. The designed protocol is rapid and precise with a high degree of sensitivity.

Multiplex PCR

The simultaneous detection of two or more DNA or/and RNA targets can be afforded by duplex or multiplex PCR in a single reaction with several specific primers included in the PCR cocktail. Multiplex PCR is very useful in plant pathology because different bacteria or viruses frequently infect a single crop or host. This methodology has demonstrated to be a valuable tool for detection and identification purposes. There are several examples of simultaneous detection of viruses and also bacteria and fungi at the same time. Nevertheless, there are still very few examples in which more than three plant pathogens are amplified in a single PCR-based assay, probably due to the technical difficulties of a reaction involving so many compatible primers. Cho *et al.* (2016) successfully multiplexed for four pathogens of cacti (*F. oxysporum, B. cactivora, P. nicotinae,* and *P. cactorum*). There are other examples of simultaneous detection of the six major viruses affecting olive trees: CMV, CLRV, SLRSV, *Arabis mosaic virus* (ArMV), *Olive latent virus-1* and *Olive latent virus-2* (Al Rwahnih *et al.* 2011) and the simultaneous detection of nine grapevine viruses (ArMV, grapevine fanleaf virus, grapevine virus A, grapevine virus B, stem pitting-associated virus, grapevine fleck virus, grapevine leaf roll-associated virus-1, -2 and -3).

Real-time PCR

Conventional PCR has demonstrated its sensitivity and specificity under optimized and controlled conditions. However, it does not provide information about the amount of the pathogen in the sample, and users must employ agarose gel electrophoresis, hybridisation or colorimetric detection as the endpoint analysis. On the contrary, real-time PCR allows the monitoring of the reaction while it is in course, thus avoiding the need to manipulate amplicons that implies high risk of contamination. At the same time the method requires fewer reagents and less time, and also allows additional studies to be performed during detection (quantification of original target population, detection of several variants of a pathogen or point mutations in a gene). Among the different variants of PCR, real-time PCR represents a quantum leap and is a tool that has proven indispensable in a wide range of molecular biology protocols. In the detection field, this high throughput technique has improved the systems in use, achieving very accurate speed, specificity and reliability, with many protocols having been developed in recent years. Real time PCR exemplifies an advance that overcomes the principal drawbacks of conventional PCR (risk of cross-contamination, no quantification of the sample) and increases the possibilities of analyses (multiplex, quantitative PCR), due to the use of modified primers, different labels primers in combination with probes, etc. with a high sensitivity (Lievens *et al.*, 2006).

The basis of conventional PCR and the majority of the primers designed for detection can be adapted to the peculiarities of real time PCR, adding another important reason for such transfer. When setting up a real-time PCR protocol for detection, it is necessary to adapt it to the specific conditions of the detection system and instrumentation, and to the characteristics of the concentration of reagents and cycling, which differ to those of conventional PCR. Among them, the most important are primer design, reaction components and conditions. In contrast to standard PCR, which allows amplification products of several hundred bases without compromising the sensitivity and specificity of the diagnosis, real-time PCR works better with small amplicons. Another difference is the $MgCl_2$ concentration, usually higher than in conventional PCR, as well as the primers and dNTPs concentration. Sometimes, it may be necessary to employ an asymmetric primer concentration to obtain the best results, in sharp contrast to standard PCR, which requires equimolar concentration of primers. Because the amplified product is generally quite small, it allows shorter cycling conditions, and thus faster analysis of the samples using 0.2 ml tubes included in plates or capillary tubes. PCR based rapid detection and quantification of *Alternaria solani* in tomato was demonstrated by Sudheer Kumar *et al.* (2013). Similarly, Singh *et al.* (2014) developed real time PCR based detection from microsatellite locus which was highly specific for *A. brassicicola*, as no amplification was observed from twenty-nine other closely related taxa. Primer set, ABS28F/ABS28R, amplified a specific amplicon of 380 bp from all *A. brassicicola* isolates causing leaf spot in mustard. The lowest detection limit of assay was 0.01 ng.

Loop-mediated isothermal amplification (LAMP)

Loop-mediated isothermal amplification (LAMP) (Notomi *et al.*, 2000) is being increasingly used in the diagnostic field offering sensitivity and economic costs. The method requires a set of four specifically designed primers that recognize six distinct sequences of the target and a DNA polymerase with strand displacement activity. LAMP relies on auto-cycling strand displacement DNA synthesis in the presence of Bst DNA polymerase, specific primers and the target DNA template. The amplification products are stem-loop DNA structures with several inverted repeats of the target and cauliflower-like structures with multiple loops, yielding >500 µg/ml. The LAMP reaction was enhanced by the addition of loop primers, reducing time and increasing sensitivity. The amplification takes place at 60-65ºC for 60 min. LAMP products can be directly observed by the naked eye or using a UV transilluminator in the reaction tube by adding 2.0 µl of 10 fold diluted SYBR Green I stain to the reaction tube separately. Under UV illumination, the gel shows a ladder-like structure from the minimum length of target DNA up to the loading well, which are the various length stem-loop products of the LAMP reaction. Although it was initially developed for DNA it can be adapted to amplify RNA (RT-LAMP). This isothermal method has been applied for the rapid detection of *Fusarium graminearum* in contaminated wheat seeds (Abd-Elsalam *et al.,* 2011) and for the detection of *Phytophthora ramorum* and *P. kernoviae* in field samples (Tomlinson *et al.*, 2007, 2010).

Microarray technology

DNA array hybridization or macroarray is a technique based on hybridization of amplified and labelled genome regions of interest to immobilized oligonucleotides spotted on a solid support platform. Since the development of microarray technology for gene expression studies by Schena *et* *al.* (1995), this approach is extending their application to the detection of pathogens due to the multiplex capabilities of the system. A DNA array is a collection of species-specific oligonucleotides or cDNAs (known as probes) immobilized on a solid support that is subjected to hybridisation with a labeled target DNA (Lievens *et al.* 2006). Microarrays uses higher density chips such as glass or silicon, or microscopic beads in where thousands of sample spots (less than 200 μm in diameter) are immobilised via robotisation. Microarrays are generally composed of thousands of specific probes spotted onto a solid surface (usually nylon or glass). Each probe is complementary to a specific DNA sequence (genes, ITS, ribosomal DNA) and hybridization with the labeled complementary sequence provides a signal that can be detected and analyzed.

The DNA macroarrays that developed for detection are based on a single region for the detection of a specific taxonomic group. Among these regions, 16S ribosomal DNA has been used for the detection of bacteria (Xiong *et al.* 2006). Various genome regions, such as ribosomal DNA spacers (ITS), mitochondrial genes (e.g. cytochrome oxydase c subunit 1, cox1) and some protein coding regions (β-tubulin, EF-1a, etc.), are chosen to target fungi and fungus-like organisms (Chen *et al.* 2009, Harper *et al.* 2011). Although there is great potential of microarray technology in the diagnosis of plant diseases, the practical development of this application is still in progress. For example, following the methodology utilized for genetic analysis large numbers of DNA probes used in two-dimensional arrays have allowed thousands of hybridization reactions to be analyzed at the same time. This technology has been applied for detecting oomycete plant pathogens by using specific oligonucleotides designed on the ITS region (Izzo & Mazzola, 2009). Until now, the microarray technology focuses its use in multiplex format of similar or very different pathogens, taking advantage of the number of probes that can be employed in one chip.

Methods based on the analysis of volatile compounds as biomarkers:

Plants emit many volatile organic compounds (VOCs) into their immediate surroundings that can indicate its physiological health status (Federico *et al.* 2015). VOC profiling is an emerging field with potential for immediate applications within the plant sciences; the ability to rapidly, frequently, and noninvasively monitor the health status of high-value commodity crops is highly desirable to growers. Novel analytical methods, instrumentation, and multivariate data analysis (MVA) methods are required to make and interpret these data sets; the development of such hardware and software tools is critical to bring these concepts into the field.

Nanosensors for plant disease diagnosis

Immunological and molecular techniques are advanced but have some issues related to rapidity, signal strength and instrumentation. The integration of immunological and molecular diagnostics with nanotechnology systems offers an option where all detection steps can be accommodated on a portable miniaturized device for rapid and accurate detection of plant pathogens (Kashyap *et al.* 2017). The sensitive nature of functionalized nanoparticles can be used to design phytopathogen detection devices with smart sensing capabilities for field use. Most DNA biosensors techniques are based for determination of DNA hybridization events including electroluminescence, fluorescent and colorimetric approaches in addition to label-free voltammetric etc. (Khater *et al.*, 2017). In spite of advantages of DNA biosensors in terms of sensitivity, selectivity due to great recognition properties, their in-field application is still suffering from sample treatment requisites (eg. DNA extraction). DNA detection on lateral flow (LF) test strips have been developed for the analysis of different plant diseases, in most cases using gold nanoparticle (AuNP)- labeled DNA probes. As example, a competitive DNA hybridization format was presented by Zhao *et al.* (2011) for detection of *Acidovorax avenae* subsp. *citrulli* (AAC) causing bacterial disease of melons. The developed strip allowed reaching a low detection limit of 0.48nM. Similarly, Lau *et al.* (2017) developed a nanoparticle based electrochemical biosensor for rapid and sensitive detection of plant pathogen DNA on disposable screen-printed carbon electrodes. This assay relied on the rapid isothermal amplification of target pathogen DNA sequences by recombinase polymerase amplification (RPA) followed by gold nanoparticle-based electrochemical assessment with differential pulse voltammetry (DPV). This is 10,000 times more sensitive than conventional polymerase chain reaction (PCR)/gel electrophoresis and could readily identify *P. syringae* infected plant samples even before the disease symptoms were visible.

Conclusion

Besides the unique advantages offered by the various disease detection methods for plant disease detection application, each method has its own limitations. It is beyond any doubt that the advancement of molecular biology has offered novel dynamic tools to the diagnosis of plant pathogens. Along these lines, in the near future DNA-based techniques are expected to contribute towards the in-depth elucidation of various aspects of plant pathology i.e. the understanding of the competition of soil-borne pathogens in their complex terrestrial environment, the study of host-pathogens interactions at the molecular level, the discovery of pathogen genes responsible for virulence and the respective pant genes that provide resistance to plants. All these new sequences will be added to the DNA databases and thus offer even more precise targets for designing more sensitive and specific assays with the final goal to quickly and accurately achieve early and correct diagnosis of the pathogen involved in a plant disease, thus planning and implementing control strategies with less chemical inputs, more effective and less costly for the grower and more sound for the environment. The nanotechnology play important role in increasing sensitivity and detection limit of theses assays. Finally, the so far limited use of robotics to DNA technology will become economically feasible and thus accessible to farmers and will offer the possibility of using a single DNA chip as a practical tool for the diagnosis of hundreds of plant pathogens.

References

Abd-Elsalam, K., Ali Bahkali, Mohamed Moslem, Osama E. Amin, and Ludwig Niessen. 2011. An optimized protocol for DNA extraction from wheat seeds and loop-mediated isothermal amplification (lamp) to detect *Fusarium graminearum* contamination of wheat grain. Int J Mol Sci. 12(6): 3459-3472. doi: 10.3390/ijms12063459

Al Rwahnih, M., Guo, Y., Daubert, S., Golino, D. and Rowhani, A. 2011 Characterization of latent viral infection of olive trees in the national clonal germplasm repository in California. Journal of Plant Pathology. 93 (1), 227-231.

Babu K.B., Saxena A.K., Srivastava A.K. and Arora D.K. 2007 Identification and detection of *Macrophomina phaseolina* by using species specific oligonucleotide primer and probe. *Mycologia* 99: 797-803.

Chen W., Seifert K., and Lévesque C.A. 2009. A high density COX1 barcode oligonucleotide array for identification and detection of species of *Penicillium* subgenus *Penicillium*. Molecular Ecology Resources 9: 114-129

Cho, H.J., Seong Won Hong, Hyun-ju Kim, and Youn-Sig Kwak 2016 Development of a Multiplex PCR method to detect fungal pathogens for quarantine on exported cacti. Plant Pathol. J. 32(1): 53-57. doi: 10.5423/PPJ.NT.09.2015.0184

Federico Martinelli, Riccardo Scalenghe, Salvatore Davino, Stefano Panno, Giuseppe Scuderi, *et al.* 2015 Advanced methods of plant disease detection. A review. Agronomy for Sustainable Development, Springer Verlag/EDP Sciences/INRA, 35 (1), pp.1-25. <10.1007/s13593-014-0246-1>. <hal- 01284270>

Harper K.A., Smart C.D., and Michael Davis R. 2011 Development of a DNA-based macroarray for the detection and identification of *Amanita species*. Journal of Forensic Science 56: 1003-1009

Izzo, A.D. and Mazzola, M. 2009 Hybridization of an ITS-based macroarray with ITS community probes for characterization of complex communities of fungi and fungal-like protists. Mycological Research. 113: 802-812

Kashyap, P.L., Sudheer Kumar and Srivastava, A.K. 2017 Nanodiagnostics for plant pathogens. Environ Chem Lett. DOI 10.1007/s10311-016-0580-4

Khater, M., de la Escosura-Muñiz, A. and Merkoçi, A. 2017 Biosensors for plant pathogen detection. Biosensors and Bioelectronics. 93: 72-86, DOI: 10.1016/j.bios.2016.09.091

Lau, H. Y. *et al.* 2017 Specific and sensitive isothermal electrochemical biosensor for plant pathogen DNA detection with colloidal gold nanoparticles as probes. Sci. Rep. 7, 38896; doi: 10.1038/srep38896.

Lievens B. and Thomma B. P. H. J. 2005 Recent developments in pathogen detection arrays: Implications for fungal plant pathogens and use in practice. Phytopathology 95 (12):1374-1380 doi.org/10.1094/PHYTO-95-1374

Lievens B., Brouwer M., Vanachter A., Cammue B., and Thomma B. 2006 Real-time PCR for detection and quantification of fungal and oomycete tomato pathogens in plant and soil samples. *Plant Science* 171 (1): 155-165.

Lievens B., Claes L., Vanachter A.C.R.C., Cammue B.P.A. and Thomma B.P.H.J. 2006 Detecting single nucleotide polymorphisms using DNA arrays for plant pathogen diagnosis. *FEMS Microbiology Letters*, 255 (1): 129-139.

López M.M., Llop.P, Olmos A., Marco-Noales E., Cambra M. and Bertolini E. 2009 Are molecular tools solving the challenges posed by detection of plant pathogenic bacteria and viruses? *Current Issues in Molecular Biology* 11: 13-46.

Martin R.R., James D. and Lévesque C.A. 2000 Impacts of molecular diagnostic technologies on plant disease management. *Annual Review of Phytopathology* 38:207-39

Miller S.A., Beed F.D. and Harmon C.L. 2009 Plant disease diagnostic capabilities and networks. *Annual Review of Phytopathology*, 47: 15-38. DOI: 10.1146/annurev-phyto-080508-081743.

Notomi T., Okayama H., Masubuchi H., Yonekawa T., Watanabe K., Amino N., Hase T. 2000 Loop-mediated isothermal amplification of DNA. Nucleic Acids Res. 15; 28(12):E63.

Owens R.A., and Diener T.O. 1981 Sensitive and rapid diagnosis of potato spindle tuber viroid disease by nucleic acid hybridization. Science. 7; 213(4508):670-2.

Schena M., Shalon D., Davis R.W., and Brown P.O. 1995 Quantitative monitoring of gene expression patterns with a complementary DNA microarray. Science. 20; 270(5235):467-70.

Singh, R., Sudheer Kumar, P.L. Kashyap, A.K. Srivastava, S. Mishra and A.K. Sharma 2014 Identification and characterization of microsatellite from *Alternaria brassicicola* to assess cross-species transferability and utility as a diagnostic marker. *Molecular Biotechnology*. DOI 10.1007/s12033-014-9784-7

Sudheer Kumar, R. Singh, P.L. Kashyap, and A.K. Srivastava, 2013 Rapid detection and quantification of *Alternaria solani* in tomato. *Scientia Horticulturae* 151, 184-189

Tomlinson J.A., Barker I., and Boonham N. 2007 Faster, simpler, more-specific methods for improved molecular detection of *Phytophthora ramorum* in the field. Appl. Environ. Microbiol.73:4040-4047.

Tomlinson, J. A., Dickinson, M. J. and Boonham, N. 2010 Rapid detection of *Phytophthora ramorum* and *P. kernoviae* by two-minute DNA extraction followed by isothermal amplification and amplicon detection by generic lateral flow device. Phytopathology. 100: 143 - 149

Tsui, C. K.M; James Woodhall, Wen Chen, C. André Lévesque, Anna Lau, Cor D. Schoen, Christiane Baschien, Mohammad J. Najafzadeh, and G. Sybren de Hoog 2011 Molecular techniques for pathogen identification and fungus detection in the environment. IMA Fungus. 2(2): 177-189. doi: 10.5598/imafungus. 2011.02.02.09

Xiong L., Kong F., Yang Y., Cheng J., Gilbert G.L. 2006 Use of PCR and reverse line blot hybridization macroarray based on 16S-23S rRNA gene internal transcribed spacer sequences for rapid identification of 34 Mycobacterium species. Journal of Clinical Microbiology 44: 3544-3550

Yang, X. *et al.* 2017 Development of a nested-PCR assay for the rapid detection of *Pilidiella granati* in pomegranate fruit. Sci. Rep. 7, 40954; doi: 10.1038/srep40954.

Yola M. L., Eren T. and Atar N. 2014 A novel and sensitive electrochemical DNA biosensor based on Fe@Au nanoparticles decorated graphene oxide. Electrochim Acta 125, 38-47, doi: 10.1016/j.electacta.2014.01.074.

Zhao, W., Lu, J., Ma, W., Xu, C., Kuang, H., and Zhu, S., 2011. Rapid on-site detection of *Acidovorax avenae* subsp. *citrulli* by gold-labeled DNA strip sensor. Biosens Bioelectron. 26(10), 4241- 4244.

Major Nematode Problems of Hill Region and their Management Strategies

Archana U. Singh and D. Prasad*

*Division of Nematology, ICAR- IARI, *NCIPM, New Delhi*
Email: arch_212@yahoo.com

Introduction

Plant- parasitic nematodes are one of the major limiting factor in crop production throughout India. Large number of plant parasitic nematode is recorded from the rhizosphere of many crops like Root-knot nematode (*Meloidogyne* spp.), Reniform nematode (*Rotylenchulus reniformis*), cyst nematode (*Globodera* spp.), lesion (*Pratylenchus penetrans*) etc. Among all the plant parasitic nematodes, root-knot nematode (*Meloidogyne* spp.) are the major phytonematodes causing damage to crops. They are distributed all over the world in different kinds of habitats and found in nearly every biological niche that supports life. They damage the crops not only by feeding on plants but also by interacting with various other organisms. Sasser and Freckman (1987) have indicated an annual crop loss due to phytonematodes on world wide basis to the tune of $100 billion. A committee in 1971 on the estimation of crop losses constituted in the USA estimated 6 per cent loss in field crops, 12 per cent loss in fruit and nut crops, 11 per cent loss in vegetable crops and 10 per cent loss in ornamental crops which gives an annual monetary loss of 1590.7 million dollars due to nematodes. Losses estimated due to nematode attack to different cultivated crops all over the world by F.A.O is around 400 million dollars. Visible symptoms of nematode attack often include reduced growth, varying degrees of chlorosis, wilting and sometimes death of plants. The yields of okra, tomato and brinjal are reduced by 27.3 percent respectively due to *Meloidogyne incognita* infestation @ 3-4 larvae g/soil under field conditions (Bhatti and Jain, 1977). Thus, nematodes either alone or in combination with other pathogens like fungi, bacteria, viruses, mycoplasma, etc. and the intensity of the disease often gets aggravated hence, constitute an important constraint to world agricultural production.

Nematodes causing damage to Agricultural Crops

Root-knot nematodes (*Meloidogyne* spp.): Due to its polyphagous nature (wide host range), it is rated as one of the most important nematode problem not only in the country but in the world. This nematode mainly attacks vegetable crops. The four most common species viz., *M. incognita*, *M. javanica*, *M. hapla* and *M. arenaria* are by far the most important and leads to the formation of conspicuous root galls or knotted root system, which could be easily recognized by naked eye. *M. incognita* and *M. javanica* are widely spread whereas *M. hapla* is encountered under temperate conditions and attack potato and other vegetables while *M. arenaria* infects chillies and groundnut. (Prasad *et al*., 1977). Therefore, it has widely been considered as a limiting factor for the cultivation of vegetables (Fig. 1 and 2 A, B, C and D).

Fig. 1: *Clean roots of vegetables; and Nematode Infected roots of vegetables*

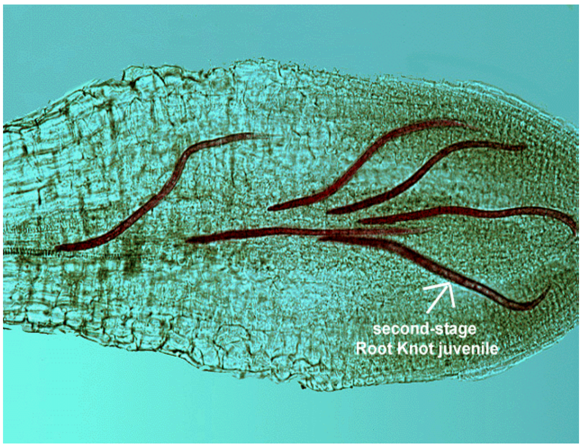


Fig. 2A: *Second-stage juveniles of root-knot nematode, Meloidogyne sp., penetrating root-tip of tomato*

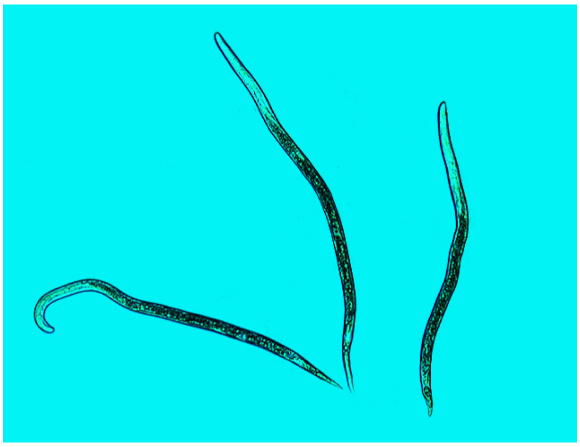


Fig. 2B: *Light micrograph of three second-stage juveniles of Meloidogyne sp.*

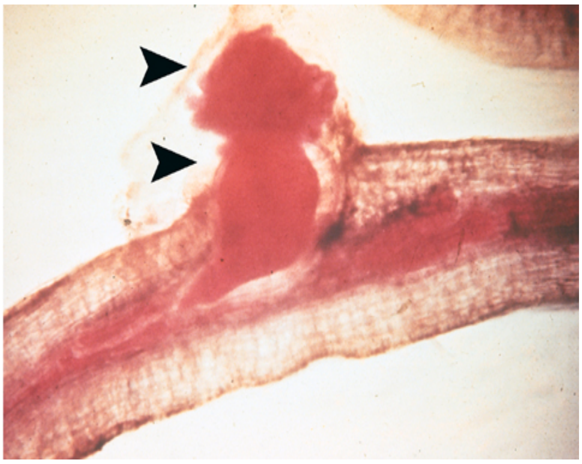


Fig. 2C: *Stained adult female root-knot nematode with egg- mass on bean root*

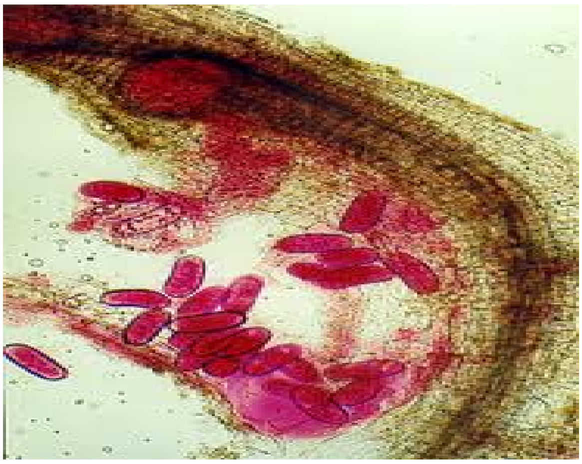


Fig. 2D: *Egg-mass having eggs of root-knot nematode*

Reniform nematode (*Rotylenchulus reniformis*): The reniform nematode is one of the important nematode pest of vegetables in tropical and semitropical areas. This nematode is mainly distributed in all vegetable and pulse growing areas in the state of Tamil Nadu, Maharashtra and Gujarat in India. (Fig. 3) Two races A & B of *R. reniformis* reported from India. Race A was found to infect cotton, castor, and cowpea while Race-B infect only cowpea. It is polyphagous and known to feed and multiply on a wide range of horticultural, vegetable and plantation crops. Some of the crops on which this nematode is recorded are cowpea, okra, beans, eggplant, etc.

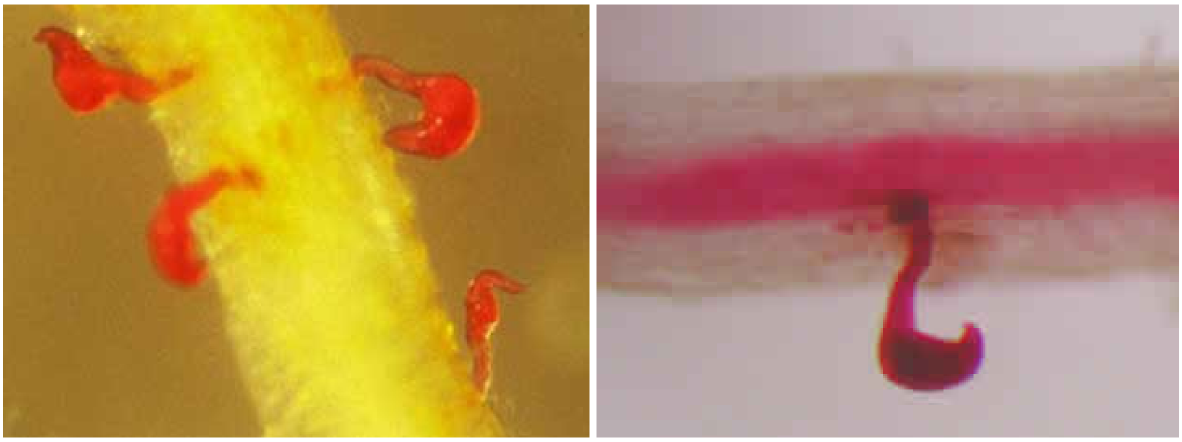


Fig. 3: *Reniform nematode, Rotylenchulus reniformis*

Root-lesion nematodes (*Pratylenchus spp.*): At present there are more than 68 species of this genus in world and 36 are reported from India. At least five species viz., *P.brachyurus*, *P. coffeae*, *P. penetrans*, *P. scribneri* and *P.vulnus* have been reported to infect tomato. Root lesion infected plants show gradual decline or lack of plant vigour with stunting as chlorosis leading to rapid wilting (Fig. 4). On the roots, there is formation of lesions and necrosis, which provides site for other micro-organisms to infect, grow and reproduce, thereby leading to other disease complexes. The nematodes belonging to this genus are endoparasitic root feeders which migrate inter and intra-cellularly and feed in the cortical region leading to cell death and breakdown.

Potato cyst nematode (*Globodera* spp.): *G. pallida* and *G. rostochiensis* are the most important pests of potato. This nematode has been reported from Nilgiris and Kodai Hills of Tamil Nadu and Munar Hills of Kerala (Fig. 5). Out of 9,000 ha under potato, 3,000 ha are infected by this nematode in Nilgiris and in Kodai Hills about 200ha are infected. The life cycle processes are similar to the other cyst-forming species with one life cycle being completed in 5-7 weeks. This is mainly a temperate area problem and thrives well under cool conditions. Under severe infestation conditions, the plants tend to wilt during day time but recover at night.

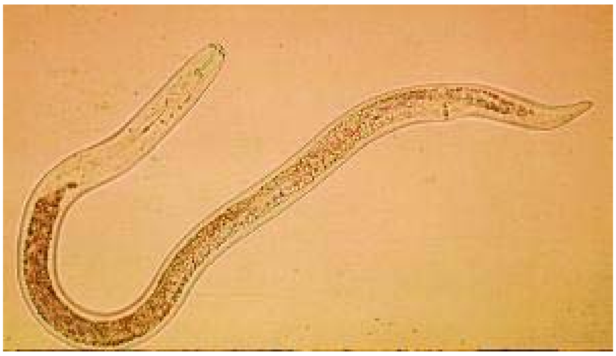


Fig. 4: *Lesion nematode, Pratylenchus spp.*

Fig. 5: *Cyst of Globodera spp.*

Stunt nematodes (*Tylenchorhynchus* spp.): Nematodes of this genus are widely distributed and are root parasites. The most common species feeding on vegetables is *Tylenchorhynchus brassicae* causes poor germination and growth of cabbage and cauliflower. Besides cauliflower and cabbage, tomato, radish, sugarbeet and lettuce are also good hosts (Fig. 7). Members of this group are ecto-parasites and rarely encountered in the cortical cells, one to two cell deep and feed on roots and root hairs. The optimum temperature for growth and reproduction is around 30 C with 25 -30 per cent moisture. Although, it is widely distributed both in temperate and tropical zones yet only a few species are known to be pathogenic to various vegetable crops. In southern USA, *T. claytoni* has been responsible for stunting of pea and *T. marioni* in sweet potato, *T. brassicae* damages cabbage and cauliflower and *T. dubius* parasitizes cauliflower, pea, radish and turnip in Netherlands.

Spiral nematode (*Helicotylenchus* spp.): Okra, brinjal, tomato, chillies are found to be good host for this nematode (Fig. 6).

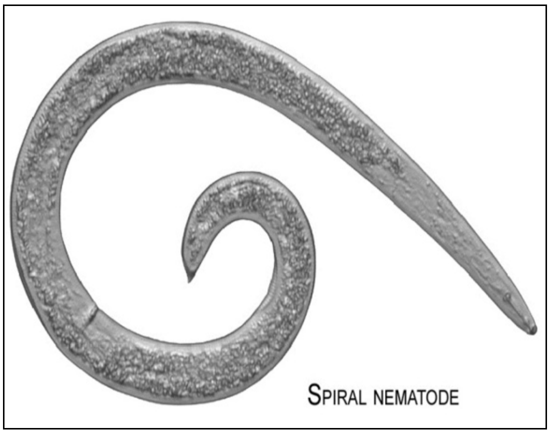


Fig. 6: *Helicotylenchus spp.*

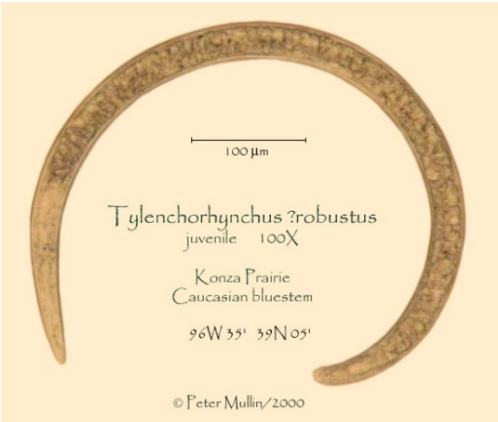


Fig. 7: *Tylenchorhynchus spp.*

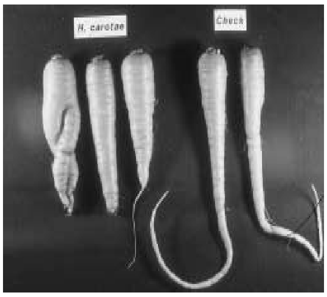
Damage Symptoms of nematodes:

The symptoms caused by the plant parasitic nematodes in vegetables are mainly divided into two types i.e., above ground and below ground symptoms.

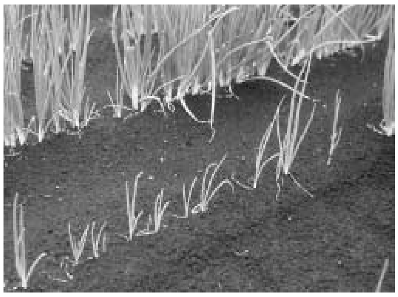
Above ground symptoms: These are non-specific and may be mistaken for the micronutrient deficiencies in the soil. The typical above ground symptoms of nematode infections include stunting, yellowing, wilting, patchyness and reduced yield. The patches of poor growth visible in the fields from a distance. Chlorosis, wilting, delay in flowering and fruit formation, reduction in plant size, yield etc. may be noted in above ground parts of infected plants.

Below ground symptoms:

- Small galls/knots seen on the roots which at a latter stage coalesce to form very large galls (Fig. 8 and 9).
- Bushy appearance of secondary roots.
- Total reduction in root system.
- Other symptoms include Lesions and "Dirty Roots".



Carrot damage by the carrot cyst nematode Heterodera carotae



Northern root-knot nematode damage on onion Meloidogyne hapla

Root-knot nematode damage in Tomato Meloidogyne incognita

Stem and bulb nematode damage on onions Ditylenchus dipsaci

Root-knot nematode damage in Brinjal Meloidogyne incognita

Potato damaged by Cyst Nematode

Nematode management

Nematode management is important for high yields and quality that are required by the high cost of modern crop production. Therefore, the idea of keeping the nematode population below the economic damage level by adopting different available tactics is advised to the growers. The young tender seedlings of various crops are very much vulnerable to attack by nematode while the older plants achieve some degree of tolerance. (Dhaliwal *et al.*, 2004; Meena *et al.*, 2013). The different management practices adopted for controlling nematodes in case of vegetables are as follows:

(I) Cultural methods:

These are the most effective and economical means of managing nematode problems and are as follows:

1) **Fallowing:** Clean fallow during the off-season is probably the single most important and effective cultural control measure available for nematodes. Due to fallowing the food sources are no longer readily available, soil population densities of nematodes gradually decline with death occurring as a result of starvation.

2) **Deep summer ploughing** of nematode infested fields 2-3 times at an interval of 10-15 days during the hot summer month of may and June under tropical and subtropical conditions helps in reducing the population of root knot nematode and reniform nematodes in the soil in case of vegetable crops.

3) **Cover/trap crops:** are useful for reducing nematode population as well as conserving soil and often improving soil texture. In localities where land availability permits, the use of cover crops, especially plants that serve as trap crop offer suppressive effects on nematode populations. Incorporation of such crop in cropping system either as inter-crop or alternative crop should be considered whenever feasible (Singh *et al*., 2010; Rather and Siddiqui, 2007). Cowpea a trap crop causes the root knot nematode eggs to hatch, larvae enter the roots and develop to immobile stage. Then the crop is destroyed before the nematode mature. Mustard, Marigold, Asparagus and Sesame are used as enemy plants for reducing nematode population. Root-knot development on tomato and okra was low when implanted with *Tagetes erecta*. Alpha-terthienyl is the active principle in *Tagetes* which is toxic to these nematodes. Asparagiusic acid is the active principle involved in *Asparagus officinalis* toxic to nematodes. However, when okra was grown in *M. incognita* infested soil it was only slightly attacked and there were fewer nematodes compared with when okra was grown in the absence of sesame.

4) **Time of planting/harvesting:** may be utilized to exploit differential environmental effects on nematode populations versus crop growth and maturity. For example, early planting of crops such as potato has restricted associated nematode damage in some instances because of the prevailing temperatures and the conditions required for optimum growth of most crops. Planting of potato during third or fourth week of March in Shimla Hills would reduce the damage to *M. incognita*.

5) **Selection of Healthy Propogating Material:** The potato cyst nematode, *Globodera rostochiensis* can be eliminated by selecting nematode free planting material.

6) **Crop Rotation:** This is one of the oldest and most effective tactics for managing plant-parasitic nematodes. The goal of rotation is to bring about a striking population decline of the target nematodes that will facilitate the subsequent crop to grow and produce an acceptable yield. Use of non host crop like mustard, garlic, onion and cereals at least for 2-3 years in suitable cropping system helps in controlling nematode population.

7) **Organic amendment**: The use of organic amendment is a well established and age old practice. The three basic principles involved in management of phytonematodes with organic amendments are - habitat management, host modification and direct toxicity of the allelo-chemicals which are released through decomposition of organic materials. (Kaur and Rishi, 2012) Farmers use plant and animal wastes in the form of compost and farmyard manure, crop residues, oilcakes, municipal refuse and industrial wastes have been used as they provide better media for plants to grow, result in better soil texture, increase water holding capacity, supply the nutrients to deficient soil and stimulate microbial population of actinomycetes, bacteria, fungi which might be antagonistic to nematodes. (Mojumder and Mittal, 2003; Singh *et al.*, 2012). The organic amendments have not only been found effective in normal cultivated crops but are well suited in nurseries of vegetables.

(II) Physical Control: The different physical methods of control are as follows--

1) **Solarization:** Soil solarization is a simple, safe, and effective method of nematode control. It allows the grower to bypass lengthy crop rotations and gives the added benefit of controlling other soil pests such as insects and weeds. Radiant heat from the sun is the lethal agent involved

in soil solarization. A clear polyethylene mulch or trap is used to trap solar heat in the soil. Over a period of several weeks to a few months, soil temperatures become high enough to kill nematodes, as well as many other soil pests and weeds. None of the pests will be completely eradicated, but their numbers will be greatly reduced, allowing successful production of crop. The longer the soil is heated, the better and deeper the control of nematodes and other soil pests. Soil solarization of the nursery bed area using thin transparent polythene sheet for 2-4 week in summer and application of carbofuran and phorate @ 0.1 g a.i/m^2 before sowing could provide nematode free healthy seedlings of transplanted crop like tomato and brinjal under Indian conditions.

(III) Chemical Control: The performance of nematicides starting from fumigants to non-fumigants have been evaluated for the control of nematodes infesting vegetable crops. However, due to their limitations their application at the field scale has not been taken off. Since their application cannot be totally dispensed with, measures like nursery bed treatment, bare root dip, seed dressing and seed soaking are being evaluated for maximum economic returns with minimum environment and health hazards. (Singh and Singh, 2010; Thomason, 1987) Seed dressing and seed soaking with chemicals is now viewed to be an alternative in protecting the plants from nematode damage at their initial stages of growth period. Nursery bed treatment with metham sodium @ 25ml/$m^{2,}$ carbofuran @ 0.3 g a.i/m^2 is reported to give seedlings better stand and improved growth vigour and nematode free root system. However, reduced gall index and enhanced yield in tomato, brinjal and chilli crops have been recorded. Bare root dip treatment of EC formulation of systemic pesticides at the transplanting stage for 6-8 hours during suuny day has been reported to suppress nematode populations. Triazophos @ 0.1% has proved effective in giving protection to okra plants against *M. javanica*. Bare-root dip treatment of brinjal seedlings with carbofuran @ 500 to 1000ppm was effective in reducing reniform nematode population. Thus, nematicides are one of the most important means of controlling a wide variety of nematodes even though causes environmental problems, health hazards and destruction of beneficial organisms (parasites and predators).

(IV) Biological Control: Biological control or biocontrol is broadly defined as the "use of natural or modified organisms, genes or gene products" to reduce the effects of pests and diseases. (Singh and Prasad, 2010; Prasad and Mittal, 2004). The different approaches of biological control can be categorized simply into three strategies 1) Regulation of the pest population 2) exclusionary systems of protection and 3) systems of self-defense. This method of control is more inconsistent, less effective and slower acting than control normally achieved with chemicals. (Mahapatra and Sahani, 2007; Simon and Bhandari, 2010) Several bioagents like *Pseudomonas fluorescens*, *Paecilomyces lilacinus* and *Trichoderma harzianum* each @ 10 g/kg seed and their soil application @ 50 g/m2 were found effective in reducing population of nematodes. But, *Paecilomyces lilacinus* as nursery treatment and its soil application at transplanting alone and in combination with toxic fungus like *Trichoderma viride* or *Aspergillus terreus/A. niger* was found effective in controlling root knot nematode population in case of vegetable crops. (Mittal and Goswami, 2004; Mukherjee and Mittal, 2007)

(V) Host Plant Resistance: Plant resistance plays an important role in nematode management programme however, availability of resistant varieties of crops are very few in number and many of them are not acceptable to the farmers. (Devi, *et al*., 2007) It will provide an increasingly important contribution to the solution of many nematode problems. With the enhanced availability of germplasm that has nematode resistance genes and rapidly advancing molecular-transfer techniques, resistant cultivars should become a primary management tactic in nematode management programme. (Mittal *et al.*, 2000)

(VI) Integrated Nematode Management:

INM programs developed so far have already contributed to decline in chemical inputs on many agricultural crops. In the current agricultural scenario, INM have been emphasized due to social, economical and environmental status in the agricultural society (Thomason, 1987). Integrated management for nematodes requires: 1) determining whether pathogenic nematodes are present within the field 2) determining whether nematode population densities are high enough to cause economic loss and 3) selecting a profitable management option. Attempts to manage nematodes may be unprofitable unless all of the above Integrated management procedures are considered and carefully followed. (Singh and Singh, 2010) Similarly, some management methods pose risk to people and the environment. Individual methods of nematode control have either proved ineffective or uneconomical against plant-parasitic nematodes. Therefore, integration of various suitable tactics may be an eco-friendly, economically viable and practically feasible approach for managing nematode problems in vegetable crops. (Fazal *et al*., 2011) The adoption of deep summer ploughing during summer period at fortnightly interval along with organic matter application followed by planting with nematode free seedlings is a feasible approach to reduce nematode population in vegetables (Mallick and Mahapatra, 2012). Integration of *P. lilacinus* and carbofuran at 1 kg a.i/ha has proved to be effective in the management of reniform nematode, *R. reniformis* on brinjal. Similarly, farmers with their available resources could follow integration of cultural, biological, chemical methods and resistant varieties in suitable combination for each crop cultivation system. Hence, suitability of different practices in case of agricultural crops should be adopted based on feasibility, utility and compatibility in the IPM programme and thus successfully managing nematode population. However, effective awareness programmes have to be launched among the farming community for imparting a clear understanding of nematode damage.

Conclusion

1. Intensive and extensive surveys on the presence of parasitic nematodes infesting agricultural crops should be conducted.
2. Use of cultural practices should be emphasized depending on area/locality.
3. Emphasis should be given on the integration of nematode management practices by adoption of cultural practices, resistant varieties, nematicides, organic amendments, biological control agents, etc.
4. Role of secondary organisms in causing diseases along with nematodes should be studied and nematode management practices be evolved.
5. Need to develop varieties, which are resistant or tolerant to nematodes. Varietal screening and subsequent breeding programmes should be intensified.
6. Attempts should also be directed towards biological control. *Paecilomyces lilacinus, Trichoderma harzianum*, *Verticillium chlamydosporium* and VAM fungi have been identified all over the world as potential biocontrol agents against plant parasitic nematodes. The possibility of using these bacteria and fungi as biocontrol agents against nematodes infecting vegetable crops should be explored.

References

Bhatti, D.S. and R.K. Jain (1977) Estimation of loss in okra, tomato and brinjal yield due to *Meloidogyne incognita*. *Indian. J. Nematol.* **7**(1): 37-47.

Devi, G; Yadav, R. K and Thankur, N. S. A (2007) Screening of tomato varieties/lines for resistance against root-knot nematode (*Meloidogyne incognita*). *Indian J Nematol*. 37 (1) 81-82

Dhaliwal, G.S., Arora, R. and Dhawan, A.K (2004). Crop losses due to insect pests in Indian agriculture: An update. *Indian J.Ecol.***31:** 1-7.

Fazal, M; Bhat, Y. M and Ashaq, M (2011) Combined application of *Paecilomyces lilacinus* and carbosulfan for management of *Meloidogyne incognita* and *Rotylenchulus reniformis*. *Annals of Pl. Protec. Sci.* 19(1) 168-173.

Ganal, M. W., Simon, S., Bronmon Schenkel, M. Arndt, M. S. Philips, S. D Tanksley and A Kumar (1995) Genetic mapping of a wide spectrum nematode resistance gene (Hero) against *Globodera rostochiensis* in tomato. *Mol. Plant Microbe Inter*., **8**: 886-891.

Kaur, H and Rishi, P (2012) In vivo evaluation of nematicidal action of neem leaf and seed extracts on *Meloidogyne incognita* in tomato and soil pH. *Indian J Nematol.* 42 (2) 150-155.

Mallick, J. K and Mahapatra, S. N (2012) Comparative efficacy of oilcakes on the management of *Meloidogyne incognita* infecting brinjal. *Indian J Nematol.* 42 (2) 194-195.

Mahapatra, S. N and Sahani, N. R (2007) Toxicity of some fungal culture filtrates on the development of *Meloidogyne incognita* in brinjal roots. *Indian J Nematol*. 37 (1) 99-100.

Meena, M; Bhargava, S; Sharma, M. K and Gurjar, H. R (2013) Effect of different plant extracts as root dip treatment against root-knot nematode, *Meloidogyne incognita* infecting tomato. *Indian J Nematol*. 43(1) 106-108.

Mittal, A; Kumar, V and Ahmad, I (2000) Status and prospects of Nematode resistance in crop plants - a review. *Agricultural Reviews.* **21** (1) 16-25.

Mittal, A and Goswami, B. K. (2004) Hatching inhibition of black egg-masses of *Meloidogyne incognita* caused by Hyphomycetous fungi. *J. Mycol. Pl. Pathol*. **34** (2): 283.

Mojumder, V and Mittal, A (2003) Effect of neem products as seed coating against *Heterodera cajani* in cowpea. *Legume Res*., **26** (3): 231-232.

Mukherjee, I and Mittal, A (2007) "Dissipation of beta-cyfluthrin by two fungi *Aspergillus nidulans var. dentatus* and *Sepedonium maheswarium. Toxicological & Environmental Chemistry*, **89** (2) 319-326.

Prasad, D and Mittal, A (2004) Fungal Biocontrol of Plant Parasitic Nemtodes. In: Book entitled "*Advances in Plant Protection Science*" eds D. Prasad and Amerika Singh, 219-230.

Prasad, D., Dubey, K. N and Mittal, A (1997) An integrated approach for management of plant-parasitic nematodes in groundnut. (*Arachis hypogea L.*) *Ann. Pl. Protec. Sci*. 5 (2): 217-219.

Rather, A. M and Siddiqui, M. A (2007) Neem for the control of root-knot nematode infecting tomato. *Indian J Nematol*. 37 (1) 81-82.

Sasser, J.N. & Freckman, D.W. (1987). A world perspective on nematology: the role of the society. *In* J.A.Veech & D.W. Dickson, eds. *Vistas on nematology,* Hyattsville, Maryland, USA, Society of Nematologists, 7-14.

Simon, S. L and Bhandari, G (2010) Antagonistic efficacy of *Paecilomyces lilacinus* and *Verticillium chlamydosporium* against *Meloidogyne incognita* infecting okra. *Indian J Nematol*. 37 (1) 113.

Singh, U. A and Singh, V (2010) Effect of bare-root dip treatment of Ozoneem Trishul, Agroneem, Carbofuran, *Aspergillus terreus*, neem cake (soil application) against *Meloidogyne incognita* on brinjal crop cv. *Pusa uttam* in 8th National Symposium on Problems and Perspectives in Eco-friendly Innovatives to Plant Protection, Society of Plant Protection Sciences, IARI, New Delhi and C. S. Azad University of Agriculture and Technology, Kanpur during 24-25th Jan, 2010, 136.

Singh, U. A and Prasad, D (2010) Nematode management by the use of botanicals and fungal bioagents in the 8th National Symposium on Problems and Perspectives in Eco-friendly Innovatives to Plant Protection, Society of Plant Protection Sciences, IARI, New Delhi and C. S. Azad University of Agriculture and Technology, Kanpur during 24-25th Jan, 2010, 146.

Singh, U. A; V. Singh and Prasad, D (2010) Botanicals for the management of Phytonematodes In "*Pests and Pathogens: Management Strategies*" by D. Reddy Vudem, N. R. Poduri and V. R. Khareedu, 251-274.

Singh, T; Patel, B. A and Thumar, R. K (2012) Management of root-knot nematode, *Meloidogyne incognita* in bottle gourd using botanicals in pots. *Indian J Nematol.* 42 (2) 150-155.

Thomason, I.J. (1987). Challenges facing nematology: environmental risks with nematicides and the need for new approaches. *In Vistas on nematology*, eds. J.A. Veech & D.W. Dickson, Society of Nematologists, USA, 469-476.

Organic Farming and Plant Disease Management

Y.S. Paul
Ex Dean, College of Agriculture, CSKHP Krishi Vishvavidyalaya, Palampur-176061 (HP)

Organic agricultural system involves biodiversity at soil, crop, field level and integration of crop and livestock production systems on the farm. Organic agriculture not only refers to the avoidance of chemical inputs and the application of agro-ecological principles, but also implies the acknowledgement and appreciation of 'integrity of life'. The high biodiversity provides many ecological benefits that increase farm resilience to a greater extent. Agronomic practices with genetic diversity at crop level provide insurance against biotic and abiotic stresses on crop yield and quality. Presently, more than 95% of organic production is based on crop varieties that were bred for the high-input conventional farming.

Conventional farming has played an important role in enhancing food productivity but since it has largely been dependent on intensive inputs of chemicals *viz.* synthetic fertilizers and pesticides, which have raised many environmental and public health issues including reduction in biodiversity, environmental contamination and soil erosion. This concern has led to an increasing interest in alternative farming practices with lower use of synthetic chemicals and greater dependence on natural biological processes. Organic farming avoids application of fertilizers and pesticides and depends on organic inputs and recycling for nutrient supply, emphasizing cropping system design and biological processes for pest management. It enhances soil biodiversity, alleviates environmental concerns and improves food safety through eliminating the applications of synthetic chemicals, thus most negative effects attributed to conventional farming are reduced. Well-established organic systems have shown low incidence and severity of plant diseases caused by soil borne pathogens compared to conventional systems. Organic farming is gaining worldwide acceptance. Organic agriculture is becoming widespread due to increased consumer demand and regulatory and political support.

Many techniques used in organic farming like inter-cropping, mulching, botanicals, and integration of crops and livestock have been used in the traditional agriculture. However, involvement of modern developments in agricultural sciences like selection of areas, crops/varieties, composting methods, biofertilizers, bioagents, parasites, predators, traps etc. have provided strong scientific base for organic farming which capacitates to get higher and quality yields in various crops and also helps in maintenance and improvement of soil, water and environmental properties. Organic farming involves management of the agro-eco system as autonomous, based on the capacity of the soil in the given local climatic conditions. Various techniques used in organic farming include Homa farming (Agnihotra, Tryambkam), Biodynamic farming (biodynamic calendar, biodynamic composts, horn manures), Vedic krishi (use of cow urine, cowdung, buttermilk etc, panchgavya, botanical extracts in cow urine etc, FYM, Nadep compost, Indore compost, biofertilizers and biopesticides (*Azotobacter*, *Azospirillum*, *Rhizobium*, P-solubilising bacteria, Mycorrhizae, botanicals, *Trichoderma*, *Pseudomonas*, NPV, *Beauveria* etc. and Agronomic practices (crop rotation, Intercropping, green manuring, mulching).

Principles of Plant Disease Management in Organic Farming-

Plant Disease Management in Organic Farming is based on several principles such as-

- Avoidance, exclusion, eradication, resistance etc (no chemicals)
- Clean cultivation-suffer less damage from diseases.
- Selection of varieties: organic input responsive with a natural resistance. Local varieties are better at resisting local pest and diseases than introduced varieties.
- Timely planting of crops to avoid the period when a pest does most damage.
- Companion planting with other crops so that avoid pests such as onion or garlic.
- Trapping or picking vectors from the crop
- Using crop rotations to help break pest cycles and prevent a carry over of pests to the next season
- Biopesticides

Managing the ecosystem on an organic farm is very challenging particularly for the management of insect pests and diseases. Since the use of synthetic pesticides is not allowed in the organic cropping system, disease management should be focused on the *prevention* of disease outbreaks rather than coping with them after they occur. No single method is likely to be adequate for all the diseases. Successful pest management depends on the incorporation of a number of control strategies. Some strategies will target insect and disease pests separately and others will target them together.

Timely irrigation, maintenance of proper spacing, pruning, mulching, sanitation etc are some of the cultural practices, which help in reducing the initial inoculums as well as disease development. A brief discussion on various issues pertaining to disease management under organic system is given below:

Resistance

Selection and plantation of disease resistant cultivars is one of the most important components of organic disease management. However, these may not be available for many crops. In some cases, the varieties resistant to one disease may be susceptible to other disease or new strains of the pathogen may lead to the breakdown of resistance. Thus under organic system the available resistant cultivars should be thoroughly investigated to determine their performance under particular organic system. Factors such as leaf and stem toughness, pubescence, nutrient content, plant architecture, growth habit and differences in maturity between crops and varieties can influence pest growth, reproduction and host preference.

Site selection

Site selection and crop rotation strategies are very important to avoid diseases for particularly soil borne diseases. Pathogens like *Fusarium, Sclerotium, Verticillium* are soil inhabitants and persist in soil for many years. Soil borne pathogens like *Pythium, Phytophthora, Rhizoctonia* and *Ralstonia* are more widespread, so for these, site selection may be less important. Planting situations like near grasslands, foothills, riverbanks that support weeds and natural vegetation should be avoided as these act as reservoirs of pathogens that cause virus or phytoplasmal diseases.

Exclusion

Exclusion is the practice of keeping away the infected or contaminated plants and planting materials from the production system. Use of disease free or treated planting material, clean and new pots, soil mix, avoiding introduction of infested soil, water and equipments/implements, use of disease free and new staking material are some of the methods that help in exclusion of the pathogens. The use of high-quality seed is especially important in preventing seed borne diseases. Relatively few diseases are exclusively seed-borne, and it is more common for pathogens to be transmitted from soil, stubble, or wind, as well as with the seed. Planting physically sound seed is also important.

Cultural practices

To prevent the organic farms from the attack of diseases it is essential to consider various cultural practices which if followed properly lead to reduced inoculums and disease development rates. A brief account of such practices is given below-

a. **Crop rotation:** Rotation using diverse crops, inclusion of cover crops and appropriate host free periods contribute toward reduction of inoculums levels of soil borne pathogens and increased diversity of soil micro flora. Too little crop rotation can also stimulate a monoculture effect that might increase foliar diseases. Rotations should be used with other cultural practices to achieve the greatest benefit. Crop rotation is an extremely effective way to minimize most pest problems while maintaining and enhancing soil structure and fertility. Diversity in crop rotation program aimed at plant disease management is the key to its success. Rotations are effective in controlling soil- and stubble-borne diseases. The success of rotations in preventing disease depends on many factors, including the ability of a pathogen to survive without its host and the pathogen’s host range. Those with a wide range of hosts will be controlled less successfully. Rotations will not have much effect on pathogens that live indefinitely in the soil, but will shorten the life span of pathogens that can survive only brief periods apart from their hosts. Other situations that limit the benefit of crop rotations include the transmission of pathogens via seed, the presence of susceptible weeds and volunteer crops that harbour pathogens, and the invasion of pathogens by wind and other means.

b. Intercropping: The practice of intercropping (where two crops are grown at the same time) can reduce disease problems by making it more difficult for the pathogens to find a host crop. This technique also provides habitat for beneficial organisms. Strip-cropping row crops with perennial legumes often leads to better disease control.

c. Date of sowing: Planting should be scheduled so that the most susceptible time of plant growth does not correspond to the peak in disease cycles. Early seeding reduces crop damage caused by barley yellow dwarf virus in barley and wheat, powdery mildew in peas and pasmo in flax.

d. Seed Rate: Using a higher seeding rate affects disease infestations by creating favourable microclimate. A dense leaf canopy can also create a moist soil surface and elevated humidity within the crop, conditions favourable to certain leaf disease pathogens. Reducing the seeding rate may decrease the severity of take-all in spring wheat, but the reduced canopy may also allow weeds to invade.

e. Planting depth: Planting depths should be tailored in a way that enhances germination. Optimum seeding depth is also important. Deep seeding in cold soils may result in seedling blights and damping-off, especially in pulses and small-seeded crops. Seeding depth should generally be no deeper than required for quick germination and even emergence. Variables include seed size, soil type and moisture conditions. If the soil is loose before seeding, a packing operation will firm up the soil and bring moisture closer to the surface. For most crops, seeding should ideally be done when the soil is warm enough for rapid germination. Seeds that remain ungerminated in cool soil are more susceptible to damage.

f. Soil solarization using plastic tarps especially in areas with acceptably high summer temperatures reduces the population of soil borne pathogens in addition to weeds and insect pests.

g. Sanitation: Reducing or removing crop residues and alternate host sites can be used to control many diseases. Incorporating the residue into the soil hastens the destruction of disease pathogens by beneficial fungi and bacteria. Burying diseased plant material in this manner also reduces the movement of spores by wind. Incorporation of the plant residues of some crops like crucifers has been shown to have suppressive effect against some pathogens like *Verticillium.*

h. Roguing: Roguing refers to the labour-intensive practice of walking the fields to remove diseased plants. Roguing may not be practical for large fields, but could be suitable for seed plots or crops having highly infectious and destructive diseases e.g. bacterial blackleg in potatoes and certain viruses in other crops.

Composts

Application of composts not only benefits soil fertility and soil conditions but also undoubtedly helps in disease management in some way. The microbial population and diversity increases in soil that results in competition, parasitism, as well as antagonism with the plant pathogens and ultimately reduces the disease pressure.

Forecasting

Forecasts for various diseases well in advance are helpful in taking preventive measures before the onset of the disease. The forecasts are usually available for some of the destructive diseases. Disease monitoring is imperative that the producer has a positive identification of the disease causing damage before choosing a method of treatment.

Organic inputs

Many organic inputs have been used by organic practitioners based on ITKs for the management of various diseases as given below. Many of them have been tested by the department of Organic Agriculture at CSK HPKV, Palampur against a number of diseases of cereals and vegetable crops and found effective. Beejamrit---Cowdung+ lime (Extracts); Jeevamrit- Cowdung+ cowurine+ Grampowder+ jaggery; Panchgavya-CU+ CD+ Milk+ curd+ ghee; Amritpani- CD+ ghee+ honey; Horn manures (BD500, D507); Matkakhad-CD+ CU+ Jaggery+ water; Vermiwash; Biosol etc.

Bioagents and botanicals

In a healthy, balanced ecosystem, biological control by natural predators is constantly occurring. The more diverse a cropping system becomes, the greater the spectrum of pathogens and micro-organisms within it. This leads to the development of more natural parasites and competitors within the ecosystem. Many microorganisms have been isolated, identified and after mass multiplication being used for the management of various disease. Species of *Trichoderma, Bacillus* and *Pseudomonas* have been widely exploited and used. Similarly, many botanicals or plant based inputs are available in the market or can be prepared on farm which are effective against many diseases e.g. neem oil, neem products, asfoetida, eupatorium extracts etc.

Diseases of Pulses Crops: Present Scenario and Future Perspectives

S.K. Singh, Shahid Ahamad[1], Akash Sharma and Satish K. Sharma[2]

[1]Directorate of Research, [2]Research Farm, Chakroi,
Organic Farming Research Centre, Chatha, Sher-e-Kashmir University of Agriculture Science& Technology-Jammu

Introduction

In India as well as J&K with the shifting of pulse cultivation from recent irrigated areas, its production and productivity is decreasing day by day. Annonyms (2010-11), pulses are cultivated in 28.91(, 000) ha and which are continuously decreasing from 1955-56 (44,0000ha and from the max. area in the year 1968-69 (55,000 ha). The major pulse crops in Jammu region are gram, black gram, green gram, lentil and pea. Several major diseases of pulses are given below-

1. Wilt of chickpea

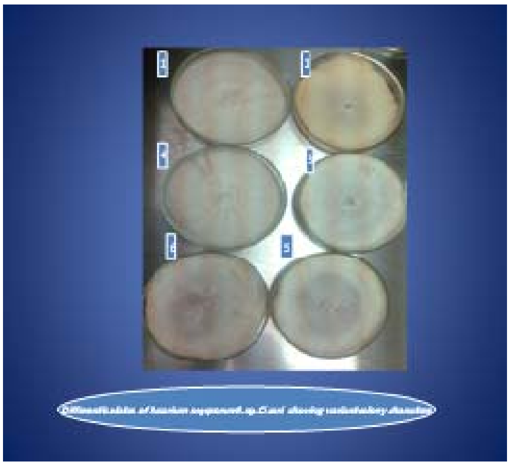
***Fusarium* wilt:** [*Fusarium oxysporum* Schlecht. emend Snyd. & Hans. f. sp. *ciceri* (Padwick) Snyd. & Hans.]

In India, it has been reported from all the states where the crop is grown and causes an annual loss of 10% (Singh and Dahiya, 1973). This diseases appears 3-5 weeks after sowing when foliage of diseased plants develops a grayish-green chlorosis. Affected seedlings do not rot on the stem or root surface. However, when split open vertically from the collar downwards or cut transversely, dark brown to black discoloration of the internal stem tissues is clearly visible. At Adult stage, the affected plants show typical wilting, i.e, drooping of the petioles, rachis and leaflets. Early wilting causes 77-94% loss and late wilting causes 24-65% loss (Haware and Nene, 1980).Wilt incidence is generally higher in warmer and drier climates (> 25°C) and when crop rotations are not practiced.

Management:

1. Grow resistant varieties such as SCS-3,GNG-469,GNG-1581,PBG-1 and C-235
2. Eradication of crop debris, stubbles and also turning of soil with mould board plough
3. Soil solarisation during summer month with transparent polythene sheet for solar heating of soil which ultimate kill soil borne pathogens or deep summer ploughing
4. Follow crop rotation with Jowar or Bajra
5. Seed treatment with Bio-control agents *Trichoderma harzianum* @4g/kg + Vitavax @ 1g/kg seed

Field view of Wilt Sick Plot at P.R.S.S., Samba



2. Lentil

i) Wilt (*Fusarium oxysporum* f.sp.*lentis*)

Chlorosis of leaves and discoloration of vascular tissues of the roots is the typical characteristics of this disease; ultimately plants wither and dry up.

Management:

i) Use of resistant varieties eg.PL-4,PL-5,L-4147 and DPL-15

ii) Eradication of crop debris, stubbles and also turning of soil with mould board plough

iii) Soil solarisation during summer month with transparent polythene sheet for solar heating of soil which ultimate kill soil borne pathogens or deep summer ploughing

iv) Follow crop rotation with Jowar or Bajra

v) Seed treatment with Bio-control agents *Trichoderma harzianum* @4g/kg + Carbendazim @ 2g/kg seed

3. PEAS

i) Powdery mildew(*Erysiphe pisi*)

This disease is characterized by white floury patches on both surfaces of leaves. At advanced stage all aerial parts covered with these white floury patches. A physiological change occurs in plant with increased respiration and decrease in photosynthetic rate ultimately damages the host.

Management:

i) Grow resistant varieties eg. Rachna

ii) Crop should be planted in well drained soil.

iii) Crop rotation with non-host crops

iv) By formulations of wettable Sulphur such as Sulfex and Thiovit @3kg/ha or Karathane (Dinocap-0.05%)

ii) Rust (*Uromyces fabae*)

Spore stages such as aecia are formed in round or elongated clusters with slight yellowing ultimately turns brown and another uredial pustules develop on both surfaces of the leaves &other plant parts appears as powdery light brown. Telial stage occurs on the same sorus with dark brown or almost black in colour.

Pea entries showing rust susceptible reaction under MULLaRP Coordinated trial

Management:

i) Field sanitation to destroy crop debris

ii) Spray the crop with Propiconazole @0.1%

4. Urdbean and Mungbean-

Younger leaves may become completely chlorotic, curl downwards or become papery white. Older leaves show scattered yellow specks that later develop into irregularly shaped green and yellow patches. The green areas are slightly raised, giving the leaf a puckered appearance. The lesions enlarge and coalesce, and start to become necrotic. The growth of affected plants is stunted. They produce fewer flowers and pods. Their pods are small, thin and mottled, and they sometimes curl upwards. They also contain fewer and smaller seeds.

Management:

i) Grow resistant varieties

ii) Crop should be planted in well drained soil.

iii) Crop rotation with non-host crops

Crop Specific Strategy/Recommendations (var. / Plant Protection)

1. **Chickpea:** Improved varieties, Integrated Diseases Management (IDM), deep summer ploughing, crop rotation with non legumes, deep or late sowing, wider spacing and inter-cropping with any one among wheat, barley or mustard for effective control of wilt, root rot, *Ascochyta* blight and other soil borne diseases, seed treatment with Benlate, Benomyl, Carbendazim or Thiram @ 2-3 g/kg is recommended with the T. *viridae* or *Bacillus subtilis* or *Gliocladium virens* @ 4 g/kg of seed supplemented with management practices for wilt and root rot are the best options.

2. **Black gram (Urd):** To enhance the kharif productivity selection of appropriate varieties such as Pant U-19 and Uttara resistant to YMV are best option. Use of bio-fertilizer. **-** In case of summer urd, crop has to be grown under better management conditions, mostly inter-cropped with sugarcane and sunflower.

3. **Green gram (Moong):** The increase in productivity during kharif season is to be achieved by use of improved seed of varieties ML-818, PDM-54 and seed treatment of pests through IPM.

4. **Lentil:** Bold seeded varieties namely, DPL 15 and Pant L 5. Provide seeds of improved varieties resistant to wilt and rust, seed treatment with fungicide and *Rhizobium* culture.

5. **Peas:** Field peas normally receive better management and thus farmers pay adequate attention to this crop. However, the targeted productivity would be achieved by providing seeds of better varieties such as Rachna resistant to powdery mildew, seed treatment, application of gypsum, managing rust disease and providing irrigation, etc. **-**Early sowing (during 1st week of Oct.) to escape onset of powdery mildew and rust diseases in NWPZ. **-**Fungal seed treatment to reduce incidence of seed rot and root-rot, 2-3 foliar spray of wettable sulphur (0.3%) for control of powdery mildew and rust.

The following initiatives are being under taken by Govt. of India, to attain required production of pulses-

i) Focus is on key areas like seeds of improved varieties, irrigation tailored to pulses (especially micro irrigation), bringing new niche areas under pulse cultivation, attractive minimum support price (MSP) and markets that allow farmers to increase their profitability aligned to improved farmer welfare.

ii) For ensuring the availability of quality seeds of pulses, 100 seed hubs are being established in 22 states during 2016-17 through ICAR institutes, State Agriculture Universities and KVKs. An amount of Rs. 1.50 crore is approved for each seed hub and 1000 quintals of quality seed is to be produced at each seed hub.

iii) Government of India is committed to accord high priority to water conservation and its management. To this effect Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has been formulated with the vision of extending the coverage of irrigation 'Har Khet ko pani' and improving water use efficiency 'More crop per drop' in a focused manner with end to end solution on source creation, distribution, management, field application and extension activities. PMKSY is being extended to pulse growing districts so that protective irrigations are made to pulses through micro irrigation.

Eco-friendly Management of Chickpea Diseases with Special Reference to Ascochyta Blight of Chickpea for Enhancing the Area and Production of Chickpea in North India

Ashwani Kumar Basandrai, Daisy Basandrai and Mamta Sharma
CSK HPKV, Himachal Pradesh Krishi Vishavidyalaya, Palampur, Kangra (HP)-176062
**International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru-502324 (Telengana)*
[@]Presenting author: bunchy@rediffmail.com

Chickpea, is a major and cheap source of protein accounting for about 45% of total pulses produced in the country. It is best suited to the areas with low to moderate rainfall (60-90 cm per annum) and a mild cold weather. The north Indian states viz. Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Jammu and Kashmir etc. were the traditional areas for its cultivation till early 1980s. However, during the green revolution era with an increase in irrigation facilities, rice - wheat cropping system became predominant and chickpea area was replaced with wheat. It was due to the development and popularization of more remunerative dwarf, high yielding and fertilizer responsive i.e. varieties, epidemics of dreaded diseases like Ascochyta blight and insect pests pod borer further worsened the situation resulting in drastic reduction in the area under chickpea from 4.2 million ha (1970-71) to about 0.7 million ha (2014-15).

Pulses in general and chickpea in particular are less water and fertilizer consuming. Chickpea help to fix atmospheric nitrogen resulting in enhancing and maintaining the soil fertility and reduced fertilizer use. Hence, during the rabi season chickpea has the potential to mitigate the ill effects of rice-wheat cropping system and to sustain the deteriorating agro-ecosystem of the north India.

India is the largest producer and consumer of chickpea with about 8.35 million tons production (67% of the global production). The national productivity of chickpea (859 kg/ha) is very less compared to the potential yield of commercially cultivated varieties and with the countries like USA, Canada, etc. Among various factors for the low yield, diseases viz. wilt (*Fusarium oxysporum* f. sp. *ciceri*), root rot (*Rhizoctonia bataticola*) and Ascochyta blight (*Ascochyta rabiei).* Botrytis grey mould(BGM) [*B.cinerea*] etc. are the most serious constraints to chickpea productivity in north India causing losses up to 100% losses. Wilt and root rot (WRR) are seed and soil borne diseases and may be managed by cultivation of resistant varieties and seed treatment using fungicides and bio-control agents. Ascochyta blight had been one of the major factors for drastic reduction of crop area in North India. During 2013-14, disease has appeared in epidemic form in North India and its impact was experienced even in the North Eastern Plain Zone up to Kanpur. BGM is a disease of north eastern plain zone however, it is emerging as a major threat in all the chickpea growing areas in north India. Such changes may be attributed to the climatic change. Management of BGM and Ascochyta blight may be attained through cultivation of resistant varieties and foliar sprays of fungicides. However, resource poor, small and marginal farmers in the country cannot afford costly spray schedules. Further, soil, water and environmental pollution due to excessive use of fungicides discourage their use. Hence, host plant resistance is emphasized for the management of chickpea diseases as a sole strategy or as an important component of IDM. As a result of consistent and persistent efforts of the breeders and pathologists in NARS and International institutes like ICRISAT and ICARDA, stable sources with multiple resistance against WRR, AB, BGM have been identified. Epidemiology, virulence pattern in pathogens, genetics of resistance in host and genotype × environment (GE) interaction to identify stable and durable sources of resistance have been widely studied. The work is in progress using molecular techniques and MAS to develop disease resistant varieties for their utilization directly or in integration with need based judicious fungicidal applications and cultural means to find environmental friendly means to manage the disease. In this context, future efforts needs to focused on the following lines:

- Identification of donors with high level of multiple resistance to WRR, BGM and AB
- Identification of donors against AB and BGM with resistance at all vulnerable stages i.e. vegetative, flowering and podding based on multi-location and multi-season testing at hot spots.

- Information on inheritance and diversity of genes in the host and variability in disease pathogens to pyramid resistance genes in an agronomically desirable background.
- Molecular markers associated with major QTLs conferring resistance to AB, WRR, BGM etc. have been identified. Stability, effectiveness and usefulness of the such introgressed and pyramided resistances needs to be validated at hot spot locations and under controlled environment.
- Combining high levels of resistance with other desirable traits for their incorporation into future releases to develop promising cultivars of different market classes of chickpea.
- International institutes viz. ICRISAT and ICARDA may be of great help for resistance donors.
- Unidentified AB, BGM, WRR resistance genes in wild *Cicer* species should be transferred to the cultivated species.
- Mutation, systemic activated and acquired resistance and allelopathy techniques should be used to develop higher levels of resistance.
- Double haploidy may be harnessed for fast track resistance transfer.
- Breeders and pathologists working on chickpea diseases should develop an effective network
- Replacement of a large number of land races with few improved cultivars has necessitated their deployment in strategic manner.
- Variety specific management strategies need to be developed depending upon variety's susceptibility to minimize fungicide usage and maximize profits.

The demand for chickpea is growing due to faster increase in populations, importance of pulses as a protein source for vegetarian populations, income growth for low-to-medium-income consumers, growth in urban populations and increased demand for processed pulse products, and the realization of the health benefits of pulses. The information generated on the effective and eco-friendly management of chickpea diseases will help to make the crop stable and competitive. It will help to make rice-wheat cropping system more sustainable. The growing season of the crop is prolonged under north Indian conditions hence, it is more suited for more remunerative for the kabuli chickpea. The expansion of area will increase the chickpea production leading to improved soil fertility especially under the fragile hill ecology if the states like HP and J&K. Further, it will lead to nutritional security of rural population and reduce the burden on foreign exchequer incurred on the import pulses.

Crop Diseases and their Management under Climate Change Scenario

Amrish Vaid, Anamika Jamwal, Saurav Gupta and Vishal Mahajan
Krishi Vigyan Kendra, Rajhani, Kathua-184104
She-e-Kashmir, University of Agricultural Sciences and Technology, Jammu-180009
Email: amrishvaid@gmail.com

The term DISEASE is coined by combining the words DIS + EASE = DISEASE. The prefix DIS means negative, reverse, or opposite, and the word EASE means comfort, or freedom from pain or discomfort. DIS-EASE therefore means not well, and the cause can be many. A plant disease may therefore be defined as: Any harmful deviation or alteration from the normal functioning of physiological processes. It is also defined by some as: Disease is a malfunctioning process that is caused by continuous irritation which results in suffering. A more practical definition of a disease would be: A plant is diseased when its systems are not normal and, therefore, it is not producing as well as it should according to normal expectations of the farmers. The pathogens, especially the animate ones, will not always be able to cause a disease unless environmental conditions and suitability of the host are also favourable for survival, multiplication, and entry of the pathogen into the plant and further development of the disease. For a pathogen to cause a disease, the pathogen has to be virulent in the first place; the host has to be susceptible, and the environmental conditions favourable. Disease will not develop if anyone of the 3 conditions is not fulfilled. This is known as the disease triangle. The mere presence of pathogen and its susceptible host in the field does not necessarily mean that disease will develop. The environmental factors which most commonly affect the initiation and development of infectious plant diseases are temperature and moisture on the plant surface Soil Nutrients also play an important role in some diseases, and to lesser extent, light, soil pH and oxygen and carbon dioxide levels, particularly in soil environment also affect disease development. These factors affect disease development through their influence on the growth and susceptibility of the host, on the multiplication and activity of the pathogen as it is relevant to the severity of symptom development. For a disease to occur and to develop optimally, a combination of three factors must be present susceptible plant, infective (virulent) pathogen, and favourable environment. Although plant susceptibility and pathogen virulence remain essentially unchanged in the same plant for at least several days, weeks or months, the environmental conditions may change more or less drastically.

The major predicted results of climate change increases in temperature, moisture and CO_2 - can impact all three legs of the plant disease triangle in various ways. Precisely predicting the impact of climate change on plant disease is tricky business.

Effect of rising temperature on plant diseases

Temperature has potential impacts on plant disease through both the host crop plant and the pathogen. Research has shown that host plants such as wheat and oats become more susceptible to rust diseases with increased temperature; but some forage species become more resistant to fungi with increased temperature (Coakley *et al*. 1999). Seasonal and regional occurrence of disease is to a great extent, determined by temperature. The too low temperatures of winter and very high temperatures of summer are, below the minimum and above the maximum respectively required by most pathogens. Therefore, diseases may not be initiated and those in progress may come to a halt during these periods of the year in our country. With the advent of favourable temperature pathogens become active and if other conditions are favourable they can cause the disease. Pathogens differ for their choice of low or high temperatures. Thus some species of *Typhula* (snow molds of cereals and turf grasses) thrive only in cool seasons or cold areas. Peach leaf curl caused by *Taphrina deformans* occurs only in cool (temperate) areas. This plant is grown in India both in hills as well as the plains. But the disease is found only in the hills, assuming severe state during cold and humid spring. Yellow rust of wheat and stripe disease of barley are also favoured by low temperature. The late blight pathogen, *Phytopthora infestans* is most destructive only during winter in our country and other sub tropical areas. Some diseases on the other hand are favoured by high temperatures and thus are common in the warm climate of tropics and subtropics. Thus *Fusarial wilts,* the *Phymatotrichum* root rots, the brown rot of stone solanaceous plants (*Pseudomonas solanacearum*) and *anthracnose*s caused by *colletotrichum* are more prevalent in warmer areas.

*Pseudomona*s *solancearum*, causing bacterial wilt and brown rot of potato does not affect the potato crop in the plains of India which is raised during winter but may occur when the crop is planted during February. Even on the hills of north India the disease is more common in the valleys (warmer) than on higher altitudes. The soft rot of potato (*Erwinia* spp.) is also common in warm, humid seasons. *Sclerotium rolfsii*, causing rot in many crop plants is destructive in warmer areas.

In blast disease of rice (*Pyricularia oryzae*) plant age and host nutrition become of secondary importance when temperature and moisture are favourable for stages in the disease development viz. production and germination of conidia, dispersal, host resistance alteration and nutrition. As a group, the powdery mildews have an optimum temperature for conidia germination and growth of about 21°C. The late blight for potato is reported to be unknown in areas where the mean atmospheric temperature exceeds 25°C. The temperature affects disease incidence and its spread also indirectly through its effect on insect vectors. Temperature, in combination with sunlight may determine seasonal appearance of symptoms in various viral diseases. Viruses causing yellows or leaf- rolls are most severe in summer whereas those causing mosaics or ring spots during spring or winter.

Effect of moisture on disease development in crops

Moisture also effects the initiation and development of diseases in many interrelated ways. The most important influence is on the germination of fungal spores and penetration of host by germ tube. Moisture also activates the bacterial, fungal and nematodal pathogens. As splashing rain and running water, moisture also plays important role in distribution and spread of many pathogens, on the same plant or from one plant to another. Moisture also increases the succulence of host tissues.

The occurrence of many diseases only in particular region is closely correlated with the amount and distribution of rainfall within the year. Thus, late blight of potato, apple scab, downy mildews, fire blight etc. rarely occur in dry areas and found or are severe only in areas with high rainfall or high relative humidity during the growing season. Most fungal pathogens depend on the presence of free moisture on the host or of high relative humidity in atmosphere only during the spore germination, and become independent once they can obtain nutrients and water from the host. Some, as late blight of potato and downy mildews, however, require high relative humidity in the air throughout their development. These diseases come to a halt as soon as dry, hot weather sets in n resume only after a rain or after the return of humid weather.

Contrary to most fungal and bacterial pathogens of aboveground plant parts (that require water film), the spores of powdery mildews can germinate, penetrate and cause infection when there is high relative humidity in the atmosphere surrounding the plant. In some powdery mildews, most severe infections occur when relative humidity is rather low (50-70%). Thus powdery mildews are more common and more severe in drier areas of the world. Most bacterial diseases and many fungal diseases of young tender tissues are favoured by high moisture or high relative humidity.

Some example of the diseases favoured by dry soil or water deficiency are, seedling blight of cereals (*Fusarium roseum*), common scab of potato (*Streptomyces scabies*) root and stem rot of peas (F. solani f. sp pisi), charcoal rot of jowar, potato, cotton etc. (*MacropHomina pHoseolina*), stalk rot of maize (*Fusarium moniliforme*), rice blast (Pyricularia oryzae), etc. Some example of the diseases favoured by wet soil or high relative humidity are root rot of cotton (*PHymatotrichum omnivorum*), take all of wheat *(Gaeumannomyces graminis* var. *tritic*i), stripe of barley (*Drechslera graminea*), root rots (*Sclerotium rolfsii*), black root rot of tobacco (*Thielaviopsis basicola*), sclerotinia diseases of vegetables and field crops (*Sclerotinia sclerotiorum*), wart of potato (*Synchytrium endobioticum*), damping off of seedlings (Pythium spp.) late blight of potato (*PHytopHthora infestans)*, root-knot of many plants (*Meloidogyne incognita*), bacterial wilt of tomato and potato (*Pseudomonas solanacearum*) etc.

Effect of CO_2 levels on disease in crops

Increased CO_2 levels can impact both the host and the pathogen in multiple ways. Some of the observed CO_2 effects on disease may counteract others. Researchers have shown that higher growth rates of leaves and stems observed for plants grown under high CO_2 concentrations may result in denser canopies with higher humidity that favor pathogens. Lower plant decomposition rates observed in high CO_2 situations could increase the crop residue on which disease organisms can overwinter, resulting in higher inoculums levels at the beginning of the growing season, and earlier and faster disease epidemics. Pathogen growth can be affected by higher CO_2 concentrations resulting in greater fungal spore production. However, increased CO_2 can result in physiological changes to the host plant that can increase host resistance to pathogens (Coakley et al 1999). Host resistance to disease may be overcome more quickly by more rapid disease cycles, resulting in a greater chance of pathogens evolving to overcome host plant resistance. Fungicide and bactericide efficacy may change with increased CO_2, moisture, and temperature. The more frequent rainfall events predicted by climate change models could result it difficult to keep residues of contact fungicides on plants, triggering more frequent applications. Systemic fungicides could be affected negatively by physiological changes that slow uptake rates, such as smaller stomata opening or thicker epicuticular waxes in crop plants grown under higher temperatures. These same fungicides could be affected positively by increased plant metabolic rates that could increase fungicide uptake. Exclusion of pathogens and quarantines through regulatory means may become more difficult for authorities as unexpected pathogens might appear more frequently on imported crops.

Management Strategies

Disease management strategies depend on climate conditions. Climate change will cause alterations in the disease geographical and temporal distributions and consequently the control methods will have to be adapted to this new reality. There are few discussions on how chemical control will be affected by climate change, despite the importance of this subject. Changes in temperature and precipitation can alter fungicide residue dynamics in the foliage, and the degradation of products can be modified. Alterations in plant morphology or physiology, resulting from growth in a CO_2 -enriched atmosphere or from different temperature and precipitation conditions, can affect the penetration, translocation and mode of action of systemic fungicides. Besides, those changes in plant growth can alter the period of higher susceptibility to pathogens which can determine a new fungicide application calendar (Coakley *et al.*, 1999; Chakraborty and Pangga, 2004). The main impact of climate change on chemical control will be in the cultural realm. The fact that the entire humanity is suffering the consequences of anthropogenic activity in the process of exploiting the resources of the planet will raise awareness that this activity must be conducted in a sustainable way. Society will certainly exert pressure for the use of nonchemical methods to control plant diseases. One of the direct consequences of climate change in the pathogen-host relationship is the genetic resistance of plants to diseases. Many changes in plant physiology can alter the resistance mechanisms of cultivars obtained by both traditional and genetic engineering methods. Current agricultural practices may need to be revisited because of climate change.

References

Chakraborty, S., Tiedemann, A.V. and Teng, P.S. 2000. Climate Change: Potential impact on plant diseases. Environ. Poll. 108:317-326.

Coakley, S.M., Scherm, H. and Chakraborty, S.. 1999. Climate Change and Disease Management. *Ann. Rev. Phyto*. 37:399-426.

Racial Variability and Identification of Rusts in Wheat and Barley

M.K. Pandey, Anil Gupta and Shahid Ahamad[1]
Division of Plant Breeding and Genetics, FOA, SKUAST-J, Chatha, Jammu-180009
[1]Directorate of Research, SKUAST-J, Chatha, Jammu-180009
Email: mukkp@yahoo.co.in

The rust diseases of wheat and barley such as leaf rust, stem rust, and stripe rust have historically been among the major biotic constraints in the world (Todorovska *et al.*, 2009). Three rusts of wheat i.e black (stem) rust (*Puccinia graminis* Pers. f.sp *tritici* Eriks. & Henn.), brown (leaf) rust (*P. triticina* Eriks.), yellow (stripe) rust (*P. striifromis* Westend.) and yellow rust in barley (*P. striiformis* f. sp. *hordei)* are known to cause significant losses in wheat and barley worldwide. Yield losses caused by brown rust epidemic are estimated at around 40 per cent (Anonymous, 1992) and losses due to black and yellow rust epidemics can be as great as 100 per cent.

Racial Variability

The ability of rust fungus to mutate, multiply rapidly and spread over large areas has led to widespread epiphytotic conditions in India (Nagarajan and Joshi, 1975). With the domestication of wheat, new rust resistance genes were introgressed and some of these from alien sources. However, there had been a consequential evolution of rust pathogens also. Both wheat and rusts have undergone series of steps in the course of evolution. The rust pathogens are highly variable. The evolution of new pathotypes occurs in rust rendering a resistant variety susceptible. In India most of the pathotypes of *Puccinia* species on wheat originate through mutation, parasexuality and in some cases especially yellow rust, these get introduced from Western Asia. The pathogenic variability in wheat rusts can arise due to sexual recombination, mutation, parasexuality and heterokaryosis. In the absence of functional alternate hosts under Indian conditions, the sexual recombination does not occur. There are many instances where mutation and heterokaryosis or somatic crossing over have been putatively referred to give rise to new pathotypes (Bhardwaj *et al*., 2010; Prashar *et al*., 1991).

Mutation is known to be an important way for variability in wheat rusts. Genes for virulence in rust pathogens are generally recessive. Recessive mutations are more frequent than dominant ones. The mutation frequency is $1x10^{-5}$ or 10^{-6}. Many pathotypes have emerged through mutation for avirulence. Reverse mutation has been recorded for *Lr*2a, *Lr* 2b, *Lr* 2c, *Lr* 20 and very recently for *Lr* 3 Pathotype 125R28 arose due to mutation for avirulence to *p*2a, *p*2b and *p*2c. Similar phenomenon has also been recorded in pt.121R60-1(77-9) with avirulence to *p*2a, *p*2b, *p*2c, vis-a-vis pt.121R63-1 (Bhardwaj *et al*., 2010). Pathotype 125R28 appears to be the result of avirulence to *p*2a, *p*2b, *p*2c in pathotype 109R31-1 (77-2). Recently, avirulence for *Lr3* was found to be the cause of evolution of pathotype 21R59. Statler (1985, 1987) found in *P. recondita* that mutations to virulence were induced at the *p*1, *p*3 *p*16, *p*17, *p*23, *p*27, *p*29 and 5 other loci whereas mutations to avirulence were recovered at *p*2a, *p*2c and *p*28 loci. Mutation is common on some of the loci. For example in case of black rust, mutation for *Sr*30, 13, 24, 26 and 27 are less common. Likewise, there were practically few virulences on *Yr*5 also (Bhardwaj, 2012). Black rust Identified pathotypes 5R13(12A) and 5R37(12-1).

Brown Rust

Yellow Rust Field View

Yellow Rust

Susceptible Line of Yellow Rust

Wheat

Black (stem) rust:

Khapli and Reliance were used in breeding for black rust resistance in 1934-35. Subsequently, pathotype 7G35 with virulence to Khapli was detected in 1947. None of the pathotypes had virulence to *Sr11* prior to 1945. Subsequent to the use of exotic material in the breeding programme in 1940s, pathotypes 37G3 with virulence for *Sr11* in 1945 and 7G35 with virulence for both Khapli and *Sr*11 were detected. Later on Timstein was used in breeding programme followed by Ridley, Gabo, Yalta, Gaza and other exotic introductions in 1950's. Consequently pathotypes, 79G31 virulent on *Sr5, Sr11* in 1962, 16G2 with virulence on *Sr8b* in 1959, 73G7 with virulence for Kota and *Sr30* in 1954, 7G11 in 1952, 36G2 in 1961, 7G43 in 1962 with additional virulence on *Sr*11 were identified. Large scale cultivation of Mexican wheat like Chhoti Lerma in Nilgiri hills led to the selection of more virulent pathotypes 62G29 in 1974. Subsequently, more pathotypes have been detected in last 17 years. Pathotype, 62G29-1 with virulence for *Sr*24 was detected in Nilgiri hills in 1989, much before the release of variety HW 2004 (*Sr*24) in 1995 (Bhardwaj *et al*., 1990). Recently *Sr*25 has also become susceptible to black rust of wheat (Jain *et al.*, 2009). In India, 32 pathotypes of black rust were identified and maintained in RRS, Flowerdale, Shimla up to 2012-13 (Bhardwaj, 2011).

Brown (leaf) rust

Dr. K.C. Mehta pioneered the race identification in India during late 1920's. The first batch of races (11 and 63) is being maintained since 1931.Since then more than 50 races/ pathotypes have been reported from India and these pathotypes being maintained at Regional Station, D.W.R., Flowerdale, Shimla (Bhardwaj, 2011). Many useful resistance genes namely *Lr1, Lr 3, Lr 9, Lr 10, Lr19, Lr23, Lr26* and *Lr28* have been rendered ineffective. Pathogen has also moved from virulence to few resistance genes to many genes. Though the most virulent pathotypes 121R127 (77-7, which is virulent on *Lr9*) and 377R60 (77-10) that has virulence for *Lr28*) are known, however, pathotypes 121R63-1 (77-5) and 21R55 (104-2) predominate the flora at present (Bharadwaj *et al.*, 2010).

Yellow (stripe) rust

In yellow rust, Spaldings Prolific and Carstens V were used in breeding for resistance against *P. Striiformis* in 1934-35. After the introduction of Mexican wheat, Kalyansona and Sonalika were resistant to yellow rust up to 1970. In 1970 Kalyansona (*Yr2*) became susceptible to 3 new pathotypes i.e. 66S64, 70S64 and 66S64-1. Pathotype 38S102 was picked up in 1973 from Nilgiri hills and 47S102 from Punjab in 1982 which rendered Sonalika susceptible. Since 1990, three pathotypes 70S69, 46S103 and 47S103 virulent to Hybrid 46 (*Yr*4) have been picked up. Another pathotype designated as 46S119 having virulence for *Yr*9 was picked up in 1996 (Nayar, 1996). In case of yellow rust pathotypes virulent for Kalyansona and *Yr*9 appeared to have got to India from Middle East. There has been the introduction of pathotypes from Eastern Europe to India via West Asian nations. The introduction of yellow rust pathotypes from the adjoining countries always makes wheat crop in Northen India prone to yellow rust. In 2000; pathotype 78S84 rendered *Yr*9 and *Yr*27 (PBW343 & PBW373) susceptible.

In India, 28 pathotypes were identified up to 2012-13 (Bhardwaj, 2011). Besides these five new pathotypes of *P. striiformis* have been identified in 2014. These have been designated as 46S117, 110S119, 238S119, 110S247 and 110S84 (Anonymous, 2014). These new pathotypes were more virulence than the existing pathotypes and appeared to be mutation in existing pathotypes on Suwon x Omar and Riebesel 47/51. Among these pathotypes 110S119 was most common and was identified in about 12% samples in 2014-15. The pathotypes of North India displayed differences in distribution, frequencies and diversity across the states. The pathotype 46S119 was predominant before 2004-05 thereafter pathotype 78S84 was dominant up to 2010-11 seasons (Prashar *et al.*, 2015).

Barley

Stripe rust

In India, only 5 pathotypes were identified. Two pathotypes which were observed in high frequency were 1S0 (M) and 0S0-1(24). The most predominant pathotype 1S0 (M) was pathotype first identified from Shimla in 1987 (Kumar *et al.*, 1989) has virulence to Yr1 (Chinese 166). It started to build up the population and was second most predominant pathotype in 1994 followed by the pathotypes 0S0 (57) (Prashar *et al.*, 1999). Other pathotypes such as 0S0 (57), 4S0 (G) and 4S0-3 (G-1) were observed in low frequencies. Frequency of pathotypes may be varying year to year depending upon the climatic factors. The most predominant pathotype 1S0 (M) was virulent on *Yr1*. Pathotype 4S0 exhibited susceptible reaction on Heines Kolben (*Yr6*) whereas 4S0-3 was virulent to *Yr6* and WH416. Pathotypes 1S0 (M) and 0S0-1 (24) were widely distributed in Himachal Pradesh followed by Uttrakhand, in other states like Punjab, Haryana, Rajasthan. Amongst the pathotypes, pathotype 1S0 (M) was most prevalent in all states of North India with high frequency in Himachal Pradesh. Diversity of *Puccinia striiformis* f.sp. *hordei* was low in India (Parashar *et al.*, 2014).

Identification rust

Stakman *et al.* (1962) defined the physiologic race as a biotype or a group of biotypes with in a species or lower taxon and can be distinguished from the other biotypes by physiological characters including pathogenicity. Genetically the term biotype denotes the population of the individuals of the same genetic constitution. Further each formae special of rust species contains enormous variation. These variants are called races which are differentiated on the basis of avirulence/ virulence on a set of hosts called differentials. The first authenticated report of distinct physiologic race of rust pathogen was given by Main and Jackson in 1926. In India, the identification of races in different wheat rust was initiated by Mehta (1923). With the discovery of gene for gene theory of Flor (1955) and its use later by Stakman *et al.*, (1962), it was realized that pathotypes identification system requires modification in order to be more meaningful. Consequently, numerous methods using near isogenic lines were suggested around the world (Watson and Luig, 1963; Johnson *et al.*, 1972; Roelfs and Mcvery, 1974). Different countries have different systems of identification. Each system has its merits and demerits. In United States of America,Canada and Mexico, a letter code system based on 3-5 sets of isogenic lines is followed. A pathotype is coded as BCTTQ. However, 5 of the Indian pathotypes (77-2, 77-4, 77-8, 77A, 77A-1) of *P. triticina* get designation as TGTTQ in the designation system of United States of America. In Europe Octal system of nomenclature is followed. In Australia standard differentials/notation of races succeed the number of susceptible supplementary differential. South Africa has different system of nomenclature of pathotypes of wheat rust pathogens (Bhardwaj, 2012).

A reevaluation of race identification and race nomenclature of wheat stripe rust was made by Johnson *et al*. (1972), introducing the binary notation, which is also being used in India for brown rust proposed in 1981 by Nagarajan *et al.* (1983) and was, modified subsequently for wheat and barley (Prashar *et al*., 2007). Subsequently on similar pattern pathotypes analysis system were developed for black (Bahadur *et al.*, 1985) and yellow rust (Nagarajan *et al.*, 1983). The constituents of this system have been placed in three groups that are named as Set-A, Set-B and Set-0. Presently Set-A has 9, Set-

B has 8 and Set-0 has 7 entries. Set-A consists of the old world differentials, which helps in maintaining a link to that of naming system of other countries, Set-B accommodated few European supplemental entries, Indian varieties and Tc**Yr9* (Thatcher with *Yr7* and *Yr9*), and Set-0 has popular varieties of wheat in India (Bhardwaj, 2011). Subsequently on similar pattern pathotypes analysis system were developed for black (Bahadur *et al.*, 1985), brown rust (Nayar *et al.*, 1985) of wheat and barley.

References

Anonymous. (1992). The wheat rust patrol-striking a fast moving target. Partners in Research for Development. No. **5**:20-21. ACIAR, GPO Box 1571, Canberra, ACT, 2601, Australia.

Bahadur, P., Nagarajan, S and Nayar, S.K. 1985. A proposed system of virulence designated in India. II *Puccinia graminis* f.sp *tritici*. *Proceeding of the Indian Academy of Science (Plant Sciences)* 95: 29-33.

Bhardwaj, S.C., Nayar, S.K., Prashar, M., Menon, M.K. and Singh, S.B. 1990. A Pathotype of *Puccinia graminis* f.sp. *tritici* on *Sr24* in India. Cereal Rusts and Powdery Mildews Bulletin 18(1): 35-38

Bhardwaj, S.C. 2011. Resistance genes and adult plant rust resistance of released wheat varieties of India. Research Bulletin No. 5. Regional Station, Directorate of wheat research, Flowerdale, Shimla, pp 31.

Bhardwaj, S.C. 2012. Wheat Rust Pathotypes in Indian Subcontinent Then and Now. *WHEAT: Productivity Enchancement under Changing Climate, 227-238.*

Bhardwaj, S.C., Prashar, M., Jain, S.K., Kumar, S. and Datta, D. 2010. Adult plant resistance in some Indian wheat genotypes and postulation of leaf rust resistance genes. *Indian Phytopathology,* 63 (2): 174-180.

Johnson, R., Stubbs, R. W., Fuchs, E. and Chamberlain, N. H. 1972. Nomenclature for physiologic races of *Puccinia striiformis* infecting wheat. *Transactions of the British Mycological Society,* 58: 475-480.

Kumar, J., Nayar, S.K., Prashar, M., Bhardwaj, S.C., Bhatnagar, R. and Singh, S.B. (1989). New forms M(1S0) and N(46S102) of Puccinia striiformis Westend. in India. *Indian J. Mycol. Plant Pathol*. 19(3): 322-324

Parashar, M., Bhardwaj, S.C., Gangwar, O.P. and Jain, S.K. 2014. Virulence distribution and frequency of *Puccinia striiformis* f. sp. *hordei*, causing stripe rust of barley in northern parts of India. *Indian Phytopath*. 67 (1): 38-41

Nagarajan, S. and Joshi, L.M. 1975. A historical account of wheat rust epidemics in India and their significance. *Cereal Rusts Bulletin,* 2: 29-33.

Nagarajan, S., Nayar, S.K. and Bahadur, P. 1985. The proposed systems of virulence analysis III. *Puccinia striiformis*, West. *Kavaka*, 13(1): 33-36.

Prashar M, Nayar SK, Kumar J and Bhardwaj SC (1991). A new pathotype 107-1 (45R35) of *Puccinia recondita tritici* in India. *Indian J. Agri. Sci*. **61(**4): 285-286.

Prashar, M., Bhardwaj, S.C., Jain, S.K. and Datta, D. 2007. Pathotypic evolution in *Puccinia striiformis* in India during 1995-2004. *Australian Journal of Agriculture Research,* 58: 602-604.

Prashar, M., Bhardwaj, S.C., Jain, S.K. and Gangwar, O.P. 2015. Virulence diversity in *Puccinia striiformis* f.sp. *tritci* causing yellow rust on wheat (*Triticum aestivum*) in India. *Indian Phytopath.,* 68(2): 129-133.

Prashar, M., Nayar, S.K., Bhardwaj, S.C. and Bhatnagar, R. (1999). Pathotype distribution of *Puccinia striiformis* West., in India during 1993-94. *Indian J. Mycol. Plant Pathol*. 29: 244-247.

Roelf, A.P. and Mcvery, D.V. 1974. Races of *Puccinia graminis* f.sp. *tritici* in USA during 1973. *Plant Dis. Reporter,* 58: 608-611.

Bhardwaj, S.C. Prashar, M. and Sharma, Y.P. 2010. Leaf rust races in India - an overall account including yield losses. National Seminar "Checkmating evolution of race group 77 of wheat leaf rust pathogen" on 14th March, 2010 Indian Agricultural Research Institute Regional Station, Wellington Distt. Nilgiris, Tamil Nadu,:10-11.

Stakman, E.C., Stewart, D.M. and Loegering, W.Q. 1962. Identification of physiological races of *Puccinia graminis* var. *tritici*. U.S. *Agriculture Research Survey,* ARC E- 617, p. 53.

Todorovska, E., Christov, N., Slavov, S., Christova, P. and Vassilev, D. 2009. Biotic stress resistance in wheat-Breeding and Genomic selection implications. *Biotechnological Equipment*, 23: 1417-1426.

Watson, I.A. and Luig, N.H. 1963. The classification of *Puccinia graminis* var. *tritici* in relation to breeding resistant varieties. *Proceedings of the Linnean Society of New South Wales,* 88: 235-258.

Biological Management and Bio-pesticides: Commercial Entrepreneurship

Vishal Gupta, V.K. Razdan, Akash Sharma and Satish K. Sharma
Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha (J&K)

Presently, global population is over 7 billion and is projected to reach 9 billion by 2050. One of the biggest challenges is to substantially increase the food production in a sustainable and environmentally friendly manner. In order to meet global food demand by 2050, we will need to increase food production by at least 70 per cent. To date, modern agriculture has largely achieved crop production objective by intensive and extensive cultivation of high yielding varieties coupled with chemical fertilizers and pesticides. The worldwide consumption of pesticides is about two million tonnes per year, out of which 45 per cent is used by Europe alone, 25 per cent is consumed in the USA, 25 per cent in the rest of the world, out of which India's share is just 3.75 per cent. The usage of pesticides in Korea and Japan is 6.6 and 12.0 kg/ha, respectively, whereas in India, it is only 0.5 kg/ha. While comparing the worldwide consumption of pesticide, 47.5 per cent is the share of herbicides, 29.5 per cent is the share of insecticides, 17.5 per cent is that of fungicides, and others account for 5.5 per cent only in which bio-control represent only about 1 per cent of agricultural chemical sales. Bio-control agents are a class of environmentally friendly micro-organisms that are increasingly being used to manage the pests including insects, weeds and diseases have following advantages.

- Biological control is less costly and cheaper than any other methods.
- Bio-control agents give protection to the crop throughout the crop period
- They are highly effective against specific plant diseases.
- They do not cause toxicity to the plants
- Application of bio-control agents is safer to the environment.
- They multiply easily in the soil and leave no residual problem
- Bio-control agents can eliminate pathogens from the site of infection.
- Bio-control agents not only control the disease but also enhance the root and plant growth by way of encouraging the beneficial soil microflora.
- It increases the crop yield also.
- It helps in the volatilization and sequestration of certain inorganic nutrients.
- Bio-control agents are very easy to handle and apply to the target.
- Bio-control agents can be combined with bio-fertilizers.
- They are easy to manufacture.

In spite of the efficacy of bio-control agents for successful management of agricultural pest by different mechanism of actions, the availability is one of the greatest challenges as it lacks the link between the research, field and industry. Development of formulations with increased shelf life and broad spectrum of action with consistent performance under field conditions could pave the way for commercialization of the technology at a faster rate. A thorough knowledge on the mechanisms and performance related to pest management will help in the selection of promising candidates (bio-control agents) that suits industries to produce reliable commercial products. For an ideal formulation of bio-control agents: it should have increased shelf life, not be phytotoxic to the crop plants, dissolve well in water and should release the bio-control agent, tolerate adverse environmental conditions, cost effective and should give reliable management of plant pest, compatible with other agrochemicals and carriers must be cheap and readily available for formulation development.

Bio-control agents are important if applied properly. The basic reason why this is used is its multifaceted nature and broad range. It can also be used in conjugation with other microbes, which thereby increases its efficiency. plants from pathogen attack. Further, plant growth would also improve. Realistically, biocontrol may not totally replace chemicals; but the judicious use of biocontrol agents can significantly enhance our lives, the environment, and agriculture productivity.

Breeding for Diseases Resistance

Manmohan Sharma and Ramesh Kumar Salgotra
School of Biotechnology, SKUAST-Jammu

As agriculture struggles to support the rapidly growing global population, plant diseases reduce the production and quality of food, fibre and biofuel crops. It has been estimated that an average of 20-30 per cent of crop yield is lost annually from the field even. The losses may be substantially greater in subsistence agriculture, where crop protection measures are often not applied. Losses due to postharvest diseases are high, particularly when adequate storage and marketing facilities are not available. Many postharvest pathogens also produce toxins that create serious health problems for consumers. Plant protection in general and the protection of crops against plant diseases in particular, have an important role to play in meeting the growing demand for food quality and quantity.

1. Introduction

Plant breeders have very successfully increased potential crop yields, however, much greater emphasis is required to address reasons for the gap between potential and actual yields achieved by farmers, and research that is focussed on narrowing this gap. A major component in the development of food crop production systems is the breeding of crop cultivars that have resistance to various biotic stresses such as diseases, insect pests and weeds. Management of crop diseases through disease resistance is considered to be the most desirable, profitable, economical and environmentally safe approach. Crop varieties are domesticated and their continued cultivation depends on continuous breeding programmes for disease and virus resistance. Selecting/breeding plant varieties that exhibit certain degree of resistance or tolerance to the prevalent races of pathogens helps to lessen the use of chemicals or other management practices for environmentally safe agriculture and play an important role in integrated disease management strategies. Breeding approaches involving incorporation of disease resistance have shown satisfactory results in different crops, including field crops, vegetables, fruits and ornamentals.

2. Role of R genes in resistance breeding:

For most proteins coded by *R* genes there are characteristic, conserved, structural domains. In general, we can divide R proteins according to the mode of resistance, to race-specific and race-non-specific. According to structural motif, they can be divided into five classes (Hammond-Kosack & Parker, 2003). In the first class, there are serin/threonin kinases such as *Pto* gene in tomato conferring resistance to bacteria *Pseudomonas syringae*. All other R proteins, combined in four classes, have leucine rich repeat domain and are distinguished by the localization of these domains. R proteins of second class are transmembrane receptors with extracellular LRR domain (*Cf* gene family in tomato), while R proteins of third class have extracellular LRR domain connected to kinase domain (*Xa21* gene at rice). *R* genes belonging to the fourth and fifth group code for intracellular proteins with NBS and LRR domain. LLR domain is important for ligand binding and the recognition of pathogen effectors (Young, 2000). The C- and N-terminal end of LRR domain are proposed to have distinct functions, the C-terminal end is responsible for the ligand recognition and important for determining R-Avr specifity, while N-terminal end is responsible for activation of further signal transduction (Inohara & Nunez, 2003; Tanabe *et al*., 2004; Chen *et al*., 2004). Structural similarities between NBS-LRR proteins of different species and taxa confirm the conservation of basic mechanism of defense against pathogens during the evolution and diversification (Moffet *et al*., 2002). Although R proteins share similar structure at the amino acid level, they clearly differentiate at the nucleotide level.

3. Genetics and mechanism of disease resistance:

Farmers have noticed for centuries that some individual plants in a given species manage to survive disease epidemics relatively unscathed, while their neighbors succumb to infection or insect predation. In 1905, Sir Roland Biffen wondered whether healthy plants inherited pest resistance, just as they might inherit the tendency to be tall or short. His experiments on two varieties of wheat showed that the ability to resist infection by a rust fungus was indeed inherited in Mendelian fashion, a discovery that intensified attempts by farmers and plant breeders to produce varieties of disease-resistant crop plants. About 50 years later a plant scientist Harold Flor, while working with flax and the rust fungus *Melampsora lini*, found that host resistance to a pathogen was not only dependent on the host genetic makeup (resistance genes, *R*-genes), but also on the genetic makeup of the pathogen (a virulence genes, *Avr*-genes). With these findings Flor introduced the widely accepted concept of the Gene-for-Gene theory of disease resistance (often referred to as race-specific or vertical resistance), which predicts that a host will achieve successful disease resistance only if both a host's *R* genes and the pathogen's corresponding *Avr*-genes are present. Since that time many *R*-*Avr* interactions have been studied and documented. Dozens of *R*-genes, against many different pathogens have been identified from a variety of plants. These genes encode proteins that can be grouped into superfamilies based on sequence and structure similarity (McDowell and Woffenden 2003); and based on their structure it can be deduced that some of these *R*-proteins are found in the cell cytoplasm, some are anchored to the cell membrane, and some traverse the cell membrane (Dangl and Jones 2001). Plant defense starts with non-self recognition and/or cellular intactness. During host invasion, pathogens release exogenous as well as endogenous elicitors (Vorwerk *et al*. 2006; Huckelhoven 2007). Elicitors are molecules produced by either the host or the pathogen that in turn induce a response by either the host or the pathogen. Fungal pathogen elicitors include enzymes which break down the cuticle or cell wall polysaccharides. Chitin, the major constituent of fungal cell walls is also known to be an elicitor which triggers a defense response in plants. The bacterial protein, flagellin, is also an elicitor of host defense. Cuticle and cell wall fragments are examples of endogenous elicitors of host defense. As these tissues are under physical or enzymatic attack, released fragments are detected by *R*-proteins stationed in the cell membrane and a defense response is initiated. Within 15 minutes of pathogen recognition, host cells begin producing new proteins in reaction to the attack (Dangl and Jones 2001). This first response to invasion is known as a basal defense, and includes production of proteins that inhibit pathogen enzymes, structural and chemical remodeling of the host cell wall at penetration sites, and production of antimicrobial agents that will kill the intruder. Examples of *R-Avr* interactions have been described in tomato, where *Pto* interacts with *AvrPto* gene product of *Pseudomonas syringae* (Scofield *et al*. 1996), in rice-rice blast pathosystem, where *Pi-ta* interacts with Avr-Pita (Jia *et al*., 2000) and in *Arabidopsis*, where RRS1 protein interacts with *Avr-PopP2* gene product of *Ralstonia solanacearum* (Bernoux *et al*., 2008).

A second, more extreme, line of defense is known as the hypersensitive response (HR), or programmed cell death (PCD) (Greenberg and Yao 2004; Lam *et al*. 2001; Day and Graham 2007). The hyper sensitive response is a strategy of "scorched earth" where the plant cell introduces toxic molecules into the surroundings; creating a localized environment that is incapable of sustaining life for both the pathogen and the cell itself. The HR is an efficient means of defense against many pathogens, but is ineffective against necrotrophic fungi.

4. Breeding strategies

Breeders have successfully developed lines resistant to diseases by integrating *R* genes into their cultivars for many years; but a durable (sometimes called Horizontal Resistance, Race non-specific resistance, or Qualitative Resistance), long lasting resistance in many cases has been difficult to achieve as pathogens quickly evolve and develop counter resistance genes that circumvent the host cultivars resistance. Breeders often spot this breakdown in resistance and hurriedly integrate a newly found effective *R* gene into their populations. In time, the new *R*-gene loses its effectiveness and the boom bust and induced co-evolution between crop and pathogen continues.

Two methods are available to plant breeders in order to increase the durability of their resistant cultivars. The first is known as the High-Dose/Refuge or Multiline strategy (Rausher 2001; Pink 2002). Recall that a host's resistance to a disease is conferred by the interaction of its *R*-gene with the pathogen's *Avr*-gene. A change due to a mutation of the pathogen's allele for an *Avr*-gene will allow the pathogen to circumvent or suppress host defenses and cause disease. A multiline or refuge will reduce the selection intensity against the *A*1*A*1 and *A*1*A*2 genotypes by providing an acceptable host for the pathogen; and maintaining (for an extended period) a higher frequency of the *Avr*-gene, recognizable by the wheat cultivar's *R*-gene, within the pathogen population. Suppose 10 to 20% of the wheat field contains susceptible cultivars to the pathogen *A*1*A*1 and *A*1*A*2 genotypes; the selection intensities are decreased and the number of generations necessary for the new allele to become predominant increases dramatically. The multiline strategy requires that some level of disease is acceptable and that the pathogen reproduces by sexual means. Also, multilines may not hold a necessary uniformity that many cropping systems require.

A second option for the plant breeder in generating a cultivar with durable resistance is know as gene pyramiding. In this strategy several *R*-genes are deployed in the same cultivar (McDowell and Woffenden 2003; Pink 2002). In theory, pyramiding several “undefeated” *R*-genes into a single cultivar will provide a more durable resistance as several mutations would need to take place, one at each of the pathogen’s corresponding *Avr*-loci. With modern molecular biology techniques, it is possible to use markers and probes to track the introgression of several *R*-genes into a single cultivar from various sources during a crossing program.

Although many disease resistances often follows the gene-for-gene model some follow a race-non-specific, or qualitative mode of resistance (also known as horizontal resistance) where resistance is controlled by genes with minor to intermediate and additive effects. Combinations of 3 to 5 of these minor genes can result in a high level of resistance (Singh *et al*. 2000). A third type of resistance is known as partial resistance and most commonly is associated with slow rusting cultivars. Slow rusting as defined by Caldwell (1968) is a type of resistance where disease progresses at a retarded rate, resulting in intermediate to low disease levels against all pathotypes of a pathogen. Partial resistance is a form of incomplete resistance characterized by a reduced rate of epidemic development despite a high susceptible infection type. The components that cause slow rusting of a cultivar are longer latent period, low receptivity or infection frequency, as well as smaller uredial size and reduced duration and quantity of spore production. All of which can affect disease progress in the field. Slow rusting resistance has dominated in CIMMYT’s bread wheat improvement program for more than 25 years. Wheat cultivars susceptible to a disease may in fact show no significant yield reduction (Zuckerman *et al*. 2006). Protection of yield, or tolerance**,** in infected plants was defined by Caldwell and Shafer (1958) as the ability of a crop to endure severe epidemics by the pathogen while sustaining only insignificant yield losses as compare with an infected non-tolerant cultivar. The tolerance that some cultivars demonstrate over others is not yet well understood, but it has been proposed that storage of carbohydrates and their mobilization to the sink under stress conditions; or that tolerant plants have the ability to compensate for the loss of photosynthetic leaf area by increasing the photosynthetic capacity of the unaffected leaf area contribute to the tolerance to disease (Zuckerman *et al*. 1996).

5. Breeding methods:

The methods of breeding for disease resistance are essentially the same as those for other agronomic characters. The following breeding methods have been commonly used:

1) Introduction, 2). Selection, 3) Hybridization and selection, 4) Mutation breeding 5) Multiline breeding 6) Map based cloning of R genes 7) Pyramiding R genes by marker assisted selection (MAS), 8) Somaclonal variations, and 9) Genetic engineering.

5.1. Introduction:

This is easy and rapid method of developing disease resistant varieties. The resistant varieties may be introduced and after testing, if found suitable, can be released in the disease prone areaa. In 1860, the grape crop in France was completely destroyed by the attack of *Phylloxera vertifolia*. Introduction of resistant root stocks to this pest from USA saved the grape crop from extinction in France.

5.2. Selection:

When the source of resistance is a cultivated variety, mass selection and pure lines selection in self pollinated crops, mass and recurrent selection in cross pollinated species, and clonal selection in the vegetatively propagated crops will be ideal for isolating disease resistant plants. The resistant plants may be multiplied, screened for disease resistance and released a variety.

5.3. Hybridization and selection:

Hybridization is used when resistant genes are available either in the germplasm or in wild species of crop plants. After hybridization, the hybrid material is handled either by pedigree method or by backcross method. The pedigree method is used when the resistance is governed by polygene and the resistant variety is an adapted one which also contributes some desirable agronomic traits. The backcross method is used when resistance to governed by oligogenes. The various sequential steps are: screening germplasm for resistance sources, hybridization of selected parents, selection and evaluation of hybrids and segregants and testing and release of new varieties. Some of the released crop varieties bred by hybridization and selection for disease resistance to fungal, bacterial and viral diseases are given below:

Crop	Variety	Resistance to diseases
Wheat	Himgiri	Leaf and stripe rust, hill bunt
Brassica	Push swarnim	White rust
Cauliflower	Pusa shubhra, Pusa Snowball K-l	Black rot and Curl blight black rot
Cowpea	Pusa Komal	Bacterial blight
Chilli	Pusa Sadabahar	Chilly mosaic virus. Tobacco mosaic virus and Leaf curl

5.4. Mutation breeding:

The discovery of x-rays inducing mutations in *Drosophila melanogaster* presents the beginning of mutation breeding in plants. According to the FAO/IAEA database there are 320 cultivars with improved disease resistance using mutagenic agents that were obtained as direct mutant or derived from hybridization with mutant or from progeny (for example by self fertilization). Induced mutations have been used to improve economically important crops such as wheat, barley, rice, cotton, peanut, banana etc. Disease resistance in commercial crops was improved mostly in cereals (rice, barley, maize and wheat) and legumes (bean and green pea).

4.4.1. Spontaneous mutagenesis

Spontaneous mutations occur at low frequencies, one in a million per gene. If two independent mutations are necessary in recessive alleles to obtain resistant phenotype, the frequency lowers to 10-18 per nucleotide (Gressel & Levy, 2006). Mutagenesis is used to accelerate spontaneous mutations in driven evolution. For the improvement of disease resistance, the induction of spontaneous mutations is applied by different mutagenesis approaches: virus induced gene silencing, RNA-mediated interference, *Agrobacterium*-mediated insertional mutagenesis, radiation and chemical mutagenesis and with combined approaches such as Targeting Induced Local Lesions in Genome (TILLING). For the identification of mutants, different methods have been developed through years, that include: i) high resolution melting techniques (HRM), ii) protein truncation test that detect mutants from the termination of mRNA translation, iii) single-strand conformation polymorphism (SSCP) for the detection of frameshift mutations, nonsense and missense mutations, iv) Southern hybridization for detecting large mutations (deletion, insertions, rearrangements), v) denaturing gradient gel electrophoresis (DGGE), vi) DNA microarray, vii) single and multi parallel DNA sequencing, viii) TILLING for the detection of mutations in large exon-rich amplicons and ix) PCR based detection technique. Novel sequencing approaches based on Sequence Candidate Amplicons in Multiple Parallel Reactions are now most commonly used in genomic analyses of gene expression and regulation modes, including the production of genetic maps. The new generation machines (Illumina Genome Analyser, ABI SOLiD, Roche 454) are capable of producing millions of DNA sequences in a single run. The advantage of multiparallel sequencing using pooling strategy is the identification of rare mutations that are distinguishable from background sequencing errors.

4.4.2. Induced mutagenesis

Most mutagenic populations are generated by treating seeds with radiation or chemical mutagens. Physical mutagens are X-rays, Gamma rays, alpha particles, UV and radioactive decays. Irradiation usually cause large mutations (large-scale deletions of DNA), while chemical mutagens usually cause point mutations. Mutations induced by chemical mutagens are point mutations and are less damaging (not lethal) than large rearrangements. The advantage of chemical mutagenesis is that is can provide loss- and gain- of - function of genes. There are various chemical mutagens used for generating variability, such as sodium azide, ethyl methanesulphonate (EMS), methyl methanesulphonate (MMS), hydrogen fluoride (HF), diethyl sulphate, hydroxylamine and N-methyl-N-nitrosourea

(MNU). Most commonly used mutagen in creating TILLING populations in maize, rice, *Brassica* sp., pea, barley, wheat, soya and cucumber is ethyl methane sulphonate (EMS).

5.5. Multiline breeding:

Multilines are defined as 'mixtures of cultivars that vary for many characters including disease resistance, but have sufficient similarity to be grown together'. Cultivar mixtures do not cause major changes to the agricultural system, generally increase yield stability, and in some cases can reduce pesticide use. Cultivars used in the mixture must possess good agronomic characteristics and may be phenotypically similar for important traits including maturity, height, quality and grain type, depending on the agronomic practices and intended use. Cultivar mixtures in barley and wheat for the control of powdery mildew and rusts, respectively are examples of phenotypically similar mixtures, whereas red- and white-grained sorghum mixtures used in Africa are an example of phenotypically different mixtures. Epidemics are the exception in natural and semi-natural ecosystems, reflecting the balance derived from the co-evolution of hosts and pathogens. However, in modern agriculture in particular, this balance is far from equilibrium, and epidemics would be frequent were it not for highly effective pesticides and a plant breeding industry which introduces new cultivars to the market with new or different resistance genes. Such a situation is generally profitable when commodity prices are high, but it is costly and rates very poorly on sustainability and ecological or environmental parameter scales.

5.6. Map-based cloning

Map-based cloning is an approach to identify *R* gene and determine the sequence of a gene using molecular markers. We distinguish two different types of mapping: i) genetic mapping based on the classical techniques using pedigree or breeding of recombinant phenotypes and ii) physical mapping based on the use of biotechnological techniques (genetic fingerprinting) to determine the order and spacing between markers or genes. Linkage map is a genetic map presenting genes in lineage order and distance in between in centimorgans (cM). Mapping Quantitative Trait Loci (QTLs) is effective approach for studying plant disease resistance. The first step in map-based cloning is to place molecular markers that lie near a gene of interest and co-segregate with proposed gene without recombination. It has been shown that soybean cist nematode resistance, rice blast resistance and black mold resistance in tomato, grey leaf spot and common rust in maize are under the control of QTL (Wang *et al*., 1994, Robert *et al*., 2001; Concibido *et al*., 2004; Danson *et al*., 2008). The second step is to clone the gene by chromosome walking and sequencing the gene. Determination of QTLs is important for studying epistatic interactions and race specifity. More than 35 QTLs in rice were found near *R* genes for resistance to blast (Ballini *et al*., 2008; Fukuoka & Okuno, 1997; Tabien *et al*., 2000, 2002). Identification of markers linked to QTL facilitates the targeting of recessive alleles, which can be masked by epistasis in the specific environment (Joshi & Nayak, 2010).

4.7. Pyramiding R genes by marker assisted selection (MAS)

In order to avoid breakdown of resistance conferred by single *R* gene, pyramiding multiple *R* genes in genetically uniform lines presents an alternative. The idea of pyramiding *R* genes into crops is to construct sufficiently large pools of *R* genes that correspond to all avirulence genes in pathogen populations of specific regions. The probability of pathogen to break resistance to two or even more genes is much lower than to single gene. Advantages of pyramiding genes in single genotype are: i) more effective control of insect resistant to single toxin that may be controlled by a second toxin, ii) lower probability of evolving resistance to two independent actions through selection of one toxin, and iii) a single effector cannot break resistance to binding to immunologically different targets (Gahan *et al*. 2005). The problem of introducing several genes by classical breeding is the transfer of undesirable traits that need to be removed by backcrossing. Gene pyramiding by classical breeding is also difficult due to the dominance and epistatic effects (Singh *et al*., 2001), but the identification of molecular markers linked to resistance genes or loci ease the identification of desired plants. The selection of desirable phenotype by molecular markers is termed marker assisted selection (MAS). MAS-based gene pyramiding is an analogue approach to classical breeding but less time consuming and relying on the use of molecular markers that speed up the selection procedures. Using sequence tagged sites (STS) markers, MAS based gene pyramiding and marker-aided backcrossing procedures several genes have been successfully transferred in elite rice cultivars (Huang *et al*., 1997; Singh *et* *al*., 2001). In common wheat, three leaf rust resistance genes *Lr41*, *Lr42*, *Lr43* were successfully pyramided as well (Cox *et al*., 1993).

5.8. Somaclonal Variation:

Genetic variation present among plant cells during tissue culture is called somaclonal variation. The term somaclonal variation is also used for the genetic variation present in plants regenerated from a single culture. This variation has been used to develop several useful varieties. Disease resistant somaclonal variants can be obtained in the following two ways, firstly, plants regenerated from cultured cells or their progeny are subjected to disease test and resistant plants are isolated. Secondly, cultured cells are selected for resistance to the toxin or culture filterate produced by the pathogen and plants are regenerated from the selected cell. Cell selection strategy is most likely to be successful in cases where the toxin is involved in disease development. Some of the somaclonal variations are stable and useful, e.g., resistance to diseases and pests, stress tolerance, male sterility, early maturation, better yield, better quality, etc. Thus somaclonal variations have produced wheat tolerant to rust and high temperature, Rice to leaf ripper and Tungro virus, potato to *Phytophthora infestans* (late blight of Potato), etc. Other useful variations include high protein content of Potato, short duration sugarcane and increase shelf life of tomato.

Somaclonal variations can be of genetic or epigenetic nature. Genetic variability is caused by mutations or other changes in DNA (changes in ploidy, structural changes in DNA, activation of transposon and chimera rearregement) and is heritable, while epigenetic variability is caused by temporary phenotypic changes (rejuvenation). Seven wheat cultivars having some degree of resistance to *Bipolaris sorokiniana*, *Magnaporthe grisea* or *Xanthomonas campestris* pv. *undulosa* (Xcu) provide somaclonal variation for disease resistance (Mehta & Angra, 2000). The stability of somaclonal variants must be examined through several generations in order to distinguish from epigenetic changes, which is the reason for lower utility.

5.9. Genetic Engineering:

Genetic engineering is a process in which the alteration of the genetic makeup of cells is done by deliberate and artificial means. This process involves transfer or replacement of genes to create recombinant DNA. Genes expected to confer disease resistance are isolated, cloned and transferred into the crop in question. By this method, they acquire useful characters, such as disease resistance or to make useful enzymes, hormones, vaccines, etc. In case of viral pathogens, several transgenes have been evaluated, viz, virus coat protein gene, DNA copy of viral satellite RNA, defective viral genome, antisense constructs of critical viral genes, and ribozymes. Viral coat protein gene approach seems to be the most successful. A virus transgenic variety of squash is in commercial cultivation in U.S.A.

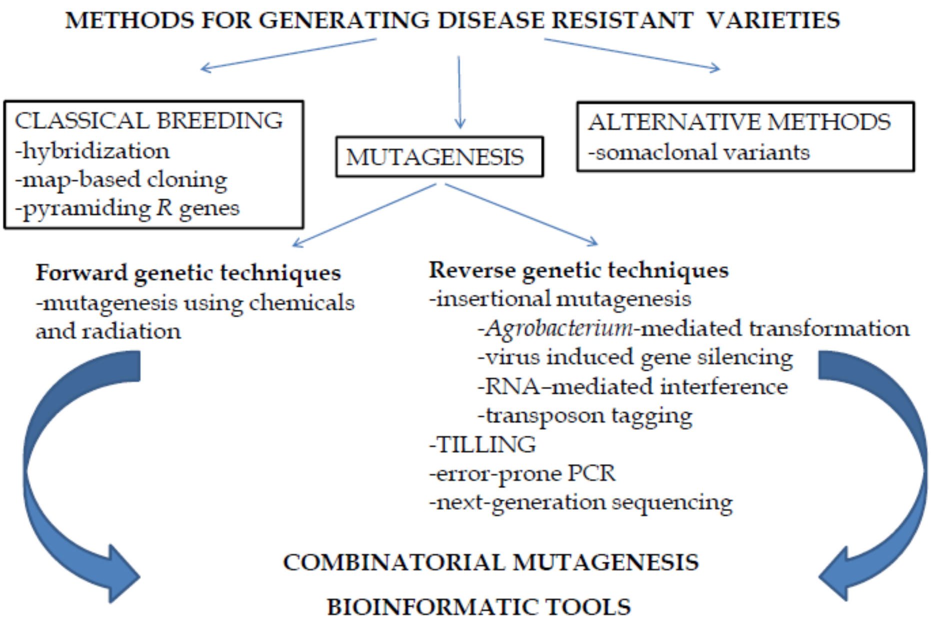


Fig.: *Breeding methods for disease resistance (taken from Kozjak and Meglic, 2012)*

Mushroom and Spawn Production: A Successful Entrepreneurship

Sachin Gupta, Baby Summuna*, Anil Gupta and Ranbir Singh
*Division of Plant Pathology, SKUAST-J, Jammu, *SKUAST-K, Srinagar, Jammu & Kashmir*

Mushroom cultivation is increasingly becoming popular because it not only meets the dietary requirements but also adds to the income, especially of growers with very less land. It is really amazing that a small quantity of spawn when planted in suitable growing medium can, within almost six weeks, grow into a highly profitable crop inside a room. Moreover, mushrooms have more uses in modern culinary cuisine than any other food crop. Mushroom cultivation can be carried out indoor in any room, shed, basement, garage, etc. which is well ventilated, paddy straw mushroom being the exception as it can be grown outside in shady places also.

Mushroom cultivation can help reduce vulnerability to poverty and strengthens livelihood through the generation of a fast yielding and nutritious source of food and a reliable source of income. Since it does not require access to land, mushroom cultivation is a viable and attractive activity for both rural farmers and semi-urban dwellers. Small-scale growing does not include any significant capital investment: mushroom substrate can be prepared from any clean agricultural waste material and mushrooms can be produced in temporary clean shelters. They can be cultivated on a part-time basis and require little maintenance. Indirectly, mushroom cultivation also provides opportunities for improving the sustainability of small farming systems through the recycling of organic matter, which can be used as a growing substrate and then returned to the land as fertilizer. Through the provision of income and improved nutrition, successful cultivation and trade in mushrooms can strengthen livelihood assets, which can not only reduce vulnerability to natural calamities, but enhance an individual’s and a community’s capacity to act upon other economic opportunities.

Among the cultivated mushrooms, only four types *viz*. button mushroom (*Agaricus bisporus*), straw mushroom (*Volvariella volvacea*), oyster mushroom (*Pleurotus* spp.) and milky mushroom (*Calocybe indica*) are being commercially cultivated in India. Button mushroom is grown in winter. The most suitable temperature for the spread of the mycelium is 24-25°C, while 16-18°C is essential for the formation of fruit bodies. Higher temperature is harmful and low temperature retards the development of both mushroom mycelium and fruit bodies. Paddy straw mushroom can be grown around 35°C. Temperature should not go below 30°C or above 40°C for more than 4-8 hours during growing period. However, Dhingri (oyster mushroom) grows best between 22-28°C.

Nutritional value

Mushrooms add flavour to bland staple foods and are a valuable food in their own right: they are often considered to provide a fair substitute for meat, with at least a comparable nutritional value to many vegetables. The consumption of mushrooms can make a valuable addition to the often unbalanced diet of people from developing countries. Fresh mushrooms have high water content, around 90 percent, so drying them is an effective way to both prolonger their shelf-life and preserve their flavour and nutrients. Mushrooms are a good source of vitamin B, C and D, including niacin, riboflavin, thiamine, and folate and various minerals including potassium, phosphorus, calcium, magnesium, iron and copper. They provide carbohydrates but are low in fat as well as fibre and contain no starch. Furthermore, edible mushrooms are an excellent source of high quality protein and white button mushrooms contain more protein than kidney beans. In addition to all the essential amino acids, some mushrooms have medicinal benefits of certain polysaccharides, which are known to boost the immune system.

Medicinal value

Recently, there has been a spectacular growth in commercial activity associated with dietary supplements, functional foods and other products that are ‘more than just food’. Medicinal fungi have been routinely been used in traditional Chinese medicine. Today, an estimated six percent of edible mushrooms are known to have medicinal properties and can be found in health tonics, tinctures, teas, soups and herbal formulas. *Lentinula edodes* (shiitake) and *Volvariella volvacea* (Chinese or straw mushroom) are edible fungi with medicinal properties widely diffused and cultivated. The medicinal properties of mushrooms depend on several bioactive compounds and their bioactivity depends on how mushrooms are prepared and consumed. Shiitake are said to have anti-tumour and antiviral properties and remove serum cholesterol from the blood stream. Other species, such as *Pleurotus*, *Auricularia*, *Flammulina*, *Termella* and *Grifola*, all have varying degrees of immune system boosting, lipid-lowering, anti-tumour, antimicrobial and antiviral properties, blood pressure regulating and other therapeutic effects. Mushrooms represent a vast source of yet undiscovered potent pharmaceutical products and their biochemistry merits further investigation.

Economic benefits of mushroom cultivation:

Mushroom cultivation activities can play an important role in supporting and enhancing the local economy by contributing to subsistence food security, nutrition and medicine; generating additional employment and income through local, regional and national trade and offering opportunities for processing enterprises.

Income from mushrooms can supplement cash flow, providing either:

- A safety net during critical times, preventing people falling into greater poverty;
- A gap-filling activity which can help spread income and generally make poverty more bearable through improved nutrition and higher income; or
- A stepping stone activity to help make people less poor, or even permanently lift them out of poverty.

Essentials of mushroom cultivation

Unlike the leaves of green plants, which contain chlorophyll to absorb light energy for photosynthesis, mushrooms rely on other plant material (the substrate) for their food.

Life cycle of a mushroom

The key life cycle stages for mushroom fungi are as follows:

Vegetative growth of the mycelium in the substrate

As spores released from the gills germinate and develop, they form hyphae which are the main mode of vegetative growth in fungi. Collectively, these are referred to as mycelium and these feed, grow and ultimately produce fruit bodies.

Reproductive growth in mushrooms:

Reproductive growth**s** of mushrooms occur when the fruit bodies are formed. The appearance of fruit bodies or mushroom varies according to the species, but generally all have a vertical stalk (stipe) and a head (pileus or cap).

Production of spores by the mushroom fruit bodies

The underside of the cap has gills or pores from which mushroom spores are produced. The mushroom produces several million spores in its life and this life cycle is repeated each time the spores germinate to form the mycelium.

Mushroom growing systems

Cultivated mushrooms are edible fungi that grow on decaying organic matter. Mushrooms obtain their nutrients in three basic ways:

1) **Saprophytic**, growing on dead organic matter. Saprophytic edible fungi can be wild harvested, but are most widely valued as a source of food and medicine in their cultivated forms. They need a constant supply of suitable organic matter to sustain production and in the wild this can be a limiting factor in production.
2) **Symbiotic**, growing in association with other organisms. The majority of wild edible fungi species (e.g. chanterelles-*Cantharellus* and *Amanita* species) are symbiotic and commonly form mycorrhizas with trees, where the fungus helps the tree gather water from a wider catchment and delivers nutrients from the soil that the tree cannot access and the tree provides the fungus with essential carbohydrates.

3) **Pathogenic** or parasitic plant pathogenic fungi cause diseases of plants and a small number of these microfungi are eaten in the form of infected host material.

Essentially, mushroom species can be cultivated in two ways:

Composted substrates: Wheat and rice straw, corn cobs, hay, water hyacinth, composted manure, and various other agricultural by-products including coffee husks and banana leaves.

Woody substrates: Logs or sawdust. Generally, each mushroom species prefers a particular growing medium, although some species can grow on a wide range of materials eg. saprophytic species. Some mushrooms-matsutakes and chanterelles - can also be cultivated by inoculation of tree roots with species that form mycorrhizae that then infect the roots, as with truffles;

Key steps in mushroom production

The basic concept in cultivation is to start with some mushroom spores, which grow into mycelium and expand into a mass sufficient in volume and stored up energy to support the final phase of the mushroom reproductive cycle which is the formation of fruiting bodies or mushrooms.

The key generic steps in mushroom production - a cycle that takes between one to three months from start to finish depending on species - are:

1) Identifying and cleaning a dedicated room or building in which temperature, moisture and sanitary conditions can be controlled to grow mushrooms in;
2) Choosing a growing medium and storing the raw ingredients in a clean place under cover and protected from rain;
3) Pasteurising or sterilizing the medium and bags in which or tables on which mushrooms will be grown.
4) Seeding the beds with spawn (Spawning)
5) Maintaining optimal temperature, moisture, hygiene and other conditions for mycelium growth and fruiting, which is the most challenging step; adding water to the substrate to raise the moisture content since it helps ensure efficient sterilization.
6) Harvesting and eating, or processing, packaging and selling the mushrooms.
7) Cleaning the facility and beginning again.

Spawn and inoculation

Mushroom spawn is purchased from specialist mushroom spawn producers, and there are several types or strains of spawn for each type of mushroom. It is not generally advisable for mushroom growers to procure spawn from a reliable source because of the care needed to maintain the quality of spawn in the production process. Spawn is produced by inoculating a pasteurised medium, usually grain, with the sterile culture (grown from spores) of a particular mushroom species. The cheapest cultivation system using composted substrate is one where mushrooms are grown in plastic bags containing substrate or compost in a simple building to provide controlled growing conditions. Wooden trays of different sizes can also be arranged in stacks to provide a useful cultivating space. Spawn is added to the sterilized/pasteurised substrate under hygienic conditions, in an enclosed space, and mixed thoroughly to ensure that the mushroom mycelium grows evenly throughout the substrate.

Maintaining suitable growing conditions

The inoculated substrate is put into bags, trays etc. and transferred to an enclosed and darkened room or building to incubate for a period of up to 12 weeks, depending on the variety of mushroom. If space is limited, plastic bags can be suspended or hanged in darkened rooms. Humidity levels are important for the mycelium to colonise over the next two weeks, so water needs to be available, and the temperature controlled accordingly to the variety of mushroom. The crop should be protected from sunlight and strong winds at all times, which can cause the mushrooms to dry out. Humidity can be maintained in the growing room by hanging wet rags at several points around the walls or watering the floor while temperature can be regulated by a using a table fan blowing over a container of water, and air circulating between the sacks should help assist with temperature regulation. It is essential to maintain hygienic conditions over the general cropping area, in order to protect the crop from contamination.

Constraints in mushroom cultivation

The major constraints faced in mushroom cultivation are as follows:

Financial constraints

- Huge investment on infrastructure
- Lack of working capital
- Huge cost of inputs
- Huge cost of electricity
- High cost of labour
- High cost of land acquisition

Situational constraints

- Unsuitable climate for mushroom cultivation
- Non availability of spawn
- Non availability of poultry manure
- Non availability of straw/ bagasse
- Non availability of gypsum and other chemicals
- Insufficient electricity supply
- Lack of skilled labour
- Lack of good quality ground water
- Contamination in spawn
- Maturity of spawn

Technological constraints

- Lack of technical information
- Exploitation by consultants
- Long gestation period
- Spawn standards
- Pest and disease problem

Marketing constraints

- Lack of market information
- Market accessibility
- Lack of transport
- Lack of storage facility
- No good price for mushrooms
- Exploitation by middlemen
- Quality standards

In general, mushroom cultivation can be successfully adopted by farming woman and unemployed youth for self sustenance and by its adoption they can prove to be successful entrepreneurs. This small step can lead to great nutritional security of the nation. Efforts should be made to motivate unemployed youth and farming women to adopt mushroom cultivation as a successful entrepreneurship.

Recent Trends in Diagnosis of Bacterial Diseases of Plants

Dinesh Singh

Division of Plant Pathology, ICAR- Indian Agricultural Research Institute, Pusa, New Delhi- 110012
Email: dineshiari@rediffmail.com

Bacteria are a second important pathogen after fungi to cause plant diseases. In India, more than 200 diseases of plants are known and out of these, 75 bacterial diseases are of economic importance. They damage the crops by reduction of assimilating surface by yellowing and necrosis, death of organs complete plants, malformation and growth reduction. Losses caused by bacterial diseases are mainly economic, but may also be personal or aesthetic. The estimated loss due to bacteria is varied from disease to disease, environmental conditions and also place to place. However, the losses due to some important bacterial diseases caused by *Pseudomonas syringae* pv *glycinea* (64%), *Ralstonia solanacearum* (9%), *Xanthomonas axonopodis* pv. *malvacearum* (5%) and *Xanthomonas campestris* pv. *campestris* (5%). In any plant diseases management, correct diagnosis is play vital role. There are 8 steps in diagnosis such as assessment of symptoms (leaf spot, excrescences and galls, tumours, wilting, necrosis rotting bacteria embedded in slime), isolation pathogenic bacteria, pure culture isolated bacteria, identification of pure culture, pathogenicity, reisolation from inoculated plants, reidentification of reisolate and diagnosis report. Several methods for diagnosis are now available, which can be divided into two groups as direct and indirect methods. The directs methods are growing on tests, visual observation on dry seeds, examination of seeds under UV, selective media, infectivity tests to diagnose bacterial pathogens. However, these methods require at least technical knowledge/competence, but these can be expensive, time consuming and in many cases rather inconclusive. These many therefore serve the purpose as presumptive tests only. In indirect detection includes viable and non- viable methods and these methods are host plant inoculation, use of selective media for isolation, serology, fatty acid analysis, profile and use of nucleic acid probe/ primers. The most commonly used assays for bacteria detection and identification are agglutination, enzyme-linked immunosorbent assay (ELISA), immunofluorescence, lateral flow strip tests or flow-through assays immunodiagnostic assays using *R. solanacearum* specific. Antibodies are proteins that are used by the immune system to identify and neutralize foreign objects, such as bacteria. Now days DNA based detection of phytopathogenic bacteria is more common, which is rapid, sensitive and specific to detect the bacteria even in latent period. However, classical PCR (Polymerase chain reaction) and BIO- PCR techniques had the advantage of not requiring pathogenicity to confirm the identity of colonies tentatively identified. The PCR sensitivity can be increased by in several ways like BIO- PCR, nested PCR, immunocapture and multiple displacement amplification (MDA) techniques. In real-time PCR provides much greater quantification range, greater sensitivity, reduced risk of samples contamination and a greater amenity to multiplexing. Multiplex polymerase chain reaction (PCR) protocol has been developed for simultaneous detection of *Ralstonia solanacearum* and *Erwiniacarotovora* subsp. *carotovora* from potato tubers. A set of oligos targeting the pectatelyase (pel) gene of *E. carotovora* subsp. *Carotovora* and the universal primers based on 16S r RNA gene of *R. solanacearum* were used. The standardized multiplex PCR protocol could detect *R. solanacearum* and *E. carotovora* subsp. *Carotovora* up to 0.01 and 1.0 ng of genomic DNA, respectively. A multiplex real-time PCR method to detect simultaneously *Clavibacter michiganensis* subsp. *sepedonicus* and *R. solanacearum,* causing ring rot and brown rot disease in potato respectively. The detection limit of developed duplex was at least 100 cfu/ml of potato macerate for each pathogen. The LAMP method proved to be the best approach for amplifying nucleic acid with high specificity, efficiency, and rapidity without the need for thermocycling. The principle is based on strand displacement activity followed by amplification using a unique DNA polymerase and a set of four specially designed primers that recognize a total of six distinct sequences on the target DNA. Species-specific primers are designed by targeting the *R. solanacearum fli* C gene coding for flagellar proteins or other conserve genes. Amplification performed for 60 min at 65°C resulted in production of magnesium pyrophosphate, which increased the turbidity of the solution, permitting visual assessment. The LAMP product was detected only in samples containing *R. solanacearum* and not from other species.

Molecular Approaches in Plant Disease Resistance

R.K. Salgotra[1*], Manmohan Sharma[1], Shahid Ahamad[2] and Jag Paul Sharma[2]

*1School fo Biotechnology, 2Directorate of Research, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Chatha, Jammu-190008 (J & K), India *E-mail: rks_2959@rediffmail.com,*

Abstract

The future of sustainable agriculture will increasingly rely on the integration of biotechnology with traditional agricultural practices. Resistance to nearly all pathogens occurs abundantly in our crops. Plant breeders have used disease resistance genes (R-genes) to control plant disease since the turn of the century. Molecular cloning of R-genes that enable plants to resist a diverse range of pathogens has revealed that the proteins encoded by these genes have several features in common. Understanding acquired resistance may open interesting approaches to control pathogens. This is even truer for molecular techniques, which already represent an enormously wide range of possibilities. While searching for disease resistance genes, molecular approaches have been found to be more result oriented involving less time and efforts in identification, isolation, cloning and transfer of disease resistance genes across genera and species. Molecular geneticists are now focusing more on mapping and tagging of disease resistance genes and making such information available to scientific community across the world.

Plant pathogens represent real threat to world agriculture. More than 70% of all major crop diseases are caused by fungi (Agrios, 2005). Crops of all kinds often suffer heavy losses. Fungal plant diseases are usually managed with applications of chemical fungicides. For some diseases, chemical control is very effective, but it is often non-specific in its effects, killing beneficial organisms as well as pathogens, and it may have undesirable health, safety, and environmental risks (Cavrilescua and Chisti, 2005). Control of disease is a subject of great interest for biotechnologists. Biotechnology will enhance our understanding of the mechanisms that control a plant ability to recognize and defend itself against disease causing fungi (Punja, 2007). An attack by disease-causing organisms generates a complex immune response in a plant, resulting in the production of disease-specific proteins involved in plant defense and in limiting the spread of infection. Pathogens also produce proteins and toxins to facilitate their infection, before disease symptoms appear. These molecules play vital role in the development of plant diagnostic kits. To save plants from irreparable damage by pathogens, farmers have to be able to identify an infection even before it becomes visible. The future of sustainable agriculture will increasingly rely on the integration of biotechnology with traditional agricultural practices.

Molecular basis of plant responses to pathogen invasion

At the molecular level, defense systems often depend on the combination of a specific set of dominant R-genes in the plant and a corresponding set of dominant avirulence (*Avr*) genes in the pathogen (Keen, 1990). Expression of the *Avr* genes triggers plant defense responses governed by the product of the R gene (Bogdanove, 2002). This gene-for-gene resistance strategy underlies the molecular basis of defense systems in plants. The strategy was originally proposed by Flor (1955) when studying resistance to the rust disease of flax. This molecular basis is defined by a single plant R gene for a single pathogen *Avr* gene, hence the name gene-for-gene resistance. According to the terminology involved in gene-for-gene resistance, when the plant is resistant, the pathogen is said to be avirulent and the interaction is said to be incompatible. When the plant is susceptible, the pathogen is said to be virulent and the interaction is said to be compatible. In a given plant-pathogen interaction, it is often possible that more than one specific combination of *Avr* and R genes are operating at the same time, and such different combinations are often co-dominant. These multiple combinations reflect the complexity of defense mechanisms of the plant during pathogen attack. Physiological features such as K^+/H^+ exchange, rapid oxidative burst, hypersensitivity at the site of infection, crosslinking of plant cell walls, synthesis of antimicrobial compounds known as phytoalexins, and induction of pathogen-related proteins such as chitinases and glucanases (Lamb *et al*., 1989) represent some of the multiple metabolism turnover leading to disease resistance.

Signal perception and defense activation

The perception of inductive signals by plants has received considerable attention mainly as a consequence of recent data on clones and genes encoding signalling components. The first process in signal transduction is the perception of an extracellular signal and its transmission via the plasma membrane, resulting in accumulation of intracellular signaling molecules and induction of a phosphorylation/dephosphorylation cascade, a cue system for the activation of R-gene expression. Plant recognition of pathogens is mediated by large families of highly polymorphic R genes. The products of these genes function to recognize directly or indirectly the products of pathogen coded *Avr* genes. The majority of the identified R genes encode for intracellular proteins containing a predicted nucleotide binding site (NBS) followed by a series of leucine-rich repeats (LRR) at their C termini, although some R genes are notably different (Xiao *et al*., 2001). NBS-LRR resistance proteins generally contain one of two types of N-terminal domains. These are either a domain that has homology with the Toll and Interleukin-1 Receptor proteins (TIR) or a predicted coiled-coil domain (CC). Studies of resistance proteins have indicated that the highly variable LRR domains determine recognition of the pathogen Avr products (Dodds *et al*., 2001; Ellis *et al*., 1999; Jia *et al*., 2000), whereas the more conserved TIRNBS or CC-NBS regions are believed to propagate the perception signal (Tao *et al*., 2000). A favored model based on genetic data postulates that R proteins (products of R genes) act as receptors for pathogen encoded Avr proteins to initiate a signal, which activates plant defense responses to arrest pathogen propagation.

The R-genes and genes encoding signal transduction proteins possess loci at their downstream sequences for production of pathogenesis-related proteins (PRs), enzymes involved in the generation of phytoalexins and protection of plants from oxidative stress, tissue repair, and lignification. Eleven pathogenesis-related protein families from different plant species have been characterized and classified according to sequence similarities (Van Loon, 1997). They were found to play different protective roles against pathogens. Despite these significant insights into R gene structure, much remains to be elucidated. Interestingly for example, the NBS-LRR class of R genes represents only 1% of the *Arabidopsis* genome (Ellis *et al*., 2000). This indicates the probable involvement of many other gene families in defense responses.

Resistance at cellular level

Investigations for the study of host-parasite systems at the cellular level have revealed that the resistance gene encoded proteins (receptors) act as sensors on and inside the cell membrane. Whenever these resistance gene products come in contact with their specific pathogen gene product (ligand or elicitor), the signal is transferred inside the cell. This signal transfer leads to ionic imbalance, increase in Ca2+ ions in cytoplasm, production of reactive oxygen species (ROS like; H_2O_2, Nitric oxide) and salicylic acid. Production of ROS in the cytoplasm has not only been found in plants but also in animals like human beings under stress conditions. In order to reduce these ROS and bring the plants to normal condition, biochemists suggest the application of peroxidases and catalases. Any of the above conditions present in the cell stimulate the defense response genes. This defense response is often in the form of localized cell death caused by the production of phytoallexins. This receptor-ligand interaction model holds true for fungal, bacterial and viral as well as in insect related resistance gene responses (Khan, 2009).

Molecular mapping of disease resistance genes

The process of locating genes of interest via linkage to markers is referred as gene tagging. The tagging of disease resistance genes with molecular markers involves the evaluation of classical phenotype for resistance and molecular marker genotype on the same individuals and the data is analysed to determine, if any of the markers co-segregates with the target phenotype. A molecular marker closely linked to a resistance gene can be used for indirect selection of the genes in breeding programme. There are various methods of developing DNA markers linked to the R-genes. The basic requirement of tagging plant disease resistance genes with molecular markers is the development of a mapping population. NILs differing for single gene for resistance are considered a very good material for use in R-gene mapping experiments, NILs are developed by crossing resistant individuals with universally susceptible plants and back crossed for 6-7 generations with the susceptible recurrent parent to get homozygous resistant lines, which differ only for one gene for resistance. The NILs which differ by the presence or absence of a specific R-gene are crossed.

The F_2 segregating population is analysed for detecting DNA polymorphism using one of the DNA markers technology. Polymorphic bands produced between resistant and susceptible lines are analysed for their linkages with the R-gene(s). In those cases where NILs are not available, RILs are used, RILs can be produced by making crosses between resistant and susceptible lines by using single seed descent method in seven or more generations. Plant disease resistance is many times controlled by multiple genes. These genes are difficult to detect in F_2 populations of NILs. Therefore, for such analysis of resistance, fixed populations of doubled haploids are produced by using anther culture technique, and thus plants with 100% homozygocity can be produced after a single generation. In those cases where NILs are not available, bulk segregant analysis (BSA) is the method of choice. In this method, polymorphisms survey is conducted in the DNA bulks made from resistant and susceptible F2 plants. Each resistant and susceptible bulk consists of individuals homozygous for all the characters, which differ genetically for the regions cointaining R-genes. The R-genes tightly linked to the markers produced polymorphic band between R-bulk and S-bulk. While, unlinked regions give rise to monomorphic banding pattern. There are many reports available on molecular mapping of R-gene in different host- pathogen interactions (Mohan *et al*, 1997; Sharma *et al.*, 1999).

Deployment of resistance gene in crop improvement

The genes involved in qualitative resistance and quantitative resistance are significant in providing resistance against pathogens, widely used in crop improvement. The R gene-mediated resistance or effector triggered immunity in crop varieties involves direct or indirect recognition of complementary pathogen effector protein which halting the disease. The resistance provided by R-genes is a major strategy to control the diseases. The use of host resistance generally involves introduction of single or multiple genes into susceptible cultivars via backcrossing or more recently genetic engineering approaches. Through the genetically modified plant approach, a minimum of 10-15 years could be saved as compared to the conventional breeding approaches. However, R-genes are vulnerable to evolutionary potential of pathogens as a result of which resistance provided by single R-gene is not durable as observed in many cases, *e.g.* resistance mediated by *Rlm* gene was overcome within five years of its deployment in *Brassica*. Several recent studies show that the management strategies of resistance source could be useful for achieving durability of race specific resistance genes. With regards to durability, the selection of R-genes and previous knowledge about genetic background of susceptible cultivar into which R-gene introgression applied is very important. Gene stacking or pyramiding or combination of genes in a single genotype in place of single R gene is expected to overcome the evolutionary effect of pathogen virulence thereby increasing durability.

Gene pyramiding is the technique of combining more than one gene for resistance in a common genetic background by the repeated back crossing and selection with the virulent races of the pathogen. The technique is highly effective in getting durable resistance to the target pathogen. Using conventional methods, it is really very difficult to pyramid 2-3 genes in a cultivar through crossing and normal screening procedures, since, presence of one gene in the plant masks the effect of others. Secondly, there should be specific pathogen races (isolates) to discriminate both the R-genes separately so that screening of both the genes can be done in segregating populations. In such cases, DNA markers highly linked to the R-gene can be used for detecting the presence or absence of both the genes in each plant after molecular analysis.

Marker assisted gene pyramiding has been used successfully for development of disease resistance in number of crops. Gene stacking and rotation of R-genes lowers the evolutionary risk posed by the pathogen in comparison to single R gene deployment in monoculture. Genetic engineering can be used to attain durability and broad spectrum resistance through introgression of gene stacking of R-genes into susceptible cultivars. Depending on the crop, stacking via genetic engineering may commonly be more practical as compared to other breeding techniques. This kind of R-gene cooperation may be deployed in different crops to enhance durability and broad spectrum resistance. It has been noticed that the transfer of R-genes between unrelated species shows good success rate in attainment of durable disease resistance. Further studies are under way for how to achieve durability of resistance using R-genes. Recently RNAi technology has emerged as one of the most potential and promising strategies for enhancing the building of resistance in plants to combat various fungal, bacterial, viral and nematode diseases causing huge losses in important agricultural crops. The nature of this biological phenomenon has been evaluated in a number of host-pathogen systems and effectively used to silence the action of pathogen. RNAi technology illustrate the possibilities for commercial exploitation of this inherent biological mechanism to generate disease-resistant plants in the future by taking advantage of this approach.

Conclusion

Plant pathogens are a serious threat to plant and crop productivity. A sustainable and eco-friendly biological strategy is needed to overcome this problem. Identification of disease resistance gene opens new avenues to develop molecular marker linked with these resistance genes in different crops. Despite the identification of a number of candidate resistance gene in various plants has remained a great challenge due to clustering of resistance genes and occurrence of polyploidy in many plants. The use of resistance genes could become a unique approach to develop resistant cultivars and control various plant diseases. The development of a disease resistant variety through the insertion of cis resistance gene and trans resistance gene will be required in future taking concern to the ethical policies. Another aspect is durability and broad spectrum resistance in resistant cultivar which is very important for developing a disease resistant variety. Several research approaches are in progress to achieve such durability and broad spectrum disease resistance. Hopefully, the coming time will be of genetically modified disease resistant crops to face such upcoming challenge ahead.

Theme-I

Integrated Disease Management in Important Vegetable

ORAL PRESENTATIONS

1A.1

Multi-location IPM Technology validation for protected cultivation through network approach

Jitendra Singh and Nasim Ahmad
ICAR-National Research Centre for Integrated Pest Management, Pusa Campus, New Delhi-110012

IPM practices were applied for tomato and capsicum cultivation under poly-house conditions at village Gillakhera, Haryana. Healthy nurseries of indeterminate tomato cv GS-600 and coloured *Capsicum* cv oroville were grown in plastic portable trays using soilless medium (Cocopeat, vermiculite) based on standard protocols under net-house conditions. Seeds of tomato and capsicum were treated with NCIPM strain of *Trichoderma harzianum* (2 x 10^8 CFU/g) @ 5g/kg seeds. Nurseries were sprayed by *Verticillium lecanni* for the protection against sucking pests. Before transplantation of tomato and capsicum inside the poly-houses, soil amendments were carried out using mustard straw @ 1 kg/m^2 and three times of irrigated (flood) for nematode management. Seedlings of both the crops were transplanted on raised beds (1 x 42 m) and drip irrigation system was installed for controlled and scheduled irrigation. As per recommended doses, the water soluble fertilizers and inputs for pest control measures were applied through ventury irrigation system (fertigation). A lateral single inline of LLDPE with 16 mm of diameter and with 40 cm dripper spacing were laid along with each row of the crops. The discharge rate of inline dripper was 4 LPH (liter per hour). Similarly, foggers (14 LPH discharge) were also used to maintain percent relative humidity (70-80%) inside the poly-house conditions, which is very useful for highest quality produce in terms of marketable yield. Tomato and capsicum were transplanted in first week of October, 2016 treated with imidacloprid seedling root dipping (17.8% SL, @ 7.0 ml/ L) for 15 minutes. *T. harzianum* enriched FYM (2 kg/m^2) was applied in the beds. In this way poly-house conditions provided favourable microclimate for plant growth. Finally carbendazim (50% WP) was also supplemented for the management of soil borne diseases. As per observations, higher fruit weight, yield and good quality of tomato and capsicum were found under poly-house conditions. Comparatively less infestation of whitefly, aphid and mealybug was observed inside the polyhouses. Weekly treatment of *V. lecanii* was found quite effective for the management of sucking pests. Minor *Phythohpthora* infection was recorded, which was managed by the soil treatment of *T. harzianum* by ventury along with irrigation. No early and late blight infection was found in tomato. Very good marketable yield of tomato and capsicum was achieved and on an average it was 9.5 kg/plant and 3.6 kg/plant for tomato and capsicum respectively with bigger fruit sizes. Whereas in open field conditions, poor plant growth with reduced yield was observed that were only 3.3 kg/plant for toamto and 1.6 kg/plant for capsicum with comparatively smaller fruit sizes.

1A.2

Management of purple blotch in onion

Anamika Jamwal[1], Sonika Jamwal[2], Amrish Vaid[1], Upma Dutta[3], A.C. Jha[2], Neerja Sharma[4], Sourav Gupta[1], Pawan Kumar Sharma[1], Vishal Mahajan[1] and Vijay Kumar Sharma[1]
[1]*Krishi Vigyan Kendra, Kathua;* [2]*ACRA-Dhiansar,* [3]*Division of Microbiology;* [4]*KVK- Samba*
Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu-180009
annajamwal@gmail.com

Purple blotch, commonly known as leaf blotch, caused by *Alternaria porri* is a serious disease of onion affecting both bulb and seed production by breaking of floral stalks and every year causing huge economic loss due to low yield also. Therefore, KVK-Kathua conducted On Farm Trial at different locations to evaluate the efficacy of fungicides on disease incidence. The results of OFT revealed that application of Ridomil MZ@0.25% resulted in reduction of purple blotch disease to an extent of 82.97% and increase the yield to the tune of 64.28% over farmers practice and application of Mancozeb @0.25% resulted in the increased yield of onion by 57.1%.

Key words: Onion. On Farm Trial, Purple blotch

1A.3

Chemical management of *Cladosporium carpophilum* causing scab in almond

Nassreen F. Kacho[1], Khurshid Hakeem[2], Mushtaq A. Bhat[2], Nazeer Ahmad[3], Mohd Hussain[4], Saba Banday[2] and Sabiha Ashraf[2]

[1]KVK Kargil, Ladakh, [2]Division of Plant Pathology, SKUAST-Kashmir, Srinagar;
[3]Vice Chancellor Secretariat, of SKUAST-Kashmir; [4]Govt. Degree College Kargil
ftmkacho898@mail.com

Six fungitoxicants namely copper oxycholoride 50 WP, carbendazim 50WP (0.05%), chlorothalonil 75 WP, difenaconazole 25 EC (0.03%), captan 50 WP (0.3%) and pyraclostrobin 60 WG were evaluated against *Cladosporium carpophilum* causing scab in almond. The tested fungitoxicants proved significantly effective as compared to check. The minimum leaf scab intensity of 1.92 per cent and twig intensity 2.48 per cent as compared to check (26.35 and 28.92%, respectively) were recorded in treatment T1 where copper oxycholoride 50 WP (0.3%) was applied at dormant stage beside carbendazim 50WP (0.05%), chlorothalonil 75 WP (0.3%), difenaconazole 25 EC (0.03%), captan 50 WP (0.3%) and pyraclostrobin 60 WG (0.025%) applied at pink bud, petal fall, fruit let, 15 days after fruitlet and 30 days after fruitlet stages, respectively. Maximum leaves scab intensity of 16.83 per cent and twig intensity of 18.37 per cent were recorded in case of treatment T4 where only carbendazim 50WP (0.05%), chlorothalonil 75 WP (0.3%) and difenaconazole 25 EC (0.03%) were applied at respective phenological stages.

1A.4

Evaluation of fungicides for management of karnal bunt (*Tilletia indica*) of wheat

A.K. Singh[1], Anil Gupta[1], S.K. Singh[1], Ranbir Singh[1], V.B. Singh[2] and Sachin Gupta[1]

Division of Plant Pathology, Faculty of Agriculture, SKUAST of Jammu-180 009
[2]RRSS, Raya, SKUAST of Jammu-181143

The efficacy of different fungicides as seed treatment against karnal bunt (*Tilletia indica*) on wheat was carried out in SKUAST-J, Chatha during cropping seasons of 2015-16 and 2016-17. The efficacy of different fungicidal treatments *viz*., tebuconazole 6% FS, tebuconazole 2% DS and carboxin 75% WP along with control were evaluated against *Tilletia indica* causing karnal bunt disease. The minimum disease incidence of karnal bunt was recorded of 1.05-1.33 per cent in tebuconazole 6% FS @ 0.35 ml/kg of seeds for both the seasons. Tebuconazole 6% FS @ 0.30 ml/ kg of seeds also minimize the karnal bunt incidence (1.28 and 1.45%) and which was at par with the dose of Tebuconazole 6% FS @ 0.35 ml/ kg of seeds. Maximum incidence of Karnal Bunt (18.22 and 19.30%) was recorded in control. Tebuconazole @ 0.30-0.35 ml/kg of seeds was significantly reduced the karnal bunt incidence than the other treatments along with control.

1A.5

Bioprospecting of endophytic microorganisms from *Allium sativum*

Upma Dutta, Deepika Khajuria, Sachin Gupta, Sonika Jamwal and Anamika Jamwal
Division of Microbiology, faculty of Basic Sciences, SKUAST-J, Chatha-180009
paarthupma@gmail.com

Endophytes are microorganisms that reside within the inner parts of plants without causing any disease symptoms. The endophytes may provide protection and survival conditions to their host plant by producing a plethora of substances which may also have potential for use in industry, agriculture and medicine. *Allium sativum* is commonly known as garlic. Garlic contains an abundance of chemical compounds that have antimicrobial, anticancer and antioxidant activity. Healthy plant samples of *Allium sativum* were collected from different locations of Jammu. Total 20 bacterial and 15 fungal endophytes were isolated from leaves and bulbs of *Allium sativum*. All endophytes were subjected to screened for their antimicrobial activity against human pathogens *viz Salmonella typhi* and *Pseudomonas aeruginosa* obtained from IMTECH, Chandigarh and plant pathogens *viz. Rhizactonia solani* and *Macrophomina phaseolina* obtained from Division of Plant Pathology, SKUAST-J, Chatha, Jammu. Out of 20 bacterial isolates AL-2, AL-3, AB-6 and AB-7 showed significant results against *Salmonella typhi,* AL-5, AB-6 and AB-7 isolates showed significant results against *Pseudomonas aeruginosa,* AL-5, Al-9 and AB-6 showed significant results against *Rhizactonia solani.* Out of fifteen fungal isolates, isolate ALF-1, ALF-3, ALF-3, ALF-6 and ABF-8 showed best results against *Psudomonas aeruginosa*, ALF-3, ALF-6, ABF-6 and ABF-8 showed best results against Salmonella typhi, ALF-1 and ABF-8 showed best results against *Rhizactonia solani*. None of the bacterial and fungal endophyte showed antimicrobial activity against *Macrophomina phaseolina.* The effective bacterial isolates were identified on the basis of their morphological, biochemical and microscopic characteristics and the isolates identified belonged to *Pseudomonas* sp., *Bacillus* sp. and *Burkholderia* sp. Whereas, the effective fungal isolates were identified on the basis of their morphological and microscopic characteristics and the isolates identified belonged to *Alternaria* sp., *Aspergillus* sp., *Phoma* sp., *Cladosporium* sp. and *Fusarium* sp. Bacterial and fungal endophytes isolated from *Allium sativum* showed antimicrobial activities against human and plant pathogens. So, these endophytes can be further used for the production of antibiotics and drug development.

1A.6

Prevalence and management of powdery mildew (*Oidium mangiferae*) of mango under rainfed sub-tropics of Jammu

V.B. Singh[1], Neeraj Gupta[1], A.K. Singh[2], Rakesh Kumar[1], S.K. Singh[2] and Vijay Kumar[1]
[1]*Rainfed Research Sub-station for Sub-tropical Fruits, Raya, SKUAST-Jammu (181143)*
[2]*Division of Plant Pathology, FoA, Chatha, SKUAST-Jammu (180009)*

An intensive survey was conducted during flowering stage of mango orchard in different areas of Jammu for occurrence and incidence of powdery mildew during the two consecutive seasons 2014-15 and 2015-16. The disease ranged to the tune of 8.5-42.5 per cent. The Maximum incidence (42.5%) was recorded in village Badhori in district Samba. It was followed by Guraslathia (37.8%) and Baroi (28.50%) powdery mildew incidence. It was also recorded that older and desi mango trees were more susceptible against powdery mildew. For the management of powdery mildew disease in mango, trials were conducted during the two consecutive seasons 2014-15 and 2015-16 in randomized block design, where in, six fungicides i.e. copper oxychloride (0.25%), carbendazim (0.1%), wettable sulphur (0.2%), mancozeb (0.25%), hexaconazole (0.1%) and dinocap (0.1%) along with two plant extracts i.e. Drake seed kernel extract (DSKE 4.0%) and neem seed kernel extract (NSKE 4.0%) were tested for their efficacy to manage the powdery mildew of mango The fungicides and plant extracts were sprayed twice at 20.0% flowering stage and above 80% flowering stage. The fungicide hexaconazole was found most efficacious in reducing the disease severity (40.5.5%). It was followed

dinocap (32.5%). However, plant products NSKE and DSKE were less effective in managing the disease.

1A.7

Screening of Indian mustard (*Brassica juncea*) cultivars/lines for resistance against alternaria blight

M.K. Pandey[1], S.K. Rai[1], S.K. Gupta[1], Rajav Bharat[1] and A.P. Rai[2]

[1]*Division of Plant Breeding and Genetics,* [2]*Division of Soil Science*

Division of Plant Breeding and Genetics, FOA, SKUAST-J, Chatha, Jammu-180009

mukkp@yahoo.co.in

The study was conducted with the objective to assess the resistance source against alternaria blight in Indian mustard at Research Farm, Chatha, SKUAST-Jammu during Rabi 2015-16. None of the 30 cultivars/lines screened against blight of the mustard was found immune or highly resistant and resistant. The five cultivars/ lines TM-108, RH 1202, RL-JEB-84, VARUNA and SVJ-64 were found to be moderately Resistant (MR). Eighteen genotypes viz. SKJM-5, NPJ 196, NPJ-195, PR2012-12, RH 749, RL-JEB-52, RRN-871, RGN-385, RMM 09-10, DRMR 15-5, KMR 15-3, KMR 15-4, KM 126, GANGA, DRMRIJ 15-85, Kranti and Giriraj were found to be susceptible. Seven lines viz. PR-2012-9, RH-1209, Divya-88, SKM 1313, and Sitara Srinagar were found to be highly susceptible. Nine lines were categorized as highly susceptible.

Key words: Alternaria, Mustard, Blight, Disease Resistant

POSTER PRESENTATION

1B. 1

Integrated management of phomopsis blight of brinjal in Kashmir

Mudasir Bhat, Ali Anwar, M. Najeeb Mughal, Fayaz Mohiddin and Uzma Fayaz
Division of Plant Pathology, SKUAST-Kashmir-190025
mudasirpatho@gmail.com

Brinjal is also known as eggplant due to the shape of fruits of some varieties which are white and resemble the chicken eggs. In Jammu and Kashmir, it is cultivated over an area of 2.02 thousand hectares with an annual production of 45.24 thousand MT. In Kashmir it is grown as a warm season crop but is susceptible to severe frost. Brinjal is attacked by many fungal, bacterial, viral and nematode diseases of which Phomopsis blight caused by *Phomopsis vexans* is considered to be the most destructive and one of the major constraints of brinjal production. Management of Phomopsis blight of brinjal has mainly been through the use of fungicides. However, fungicide applications are only partially effective under environmental conditions that are favourable for pathogen infection. Furthermore, fungicides alone are not sustainable especially in small holding farming system in Kashmir, due to the high cost and risks to the environment. Keeping the prospects under the economic importance of the crop and amount of destruction by *P. vexans*, field evaluation of soil amendments, seed treatments with bioagents and fungitoxicants and foliar sprays with fungitoxicants during two cropping seasons of 2015 and 2016 were carried out. The results revealed significant disease control by all these treatments in both nursery and in transplanted field. Among all the treatments in nursery, highest seed germination of 94.72 per cent was recorded in soil amendment with vermicompost @ 7q/ha + seed treatment with carbendazim @ 2g/kg seed and the lowest seed germination 73.38 per cent but far better than control was recorded in soil amendment with FYM @ 10q/ha. In controlling damping off and seedling blight in nursery, the performance of the treatments were in similar trend of germination percentage. In transplanted field, the treatment combination viz. vermicompost @ 7q/ha as soil amendment + *T. viride* @ 5 kg/ha as soil amendment + carbendazim 50 WP @ 0.1% as root dip + carbendazim 50 WP @ 0.1% as foliar spray was noted as the best treatment against leaf blight, stem blight and fruit rot showing intensity values of 5.48, 0.95 and 5.63 per cent respectively while the lowest performance against *P.vexans* was recorded in the treatment Soil amendment with vermicompost @ 7q/ha showing intensity values of 19.29, 13.59 and 20.83 per cent respectively. Further, the highest fruit yield of 234.38 q/ha was also recorded in the same treatment combination.

1B. 2

Studies on spot blotch [*Bipolaris sorokiniana* (Sacc.) Shoem.] of wheat and its management

Manmohan Singh[1], S.K. Singh[1], A.K. Singh[1], V.B. Singh[2], Ranbir Singh[1], Sachin Gupta[1] and V.K. Razdan[1]
Division of Plant Pathology, Faculty of Agriculture, SKUAST of Jammu-180 009
[2]RRSS, Raya, SKUAST of Jammu-181143

The studies regarding status and management of *Bipolaris sorokiniana*, the causal organism of spot blotch of wheat and the yield loss caused by it was carried out in Jammu subtropics. The disease was reported in all the wheat growing areas of Jammu subtropics with the maximum AIDX observed in Kathua district with the range of 29.55-48.15 per cent, followed by Samba ranging from 29.28-45.82 per cent. However, minimum disease was observed in Jammu district (30.06-40.61%). The loss in grain yield varied from 9.43 to 27.88 per cent depending upon the disease severity in different genotypes, while in genotype Sonalika highest loss in 1000 grain weight (15.43%) was noticed followed by PBW-550 (13.14%) and least in HD-2967 (3.48%) was observed. Sixty two wheat genotypes were screened against spot blotch disease under artificially inoculated field conditions.

Wheat genotypes viz. HD-2967, HD-3043, HP-1102, HS-277, JAUW-598, PBW-660, PBW-692 and VL-907 were reported as resistant, while as, DBW-88, DL-784-3, DPW-621-50, HD-2733, HD-3059, HD-3086, HI-1563, HS-1138, HS-207, HS-375, HS-490, HS-507, HS-542, JAUW-584, JAUW-595, Narmada-112, RSP-561, VL-892, WH-1021, WH-1080, WH-1105, WH-1124, HS-507, RAJ-4037, HS-542, PDW-291 and PDW-314 were ranked as moderately resistant against B. sorokiniana. Propiconazole and tebuconazole both at 0.01 per cent were most effective, completely inhibiting the mycelial growth of pathogen (BS_9) followed by difenconazole (96.27%) at same dose, whereas, Trichoderma harzianum-1 proved best among the bioagents tested, inhibiting 77.90 per cent of mycelial growth of the pathogen under dual culture method. In field studies, propiconazole @ 0.1% significantly reduced the spot blotch disease (75.50%) and increased grain yield by 27.20 per cent of wheat followed by azoxystrobin, which also reduced disease severity (74.09%) and increased grain yield by 24.83 per cent of wheat.

1B. 3

In vitro evaluation of Chemicals against *Xanthomonas cucurbitae* causing bacterial leaf spot of bottle gourd

Deepak Kumar[1], Raivati Raman Sharma[1], M.C. Dwivedi[2] and V.K. Razdan[1]
[1]*Division of Plant Pathology,* [2]*Division of Agronom, SKUAST-J, Chatha, Jammu*
deepakksrivastava@rediffmail.com

Bottle gourd (*Lagnaria siceraria Mol.*) is one of the earliest domesticated vegetable crop plants belonging to the family cucurbitace. It is a monoecious, annual, climbing or trailing herb, with proximally bified tendrils. In Jammu Division of Jammu and Kashmir, bottle gourd is cultivated as a major summer season vegetable crop in an area of 715 ha with an annual production of 6596.5 M. tonnes (Anonymous, 2012). Bottle gourd is highly prone to several diseases, among which bacterial spot caused by *Xanthomonas cucurbitae* is one of the important disease with moderate to heavy losses of 10.07 to 70.61 per cent in Himachal Pradesh (Pruvost *et al.*, 2009 and Jarial *et al.*, 2011). The pathogenicity of *Xanthomonas cucurbitae* was tested by detached leaf method under *in-vitro* condition which confirmed the pathogenic nature of the organism. Bioassay of the antibiotics against the test bacterium *Xanthomonas cucurbitae* was done under *in vitro* conditions following the methodology described by the Skinner (1955). The microbial response/ sensitivity of the target bacterium were evaluated by measuring the inhibition zone around the disc of antibiotics on seeded plates. Three fungicides (copper oxychloride, mancozeb, carbendazim), six antibiotics (streptomycin, tagmycin, tetracycline, norfloxacin, ciprofloxacin and ofloxacin) and nine plant extracts [Dhatura (*Dhatura metal)*, Neem (*Azadirachta indica*), Madar or Aak (*Calotropis gigantae*), Kaner (*Thevetia peruviana)*, Tulsi **(***Ocium sanctum)*, Bhang (*Cannabis sativa*), Lantana (*Lantana camara)*, Karanj (*Pongamia pinnata)* and Draink (*Melia azedrach*)] were evaluated against the pathogen. The observation regarding the measurement of inhibition zone (clear area around the discs) was recorded after 48 hours of incubation. The result of the experiment showed that in case of fungicides copper oxychloride (1500 ppm) showed maximum inhibition zone of 15.80 mm followed by mancozeb (1250 ppm) with the inhibition zone of 9.50 mm. Carbendazim (500 ppm) was observed as the least effective chemical with 0.00 mm inhibition zone. The results showed that in case of antibiotics tagmycine gave maximum inhibition with the inhibition zone of 21.40 mm followed by tetracycline. Streptomycine was observed as the third best treatment with the inhibition zone of 20.40 mm. Ofloxacin was found to be least effective antibiotics against the pathogen. In case of plant extracts Aak gave maximum inhibition of the pathogen growth with an inhibition zone of 15.40 mm followed by Dhatura which showed an inhibition of 12.20 mm at 10 per cent concentration. Other plant extracts were not found effective in inhibiting the growth of the pathogen among nine plant extracts evaluated at 10 per cent concentration. The same trend of the result was observed in both the cases ie., 15 per cent and 20 per cent. Aak showed the inhibition zone of 17.50 and 18.60 mm at 15 per cent and 20 per cent respectively followed by Dhatura, which showed 14.50 and 17.50 mm at 15 per cent and 20 per cent, respectively.

1B. 4

Citrus phytophthora diseases: management and challenges

Mudasir Iqbal[1], V.K. Wali[1], V.K. Razdan[2], Parshant Bakshi[1], Mohsin Iqbal[2] and Darpreet Kour[1]

[1]Division of Fruit Science, [2]Division of Plant Pathology, Faculty of Agriculture, Main Campus, Chatha, SKUAST- Jammu, J&K-180009

mudasirkas111@gmail.com

Phytophthora spp. cause the most important soil and water-borne diseases of citrus. These pathogens are worldwide in distribution and cause significant citrus production losses in the high rainfall subtropics. Losses due to *Phytophthora* spp. may occur in seedbeds from damping-off; in nurseries from foot rot and root rot; in groves from foot rot, fibrous root rot, brown rot of fruit, and from further spread of the pathogen to adjacent fruit in packing boxes. The most serious disease caused by *Phytophthora* spp. is foot rot, also known as gummosis, where in drier climates the water-soluble gum is not washed from the trunk by rainfall. Infection of the scion occurs near the ground level, and produces lesions which extend down to the bud union on resistant rootstocks, or up the trunk into the major limbs of the tree. The cambium and inner bark are damaged and lesions spread around the circumference of the trunk, girdling the cambium and killing the tree. Nursery trees and young grove trees of small trunk circumference can be rapidly girdled and killed. Large *Phytophthora* spp. are much more prevalent in some years in certain locations, because these diseases are particularly damaging under wet or flooded conditions. Disease-related losses due to root rot are difficult to estimate because fibrous root damage and yield loss are not always directly proportional. Challenges from phytophthora diseases have been addressed by enacting phytosanitary requirements for production of pathogen-free nursery trees in enclosed structures, propagated from indexed and certified pathogen-free sources, in conjunction with several other cultural management practices. A statewide soil sampling program provides growers with soil propagule counts to estimate the damage that *Phytophthora* spp. are causing to fibrous roots. The results can be used along with rootstock tolerance, soils, topography, irrigation, and drainage to make a decision for the need to treat with fungicides in addition to modification of cultural managements. The production of clean stock has resulted in a low prevalence of phytophthora disease in newly established groves. The best solution for endemic *Phytophthora* spp. has been and will continue to be resistant rootstocks for minimizing risk of phytophthora disease-related losses. Most rootstocks are at least moderately resistant to bark infection, but vary widely in their susceptibility to root rot depending on the predominant *Phytophthora* spp. New rootstocks based on Trifoliate orange hybrids with Pummelo and Mandarin have been screened under the adverse soil, climate, disease, and pest conditions and also demonstrated to have resistance/ tolerance to *P. nicotianae* and *P. palmivora*. Given the increasing incidence of Huanglongbing (HLB) and deterioration of root density due to Las damage, research experiences and current phytophthora data trends suggest the need for more comprehensive management of root health by reducing the impact of abiotic and biotic stresses, including the interaction with Phytophthora spp.

1B. 5

In vitro evaluation of bio-agents against *Sphaceloma ampelinum* causing grape anthracnose in Kashmir

Uzma Fayaz, Saba Banday, Efath Shahnaz, N.A. Khan, Sheikh Adeeba and Rabia Latif

Division of Plant Pathology, SKUAST-Kashmir-190025

uzma78682@gmail.com

In J&K the area under grapes is 315 hectares with production of 129 million tonnes. Though Kashmir is not the principal center of grape cultivation, it was famous for producing quality juicy grapes in past. Grape is the host to a wide range of diseases which significantly impair its quality and production. However, the fungal diseases inflict huge losses to the crop. Among the fungal diseases anthracnose disease is considered to be the major threat to successful grape cultivation in Kashmir.

Sphaceloma ampelinum, the causal pathogen of grape anthracnose, is the anamorph stage of *Elsinoe ampelina*. Management of anthracnose disease in Kashmir has mainly been through the use of fungicides. However, fungicide applications are only partially effective under environmental conditions that are favourable for pathogen infection. Furthermore, fungicides are not sustainable especially in small holding farming system in Kashmir, due to the high cost and risks to the environment. Keeping the prospects under the economic importance of the crop and amount of destruction caused by the disease, one fungal and two bacterial biocontrol agents (BCAs) were evaluated under *in vitro* conditions for their antagonistic potential against *Sphaceloma ampelinum* isolated from grapes. Among the evaluated bioagents *T. harzianum* was found to be significantly superior to all showing 71.0 per cent inhibition followed by *Bacillus subtilis* (58.3%) and *Pseudomonas fluoresence* (39.5%). Studies on the mechanism of action using mycoparasitism technique and antibiosis observed under light microscope revealed that *T. harzianum* inhibited the growth of *S. ampelinum* by coiling and penetration into the hyphae. Consequently, the hyphae of *Sphaceloma ampelinum* became malformed and swollen. *Bacillus subtilis* and *Pseudomonas fluorescence* to lesser extent also caused mycelial malformation; the mycelia turned vacuoled and swollen in or at tips of hyphae.

1B. 6

Citrus greening disease- a major cause of citrus decline in the world

Shilpy Kumari, Akash Sharma and Vishal Gupta

Advanced Centre for Horticulture Research, Udheywalla, SKUAST- Jammu

0016.rsharma@gmail.com

Citrus Greening, also known as Huanglongbing (HLB), is considered to be the most destructive disease of citrus. It is transmitted by psyllid vectors identified as *Trioza erytreae* (Del Guerico) in Africa and *Diaphorina citri* (Kuwayama) in Asian countries. In India, the disease is spread by *Diaphorina citri*. Even a single psyllid was capable of spreading the pathogen. Infected trees may produce misshapen, unmarketable, bitter fruit. Citrus greening reduces the quantity and quality of citrus fruits, eventually rendering infected trees useless. The infected insect spreads the disease as it feeds on the leaves and stems of citrus trees. Once the Asian citrus psyllid picks up the disease, it carries it for the rest of its life. Citrus greening is then spread by moving infected plants and plant materials such as bud wood and even leaves. The disease is associated with a decline of citrus trees and is probably widespread in all the citrus growing countries of the world. It possesses a great potential to affect citrus trees of all cultivars and cause great damages to the citrus industry by shortening the productive life span of trees. Greening affects almost all citrus cultivars; relatives like sweet orange, tangelo and mandarin are the most susceptible, while lime, pummelo and trifoliate orange are the least susceptible. Different management strategies are needed to avoid a potential threat of greening disease. Purchase virus free healthy propagation material from reputable nurseries that use Auscitrus seed and budwood, which is routinely tested for disease. Young trees (less than four-year old) and those not bearing fruits and showing symptoms should be eradicated and replaced, whereas trees with fruit should be pruned. Trees infected up to 50-70% should be eradicated. Attempts have been made to control the vectors through different approaches e.g. by means of cultural, chemical or biological measures. The parasite (*Tamarixia radiata*) was found effective against the disease. Systemic insecticides like dimethoate controlled *D. citri*. Sometimes 44% Dimethoate EC and 40.64% carbofuran FP showed economically good control of the Psylla.

Key words: citrus greening disease, citrus decline, disease/ virus.

1B. 7

Citrus Decline- Causes and Control

Darpreet Kour, V.K. Wali, Nirmal Sharma, Parshant Bakshi, Deep Ji Bhat, Amit Jasrotia and Mudasir Iqbal

Division of Fruit Science, Faculty of Agriculture, Main Campus, Chatha, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009

darpreetkour@gmail.com

Citrus is considered to be one of the most remunerative fruit crops that have a lasting niche in international trade and world finance. Citrus is considered to be one of the most remunerative fruit crops that have a lasting niche in international trade and world finance. It is an important group of fruit crops in northern India, however affected by number of diseases and insect pests and one of the devastating factor in citrus fruit industry is citrus decline. Citrus decline or die back is not a specific disease but is a symptomatic expression of many disorders in the plant. In recent times it has also been reported in Jammu subtropics and various causes *viz.* orchard neglect, poor plant nutrition, water logging, fungal diseases and nematodes have been identified and found to be responsible for citrus decline. Since number of factors are involved which are responsible for citrus decline in India, therefore, an integrated management strategies involving proper nutrition, cultural practices, soil management, disease and insect-pest management etc. is required for checking this problem. Among insect control measures spraying of insecticide like Dimethoate, Phosphomidon, monocrotophos or aldicarb for aphid control has been suggested, whereas, spray of Carbendazim (100g/100L water) or Copper oxychloride (300 g/100L water) or Mancozeb (250 g/100L water) or Thiophanate methyl (100 ml/100L water) can be done for controlling fungal disease. Besides, adoption of integrated control measures like budwood certification, use of resistant rootstocks and fungicides/ insecticides can also help to check citrus decline.

1B. 8

Antibacterial efficiency of *Momordica charantia*

Arti Heer[1], Vikas Sharma[2], Sahil Gupta[3] and Madhulika Bhagat[4]

[1,2]Division of Biochemistry, Faculty of Basic Sciences, SKUAST-Jammu, Chatha, Jammu-180009, [3,4]School of Biotechnology, University of Jammu, Baba Saheb Ambedkar Road, Jammu-180006, India

aartee08@gmail.com

Indigenous plants are the first source of therapy for most of the common ailments because of availability, economic status of the users and incidence of resistant. Multiple drug resistance has been developed due to the indiscriminate use of commercial antimicrobial drugs. Antibiotics are associated with adverse effects on the host including hypersensitivity, immune-suppression and allergic reactions. In view of the alarming situation of antibiotic resistance in bacteria of medical importance, there is a constant need for new and effective therapeutic agents. Moreover, there are several reports on the antimicrobial activity of different herbal extracts in different regions of the world. *Momordica charantia*, a medicinal plant belonging to the family cucurbitaceae is found in tropical and subtropical regions of the world (India, Asia, South America) and widely used as food and medicine. Commonly known as bitter gourd or karela, the plant contains an array of biologically active chemicals including triterpens, proteins, steroids, alkaloids, saponins, flavonoids and acids due to which it possesses anti-fungal, anti-bacterial, anti-parasitic, anti-viral, anti-fertility and anti-carcinogenic properties. In the present research work, antibacterial potential of bitter gourd was evaluated against *Bacillus subtilis* (MTCC2389), *Staphylococcus aureus* (MTCC7443), *Escherichia coli* (MTCC2127), *Klebsiella pneumonia* (MTCC7162) and *Micrococcus luteus* (MTCC4821) *via* agar well diffusion method. Chloramphenicol was used as a positive reference and DMSO as a negative control. The minimum inhibitory concentration (MIC) was determined using broth micro dilution method (ranging from 62.5-2000 µg/mL). Results revealed that methanolic extract of *M. charantia* has potential to inhibit some pathogenic bacteria as it showed remarkable zone of inhibition against *M. luteus* (17.3±0.31

mm) followed by *B. subtilis* (17±0.32 mm), *S. aureus* (17±0.31 mm), *E. coli* (16.3±0.39 mm) and *K. pneumoniae* (16±0.42 mm). The present study showed that fruit part of *M. charantia* has a potency to act as a antimicrobial agent and isolation of active ingredient (responsible for the observed activity) is required.

Key words: *Momordica charantia*, karela, antibacterial, agar well-diffusion method

1B.9

Integrated disease management in cruciferous vegetables

***Qurat ul Ain*, Sheikh Bilal Ahmad, Jamal Ahmad, Munazah Yaqoob and Insha Hamid**

Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus-190025, Srinagar, J&K., INDIA

quratulain0017@gmail.com

Cruciferous vegetables grown in many parts of the world form an important component of human diet. They have great economic and commercial value due to their nutritional, medicinal, biocontrol and crop rotation properties. A significant loss in their production is incurred by plant diseases which are considered as an important biotic constraint. Important diseases of cruciferous vegetables include Black Leg (*Phoma lingam)*, Black Rot (*Xanthomonas campestris* pv. c*ampestris)*, Alternaria (*Alternaria brassicae)*, and Seed rot and damping off (*Pythium* spp). Integrated disease of management (IDM), which combines biological, cultural, physical and chemical control strategies in a holistic way are effective and sustainable for controlling these diseases. Fungi toxicants which form an inseparable tool were used in disease management programme of cruciferous vegetables but the WTO scenario focused on high quality disease free vegetable produce to withstand competition in international market, thus compel to shift away from the total dependence on the chemicals and adopt IDM strategies for plant disease management. One of the important tool to manage the diseases is exploitation of host plant resistance and use of resistant varieties. Cultural practices such as cultivation techniques, mulching, intercropping, plant density, planting date, crop rotation, strip farming, timing of harvest, barrier crops, crop mixtures, roguing, healthy planting material, soil solarization, soil amendments and fertilizer management, and water management used singly or in combination as tools for disease management. Use of bio agents and enforcement of strict quarantine has also aided in management of plant diseases. For cruciferous vegetables, integrated methods needed to control black leg and black rot diseases include use of disease-free seed, hot water treatment, or fungicide treatment of seed, maintaining good sanitation of planting beds, using crop rotation and planting resistant cultivars. Weed management and residue management are effective methods for managing Alternaria. Methods employed for managing clerotina include wider plant and row spacing, soil solarization, water management and crop rotation with a crop that is not susceptible to Sclerotinia (e.g., sweet corn). Downey mildew funguses (*Peronospora parasitica*) which overwinter on crop debris is favored by cool and moist weather conditions can be effectively managed by growing resistant varieties, water management, removal and destruction of crop residues. Moreover, use of bio-agents viz; *Trichoderma harizanum*, *Gliocaladium virens* and *Streptomyces griseus* has been found effective.

1B. 10

Guava anthracanose/ die back- causes and control

Arti Devi, Parshant Bakshi, V.K. Wali, Nirmal Sharma, Deep Ji Bhat and Amit Jasrotia

Division of Fruit Science, Faculty of Agriculture, SKUAST-Jammu, J&K-180009

artiskuastj@gmail.com

Guava (*Psidium guajava* L.) is an important fruit crop of India and is considered poor men’s apple. Guava is a very productive and highly profitable fruit crop. It is liked by fruit growers due to its wide adaptability and higher return per unit area. But its successful cultivation is hampered by anthracanose/die back disease. Anthracnose is the most commonly observed disease that affects both

pre- and postharvest management of guava. This disease can cause considerable postharvest losses and can affect young developing flowers and fruit. It has been reported in all guava-growing areas around the world where high rainfall and humidity are present. The characteristic symptoms consist of sunken, dark colored, necrotic lesions. Under humid conditions, the necrotic lesions become covered with pinkish spore masses. As the disease progresses, the small sunken lesions coalesce to form large necrotic patches affecting the flesh of the fruit. High rainfall, dense canopy and infected planting material and fungal diseases are the main causes for guava anthracanose. Since number of factors are involved which are responsible for guava anthracanose. Therefore, an integrated management strategies involving proper canopy management, timely harvesting and disease and insect-pest management etc. is required for checking this problem. The control measures include spraying copper oxychloride (300g/100L water), mancozeb (250 g/100L water) or captan (300g/100L water) soon after pruning, repeat spray at 15 days interval after fruit set. Spray of Bordeaux mixture (3:3:50) or Copper oxychloride (0.3%) just after initiation of disease.

1B. 11

Management of chickpea wilt caused by *fusarium oxysporium f.* sp. *ciceris*

S.K. Singh[1], Shahid Ahmad[1], Vikas Sharma[2], Reena[3] and Amitesh Sharma[4]

[1]Directorate of Research, [2,4] O.F.R.C., Chatha, [3]ACRA, Dhiansar, Bari Brahmana, Sher-E-Kashmir University of Agriculture Science& Technology-Jammu

In India, it has been reported from all the states where the crop is grown and causes an annual yield loss of 10%. Wilting occurs at two crop stages viz. early and late wilting which inflicts losses 77-94 and 24-65 percentage respectively. Biological control of plant diseases is presently crucial technique for an increasing crop yield and managed ecosystems. Therefore, an experiment was conducted during the years of 2011-12, 2012-13 and 2014-15 at farmer's field under the rigorous monitoring of PRSS, Samba, SKUAST-J. *In vitro* and *in vivo* studies on the effect of bio-agents and fungicides were carried out against the chickpea wilt incited *by Fusarium oxysporium* f. sp. *ciceri*. Amongst the fungicidal seed treatments, carbendazim + Thiram and Vitavax power by 12.15% and 14.98% respectively while as highest impedance of disease was found by recording the minimum disease incidence of 9.87% when *Trichoderma harzianum* along with vitavax applied for seed treatment. Study conducted on fungi toxicity of fungicides against *F. oxysporium* f. sp. *ciceri in vitro* revealed that chickpea seeds treated with Vitavax Power effectively inhibited the mycelia growth (90%) of pathogen with its colony diameter (9 mm) and found significantly superior to rest of fungicidal treatments. The next best fungicide observed was Thiram (0.15%) + Carbendazim (0.1%) with 88.85% colony growth followed by Thiram + Captan (84.55%), Captan (76.63%) which produced average colony diameter of 10, 12 and 25 mm, respectively. An increase in yield was recorded with all the treatments individually or in combination over untreated control. Treatment with *Trichoderma harzianum* + Vitavax Power exhibited maximum increase in yield of 18.2% followed by carbendazim + Thiram (142%) over control. Minimum increase in yield of 16.20% was recorded with *Trichoderma harzianum* alone in all three years.

1B. 12

Role of phytoalexins in plant disease resistance

Mushtaq Ahmad Guroo[1], Rayees Ahmad Ahanger, Muneeshwar Sharma and Ajay Gupta

Krishi Vigyan Kendra, Poonch (J&K)

Plants respond to pathogen attack by the formation of reactive oxygen species (ROS), synthesis of pathogenesis-related proteins (PRPs), and activation of defense genes for cell wall reinforcement and production of antimicrobial compounds. Among these antimicrobial compounds are phytoalexins, which are involved in mediating plant interaction with biotic and abiotic factors and plant adaptation to the changing environments. Phytoalexins have inhibitory activity against bacteria, fungi, nematodes, insects and toxic effects for the animals and for the plant itself. The mode of action of phytoalexins on fungi includes cytoplasmic granulation, disorganization of the cellular contents, rupture of the plasma membrane and inhibition of fungal enzymes, reflecting on the inhibition of spore germination and elongation of the germ tube and reduction or inhibition of mycelial growth. Several parts of the plant can produce phytoalexins such as leaves, flowers, stems, seeds and root tubers. Chromatographic techniques and the high-performance liquid chromatography (HPLC) coupled with mass spectrometry are used to carry out the characterization of these compounds. Phytoalexins constitute one of the fastest metabolic responses of plants to the action of external elicitors and therefore, to identify inducing agents of plant resistance to pathogens, it is important to observe biochemical changes occurring in the plant, through the accumulation of phytoalexins.

1B. 13

Antifungal activity of important botanicals against plant pathogens

Upma Dutta, Sakshi Bhagat, Sonika Jamwal, Anamika Jamwal and Sachin Gupta
Division of Microbiology, faculty of Basic Sciences, SKUAST-J, Chatha-180009

Medicinal plants are store house of remedies to cure all ailments of mankind. The use of plants as medicine is widespread throughout the world. The secondary metabolites present in the plants showed various biological activities and act in plant defence mechanism. Various pathogenic organisms such as bacteria, fungi, viruses attack plants at various stages of their development and thereby reduce their yield and productivity. Among all the pathogenic organisms, phytopathogenic fungi cause severe losses in plants and crop-production. However, these fungal diseases can be managed by the use of synthetic fungicides but due to the overzealous and indiscriminate use of these synthetic fungicides, has created different types of environmental and toxicological problems. Therefore, natural products symbolize safety in contrast to the synthetics as they have eco-friendly approach and are cheap. In the present investigation, the methanol and aqueous extracts of leaves as well as rhizome of three different medicinal plants viz. *Azadirachta indica*, *Lantana camara* and *Curcuma longa* were used against five fungal phytopathogens viz. *Curvularia lunata*, *Bipolaris specifera*, *Rhizoctonia solani*, *Macrophomina phaseolina and Alternaria alternata* by agar well diffusion method. Methanolic extracts of plant parts showed maximum antifungal activity against the phytopathogens than the aqueous extract. *Curcuma longa* rhizome extract showed antifungal activity against all the plant pathogens and maximum zone of inhibition was showed at conc. 200µl/ml against *Rhizoctonia solani*, *Bipolaris specifera*, *Curvularia lunata* and *Macrophomina phaseolina* (11mm, 7.66mm, 8mm and 7mm respectively), followed by leaf extract of *Curcuma longa* and *Azadirachta indica*. The minimum activity was showed by *Lantana camara*. Phytochemical screening of plant extracts revealed that the maximum phytoconstituents (Saponin, steroid, alkaloid, Flavonoid, carbohydrate, tannin, anthocyanin) is present in methanolic extracts than the aqueous extract. Hence, it was concluded that methanolic extract possess sufficient antifungal activity under controlled conditions to warrant a further investigation under field conditions.

1B. 14

Trizoles evaluation against yellow rust of wheat in cold arid zone of Kargil district

Nassreen F. Kacho,[1] Nazir A. Bhat[2] and Nazir Hussain[1]
[1]*KVK-Kargil, SKUAST-K, Kargil Ladakh- 194103;* [2]*Division of Plant Pathology, SKUAST- K, Wadura*

A field experiment was conducted to determine the efficacy of different triazole fungicides against yellow rust of wheat caused by *Puccina striiformis*. Five fungicide were used in this experiment namely propiconazole @ 0.1% tebuconazole @ 0.1%, difenconazole @ 0.05%, azoxystrobulin + difenconazole @ 0.05%, and hexaconazole @ 0.05%. The experiment field were divided into two parts one part is sprayed with sterile water and another with propoconazole before the appearance of disease (25 days before second spray). All the fungicides treatments significantly reduced the disease intensity by 6.1% to 9.5% as compared to control (35.5%) The minimum disease intensity (6.1%) of per cent was recorded in treatment where propiconazole before disease appearance and azoxytrobulin + difeconazole after disease appearance was sprayed fallowed by propiconazole and tebuconazole with disease intensity of 7.8%. Whereas, 8.2 per cent disease intensity was recorded in treatment where propoconizale was again sprayed after disease appearance followed by propoconazol and hexaconazoles (9.3%). Whereas, maximum disease intensity was recorded where propiconazole and hexaconazole was sprayed.

1B. 15

Assessment of losses due to important diseases of pea (*Pisum sativum* L.) and their management in hills of Doda (J&K)

A.C. Jha[1], Sonika Jamwal[1], Reena[1], Anamika Jamwal[2], Anil Kumar[1] and Permendra Singh[1]
[1]Advance Centre for Rainfed Agriculture, Bari Brahmna, Dhiansar; [2]KVK Kathua SKUAST- Jammu

Pea (*Pisum sativum* L.) is a valuable vegetable as well as pulse crop grown all over the world and is also known as ‘Matar’. Major obstacles in the way of increased pea production are the diseases caused by the fungal, viral and bacterial pathogens. Pea is affected by several plant pathogens includes fungi, viruses and bacteria that causes various serious diseases. Among the fungal diseases powdery mildew caused by *Erysiphe pisi* and ascochyta blight caused by *Ascochyta pinodella* are two major diseases of pea causes severe damage. All the fungicides and bio-control agents gave significant reduction in the severity of diseases of pea i.e. ascochyta blight and powdery mildew diseases and also significantly increased the yield over the check. Among the treatments hexaconazole (0.1%) was most efficacious treatment in which the severity of ascochyta blight (10.65%) and powdery mildew (8.83%) which gave disease control of ascochyta blight 74.69% and powdery mildew 76.55% over the check 42.08% and 37.66% of the respective diseases and thereby resulting in 134.83% increase yield as compare to check and this treatment was also found significantly superior than all treatments. The bio-agents *Trichoderma viride* and *Trichoderma harzianum* were found the least effective treatments over the check to manage the ascochyta blight and powdery mildew diseases of pea respectively.
Key words: Powdery mildew, pea, Ascochyta, blight, *Trichoderma spp.*, Hexaconazole.

1B. 16

Survey of wilt disease (*Fusarium oxysporum* f. sp. *ciceri*) of chickpea at selected districts of Jammu, India

Sonika Jamwal[1], Anamika Jamwal[2], Upma Dutta[3], A.C. Jha[1], Anil Kumar[1], Sanjeev Kumar[1], Reena[1], Jai Kumar[1] and Brinder Singh[1]
[1]ACRA-Dhiansar, [2]KVK Kathua, [3]Div. of Basic Sciences, SKUAST-Jammu

A survey was carried out for assessing *Fusarium* wilt disease incidence of chickpea in selected districts of Jammu. From each selected district, three blocks were selected and in each block, three chickpea grown villages were selected for the survey. Two to five chickpea fields were surveyed in every village and number of wilted plants was observed in selected area (3 m^2). The highest incidence 81.30% was recorded in Barwal block of Kathua district followed by 74.5% in Reayan village of Samba district. The lowest disease incidence was reported 10.67% from Khaner of Bari Brahmana block of Samba district. The disease incidence ranged from 10.67% - 81.30% among all blocks of selected districts. During survey it was noticed that wilt disease chickpea causes significant loss to tomato crop and leading to low tomato production and productivity in Jammu and Kashmir, India.
Key words: Survey, wilt disease chickpea, *Fusarium oxysporum* f. sp. *ciceri*

1B. 17

Integrated management practices for important diseases of aonla (*Emblica officinalis* Gaertn.)

Arti Devi, Parshant Bakshi, V.K. Wali, Nirmal Sharma, Deep Ji Bhat and Amit Jasrotia

Division of Fruit Science, Faculty of Agriculture, Main Campus, Chatha, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009

artiskuastj@gmail.com

India ranks first in the world in area and production of aonla. Being the richest source of vitamin C among fruits next to barbados cherry, aonla is very lucrative crop to grow. In Jammu and Kashmir, aonla is successfully grown in Kathua, Samba, Akhnoor, parts of Udhampur and Reasi districts however, affected by number of diseases such as rust caused by *Ravenelia emblicae*, blue mould caused by *Penicillium citrinum*, anthracanose caused by *Colletotrichum* spp. and fruit rot caused by *Phoma* spp. Rust appears as black pustules which later form a ring, join together covering a large area. In anthracanose, the lesion may vary in size and shape with spore masses appearing on fruiting bodies at high humidity. In blue mould, brown patches and water-soaked areas appear on the fruit surface. There is exudation of drops of yellowish liquid on the fruit surface and fruits emit a bad odour. The entire fruit finally gives a bluish-green postulated or beaded appearance. In fruit rot, initial symptoms appears as small, pinkish brown necrotic spots resulting in partial or complete rotting of fruit. Number of fungicide treatments have been recommended to control these diseases, but integrated pest management practices are best suited for limiting the use of fungicides. IPM to control rust involves three sprays of 0.4 percent wettable sulphur or 0.2 percent Dithane Z-78 during July-September, however, Banarasi and Chakaiya cultivars are relatively free from rust disease. Anthracanose can be managed by spraying 0.1 percent carbendazim before harvesting of fruits. To check blue mould, avoid bruising or injury to fruits while harvesting and during storage sanitary conditions should be maintained. The fruit should be treated after harvest with 1 percent borax or sodium chloride and 0.1 percent carbendazim or thiophanate methyl. Fruit rot can be controlled by spraying 0.1 percent carbendazim, 15 days prior to fruit harvest and treating the harvested fruits with 0.5 percent borax or 1.0 percent sodium chloride.

1B. 18

Inheritance of stripe resistance (*Yr*) gene in selected wheat cultivars to pathotype of *Pcccinia striiformis*

Raj Kumar, M.K. Pandey, V.K. Razdan, Shahid Ahamad, Bupesh Kumar and Anil Gupta

Division of Plant Breeding and Genetics, FOA, SKUAST-J, Chatha, Jammu-180009

mukkp@yahoo.co.in

Stripe or yellow rust caused by *Puccinia striiformis* Westend. f.sp. *tritici* Eriks. is a specialized pathogen consisting of races with different virulence spectra. Hence present studies were conducted at SKUAST-J, Research Farm, Chatha with objectives to generate genetic back ground information of selected wheat cultivars (RSP 561, JAUW 584, JAUW 598 and RAJ 3765) to pathotypes of *P. striiformis.* The pattern of host pathogen interaction between selected cultivars and six pathotypes 78S84, 46S119, 46S103, 47S102, 70S69 and 67S8 of *P. striiformis* was revealed that only 4 pathotypes (46S103, 47S102, 70S69 and 67S8) permitted for postulation of host resistance gene(s). Effect of Agra Local (AL) back ground on *Yr* expression in selected wheat cultivars, direct and reciprocal crosses were made between above bread wheat cultivars with susceptible AL to generate F_1 and F_2 seeds. F_1 population of RSP 561 showed dominant nature of resistance against all the selected pathotypes and F_2 population showed the presence of two dominant genes confirming resistance against 46S103 and 47S102 but one dominant and one recessive gene confirming the resistance against 70S69 and 67S8. F_1 population of JAUW 584 revealed the dominant nature of resistance against 46S103, 70S69 and 67S8 pathotypes. F_2 population showed the presence of two dominant genes confirming resistance to 46S103 and 67S8. While one dominant independent gene confirming

the resistance to 70S69. F_1 population of JAUW 598 revealed dominant nature of resistance against all the test pathotypes. F_2 population showed the presence of one dominant and one recessive gene against the 46S103 and 67S8 while three dominant independent genes and two dominant genes confirming the resistance against 47S102 and 70S69 respectively. F_1 population of RAJ 3765 showed dominant nature of resistance and F_2 segregation showed the presence of one dominant genes confirming resistance against 47S102. Mode of inheritance (*Yr*) in selected wheat cultivars revealed that RSP 561, JAUW 584, and JAUW 598 have similar type of resistance gene while RAJ 3765 showed dissimilar gene for resistance. *Yr9* and *Yr9+* gene was postulated in RSP 561, JAUW 584, and JAUW 598 while *Yr2KS* gene postulated in RAJ 3765.

Key words: Bread wheat (*Triticum asetivum*), Stripe rust (*Puccinia striiformis),* Segregating ratio, Crosses.

1B. 19

Screening of basmati genotypes of Jammu for resistance to bacterial leaf blight

Bupesh Kumar, Anil Gupta, M.K. Pandey, A.K. Razdan and R.K. Salgotra
Division of Plant Breeding and Genetics, FOA, SKUAST-J, Chatha, Jammu-180009
mukkp@yahoo.co.in

Bacterial blight disease caused by *Xanthomonas oryzae* pv. Oryzae poses a major threat to sustainable basmati rice production having unique status in North West India including J&K state, especially in the foot hills of Jammu division. Host plant resistance is an important component of integrated management strategies for bacterial blight in paddy. In the present investigation an attempt has been made to screen out the 16 basmati genotypes viz, SJR-70, SJR-72, SJR-74, SJR-76, SJR-80, SJR-81, SJR-82, SJR-92, SJR-103, SJR-105, SJR-108, SJR-115, SJR-120, SJR-121, SJR-122 and SJR-129 with one highly susceptible check PB-1 against the bacterial blight pathogen under epiphytotic conditions in field at Research Farm of Division of Plant Breeding and Genetics during kharif season of 2012 and 2013. Perusal of data revealed that all genotypes showed genetic variation of resistance level against bacterial blight pathogen. No one was found to be immune to bacterial blight. Five genotypes viz., evaluated SJR-70, SJR-74, SJR-76, SJR-121 and SJR-129 were found to be moderate resistance while six were found to be moderate susceptible against the disease. However, four genotypes showed susceptible reaction and rest of two genotypes viz., SJR-81 and susceptible check PB-1 were highly susceptible to bacterial blight.

Key words: Bacterial blight, Resistance, Genotypes

1B. 20

Diagnosis and Recommendation Integrated System concept and applications on nutritional diagnosis in fruit crops

Mudasir Iqbal[1], VK Wali[1], Parshant Bakshi[1], Deep Ji Bhat[1], Akash Sharma[1], Amit Jasrotia[1], Nirmal Sharma[1] and Mohsin Iqbal[2]
[1]*Division of Fruit Science,* [2]*Division of Plant Pathology, Faculty of Agriculture, Main Campus, Chatha*
Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009, India
mudasirkas111@gmail.com

Importance of nutrient balance in determining yield and quality of crops is well established but there was no means to quantify it until the introduction of the Diagnosis and Recommendation Integrated System (DRIS) in which leaf analysis values are interpreted on the basis of inter-relationship among nutrients, rather than nutrient concentration themselves. The DRIS is based on the comparison of crop nutrient ratios with optimum values from a high yielding group (DRIS norms). The DRIS provides a means of simultaneous identifying imbalances, deficiencies and excesses in crop nutrients and ranking them in order of importance. The major advantage of this approach lies in its ability to minimize the effect of tissue age on diagnosis, thus enabling one to sample over a wider range of tissue age than

permissible under the conventional critical value approach. Several researchers affirm that once DRIS norms based on foliar composition has been developed for a given crop, they are universal and applicable to that particular crop grown at any place and at any stage of its development **(**Bangroo *et al*., 2010)**.** The DRIS approach was designed to provide a valid diagnostic irrespective of plant age, tissue origin (Sumner 1980; Bailey *et al*., 1997; Jones, 1993) cultivar, local conditions (Payne *et al*., 1990), or changes in the method of tissue sampling or the time of sampling (Moreno *et al*., 1996). The DRIS is sometimes less sensitive than the sufficiency range approach to differences caused by leaf position, tissues age, climate, soil conditions, and cultivar effect because it uses nutrient ratios (Sanchez *et al*., 1991). Once DRIS norms have been established and validated from a large population of randomly distributed observations, they should be universally applicable to that crop (Sumner 1980), there appear to be specific nutrient ratios for maximum crop performance that transcend local conditions, such soil, climate and cultivars (Snyder and Kretschmer, 1988; Snyder *et al*., 1989). Most of the developed research works turns clear that DRIS is as effective as the conventional methods of nutritional diagnosis (critical values and sufficiency range) with the additional advantage of establishing a nutrient deficiency or excess ranking, according to its importance, and a strong relation among them, quantifying the plant nutrient balance.

1B. 21

Current scenario and future prospectus of mango malformation

Mudasir Iqbal[1], V.K. Wali[1], Parshant Bakshi[1], Akash Sharma[1], Deep Ji Bhat[1], Mohsin Iqbal[2] and B.K. Sinha[3]

[1]Division of Fruit Science, [2]Division of Plant Pathology, Faculty of Agriculture, [3]Division of Plant Physiology, Faculty of Basic Sciences, Main Campus, Chatha, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009, India
mudasirkas111@gmail.com

Malformation is one of the most important problems of mango and a serious threat to mango production in India and other mango growing countries (tropical and subtropical) of the world. It is described as disease and a physiological disorder. It was first reported about hundred twenty years back from Darbhanga district in Bihar by Maries, though it has debatable issue for the scientists for the last 6-7 decades. The characteristic symptom of mango flower malformation caused by *Fusarium mangiferae* is a reduction in the length of the primary axis and the secondary branches of the panicle, which makes the flowers appear in clusters. The flower buds are transformed into vegetative buds, and a large number of small leaves and stems, characterized by appreciably reduced internodes, gives the appearance of a witches'-broom. This disorder is widespread in flowers and vegetative shoots of mango. It has a crippling effect on mango production, bringing in heavy economic losses. In spite of several decades of incessant research, since its recognition in 1891, the etiology of this disease remained confusing and no effective control measure is known, though strong evidence is for its origin of fungal nature. *Fusarium moniliforme* var. *subglutinans* is the causal agent of malformation in mango (*Mangifera indica* L.) in the form of malformation on leaves, apical shoots, flowers and inflorescence. Accordingly, the malformation on former two portions is described as vegetative malformation and the latter two portions as floral malformation. Infection on flowers results in severe losses. The symptoms on shoots and flowers are not always identical and sometimes may be attributed to environmental conditions or existence of variability among the pathogenic isolates from different agro-climatic regions. The morphological and physiological methods used for identification and classification of *F. moniliforme* isolates have proved problematic. Variability, taxonomic and evolutionary studies in fungi have increased with the development of molecular techniques. PCR-based fingerprinting techniques (RAPDs, SSRs and AFLPs) offer highly sensitive, easy, rapid detection method and less time consuming for diagnosis of pathogen. Random Amplified Polymorphic DNA (RAPD) is a DNA polymorphism assay based on the amplification of random DNA segments with single primers of arbitrary nucleotide sequence. Therefore, a rapid and reliable assay for the detection of *F. mangiferae* var. *subglutinans* would benefit the mango production. Molecular marker based characterization of mango malformation pathogen using **RAPD markers** for

genetic diversity analysis and development of a SCAR marker based diagnostic kit would be a possible solution to early detection and diagnosis of mango malformation disease. In addition to contributing to the understanding of the diseases caused by this pathogen and improving crop productivity, this information will improve the basic understanding of the molecular biology of this pathogen and will be of importance to many other agricultural systems.

1B. 22

Powdery mildew of apple- Causes and control

Koushalya Devi, V.K. Wali, Nirmal Sharma, Rajesh Kumar, Deep Ji Bhat and Ambika Bhandari

Division of Fruit Science, Faculty of Agriculture, Main Campus, Chatha, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009, India

koushalya18@gmail.com

Apple is an important temperate fruit crop in northern India, however affected by number of diseases and insect pests and one of the devastating factor in apple fruit industry is powdery mildew. Powdery mildew of apple caused by *Podosphaera leucotricha*, occurs in all apple-producing regions of the world. The disease causes economic damage by reducing tree vigor, flower bud production, and fruit quality. Powdery mildew of apple produces symptoms on young shoots, leaves, blossoms, and fruit. In general, symptoms are most noticeable on the leaves and fruit. Infections on the blossom receptacle or of young fruit will cause net like russeting and discoloration as the fruit matures. Fruit may also become distorted and dwarfed. Mildew reduces both apple yield and quality. Conidial germinate at high relative humidity (greater than 70%) at temperatures between 10 and 25°C. Primary infections can be controlled by removal of the primary inoculum sources (*i.e.*, flower and shoot buds infected the previous year). Growers should note any whitened terminal shoots and prune them out during winter or early spring. The use of less susceptible apple cultivars is perhaps the most effective means of preventing mildew. Enterprise, Fuji, Gala, Delicious, Jonafree, Winesap Braeburn, Britegold are resistant cultivars to powdery mildew. Secondary infections and fruit infections can be controlled by foliar fungicide applications. Spraying the tree at green tip, petal fall, 20 and 40 days after fruitlet stage with dinocap (50g/100lt of water), carbendazim (50g/100lt of water), tridemorph (100g/100ltr of water), carboxin (100g/100ltr) fosetyl-al (70ml/100ltr of water). All of these can provide effective control, but growers should not rely solely on one class of fungicides. Whenever possible, growers should rotate or alternate with different mode of action groups, use multi-site fungicides (like sulfur) at times of low risk, and plant less susceptible cultivars. Benzimidazoles had activity against mildew, but their utility in the apple disease management program was reduced due to widespread resistance development in *Venturia inaequalis* (apple scab). Horticultural oils, waxes, and biological compounds produced by *Bacilllus* strains are also available, but their effectiveness is somewhat inconsistent.

1B. 23

Guava wilt- Causes and control

Simrandeep Kour, Arti Sharama, V.K. Wali, Akash Sharama, Darpreet Kour and Shilpy Kumari

Division of Fruit Science, Faculty of Agriculture, Main Campus, Chatha,
Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009, India

simrandeep.kour88@gmail.com

Citrus is considered to be one of the most remunerative fruit crops that have a lasting niche in international trade and world finance. Guava (*Psidium guajava* Linn.) is an important fruit of subtropical region. It is grown almost in all states of India. Wilt is one of the most destructive diseases of guava in India and loss due to this disease is substantial. Wilt is predominantly caused by the species of *Fusarium*, of which *Fusarium oxysporum* is generally the main cause. The disease is of soil borne in nature, there are limitations for the control of this disease. Wilt is a pernicious disease and a

curse to guava industry. First external symptom of the disease is the appearance of yellow colouration with slight curling of the leaves of the terminal branches and an abrupt wilting of the foliage that begins in the upper branches and spreads to the whole tree. When decline is rapid, leaves tend to shrivel and die on the trees, which assume a fire-scorched appearance. When decline occurs more slowly, leaves drop gradually, resulting in complete defoliation. Different management strategies are needed to avoid a potential threat of wilt disease. Disease can be controlled by proper sanitation in the orchard. Wilted trees should be uprooted, burnt and trench should be dug around the tree trunk. While transplanting, roots of plants should not be severely damaged. Maintenance of proper tree vigour by timely and adequately manuring, inter-culture and irrigation enable them to withstand infection. The pits may be treated with formalin and kept covered for about 3 days and then transplanting should be done after two weeks. Biological control by *Aspergillus niger* strain AN-17 is also found effective in control of wilt. Use of rootstocks resistant to wilt could be an alternative effective method for the control of disease. Cross of *Psidium malle x P. guajava* has been found free from wilt and this material can be used as resistant root stock.

Key words: Guava wilt disease, *Fusarium spp,* GWD.

1B. 24

Anthracnose in mango- Causes and control

Ambika Bhandari, V.K Wali, Amit Jasrotia, Arti Sharma and Koushalya Devi

Division of Fruit Science, Faculty of Agriculture, Main Campus, Chatha, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009, India

ambikabhandari901@gmail.com

Citrus is considered to be one of the most remunerative fruit crops that have a lasting niche in international trade and world finance. Mango (*Mangifera indica* L.) has been grown in India since long and is considered to be king of fruits. In India mango is grown under an area of 2267.000 ha with production of 20295.000 MT (NHB 2016-17). Mango is a tropical fruit, in high demand and fetches a good price all over the world. However, the crop is challenged by several pre as well as post-harvest diseases which cause perceptible loss to quality and yield of mango across the country. Anthracnose disease is generally found in the eastern part of the United States, caused by fungi in the genus *Colletotrichum*, a common group of plant pathogens that are responsible for diseases on many plant species. Anthracnose symptoms occur on leaves, twigs, petioles, flower clusters (panicles) and fruits. The incidence of this disease can reach almost 100% in fruit produced under wet or very humid conditions. On leaves, lesions start as small, angular, brown to black spots and later enlarge to form extensive dead areas. Panicles develop small black or dark-brown spots, which can enlarge, coalesce, and kill the flowers. Petioles, twigs, and stems are also susceptible and develop the typical black, expanding lesions. On the lesions and dead portions, minute pink cushion shaped fructifications called acervuli are seen under moist conditions. Fruits may also drop from trees prematurely due to rotting. On immature fruits infections penetrate the cuticle, but remain quiescent until ripening of the fruits begins. Green fruit infections that take place at mature stage remain latent and invisible until ripening and carry the fungus into storage. Under favourable climatic conditions of high humidity, frequent rains and a temperature of 24 - 32° C coinciding with flowering favours anthracnose infections in the field. The pathogen survives between seasons on infected and defoliated branch terminals and mature leaves. Field infection in developing fruit leads to Quisecent infection/Latent infection. Later once the ripening starts, lesions begin to develop under post-harvest conditions which affects fruit quality and leads to enormous loss. Proper sanitation of orchard by periodical removal of fallen plant debris and pruning of trees eradicates the fungus and checks further spread of the disease. Maintaining tree vigour with proper irrigation and fertilization eradicate the anthracnose in mango. Fungicide sprays should begin when panicles first appear and continue at the recommended intervals until fruits are picked. Spraying the trees twice with Carbendazim (0.1%) or Mancozeb (0.2%) or combination of Carbendazim 12% + Mancozeb 63% @ 0.1% at 15 days interval during flowering to control blossom infection and twice during pea nut stage to prevent fruit infection. Alternate sprayings of Carbendazim and Mancozeb to avoid development of resistance in pathogen to fungicides. Spraying five times with

Pseudomonas fluorescens FP 7 (0.5%) from flowering until harvest at 3 weeks interval reduces anthracnose incidence and improves fruit quality. For post-harvest anthrcanose, fruits are dipped in hot water at 50 C for 30 min. in combination with 0.05% carbendazim. Only one genotype Keitt showed resistant reaction whereas, Himsagar and Ostin showed moderate resistance against mango anthracnose.

1B. 25

Pecan nut (*Carya illinoinensis*) scab and its management

Sohnika Rani, Arti Sharma, V.K. Wali, Akash Sharma and Rucku Gupta

Affiliation: Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Chatha. J&K
House number 41-A, Hazipura, Last Morh, Gandhi Nagar, Jammu. 180004
sohnika88@gmail.com

The Pecan nut [(*Carya illinoinensis* (Wang) C. Koch] known as queen of nuts belongs to the family "Juglandaceae". It is an important edible nut crop which can be grown successfully in areas having an elevation of about 914-1829 m above mean sea level and free from spring frost. Pecan is superior to walnut in quality and thrives best in the areas which are considered somewhat lower and hotter for walnut cultivation. In India, pecans were introduced from its native place, North America in 1937 in Himachal Pradesh. The area under pecan nut in Jammu region is around 464.68 ha with production of about 104.03 metric tonnes in 2015-16. In the present study, survey was carried out in districts of Rajouri and Poonch to find out the best seedling pecan nut trees in terms of nut and kernel quality. During the survey it was observed that there is incidence of disease in pecan nut called pecan scab caused by the fungus *Fusicladiumeffusum* and abundant pickings of high-quality nuts are only possible if the tree escapes the devastating disease as it is the most destructive disease of pecan nut. The spores overwinter on the tree and become active in spring, causing small round spots on new leaves, tender young stems and the husks of the nuts as they form. The fungus causes the husks to crack open and drop off the tree prematurely. Other opportunistic pathogens often attack the affected areas, further weakening the tree. Often, the entire nut crop is lost in badly infected trees. Pecan scab can be controlled by adopting following measures:

Cultural Control: The severity of pecan scab is directly related to moisture and humidity levels. Planting pecans where they will receive the best possible airflow is one way to encourage dry air and minimize the spread of the disease. Allow ample space around individual trees -- dense plantings with other trees, shrubs and structures restrict airflow. Likewise, it is best to avoid planting pecans in low-lying areas with still air. Finally, raking up all the fallen leaves, husks, nuts and twigs that fall throughout the season helps to reduce the concentration of spores the following year. These should be removed from the vicinity of the pecan tree and destroyed.

Chemical Control: Commercial pecan growers routinely treat their orchards with fungicides that effectively control scab. For homeowners, this becomes a difficult task once pecans reach their mature height of over 50 feet. However, young trees are easy to treat with a fungicide such as thiophonate-methyl. Using a hand-held pump sprayer, drench the entire tree as soon as it emerges from dormancy in spring. Repeat twice more at two-week intervals and then reduce the fungicide applications to three week intervals for the rest of the growing season.

Disease-Resistant Cultivar: The most practical form of control is to plant disease-resistant cultivars. "Elliot" is the most widely recommended scab-resistant cultivar with excellent yields of high-quality nuts, though the trees take 10 or 12 years to bear fruit. "Kanza" is a similar variety recommended for growers because of its greater cold tolerance.

Theme-II

Role of Epidemiology and Forecasting in Effective Disease Management

ORAL PRESENTATIONS

2A.1

Effect of weather parameters on development of stalk rot disease and their influence on yield of maize cultivars

Mahender Singh, Lobzang Stanzen, Charu Sharma and B.C. Sharma
Agrometeorology Section, Division of Agronomy, SKUAST-Jammu, Chatha-180009
drmahendersinghg@gmail.com

Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. Maize requires optimum growth conditions to express its genetic potential. Evaluating maize under different varieties and sowing dates provides a novel strategy of improving its productivity. To achieve this, a field study was conducted at the Research Farm of Agrometeorolgy section, Division of Agronomy, SKUAST-Jammu Chatha during 2016 cropping season to determine the effect of different varieties and sowing dates on stalk rot disease incidents and their influence on phonological stages, growth parameters and yield of maize. Three maize varieties, Double dekalb, kanchan-612 and Proagron-4794 and three different sowing dates (15th June, 29th June and 13th July 2016) were taken. The experiments were laid in a randomized complete block design with three replications and spacing of 20 cm row distance. The crop was fertilized with 90 kg N, 60 kg P and 30 kg/ha through urea, diammonium phosphate (DAP) and muriate of potash respectively. The soil of the experimental plot was sandy clay loam, having low in nitrogen and medium in organic carbon, phosphorous and potassium. The result showed that different sowing date had significantly effect on stalk rot disease incidence. Maximum mean disease incidence was observed when crop was planted on 13th July followed by 29th june and 15th June. So first date of sowing (15th June) had significant and positive effect on phonological stages, plant height, dry matter, leaf area and grain yield and followed by 29th June sowing. This result implies that 15th June sowing date appears to provide the optimum conditions for maize cultivation under lower belt of Jammu. Whereas, growth of maize in-terms of plant height and grain yield varied non-significant under different maize cultivars.
Key words: stalk rot, maize, yield, date of sowing, cultivars, disease

2A.2

Sustaining impact of pathogens on fruit production systems

Brajeshwar Singh[1] and Anil Bhushan[2]
[1]Division of Microbiology, Faculty of Basic Sciences, Main Campus, Chatha, [2]Advanced Centre for Horticulture Research, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu-180009
brajeshbhau@yahoo.co.in

India stands second after China with total fruit production of 81285334 thousand tonnes on 6982015 thousand hectares land (Ministry of Agriculture, GOI. 2013-14). In 2014-15, Indian area of production was 6242.30 thousand hectares with total fruit production of 86283 thousand tonnes (Ministry of Agriculture, GOI). Based on their climate and topography, fruit growers have ample choice of suitable fruit varieties. Cultivation of fruits is not comparable to cereals and is comparatively more technical. Fruit production requires updated technologies for better plant and fruit management. Fruits are comparatively perishable so there storage and marketing needs special emphasis. Like any other plant/crop, fruit trees are equally affected by many abiotic and biotic stresses. Abiotic stresses like climate, soil and water conditions are equally responsible for a good fruit crop. Biotic stress mainly involves infestation of fruit crop with insects or pathogens. These factors greatly influence quality and quantity of fruits harvested and finally their shelf life too. Diseases can create havoc and complete crop failure if provided with congenial conditions. Irish potato famine is a well-quoted example of such incidence that led to demographical alterations. Fruit diseases are equally important since fruit forms an important component of food basket.

Key words: Fruits, Sustaining, Biotic, Abiotic & Stress

2A.3

A serious threat to *Pinus roxburghii* by pythium rot in nursery

Amrish Vaid, Vishal Mahajan, Anamika Jamwal and Saurav Gupta
Krishi Vigyan Kendra, Kathua, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu (J&K), India

Pythium rot is one of the dreadful disease in Pine (*Pinus roxburghii*) nursery. The affected portions of *Pinus roxburghii* were randomly collected from different locations in the Udhampur (range: Panthal) and Batote forest divisions (range: Batote). Isolation, characterization and pathogenicity tests of *Pythium* were conducted for both forest nurseries. The samples were collected to isolate the test pathogen and pathogenicity; tests were conducted in nursery thereafter, which confirmed the occurrence of the disease causing pathogen. Subsequently, the lab experiments were conducted for management strategy of disease which included the dual culture experiments of different strains of *Trichoderma* spp. with the test pathogen. The most effective strains, *Trichoderma viride* (Tv3 and Tv5) and *Trichoderma harzianum* (Th6) from the lab experiment were used in the Pine nursery to manage the disease. Carbendazim @ 0.1 per cent, thiophanate methyl @ 0.1 per cent and metalaxyl + mancozeb @ 0.25 per cent were also used along with control. It was observed that metalaxyl + mancozeb @ 0.25 per cent was most effective in managing the disease followed by carbendazim @ 0.1 per cent and thiophanate methyl @ 0.1 per cent. The biocontrol agents were also tested for the disease and the results revealed that *Trichoderma viride* Tv3 was most effective followed by Tv5 in the management of disease.

2A.4

Development & Validation of forewarning model for stripe rust of wheat

Vishal Gupta, V.K. Razdan, Indar Singh, Akash Sharma and Satish Sharma
Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha-J&K

Environmental conditions play a decisive role in driving the pathogen-host-rust epidemic system. Forecasting of the disease is alternative strategies to manage the disease and presently various models are available to predict the plant diseases. The prediction of disease epidemics or disease forecasting provides information regarding the timing of disease infection, infection cycle, severity of disease infection, crop loss and estimating the frequency or the probability of the disease. A forewarning model of stripe rust of wheat for predicting the disease initiation in Jammu sub-tropics was developed by the analysis of disease severity data pertaining to the years from 2005-06 to 2012-13 obtained from AICRP research experiments available in the Division of Plant Pathology. The corresponding data regarding abiotic factors *viz*., minimum and maximum temperatures, maximum and minimum relative humidity and rainfall were collected from the Agro-meteorological section of University. The analyzed data was validated during *rabi* season 2014-16. There was significant and positive correlation of maximum and minimum temperature and negative correlation of maximum and minimum relative humidity with the stripe rust severity. Linear regression showed that maximum and minimum temperatures, maximum and minimum relative humidity and rainfall were responsible for 91.3 and 84.00 per cent variation in the model (general) during 2005-13 and 2014-16, respectively, whereas in stepwise regression, maximum temperature and minimum relative humidity caused 89.50 per cent and maximum temperature contributed 77.80 per cent in variability of disease severity, respectively. Gompertz model showed more (99.50%) accuracy than the Logistic model in predicting the severity of stripe rust.

2A.5

Impact of plant protection activities in increasing the income of the Ginger growers in Reasi district of J&K

Banarsi Lal[1], Shahid Ahamad[2] and Vikas Tandon[3]

[1]*Krishi Vigyan Kendra, Tanda, Reasi (J&K)-182301,* [2]*Directorate of Research*
[3]*Krishi Vigyan Kendra,Jammu, SKUAST-Jammu, J&K*
drbanarsi2000@gmail.com

Ginger (*Zingiber officinale*) is one of the oldest spices with a distinct flavour and pungency. It belongs to the family Zingiberaceae. It has a wide range of uses that include culinary, flavourant in soft drinks, alcoholic beverages, confectionery, pickles, pharmaceutical preparations etc. India is the largest producer and exporter of ginger in the world. It's ginger is considered as one of the best in the world and contributes about 50 per cent of the total requirement of ginger in the world. It's is also known as the potentially good producer and exporter of ginger products such as ginger oil and oleoresin. In J&K ginger is commercially grown in different pockets of the state. Commercial ginger cultivation has been changing economic face of Reasi district of J&K. Ginger cultivation has a positive and remarkable impact on economic status of the farmers. The present study was conducted in hilly districts Reasi of Jammu and Kashmir which was selected purposively. Two blocks namely Pouni and Reasi were selected purposively. Out of two blocks six villages were randomly selected.120 ginger growers were selected randomly for the study purpose. Impact analysis was done to find out the increased ginger production and income of the respondents after applying the plant protection activities. Study revealed that plant protection activities had a positive impact on the production and knowledge gained by the ginger growers and also there was increase in the income of the respondents. Majority of farmers responded that plant protection activities in the ginger farming played an important role in upgrading the knowledge, production and productivity due to which ultimately their income was enhanced.

Key words: Ginger, Plant Protection, Knowledge, Production

2A.6

Prevalence of tomato leaf curl virus and potato leaf roll virus from Poonch and Rajouri districts of Jammu and Kashmir

Ranbir Singh, Manika Sharma, Dechan Choskit and Sachin Gupta

Division of Plant Pathology, Faculty of Agriculture, Main Campus Chatha, SKUAST-Jammu

Tomato and potato production in Jammu and Kashmir has suffered considerable losses in yield and fruit quality due to infections of tomato leaf curl and potato leaf roll viruses. To develop various strategies for controlling viral diseases in tomato and potato, the relative distribution and incidence of these viruses was determined. A roving survey was under taken in different locations of Rajouri and Poonch districts to know the incidence of tomato leaf curl virus disease (ToLCV) and potato leaf roll virus. All the plants showing leaf curl and leaf roll symptoms were recorded separately to calculate per cent disease incidence. The overall disease incidence was recorded based on symptoms. The survey data revealed that for ToLCV the range was 46.00 to 57.60 per cent in Poonch and 52.00 to 60.80 per cent in Rajouri while for potato leaf roll virus the incidence of the disease was 28.80-36.00 per cent in Poonch and 24.00 to 40.00 per cent in Rajouri district respectively.

POSTER PRESENTATION

2B.1

Studies on *Cylindrosporium padi* (Lib.) P. Karst. Ex Sacc an incitant of Blumeriella leaf Spot (BLS) Disease in Kashmir valley

Kamran Ahmed Khan[1], Nissar A. Khan[1], Sajad Un Nabi[2], Owais Bashir[3] and Varsha Bharti[1]

[1]*Division of Plant Pathology, SKUAST-K, Shalimar Srinagar-190025, Jammu and Kashmir,*
[2]*ICAR-CITH, Srinagar, Jammu and Kashmir, 191132;* [3]*Division of soil science, SKUAST-K, Shalimar Srinagar, Jammu and Kashmir, 190025*
kamrankhan1202@gmail.com

Cherries occupy unique position among temperate fruits all over the world and are season's first tree fruit to reach the market, maturing within 60-70 days after full bloom and therefore, fetches premium price. The cherry productivity per unit area is low owing to many biotic and abiotic factors. Among them, Blumeriella leaf spot (BLS) caused by *Cylindrosporium padi (Lib.) P. Karst. Ex Sacc.* has assumed an alarming proportion in the major cherry growing areas and causes huge economic losses through mid-summer pre-mature defoliation upto the extent of 80-90%, which ultimately results in reduced fruit bud survival and fruit set in the following year. In India, particularly in Jammu and Kashmir state, no research work has been done except for a report and hence investigation was undertaken to characterize the pathogen associated, effect of weather parameters on disease development and management of the disease at field level. Survey of cherry orchards in main cherry growing districts viz; Srinagar, Ganderbal and Baramulla revealed disease incidence and intensity ranging from 13.00 to 52.50 per cent and 5.78 to 30.48 per cent, respectively. Symptomatological studies revealed that the disease first appeared as small, circular to irregular, purple red speck on upper leaf surface. Periodic changes in colour, shape and size of the spots coupled with formation of irregular necrotic patches led to pre-mature defoliation. The fungus isolated produced compact and circular greyish white fungal colonies composed of hyaline, thick walled, septate and branched mycelium. Acervuli produced were dark brown to black, circular, discoid and measured 260.50 µm in diameter. Conidia were hyaline, bicelled, elongated, curved or flexous with tapered apex and rounded base. In the present study, it was confirmed that the disease development under field conditions had a positive correlation with average maximum relative humidity and average rainfall during the corresponding periods of disease development suggesting that high humidity and rainfall favours disease development. Fungitoxicants, both systemic and non-systemic evaluated under natural field conditions for their comparative efficacy against the disease, showed that systemic fungicides were significantly superior to non-systemic fungicides in managing the disease. Difenaconazole 25 EC (0.03%) Tebuconazole 25.9 EC (0.05%), Dodine 65 WP (0.06%), Copper oxychloride 50 WP (0.30%), Captan 50 WP (0.30%) can be effectively used for management of the disease. The future prospects are molecular characterisation, identification of resistance source and host-pathogen interaction under temperate conditions.

2B.2

Influence of rootstock x scion interactions against apple scab under high density orchard system

Sheikh Adeeba, Mushtaq Ahmad Bhat and Zahoor Ahmad Bhat

Division of Plant Pathology, Faculty of Horticulture, SKUAST-K, Shalimar Campus, Srinagar-190025
hejazee2011@gmail.com

The aim of the extensively evaluated clonal rootstock x scion combinations under field condition against major fungal foliar disease of apple was to find the best interactions with least disease incidence and intensity under high density orchard system. For this purpose, four clonal rootstocks of *Malus domestica* Bork viz; M4, M7, MM106 and M9 grafted on two apple cultivars Silver Spur and

Vance Delicious were evaluated against apple scab. The observations recorded showed varied and significant effect of rootstocks on status of scab of apple. Both the cultivars grafted on M9 rootstock found highly susceptible to apple scab exhibiting incidence of 89.11 per cent and 58.06 per cent intensity whereas, MM106 was recorded with lowest leaf scab incidence and intensity of 19.11 and 9.20 per cent respectively. The lone clone M7 found to be best rootstock against fruit scab with lowest disease incidence of 15.33 per cent and intensity of 4.13 per cent. The rootstock-cultivar combinations best suited against leaf scab is Vance Delicious x MM106 with the incidence and intensity of 26.33 and 12.00 per cent respectively and Vance Delicious x M7 proved to be the best combination against fruit scab by exhibiting fruit scab incidence of 15.33 per cent and intensity 4.13 per cent

Key words: apple, clonal rootstocks, scab, Alternaria leaf blotch, incidence and intensity

2B.3

Screening of different germplasm and evaluation of different insecticides against Potato leaf roll virus under field conditions

Kiran Bala, Ranbir Singh, Dechan Choskit, Sachin Gupta and S.K. Singh
Division of Plant Pathology, Faculty of Agriculture, Main Campus Chatha, SKUAST-Jammu

Potato (*Solanum tuberosum* L.) occupies a prominent position among the vegetable crops consumed by human beings due to high production, good nutritional value and better quality of the starch. Important viral potato diseases are potato virus X (PVX), Potato virus Y (PVY), Potato virus M (PVM) and Potato leaf roll virus (PLRV). Economically, potato leaf roll virus (PLRV) is one of the most important disease affecting potato crops worldwide. Eight germplasm were screened under field conditions against PLRV, and it was found that no germplasm was immune to the disease. Kufri Sindhuri and Kufri Lauvkar showed moderately susceptible reaction, while Kufri Badshah and Kufri Pukhraj were found moderately resistant whereas Local, Kufri Chipsona-1, Kufri Chipsona-2, Kufri Jyoti were found resistant under field conditions. Field evaluation of various insecticidal combination revealed that combination of soil application of carbofuran + seed treatment of Imidacloprid + foliar sprays of Imidacloprid recorded the lowest disease and thereby indicating their usage in the absence of any suitable variety.

2B.4

Prevalence of potato leaf roll virus in Jammu and its correlation with environmental factors

Kiran Bala, Ranbir Singh, Dechan Choskit, Stanzin Diskit, Sachin Gupta and S.K. Singh
Division of Plant Pathology, Faculty of Agriculture, Main Campus Chatha, SKUAST-Jammu

Extensive survey of potato fields conducted in winter season of 2014 revealed that disease was prevalent in all locations and per cent disease incidence varied from 20.00 to 33.33 per cent, respectively. Maximum per cent disease incidence of (33.33) was recorded from Barnoti in Kathua block, whereas minimum disease incidence (20.00%) was recorded from Ramgarh in Vijay Pur block. The correlation of disease intensity/vector population with weather parameters revealed that temperature (maximum and minimum) exhibited highly significant and positive correlation. However, relative humidity (maximum and minimum) and rainfall exhibited significant and negative correlation. Multiple correlation coefficients indicated that temperature (minimum and maximum), relative humidity (minimum), and rainfall had strong relationship with disease intensity and its vector population on different potato germplasm. Rise in minimum temperature was conducive for disease development while increase in relative humidity was detrimental to whitefly population. These findings can be used to develop a disease forecasting model to apply chemicals economically.

2B.5

Assessment of yellow mosaic of mungbean from different locations of Jammu region

Manpreet Kour, Ranbir Singh, Stanzin Diskit, Dechan Choskit, Sachin Gupta and S.K. Singh
Division of Plant Pathology, Faculty of Agriculture, Main Campus Chatha, SKUAST-Jammu-180009

Mungbean [*Vigna radiata* (L.)] is one of the thirteen food legumes grown in India and third most important pulse crop after chick pea and pigeon pea. It is an important short duration summer food legume in the tropical and sub tropical countries of the world. Yellow mosaic of mungbean (MYMV) is considered as the most destructive disease of the crop causing considerable loss in yield. The disease is transmitted by whitefly (*Bemisia tabaci*) in a persistent manner. Extensive survey of mungbean fields revealed that disease was prevalent in all the locations and overall percent disease incidence (PDI) varied from 23.80 to 38.20 per cent with overall mean of 30.94per cent. In Samba district the maximum PDI (37.60%) was recorded from Nanke chakk, whereas minimum PDI (24.60%) was recorded from Rakh while in Jammu district, the PDI ranged between 23.80-38.20 per cent. The maximum PDI was recorded at Chatha Village (38.20%) followed by Udheywala (35.20%), Marh (31.80%), Vijaypur (24.20%) and Bishnah (23.80).

2B.6

Reaction against Alternaria blight caused by *Alternaria brassicae* in Brassica genotypes

Vanya Bawa, S.K. Gupta and Manmohan Sharma
Division of Plant Breeding and Genetics, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu (SKUAST-J)
vanyadarsh@gmail.com

Brassica juncea suffers much due to biotic and abiotic factors. Among them, most important disease, Alternaria blight caused by *Alternaria brassicae* (Berk.) Sacc. causing yield losses may vary from 10 -70 per cent depending on the type of crop species grown and prevailing environmental conditions; (>70%) being in yellow sarson and toria and low to moderately high (35-40%) in mustard. As far as the literature is concerned almost no source of fully resistant genotype is observed in Indian mustard and Little efforts have been made so far to find out the sources of resistance against this important disease in different species of rapeseed-mustard except fungicidal treatment. For this study, Core collection Set of 40 brassica germplasm lines were screened for Alternaria blight at field conditions. Significant variability in the severity of the disease was observed among genotypes along with other yield related traits. Here the core set of 40 different genotypes were grown at the farm of SKUAST-J. The recommended agronomical practices were followed to raises good crop except application of any control measure. To maintain a high humidity level in micro-climate of the field, time to time light irrigation was applied for favouring the development of disease. The scoring of Alternaria blight was done using 0-5 scale at three stages *i.e.* leaf, flowering stage and siliquae phase as suggested by (Conn *et al.*, 1990). Alternaria blight was recorded on leaves, 100% flowering phase and 20 days before harvesting on pods. The disease was scored on per cent area of leaf as well as pod affected on respective stage of the genotype grown at the field. Least severity of disease on leaves was observed in case of B1, B2,B6, B9, B15, B24, B47 at leaf stage followed by flowering stage genotypes viz. B9, B10,B15, 24,B42, B46, B80. Whereas, genotypes namely B2, B4, B8, B42, B43, B55 showed least severity of diseases on leaves during silique phase. RSPR-01 and VARUNA was also taken as checks have showed moderately high reaction towards Alternaria blight. The values have shown the severity is more pronounced at mature stage on leaves than pods in all 40 genotypes as well as checks, but genotypes B2, B42 were lowest in infection of Alternaria blight till maturity of siliquae.

2B.7

Impact of yellow rust on seed yield and growth stages in wheat under different sowing environments in Jammu region

Lobzang Stanzen, Mahender Singh, Charu Sharma and Veena Sharma
Agrometeorology Section, Division of Agronomy, SKUAST-Jammu, Chatha-180009
stanzen2015@gmail.com

Wheat is the most widely cultivated food crop in the World and in India; it is the second important staple cereal food grown during *rabi season* (winter). Wheat crop played vital role in stabilizing the food grain production in the country. In the present study, the grain yield data of wheat and weekly meteorological parameters such as temperature (max. & min.), amount of rainfall, relative humidity (morning & evening) for the period of 15 years data was used to developing the forecast models and remaining three years data was used for the validation of the models has been taken for prediction of wheat seed yield. With the increase in incidence of yellow rust in region the crop yield forecasting at different growth stages (F_1, F_2 and F_3) were carried out for four selected districts (Jammu, Udhampur, Rajouri and Kathua) during *rabi* season 2016-17. The initiation of yellow rust the F_1 forecast (at tillering stage, 23rd December, 2016) for the grain yield were under estimated to be 18.79, 14.94, 18.33 and 22.46 q ha^{-1} for Jammu, Udhampur, Rajouri and Kathua, respectively. Thereafter, the under controlled condition the F_2 (at flowering stage on 30th January, 2017) and F_3 (at pre-harvesting stage on 3rd April, 2017) predicted yield were 17.35, 17.56, 16.43 & 19.00 q ha^{-1} and 19.78, 15.14, 19.31 & 23.33 q ha^{-1} for Jammu, Udhampur, Rajouri and Kathua, respectively. In this study, an attempt has been made to develop and validate suitable pre-harvest forecasting model for prediction of wheat yield in different districts of Jammu region with different levels of yellow rust infestation. Due to this crop yield prediction model grain yield of wheat can predict at three different stages (F1, F2 & F3) under and over estimate with the increase or decrease of yellow rust infestation in wheat crop in Jammu region. Then timely control of this disease and overcome from menace of yield reduction in the area.

Key words: Yellow rust. Weather, wheat crop, yield, incidence, prediction.

2B.8

Correlation of weather factors on development of marssonina leaf blotch of apple caused by *Marssonina coronaria* [(Ell. & J. J. Davis) J. J. Davis] in Kashmir valley

S.A. Rather, M.A. Bhat and N.A. Khan
Division of Plant Pathology SKUAST-K, Shalimar, Srinagar, J&K, -190025, India
sajjadplpath36@gmail.com

Apple (*Malus* × *domestica* Borkh.) is the most important fruit crop of the J&K and cultivated over an area of 157.2 thousand hectares. Marssonina leaf blotch (MLB) is nowadays wide spread foliar disease of *Malus spp.* and is emerging as the most destructive disease wherever apple is grown and causes premature defoliation (Kumar *et al.,* 2014). The classical disease triangle recognises the role of climate in disease development. So far, meagre research has been conducted in our country to find out the peak disease appearance in correlation with macro-climatic conditions on MLB disease development and this necessitated carrying out the present study under temperate region of the country. The present study will also indicate the role of weather factors on the disease development of Marssonina leaf blotch of apple. The studies were conducted in the experimental orchards of SKUAST-K, Srinagar and Krishi Vigyan Kendra, Ganderbal to carry out the influence of weather parameters on disease intensity during the year 2014. Five apple trees cv. Red delicious were randomly selected and tagged in the month of June 2014. Tagged plants were examined regularly for first appearance of disease and observations were recorded weekly. Weather data was procured from meteorological observatory of SKUAST-K and Indian Meteorological Department. Disease intensity

and infection rate was calculated by adopting method given by Yin *et al*. (2013). The maximum infection rate of 0.198 and 0.156 unit/day was observed during 3rd and 4th week of July in district Srinagar and in Ganderbal respectively, under the natural epiphytotic conditions. The percent disease intensity showed the positive correlation with the maximum and minimum relative humidity and rainfall. However, negative correlation was established with the maximum and minimum temperature in both the districts. The positive correlation of weather factors with the disease intensity may be attributed to the high relative humidity and better rainfall and optimum temperature during the period essential for disease initiation and development. The multiple regression analysis showed that the weather factors accounted for 95.9 and 88.2 per cent variation in disease development in district Srinagar and Ganderbal, respectively. The correlation analysis of various meteorological factors revealed that the disease intensity is positively correlated with maximum and minimum relative humidity and rainfall and negatively correlated with maximum and minimum temperature in both the districts *viz*. Srinagar and Ganderbal. The multiple regression analysis showed that weather factors influenced the disease intensity to the extent of 95.9 per cent in district Srinagar and 88.2 per cent in district Ganderbal.

2B.9

Screening of maize (*Zea mays* l.) inbred lines for identification of resistant sources against *Turcicum* leaf blight (*Exserohilum turcicum*) under high altitude conditions

Rayees A. Lone*[1], Gul Zaffar[2], Zahoor A. Dar[2], M. Ashraf Bhat[1], Ajaz A. Lone[2], M. Ashraf Ahangar[4] and Asif B. Shikari[3]

[1]Division of Genetics and Plant Breeding, [2]Dryland Agriculture Research Station, Budgam, Jammu and Kashmir, India, [3]Division of Plant Biotechnology, [4]Division of Plant Pathology, MRCFC, Khudwani Anantnag-192101, SKUAST- Kashmir-190025, India; rayees181@gmail.com

A study was conducted to identify the sources of resistance against northern corn leaf blight caused by fungus *Exserohilum turcicum* (Pass.) in maize. 50 inbred lines of maize were evaluated at hot spot location, Larnoo for TLB. Out of these 50 inbreds, 2 entries were found to have disease score of 1, 20 lines were having disease score of 2, 3 lines were having score of 4 and 25 inbred lines were having a disease score of 3. The two inbred lines VL-102 and VL-109545 having disease score of 1 showed high degree of resistance to TLB where as 248(D48), NAI-228 and NAI-138 having a disease score of 4 were found to be highly susceptible. The lines identified to possess low disease severity score against *Turcicum* leaf blight in the present study could be used successfully in developing genotypes having desirable level of resistance in disease endemic areas to aim for sustainable productivity.
Key words: *Zea mays* L., Northern corn leaf blight, screening

2B.10

Integrated management of grape Anthracnose (*Elsinoe ampelina) cl Sahibi* in Kashmir valley

Sabiha Ashraf, S.A. Simnani, Nasreen Jahan, Nasreen Fatima and Vaseema Yousuf

Division of Plant Pathology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar

Grapes (*Vitis vinifera*) are a commercial fruit in India and Kashmir valley. Anthracnose of grapes caused by *Elsinoe ampelinais* a serious disease of grapes that causes huge losses to grape growers worldwide by making the berries unmarketable particularly under temperate regions with cool moist weather in spring. It is commonly called birds eye rot for the distinctive spots it causes on grape berries. The main purpose of this study was to devise management strategies for producing disease free and marketable acceptable berries besides increasing yield. The experiment was conducted in a farmer's field on the local cultivar *Sahibi* with three treatments: T1: farmers practice, T2: spray with carbendazim 50 WP @ 0.05% + destruction of diseased plant material T3: dormant spray of copper oxychloride 50 WP @ 0.3% + proper disposal of diseased plant material + spay with hexaconazole 5EC@0.05%. The results showed that the dormant spray of copper oxychloride @ 0.3% + spray with hexaconazole 5 EC @ 0.05% + proposal disposal of diseased plant material recorded lowest disease incidence and intensity of 28.14% and 15.46% whereas disease incidence and intensity of 86.42% and 59.88% was recorded in T1 treatment (farmers practice) compared to 36.56% and 24.63% in T2 treatment. The marketable yield increased from 1.6 to 6.4MT/hac and returns increased from 1.6 to 6.2 lakh/ha in treated plots.

Key words: Anthracnose, disease incidence, disease intensity, fungitoxicants, grapes, management, yields

2B.11

Genetic diversity of *Venturia inaequalis* (Cke.) Wint. in mixed orchard system of Kashmir

Mohammad Saleem Dar[1], B.A. Padder[1], M. D. Shah[1], Mushtaq Ahmad[1], N.A. Bhat[1], M.A. Khan[2]

[1]Division of Plant Pathology, [2]Division of Genetic and Plant Breeding, SKUAST-K, Shalimar-190025
saleemdar0001@gamil.com

Apple scab caused by *Venturia inaequalis* is a successful parasite on apple because it has accumulated numerous parasitic fitness attributes (genes) that enable it to infect and reproduce. Apple scab fungus has been an important genetic model for fungal genetics and pathogenicity determinants. In Kashmir diminutive work has been carried out on population genetics of *V. inaequalis* and no information is available on population structure in mixed orchard system which necessitates working out the genetic diversity and population structure of *V. inaequalis* in mixed orchard system of Kashmir. Fifty four isolates of *V. inaequalis* collected from different cultivars and were isolated, purified and maintained. Molecular diversity using ten microsatellite markers revealed a high level of polymorphism and similarity coefficients ranged from 0.00 to 1.00. Isolates formed 54 haplotypes indicating a high level of genetic diversity in *V. Inaequalis* in Kashmir valley. Analysis of molecular variance using microsatellite markers also revealed a high level of variability within populations (geographical location, cultivar or host) than among the population. Pair wise F_{ST} (fixation index) values at 2 and 3 population level were low (0.02 - 0.04) revealing less genetic differentiation among the *V. inaequalis* populations. However, fixation index values (0.06 - 0.36) were moderate to very high among the 18 *V. inaequalis* populations indicating significant genetic differentiation. Principal coordinate analysis (PCA) separated *V. inaequalis* isolates into three distinct groups with the first, second and third component representing 26.34, 19.06 and 15.02 per cent of total variation. It is evident from the present study that gene flow is prime factor responsible for shaping or structuring populations of *V. inaequalis* in Kashmir valley. Due to strong selection against immigrants i.e. host specificity from different host varieties will have important implication on the use of mixture in practice for management of scab.

2B.12

Impact of weather factors in the development of Phomopsis blight of brinjal in Kashmir

Mudasir Bhat, Ali Anwar, M. Najeeb Mughal, Fayaz Mohiddin, Arif Hussain and Uzma Fayaz

Division of Plant Pathology, SKUAST-Kashmir-190025
mudasirpatho@gmail.com

Phomopsis vexans causes leaf blight of brinjal and is one of the major constraints in the cultivation of the crop. Climate not only affects the crop but also affect the pathogens that decrease the crop yield. Due to industrial emissions, concentration of Co_2 and temperature would increase leading the world towards global climate change. The effect of weather parameters *viz*. temperature, relative humidity

and rainfall on the development of Phomopsis blight of brinjal was therefore investigated under prevailing environmental conditions on susceptible cultivar Pusa Purple Long during 2015 and 2016. The data regarding per cent disease intensity was recorded at fifteen days intervals from May-October. Data obtained was correlated with the mean maximum and minimum temperature, mean maximum and minimum relative humidity and mean rainfall during the corresponding period. The data revealed that in 2015 the disease initiated under field conditions in the second week of June on leaves and last week of June on twigs. The per cent disease intensity increased slowly and reached as high as 59.48 and 39.97 on leaves and twigs respectively, during the last week of October. However, on fruits the disease symptoms were first observed during last week of July when the mean atmospheric temperature both maximum and minimum were 29.03°C and 17.84°C, respectively and mean relative humidity both maximum and minimum were 86.73 and 65.60 per cent, respectively and reached as high as 60.90 per cent in the last week of October. The maximum rate of disease progress (0.0722, 0.0779 and 0.0712) was observed during the second week of August, last week of August and second week of September on leaves, twigs and fruits, respectively which coincided with the favourable temperature and relative humidity for its progress. The minimum infection rate of 0.0058, 0.0066 and 0.0053 was recorded in the last week of October when the maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and rainfall during the previous week were 18.03, 6.53, 89.13, 67.73 and 5.93, respectively. Epidemiological studies further revealed that the relationship between disease intensity on leaves and weather factors indicated significant positive correlation with maximum relative humidity, significant negative correlation with maximum temperature, minimum temperature and minimum relative humidity while as it showed non-significant positive correlation with rainfall. In case of stem blight, the relationship showed positive and significant correlation with minimum temperature and maximum relative humidity, significant and negative correlation with maximum temperature and minimum relative humidity and non-significant negative correlation with rainfall. For fruit rot, the relationship indicated significant and negative correlation with maximum temperature, minimum temperature and minimum relative humidity, significant and positive correlation with maximum relative humidity and non-significant but positive correlation with rainfall.

2B.13

Status and variability studies against *Colletotrichum capsici* causing chilli anthracnose

Arvind Kumar[1], S.K. Singh[1], A.K. Singh[1], V.B. Singh[2], Ranbir Singh[1] and Sachin Gupta[1] and V.K. Razdan

[1]*Division of Plant Pathology, Faculty of Agriculture, SKUAST of Jammu*
[2]*RRSS, Raya, SKUAST of Jammu*

The investigations regarding status and variability studies of *Colletotrichum capsici*, the causal organism of chilli anthracnose was carried in Jammu sub-tropics. The disease was reported in all the chilli growing areas of Jammu subtropics with the maximum dieback intensity observed in Udhampur (24.80%), followed by Jammu (23.20%) whereas, maximum fruit rot intensity (39.46%) was observed in Udhampur followed by Kathua (39.20%) at fruit maturity stage. The pathogenicity of *C. capsici* isolates (Cc_1 to Cc_{10}) was conducted on detached chilli fruits (cv. Pusa Jawala), where the maximum fruit rot intensity (44.22%) was in case of isolate Cc_{10} and least in Cc_1 (22.44%). Cultural and morphological variability of *C. capsici* isolates exhibited that the colonies were cottony or fluffy, rarely suppressed with colour ranging from white to brown, colony margins varied from regular to irregular. The spore size ranged from 21.42 to 32.20 µm in length and 2.11 to 5.35 µm in breadth. The shape of spores was observed as falcate to fusiform. Setae size also varied in length and breadth ranging from 63.20 to 121.22µm and 4.48 to 5.35 µm, respectively. Acervulli production varied from 31-55/5mm fungal disc among the ten *C. capsici* isolates. All the isolates (Cc_1 to Cc_{10}) showed excellent growth on PDA while on ZDA and PCA medium showed fair growth.

2B.14

Variability studies against *Bipolaris sorokiniana*, causal pathogen of spot blotch of wheat

Manmohan Singh[1], S.K. Singh[1], A.K. Singh[1], V.B. Singh[2], Ranbir Singh[1], Sachin Gupta[1] and V.K. Razdan[1]

[1]*Division of Plant Pathology, Faculty of Agriculture, SKUAST of Jammu*
[2]*RRSS, Raya, SKUAST of Jammu-181143*

The pathogenicity of *B. sorokiniana* isolates (BS_1 to BS_{10}) on cv. Sonalika revealed maximum AIDX (49.10%)) in isolate BS_9 and least in BS_{10} (25.42%). Cultural and morphological variability of *B. sorokiniana* isolates exhibited that the colonies were effuse grey-white to effuse black and velvety-white mycelial growth with regular to irregular margins. The colour of colonies varied from grey to dark brown and white to light grey. The number of septation in isolates ranged from 3.9 to 6.3 and spore size ranged from 35.07 to 60.53µm in length and 13.20 to 17.60µm in breadth. The shape of the spore was elliptical, slight curved and straight with tapered end. All the isolates (BS_1 to BS_{10}) showed excellent growth on PDA while on CDA and PCA medium they showed fair growth. On the basis of pathogenic response of *B. sorokiniana* isolates on different wheat genotypes, isolates BS_2 and BS_9 were categorised as highly virulent, whereas isolates BS_7 and BS_{10} as least virulent. Isolates BS_2, BS_3, BS_4, BS_5, BS_6 and BS_8 were moderately virulent.

2B.15

Granulation: A major threat in citrus production

Mudasir Iqbal[1], V.K. Wali[1], Parshant Bakshi[1], Mohsin Iqbal[2], Kiran Kour[1], Arti Sharma and B.K. Sinha[3]

[1]*Division of Fruit Science,* [2]*Division of Plant Pathology, Faculty of Agriculture,* [3]*Division of Plant Physiology, Faculty of Basic Sciences, Main Campus, Chatha, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009, India*
mudasirkas111@gmail.com

Granulation is a serious problem of citrus, especially under North Indian conditions. This abnormality is initiated at the stem end of the fruit which gradually extends towards the stylar end. The affected juice sacs become hard and dry, fruits become grey in colour, enlarged in size, have flat and insipid taste and assume a granular texture. Granulated fruits contain less extractable juice as most of it turns into gelatinous mass. This results in more quantity of rag and thus low pulp/rag ratio. Granulation is a serious problem of citrus, especially under North Indian conditions. Granulation is a physiological disorder of the juice sacs of citrus fruits wherein they become comparatively hard, assume a grayish colour and somewhat enlarged with an increase in pectin, lignin and other polysaccharides resulting in considerable decrease in juice, TSS and acid contents and increase in rag and peel proportion and water content of both pectin fruit sacs and increase in respiratory activity. The term granulation, crystallization and dry end is used to describe this trouble. It is much more prevalent in larger sized fruits than small fruit, young than old trees and in humid than dry areas. Several factors like luxuriant growth, rootstock and the variety, frequent irrigation, mineral constituents in plant tissues, time of harvest, exposure to sunlight, etc., are found to be associated with this malady. It is much more prevalent in larger sized fruits than in small fruit, in young than in old trees and in humid than in dry areas. Several factors like luxuriant growth, rootstock and the variety, frequent irrigation, mineral constituents in plant tissue, time of harvest, exposure to sunlight, etc., are found to be associated with this malady. The incidence is relatively high in the fruits of younger plants as compared to those in older plants. The vigorous rootstocks like rough lemon increase the incidence of granulation as compared to less vigorous rootstocks. Late maturity and persistent cold weather throughout the period of maturity have been found to increase the incidence of granulation. Citrus trees growing in humid climate are reported to have a higher incidence of granulation than other growing in dry regions. It is

serious problem of Hamlin, Washington Navel, Blood Red, Jaffa and Mosambi varieties of sweet orange. Pineapple variety of sweet orange shows comparatively lesser incidence of granulation while Kinnow mandarin under North India conditions and Khasi santra of Assam region are reported to be mostly free from this menace. The vigorous rootstock like rough lemon increase the incidence of granulation as compared to less vigorous rootstocks. Cleopatra mandarin reduces the incidence of granulation and improves the fruit quality to a great extent. An enhanced formation of lignin probably due to Zn shortage, induced low auxin content and an increase in pectin and a decrease in pectin esterase activity were associated with granulation. Higher level of auxins, cytokinins and abscisic acid low gibberellins were noted in the granulated fruits than in the normal fruits.

2B.16

Sustaining impact of pathogens on fruit production systems

Brajeshwar Singh[1] and Anil Bhushan[2]

[1]Division of Microbiology, Faculty of Basic Sciences, Main Campus, Chatha, Jammu,
[2]Advanced Centre for Horticulture Research, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu
brajeshbhau@yahoo.co.in

India stands second after China with total fruit production of 81285334 thousand tonnes on 6982015 thousand hectares land (Ministry of Agriculture, GOI. 2013-14). In 2014-15, Indian area of production was 6242.30 thousand hectares withtotal fruit production of 86283 thousand tonnes (Ministry of Agriculture, GOI). Based on their climate and topography, fruit growers have ample choice of suitable fruit varieties. Cultivation of fruits is not comparable to cereals and is comparatively more technical. Fruit production requires updated technologies for better plant and fruit management. Fruits are comparatively perishable so there storage and marketing needs special emphasis. Like any other plant/crop, fruit trees are equally affected by many abiotic and biotic stresses. Abiotic stresses like climate, soil and water conditions are equally responsible for a good fruit crop. Biotic stress mainly involves infestation of fruit crop with insects or pathogens. These factors greatly influence quality and quantity of fruits harvested and finally their shelf life too. Diseases can create havoc and complete crop failure if provided with congenial conditions. Irish potato famine is a well-quoted example of such incidence that led to demographical alterations. Fruit diseases are equally important since fruit forms an important component of food basket.

Key words: Fruits, Sustaining, Biotic, Abiotic & Stress

2B.17

Symptomatology and etiology of Alternaria leaf spots and blight of oilseed crops

Shahid Ahamad

Directorate of Research, SKUAST-Jammu

Eight oleiferous crops are grown in diverse agro-climatic conditions in India in all the seasons, *Rabi, Kharif* and *Zaid*. The oil extracted from their seeds are not only utilized for cooking purposes but some of them have medicinal values also (castor, linseed, sesame). Eleven species of *Alternaria* cause leaf spots and blight on eight oil yielding crops in India. Some of them are very specific to parasite only a particular oilseed plant like *A. helianthi* (sunflower), *A. brassicae* and *A. brassicicola* (rapeseed and mustard), *A. linicola* (linseed), *A. sesami* (sesame), *A. ricini* (castor) and *A. carthami* (safflower). *Alternaria alternata* is of wide spread occurrence causing leaf spots and blight of sunflower, mustard, groundnut and soybean. *A. tenuissima* is next to *A. alternata* in causation of disease. The disease symptoms on all the oil yielding crops along with morphological characters of causative *Alternaria* spp. have been given in greater detail. On rapeseed/ mustard and sunflower there is the involvement of four species of *Alternaria* on each crop so, a comparative study of symptomatology and etiology

has been made and a very simple and feasible key has been framed for ready and correct identification of *Alternaria* spp. associated with them.

2B.18

Prevalence of Bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*) in Jammu subtropics

Ashok K. Singh[1], Prem Chinabi[1], S.K. Singh[1], V.B. Singh[2], Anil Gupta[1], Ranbir Singh[1] and Sachin Gupta[1]

[1]*Division of Plant Pathology, Faculty of Agriculture, SKUAST of Jammu*
[2]*RRSS, Raya, SKUAST of Jammu-181143*

An intensive survey was conducted during *kharif* 2015 to assess the prevalence of bacterial leaf blight of paddy in Jammu, Kathua and Samba districts of Jammu at boot leaf stage. The disease incidence in Jammu district, ranged from 34.10 to 45.33 per cent with the mean of 34.59 per cent. In Kathua district disease incidence ranged from 15.21 to 40.13 per cent with mean of 29.67 per cent while in Samba district the incidence ranged from 15.23 to 40.21 per cent with mean of 36.35 per cent. Maximum disease incidence was recorded in Kulian village (45.33 per cent) of Jammu district and minimum at Jagatpur (15.21 per cent) of Kathua district. Overall disease incidence for all three districts was 33.53 per cent. Maximum disease incidence (45.33 per cent) was recorded IET-1410 whereas minimum incidence (34.10 per cent) was recorded in Basmati-370. In Kathua district, five varieties IET-1410, Pusa-1121, Neha, PHB-71, and Basmati-370 were grown. Maximum and minimum incidence of 40.13 per cent and 15.21 per cent respectively was recorded in IET-1410 and Neha. In Samba district, three varieties i.e. Basmati-370, Neha and Ratna were grown by most of the farmers. Maximum disease incidence 40.21 per cent was recorded in Ratna while minimum incidence 15.23 per cent was recorded in Neha.

2B.19

Screening of brinjal hybrids against phomopsis blight under subtropical conditions of Jammu and Kashmir

Anil Bhushan, R.K. Samnotra and Sandeep Chopra

Advanced Centre for Horticulture Research, Udheywalla, SKUAST-Jammu

Brinjal, one of the most important vegetable crops, is susceptible to a wide range of diseases which causes severe loss in all stages of growth and development. It is known to suffer from 12 diseases and among them phomopsis blight and fruit rot, caused by *Phomopsis vexans*, has been considered as major constraints to brinjal cultivation in the subtropical conditions of Jammu region. In order to identify the resistant types as well as most suitable season of growing, the present investigation was carried out at Vegetable Research Farm, Division of Vegetable Science & Floriculture, FoA, Chatha, SKUAST-Jammu during three seasons i. e. Spring-summer, autumn-winter and rainy spreading across two years i.e. 2013-14 and 2004-15. A total of ten hybrids namely, Rajni, PPL-74, Navkiran Improved, Sandhya, MH-80, Chhaya, PBH-3, Nisha Improved, Shamli and Abhishak, were screened under the present study. The results revealed significant genotypic differences with respect to phomopsis blight incidence. Minimum incidence was recorded in long fruited hybrids viz., PPL-74 (8.81%) followed by Shamli (8.92%) whereas maximum incidence was recorded in round fruited hybrids viz., MH-80 (20.08%) followed by PBH-3(17.17%). Among all the three growing seasons, autumn-winter recorded overall minimum phomopsis incidence (11.25%) followed by spring-summer (17.50%) whereas rainy season recorded maximum disease incidence (21.44%).

Theme-III

Effect of Soil Ecology Upon Disease Management

ORAL PRESENTATIONS

3A.1

Soil microorganisms and disease control

Baseerat Binti Nabi, M.A. Dar, Subhash Chand, Rehana Rasool, Khushboo Farooq and Rehana Jan

Division of Soil Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus-190025, Srinagar, J&K, India

baseerat158nabi@gmail.com

The community of organisms that lives in soil plays many important roles in the successful functioning of agricultural ecosystems. This community consists of bacteria, fungi, protozoa, nematodes (predators of microorganisms and pathogens of plants), earthworms, arthropods, and other organisms. Although certain species are harmful to crops, most are beneficial and even essential for the well-being of plants. There are striking similarities between the roles of microorganisms in the human body and in the soil. Production of crops is affected by soil borne pathogens that need control. Chemical and physical attributes of soil, including pH, organic matter and clay content, can operate in the reduction of plant diseases directly or indirectly through their impact on soil microbial activity. Although these abiotic characteristics of soil can contribute to disease suppression, soil suppressiveness is often times directly or indirectly a function of the activity of soil microorganisms or microbial metabolites. There are several ways and strategies that are adopted in the management of plant diseases. Some of these ways are developing resistant varieties, use of agrochemicals and physical methods. Since all these have an adverse effect on environment in various ways, so use of biological control is under consideration. Several microbes have been seen to have antagonists which possess characteristic to suppressive soils. These microbes also play some other functions in management of plant diseases such as; they increase plant vigour and induce systemic resistance in host against the pathogen causing disease. Control of pathogen causing plant disease by biological means has two approaches which are: management of the already existing population and introduction of specific organisms which help to reduce the disease incidence. In order to control disease soil microbes must compete for the available nutrients supplied in different forms like exudates, leachates etc. There are a large number of nutrients present in the root zone therefore they attract a large diversity of microorganisms. The competition between theses available nutrients and soil microorganisms is a fundamental mechanism by which plants can be protected from the parasitic organisms.

3A.2

Soil-borne diseases in crop plants and their sustainable management

Tabasia Amin[1], Tariq A. Shah[2], Mohd Tahir Amin khan[3], Tabarak Amin Khan[4], Yusra Musteequm Choudhary[5] and Nusrat-ul-Islam[6]

[1]Division of Plant Pathology FAO, Wadura, Soopore, [2]Division of Plant Pathology, Saffron Research Station Pampore, [3]Research scholar CMJ Meghalaya, [4]Department of economics, GDC Mendhar, [5]Department of Biotechnology, SMVDU Katra Jammu, [6]Division of Genetics and Plant Breeding FAO, Wadura, Soopore, SKUAST- K

tabasia863@gmail.com

Plant diseases are considered an important biotic constraint, which leads to significant crop losses world-wide. Integrated disease management which combines biological, cultural, physical and chemical control strategies in a holistic way rather than using a single component strategy proved to be more effective and sustainable. Soil-borne diseases are very critical in realizing the yield potential of improved cultivars in several agricultural crops. Many factors in the soil influence the activity of soil-borne pathogens and disease such as soil type, texture, ph, moisture, temperature and nutrient levels are among them. Often these diseases are very difficult to manage due to their highly

heterogeneous incidence and lack of knowledge on the epidemiological aspects of soil-borne pathogens. Soil-borne diseases are difficult to control because they are caused by pathogens which can survive for long periods in the absence of normal crop host. These diseases are often very difficult to diagnose accurately and the pathogens may be difficult to grow in culture and identify accurately. The expansion in the crop diversity in agriculture has required parallel expansion of strategies to minimize soil-borne disease. The effective control of the soil-borne disease is possible only through detailed study on survival, dissemination of soil-borne pathogens, effect of environmental conditions role of cultural practices and host resistance and susceptibility will play a major role in disease management.

Key words: Soil-borne pathogens, Soil-borne diseases, Environment

3A.3

Factors affecting development of collar rot disease of chickpea in bundelkhand region

Meenakshi Arya*, Anshuman Singh and Upagya Sah
Rani Lakshmi Bai Central Agricultural University, Jhansi
meenakshirlbcau@gmail.com

The study was conducted during the Rabi season of 2016 to assess the effect of factors like inoculum potential, age of the seedling and soil type on the incidence of collar rot disease in chickpea caused by *Sclerotium rolfsii* Sacc. The present study was conducted to ascertain the effect of different levels of inoculum of the pathogen, seedling age and soil type on the development of collar rot in chickpea. The study indicated that an increased inoculum load of the pathogen enhanced the disease incidence. The pathogen was isolated from infected chickpea plants and was multiplied on wheat grains for use in different trials. Among the techniques used for pathogenicity, the inoculum was used in form of wheat grains fully impregnated with mycelium of the pathogen was found to be simple, feasible and highly effective whereas in case of the soil textures it was found that the mortality of seedling was higher in clayey and saline soil. Further the study also revealed that the younger seedlings were more susceptible and the susceptibility decreased with the increase in age of seedlings. However, the study may further be conducted and results may be further confirmed by for another two to three years.

3A.4

Rhizome rot of ginger pose a threat to ginger production in Jammu region

Shahid Ahamad, Jag Paul Sharma and Deepak Kher
Directorate of Research, SKUAST-Jammu (J&K)
shahid_2056@yahoo.co.in

Ginger (*Zingiber officinale* rose L.) is an important spice crop belonging to family *Zingiberaceae*. Rhizome rot of ginger caused by *Pythium aphanidermatum* (Edson) Fitz is a major constraint in the production of healthy rhizome, sometimes causing total failure of crop.It is a serious rhizome as well as soil borne disease and the symptoms can be seen from July. Yellowing of leaves appear first on the lower leaves and proceeds to upper leaves. Roots arising from the affected rhizome become rotten and show brown discoloration of the rhizome tissue. Sometimes the pseudostem comes off easily with a gentle pull. The rotten parts attract other fungi, bacteria and insects. During the rainy season, this disease spreads very fast from infected field to healthy field. Management of this disease through biological or organically is not possible because pathogen is seed and soil borne. It is a major disease in Reasiand Udhampurdistrict of Jammu region. So fungicidal treatments were taken to manage this disease. The three chemicals and five different treatments reduced disease severity, though every chemical had differential effect of every character of disease data. This result was observed in both the two years differential disease reaction and conclusion was drawn with the two years pooled mean data. The results showed from the two years data it is revealed that maximum disease incidence was

recorded during Kharif2015 i.e55.25% without rhizomes dip treatment (farmers practices in Jammu province)while lowest was recorded during Kharif-2014 i.e. 7.5% when rhizomes dip treatment was given with mancozeb + carbendazim (1:1 ratio) along with drenching with metalaxyl @0.125% was given. However, maximum yield was recorded during Kharif-2014 with rhizomes dip treatment with mancozeb + carbendazim (1:1 ratio) along with drenching with metalaxyl @0.125% followed by 125 q/ha with rhizomes dip treatment was given with mancozeb + carbendazim (1:1 ratio) and lowest yield was recorded 90 q/ha during Kharif-2014 when rhizomes was sown without dip treatment. The mean disease incidence was recorded 9.00% in case of T3 - T2 + drenching with metalaxyl @ 0.125% and maximum mean diseases incidence was recorded 45.37% in case of T1 - Check without Seed treatment. The mean maximum yield 132.5 q/ha was recorded in case of T3 - T2 + drenching with metalaxyl @ 0.125% and minimum mean yield 82.5 q/ha was recorded in case of T1 - Check without Seed treatment. C:B ratio was also recorded highest during *Kharif*-2014 with rhizomes dip treatment with mancozeb + carbendazim (1:1 ratio) along with drenching with carbendazim and lowest yield was recorded 90 q/ha during*Kharif*-2014 when rhizomes was sown without dip treatment and lowest was recorded 1:2.5.

Key words: Ginger, *Pythium aphanidermatum*, rhizome rot of ginger.

3A.5

Efficacy of fungitoxicants and bio control agents against wilt of lentil *Fusarium oxysporum* f. sp. *lentis*

Sonika Jamwal[1], Anamika Jamwal[2], Upma Dutta[3], A.C. Jha[1], Sanjeev Kumar[1], Anil Kumar[1] and Reena[1]

[1]*Advanced Centre for Rainfed Agriculture, Dhiansar, 181133;* [2]*KVK Kathua 184101;* [3]*Div. of Basic Sciences 18000 SKUAST-Jammu, Main Campus-Chatha*
sonikajamwal1@gmail.com

Bio control agents (*Trichoderma viride*, *Pseudomonas fluorescens*) and various fungitoxicants were tested for their efficacy in controlling the Fusarium wilt of lentil caused by *Fusarium oxysporum* f. sp. lentis *in vitro* and *in vivo*. *In vivo* conditions soil inoculated with *Fusarium oxysporum* f. sp. *lentis* was conducted to compare the efficacy of different treatments viz. seed treatment with bio-control agents and fungitoxicants in the management of lentil wilt. All the treatments significantly reduced the wilt incidence. carbendazim, Thiram and *Trichoderma harzianum* were the most effective and reduced the wilt incidence as compared to inoculated control respectively where as neem leaf extract and neem bark extract was the least effective over inoculated control. Seed treatment with *Pseudomonas fluorescens* and *Trichoderma viride* effectively enhancing the growth of chickpea viz. Shoot length, root length, shoot weight and root weight as compared to control. *In vitro* condition all the treatments used *in vivo* conditions were evaluated at different concentrations for their efficacy is significantly inhibited the radial growth and mycelial weight of *Fusarium oxysporum* f. sp. *lentis.* All the treatments were effective and significantly reduced the radial growth and mycelium weight of *Fusarium oxysporum* f. sp. *ciceri.*

Key words: *Pseudomonas fluorescens, Trichoderma viride,* fungitoxicants, *Fusarium oxysporum* f. sp. *Lentis.*

POSTER PRESENTATION

3B.1

Management of anthracnose of Rajmash (*Phaseolus vulgaris* L.) in Poonch district

Muneeshwar Sharma, Ajay Gupta, R.K. Arora, Muzaffar Mir, Pawan Sharma and M.A. Guroo
Krishi Vigyan Kendra, Poonch

Rajmash (*Phaseolus vulgaris* L.) is the major pulse crop of the Poonch District. It is grown as mixed crop with maize in the upper reaches of the district. Farmers sell and consume beans as vegetable in the early stage of the crop and after maturity as pulses. Rajmash is the major source of income for the farmers of the district. Low production in rajmash due to anthracnose caused by *Colletotrichum lindemuthianum* (Sacc. and Magn.) Lams Scrib. warrants a serious attention as it inflicts heavy economic losses to the crop, which may reach up to 100%, under conducive conditions. An On Farm Trial (OFT) was conducted by KVK Poonch for the management of anthracnose of rajmash (*Phaseolus vulgaris* L.) and checking fall in production due to crop damage. Three trials were conducted at three different locations of block Mandi of district Poonch with three treatments at each location in the year 2016-17. Two technologies were assessed for the control of the disease, whereas farmers practice was considered as control. Treatment I- Farmers Practice (no measures), Treatment II- Seed treatment with carbendazim @ 2.5 gm/kg + two sprays of carbendazim @ 0.5 gm/l, Treatment III- seed treatment with carbendazim @ 2.5 gm/kg + two sprays of mancozeb @ 3 gm/l. Results of the trial at farmers field revealed that anthracnose in rajmash can be effectively managed by the carbendazim @ 2.5 gm/kg + two sprays of carbendazim @ 0.5 gm/l proved best in managing the anthracnose disease (10.4% disease incidence) with BC ratio of 4.49 and a yield of 5.57 q/ha, followed by seed treatment with carbendazim @ 2.5 gm/kg + two sprays of mancozeb @ 3 gm/l (14.4% disease incidence) BC ratio of 4.01 and yield 5.01 q/ha, whereas, maximum disease incidence 40% and lowest yield of 3.61q/ha with BC ratio of 2.97 was recorded from farmers Practice (no measures). Farmers were recommended to treat the seeds of rajmash before sowing with carbendazim @ 2.5 gm/kg followed by two sprays of mancozeb @ 3 gm/l after the emergence of disease for the effective control of anthracnose of rajmash (*P. vulgaris* l.).

3B.2

Evaluation of fungicides against seed borne diseases of wheat

Anamika Jamwal[1], Sonika Jamwal[2], Amrish Vaid[1], Upma Dutta[3], A.C. Jha[2], Sourav Gupta[1], Pawan Kumar Sharma[1], Vishal Mahajan[1] and Vijay Kumar Sharma[1]
[1]*Krishi Vigyan Kendra, Kathua;* [2]*ACRA-Dhiansar,* [3]*Division of Microbiology*
Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu- 180009
annajamwal@gmail.com

Wheat is an important cereal crop and serves as staple food of the people of Kathua region. But every year due to infestation of loose smut and flag smut disease, yield loss to an extent of 7% to 10% has been observed on the farmers field. Therefore, KVK-Kathua conducted an On-Farm trial at different locations to assess the efficacy of fungicides against seed borne diseases of wheat. The results revealed that seed treatment with tebuconazole @ 2g/kg seed resulted in disease reduction of loose smut to an extent of 91.42% and 88.92% in case of flag smut over farmers practice.

Key words: Wheat, On Farm Trial, seed borne diseases

3B.3

Integrated disease management: A holistic approach

Rukhsana Jan[1] and Asha Nabi[2]
[1]Division of Agronomy, SKUAST-Kashmir; [2]Division of Plant Pathology, SKUAST-Kashmir-190025
rukhsanamalik75@gmail.com

Integrated disease management (IDM), which combines biological, cultural, physical and chemical control strategies in a holistic way rather than using a single component strategy proved to be more effective and sustainable. Plant diseases caused by a variety of causal agents (fungi, bacteria, viruses, phytoplasmas and nematodes) is a group of biotic constraints that reduces crop yields worldwide. In developing countries, from tropical to subtropical to Mediterranean and temperate climates, crop losses are often higher than in the developed countries, mainly because farming communities lack most appropriate solutions and resources devoted to their study. It is estimated that 10-15% of the already low yields in developing countries is lost due to disease attack, and losses can be higher if post-harvest diseases are considered. A recent study dealing with all production constraints (including diseases) for six major crops (wheat, rice, sorghum, chickpea, cassava, and cowpea) in 13 Asian and African farming systems showed that losses caused by diseases ranged from 3 to 14%, whereas yield losses due to all biotic stresses ranged from 16 to 37% and yield losses to all crop production constraints ranged from 36 to 65% (Waddington et al., 2010). Disease can be managed by Cultural practices such as cultivation techniques, mulching, intercropping, plant density, planting date, crop rotation, strip farming, timing of harvest, barrier crops, crop mixtures, rouging, healthy planting material, soil solarization, soil amendments and fertilizer management, and water management have been used singly and in combination as tools for disease management. Chemical control such as fungicides played an important role in disease control, Biological control against plant pathogens started with the control of crown gall with *Agrobacterium radiobacter* and that of seedling blights caused by *Pythium and Rhizoctonia* with *Trichoderma harzianum* and application of physical methods involving the use of heat, solar energy and irradiation may reduce the pathogen population or weaken their pathogenic potential. The success and sustainability of IDM strategy, especially with resource poor farmers greatly depends on their involvement in helping generate locally specific techniques and solutions suitable for their particular farming systems and integrating control components that are ecologically sound and readily available to them.

3B.4

Integrated disease management of white mold disease of tomato caused by *Sclerotinia sclerotiorum*

Ved Ratan, Naveen Kumar Upadhyay, M.R. Dabas and Abhishek Mishra
Department of Plant Pathology, C.S. Azad University of Agriculture & Technology, Kanpur-208002
abhishekmishracsa@gmail.com

Tomato (*Lycopersicon esculentum* Mill) is solanacious vegetables widely grown vegetables in the world. Tomato crop effected by different fungal diseases in which Fruit rot known as target spot disease incited by *Sclerotinia sclerotiorum*. Disease severity varied (30.50 to 18.60%) in different location of Kanpur. Highest disease severity (30.50%) recorded at vegetable research farm, Kalayanpur, Kanpur. The lowest disease severity (18.06%) was noticed at the farmer's field at Billhore, Kanpur. *Sclerotinia sclerotiorum* is a soil borne pathogen which causes symptoms on ripe fruits. Pathogen isolated from infected fruits. Eight fungicides were tested against pathogen *In-vitro* condition. Among of them Metalaxyl, Topsin-M, Tebucanazol, Andrachite and Bavistin were showed 100% growth inhibition. Seven bio-agents (*Trichoderma* spp.) were also tested in *In-vitro* condition, in which *T. virens* inhibited 66.28% radial growth of pathogen followed by *T. atroviridae* (63.14%). *T. virens* was tested *in-vivo* condition with fungicides (Bavistin and Topsin-M). Eight treatments apply for management of white mold disease. T_6 (*T. virens* + bavistin) showed minimum disease incidence (16.67%) and maximum fruit yield (243.70 quintal/hac).

3B. 5

Guava Anthracanose/Die Back- Causes and Control

Arti Devi, Parshant Bakshi, V.K Wali, Nirmal Sharma, Deep Ji Bhat and Amit Jasrotia

Division of Fruit Science, Faculty of Agriculture, Main Campus, Chatha, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K-180009, India

artiskuastj@gmail.com

Guava (*Psidium guajava* L.) is an important fruit crop of India and is considered poor men's apple. Guava is a very productive and highly profitable fruit crop. It is liked by fruit growers due to its wide adaptability and higher return per unit area. But its successful cultivation is hampered by anthracanose/die back disease. *Colletotrichum gloeosporioides* is the pathogen responsible for causing anthracnose. Anthracnose is the most commonly observed disease that affects both pre- and postharvest management of guava. This disease can cause considerable postharvest losses and can affect young developing flowers and fruit. It has been reported in all guava-growing areas around the world where high rainfall and humidity are present. The characteristic symptoms consist of sunken, dark colored, necrotic lesions. Under humid conditions, the necrotic lesions become covered with pinkish spore masses. As the disease progresses, the small sunken lesions coalesce to form large necrotic patches affecting the flesh of the fruit and deteriorate the quality of fruit. High rainfall, dense canopy and infected planting material and fungal diseases are the main causes for guava anthracanose. Since number of factors are involved which are responsible for guava anthracanose, therefore, an integrated management strategies involving proper canopy management, timely harvesting and disease and insect-pest management etc. is required for checking this problem. Anthracanose can be managed by spraying copper oxychloride (300g/100L water), mancozeb (250 g/100L water) or captan (300g/100L water) soon after pruning, repeat spray at 15 days interval after fruit set. Spray of Bordeaux mixture (3:3:50) or Copper oxychloride (0.3%) just after initiation of disease.

3B.6

Status and distribution of sheath blight of rice in Jammu division

Upma Dutta, Anamika Jamwal, Sachin Gupta and Sonika Jamwal

Division of Microbiology, faculty of Basic Sciences, SKUAST-J, Chatha-180009

Rice (*Oryza sativa* L.) is one of the most important cereal crops of Jammu division of J&K. The crop suffers with a number of diseases and among them sheath blight caused by *Rhizoctonia solani* Kuhn is the most important causing enormous losses in yield which may range from 5.2-70 per cent depending on environmental conditions, variety sown and stage of the crop at the time of appearance of disease. The disease is occurring regularly in the region causing substantial loss in productivity. Extensive survey of rice growing areas of Kathua, Jammu and Udhampur districts of Jammu division was conducted to monitor the prevalence of sheath blight of rice. The observations on disease were recorded at 3rd and 9th stages of the crop growth i.e. at stem elongation and maturity stages. The data were pooled at the end to determine the relative distribution of disease in the locality. The disease was more at maturity stage than at stem elongation one in all the locations. Pooled analysis of data showed the maximum incidence (72.8%) of disease in Jammu district and minimum (60.5%) in Udhampur of Jammu division. Among the location surveyed, disease was maximum in village Muthi of Jammu district and minimum in Rown domail of Udhampur. The variations in disease could be due to differences in varietal status of the crop and time of transplanting of crop in locations surveyed in addition to the prevalent environmental conditions.

3B.7

Effect of *Macrophomina phaseolina* (Tassi) Goid. on seedling vigour of sesame genotypes

Kumar Saurabh, H.S. Saharan and A.S. Rathi
Department of Plant Pathology, CCS Haryana Agricultural University, Hisar-125004, India
kumarsaurabh92@gmail.com

Sesame (*Sesamum indicum* L.) is among the important edible oilseeds cultivated in India for its oil used for edible purposes and industrial purposes. *Macrophomina phaseolina* is very serious and destructive in all sesame growing areas and a key factor in yield loss. Therefore, the present research work was undertaken to study the effect of *M. phaseolina* on seed germination and seedling vigour of seven sesame genotypes. Significant reduction was observed in per cent germination, shoot and root length, fresh and dry weight including vigour index between inoculated and un-inoculated seeds with *M. phaseolina.* Reduction in seed germination ranged between 9.69 to 41.57 per cent in comparison to un-inoculated control *in vitro* whereas, the reduction of vigour index among all genotypes ranged between 30.49 to 60.98 per cent. Under screen house conditions, reduction in seed germination ranged in between 14.51 to 33.52 per cent in comparison to un-inoculated control with reduction in seedling vigour index observed among all genotypes ranging between 19.81 to 40.96 per cent. It was concluded that, significant reduction was observed in seedling vigour among all genotypes due to *M. phaseolina* with varying degree which can be attributed due to their genetic variation for their relative tolerance. Genotype HT-2 was found to be least affected by the charcoal rot both *in vitro* and under screen house conditions.

3B.8

Seed health vis-à-vis quarantine testing of plant genetic resources and conservation in National Gene Bank

Jameel Akhtar, Baleshwar Singh, Pardeep Kumar, Raj Kiran and S.C. Dubey
Division of Plant Quarantine, ICAR-National Bureau of Plant Genetic Resources, New Delhi - 110012

Seed health testing (SHT) involving conventional and molecular techniques has major applications in quarantine of plant genetic resources (PGR) under exchange, conservation of PGR, seed certification and making decision for seed-treatment. Seed health testing for quarantine involves testing of seed during transboundary movement of seed and other planting materials in international trade and exchange. Some of the examples of dangerous pathogens/ diseases getting entry into new areas along with the introduced planting material causing havoc and leading to profound political, economic and social consequences such as late blight of potato (*Phytophthora infestans*) from Central America (Peru) to Ireland in 1845, powdery and downy mildews of grapes (*Unicinula necator* and *Plasmopara viticola*) from Central America to France in 1847, flag smut of wheat (*Urocystis agropyri*) from Australia to Mexico, chestnut blight (*Cryphonectria parasitica*) from orient countries including Japan and Korea to USA, coffee rust (*Hemileia vastatrix*) from Sri Lanka to India in 1875, Karnal bunt of wheat (*Neovossia indica*) from India to USA in 1996 and bunt of wheat (*Tilletia caries*) from India to Mexico in 1970, etc. Whereas, conservation of PGR in Genebank for long-term storage involves testing of seed to make them free from associated pathogens. Therefore, critical laboratory examinations with specialized tests, involving conventional and molecular approaches, are conducted in seed health testing for quarantine as well as conservation of PGR that ensure the interception/ detection and identification of associated pathogens with seeds and other planting materials.

Key words: Seed-health testing, quarantine, seed-borne fungi, PGR, conservation

Theme-IV

Molecular Approaches in Plant Disease Diagnosis and Management

ORAL PRESENTATIONS

4A.1

Antimicrobial peptides in plant immunity

Rayees Ahmad Ahanger and Arif Hussain Bhat
Division of Plant Pathology, SKUAST-Kashmir, Shalimar, Srinagar 190025, J&K, India

Plant pathogens infect plants from the planting to harvesting and storage of the produce. The plants must overcome the pathogenic mechanisms that results in the disease process for their survival. Plants have evolved innate immune systems or defence mechanisms that recognize the presence of potential pathogens and initiate effective defence responses, whereas successful pathogens have evolved effector proteins that can suppress host immune responses. These defence mechanisms refer to two distinct aspects of plant-pathogen interaction, constitutive and induced defences. Protection of plants and animals against infectious microorganisms depends on both constitutive and induced defense mechanisms. Antimicrobial peptides (AMPs) are an important component of constitutive and induced defenses. The biological activity of plant AMPs primarily depends on interactions with membrane lipids, but other modes of action also exist. As plants also biosynthesize protective secondary metabolites, AMPs may not be as crucial for the first line of defense as in animals. The recent convergence of molecular studies of plant immunity and pathogen infection strategies is revealing an integrated picture of the plant-pathogen interaction from the perspective of both organisms. So in order to have effective pathogen control policy and strategy, it is important that what causes pathogen growth arrest be well studied

4A.2

Molecular markers in fungal taxonomy and diversity

Devanshi Pandit, V.K. Razdan, Kausar Fatima and Saima Khushboo
Division of Plant Pathology, SKUAST-J Chatha-180009
devanshi.pandit17@gmail.com

During the last decade, genetics and molecular markers have gained an increasing presence in Plant Pathology. The most popular markers in fungal taxonomy and diversity include Restriction Fragments Length Polymorphism (RFLP), Random Amplified Polymorphism DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP), Simple Sequence Repeats (SSR), Internal Transcribed Sequence (ITS) and Single Nucleotide Polymorphism (SNP). Molecular markers offer the possibility of faster and accurate identification and early detection of plant pathogen. On the other hand, with the advances of molecular biology many complex questions could be answered such as the sources of inoculum, changes in their population's structures and the population dynamics of the disease they cause. Among others important applications of these technologies which are increasingly developed as resourceful tools for quickly and sometimes cheaply assessing diverse aspects of plant pathogen genomes. These include genetic variation characterization, genome fingerprinting, gene mapping and tagging, genome evolution analysis, population genetic diversity, taxonomy and phylogeny of plant pathogen taxa. Furthermore, the polymorphic diversity could provide significant information relating to the pathosystem. AFLPs have gained popularity for genetic diversity analysis for numerous plant pathogens because of the large number of loci that can be screened simultaneously. These markers have been successfully used to assess genetic diversity of pathogen such as *Phytophthora nemorosa* and *P. pseudosyringae*. The AFLP markers have been used to assess the population diversity of 213 isolates of *Mycosphaerella graminicola* across Germany where 142 multilocus haplotypes were identified revealing a high degree of genotypic diversity. Also, RAPD markers have successfully been used for analyzing genetic diversity particularly for asexual or clonal reproducing plant pathogen. Similarly, the SSR markers are also highly polymorphic which are more suitable for the comparison of population based on their allele's frequencies. The ITS regions have been proven to be of great

significance for inter and intra specific phylogenetic studies. Since these regions are highly conserved intra-specifically but variable between species it is often used in taxonomy. AFLP markers are used extensively for analyzing the relationship between closely related taxa of phylogenetic fungi. O'Neill *et al.* (1977, have already confirmed the taxonomic placement of different species of *Colletotrichum spp* using the AFLP markers. The recent molecular analysis using ITS makers, clarified the taxonomic confusing Mycosphaerella genera. Similarly using phylogenetic analysis of the ITS1 and ITS2 to determine the relationships between numbers of Mycosphaerellaceae. ITS regions have been used to assess the taxonomic and phylogenetic analysis of *Tilletia* and allied genera in order Tilletiales infecting the Poaceae members.

4A.3

Marker assisted selection of blast resistance gene in the segregating population of rice (*Oryza sativa* L.)

Padamdeep Kaur, Manmohan Sharma, R.K. Salgotra, Amarinder Singh and Sharmishta Hangloo

School of Biotechnology, SKUAST-Jammu

Blast of rice caused by the fungus *Magnaporthe oryzae* (Hebert) Barr is one of the major constraints in rice production in J&K and exploiting host plant resistance by utilizing resistance genes is considered to be the economically viable and environmentally safe approach to tackle this disease. Of 102 blast resistance genes identified so far, *Pi-54* is reported to provide broad spectrum resistance to prevalent races of *M. oryzae* under North Western hill ecology. *Pi-54* is a cloned and characterized gene with availability of closely linked and functional markers. The present study aimed at selecting plants homozygous for the blast resistance gene *Pi-54* in F_2 population of the cross K 343/DHMAS. A total of 25 SSR primers were used, out of which 4 showed polymorphism with respect to these two parents; indicating the genetic similarity in their backgrounds. The SSR markers reported to be closely linked to *Pi54* locus (TRS26, TRS33 and RM206) were validated through variation in amplicon size in two parents. Out of these, RM 206 (0.7cM from *Pi54* locus) was utilized for selection of *Pi54* positive plants in F2 population as it resolved clearly through agarose gel electrophoresis. The parents were crossed to develop F1 seeds and the hybridity of the F1 was confirmed using polymorphic SSR markers (RM110, RM220, RM240, and RM263). The F2 plants along with parents were sprayed with suspension of PLP-1 culture of *M. oryzae* at 5-6 leaf stage and incubated under standard conditions for pathological phenotyping. Out of the 27 plants, 8 plants showed moderate to highly susceptible response. Other 19 plants showed immune to resistant reaction. The genotyping of parents and individual F2 plants using linked marker RM206 showed that out of 27 F2 plants, only 7 plants had target allele in homozygous dominant state and were thus identified as *Pi54* positive plants which could be utilized as superior genetic stocks.

4A.4

Management of anthracnose (*Collectotrichum lindemuthianum*) of *Phaseolus vulgaris* L. through mutation and embryo rescue techniques

Sanjeev Kumar, Anil Kumar, J.P. Sharma, Mamta Sharma, Ashwani Kumar and Sonika Jamwal

Advanced Centre for Rainfed Agriculture (ACRA) Dhiansar, Baribrahmana Jammu-181 133
Sher-e-Kashmir University of Agriculture Sciences and Technology (SKUAST-J) Jammu, India-181133

Rajmash or common bean botanically described as *Phaseolus vulgaris* belongs to family *Fabaceae.* It is a key grain legume crop and a vital source of nutrition worldwide. It is a low cost protein rich crop in many countries and also contains large quantities of complex carbohydrates, fibers and isoflavonoids. It has also medicinal importance providing protection against diseases like cancer, diabetes and heart diseases. Abiotic and biotic constraints to common bean production result in average global yields <600 kg ha-1, while yields in the U.S. and Canada are about three times as high. This yield gap results in food insecurity, and thus the need for novel sources or combinations of traits in common bean to increase potential productivity or reduce losses in lowin put agriculture. To keep up with population growth, a 30% increase in common bean yield is needed by 2050, while increasing temperatures are predicted to gradually limit the regions and/or seasons favourable for common bean production in most countries. The productivity of rajmash in state Jammu and Kashmir is only 220kg/ha and is cultivated only on an area of 2000ha. The major cause of low productivity is due high susceptibility of local land races to anthracnose (*Collectrichum lindemuthianum)* disease. In the present investigation, disease and drought resistance genes are being in progress for the introgression through embryo rescue and mutation breeding techniques. Limited crosses are being attempted between cultivated and their wild relatives in school of biotechnology with the applications embryo rescue technique. The crosses between BDL x IC-361884 and PL x IC361884 showed limited success for the development of hybrids (F_1S) as donor parent is from the tertiary gene pool of rajmash. In mutation breeding programme, two locally cultivated varieties in Bhaderwah (BDL) and Poonch (PL) were treated with gamma rays and ethyl methane sulphonate (EMS) and on the basis of findings of number of experiments LD50 were determined. LD50 in gamma rays are 200Gy, 300Gy and 400Gy and in chemical treatments: 0.2%, 0.3% and 0.4% in both varieties. The Introgression and development of mutants for anthracnose resistance are being in progress.

4A.5

CRISPR/ Cas9 system: a powerful tool for producing crop plants resistant to multiple viral infections

Chainika Gupta, R.K. Salgotra and Manmohan Sharma
School of Biotechnology, SKUAST-Jammu-180009
cg2592@gmail.com

Viruses are one of the major concerns for agricultural production and food security throughout the world. The control of plant viruses is dependent on the use of pesticides but it has many adverse environmental e ects. Geminiviridae and Potyviridae families represent the two largest groups of plant viruses containing 326 and 195 species. The clustered regularly interspaced palindromic repeat (CRISPR)/ CRISPR-associated (Cas) 9 (CRISPR/Cas9) system confers molecular immunity against nucleic acids of invading viruses. One of the most interesting feature of CRISPR-Cas9 system is its flexibility to assemble multiple gRNA modules for targeting several genes simultaneously. CRISPR-Cas9 approach has been successfully used to develop resistant plants against RNA viruses, demonstrating that CRISPR-Cas9 system is a promising and powerful tool to be considered in the near future for crop improvement programs.
Key words: CRISPR/ CAS9, crop improvement

4A.6

Harnessing genome editing techniques to engineer disease resistance in crop plants: Sustainable approach to enhance agricultural productivity

Muntazir Mushtaq[1], Aafreen Sakina[2], Shabir H. Wani[2], Asif B. Shikari[2], Anil Kumar Singh[1], Romesh Kumar Salgotra[1], Mohd Saleem Dar[2], Zafar Bashir[2] and Ajaz Ahmad Kundoo[2]
[1]*School of Biotechnology, Humanities, SKUAST-J, Chatha, Jammu*
[2]*Centre for Plant Biotechnology, SKUAST-K, Shalimar, Kashmir*
muntazirbt@gmail.com

Ever increasing world population plus the concomitant requirement to double the food produced from same amount of arable land has posed a serious threat to the economic and social stability. This sets an alarm to improve the crop productivity and minimize losses to the standing crops, inflicted by a range of phytopathogens. From classical breeding for resistance to employment of bewildering variety

of modern technologies viz, introduction of resistant transgenes in susceptible crops, RNA interference and VIGS (virus induced gene silencing) to silence viruses and other infectious particles, Targeting Induced Local Lesions IN Genomes (TILLING) to induce favorable mutations in susceptible background and 1st and 2nd generation of gene editing techniques to edit susceptibility imparting genes, technologies for embolding varieties against diseases are piling up. Each technology has its own advantages and disadvantages. However, gene editing technologies are robust and versatile tools to make precise modifications at specified locations in genome, thereby correcting disease mutations. Different gene editing techniques that have been used so far for crop improvement include Zinc finger nucleases, TALENs, LAGLIDADG homing endonucleases also termed as meganucleases and CRISPR-Cas9 system. Further, being a clean gene technique, they evade public and political concerns around the persistent use of transgenes in crops.

Key words: Genome editing, disease resistance, meganucleases, zinc finger nucleases, talens, CRISPR/Cas9, crop improvement

4A.7

Role of genetically engineered microorganisms in bioremediation

Shakeela Sofi, S.B. Zehra and Asha Nabi

SKUAST- Kashmir, Shalimar, Srinagar-190025

sofishakeela86@gmail.com

Bioremediation relies on improved detoxification and degradation of toxic pollutants either through intracellular accumulation or via enzymatic transformation to less or non-toxic compounds. Organisms may be used for bioremediation in *in-situ* and *ex-situ* conditions. In *in-situ* techniques the polluted site is treated in place without excavation whereas in case of *ex-situ* techniques the samples from polluted sites are collected and transferred to laboratory. *In-situ* and *ex-situ* bioremediation strategies rely on community dynamics of organisms, their development and existence, structure and function**.** The increasing amount of pollutants in the environment is an alarming concern to the ecosystem. A number of organic pollutants viz., polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), pesticides etc., are resistant to degradation which represent toxological threat to wildlife as well as human beings**.** Various physiological and biological measures have been employed globally to degrade these hydrocarbons so as to improve the quality of environment. Out of these, bioremediation is the most promising strategy wherein microorganisms are harnessed to degrade the organic and inorganic pollutants. There are many naturally existing microbes which are routinely employed in bioremediation process. The consortia of these microbes in various environmental conditions provide an insight about the interrelation of metabolic pathways involved in biodegradation process. Various metabolic techniques are employed to produce genetically engineered microorganisms (GEMs) with better bioremediation efficiency. Biomolecular engineering approaches such as rational designing and directed evolution have been developed to genetically modify microorganisms and their enzymes for the degradation of persistent organic pollutants (POPs) like PAHs, PCBs and pesticides. Recent developments in the field of recombinant DNA technologies such as construction of "suicidal-GEMs" (S-GEMs) have helped to achieve safe and efficient bioremediation of contaminated sites. While genetic engineering has produced numerous strains capable to degrade otherwise intractable pollutants in a Petri-dish or in a bioreactor, the practical translation of this research into actual *in situ* bioremediation practices are still in infancy. The future application of genetically engineered bacteria for pollution remediation will not be free from the risks associated with their release in the environment.

Key words: Bioremediation, Bioaugmentation Genetically engineered microorganisms GEMs

4A.8

Current approaches in plant disease diagnosis

Vishal Sharma[1,2] and Sundeep Jaglan[1,2]

[1]Microbial Biotechnology Division, CSIR-Indian Institute of Integrative Medicine, Jammu-180001, India
[2]Academy of Scientific and Innovative Research (AcSIR), Jammu Campus, Jammu-180001, India
Email ID: vishalpangotra12@gmail.com

Food losses due to infections of crops by viruses, bacteria and fungi is a centuries old problem. Biotic stresses that includes diseases and pests are responsible for about 42% of the world's total crop loss. Crop losses can be decreased by using specific treatments for fight specific pathogens if the plant diseases are diagnosed at an early stage of infection. These treatments will be useful for the environmental and economic gains. Traditionally, plant diseases are identified by visual examination. This is possible at the later stages of disease when the major damage has already took place, so the treatment will be of less effective. Pathogens that cause systemic infections are usually transmitted through vegetative mode from infected plants to the younger plants. If all the seeds or planting materials are infected, it will cause a great loss after of the crop plantation. Diseases can be easily transported to new places with the transport of planting material. In order to prevent massive crop damage advanced disease detection and prevention strategies are needed.Current strategies for plant disease diagnosis involves use of direct and indirect methods. Methods for the direct detection of plant diseases include Fluorescence *in-situ* hybridization (FISH),polymerase chain reaction (PCR), immunofluorescence (IF), flow cytometry (FCM), enzyme-linked immunosorbent assay (ELISA), and gas chromatography-mass spectrometry (GC-MS) while fluorescence imaging, thermography, and hyperspectral techniques are the indirect methods for disease identification. Recently, biosensors are used for the rapid detection of crop diseases. Biosensor based techniques employ the use of antibody, enzyme, bacteriophage and DNA/RNA. Molecular methods for the diagnosis of plant diseases provide us a number of advantages over the traditional methods. They help us in the detection of plant diseases prior to the formation of symptom with increased accuracy, speed and efficacy of diagnosis.

POSTER PRESENTATION

4B.1

Identification and molecular characterization of yellow mosaic virus in mungbean

Sonali Abrol, Prachi Sharma and Susheel Sharma
Division of Plant Pathology, SKUAST-Jammu (J&K), India-18009
abrol.sonali222@gmail.com

Mungbean yellow mosaic disease caused by mungbean yellow mosaic begomovirus (MYMV) is the most destructive viral disease of mungbean. The virus causes uneven yellow and green specks or patches on the leaves which finally turn entire yellow. Affected plants generate fewer flowers and pods, which also develop mottling and remain small and contain fewer, smaller and shrunken seeds. Development of MYMV tolerant/resistant varieties using an antiviral strategy may be one of the potential options to overcome MYMV diseases. An investigation was carried out to characterize the virus which causes yellow mosaic among different accessions of mungbean, collected from various sources/locations. A set of 73 mungbean accessions was sown in randomized block design (RBD) with two replications during *kharif* 2015 at Research Farm of Division of Plant Pathology, SKUAST-J, Chatha. In the present investigation, the data recorded on disease incidence in different accessions of mungbean, four accessions (LM-291, M-131, M-237 and LM-1402) were found to be resistant, two accessions (LM-27 and LM-11686) were moderately resistant, twenty two accessions were moderately susceptible, thirty three accessions were susceptible and twelve were found to be highly susceptible to yellow mosaic disease. Molecular identification and characterization of yellow mosaic disease of (MYMV) was attempted. The DNA sequence so obtained was exploited using various bioinformatic tools to establish the identity of the virus causing yellow mosaic in mungbean. The phylogenetic tree so constructed using multiple sequence alignment clustered the test sequence with *Mungbean yellow mosaic India virus* (MYMIV). Thus, the molecular analysis showed that the virus responsible for yellow mosaic in mungbean in Jammu was found to be the *Mungbean yellow mosaic India virus* (MYMIV).

4B.2

Molecular mechanism of anthracnose resistance in common bean

Chainika Gupta, R.K. Salgotra, Manmohan Sharma and Mridhu Sharma
School of Biotechnology, SKUAST-Jammu, 180009
cg2592@gmail.com

Attempts to understand durable or partial resistance to *Collectotrichum lindemuthianum* in common bean have been made. Linkage mapping with resistance gene analogs, derived from different R gene motifs, has detected several loci associated with resistance to anthracnose as well as angular leaf spot and bean golden mosaic virus, with some loci associating with resistance to one specific disease and some other loci detecting resistance to multiple diseases. More than 20 anthracnose resistance loci have been reported using the *Co* symbol and there are four allelic series that confer resistance to *Collectotrichum lindemuthianum*. Some of these alleles have been mapped in the common bean genome and are widely used in common bean breeding programs. On the common bean map, most of these genes are allocated to 11 linkage groups, referred to as Pv groups. The *Co-5* gene has a wide resistance spectrum and confers resistance to 31 races of *Collectotrichum lindemuthianum.* The genes have been cloned that confer race-specific disease resistance and encode proteins containing a central nucleotide-binding domain and a C-terminal leucine-rich repeat (NBS-LRR) proteins. Several R gene clusters composed of subclasses of NBS-LRR domains have been found in common bean genome against *C. lindemuthianum*.
Key words: Anthracnose disease, molecular mechanism, *Co-5* gene, *Phaseolus vulgaris* L.

4B.3

Marker assisted breeding for development of anthracnose resistant varieties of common bean (*Phaseolus vulgaris* L.)

Chainika Gupta, R.K. Salgotra, Manmohan Sharma and Mridhu Sharma
School of Biotechnology, SKUAST-Jammu-180009
cg2592@gmail.com

Anthracnose of common bean (*Phaseolus vulgaris* L) caused by the hemibiotrophic fungus *Colletotrichum lindemuthianum* is one of the globally important fungal pathogens affecting sustainability of production. The disease is wide spread in many bean growing areas but is more prevalent in subtropical and temperate regions and can be transmitted through infected seed. Therefore, the production and the use of certified seeds is one control measure that is effective in dealing with the disease. The development of pathogen depends on the susceptibility of the particular cultivar involved and environmental conditions favorable to fungal growth and spread So, host resistance is also most cost-effective strategy for controlling anthracnose in the common bean. Genetic linkage maps have been used to identify DNA markers tightly linked with resistance traits in common bean for purposes of marker-assisted selection (MAS). Several types of DNA markers have been used to tag and monitor disease resistance traits but very few of them are functional gene-based markers. However, genetic linkage between random DNA markers and a target locus allele, established by QTL studies, can be broken by genetic recombination. By contrast, candidate/functional gene markers are markers derived from polymorphisms within genes and have complete linkage with target loci. Thus, the development of such functional gene-based markers can be used for improvement of varieties of common bean by transferring resistant gene through marker-assisted backcross breeding (MABB).

Key words: Anthracnose disease, marker-assisted breeding (MAB), *Phaseolus vulgaris* L.

4B.4

Marker assisted selection of blast resistance gene in the segregating population of rice (*Oryza sativa* L.)

Padamdeep Kaur, Manmohan Sharma, R.K. Salgotra, Amarinder Singh and Sharmishta Hangloo
School of Biotechnology, SKUAST-Jammu

Blast of rice caused by the fungus *Magnaporthe oryzae* (Hebert) Barr is one of the major constraints in rice production in J&K and exploiting host plant resistance by utilizing resistance genes is considered to be the economically viable and environmentally safe approach to tackle this disease. Of 102 blast resistance genes identified so far, *Pi-54* is reported to provide broad spectrum resistance to prevalent races of *M. oryzae* under North Western hill ecology. *Pi-54* is a cloned and characterized gene with availability of closely linked and functional markers. The present study aimed at selecting plants homozygous for the blast resistance gene *Pi-54* in F_2 population of the cross K 343/DHMAS. A total of 25 SSR primers were used, out of which 4 showed polymorphism with respect to these two parents; indicating the genetic similarity in their backgrounds. The SSR markers reported to be closely linked to *Pi54* locus (TRS26, TRS33 and RM206) were validated through variation in amplicon size in two parents. Out of these, RM 206 (0.7cM from *Pi54* locus) was utilized for selection of *Pi54* positive plants in F2 population as it resolved clearly through agarose gel electrophoresis. The parents were crossed to develop F1 seeds and the hybridity of the F1s was confirmed using polymorphic SSR markers (RM110, RM220, RM240, and RM263). The F2 plants along with parents were sprayed with suspension of PLP-1 culture of *M. oryzae* at 5-6 leaf stage and incubated under standard conditions for pathological phenotyping. Out of the 27 plants, 8 plants showed moderate to highly susceptible response. Other 19 plants showed immune to resistant reaction. The genotyping of parents and individual F2 plants using linked marker RM206 showed that out of 27 F2 plants, only 7 plants had

target allele in homozygous dominant state and were thus identified as *Pi54* positive plants which could be utilized as superior genetic stocks.

4B.5

Molecular approaches to detect the *Xanthomonas oryzae* (*Xoo*) causing Bacterial blight in rice

Mridhu Sharma and Chainika Gupta
SKUAST- Jammu, Jammu and Kashmir 180009
sharmamridhu06@gmail.com

Xanthomonas oryzae (*X. oryzae*) is gram-negative, obligate aerobic rod shaped species varying in length from approximately 0.7 µm to 2.0 µm and in width from 0.4 µm to 0.7 µm species that does not form spores. Optimal temperature for growth is between 25 and 30°C. *X. oryzae* cells produce copious capsular extracellular polysaccharide (EPS) which is important in the formation of droplets or strands of bacterial exudate from infected leaves, providing protection from dessication and aiding in wind- and rain-borne dispersal (Ou, 1972; Swings *et al*., 1990). Xoo and Xoc often occur in rice fields simultaneously, and individual leaves may show symptoms of both diseases (Goto, 1992; Mew et al., 1993) (R. Sonti, personal communication). BB and BLS symptoms are easily differentiated in the early stages of disease and reflect the different modes of infection by each pathogen but later depending on the growth conditions or the degree of resistance of the cultivars, BB and BLS may be confused with each other or with unrelated physiological disorders of the plant.

4B.6

Molecular techniques in plant disease diagnosis

Kausar Fatima, V.K. Razdan, Vishal Gupta, Devanshi and Saima Khushboo
Division of Plant Pathology, SKUAST-J Chatha, 180009
kausarf651@gmail.com

Plant diseases are of important concern because of its relationship between plant health and the welfare of people, animals, and the environment. The production of adequate food and fibre has been reducing therefore a continuous improvement for sustainable plant disease management is required to meet these demands. Plant diseases caused by fungal pathogens are one of the major concerns in agriculture worldwide. Both biotic and abiotic factors or in combination are responsible for disease. Symptoms are usually the results of a morphological change and damage to plant tissue or cells due to an interference of the plant’s metabolism, the emergence of a biotic symptom will indicate the relatively late stage of an infection and colonization of a pathogen. Pathogens pose a threat to plants. The accurate disease diagnosis and management may lead to reduce huge losses in plant production and related commodities that cause nutritional food scarcity. Plant health testing is an essential management tool for the control of fungal diseases, pathogen detection, and the implementation of effective management strategies. Soil and seed borne diseases are difficult to diagnosis. Therefore, it is important to have proficient diagnosis strategies and integrated management practices advanced with molecular diagnostic techniques to retain plants free from pathogens, number of molecular approach have been used to diagnose disease. **PCR** technique for diagnosis of disease, **DNA probes** were among the first molecular techniques applied in the detection, identification and phylogenetic analysis of fungal pathogens. **Biosensor** contains an analytical device which has combination of a biological recognition ligand with physical or chemical signaling devices called (transducers). Plant virus detection by enzyme-linked immunosorbent assay (**ELISA**) the incorporation of serological methods into routine diagnosis for plant pathogens has improved the sensitivity and reliability of diseases diagnosis. In direct immunofluorescence assays (**IFA**), the pathogen sample is fixed onto a microscope slide, and analysed with a drop of pathogen specific antibody labelled with a suitable flurochromeisothiosyanate (FITHC), unbound FITC-conjugate is rinsed off, and the slide is examined under an epifluorescent microscope. Lateral Flow immunoassay (**LFIA**) is becoming increasingly popular as onsite diagnostic tools for plant pathogen detection. The assay consists of an immunoreactions and a chromatography step and the power of the technique lies in the speed of analysis. **Different dipstick assays** consists of a dipstick (typically nitrocellulose) coated with pathogen specific antibody. The dipstick is emerged into the sample and if present, the pathogen is specifically captured by the antibody.

4B.7

Germplasm evaluation and characterization of resistant genes against stripe rust of wheat

Saima Farooq, V.K. Razdan and Vishal Gupta
Division of Plant Pathology, Faculty of Agriculture, SKUAST- Jammu, Chatha

Thirty one wheat germplasm were screened under natural epiphytotic conditions against stripe rust at University Research Farm, Chatha, during *Rabi*, 2014-15. On the basis of final rust severity (FRS), area under rust progress curve (AURPC) and coefficient of infection (CI), eight lines (Raj 4037, Sonara 64, NP 823, HPW 42, K9351, NIAW 301, PBW 12, and HUW 213) exhibited partial resistance to the disease while as on the basis of infection rate (r) six lines (NP 825, HP 1633, K8434, PBW 12, Ajanta and K9533) showed partial resistance to the disease. Field response of these lines against stripe rust showed that 14 genotypes (Sonara 64, Utkalia, NI 5439, NIAW 301, PBW 12, HUW 213, Ajanta, NP 823, K8434, K9533, Sharbati Sonara, Raj 4037, HP 1633, HPW 42 and K9351) were moderately resistant, 16 (Tawa, KRL, RW 346, HD 2643, HS 1097, NP 825, WH 291, HUW 12, PBW 226, NI 179, NI 5439, K9644, HD1925, PBW 65, PV 18 and GW 503) were moderately susceptible and one genotype (Agra Local) was susceptible. Assessment of losses was also calculated at different growth stages and it was observed that losses at flowering stage and dough stage were highest in one line (Agra Local). Nineteen wheat germplasm lines (Sonara 64, K9351, HP 1633, Raj 4037, Sharbati Sonara, K9533, K8434, NP 823 and Ajanta) amplifying a band of 523 bp fragment indicating presence of *Yr18* gene.
Key words: Stripe rust, Severity, Allele specific marker, *Yr18*, FRS, AURPC, CI, r, *Cssfr2*

4B.8

Current and prospective methods for plant disease detection and management

Pankaj Pandotra and R.K. Salgotra
School of Biotechnology, SKUAST-Jammu
pankajpandotra@gmail.com

Plant diseases caused by plant pathogens substantially reduce crop production every year, resulting in massive economic losses throughout the world. About 42% of the world's total agricultural crop is destroyed yearly by diseases and pests. Farmers often faced situation with more than one pest or disease and new pesticide-resistant pathogenic strains attacking the same crop. However, crop losses can be minimized and specific treatments can be tailored to combat specific pathogens if plant diseases are correctly diagnosed and identified early. The early detection and identification of plant borne pathogens is an integral part of successful disease management and this is especially important in relation to the importation of foreign plant material. The rapid identification of a plant pathogen, allows for the appropriate control measures to be applied prior to the further spread of the disease or its introduction. Since most plant-based foodstuffs have a finite shelf life, it is imperative that any potentially infected material is diagnosed as rapidly and as reliably as possible, in order to avoid delays and expensive losses to the cash import. Traditionally, cultural methods have been employed to isolate and identify potential pathogens. This is a relatively slow process, often require skilled expertise to reliably identify the pathogen. This practice is made all the more difficult due to a number of factors, such as ambiguities in morphological characters, or the specific nutrient requirements & growth conditions of certain pathogens grown in vitro, or time constraints imposed by slow growing pathogens in vitro. However over the last 30 years, several techniques have been developed which have found application in plant pathogen diagnosis. This include Laboratory-based techniques such as polymerase chain reaction (PCR), immunofluorescence (IF), fluorescence *in-situ* hybridization (FISH), enzyme-linked immunosorbent assay (ELISA), flow cytometry (FCM), MALDI-TOF MS and gas chromatography-mass spectrometry (GC-MS) are some of the direct detection methods. Indirect methods include thermography, fluorescence imaging and hyperspectral techniques. The recent advancement in the development of advantageous biosensing systems for plant pathogen detection based on both antibody and DNA receptors. The use of different nanomaterials such as nanochannels and metallic nanoparticles for the development of innovative and sensitive biosensing systems for the detection of pathogens (i.e. bacteria and viruses) at the point-of-care is also shown. Plastic and paper-based platforms have been used for this purpose, offering cheap and easy-to-use really integrated sensing systems for rapid on-site detection. The fast growing databases generated by genomics and biosystematics research provides unique opportunity for the design of more versatile, high throughput, sensitive and specific molecular assays which will address the major limitations of the current technologies and benefit Plant Pathology.

4B.9

Role of nanotechnology in plant disease management

Tehsin Tabbassum[1], Naushin Bano[2], Tehsin Tarrum[3], S.K. Tripathi[4] and Shahid Ahamad[5]

[1]S.L.P. College, Jiwaji University, Gwalior; [2]CSJM, Kanpur; [3]Department of Biotechnology, Bundelkhand University, Jhansi; [4]Department of Economics, NDUAT, Kumarganj, Faizabad; [5]Directorate of Research, SKUAST-Jammu, J&K, India

t.tehsin@gmail.com

Nanotechnology, the brain child of Richard Feynman is the frontier science of materials having unique properties than their macroscopic or bulk counterparts. The ability of nano-materials to work at the molecular level, atom by atom, to create large structures with fundamentally new molecular organization is the key to its applications. It has a significant effect in the food industry - development of new functional materials, product development and design of methods and instrumentation for food safety and bio-security. According to National Science Foundation (NSF) and National Nanotechnology Initiative (NNI), nanotechnology is defined as the ability to understand, control and manipulate matter at the level of individual atoms and molecules, as well as at the supramolecular level involving clusters of molecules (in the range of 0.1 to 100 nm), in order to create materials, devices and systems with fundamentally new properties and functions because of their small structure. Nanotechnology is the creation and utilization of materials, device system, through the control of the properties and structures the matter at the nanometric scale. Nanotechnology is an interdisciplinary science encompassing areas like physics, chemistry, biology, material science and engineering. Nanotechnology, focusing on special properties of materials emerging from nanometric size has the potential to revolutionize the agricultural and food sectors, biomedicine, environmental engineering, water resources, energy conversion and numerous other areas. The application of nanotechnology to the agriculture and food industry was first addressed by a United States Department of Agriculture in 2003. There is application of nanotechnology in disease control, slow release of pesticides and developing diagnostic tools and development of functional food systems, to produce interactive, edible nano wrappers to keep the pathogens away, targeted release of chemicals, packaging, extensive nano surveillance, interactive agrochemicals as herbicides and pesticides. Hence, nanotechnology can be used for combating the plant diseases either by controlled delivery of functional molecules or as diagnostic tool for disease detection. The new nanotechnology with materials having unique properties than their macroscopic or bulk counter parts, has promised applications in various fields. The essence of nanotechnology is the ability to work at the molecular level, atom by atom, to create large structures with fundamentally new molecular organization. The aim is to exploit these properties by gaining control of structures and devices at atomic, molecular and supra-molecular levels and to learn to efficiently manufacture and use these devices. Nanotechnology has provided new solutions to problems in plants and food science (post-harvest products) and offers new approaches to the rational selection of raw materials, or the processing of such materials to enhance the quality of plant products. The heart of nanotechnology lies in the ability to compress the tools and devices to the nanometre range and to accumulate atoms and molecules into bulkier structures while the size remains very small.

Key words: Nanotechnology, Plant Disease Management.

4B.10

Role of salicylic acid in plant defence

Kousar Javaid, F.A. Misgar, S.N. Qureshi, M.S. Wani, Muneer Ahmad Sheikh, Shaziya Hassan and Y.A. Basu.

Division of Fruit Science, SKUAST-Kashmir, Shalimar, 190025

kousarjavaid11@gmail.com

Plants face numerous challenges ranging from environmental stresses such as temperature fluctuation, drought, flood and disease and insect attack. The oxidative system in plants have been found an important role against many biotic and biotic stresses. Plant defence against various types of stresses is mediated through various signalling pathways that lead to the production of many defense proteins and non-protein compounds. Among various signalling pathways plant phytohormones like ABA, jasmonic acid, ethylene and salicylic acid (SA). Salicylic acid plays an important role in providing resistance against various biotic and abiotic stresses. Salicylic acid (SA) (From Latin Salix, willow tree) is a lipophillic monohydroxybenzoic acid, a type of phenolic acid and a beta hydroxyl acid (BHA). It has molecular formulae $C_7H_6O_3$. Exogenos application of SA manipulate various physiological, biochemical and molecular processes in plants including antioxidative enzyme activities. Moreover, SA regulates the components of its own signalling pathways mediating plant resistance. It has been observed that SA affects plant growth under stress through nutrient uptake, water relations, stomatal regulation and photosynthesis. It regulates the activities of various antioxidative enzymes such as peroxidise (POD), polyphenol oxidase (PPO), superoxide dismutase (SOD), phenylalanine ammonia lyase (PAL) etc which are the major components of induced palnt defense against diseases, insects and abiotic stresses. These antioxidative enzymes act by scavenging the reactive oxygen species (ROS) which otherwise would cause cell burst and ion leakage and finally collapse of cell. Therefore, salicylic acid has a pivotal role in providing defense to plants against diseases, insects and various abiotic stresses.

Key words: Disease, Insect, Plant, Salicylic acid, stress.

4B.11

Interaction of *Co-1* locus candidate genes with plant basal immunity upon inoculation with *Colletotrichum lindemuthianum* race 73 in common bean

Mahiya Farooq, Bilal A. Padder and M.D. Shah

Division of Plant Pathology, SKUAST-Kashmir, Shalimar campus, Srinagar-190025

bapadder@gmail.com

Phaseolus vulgaris, also known by the name common bean is one of the most important legume crop grown worldwide. Anthracnose is a major limiting factor to its production, a disease caused by a hemibiotrophic fungus *Colletotrichum lindemuthianum.* A host pathogen interaction is very specific and essentially follows gene for gene model. To understand a molecular mechanism of compatible and incompatible interaction, a NIL pair that differs at *Co-1* locus (T9576R and T9576S) and highly virulent race 73 of *C. lindemuthianum* was used to evaluate Pathogen Triggered Immunity genes (PTI) and Effector Triggered Immunity genes (ETI). Quantitative Real time PCR shows temporal expression level of many defense related genes at 24, 48, 72, 96 and 120hpi. Among PTI genes, PR1a,

PR1b and PR2 remain up regulated in early hours of pathogenesis, however, PAL2 remained down regulated throughout time course till 120hpi following inoculation with race 73 in a resistant NIL. On contrary, in a susceptible NIL the expression level of PAL2 increases gradually, whereas other PTI genes expressed in late hours of pathogenesis. In case of ETI genes, the four candidate genes of *Co-1* locus such as Cytochrome P450, Tyrosine kinase, Kinase and Hydrolase express differentially upon inoculation in a NIL pair. The *Co-1* candidate gene Cytochrome P450 expressed highly in resistant NIL than in susceptible NIL. These findings emerged new results firstly the interaction of ETI genes with the plant basal immunity and reduction in candidate gene number of overlapping genes of *Co-1* allelic series and among them Cytochrome P450 is mainly responsible for imparting resistance to common bean upon inoculation with *C. lindemuthianum* race 73 and can be helpful in transferring the candidate gene in susceptible common bean lines.

4B.12

Production of disease-free planting material through tissue culture in gerbera

Mamta Sharma, A.K. Singh, Satish K. Sharma and Upma Dutta
SKUAST-Jammu

Gerbera has gained popularity in the past few years in many countries of the world and it is in great demand in the floral industry as cut flower as well as potted plant due to its beauty, colour, long vase life, and ability to rehydrate after long transportation. The most commercial cultivars are propagated through vegetative means by multiplication through divisions of clumps; however, the multiplication by this method is too slow to be commercially viable. To commercialize this crop and to meet the growing demand for planting material, tissue and organ culture techniques are being used as alternative methods for propagation in many countries. Research on micropropagation of gerbera has been done. Experiments for standardization of surface sterilization protocol of gerbera were conducted using apical bud as explant. The explants were surface sterilized using different concentrations of Bavistin and Mercuric chloride for different durations. During studies, a combination of 2% Bavistin (45 min) and mercuric chloride (3min) was observed to be effective for surface sterilization of gerbera explants. The sterilized explants have been cultured on Murashige and Skoog's (1962) medium supplemented with different growth regulators. Apical bud showed sprouting on MS medium supplemented with BAP (1mg/l), Kin (0.5mg/l) and GA_3 (1mg/l). Sub culturing was done on MS medium supplemented with BAP (1mg/l) and GA_3 (1mg/l). Experiments for achieving best multiplication rates have been conducted using different concentration and combination of growth regulators. Best growth rate has been observed in MS medium supplemented with BAP (2mg/l), Kin (0.5mg/l) and GA_3 (1mg/l). A few shoots of *in vitro* raised gerbera were separated out and cultured on MS medium supplemented with different concentrations of various auxins to achieve rooting.

4B.13

Current approaches in plant disease diagnosis

Vishal Sharma[1] and Sundeep Jaglan[2]
[1]*Microbial Biotechnology Division, CSIR-Indian Institute of Integrative Medicine, Jammu-180001, India*
[2]*Academy of Scientific and Innovative Research (AcSIR), Jammu Campus, Jammu-180001, India*
vishalpangotra12@gmail.com

Food losses due to infections of crops by viruses, bacteria and fungi is a centuries old problem. Biotic stresses that includes diseases and pests are responsible for about 42% of the world's total crop loss. Crop losses can be decreased by using specific treatments for fight specific pathogens if the plant diseases are diagnosed at an early stage of infection. These treatments will be useful for the environmental and economic gains. Traditionally, plant diseases are identified by visual examination.

This is possible at the later stages of disease when the major damage has already took place, so the treatment will be of less effective. Pathogens that cause systemic infections are usually transmitted through vegetative mode from infected plants to the younger plants. If all the seeds or planting materials are infected, it will cause a great loss after of the crop plantation. Diseases can be easily transported to new places with the transport of planting material. In order to prevent massive crop damage advanced disease detection and prevention strategies are needed. Current strategies for plant disease diagnosis involves use of direct and indirect methods. Methods for the direct detection of plant diseases include Fluorescence *in-situ* hybridization (FISH), polymerase chain reaction (PCR), immunofluorescence (IF), flow cytometry (FCM), enzyme-linked immunosorbent assay (ELISA), and gas chromatography-mass spectrometry (GC-MS) while fluorescence imaging, thermography, and hyperspectral techniques are the indirect methods for disease identification. Recently, biosensors are used for the rapid detection of crop diseases. Biosensor based techniques employ the use of antibody, enzyme, bacteriophage and DNA/RNA. Molecular methods for the diagnosis of plant diseases provide us a number of advantages over the traditional methods. They help us in the detection of plant diseases prior to the formation of symptom with increased accuracy, speed and efficacy of diagnosis.

Theme-V

Inevitable Role of Biological Control for Disease Management

ORAL PRESENTATIONS

5A.1

Efficacy of bio-control agents against wilt of chickpea caused by *Fusarium oxysporum* f.sp. *ciceris* (Foc)

Sabiya Bashir, Mohammad Najeeb Mughal, Sher A. Dar, Gul Zaffar, Seerat un Nissa, Z.A. Dar, Shafeeq Hakeem, R.A. Wani, J.A. Baba, B.A. Allie, Mehfooza Habib, Yusra Basu and A.Y. Baba

Dryland Agriculture Research Station, SKUAST-Kashmir, Rangrath-190001,
**Faculty of Agriculture, SKUAST-K, Wadura-193201*
drsabiyabashir@gmail.com

Chickpea wilt caused by *Fusarium oxysporum* f.sp. *ciceris* is serious bottle neck in safe production of chickpea (*Cicer arietinum*). Although the diseases can be controlled through different strategies such as use of chemicals but management of the disease by bio-control agents is eco-friendly and sustainable approach. Three strains of *Trichoderma viride* designated as TV-1, TV-2 TV-3 and two strain of *Trichoderma harzianum* designated as TH-1 and TH-2 were also evaluated against wilt pathogen of chickpea by dual culture method. These strains of *Trichoderma viride* and *T. harzianum* were procured from different sources except the strains of TV-2 and TV-1 which were isolated locally from the rhizosphere of healthy plants. The *in-vitro* evaluation of bio-control agents revealed that TV-2 is most efficacious resulted in 72.00 per cent mean inhibition of mycelial growth followed by TV-1 with 68.83 per cent respectively. *Trichoderma harzianum* 2 (TH-2) proved least efficious and resulted in only 44.40 per cent mean inhibition of mycelial growth.

Key words: Bio-control agents, *In vitro, Trichoderma harzianum, T. viride*

5A.2

In vitro efficacy of bio-control agents against sheath blight of rice pathogen *Rhizoctonia solani* Kuhn

Mohammad Najeeb Mughal, Sabiya Bashir, Seerat un Nissa, Z.A. Dar, Manzoor A. Ganie, Najeeb Sofi, Shafeeq Hakeem, R.A. Wani, J.A. Baba, Zahoor A. Lone, Imran Bashi Wani and G.A. Parray

Faculty of Agriculture, SKUAST-Kashmir, Wadura-193201
drnajeebmughal@gmail.com

Rice sheath blight caused by *Rhizoctonia solani Kuhn* is an emerging threat to stable rice production in Kashmir. Among different diseases managed strategies, management of disease through bio-control agents is eco-friendly and sustainable approach. The bio-control agents were evaluated *in vitro* to determine their efficacies for checking the growth of the fungal pathogen. The fungal bio-control agents *viz*., *Trichoderma harzianum* strain *1*, *Trichoderma viride* strain *1*, *Trichoderma viride* strain *2*, *Trichoderma viride* strain *4 and Aspergillus flavus* were procured from different locations. The bio-control agents, *Trichoderma harzianum* strain 2 *and Trichoderma viride* strain 3, were isolated from soils of Rice Research and Regional station, Khudwani, Anantnag, Kashmir. These bio-control agents were evaluated against *R. solani* through dual culture method. The highest mycelia inhibition (69.91%) of the mycelial growth was achieved by *Trichoderma viride* strain 2 followed by *Trichoderma viride* strain 3 (53.91%). The other bio-control agents, *Trichoderma harzianum* strain 2, *Trichoderma harzianum* strain 1, *Trichoderma viride* strain 4 and *Trichoderma viride* strain 1 caused 50.35, 43.46, 36.10 and 30.57 per cent inhibition of mycelia growth, respectively. The least effective among test bio-control agents was *Aspergillus flavus* resulting only in 7.14 per cent mycelia inhibition.

Key words: *Aspergillus flavus*, Bio-control agents, *In vitro*, *Trichoderma harzianum*, *T. viride*

5A.3

Resistance of cucumber germplasm to powdery mildew

Susheel Sharma[1], Sachin Gupta[2], Aejaz Ahmed Dar[1], Padma Lay[1] and Prachi Sharma[2]
[1]School of Biotechnology, [2]Division of Plant Pathology, SKUAST-Jammu
drsusheelsharma@rediffmail.com

Cucumber germplasm (One hundred eleven accessions) collected from diverse sources was screened against resistance to powdery mildew under natural epiphytotic conditions of Jammu during 2015-16 and 2016-17. Pusa Barkha and Pusa Navin varieties were used as spreader rows for inoculum spread. Observations on disease incidence were taken at 35 and 45 days after transplanting and the germplasm was screened on 0-5 scale of disease incidence. An in depth analysis into the two year data revealed that 23 accessions could be categorized as moderately resistant while 84 accessions showed susceptible reaction and 23 accessions of cucumber were reported to be highly susceptible to powdery mildew.

5A.4

Trichoderma- an effective biocontrol for the management of soil borne pathogens in Plants

Anamika Jamwal[1], Sonika Jamwal[2], Upma Dutta[3], A.C. Jha[2], Neerja Sharma[4] and Ajay Kumar[1]
[1]Krishi Vigyan Kendra, Kathua; [2]ACRA-Dhiansar, [3]Division of Microbiology, KVK-Samba[4], SKUAST- Jammu
annajamwal@gmail.com

Biological control is coming up as an alternate strategy for disease management which is also ecology conscious and environmental friendly. The use of micro-organisms that antagonize plant pathogens (Biocontrol) is risk free when it results enhancement of resident antagonist. Trichoderma spp. are well documented as effective biological control agents of plant diseases caused by both soil borne fungi and leaf and fruit infecting plant pathogenic fungi. Trichoderma can be applied directly to seeds (seed treatment), seedlings(bio-priming) and a single furrow treatment can significantly reduce crop losses. It is highly interactive in root, soil and foliar environments. It reduces growth, survival or infections caused by pathogens by different mechanisms like competition, antibiosis, mycoparasitism, Hyphal interaction and enzyme secretion
Key words: Trichoderma, Soil borne pathogens, Biocontrol

5A.5

Trichoderma velutinum ACR-P1: a psychrotrophic fungus as a potential biocontrol agent

Richa Sharma, Ankita Magotra and Asha Chaubey
Fermentation Technology Division, Indian Institute of Integrative Medicine, Canal Road, Jammu, 180001, India
richa.ishyasharma@gmail.com

Trichoderma, a cosmopolitan and well explored genus for plethora of bioactivities due to their cosmopolitan existence, diverse metabolomics, reproductive and competitive efficacies. seems to be The probable mechanisms underlying their use as biocontrol agents are mainly due to mycoparasitism and antibiotics production. In the current study, the aim of is to investigate the antagonistic potential of a new psychrotrophic fungus *Trichoderma velutinum* ACR-P1 as a promising biocontrol agent against destructive phytopathogens with probable underlying mechanisms. Antagonistic potential of *T. velutinum* ACR-P1 against the important phytopathogens, that is, *Fusarium oxysporum, Verticillium dahliae, Alternaria alternata* and *Colletotrichum capsici* was demonstrated by *in vitro* dual culturing experiments. Probable mechanism underlying antagonism was studied by investigating

enzymatic cell wall hydrolytic potential of the strain and potential for production of secondary metabolites i.e. non-ribosomal peptides (NRPs). The putative strain ACR-P1 demonstrated immense potential of inhibiting the growth of all four phytopathogens and its capability of producing cell wall degrading enzymes (CWDE) i.e. chitinase, cellulase and protease utilizing colloidal chitin, carboxymethyl cellulose and milk protein respectively as sole source of carbon and energy as showed by growth and agar well diffusion assays. Also, our previous study reported metabolic profiling of *T. velutinum* ACR-P1 which firstly revealed the production of two groups of NRPs by the strain (Sharma et al. 2016). Mycoparasitism supported by NRPs and CWDEs substantiate their use as biocontrol agents. The psychrotrophic strain is endowed with immense potential to be included as a new candidate in the list of biocontrol agents (BCA). The potential antagonism against the important destructive phytopathogens signifies *T. velutinum* ACR-P1 as a BCA and can be exploited in fields to get rid of devastating impacts of these phytopathogens on the crops.

Key words: *Trichoderma velutinum;* phytopathogens; antagonistic; CWDE; non-ribosomal peptides (NRPs); biocontrol agents

5A.6

Diagnostic tool for identification of *Trichoderma* producing strains using intact cell mass spectrometry

Deepika Singh, Kamal K. Kapoor and Ram A. Vishwakarma

Quality Control & Quality Assurance Division, CSIR-IIIM, Jammu

deeps.csir@gmail.com

Trichoderma, most widely applied biocontrol fungi is very useful filamentous fungi and has proven its potential importance to agricultural yields supporting the human population over the millennia. In association with other beneficial microbes it has helped to maintain the general disease suppressiveness and fertility of soils promoting plant growth. *Trichoderma* have the ability to attack and control plant pathogenic fungi improving plant resistance to diseases. Recent reports have refined *Trichoderma* spp. as endophytic plant symbionts having an intimate interaction with the plant providing a number of benefits *viz.* increased resistance of plant to various biotic and abiotic stresses such as water deficit/ excess, high salinity, extreme temperature and studies have shown that vast repertoire of genes are involved in biosynthesis of secondary metabolites such as Non Ribosomal Peptides (NRPs), polyketides, terpenoids and pyrones. These fungi are considered to act as full symbionts receiving nutrients from plants and a protected niche to colonize whereas providing to the host with improved nutrient uptake and stress protection. For these reasons, the *Trichoderma*-plant interaction proteome has recently received increasing attention by research groups and the application of biopesticides, bioinoculants, biofertilizers, plant strengthening agents, plant protectants of *Trichoderma* containing products extends worldwide following different commercial implementation models. Diagnostic tools for structural and functional investigations have made an important impact on understanding and application of microbial agents used for plant disease control. The diagnostic tool for *Trichoderma* producing strains is by using Intact Cell Mass Spectrometry (ICMS); a simple, rapid and sensitive technique for direct detection using MALDI TOF/TOF mass spectrometer. With microgram amount of fungal sample and any prerequisite for chromatographic separations and processing, accurate and reproducible results can be obtained giving quick insight into possible peptaibiotics of *Trichoderma* producing strains producers. Study at miniaturized level saves time and resources giving accurate and reliable reproducible results.

5A.7

Biocontrol: an alternative biological way for plant disease management

Ayman Azad[1] and Jahangeer A. Baba[2]

[1]Division of Agronomy, FOA, Wadura, [2]Dryland (Karewa) Agriculture Research Station, Budgam, SKUAST - Kashmir, Shalimar, Srinagar, J&K-190025

aymanazad3039@gmail.com

The extensive use of chemicals and their harmful effect on people and the environment has raised the serious concerns for sustainable agriculture. The biological control refers to use of natural alternatives to synthetic agrochemicals to control plant diseases. There are three basic strategies of biological control: importation, in which a natural enemy of a pathogen is introduced in the hope of achieving control; augmentation, in which locally-occurring natural enemies are bred and released to improve control; and conservation, in which measures are taken to increase the populations of natural enemies. The use of bio-control agents is the most important aspect of biological control and includes wide range of organisms like fungi, bacteria, nematodes and so on. Mostly they are natural inhabitants of the soil and the environment and are non-pathogenic to birds, mammals and fish. They are not genetically modified and generally have short re-entry and days to harvest intervals. Bio-control organisms work by competing with the pathogen for space and nutrients, by parasitism or predation, by inducing the plant's natural defense system, or by the production of antimicrobial substances. Sometimes several mechanisms function together to make an organism effective against a pathogen. These products are living organisms or dried spore preparations and must be handled differently than conventional chemical fungicides. They are highly sensitive to temperature extremes and must be applied immediately after mixing with water. They may also require special attention to pH, exposure to chlorine or UV light, and their shelf life may be limited.

Key words: biological, organisms, biocontrol agents, disease management.

POSTER PRESENTATION

5B.1

Antagonistic activity of fungal and bacterial biocontrol agents against Damping off of Chilli

Misba Majeed[1], Mir G. Hassan[1], F.A. Mohiuddin[1], Z.A. Badri[1], Shazia Paswal[2] and Mudasir Hassan[1]

[1]*Division of Plant Pathology, SKUAST-Kashmir;* [2]*Division of Plant Pathology, SKUAST-Jammu*
tantraymm@gmail.com

Among fungal diseases, damping off in nurseries caused by *Pythium aphanidermatum* is one of the major constraints in production of chilli. Chemical control provides certain degree of control but have adverse effects on environment. Therefore, biocontrol control provides a potential strategy to control the disease. In present study, two fungal isolates (*Trichoderma viride* and *Trichoderma harzianum*) and two bacterial isolates (*Bacillus subtilis* and *Pseudomonas fluorescens*) were tested for their ability to inhabit the pathogen, *Pythium aphanidermatum*. Dual culture study revealed that all four antagonists tested inhibited the growth of pathogen. *T. harzianum* showed maximum inhibition of 90.94 per cent over control followed by *T. viride*. *T. harzianum* and *T. viride* completely overgrew the pathogen and were placed in class I according to modified Bell's scale and were classified as strong antagonists. *P. fluorescens* inhibited 59.42 per cent whereas the minimum inhibition of 54.51 per cent over control was shown by *B. subtilis*. These bacterial antagonists parasitized the test pathogen upto two third of the medium surface after 7 days and thus were placed in class V according to modified Bell's scale and were classified as poor antagonists.

5B.2

Biological agents alternative to chemicals

Taibah Bashir, Asim Bashir, Rovidha Saba, Aqleema Bano and Rabia Latif

Division of Plant Pathology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar-190025 (J&K), India
anabiashah120@gmail.com

Biological control of disease employs natural enemies of pests or pathogens to eradicate or control their population. This can involve the introduction of exotic species, or it can be a matter of harnessing whatever form of biological control exists naturally in the ecosystem in question. The induction of plant resistance using non-pathogenic or incompatible micro-organisms is also a form of biological control. Some diseases that can be successfully controlled using biological agents are pathogens of pruning wounds and other cut surfaces, crown gall, diseases of leaves and flowers, such as powdery mildew, diseases of fruits and vegetables, such as *Botrytis*, and fungal pathogens in the soil. The most common mechanisms for microbial antagonism of plant pathogens are parasitism, predation, competition, induced resistance and the production of antimicrobial substances. Organisms for biological control of plant disease can be used in various ways, but most attention has been given to their conservation and augmentation in a particular environment, rather than to the importation and addition of new species as is often done for insect or weed control. The choice of these approaches is in part because there is usually a diverse set of microbes already associated with plants. These microbes provide substantial opportunity for development of resident species as competitors or antagonists to pathogenic organisms. Both conservation and augmentation have some application in each of the main groups of plant diseases. Biological control of plant pathogens through augmentation is based on mass culturing antagonistic species and adding them to the cropping system. Diseases of roots, stems, aerial plant surfaces, flowers, and fruit are caused by a wide variety of pathogens. Because of this diversity, the antagonist species, which negatively affect plant pathogens and the mechanisms by which they accomplish their beneficial action, are also quite varied. Fruits and

vegetables are subject to attack from a large number of pathogens during growth, at harvest and during subsequent handling and storage. In fact, fungal diseases represent a major limiting factor to the long-term storage of fruits and vegetables. There is therefore considerable interest in biological control. One of the most common pathogens targeted is *Botrytis cinerea*, the cause of grey mould in many fruit. On grape, one of its more important hosts, *B. cinerea* causes a pre-harvest berry rot, as well as postharvest damage. Infection occurs through the flowers. The fungus remains latent until the fruit begins to ripen. The fungus is spread rapidly by airborne spores. Experimentally, control has been achieved by applying spores of *Trichoderma harzianum.* Currently, fungicides are widely used for disease control, but because fruit spoilage organisms tend to be most serious when fruit are ready to consume, there are limitations to the chemicals that can be used, a single biological control agent can be applied and is expected to work efficiently and quickly on several stages of a pathogen therefore biological control agents could be developed as component of integrated management programme.

Key words: Bio-agents, *Trichoderma harzianum,* Disease control.

5B.3

Neem- A potential biopesticides

Naushin Bano[1], Tehsin Tabbassum[2], Tehsin Tarranum[3] and Shahid Ahamad[4]

[1]CSJM, Kanpur, U.P; [2]S.L.P. College, Jiwaji University, Gwalior; [3]Department of Biotechnology, Bundelkhand University, Jhansi; [4]Directorate of Research, SKUAST-Jammu

t.tehsin@gmail.com

Neem (*Azdirachta indica* A. Juss) is an evergreen fast growing tree native to be Indian subcontinent. Owing to over increasing public concerns about the harmful effects of toxic synthetic pesticides, neem based products have virtually taken the centre- stage as a possible alternative. It is considered as a valuable source of unique natural products to hold a great potential as pest and diseases control for use in agriculture with environmental harmonization. All parts of the tree such as leaf, flower, fruit, seed, kernel, bark, wood, and twig are biologically active, although the maximum activity is being associated with the seed kernel. The chemical constituents contain many biologically active compounds including alkaloids, flavonoids, triterpenoids, phenolic compounds, carotenoids, steroids and ketones but biologically most active compound is azadirachtin. It is endowed with features of diverse and broadspectrum of activity against insects, phyto-nematodes, plant pathogens, etc.

Theme-VI

Plant Disease Management Strategies under Organic Farming

ORAL PRESENTATIONS

6A.1

Trichoderma for the management of fruit rot of papaya

V.A. Patil, J.B. Patel and B.P. Mehta
Navsari Agricultural University, Navsari, Gujrat 396 450
vijay.patilagri@gmail.com

Papaya (*Carica papaya* L.) is one of the most important commercially grown fruit crops in tropical and sub-tropical region of the world. Post harvest application of chemical fungicides for treatment of fruit rotting is injudicious for human health as papaya is direct consumable table fruit. Biological control is an effective, ecofriendly and alternative approach for any disease management practice. Antagonists are well known for their potentiality against various diseases causing pathogen in *in vitro* conditions. Thus, secondary metabolites from different seven potent antagonistic microbes were studied against pre inoculated fruits. Dipping in 0.22 μ filtered suspension of seven different isolates of antagonists for 5 minutes. It was found that *Trichoderma harzianum* NAU (Navsari) isolate recorded minimum PDI (15.67%) as well as recorded maximum (96 hrs) for disease initiation followed by *Trichoderma viride* NAU (Navsari) isolate, *Trichoderma fasiculatum* NAU (Navsari) isolate.

6A.2

Crop protection in organic agriculture

R.A. Wani, Jahangeer A. Baba, S.A. Hakeem, Sabiya Bashir and S. Nissa
Dryland (Karewa) Agriculture Research Station, Budgam, SKUAST-Kashmir, Shalimar, Srinagar, J&K-190025
mohammedahyanwani2015@rediffmail.com

Pest and disease management consists of activities that support each other. Most management activities are long-term activities that aim at preventing pests and diseases from affecting crop. Management focuses on keeping existing pest populations and diseases low. Control on the other hand is a short-term activity and focuses on killing pests and diseases. The general approach in organic agriculture to deal with the causes of problem rather than treating the symptoms also applies for pests and diseases. Therefore, management is of much higher priority than control. Immense commercialization of agriculture has had a very negative effect on the environment. The use of pesticides has led to enormous levels of chemical buildup in our environment, in soil, water, air, in animals and in our own bodies. Fertilizers have a short-term effect on productivity but a long term negative effect on the environment where they remain for years after leaching and running off, contaminating ground water and water bodies. The use of hybrid seeds and the practice of monoculture has led to a severe threat to local and indigenous varieties, whose germplasm can be lost forever. While conventional agriculture uses synthetic pesticides and water soluble synthetically purified fertilizers, organic farmers are restricted by regulations to using natural pesticides and fertilizers. The principal methods of organic farming include crop rotation, green manures and compost, biological pest control, and mechanical cultivation. These measures use the natural environment to enhance agricultural productivity, legumes are planted to fix nitrogen into the soil, natural insect predators are encouraged, crops are rotated to confuse the pests and renew soil and natural material such as potassium bicarbonate and mulches are used to control diseases and weeds. It is estimated that more than 18 million hectares of land available in India can be exploited for organic production.

Key words: organic agriculture, crop, pest, disease and management.

6A.3

Organic pesticides and fungicides to control problems with fruit trees

Lalit Upadhyay, S.K. Gupta, Rajkumar and Arvinder Kumar
SKUAST- Jammu

Trees are susceptible to a variety of different pathogens like blight, rust, scab, leaf spot, black spot and mildews. Fungal spores spread easily from splashing water, insects, animals and garden debris. Pests such as insects and fungus also enjoy feasting fruit tree, which can result in foliage and fruit dropping prematurely. Pesticides and fungicides help control these problems, but commercial products can cause more harm than good, killing beneficial insects. Organic pesticides and fungicides can be used to control problems with fruit trees Garlic is chock full of antibacterial and anti-fungal properties like allicin and sulfur that work against pathogens like powdery mildew, downy mildew and leaf spot. Black spot, leaf spot, scab, mildews and other diseases are killed by apple cider vinegar solutions. Derived from the neem tree, neem oil is an all-purpose spray and safe for use in organic gardening. It helps control undesirable insects and fungal diseases that attack fruit trees without harming the fruit or the plant. Jojoba oil is used in the same manner as neem oil and treats and controls most of the same pests and diseases. *Bacillus thuringiensis* targets specific insects at their larval stage, including leaf-eating caterpillars, loopers, hornworms and leaf rollers. It is non-toxic to fish, humans, birds, bees, pets, wildlife and other beneficial insects. Peppermint oil spray repels ants and gets rid of other hard-bodied insects. Many insects will avoid hot peppers.

POSTER PRESENTATION

6B.1

Plant disease management strategies under organic farming

Jahangeer A. Baba, Gul Zaffar, R.A. Wani, S.A. Hakeem, Y.A. Basu, S. Bashir, S. Nissa and Ayman Azad

Dryland (Karewa) Agriculture Research Station, Budgam, SKUAST-Kashmir, Shalimar, Srinagar, J&K-190025
jahangeerbaba@rediffmail.com

Management of pests and diseases consist of a wide range of activities that closely support each other. Majority of management practices are long-term activities that aim at preventing pests and diseases from affecting a crop. Management focuses on keeping existing pest populations and diseases under check. Control on the other and is a short-term activity and focuses on killing pest and disease. The general approach in organic agriculture to deal with the causes of a problem rather than treating the symptoms also applies for pest and diseases. Therefore, management is of a much higher priority than control. This document describes preventive practices, as well as control practices using biological, mechanical control and natural pesticides. The interaction between living organisms and their environment is crucial for a plant's health. Plant's health is more at risk in monocultures and on-farm diversification provide a balanced interaction between different plants and pests and predators. This is why a well-managed ecosystem can be a successful way of reducing the level of pest or disease population. Certain crop varieties have more effective mechanisms than others due to the adaptive nature to the environment and therefore have a lower infection risk. The health condition of a plant depends to a large extent on the fertility of the soil. When nutrition and pH is well balanced, the plant becomes stronger and is therefore less vulnerable to infection. Climatic conditions, such as suitable temperatures and sufficient water supply, are further factors which are crucial for a healthy plant. If one of these conditions is not suitable, the plant can become stressed. Stress weakens the defence mechanisms of plants and makes them easy targets for pests and diseases. One of the most important points for an organic farmer is therefore to grow diverse and healthy plants. This avoids many pest and disease problems.

Key words: organic, plant health, disease, management.

6B.2

In vitro evaluation of bio-agents against *Sphaceloma ampelinum* causing grape anthracnose in Kashmir

Uzma Fayaz, Saba Banday, Efath Shahnaz, N.A. Khan, Sheikh Adeeba and Rabia Latif

Division of Plant Pathology, SKUAST-Kashmir-190025
uzma78682@gmail.com

In J&K the area under grapes is 315 hectares with production of 129 million tonnes. Though Kashmir is not the principal center of grape cultivation, it was famous for producing quality juicy grapes in past. Grape is the host to a wide range of diseases which significantly impair its quality and production. However, the fungal diseases inflict huge losses to the crop. Among the fungal diseases anthracnose disease is considered to be the major threat to successful grape cultivation in Kashmir. *Sphaceloma ampelinum*, the causal pathogen of grape anthracnose, is the anamorph stage of *Elsinoe ampelina*. Management of anthracnose disease in Kashmir has mainly been through the use of fungicides. However, fungicide applications are only partially effective under environmental conditions that are favourable for pathogen infection. Furthermore, fungicides are not sustainable especially in small holding farming system in Kashmir, due to the high cost and risks to the environment. Keeping the prospects under the economic importance of the crop and amount of destruction caused by the disease, one fungal and two bacterial biocontrol agents (BCAs) were evaluated under *in vitro* conditions for their antagonistic potential against *Sphaceloma ampelinum*

isolated from grapes. Among the evaluated bioagents *T. harzianum* was found to be significantly superior to all showing 71.0 per cent inhibition followed by *Bacillus subtilis* (58.3%) and *Pseudomonas fluoresence* (39.5%). Studies on the mechanism of action using mycoparasitism technique and antibiosis observed under light microscope revealed that *T. harzianum* inhibited the growth of *S. ampelinum* by coiling and penetration into the hyphae. Consequently, the hyphae of *Sphaceloma ampelinum* became malformed and swollen. *Bacillus subtilis* and *Pseudomonas fluorescence* to lesser extent also caused mycelial malformation; the mycelia turned vacuoled and swollen in or at tips of hyphae.

6B.3

Disease management strategies under organic farming

Kunzang Dolma[1] and Anuradha Saha[2]
[1]*Division of Agronomy,* [2]*Division of Plant Breeding and Genetics, SKUAST-Jammu, Chatha, Jammu- 180009*
kunzangsponbo@gmail.com

Organic farming can be defined as an “ecologically, economically and socially responsible way of farming, providing an enduring supply of safe and healthy food and fibers with least destruction to the environment”. The principal methods of organic farming include crop rotation, green manures, compost, biological pest control, and mechanical cultivation. These measures use the natural environment to enhance agricultural productivity. Managing the ecosystem on an organic farm is very challenging. It is made even more complex when there is a incidence of insect and disease pests. Since the uses of synthetic pesticides are prohibited, the organic cropping system should be more focused on the prevention of disease outbreaks rather than coping with them after they occur. Successful plant disease management depends on the incorporation of a number of control strategies viz, insect and disease avoidance, managing the growth environment and direct treatment. Which in turn can be successfully achieved by crop rotations, field sanitation, seed quality, forecasting; healthy soil, cover crops, intercrops, rouging, additions of manure and compost and reductions in soil tillage. At times, when despite all the best efforts, incidence of the disease grows to levels that cause substantial crop damage. At this point, direct treatment becomes necessary which can be achieved by application of natural pesticides.

Key words: Organic Farming, Plant Disease, Management Strategies.

Theme-VII

Management Strategies in Spawn Production and Mushroom Cultivation

ORAL PRESENTATIONS

7A.1

Biochemical compounds imparting antimicrobial properties to mushrooms

Sachin Gupta, Saloni Sadhotra, Anil Gupta and Ranbir Singh
Division of Plant Pathology, SKUAST-J, Jammu

Mushrooms have been known to possess biochemical components which show antimicrobial properties against plant pathogens. The present study was conducted to analyse the biochemical constituents of five different *Pleurotus* species *viz. P. sapidus, P. sajor-caju, P. florida, P. citrinopileatus* and *P. flabellatus.* These biochemical compounds are reported to be responsible for antimicrobial properties. Biochemical analysis of different mushrooms revealed that among the biochemical constituents, highest total phenol content (903.11 mgGAEs/100g dry wt.), tannin content (35.42 mgCAEs/100g dry wt.), alkaloid content (675.42 mgBOEs/100g dry wt.) and saponin content (36.32 mg/100g dry wt.) was reported in *P. sapidus.*

7A.2

Integrated management of green mould in mushroom

Faisal Noor Hamdani, P.K. Singh and Kousar Parveen
Division of Vegetable Science, SKUAST-Kashmir, Shalimar Campus, Srinagar, J&K-190025, India
faisalnoor17@gmail.com

Pleurotus ostreatus (oyster mushroom), *Agaricusbisporus* and *Lentinula edodes*are the important world-wide cultivated mushrooms. weed mould, or “green mould” occur in mushrooms due to infections by members of the genus *Trichoderma* which has limited their commercial production. Earlier mushroom green mould was a minor problem only, occurring due to low quality compost or poor hygiene, and was easily manageable by modifying the composting process, improving sanitation or chemical intervention but the first green mould epidemics occurred in the British Isles during 1985-1986 and in late 1990 and 1991 which caused severe losses. The Pathogenic green moulds colonize on the substrate or grow on the surface of the emerging mushrooms with no initial visible symptoms. Later on, *Trichoderma* spp. produce whitish mycelia indistinguishable from those of the mushrooms during spawn run, therefore making it difficult to recognize the infection at this stage. Subsequently, large patches of compost turn green rapidly as sporulation begins on the *Trichoderma* mycelia which had run through the compost with *Agaricus.* Green moulds develop billions of spores that are easily carried by workers, insects and contaminated equipment. Therefore, infestations are quickly spread and the control of the disease is difficult. Poor hygiene either through ineffective disinfection of equipment or through the ingress of contaminated air into spawning halls further increase the entry of the pathogen. Therefore, stringent sanitation standards coupled with the use of the proper fungicide is required to prevent a buildup of pathogen propagules around the farm. A common practice of sprinkling salt over the green mould specks or to irrigate them with a benomyl containing solution is also effective against the disease. However, in the commercial production of mushrooms, disinfectants are frequently used as an aid to general hygiene procedure and as inhibitor of the activity of many undesirable microorganisms. Also, the pasteurization of compost or wood materials used in the construction of mushroom growing rooms can also aid in decreasing the green mould infection and at same time increase yield. Adjustment of casing pH is another effective approach to *Trichoderma* management. In general, prevention has to play a central role in green mould management, however, if the infection already occurred at a mushroom producing facility, it has to be controlled. Chemical treatments are often the most effective means of managing green mould.

7A.3

Mushroom pests and diseases management

Shazia Paswal, Anil Gupta, Sachin Gupta, Seethiya Mahajan, Varsha Bharti, Misba Majeed and Fozia Wani

Division of Plant Pathology, SKUAST-Jammu, Chatha-180009

paswalshazia@gmail.com

Mushrooms cultivated under protected culture or growing wild are infested by insects, mites, nematodes as well as bacteria and fungi. Consumers prefer mushrooms that are not treated with synthetic pesticides. Alternatively, plant-based products in various formulations have been found to be effective through different modes of action against insects and mites; that is, antifeedants, pesticides, growth regulators, repellents, and oviposition deterrents. Inhibition of spore germination and growth retardation in pathogens and arresting penetration of nematodes into stalks and sporophores are other actions. Plant-derived products can be recommended to substitute for synthetic chemicals in the commercial production of edible mushrooms. Natural toxins are a source of new chemical classes of pesticides, as well as environmentally and toxicologically safer molecules than many of the currently used pesticides. Furthermore, they often have molecular target sites that are not exploited by currently marketed pesticides. There are highly successful products based on natural compounds in the major pesticide classes. These include the herbicide glufosinate (synthetic phosphinothricin), the spinosad insecticides, and the strobilurin fungicides. Integrated pest management such as Bed moisture content should be around 60-65%, fix insects proof net in the windows, fix white insect trap to attract the flies, spray malathion @1g/1lit in the floor and sides to kill the flies and beetles never spray on the mushroom beds and button. General management of diseases maintenance of farm and surrounding in a hygienic way is very important, spawn should be fresh and free from contaminants Fungal diseases management. Management of mold by sprinkle agri lime powder over infected area to check its spread, watering after harvest, inky cap management removes fruit bodies with hand, avoid over watering, *sclerotium rolfssi* management use properly pasteurized substrates, discard infected bags.

7A.4

Mushroom diseases are managed by using plant derived products

Varsha Bharti, Sachin Gupta, Shazia Paswal, Seethiya Mahajan and Devendra Kumar

Division of Plant Pathology, SKUAST-Jammu, Chatha, Jammu

varshapatho@gmail.com

For commercial production, mushrooms are cultivated under controlled conditions indoors or outside. Diseases of mushroom are very common and come at every stage of mushroom cultivation from composting to production of sporocarp. In cultivated mushrooms, chemicals are extensively applied to maintain room sanitation and reduce damage caused by insects and diseases. Synthetic insecticides (malathion, permethrin), insect growth regulators (cyromazine, methoprene), and fungicides (benomyl, thiabendazole) are regularly applied after spawning and during casing, a week later, and between flushes up to 2 days before harvesting (Anonymous, 2010). The overuse, faulty application, and persistence of chemicals may create secondary effects such as resurgence of secondary pests, pest resistance to common pesticides, environmental pollution, and hazards to non-target organisms including beneficial fauna. Mushrooms are fungi, and any fungicide-based control program in commercial production will affect the crop species. Currently, there is increasing awareness about organic products and consumers often pay premiums for certified foods. Among progressive measures, the inclusion of eco-friendly, effective, and less costly measures in mushroom protection seems to be an appropriate step. In general, neem has been extensively studied in agricultural crops. Neem products contain limonoids, terpenoids, flavonoids, and alkaloids; azadirachtin a major bioactive isomer. These constituents may act as oviposition deterrents, sterilants, anti-feedants, growth regulators, or contact toxins against insects and mites. Inhibition of spore germination and

retardation of growth are major modes of action against pathogens. With neem products, penetration by nematodes in fruiting bodies and development of juveniles can be restricted. It is a general practice for farmers to control pests and diseases by using crude preparations such as neem seed kernel powder, neem leaf extract, neem seed kernel extract, neem oil, and defatted neem cake. Similarly, over 50 commercial products based on neem extract in water or a chemical solvent as an emulsifiable concentrate are available in the market (Gahukar, 1998). Neem-based "ready-to-use" products are being widely used. Therefore, use of plant-based pesticides is preferable against pests and diseases in mushroom production (Gahukar, 2007).

7A.5

Antimicrobial potential of *Pleurotus* spp.

Saloni Sadhotra, Sachin Gupta, Varsha Bharti and Ranbir Singh
Division of Plant Pathology, SKUAST-J, Jammu

The present study was conducted to study the antimicrobial properties of different *Pleurotus* species viz. *P. sapidus, P. sajor-caju, P. florida, P. citrinopileatus* and *P. flabellatus* using three different solvents viz. methanol, cold water and hot water. Among the *Pleurotus* species evaluated *P. sapidus* showed maximum antimicrobial activity against the plant pathogens (*Fusarium oxysporum, Alternaria alternata, Rhizoctonia solani* and *Bipolaris maydis*). It showed maximum inhibition against *A. alternata* (65.34%) followed by *R. solani* (60.27%), *F. oxysporum* (58.58%) and *B. maydis* (55.75%). However, minimum inhibition was observed in case of methanol extract of *P. florida* against *A. alternata* (25.43%), *R. solani* (20.08%), *F. oxysporum* (17.43%), *B. maydis* (15.39%). Among *P. sapidus* and *P. sajor-caju*, lowest minimum inhibitory concentration (MIC) was observed in case of *P. sapidus* against A. alternata (516.67 µg/ml) whereas highest MIC was observed in case of *P. sajor-caju* against *B. maydis* (700.00 µg/ml).

7A.6

Mushroom nutraceuticals- Role in human health

Saloni Sadhotra, Roohi Jan and Varsha Bharti
Division of Plant Pathology, SKUAST-Jammu

Initially mushroom cultivation was directed at food production but now a new class of compounds, termed 'mushroom nutraceuticals' which are extractable from either the mushroom mycelium and/or spent mycelium culture fluids, or mushroom fruiting bodies and are being used as complementary medicines/dietary supplements. There are wide reports attributing a wide range of different biological effects to mushroom nutraceuticals including antitumour/ anticancer/ immune potentiating, hypoglycaemic/ antidiabetic, hypo-cholesterol-aemic, hepatoprotective and antibacterial/ antifungal/ antiviral efforts. Mushrooms also contain antioxidant-genoprotective (antimutagenic) components, and produce potent metabolites capable of penetrating cell membranes and interfering with particular signal transduction pathways linked to processes such as inflammation, cell differentiation and survival, carcinogenesis, and metastasis.

Theme-VIII

Allied Topics

ORAL/POSTER PRESENTATION

8A.1

Economy and environment: an analysis of IPM and associated policy

Sudhakar Dwivedi, Jyoti Kachroo, S.P. Singh and Anil Bhat
Division of Agricultural Economics & ABM, SKUAST-Jammu
dwivedi.sudhakar@gmail.com

IPM as a concept, or a group of concepts, came from agricultural science facing the challenge of designing ever more effective techniques for protecting crops from a host of antagonistic pests. Added to biological shifts--resistance of some species to chemical applications- have been social and economic evolutions that argued for expansion and innovation in the scope of crop protection practices. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. Agricultural economics has a direct association with IPM in taking many decisions at the farm level like what control to use from a set of controls, and how to apply it, given different timing and intensity possibilities. Subjects such as the development of response curves for pest kill or plant growth is not explicitly covered and is assumed known *a priori*. Fundamentally, the aggregate topic of interest is: what impacts will certain pest-related actions (policies, regulations, and technology development, improvement, or dissemination) have upon the economy.

Key words: IPM, Plant Protection, Regulations, Policies, Profitability

8A.2

Where there is a pest, there is a natural enemy- Sugarcane leaf hopper *Pyrilla perpusilla* (Walker) on rice and its natural suppression by *Epiricania melanoleuca* (Fletcher) in Jammu region of J&K, India

Rajan Salalia
AICRIP (ICAR), Division of Plant Breeding & Genetics, FoA, SKUAST-Jammu, Chatha - 180009
rajanjgd@yahoo.co.in

The unusual, but emerging pest in rice sugarcane leaf hopper (SLH) *Pyrilla perpusilla* was recorded for the first time during quarterly pest survey of rice in R.S. Pura area of Jammu region of J&K during *Kharif -2016*. SLH is a major pest of sugarcane in Punjab, Uttar Pradesh, Bihar and Maharashtra but occasionally infests paddy crop. During the survey, the pest infested fields were tagged and recorded with an average count ranging from 5 - 12.5 (eggs, nymphs and adults) per hill at Bhour Pind, SKUAST-J Chatha farm, Chatha Pind, Miran Sahib on the hybrid rice varieties. Interestingly this new threat to rice was naturally suppressed by a nymphal and adult parasitoid, *Epiricania melanoleuca* appreciably to the tune of 60-78%. The same was recorded and imaged at all locations where SLH was spotted. This shows that the emergence of any pest is accompanied by its natural enemy/ parasitoid. The modern farming practices have disturbed the balance of pest and its natural enemy and created iunfavourable environments for natural enemies thereby reducing its capacity to control pest insects. It can concluded that climate change is inviting the occurrence of new pest to non-traditional hosts but at the same time with relatively little effort the activity of these natural enemies can be observed and exploited. Hence this is not only safer to environment but also is in contrast to usual practice adopted by advisory personnel and farmers which promotes the use of pesticides. This kills the beneficial predators, parasites and pathogens along with the target pest and can later cause outbreaks of secondary pests or rapid resurgence of pests that were initially suppressed.

8A.3

Germination improving of pecan nut seeds under intermediate agroclimatic conditions of Jammu & Kashmir

Rajesh Kumar[1], V.K. Wali[2], Parshant Bakshi[2], Deepak Kumar[1], Vikas Sharma[1], Arvind Isher[3] and Suraj Parkash[3]

[1]Regional Agricultural Research Station, Rajouri, [2]Division of Fruit Science, [3]KVK, Rajouri, SKUAST-Jammu, Chatha (J&K) - 180009

rajeshraina80@rediffmail.com

Pecan [*Carya illinoensis* (Wangenh.) K. Koch.] often called sweet pecan, is an important source of valuable wood and a very desirable wildlife food. Since this species usually does not form pure stands, and its natural regeneration consists mainly of scattered individuals, establishment of stands for management would require an artificial regeneration by direct seeding or planting of seedlings. Nuts that fall in October or November rarely germinate before late April. This long period between seed fall and germination exposes the nuts to animal predation and rot. Keeping in view the present experiment entitled "Studies on effect of different soaking periods (Water, 0, 12, 24, 48) hrs. and concentrations of GA_3 (0, 100, 200 and 400 ppm) on germination of pecan nut" was conducted at Regional Agricultural Research Station Rajouri, SKUAST-Jammu to ascertain the treatment which is effective for maximum germinations percentage. The results obtained clearly indicated the soaking period in water (24 and 48) hrs. (4.02, 4.09) is significantly effective in increasing germination percentage, reached (82.0, 84) seedling stem diameter and dry weight of vegetative growth (19.8, 20.20) compared with control (62.0, 2.38, 16.5) gr. But the soaking period in water (48) hrs. only significantly effective the Seedling length reached (31.14 cm) on compare with seedling length in non-soaking water (27.20) cm. While the (GA_3) (400) ppm. Significantly effective on all studies parameters.

8A.4

Major concerns of Saffron production in Jammu and Kashmir

Bisma Zargar

Division of Food Science and Technology, Islamic University of Science & Technology, Awantipora, Pulwama, Srinagar, J&K.

bismazargar67@gmail.com

Saffron (*Crocus sativus*) is one of the most important foreign exchange earners among the spices of India, grown entirely in the state of Jammu and Kashmir; about 49 per cent of its total produce is exported outside the country. Saffron is world famous high value low volume cash crop of the Kashmir. But during recently the area under cultivation, production productivity is on decline with the result the saffron cultivation is under threat in the state due to presence of lot of problems in the sector. Saffron has shown its role in disease prevention and its treatment. Its stigma shows antioxidant activity and thus prevents the degeneration of cells by free radicals. The components of saffron, crocin and safranal showed role in the suppression of inflammatory pain responses and decreased the number of neutrophils and also possess strong activity against bacteria and fungi. It is an important commodity and is of great significance in the agricultural economy of Jammu and Kashmir. Saffron is well known spice it has many other uses in industries such as food, pharmaceutical, cosmetic and perfumery as well as in the textile dyes. The matter of concern is that the Saffron cultivation has declined by 25 percent from 4161 hectares in 1998 to 3110 hectares in 2008. However, Saffron production is currently suffering on several counts, especially those relating to productivity as well as post-harvest management. The decline in the sector is also due to lack of irrigation facilities, a major problem and lack of research and developmental activities in the related field related to cultivation, sowing of corms, seed protection. Also there is existence of the various intermediaries in the marketing of the saffron production of which leads to adulteration of Saffron to degrade the quality of the Saffron with the mixture of the Iran Saffron which is not in comparison to the Kashmir Saffron

which leads to fetch the lower prices to domestic cultivation in the state. The need of the hour is to make the National Mission on Saffron cultivation in the state more improved and strengthen the implementation of the programme for the fruitful results in the long run to benefit the farmers in the economy.

8B.5

Effect of soil & water conservation modules in enhancing SQI in rainfed orchards of lower Shiwalik

Vivak M. Arya, Vikas Sharma, K.R. Shrama and J.P. Sharma
Division of Soil Science & Agril. Chemistry, FoA, SKUAST-Jammu

Mango is popular among masses due to its excellent flavour, delicious taste; delicate fragrance, attractive colour and nutritive value which make it rank among the best fruits of world. However, these traits can only be obtained by proper orchard management of which soil health management is of utmost importance for proper nutrition. Soil health alone is an important aspect to be studied in orchards as it plays a major role in determining the yield as well as quality of mango fruit. The mango (*Mangifera indica* L.) is one of the choicest fruit of tropical and sub-tropical region of the world, especially in Asia. Its population and importance can easily be realized by the fact that it is often referred as “King of Fruits in the Tropical World. The nutrition that soil provides have major bearing on the fruit quality and biochemical indicators. Keeping this in view, a study was conducted to assess the quality of rainfed mango orchards in the Kandi region of Jammu division of J&K as well as the impact of conservation practices *viz.*, trenches and basins (depending upon the slope of orchards). Long-term soil conservation management in mango orchards improved the quality of soils through enhancing the organic carbon fraction and biological status. Various soil physico-chemical parameters mere assessed using standard procedures. Each parameter was given weightage depending upon its importance. The value of OC (g/kg) was 6.8, 7.3 and 7.6 for Reasi, Basohli and Billawar respectively. The nitrogen content ranged from 330-360 kgha^{-1} (Reasi - 330 kgha^{-1}, Basohli-340 kgha^{-1}, Billawar-360 kg ha^{-1}). The overall SQI for the three different agro ecologicalregions was 0.45(LESS) for Panthal, (Distt. Reasi), 0.75 (OPTIMUM**)** for Marapatti, Basholi (Distt. Kathua) & 0.95 (MORE) for Billawar. Maximum value for soil moisture content (15.10%) was recorded in full moon water harvesting structure and minimum, 11.50% in control. Soil moisture status in Cup & Saucer techniques ranged from 13.8 to 10.6% where as in control plot it varied from 10.9% to 8.2% respectively. Under plastic and organic mulches soil moisture content recorded was 15.14 and 11.2%, respectively which was higher as compared to the control. The studies revealed that plastic mulches gave higher values of soil moisture content as compared to organic mulches.

Key words: rainfed, mango orchards, soil quality, conservation practices

8B.6

Role of entomology in food bio-security

Suheel Ahmad Ganai and Rouf Ahmad Zargar
Division of Entomology, Faculty of Agriculture, Main Campus Chatha, SKUAST-Jammu
suhail_jalib@yahoo.com

In order to feed the ever increasing population of our country, food bio-security has become a first and prime importance in agricultural industry. Food Bio-security is emerging as one of the most pressing issues facing developed, developing and transition countries. Globalization, the increased movement of people, agricultural and food products across borders, changing agricultural practices, greater awareness of biodiversity and the environment, uncertainties surrounding new technologies, as well as international legal obligations are just some of the factors driving this interest. Food Bio-security is fundamental for safeguarding our valuable agricultural resources against the threat and impacts of pests, weeds and diseases (pests). Pest insects may cause problems by damaging crops and food production, parasitizing livestock, or being a nuisance and health hazard to humans. Insect pests cause great damage in field and storage and hence are considered as threat not only to bio-security but also to the food security. To protect our agricultural industries from pests and attain the food security the Entomological sciences play a vital role by providing: Works with stakeholders to identify and manage bio-security risks, develops legislation, establishes import controls, conducts inspections, provides quarantine services as required and the holistic IPM programmes. The research in entomology addresses the biology, behavior, ecology of insects, with an emphasis on insects of economic importance. The Entomologists study insects that occur in a wide range of ecosystems, including pasture crops, vegetables, fruits, vineyards, greenhouse crops and natural ecosystems. Key areas of interest are biological control of insects and weeds, integrated pest management, bio-security, crop pollination and conservation and enhancement of ecosystem services delivered by insects. The research programmes considers beneficial parasitic wasps, predatory arthropods, crop pollinators and a wide range of pest organisms. These all helps directly or indirectly in attaining the food bio-security. India is one among the 12 mega biodiversity centers in the world & is highly vulnerable to invasive pests. Thus, in order to strengthen Agricultural Bio-security in the country NIPHM which is an offshoot of entomological sciences has been designated as the nodal centre by Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India to develop capacity of all stake holders. This Bio-security Group of entomology is developing new methods to manage and prevent new pest incursions and thus becomes the tool of food bio-security through the development of socially, environmentally, culturally and economically acceptable tools for rapid decision support and Integrated Pest Eradication (IPE). The bio-security challenge increases with globalization and human population growth, but the funds to protect our biodiversity, to ensure sustainability of primary production and to safeguard human and animal health continue to diminish. Greater awareness of problems, especially by tomorrow's decision-makers, is a key step in getting the priorities right.

8B.7

Relative efficacy of bio-pesticide, *Bacillus thrunigenesis* against *Spodoptera litura* (Fab.) on okra

S.K. Singh[1], Vishwa Vikas[2], Vikas Sharma[2], N. Panotra[1], Reena[3], M.C. Dwivedi[4] and Amitesh Sharma[1]

[1]O.F.R.C., Chatha, SKUAST-Jammu; [2]Division of Soil Science, FOA, Chatha; [3]ACRA, Dhiansar, Bari Brahmana; [4]Directorate of Research, SKUAST-Jammu

Okra, *Hibiscus esculentus* have an important place among kharif vegetable crops grown in all the states of India and has appreciable nutritional and economic value. Okra is used as boiled vegetable; it is rich in minerals and vitamins. Bio-pesticides are biological or biologically-derived agents, applied in a manner similar to chemical pesticides, achieving pest management in an environmentally friendly way. *Bacillus thuringiensis* (B.t.) is the most commonly used bio-pesticide globally. Field experiments were conducted during Kharif 2016 and 2017 at Organic Farming Research Centre, Chatha, SKUAST-J. The relative efficacy of biopesticide, *Bacillus thuringiensis kurstaki* @ 2g/L was evaluated against *S. litura* at different days *viz.* 3rd, 5th and 7th Days After Spray, in ten different organic treatments with Farm Yard Manure (FYM), Vermi-compost (VC), Poultry Manure (PM) and Neem Cake (NC) alone, as well as in their different combinations. Okra crop treated with 1.2 kg NC + 1.75 kg PM and sprayed with *B.t.* recorded the highest reduction in *S. litura* larval population (90.19 and 88.64% reduction after five days of spray) during both the seasons; Kharif, 2016 and 2017 respectively. This was followed by the crop treated with 12 kg FYM+ 1.75 kg PM and sprayed with *B.t.* Reduction in *S. litura* larval population was 85.67 and 85.41 during Kharif, 2016 and 2017 respectively after five days of spray. Though B.t. acts slowly as compared to conventional insecticides, but is as effective as any of the other insecticide, besides being safe. It can be thus safely accommodated in any Integrated Pest Management program for management of *Spodoptera* in okra, when grown organically.

8B.8

Production potential of black gram (*Vigna mungo L.*) + Sesame (*Sesamum indicum L.*) intercropping under rainfed eco-systems of Jammu

M.C. Dwivedi, Sushil Kumar Suri, Deepak Kumar, V.B. Singh, Rakesh Kumar and Satish Kumar

Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu-180009

An experiment was conducted at Advance Centre for Rainfed Agriculture, Rakh Dhiansar, SKUAST-Jammu during *kharif* 2015. The experiment was laid out in randomized block design (RBD) with three replications having nine treatments *viz*. sole black gram, sole sesame, black gram + sesame (1 row of sesame in 2 rows of black gram) additive series, black gram + sesame (1:1) replacement series, black + sesame (3:1) replacement series, black gram + sesame (5:1) replacement series, black gram + sesame (1:3) replacement series, black gram + sesame (1:5) replacement series and black gram + sesame (seed mix). The experimental results revealed that both the sole crops black gram and sesame gave higher seed yield and stover yield (5.88 and 3.47 q/ha) and (18.81 and 15.84 q/ha than intercropping systems. The black gram + sesame (5:1) replacement series recorded significantly higher black gram equivalent yield (BEY) 7.01q/ha which was statically at par with black gram + sesame (3:1) replacement series, black gram + sesame (1:1) replacement series and black gram + sesame (1:1) additive series.

8B.9

Novel bioactive molecules from endophytic populations associated with *Arisaema erubescens*

Akanksha Rathore, Brajeshwar Singh, Hemshiveta Pandita, Diksha Raina and Sneahpreet Kour

Division of Microbiology, Faculty of Basic Sciences, SKUAST-Jammu
brajeshbhau@yahoo.co.in

Arisaema erubescens is one of the medicinal herbs found abundantly in the Himalayan region. Healthy plant samples of *Arisaema erubescens* were collected from Patnitop situated at an elevation of 2,065 metres (6,640 ft)**,** with 33°05'15.60"N and 75°19'49.91"E coordinates of District Udhampur in Jammu Division. Total nine bacterial and eight fungal endophytes were isolated from plant samples. Bacterial endophytes were identified on the basis of Morphological & Biochemical behaviour. Later on promising cultures were subjected to 16S rRNA tools for species identification. Fungal endophytes were identified on the basis of morphological & microscopic characteristics and most of them were of *Aspergillus* genus. Endophytes were screened for their antibiotic production potential against human pathogens *Pseudomonas aeruginosa* (MTCC741), *Escherichia coli* (MTCC1697), *Staphylococcus aureus* (MTCC96) and *Salmonella typhimurium* (MTCC98*)*. Out of nine bacterial isolates only MB-19 & MB- 25 has shown significant anti-microbial activities against *Salmonella typhimurium* and *Escherichia coli* respectively. Potent endophytes were processed for identification of active metabolites at Natural Product Lab, IIIM (CSIR) Jammu. Bacterial extracts were subjected to bioassay for confirmation of presence of active metabolites in extracts. MB-19 & MB-25 has retained antimicrobial activity.

Key words: Himalayas, *Arisema erubescens*, endophytes

8B.10

Abiotic factors affecting the distribution and abundance of gall aphids on *Alstonia* in Jammu

Anjali Dhar
Central University of Jammu
anjalidhar29@gmail.com

Foliar gall aphid, has been an important foliar pest of Sainik Colony TAB area. This paper identifies and integrates existing knowledge regarding distribution and abundance of this species. Early foliar colonization patterns by aphids were examined relative to landscape parameters, including density of overwintering hosts. Though the pest abundance explained the aphid colonization and population density, a density-dependent effect was observed. When aphid populations were low, more aphids were found in the vicinity of *Alstonia* leaves. When aphid populations were higher, more aphids were found farther from foliar areas hinting their dispersion to new areas. Galls occur isolated or agglomerated on the abaxial surface of the leaf. The insect along with the egg deposits some physiologic fluid which acts as a stimulant for the induction of the gall. This stimulus brings about hypertrophy followed by hyperplasia of cells next to the location of the deposited eggs. The homopterans presents three nymphal instars, from eclosion of the egg to the adult. Development and formation of leaf galls by homopterans is generally associated with the feeding habits of these insects which extract sap from the xylem, phloem and non-conducting tissues of the plant. Covering growth, pouch galls are formed on the both sides of the leaf which open with an ostiole, a very small in immature galls but enlarges with the development of insect and opens to liberate the adults. The set gall inducing insects inhabit a highly specialized habitat for nutrition and protecting the inducing insects from predators and parasitoids

8B.11

Studies on changes of nutritional, microbial and organoleptic quality of flavoured ladoo from different cultivars of aonla

Nitish Pandita, Neeraj Gupta, Julie D. Bandral, Monika Sood and Anju Bhat
Division of Food Science and Technology, SKUAST- Jammu, Chatha J&K-180 009, India
neeruguptapht@gmail.com

Aonla (*Emblica officinalis* Gaertn) or the Indian Gooseberry is becoming an increasingly popular minor fruit due to its nutritional as well as medicinal properties. Owing to its astringency, it cannot be consumed freely in fresh form or as juice. Therefore, the present study was conducted to develop flavoured ladoo from different cultivars of aonla. The aonla fruits of different cultivars (*Banarsi*, *NA-7* and *Desi*) were washed with plain water and then blended with sugar/raw sugar. The blended mass was heated upto 70° Brix and thereafter ginger and cardamom flavours were added. The flavoured mass was then cooled to room temperature and small balls of *ladoos* were made. The prepared *ladoos* were stored in pet boxes for three months to ascertain the changes in chemical, sensory and microbiological characteristics. An increasing trend was observed in TSS, reducing and total sugars but decreasing trend in titratable acidity, tannin and ash during three months of storage. The highest microbial count of 1.45×10^6 cfu/g was recorded in treatment T_{12} (desi + ginger + raw sugar) and the lowest of 0.41×10^6 cfu/g in T_9 (NA-7 + cardamom + raw sugar) at the end of storage. On the basis of overall acceptability, T_3 (NA-7 + cardamom + refined sugar) was found to be the best treatment. The storability study revealed that *ladoos* prepared from cultivar NA-7 have good-shelf life and can be kept for more than 90 days without affecting the quality attributes.

Key words: Aonla cultivars, refined sugar, raw sugar, quality attributes

8B.12

Effect of high temperature stress on reproductive development in summer mungbean [*Vigna radiata* (L.) Wilczek] genotypes under different dates of sowing

G. Chand[1], A.S. Nandwal [3], Bhav Kumar Sinha[1], B. Singh[2] and Sapalika Dogra[1]
[1]*Division of Plant Physiology FBSc, [2]Division of Microbilogy FBSc, [3]Department of Botany & Plant Physiology, CCS Haryana Agricultural University, Hisar-125004, Haryana, India*
gurdev74@gmail.com

High temperature is known as the major threat to reduced growth and yield of plants in arid and semi-arid regions. A study was conducted to examine the reproductive development of contrasting mung bean [*Vigna radiata* (L.) Wilczek] genotypes viz., MH 421, MH 318 and Basanti differing in their sensitivity to high temperature raised in earthen pots (30 cm diameter) filled with 5.5 kg of dune sand (Typic Torrispamments) was investigated under screen house conditions. High temperature stress was given by manipulating sowing dates i.e. normal and late sown. Samplings were done at 3 and 7 days after exposure (DAE) of temperature above 30°C at reproductive stage. Sampling below 30°C temperature was considered as control. The reproductive components such as bud, flower and pod numbers plant^{-1} and pod: Flower ratios were recorded different days after emergence (DAE). The relationship between the mean air temperature and different reproductive components were computed. Highest number of flower per plant was observed on three DAE irrespective of dates of sowing, whereas, the maximum number of pods per plant was observed on seven DAE. Among the three varieties, MH 421 recorded the maximum number of bud, flower and pod per plant. Pod: flower ratio MH 421 at 3 to 7 DAE. With the advancement of age, crop recorded highest pod:flower ratio. Number of buds per plant was found to be significantly related to the mean air temperature under different varieties. However, the number of flower and pod per plant were significantly related to the mean air temperature in both the year. Increased temperature increased the number of flower plant^{-1} but the reverse was true in case of pod. Increased temperature under delayed sowing significantly reduced the pod number plant^{-1}. A temperature above 35°C was found to be congenial for the reproductive development in mung bean.
Key words: Mungbean, high temperature, Typic Torrispamments, reproductive

8B.13

Cell signalling in plants under abiotic and biotic stress condition

Bhav Kumar Sinha[1], Reena[2], Gurdev Chand[1], G.K. Rai[3], Muneeba Banoo[1] and Spalika Dogra[1]
[1]*Division of Plant Physiology, Faculty of Basic Sciences, [2]ACRA, Dhiansar, Bari-Brahmana, [3]School of Biotechnology, SKUAST -J, Chatha - 180009*

Environmental stress conditions such as drought, heat, salinity, cold, or pathogen infection can have a devastating impact on plant growth and yield under field conditions. The recognition and signalling pathways regulating the responses to abiotic stresses (*e.g.*, drought, salinity, cold and heat) are similar to those used for responding to biotic stresses (insect attack, pathogen infection and nematode attack). The adaptation to one stress condition can therefore affect tolerance to other non-related stresses, a phenomenon referred to as cross-tolerance. Plants possess a powerful regulatory system that allows them to adapt quickly to a changing environment for example, after exposure of plants to abiotic stress leading to enhanced biotic stress tolerance, wounding increases salt tolerance in tomato plants (Capiati *et. al*., 2006). In tomato plants, localized infection by *Pseudomonas syringae* pv. tomato (*Pst*) induces systemic resistance to the herbivore insect *Helicoverpa zea*. Positive relationship between abiotic and biotic stress may also possible (Abou Qamar *et. al*., 2009), as demonstrated by the reduced infection of tomato by *Botrytis cinerea* and *Oidium neolycopersici* following the application of drought stress and exposure of ozone may induce resistance to virulent *Pseudomonas syringae* strains in *Arabidopsis*. The viral infection protects plants against drought stress. Verticillium infection in Arabidopsis plants induced the expression of the Vascular-Related No Apical meristem ATAF and

Cup-Shaped Cotyledon (NAC) domain (VND) transcription factor *VND7*. VND7 induced *de novo* xylem formation ensuring the water storage capacity results increases plant drought tolerance (Reusche *et. al*., 2012). The redundancy of some of the major signalling compounds, for example, reactive oxygen species (ROS), calcium, protein kinases, abscisic acid and salicylic acid might form the regulatory basis for developing such multiple tolerance mechanisms. Recent findings reveal a role of abscisic acid in biological defense and involvement of salicylic acid in abiotic stress, thereby indicating that these compounds have a broader importance than previously anticipated. Furthermore, cellular responses often depend on the intracellular concentrations and fluxes of some of these signaling molecules can constitute a secondary stress themselves.

Key words: Abiotic stress, biotic stress, signaling, cross talk and reactive oxygen species

8B.14

Physiological and agronomic responses of different *Brassica juncea* genotypes to drought stress in Jammu region

Sapalika Dogra[1], Gurdev Chand[1], B.K. Sinha[1] and B. Singh[2]

[1]*Division of Plant Physiology FBSc.,* [2]*Division of Microbilogy FBSc SKUAST Jammu, India*

sapalikaji@gmail.com

The drought tolerance of *Brassica juncea* genotypes Pusa Bold, RSPR-01, RSPR-03, Kranti and NRCDR-2 was investigated after exposure to drought stress at various growth stages (45, 60 and 90 DAS to drought stress) in a pot experiment. The experiment was conducted in factorial completely randomized design with three replications at Division of Plant Physiology, Chatha, SKUAST, Jammu during Rabi 2016-17. Data of various physiological (leaf chlorophyll a & b, proline and total soluble carbohydrates) and agronomic attributes (number of pods/plant, seeds/pods, and seed yield/plant) was recorded. The data revealed significant difference among the various *Brassica juncea* genotypes for leaf chlorophyll a & b, proline accumulation and total soluble carbohydrates. The chlorophyll a & b content of all *B. juncea* genotypes declined due to drought stress in all growth stages. Genotypes Kranti showed less reduction in chlorophyll content during stress condition. There were significant increases in osmosis regulating substance under drought stress. Kranti followed by RSPR-03 accumulated highest proline and total soluble sugars. Drought treatment at different growth stages reduced grain yield significantly. Greater reduction in seed yield was observed when stress was imposed at flowering. Whereas, the highest average seed yield was found in genotype Kranti followed by RSPR-03 and RSPR-01 and whereas minimum average seed yield was found in cultivar Pusa Bold.

Key words: *Brassica juncea*, proline, chlorophyll, total soluble carbohydrates, seed yield.

8B.15

An overview of bael and its benefits

Neeraj Gupta, Monika Sood and Julie D. Bandral

Division of Food Science and Technology, SKUAST- Jammu, Chatha J&K-180 009, India

neeruguptapht@gmail.com

Bael (*Aegle marmelos* Corr.) is an indigenous fruit of India belongs to family Rutaceae and it is commonly known as Bengal quince, Indian quince, Golden apple, Holy fruit, Bel, Belwa, Sriphal, Stone apple and Maredo in India. Although the bael trees grows in almost all the states of India but is most abundantly available in U.P., Bihar, West Bengal, Orrisa and M.P. Bael tree is regarded as a sacred tree. Bael fruit is a sub-tropical, deciduous tree and fruit is globuse with grey or yellowish hard woody shell. Inside this, there is soft yellow or orange coloured mucilaginous pulp with numerous seeds. Bael fruit is highly nutritive with a great medicinal use and the richest source of riboflavin. All parts of the trees viz. root, bark, leaves, flowers or fruits are used for curing one or other human ailment. The roots are sweet, astringent, bitter and febrifuge. They are useful in curing dyspepsia, dysentery, diarrhea, vitiated condition of vata, vomiting, cardiopalmus, stomachalgia, intermittent fever, seminal weakness, swelling, uropathy and gastric irritability in infants. The bark decoction for malaria and leaves are useful in opthalmia, deafness, and diabetes and asthmatic complaints. The flowers allay thirst vomiting. The unripe fruits are acrid, astringent, bitter, digestive, sour, stomachia and are useful in dysentery-diarrhea and stomachalgia. The ripe fruits are sweet, aromatic, cooling, febrifuge, laxative, good tonic for heart and brain and cure dyspepsia. Bael has a high tannin content which makes it an effective cure for dysentery and cholera. There is as much as 9% tannin in the pulp of wild fruits, less in the cultivated types and rind contains up to 20%. It contains many vitamins like vitamin C, Vitamin A, thiamine, riboflavin, niacin and minerals like calcium and phosphorus.

8B.16

Antibacterial efficiency of *Momordica charantia*

Arti Heer[1], Vikas Sharma[2], Sahil Gupta[3] and Madhulika Bhagat[4]
[1,2]*Division of Biochemistry, Faculty of Basic Sciences, SKUAST-Jammu, Chatha,*
[3,4]*School of Biotechnology, University of Jammu, Baba Saheb Ambedkar Road, Jammu-180006, India*
aartee08@gmail.com

Indigenous plants are the first source of therapy for most of the common ailments because of availability, economic status of the users and incidence of resistant. Multiple drug resistance has been developed due to the indiscriminate use of commercial antimicrobial drugs. Antibiotics are associated with adverse effects on the host including hypersensitivity, immune-suppression and allergic reactions. In view of the alarming situation of antibiotic resistance in bacteria of medical importance, there is a constant need for new and effective therapeutic agents. Moreover, there are several reports on the antimicrobial activity of different herbal extracts in different regions of the world. *Momordica charantia,* a medicinal plant belonging to the family cucurbitaceae is found in tropical and subtropical regions of the world (India, Asia, South America) and widely used as food and medicine. Commonly known as bitter gourd or karela, the plant contains an array of biologically active chemicals including triterpens, proteins, steroids, alkaloids, saponins, flavonoids and acids due to which it possesses anti-fungal, anti-bacterial, anti-parasitic, anti-viral, anti-fertility and anti-carcinogenic properties. In the present research work, antibacterial potential of bitter gourd was evaluated against *Bacillus subtilis* (MTCC2389), *Staphylococcus aureus* (MTCC7443), *Escherichia coli* (MTCC2127), *Klebsiella pneumonia* (MTCC7162) and *Micrococcus luteus* (MTCC4821) *via* agar well diffusion method. Chloramphenicol was used as a positive reference and DMSO as a negative control. The minimum inhibitory concentration (MIC) was determined using broth micro dilution method (ranging from 62.5-2000 μg/mL). Results revealed that methanolic extract of *M. charantia* has potential to inhibit some pathogenic bacteria as it showed remarkable zone of inhibition against *M. luteus* (17.3±0.31 mm) followed by *B. subtilis* (17±0.32 mm), *S. aureus* (17±0.31 mm), *E. coli* (16.3±0.39 mm) and *K. pneumoniae* (16±0.42 mm). The present study showed that fruit part of *M. charantia* has a potency to act as a antimicrobial agent and isolation of active ingredient (responsible for the observed activity) is required.

Key words: *Momordica charantia,* karela, antibacterial, agar well-diffusion method

8B.17

Antimicrobial activities of endophytic microflora isolated from *Digitalis purpurea*

Hemshiveta Pandita, Brajeshwar Singh, Diksha Raina, Akanksha Rathore and Sneahpreet Kour
Division of Microbiology, Faculty of Basic Sciences, SKUAST-Jammu
brajeshbhau@yahoo.co.in

Several endophytes which have been reported having medicinal properties Majority of natural products produced by endophytic microorganisms showing antimicrobial activity can protect the host plant against phytopathogens and can be used for drug development Microorganisms constitute

world's largest reservoir of bioactive substance and their biodiversity are crucial in the functioning of terrestrial eco-system. The term "endophytes" includes a family of microorganisms that grow intra- and/or intercellular in the tissues of higher plants without causing over symptoms on the plants in which they live. Endophytes provide a broad variety of bioactive secondary metabolites Such bioactive metabolites find wide-ranging application as agrochemicals, antibiotics, immuno-suppressant, anti-parasitic, antioxidants, and anticancer agents. Endophytes are rich sources of natural compounds, showing a variety of pharmacological and biological activities. Endophytes are rich sources of bioactive metabolites, which have important potentials in medicine, agriculture and industries. The production of secondary metabolites from endophytes is associated with environmental factors. *Digitalis purpurea* had been used for dropsy, and pulmonary consumption. Hahnemann used it around 1803. Practitioners of prevalent system of medicines used it for various purposes as like beautification, poison arrow (BC 1500), arrhythmia and many other diseases. It has been used, in varying concentration/ dilution by practitioners of different systems of medicine with paradigmatic differences to treat the patients for clinical conditions expressed in contrary to each other. Digoxin, the purified derivative of it is used in modern medicine to treat patients with increased cardiac rate. On the contrary in homeopathic system *Digitalis purpurea* is used in ultra-dilution to treat patients with decreased cardiac rate. They have become a rich source of natural products, which some of them could be used as new drug candidates and agrochemicals. Therefore, it is very important to pay more attention on the studies of biology and chemistry of endophytes from medicinal plants. The present study was envisaged with the objective of Survey and collection of plant samples, Healthy plants were collected along with intact root system. Isolation, characterization and identification of endophytes isolated from plant samples, Evaluation of anti-microbial potential of endophytes isolated from plant samples. Fungal endophytes were characterized and identified on the basis of morphological and cultural characteristics. Bacterial endophytes were characterized and identified by biochemical tests. All the experiments were done in triplicates and were analysed using one way annova. Lypholized test bacteria and fungi were purchased from MTCC (Microbial type culture collection),Institute of Microbial Technology Chandigarh. Combination of comparative TLC and HPLC were applied for rapid qualitative and quantitative analysis of the bacterial cultures. For primary screening, the metabolites obtained were analyzed using Thin Layer Chromatography (TLC) and High Performance Liquid Chromatography (HPLC) to indicate the bioactive novel products

Key words: *Digitalis purpurea*, Lyophilized, Endophyte and secondary metabolites

8B.18

Microbiological and proximate composition of brown rice based weaning food

Awsi Jan, Monika Sood, Julie D. Bandral, Neeraj Gupta, Tsering Norzom and Ambreena Nazir
Division of Food Science and Technology, Faculty of Agriculture, SKUAST-Jammu
awsijan@gmail.com

Weaning foods were formulated using varying amounts of raw materials by considering nutritive and caloric values of each ingredient in order to meet the nutrient requirement of infants. The brown rice, mungbean, apple pulp and walnut flour were blended separately in different ratios with each other alongwith 3 g of skim milk powder. The blended mixtures of weaning foods were packed in aluminium laminates to monitor the changes in proximate composition and microbial composition and were stored for a period of 6 months at ambient temperature (32±2°C). The highest total plate counts of 0.49×10^2(c.f.u/g) was recorded in treatment T_1 (100:0:0:0: BR:MB:APP:WP) followed by 0.42×10^2 (c.f.u/g) in treatment T_2 (85:5:5:5: BR:MB:APP:WP) and by 0.36×10^2 (c.f.u/g) was in treatment T_3 (80:10:5:5: BR:MB:APP:WP) and the lowest of 0.14×10^2 (c.f.u/g) was recorded in treatment T_7 (60:30:5:5: BR:MB:APP:WP) but within the safe limits (not more than 10,000/g) as per legal standards for cereal Formulations were close compared to the standard specifications and hence have good potential for use as weaning foods. based weaning foods. The results for proximate composition indicated that the moisture content of the weaning food varied from 8.27 to 8.07 per cent, crude

protein from 8.65 to 13.35 per cent, crude fat 2.87 to 5.25 per cent, crude fibre 1.17 to 2.24 per cent, ash 1.73 to 2.24, carbohydrates from 78.48 to 71.09 per cent and energy from 374.55 to 383.01 Kcal.

8B.19

Effect of active packaging on microbial and chemical characteristics of stored peach fruits

Aadil Afzal Mir, Monika Sood, Neeraj Gupta, Julie D. Bandral and Anju Bhat
Division of Food Science and Technology, Faculty of Agriculture, SKUAST-Jammu, Chatha, Jammu-180009 (J&K)
monikasoodpht@gmail.com

Peaches are climacteric fruits with short post-harvest life due to its high moisture content and relatively high metabolic activity during post-harvest phase. Therefore, the present study was carried out to find out the effect of active packaging and different levels of ventilation on quality of peach fruits under refrigerated storage conditions. Peach (*Prunus persica* L. Batch) fruits of cultivar "Shan-e- Punjab" were harvested at colour break stage and packed in thermocol trays wrapped with polypropylene (PP) and low density polyethylene (LDPE) bags comprising the following treatments: T_1 (control), T_2 (ethylene absorber + 0 perforation), T_3 (ethylene absorber + 4 perforations), T_4 (ethylene absorber + 8 perforations), T_5 (oxygen absorber + 0 perforation), T_6 (oxygen absorber + 4 perforations), T_7 (oxygen absorber + 8 perforations), respectively. The packed fruits were stored under refrigerated conditions and analysed at regular interval of 7 days to ascertain the changes occurring in chemical and microbiological quality parameters. Initially no microbial growth was observed in both the packaging materials upto 7 days whereas, after 28 days of storage highest mean microbial count of 4.29×10^4 and 5.00×10^4 CFU/g were recorded in treatment T_1 (control) in PP and LDPE, respectively. In case of both packaging materials (PP & LDPE), minimum mean decay percentage of 1.83 and 2.62 per cent and specific gravity of 0.959 and 0.951 were observed in T_3 (ethylene absorber + 4 perforations). T_1 (control) recorded minimum mean antioxidant activity of 16.98 and 16.87 per cent in PP and LDPE, respectively. However, T_3 (ethylene absorber + 4 perforations) recorded maximum mean total phenol content of 61.52 and 61.36 mg per 100 g in PP and LDPE, respectively. Overall, T_3 (ethylene absorber + 4 perforations) was best suited active packaging to retain quality as well as reduce the spoilage of peach fruits during storage under refrigerated conditions.

8B.20

Microbiological and physico-chemical composition of minimally processed carrots *(Daucus carota)*

Sahil Sharma, Julie Dogra Bandral, Neeraj Gupta, Monika Sood and Anju Bhat
Division of Food Science and Technology, SKUAST-Jammu, Main Campus, Chatha, Jammu- 180009
jdbandral@gmail.com

Fruits and vegetables are highly perishable agricultural commodities with high nutritional values and some are seasonal. Edible films and coatings can extend the shelf life and improve the quality of fruits and vegetables by creating a modified atmosphere inside packaging system. The peeled carrots were coated with carboxy methyl cellulose and sucrose (1, 2 and 3 per cent), surface dried and packed in polypropylene bags and trays wrapped with shrink wrap films and stored in refrigerated conditions. During storage, rotting index showed an increasing trend and T_1 (control) recorded the maximum rotting index of 4.80 per cent in polypropylene bags and 4.58 per cent in shrink wrap after 14 days of refrigerated storage. The reducing sugar content of minimally processed carrot decreased with advancement in storage period and the highest value was recorded by treatment T_1 (control), whereas T_4 (3% CMC) recorded the lowest value. On comparing the packaging, the reducing sugars were higher in shrink wrap packed minimally processed carrots. There was a significant increase in pH value of minimally processed of carrot with application of edible coatings and advancement in storage

period. The treatment T_4 (3% CMC) recorded highest pH value of 6.32 in polypropylene bags and 6.30 in shrink wrap after 7 days of storage. A significant increase in total plate count was noticed during refrigerated storage of minimally processed carrots and highest values were observed in T_1 (control). Minimally processed carrots packed in shrink wrap had lower total plate count than those packed in polypropylene bags. Overall T_3 (2% CMC) had lower rotting index, better retention of antioxidant activity and lower total plate count in shrink wrap packed minimally processed carrots.

Key words: carrot, minimal processing, carboxy methyl cellulose, sucrose, total phenol

8B.21

Beneficial agroforestry tree: Neem

Lalit Upadhyay, S.K. Gupta, Rajkumar and Arvinder Kumar
SKUAST- Jammu

The Neem tree has many uses in traditional medicine, hygiene and as a source of natural insecticide. Neem oil concentrate is available at many specialized lawn and garden stores under the names “Neem Oil”, “BioNeem” and others. Neem oil is extracted from the nut of the neem tree (*Azadirachta indica*). Neem oil insecticides exhibit very low mammalian toxicity and have many uses for control of pests of food crops as well as on landscape and greenhouse ornamental pests. Neem oil insecticides stop insect feeding and interfere with their normal development. The active insecticidal component of neem oil is a chemical called Azadirachtin. The oil is harvested from the trees’ seeds and leaves. Neem has been used as natural pesticide for hundreds of years. Neem oil, is biodegradable and non-toxic. It’s safe for birds, pets, fish, livestock or other area wildlife when used. While traditional chemical pesticides can harm earthworms, neem oil has the opposite effect by encouraging earthworm activity. Neem oil can be used as a dormant oil spray to control a number of insects, including: Tent caterpillars, leaf rollers and other caterpillar eggs that remain on plant leaves during winter, Aphids that cause leaf curling the following spring, Mites that overwinter on plant leaves, Scale insects. Neem oil can also be use as foliar spray during the growing season to control common pests, such as: Aphids, Spider mites, Whiteflies, Leafhoppers etc.

8B.22

Exploring endophytic wealth of Himalayas for the benefit of mankind

Brajeshwar Singh, Hemshiveta Pandita, Diksha Raina, Akanksha Rathore and Sneahpreet Kour
Division of Microbiology, Faculty of Basic Sciences, SKUAST-Jammu
brajeshbhau@yahoo.co.in

Himalayan region with its wide range of altitudes, topography and climatic conditions, is rich in medicinal wealth repository, occupying an important place in Vedic treatise. The locals extensively use about 800 valuable medicinal species found in this part of India since time immemorial for curing various human diseases. Medicinal plants sector possesses great potential to uplift the economy of India, however, various developmental and anthropogenic pressures on the forests, unscrupulous/ unscientific exploitation of medicinal plants in the wake of their increasing national and a global trade demand have caused severe depletion of the medicinal plants resource base thereby affecting the health and livelihood options of the people. It has been estimated that the Himalayan region harbours over 10,000 species of medicinal and aromatic plants, supporting the livelihoods of about 600 million people living in the area. High altitude medicinal plants are the first choice of local users as immediate therapy and by pharmaceutical companies as precious ingredients. India has a highly developed herbal and pharmaceutical products manufacturing industry, and China is a growing manufacturing centre for products such as taxanes (derived from *Taxus* spp). Microorganisms constitute world's largest reservoir of bioactive substance and their biodiversity are crucial in the functioning of terrestrial eco-system. There are several endophytes having medicinal properties and such medicinal plants have microbial association with several medicinal plants. The term "**endophytes**" includes a family of microorganisms that grow intra-and/or intercellular in the tissues of higher plants without causing over symptoms on the plants in which they live. These microorganisms represent a potential source of novel natural products for medicinal, agricultural and industrial uses, such as antibiotics, anticancer agents, biological control agents, and other bioactive compounds Endophytes provide a broad variety of bioactive secondary metabolites with unique structure, including alkaloids, benzopyranones, flavonoids, phenolic acids, quinones, steroids, terpenoids, tetralones, xanthones, and others (Tan and Zou, 2001). Such bioactive metabolites find wide-ranging application as agrochemicals, antibiotics, immunosuppressants, anti-parasitics, antioxidants, and anticancer agents (Strobel, 2003). Endophytes are the rich sources of natural compounds, showing a variety of pharmacological and biological activities.

Key words: Endophyte, Himalayas, Bioactive and metabolites

8B.23

Microbiological and proximate composition of Bottle gourd and Strawberry blended toffee

Tsering Norzom, Julie Dogra Bandral, Monika Sood and Neeraj Gupta
Division of Food Science and Technology, Faculty of Agriculture, SKUAST-Jammu, Chatha, Jammu- 180009
jdbandral@gmail.com

Lagenaria siceraria currently known as bottle gourd, *lauki* or *ghiya* is placed high in diet due to high amounts of vitamin, minerals and antioxidant. It also has potential medicinal properties to treat many diseases like ulcer, hepatic disease and cardiac disorder and is one of favourite vegetables among all consumers during summer season due to its cooling effect and various bioactive compounds. Strawberries (*Fragaria × ananassa*) have delicious flavour, texture, colour and the red colour is due to presence of antioxidant and anthocyanin. In the present study, the bottle gourd and strawberry pulp was blended in different ratios for preparation of toffee. The prepared toffee was analysed for physico-chemical, microbiological and sensory quality. The highest moisture, fibre and ash content of 14.27 per cent, 3.16 per cent and 0.69 per cent were observed in T_{11} (0:100:: Bottle gourd: Strawberry) and lowest was recorded in T_1 (100:0:: Bottle gourd: Strawberry). Highest TSS (80.88%), acidity (1.25%) and ascorbic acid (80.88%) were recorded in T_{11} (0:100:: Bottle gourd: Strawberry). Maximum value for total phenol and anthocyanin content was observed in T_{11} (0:100:: Bottle gourd: Strawberry) and as the concentration of strawberry pulp increased, the values also increased. No microbial was found in freshly prepared bottle gourd and strawberry blended toffee. Sensory evaluation of the toffee revealed that treatment T_8 (30:70:: Bottle gourd: Strawberry) was superior with colour, flavour and taste scores of 8.34, 8.29 and 8.23, respectively whereas, the highest chewiness score of 8.53 was observed in T_{11} (0:100:: Bottle gourd: Strawberry). Thus, the high perishable nature of fruits and vegetables can be overcome by converting them into valued added nutritious products thereby extending their shelf life and availability in off season.

8B.24

Climate change adaptation and mitigation strategies for sustainable agriculture

P.K. Rai, Vinod Gupta, R.S. Bandral, J.D. Bandral and Balbir Dhotra
Sher-e-Kashmir University of Agricultural Sciences & Technology- Jammu (J&K)

Agriculture over the years is losing ground to other professions, which are considered more attractive by the younger generation. Decrease in agricultural productivity with climate change and shrinking of land availability is the biggest challenge to feed increasing population. Fast depleting forest cover is a threat to several species of flora and fauna. In the last 20 years, nearly 12,000 sq. km. of forest has disappeared under the government's programmes and much more illegally. To have a natural and ecological balance we need 30% land under forest cover. The challenges before us are daunting. The

future approach shall have to be more sustainable so that while we increase productivity, on one side, we do not degrade the environment and ecology on other side. Climate change is affecting India in a big way and its impacts are many and serious- erratic monsoon, migration of agricultural zones, spread of tropical diseases, sea level rise, change in availability of fresh water, floods, droughts, heat waves, storms, hurricanes etc. Abrupt climate change could make large areas of the country uninhabitable. There is a direct link between the rise in global temperature and damage to eco-systems. About 130 million hectares land is undergoing different levels of degradation, namely water erosion (32.8 M ha), wind erosion (10.8 M ha), desertification (68.1 M ha), salinization (7.0 M ha), water logging (8.5M ha) and nutrient depletion (3.2 M ha). It could have serious repercussions on agricultural productivity, if preventive steps are not taken. Other effects of climate change are more. The key resource conservation-based technologies are the major strategies to mitigate the impact of climate change. The technologies are - in situ moisture conservation, rainwater harvesting and recycling, efficient use of irrigation water, conservation agriculture, energy efficiency in crop production and irrigation and use of poor quality water. Other strategies include characterization of bio-physical and socio-economic resources utilizing GIS and remote sensing; integrated watershed development; developing strategies for improving rainwater use efficiency through rainwater harvesting, storage, and reuse; contingency crop planning to minimize loss of production during drought/ flood years. Integrated Nutrient Management (INM) and Site-Specific Nutrient Management (SSNM) techniques have the potential to mitigate effects of climate change by reducing carbon dioxide emissions and improving crop yield.

8B.25

Impact of climate change on agriculture and food security

P.K. Rai, P. Bakshi, Akash Sharma*, J.D. Bandral and Kiran Kaur***

**ACHR, **Div. of Food Science & Technology, Sher-e-Kashmir University of Agricultural Sciences & Technology- Jammu*

The green, white and blue revolutions gave us food security. But now a days agriculture and food security are among the major casualties of climate change in India The high yielding varieties and new technologies were webbed with chemical farming. Even today we have critical gaps existing in productivity of food grains between technology using farms and traditional farming practices. The chemical farming resulted in the soil degradation, water pollution, soil erosions and salinity. By now, we face land degradation problems in 173 million hectares which is around 53% of cultivated land. Annually we loose 5000 Million Tones of top soil with NPK losses of 5-8 Million tonnes per year. About 70% of our soils are deficit in organic carbon and other micro nutrients. Soil toxicity is increasing due to industrial effluents and the use of chemicals and pesticides. The quality of food is significantly affected by temperature in most crops. An increase in temperature may have significant effect on the quality of fruits, vegetables, aromatic and medicinal plants. The nutritional quality of cereals and pulses may also be moderately affected which, in turn, will have consequences for our nutritional security. There is direct link between the rise in global temperature and damage to eco-system. Research has indeed shown that the decline in grain protein content in cereals could partly be related to increasing CO2 concentrations. In year 2006, Kashmir valley witnessed the most severe summer in three decades. Climate change will have an adverse impact on food security. Food cost will increase as food availability (cereals, livestock products, fish) will decrease. Disadvantaged region and socially and economically backward people will be affected more. Prediction based modeling studies indicate that a 0.5°C rise in winter temperature would reduce wheat yield by 0.45 tonnes per ha. Trends indicate that agricultural productivity will decline upto 25 percent which could be as much as 50 percent in *rainfed* agriculture. Small and marginal farmers with small land holdings will be more vulnerable to climate change. There is need to go for two fold approaches to mitigate the climate stress- firstly by reducing greenhouse gas emission with widespread awareness on this issue and secondly, by adopting necessary measures to mitigate adverse impacts of climate change.

Key words: Climate Change, Food Security, soil

8B.26

Introduction and spread of yellow rust resistant high yielding wheat varieties in Jammu district

Vikas Tandon, Rakesh Sharma and Puneet Choudhary
Krishi Vigyan Kendra, R.S. Pura, SKUAST-Jammu

Wheat (*Triticum aestivum*) is most important food grain crop of Jammu district and is cultivated on an area of 71000 ha. To provide yellow rust resistant varieties and to increase productivity of wheat, Krishi Vigyan Kendra (KVK) Jammu gave a push to its extension activities and laid out on farm trials (OFTs) and frontline demonstrations (FLDs) of high yielding and rust resistance wheat variety HD 2967 during 2013-14 &2014-15. With the efforts of KVK along with department of agriculture, the area under HD 2967 wheat variety increased from 2593 ha to 22,552 ha between 2013-14 and 2015-16. Krishi Vigyan Kendra, Jammu in order to provide basket of newly released yellow rust resistance varieties suitable for Jammu district, conducted on farm trials on wheat varieties namely HD 3086 and WH 1105. In Rabi 2015-16 and 2016-17, KVK Jammu laid OFTs on different locations of Jammu district under irrigated conditions and found that HD 3086 and WH-1105 performed very well in Jammu conditions in terms of yield and no symptoms of yellow rust was reported. The average productivity of HD 3086 and WH 1105 on farmers field was 37.9 and 40.4 q/ha respectively, compared to check (HD 2967) having productivity of 34.8 q/ha. The impact of OFTs of wheat varieties HD 3086 and WH 1105 laid during two years is clearly visible as the farmers have started adopting these varieties. They have also horizontally spread this technology among neighboring farmers by providing seeds of these varieties. For vertical spread of these varieties, the results of the OFTs are being discussed with farmers during training programmes and other extension activities of KVK. The adoption of HD 3086 and WH 1105 wheat varieties by farmers during the Rabi 2016-17 clearly indicated that the farmers are ready to accept the new technology. The farmers found these varieties to be highly productive and had disease resistant qualities. These varieties have also been successfully gown in neighboring states of Punjab & Haryana.
Key words: Wheat, KVK, OFT, Rabi season

8B.27

Climate change and its impact on agriculture industry

Satish K. Sharma, Akash Sharma, Vishal Gupta, M.C. Dwivedi, V.B Singh and Mamta Sharma
Sher-e-Kashmir University of Agricultural Sciences and Technology Jammu, J&K

Climate change, the outcome of Global Warming has now started showing its impact on agriculture industry, which directly affect the food production across the country. In India, majority of the agriculture system is depend on monsoon where low rainfall/ increase in the seasonal temperature reduce the maturity period as well as production/yield of many crops which drastically affects agriculture system. Climate change scenarios include higher temperatures, changes in precipitation, and higher atmospheric CO_2 concentrations which may affect on plant growth, photosynthesis and transpiration rates as well as quality and quantity of grain of crop. Recent studies of experts indicates that the every rise of 1°C temperature possibility of loss of 3 - 5 million tons in wheat production in future throughout the growing period. In agriculture industry, food production systems are extremely sensitive to climate changes like changes in temperature and rainfall, use of inputs such as herbicides, insecticides and continues use of fertilizers and irrigation water (not fresh) which may lead to outbreak of pests and diseases thereby reducing harvest ultimately affecting the food security of the country. The net impact of food security will depend on the exposure and the capacity to recover from global environmental change. Coping with the impact of climate change on food security and production, the agriculture experts will need to act and require careful management of resources like soil, water and biodiversity.

8B.28

Crop diversification: A key for maximizing farm productivity and profitability

Satish K. Sharma, Akash Sharma, Vishal Gupta, M.C. Dwivedi, A.K Singh and S.K Singh
Sher-e-Kashmir University of Agricultural Sciences and Technology Jammu, J&K

Diversification of agriculture refers to shift from the dominance of one crop to production of number of crops to meet over the increasing demand of cereals, pulses, fruits etc. with an aim to improve soil health and dynamic equilibrium of the agro ecosystem. Crop diversification has been recognised as an effective strategy for achieving the objectives of food security, nutritional security, net return, employment generation, sustainable agriculture development and environmental improvement. The opportunities for crop diversification emerge from technological breakthroughs, changes in demand pattern, development of irrigation system, availability of marketing infrastructures and new trade management (Nanher, 2015). Crop diversification is being practiced by farmers since ages, know called as cropping system in which the contribution of any farm enterprise (crop) to total productivity as well as profitability is less than 50 percent. Diversification gives wider choice in the production of variety of crops in a given area so as to expand production related activities on various crops and also to lesser risk. Crop diversification takes into account the economic returns from different value added crops. Diversity Index is the most simple and easy to estimate the diversification of crop as well as field.

8B.29

Screening, isolation, and characterization of bioactive compound isolated from entophytic fungi

Shifali Chib and Saurabh Saran*
Fermentation Technology Division, Indian Institute of Integrative Medicine, Canal Road, Jammu-180001, India
shifalichib21@gmail.com

Endophytes are ubiquitous organism found in the plants, residing intercellular or intracellular, at least for the portion of their lives without causing apparent symptoms of infection and have proven to be rich sources of bioactive natural products. Natural products have been exploited for human use for thousand of years and plants have been the chief source of compounds used for medicine. Medicinal plants have many traditional claims including the treatment of aliments of infections origin. There are nearly 1 million of different endophytes but only a few have been described which opens new horizons for the discovery of new and beneficial bioactives from endophytes. Some of the endophytic microorganisms can produce the same secondary metabolites as that of the plant thus making them a promising source of novel compounds. A total of 40 endophytes were isolated from soil, water and rice bran and were further screened for antimicrobial activity against gram positive and gram negative. Out of 40 endophytes, 22 endophytes showed activity against gram positive pathogens (*Staphyloccous aureus, Bacillus subtilis, Micrococcus luteus, Streptococcus pyogenes, Bacillus cereus*), 10 against gram negative pathogens (*Escherischia coli, Pseudomonas aeroginosa, Klebsiella pneumoniae*). Few of the endophytes like *Aspergillus fumigates*, *A. solanai, Penicillium chrysunum* were grown in complete medium and 3 compounds have been isolated from the fermented broth, out of which 1 have been identified as kojic acid, of the other two compounds is under process.
Key words: Endophytes, Bioactives, *Aspergillus fumigatus, Penicillium chrysunum*

8B.30

Standardization of vermi-composting technology under cold arid condition of Kargil

Nazir Hussain, Nassreen F. Kacho, Mansoor Hussain, Mohd Mehdi and Sabiya Asmat

KVK, Kargil, SKUAST-K, Kargil Ladakh-194103

The present investigations entitled "standardization of vermi-composting technology under cold arid condition of Kargil" were conducted at Krishi Vigyan Kendra Kargil, SKUAST-K for the years 2015. The treatments consisted of combination of two environments replicated three times in Randomized Block Design. Two was kept in the heap above the ground while the other two were kept in pits. Composting materials were same but the covering materials were different. In the present study vermi compost kept in pits that's T4 with double layer of gunny begs over it black alkathene recorded significant increase in worms production that's (21.6 kg) compare to T3, T2 and T1 respectively. Further vermi compost production recorded significant result in treatment T4 (18.3 kg) compare to T3, T2 and T1 respectively. Whereas undecomposed materials recorded highest in treatment T1 (48.6 kg) compare to T2, T3 and T4 like (31.5kg), (42Kg) and(1.1 Kg) respectively. The reason behind reduce undecomposed composting material in T4 is that the survival chance of worms kept in pits over it with gunny begs, wheat straw and black alkathene kept them warm during winter. The pits system covering with first gunny begs over it with black alkathene and wheat straw proved beneficial for boosting the population of worms especially during winter under cold arid condition of Kargil

8B.31

Indigenous technical knowledge of hilly farmers of Rajouri for the management of disease and insect pests in paddy nursery.

Vikas Sharma[1], Deepak Kumar[1], Rajesh Kumar[1], Rohit Sharma[1] and Shahid Ahmad[2]

[1]Regional agricultural research station, Tandwl, Rajouri, 2Directorate of Research, SKUAST -Jammu 180 009
vsagron@gmail.com

The farmers of hilly areas of Rajouri District in Jammu and Kashmir, possess rich cultural heritage and indigenous technical knowledge of hill farming that was inherited through generations. The importance of utilizing valuable ITK under hill conditions was found to be effective in minimizing disease and insect pest which is ecologically sound and economically viable method of management of disease and insect pest in paddy nursery. The farmers of this area use to grow paddy nursery by wet bed method. After field preparation and puddling of the nursery area they use tender leaves of Melia composite locally known as "Draink". It improves the physical condition of soil and reduces the soil borne diseases and insect pests. This practice improves the vigour of seedlings and minimizes the root damage at the time of uprooting.

8B.32

Resistance to post flowering stalk rot (PFSR) in maize of 12 hybrids

Ravinder Singh Sudan and Nisar Ahmad

AICRP Maize Research Station, Udhampur

The complex disease post flowering stalk rot of maize is caused by Fusarium Vrticilliodes, Macrophomina, Phaseolina and Harphora Maydis is widely distributed in India especially northern region causing severe yield loss. In this study we identified disease resistance of 12 maize hybrids viz UDMH-101, UDMH-112, UDMH-114, UDMH-116, UDMH-119, UDMH-120, UDMH-113, UDMH-121, UDMH-115, UDMH-127, UDMH-128 and UDMH-129 to PFSR. The result showed

that no immune or highly resistant germplasm was found. Among the twelve screened hybrids 04 were found moderately resistant. These 04 hybrids viz UDMH-128, UDMH-129, UDMH-115 and UDMH-101 had good performance in grain yield, combining ability and suitable growth period. They could be good donor of disease resistance gene to improve the other maize lines. Thus identifying resistant genes to this important disease and combining them with grain yield is priority of Indian maize programme. The study was designed to identify new sources of resistance to PFSR which can be used in developing resistant cultivars to this disease with a view to mitigate losses in farmers field.

APS TRAVEL AWARDS

1

Integrated management of phomopsis blight of brinjal in Kashmir

Mudasir Bhat, Ali Anwar, M. Najeeb Mughal, Fayaz Mohiddin and Uzma Fayaz
Division of Plant Pathology, SKUAST-Kashmir, 190025
mudasirpatho@gmail.com

Brinjal is also known as eggplant due to the shape of fruits of some varieties which are white and resemble the chicken eggs. In Jammu and Kashmir, it is cultivated over an area of 2.02 thousand hectares with an annual production of 45.24 thousand MT. In Kashmir it is grown as a warm season crop but is susceptible to severe frost. Brinjal is attacked by many fungal, bacterial, viral and nematode diseases of which Phomopsis blight caused by *Phomopsis vexans* is considered to be the most destructive and one of the major constraints of brinjal production. Management of Phomopsis blight of brinjal has mainly been through the use of fungicides. However, fungicide applications are only partially effective under environmental conditions that are favourable for pathogen infection. Furthermore, fungicides alone are not sustainable especially in small holding farming system in Kashmir, due to the high cost and risks to the environment. Keeping the prospects under the economic importance of the crop and amount of destruction by *P. vexans*, field evaluation of soil amendments, seed treatments with bioagents and fungitoxicants and foliar sprays with fungitoxicants during two cropping seasons of 2015 and 2016 were carried out. The results revealed significant disease control by all these treatments in both nursery and in transplanted field. Among all the treatments in nursery, highest seed germination of 94.72 per cent was recorded in soil amendment with vermicompost @ 7q/ha + seed treatment with carbendazim @ 2g/kg seed and the lowest seed germination 73.38 per cent but far better than control was recorded in soil amendment with FYM @ 10q/ha. In controlling damping off and seedling blight in nursery, the performance of the treatments were in similar trend of germination percentage. In transplanted field, the treatment combination viz. vermicompost @ 7q/ha as soil amendment + *T. viride* @ 5 kg/ha as soil amendment + carbendazim 50 WP @ 0.1% as root dip + carbendazim 50 WP @ 0.1% as foliar spray was noted as the best treatment against leaf blight, stem blight and fruit rot showing intensity values of 5.48, 0.95 and 5.63 per cent respectively while the lowest performance against *P. vexans* was recorded in the treatment Soil amendment with vermicompost @ 7q/ha showing intensity values of 19.29, 13.59 and 20.83 per cent respectively. Further, the highest fruit yield of 234.38 q/ha was also recorded in the same treatment combination.

2

Germplasm evaluation and characterization of resistant genes against stripe rust of wheat

Saima Farooq, V. K. Razdan and Vishal Gupta
Division of Plant Pathology, Faculty of Agriculture, SKUAST- Jammu, Chatha

Thirty one wheat germplasm were screened under natural epiphytotic conditions against stripe rust at University Research Farm, Chatha, during *Rabi*, 2014-15. On the basis of final rust severity (FRS), area under rust progress curve (AURPC) and coefficient of infection (CI), eight lines (Raj 4037, Sonara 64, NP 823, HPW 42, K9351, NIAW 301, PBW 12, and HUW 213) exhibited partial resistance to the disease while as on the basis of infection rate (r) six lines (NP 825, HP 1633, K8434, PBW 12, Ajanta and K9533) showed partial resistance to the disease. Field response of these lines against stripe rust showed that 14 genotypes (Sonara 64, Utkalia, NI 5439, NIAW 301, PBW 12, HUW 213, Ajanta, NP 823, K8434, K9533, Sharbati Sonara, Raj 4037, HP 1633, HPW 42 and K9351) were moderately resistant, 16 (Tawa, KRL, RW 346, HD 2643, HS 1097, NP 825, WH 291, HUW 12, PBW 226, NI 179, NI 5439, K9644, HD1925, PBW 65, PV 18 and GW 503) were moderately susceptible and one genotype (Agra Local) was susceptible. Assessment of losses was also calculated at different growth stages and it was observed that losses at flowering stage and dough stage were highest in one line (Agra Local). Nineteen wheat germplasm lines (Sonara 64, K9351, HP 1633, Raj 4037, Sharbati Sonara, K9533, K8434, NP 823 and Ajanta) amplifying a band of 523 bp fragment indicating presence of *Yr18* gene.

Keywords: Stripe rust, Severity, Allele specific marker, *Yr18*, FRS, AURPC, CI, r, *Cssfr2*

3

In vitro evaluation of fungicides against *Alternaria alternata* causing foliar blight of turmeric

Sajad Ahmed Azad, Deepak Kumar and V.K. Razdan
Division of Plant Pathology, SKUAST-Jammu.
sheikhsajadahmedazad19@gmail.com

In order to find out the effective fungicides against *Alternaria alternata* causing foliar blight of turmeric, five fungicides viz; mancozeb, carbendazim, copper oxychloride, hexaconazole and propiconazole, at half of the recommended dose and recommended dose of chemicals were evaluated under *in vitro* conditions, which revealed that all the fungicides significantly inhibited the growth of the pathogen over control. In case of half dose hexaconazole showed maximum inhibition over control (87.62 %) with colony diameter of 5.32 mm on 4th day and (88.41%) per cent inhibition with colony diameter 10.43 mm on 8th day. This was followed by propiconazole, which caused 84.88 per cent inhibition with colony diameter of 6.50 mm on 4th day and 86.25 per cent inhibition and colony diameter of 12.37 mm on 8th day. Among group of traditional fungicides mancozeb showed inhibition (75.58%) with colony growth i.e., 10.50 mm on 4th day and 74.63 per cent inhibition with 22.83 mm colony growth on 8th day. Carbendazim showed the least effectiveness against the pathogen with 48.09 per cent inhibition and 22.32 mm colony diameter on 4th day and 53.0 per cent inhibition and 42.30 mm colony diameter. In case of recommended dose (100 ppm) the hexaconazole showed the maximum inhibion of 88.37 over control with the colony diameter of 5.13 mm on 4th day and (88.44%) inhibition with 10.40 mm colony growth which was statistically at par with the Propiconazole showing the inhibition of (87.90%) with 5.20 mm colony growth on 4th day and (88.32%) with 10.53 mm colony diameter on 8th day. Among older group of fungicides mancozeb showed maximum efficacy and carbendazim showed least effectiveness against the pathogen.

4

Influence of bio-inoculants on yield and quality characters of *Agaricus bitorquis* (Quel.) sacc. under Kashmir conditions

Varsha Bharti[1] , Kamran Ahmad Khan[1] and Shahida Ibrahim[2]
1Division of Plant Pathology 2 Division of entomology Sher -e- Kashmir University of Agricultural Sciences and Technology Chatha, Jammu
varshapatho@gmail.com

The study was conducted under Kashmir conditions. Bio-inoculants viz., *Pseudomonas fluorescens, Azatobactor* sp., *Azospirillium* sp (0.5,1.0, and 2.0%) and carbendazim @0.05% (control) were mixed separately with casing mixture at the time of casing. There was a significant difference between supplemented and non supplemented substrates. The substrate supplemented at the time of casing with *Pseudomonas fluorescens* 2.0 % gave highest yield (16.18 kg /q) as compared to control. The lowest yield (13.05kg/q) was recorded in the case of Carbendazim 0.05% (control). However no significant difference was observed in the quality indices including fruit weight length of stipe and diameter of pileus of summer white button mushroom when adding bio-inoculants to the substrate.
Keywords: *Agaricus bitorquis*, Bio-inoculants, Quality, Summer white button mushroom and Yield.

For Narshiman Award Contest

1

Studies on *Cylindrosporium padi (Lib.) P. Karst. Ex Sacc* an incitant of Blumeriella leaf Spot (BLS) Disease in Kashmir valley

Kamran Ahmed Khan[1], Nissar A Khan[1], Sajad Un Nabi[2] and Owais Bashir[3] and Varsha Bharti[1]
[1]Division of Plant Pathology, SKUAST-K, Shalimar Srinagar, Jammu and Kashmir, 190025,
[2]ICAR-CITH, Srinagar, Jammu and Kashmir, 191132
[3]Division of Soil Science, SKUAST-K, Shalimar Srinagar, Jammu and Kashmir, 190025
kamrankhan1202@gmail.com

Cherries occupy unique position among temperate fruits all over the world and are season's first tree fruit to reach the market, maturing within 60-70 days after full bloom and therefore, fetches premium price. The cherry productivity per unit area is low owing to many biotic and abiotic factors. Among them, Blumeriella leaf spot (BLS) caused by *Cylindrosporium padi (Lib.) P. Karst. Ex Sacc*. has assumed an alarming proportion in the major cherry growing areas and causes huge economic losses through mid-summer pre-mature defoliation upto the extent of 80-90%, which ultimately results in reduced fruit bud survival and fruit set in the following year. In India, particularly in Jammu and Kashmir state, no research work has been done except for a report and hence investigation was undertaken to characterize the pathogen associated, effect of weather parameters on disease development and management of the disease at field level. Survey of cherry orchards in main cherry growing districts viz; Srinagar, Ganderbal and Baramulla revealed disease incidence and intensity ranging from 13.00 to 52.50 per cent and 5.78 to 30.48 per cent, respectively. Symptomatological studies revealed that the disease first appeared as small, circular to irregular, purple red speck on upper leaf surface. Periodic changes in colour, shape and size of the spots coupled with formation of irregular necrotic patches led to pre-mature defoliation. The fungus isolated produced compact and circular greyish white fungal colonies composed of hyaline, thick walled, septate and branched mycelium. Acervuli produced were dark brown to black, circular, discoid and measured 260.50 µm in diameter. Conidia were hyaline, bicelled, elongated, curved or flexous with tapered apex and rounded base. In the present study, it was confirmed that the disease development under field conditions had a positive correlation with average maximum relative humidity and average rainfall during the corresponding periods of disease development suggesting that high humidity and rainfall favours disease development. Fungitoxicants, both systemic and non-systemic evaluated under natural field conditions for their comparative efficacy against the disease, showed that systemic fungicides were significantly superior to non-systemic fungicides in managing the disease. Difenaconazole 25 EC (0.03%) Tebuconazole 25.9 EC (0.05%), Dodine 65 WP (0.06%), Copper oxychloride 50 WP (0.30%), Captan 50 WP (0.30%) can be effectively used for management of the disease. The future prospects are molecular characterisation, identification of resistance source and host-pathogen interaction under temperate conditions.

2

In vitro evaluation of fungicides against *Alternaria alternata* causing foliar blight of turmeric

Sajad Ahmed Azad, Deepak Kumar and V.K. Razdan
Division of Plant Pathology, SKUAST-Jammu.
sheikhsajadahmedazad19@gmail.com

In order to find out the effective fungicides against *Alternaria alternata* causing foliar blight of turmeric, five fungicides viz; mancozeb, carbendazim, copper oxychloride, hexaconazole and propiconazole, at half of the recommended dose and recommended dose of chemicals were evaluated under *in vitro* conditions, which revealed that all the fungicides significantly inhibited the growth of

the pathogen over control. In case of half dose hexaconazole showed maximum inhibition over control (87.62 %) with colony diameter of 5.32 mm on 4th day and (88.41%) per cent inhibition with colony diameter 10.43 mm on 8th day. This was followed by propiconazole, which caused 84.88 per cent inhibition with colony diameter of 6.50 mm on 4th day and 86.25 per cent inhibition and colony diameter of 12.37 mm on 8th day. Among group of traditional fungicides mancozeb showed inhibition (75.58%) with colony growth i.e., 10.50 mm on 4th day and 74.63 per cent inhibition with 22.83 mm colony growth on 8th day. Carbendazim showed the least effectiveness against the pathogen with 48.09 per cent inhibition and 22.32 mm colony diameter on 4th day and 53.0 per cent inhibition and 42.30 mm colony diameter. In case of recommended dose (100 ppm) the hexaconazole showed the maximum inhibion of 88.37 over control with the colony diameter of 5.13 mm on 4th day and (88.44%) inhibition with 10.40 mm colony growth which was statistically at par with the Propiconazole showing the inhibition of (87.90%) with 5.20 mm colony growth on 4th day and (88.32%) with 10.53 mm colony diameter on 8th day. Among older group of fungicides mancozeb showed maximum efficacy and carbendazim showed least effectiveness against the pathogen.

3

Impact of weather factors in the development of Phomopsis blight of Brinjal in Kashmir

Mudasir Bhat, Ali Anwar, M. Najeeb Mughal, Fayaz Mohiddin, Arif Hussain and Uzma Fayaz
Division of Plant Pathology, SKUAST-Kashmir, 190025
mudasirpatho@gmail.com

Phomopsis vexans causes leaf blight of brinjal and is one of the major constraints in the cultivation of the crop. Climate not only affects the crop but also affect the pathogens that decrease the crop yield. Due to industrial emissions, concentration of CO_2 and temperature would increase leading the world towards global climate change. The effect of weather parameters *viz*. temperature, relative humidity and rainfall on the development of Phomopsis blight of brinjal was therefore investigated under prevailing environmental conditions on susceptible cultivar Pusa Purple Long during 2015 and 2016. The data regarding per cent disease intensity was recorded at fifteen days intervals from May-October. Data obtained was correlated with the mean maximum and minimum temperature, mean maximum and minimum relative humidity and mean rainfall during the corresponding period. The data revealed that in 2015 the disease initiated under field conditions in the second week of June on leaves and last week of June on twigs. The per cent disease intensity increased slowly and reached as high as 59.48 and 39.97 on leaves and twigs respectively, during the last week of October. However, on fruits the disease symptoms were first observed during last week of July when the mean atmospheric temperature both maximum and minimum were 29.03°C and 17.84°C, respectively and mean relative humidity both maximum and minimum were 86.73 and 65.60 per cent, respectively and reached as high as 60.90 per cent in the last week of October. The maximum rate of disease progress (0.0722, 0.0779 and 0.0712) was observed during the second week of August, last week of August and second week of September on leaves, twigs and fruits, respectively which coincided with the favourable temperature and relative humidity for its progress. The minimum infection rate of 0.0058, 0.0066 and 0.0053 was recorded in the last week of October when the maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and rainfall during the previous week were 18.03, 6.53, 89.13, 67.73 and 5.93, respectively. Epidemiological studies further revealed that the relationship between disease intensity on leaves and weather factors indicated significant positive correlation with maximum relative humidity, significant negative correlation with maximum temperature, minimum temperature and minimum relative humidity while as it showed non-significant positive correlation with rainfall. In case of stem blight, the relationship showed positive and significant correlation with minimum temperature and maximum relative humidity, significant and negative correlation with maximum temperature and minimum relative humidity and non-significant negative correlation with rainfall. For fruit rot, the relationship indicated significant and negative correlation with maximum temperature, minimum temperature and minimum relative humidity, significant and positive correlation with maximum relative humidity and non-significant but positive correlation with rainfall.

4

Characterization of *Uromyces appendiculatus* races and identification of French bean lines with slow rusting components in Himachal Pradesh

Gurvinder Singh[*1], S.K. Gupta[1], Banita Devi[1], S.C. Bhardwaj[2], Pramod Prasad[2] and Hangwani Muedi[3]

[1]*Department of Plant Pathology, YSP University of Horticulture & Forestry, Nauni, Solan-173 230 (H.P.)*
[2]*Indian Institute of Wheat and Barley Research, Regional Station Flowerdale, Shimla-171 002 (H.P.)*
[3]*Agricultural Research Council- Grain Crops Institute, Potchefstroom-2520, South Africa*
gurvinders50@yahoo.com

Rust (*Uromyces appendiculatus* (Pers.) Unger) is one of the most devastating diseases of French bean (*Phaseolus vulgaris* L.) occurring worldwide and its pathogen is highly variable. The present studies were carried out with the objective to characterize *U. apeendiculatus* races occurring in Himachal Pradesh and to identify different cvs./lines with slow rusting components. Systematic surveys of French bean growing areas of five districts of the State viz., Solan, Shimla, Sirmour, Kullu and Mandi were conducted and leaf tissues with rust pustules were collected. Ten single pustule isolates were raised and maintained on highly susceptible Cv. Falguni. The associated pathogen on the basis of urediniospore characteristics, standard keys and ITS was identified as *Uromyces appendiculatus* (Pers.) Unger. Ten single pustule isolates were then inoculated on 12 bean rust International Differential Set obtained from South Africa. According to new International classification system and the binary nomenclature, these 10 isolates were grouped into 5 different races, most of which affected the Andean gene pool. Sixty six different germplasm lines/cvs./local selections were screened against the disease under natural epiphytotic conditions and out of which 39, 5 and 11 were found highly resistant, resistant to moderately resistant and susceptible to highly susceptible, respectively. These cvs./lines were further evaluated under artificial inoculation conditions and 29, 6 and 26 were found highly resistant, resistant to moderately resistant and susceptible to highly susceptible, respectively. Slow rusting is a kind of resistance that appears to be race non-specific and more durable than major gene resistance. Studies were, therefore, conducted to determine if any slow rusting components like incubation period, latent period, uredia size and number of uredia/cm^2 exist among different cvs./lines having varied degree of resistance/ susceptibility to the pathogen. Only five lines viz., EC-755318, EC-400442, EC-400406, EC-400390 and EC-405210 demonstrated slow rusting characteristics like longer latent period, much smaller uredia, few uredia/cm^2 than highly susceptible cv. Falguni. However, line EC-400411had only small size uredia.

LATE ARRIVAL: THEME AREA: ORGANIC FARMING

1

Organic Vegetable Seed Production Programme: An Emerging Enterprise

Satesh Kumar, Manoj Kumar, Sandeep Chopra and Sheetal Dogra
Division of Vegetable Science and Floriculture, SKUAST-Jammu
Email: sks.vegetable @gmail.com

It is well recognized that organic agriculture is a holistic approach to promote and sustain agro-ecosystem, health, biodiversity, biological cycles and soil biological activity. In general, organic farming hinges on extensive use of naturally available resources, preferably on-farm inputs to enhance soil fertility, in contrast to chemical fertilizers. The concept of organic farming is not new to Indian farming community. Several forms of organic farming are being successfully practiced in diverse agro-climatic situations, particularly in rain-fed, tribal and hill areas of the country. In rain-fed and semiarid condition, it has been demonstrated that the productivity with organic farming is comparable to conventional agriculture. Today in India over 3.5 million hectares are brought under organic cultivation in contrast to 40 million hectares in the world. While strongly advocating organic farming in the State of Jammu and Kashmir for food items like fruits cereal crops and pulse crops, the concept equally suits to grow vegetables crops. The most compelling reason for using organic seed is that seed produced organically causes less chemical impact on the environment, thereby minimizing the amount of “upstream pollution” Also, there is the important goal of developing crop varieties that are adapted to the organic farming system and the most important input required is the organic seed itself. All these reasons are important in developing an organic seed programme in vegetable crops which would be helpful to students, research workers and other entrepreneurs.

THEME AREA: SOIL ECOLOGY

2

Sustainable vegetable production through nutrient management approaches

Manoj Kumar, Satesh Kumar,Sandeep Chopra and Balbir Dhotra*
Division of Vegetable Science and Floriculture, SKUAST-Jammu
**ACHR,Udheywalla,SKUAST-Jammu*
Corresponding author: manojrajouri @yahoo.com

Since independence, India has emerged as a leading vegetable producing country and ranks 2nd in the world after china. The total vegetable production in the country has increased from 63.8mn tonnes in 1993 to 191.0mn tonnes in 2016-17.However the national average productivity of different vegetable crops is much below the potential productivity. One of the key reasons for low productivity of most of the vegetable crops in the country might be non adoption of appropriate production technologies, inefficient nutrient management. The imbalanced and indiscriminate use of chemical fertilizers coupled with negligible application of organic manures have resulted into multi-nutrient deficiencies, deteriorated soil physical, chemical and biological properties and created environmental pollution. Under such situation, integrated nutrient management (INM) practice is emerging as one of the best technologies in the recent years. It not only nourishes vegetable crops with all essential nutrients but also increase production, sustains crop productivity and enriches the soil fertility. In the state of J&K, where majority of the soils are inapproachable and un-accessible, vegetable cultivation using integrated nutrient means is the only way to move forward. Environmental pollution and cost escalation of inputs force the farming community to embrace environmental friendly approaches to sustain crop productivity. Adoption of such an integrated nutrient management approach will benefit the farmers in following ways:

- Better utilization of farm resources like FYM and compost.
- Improvement in soil organic matter content leading to better soil health
- Saving of input costs
- Higher income generation through improved yield and better quality of the produce
- Improved efficiency of applied nutrients
- Reduce soil –water and environmental pollution

THEME: DISEASE MANAGEMENT

3

Effects of planting dates and spacing on disease incidence of Alternaria blight in African marigold (*Tagetes erecta* L.)

Lakshmi, Rajesh K. Pandey, Sheetal Dogra, Nomita Laishram, Deepji Bhat, Arvinder Singh and Shivani Jamwal

Department of Vegetable Science and Floriculture,SKUAST-Jammu
Corresponding author: drkp74@gmail.com

The investigation was carried out to study the effect of different planting dates and spacing on alternaria blight of African marigold cv. ‘Pusa Narangi Gainda’. The treatments comprised of four planting dates, *viz*., 1st September (D1), 1st October (D2), 1st November (D3) and 1st December (D4) and three plant spacings, *viz.*, 40×20 cm (S1), 40×40 cm (S2) and 40×60 cm (S3). The experiment was laid out in Factorial Randomized Block Design with twelve treatment combinations replicated thrice. Among different planting dates, maximum disease incidence (52.17 %) was observed in 1st December planting, while minimum disease incidence (9.48 %) was obtained in 1st September planting. As regards the effect of spacing, more disease incidence (29.75 %) occurred at closer spacing of 40×20 cm as compared to the lesser disease incidence (23.06 %) recorded with wider spacing of 40×60 cm. With regards to interaction effects, maximum disease incidence (60.50 %) was observed in 1st December planting with closer spacing of 40×20 cm.

AUTHOR INDEX

A

B

C

K

L

M

N

P

Q

R

S

T

U

V

W

Y

Z

Notes

Notes

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu