INTRODUCTION

The Department of Plant Pathology has the mandate for teaching, research and extension education pertaining to plant diseases and mushrooms. The students admitted to M.Sc. and Ph.D. programmes are assigned research problems on different aspects of diseases of field and vegetable crops including mushrooms.

The research work in various projects is being carried out in the main department at Palampur and at Hill Agriculture Research and Extension Centre (Bajaura, Dhaulakuan and Kukumseri), Mountain Agriculture Research and Extension Centre (Sangla), Shivalik Agriculture Research and Extension Centre (Kangra), Rice Wheat Research Station (Malan) and research stations (Berthin, Akhrot and Lari). Research on wheat diseases is being carried out at Malan, Dhaulakuan and Bajaura, on rice diseases, is exclusively carried out at Malan and that on maize diseases at Bajaura and Dhaulakuan, whereas the research on diseases of pulses is being carried out at Palampur, Sangla, Berthin and Dhaulakuan and on oilseed crops at Kangra. Among the diseases of vegetable crops, bacterial wilt and fruit rots of solanaceous crops, powdery mildew, white rot and root rot/wilt complex disease of peas, fungal, bacterial and viral diseases of french bean and Phomopsis leaf blight and fruit rot of brinjal receive special attention.

The department also carries out research on different aspects of mushroom cultivation. The spawn laboratory at present is meeting the demand of Horticulture department and private mushroom growers. Teachers/scientists/students of the department are actively participating in the various seminars and symposia conducted by different scientific societies from time to time.

Several ad-hoc research projects are being carried out in the department with financial support from the Govt of Himachal Pradesh, ICAR, CSIR, DST, DBT and fungicide companies.

The department is engaged in extension education activities such as advisory service to farmers for diagnosis and control of diseases and participation in district/state level workshops/seminars. The scientists of the department are also actively involved in training and disseminating mushroom cultivation technology to the mushroom growers.

STAFF POSITION

TEACHING	
Professor/Senior Scientist	Dr. A. K .Sood (retired on 31.03.10)
	Dr. C.L Bhardwaj (w.e.f 8.3.10)
	Dr. K.S Rana (w.e.f. 31.3.10)
	Dr. B .M. Sharma
	Dr. P. N. Sharma
RESEARCH	
Palampur Campus	
Professor & Head	Dr. R. P. Kaushal
	Dr. A. S. Kapoor
Sr. Plant Pathologist	Dr. S. Dhancholia (w.e.f. 9.3.10)
Scientist	Dr. B. R. Thakur
	Dr. D. K. Banyal
Hill Agricultural Research & Extension Centre, Bajaura	
Scientist	Vacant
Assistant Scientist	Dr. R .K Devlash
Hill Agricultural Research & Extension Centre, Dhaulakuan	
Sr. Plant Pathologist	Dr.A. K. Basandrai
	Dr. Dhanbir Singh
	Dr. Akhilesh Singh
Hill Agricultural Research & Extension Centre, Kukumseri	
Sr. Plant Pathologist	Dr. S. Dhancholia (up to. 8.3.10)
Shivalik Agricultural Research & Extension Centre, Kangra	
Sr. Scientist	Dr. Ashok Kumar
Rice and Wheat Research Station, Malan	
Sr. Scientist (wheat pathology)	Dr. S. K. Rana
Rice Pathologist	Dr. Sachin Upmanyu
	Assistant Scientist (adjusted against the post of Rice Pathologist)
Mountain Agricultural Research & Extension Centre Sangla (Kinnaur)	
Assistant Scientist	Dr S K Sharma
Research Sub-Station, Berthin	
Sr. Scientist	Dr. C. L. Bhardwaj (up to l7.3.10)
Research Sub-Station, Salooni (Chamba)	
Assistant Scientist	Vacant
Research Sub-Station, Lari (Spiti)	
Assistant Scientist	Vacant
EXTENSION EDUCATION	
Sr. Extension Specialist	Dr. K. S. Rana (DEE, Palampur till 30.3.10)
Sr. Scientist	Dr. A. Singh (KVK, Bara)
	Dr. V.K. Rathi (KVK, Dhaulakuan)
Scientist	Dr. B. K.Sharma (KVK, Una)
	Dr. A. K. Sud (KVK, Kangra)
Asst Ext. Specialist	Dr. Suman Kumar (DEE, Palampur)
	Dr. Amar Singh (KVK, Mandi)
	Dr. Pardeep Kumar(KVK, Kukumseri)
	Dr. Deepika Sood (KVK, Berthin)

FINANCIAL OUTLAY AND STAFF POSITION IN DIFFERENT SCHEMES OF THE DEPARTMENT 1.7.09 TO 30.6.2010

Name of the Scheme	**Budget allocation (Lac Rs.)**	**Expenditure (Lac Rs.)**	**Staff**
APL-001-17 "Creation of facilities for PG studies in the Department of Plant Pathology", CSKHPKV, Palampur	42.20	44.70	Dr.A.K.Sood, Sr. Scientist (till 31.3.10) Dr. Y.S. Paul, Professor (shifted to Deptt. Organic Agriculture) Dr.C.L Bhardwaj Dr.K.S Rana Dr. P.N.Sharma, Professor Smt. Shashi Sharma, Sr. Asstt. Sh.M.S.Nag, Jr.Scale Stenographer Gr.I now Sr. Scale Stenographer (w.e.f. 2.1.10 Sh. Prem Chand, Jr. Technician Sh. Kishori Lal, Lab. Asstt.
APL-010-17 "Facilities for Teaching in the College of Agriculture and creation of facilities for Postgraduate Studies" in Plant Pathology, CSK HPKV, Palampur	22.03	20.1	Dr. B.M.Sharma, Professor Dr. S. Dhancholia Sh. K.S.Katoch,Sr.Asstt. Sh. Swami Ram, Tech. Asstt. Gr.II Sh. Guldev Singh, Jr. Technician Sh. Vijay Kumar, Chowkidar
APL-21-17 "Strengthening of facilities for research of Plant Pathology" CSKHPKV, Palampur	16.43	11.9	Asstt. Scientist (vacant) Sh. Ramesh Kumar, Beldar Sh. Dalip Kumar, Beldar Sh. Hans Raj, Beldar Sh. Desh Raj, Beldar Sh. Madho Ram, Beldar Sh. Rattan Chand, Beldar
APL-59-17 "Facilities for research in the department of Plant Pathology" CSKHPKV, Palampur	16.00	16.5	Dr.R.P.Kaushal, Professor Sh. Ravi Shankar Rana, Jr.Asstt.(up to 17.11.09) Sh. Sunil Kumar Beldar Sh. Hem Raj, Beldar Sh. Kehar Singh, Peon
ICAR-017-17 Pt.-II" All India Coordinated Research Project on Seed Technology Research" under NSP	14.16	14.7	Dr.A.S.Kapoor, Professor Sh. Amar Nath Walia,Sr.Tech.Asstt.Gr.I Sh.Himat Ram, Lab. Asstt.
APL-076-17 Department of Plant Pathology	-	3.00	Sh.Ghanshyam Singh, Lab.Asstt. up to 25.8.09 Sh.Ravi Kumar,Beldar Sh.Sugreev Kumar, Beldar

FINANCIAL OUTLAY OF AD HOC PROJECTS FOR THE YEAR 2009-2010

Scheme No.	Name of the scheme	Allocation	Expenditure	Staff
GOI-417-17	Characterization of variability in *Erysiphe pisi* on pea	6,26,061	4,89,595	Dr. D. K. Banyal (PI) Mrs.Nisha Kumari,JRF (up to 12/9) Ms .Sonika (up to 1/10)
GOI-428-17	Assessment of genetic diversity in *Colletotrichum capsici* using molecular markers and evaluation of resistance in capsicum.	2,97,101	2,18,295	Dr. P.N.Sharma (PI) Ms. Prachi Sharma JRF (up to 2/10) Ms. Sonika, JRF
GOI-432-17	Molecular tagging of resistance specificity in KRC 5 cv of kidney bean against Colletotrichum.	-----	47,24,069	Dr. P.N. Sharma (PI) Sh. Sanjeev Naryal, JRF up to 11/9 Ms. Kajal JRF (w.e.f 6./9) Ms. Ruby Nag ,JRF (w.e.f 1/10) Sh. Raj Kumar, F.H.
Misc.-958-17	Production of substrate and spawn and training of entrepreneurs for mushroom cultivation in H.P.	4,99,180	4,85,425	Dr. B.M.Sharma (PI) Dr. Savita Jandaik JRF (up to 10/9) Ms. Rishu Sharma JRF (w.e.f. 19/9)
Misc-CSIR-677-17	Culturing of fleshy fungi of western Himalayan region for bio-active molecules.	4,62,367	4,50,212	Dr.B.M.Sharma,(PI) Mr. Sapan Kumar, JRF Mr. Anup Kumar, F.H Mr. Tilak Raj FH
State- Misc-995-17	Developing technologies for protective cultivation in HP (RKVY)	20,83,000	2,00000	Dr. D. K. Banyal (PI) Ms. Ashlesha (JRF) Mr. Ranjeet (FA)
GOI – 467-17	Preliminary investigation on biosystemics of macrofungi for domestication of edible species in tribal area of Lahaul valley of HP	8,03,000	-	Dr. S. Dhancholia (PI)
Ad hoc ICAR-NAIP-1004-17	Biopesticides mediated value chain for clean vegetables component-2 (production to consumption system) of NAIP	16,45,000	15,73,846	Dr.Y.S.Paul (PI) Dr.B.R Thakur (Co-PI) Mr. Sachin Masand, JRF

I. TEACHING

COURSES TAUGHT: The following courses were taught during the year under report:

FIRST SEMESTER

Course No.	Course title	Credit hours	Name of Instructor
Pl. Path. 111	Plant Pathogens & Principles of Plant Pathology	2+1	Dr. A.K. Sood/ Dr. Suman Kumar
Pl. Path.231	Introductory Plant Pathology	1+1	Dr.P.N. Sharma
Pl. Path. 232	Mushroom Cultivation	0+1	Dr.J.Pal
Pl. Path 241	Crop Protection	0+1	Dr. Suman Kumar
Pl. Path. 233	Diseases of field crops & their management	3+1	Dr. Suman Kumar
PC-301	Plant Clinic-I	0+1	Dr.Y.S, Paul
Pl. Path. 501	Systematic Mycology	2+1	Dr.B.M.Sharma
Pl. Path. 502	Physiology of Fungi	2+1	Dr.B.M.Sharma
Pl. Path. 511	Principles of Plant Pathology	3+1	Dr.P.N Sharma / Dr.D.K.Banyal
Pl. Path. 512	Plant Pathological Techniques	0+2	Dr. B.R. Thakur/ Dr. P.N. Sharma
Pl.Path.514	Principles of Plant Disease Management	2+1	Dr. A.S. Kapoor/ Dr. S.K. Rana
Pl. Path. 515	Plant Disease Epidemiology	2+1	Dr.A.S.Kapoor/ Dr.D.K.Banyal
Pl. Path 517	Biological Control of Plant Diseases	1+1	Dr. A.S. Kapoor
Pl.Path.521	Biotechnology in Plant Pathology	2+1	Dr. P.N. Sharma/ Dr.R.P.Kaushal
Pl. Path. 613	Advances in Plant Disease Management	2+1	Dr. A.K. Sood, Dr. A.S. Kapoor & Dr. P.N. Sharma
Pl.Path.622	Physiology of Pathogenesis	2+1	Dr.Y.S.Paul
Pl. Path. 600	Master's Research		Respective Major Advisor
Pl. Path. 700	Ph.D. Research		
Pl. Path.591/691	Seminar		Dr. A.S. Kapoor
RAWE	RAWE Programme		Dr. B.M. Sharma
SECOND SEMESTER			
Pl. Path. 111	Plant Pathogens & Principles of Plant Pathology	2+1	Dr. A.K. Sood
Pl. Path.243	Crop Diseases and Management	2+2	Dr.P.N.Sharma/ Dr.Y.S.Paul
PC 302	Plant Clinic	0+1	Dr. Y.S. Paul
Pl. Path 484	Mushroom cultivation	1+2	Dr. B.M. Sharma
Pl. Path 513	Fungal diseases	2+1	Dr.B.R. Thakur
Pl. Path. 518	Plant Disease Resistance	2+1	Dr.R.P.Kaushal
Pl. Path. 531	Plant Bacteriology	2+1	Dr.A.K.Sood/ Dr. Pradeep Kumar
Pl. Path. 541	Plant Virology	2+1	Dr. P.N. Sharma
Pl. Path.-611	Mechanism of pathogenesis	2+0	Dr. B.R. Thakur
Pl. Path. 621	Chemicals in plant diseases control	2+1	Dr. D.K. Banyal
Pl. Path. 614	Advances in Plant Disease Resistance	2+0	Dr. P.N. Sharma
THT 481		1+2	Dr. B.R. Thakur
Pl. Path.591/ 691	Seminar	1+0	Dr.A.S.Kapoor
Pl.Path.600/700	Research		Respective Major Advisor

STUDENTS ADMITTED

The following students were admitted to the P.G. programme during the year under report

Name of the Student	Admission No.	Major Advisor
MSc		
Mr. Harish Kumar	A2009-30-33	Dr. S.K. Rana
Ms. Jaya Chaudhury	A2009-30-34	Dr D.K. Banyal
Mr. Neeraj Sharma	A2009-30-35	Dr.B. R. Thakur
Ms. Puja Kapoor	A2009-30-36	Dr. B. M. Sharma
Mr. Sumeet Sharma	A2009-30-37	Dr. Ashok Kumar
Ph.D		
Ms. Karishma Chauhan	A2009-40-9	Dr. P.N.Sharma
Ms. Renu Thakur	A2009-40-10	Dr. B.M.Sharma
Mr. Surinder Singh	A2009-40-11	Dr.Dhanbir Singh

The following students completed their M. Sc./ Ph.D. programme during the year under report

Name	Admission No.	Advisor
M Sc		
Arvind Kumar	A2006-30-26	Dr. AS Kapoor
Shalika	A2007-30-22	Dr. YS Paul
Sujata Saini	A2007-30-23	Dr. Suman Kumar
Surinder Kumar	A2007-30-24	Dr. KS Rana
Ph.D		
Ms. Prachi Sharma	A2006-40-05	Dr. P.N. Sharma

THESIS ABSTRACTS

M. Sc.

1. Name: Mr. Arvind Kumar (A2006-30-26 **Major Advisor: Dr. A.S. Kapoor**

Title: To study the wide spectrum efficacy of *Trichoderma* spp. against soilborne and foliar pathogens

Abstract: The present study was carried out to evaluate organic substrates (wheat, maize and FYM) amended with or without vermicompost for the mass multiplication of bioagents and to determine the efficacy of bioagents individually and in combination against important soil-borne and foliar pathogens under *in vitro* and *in vivo* conditions. Wheat bran was found to be the best organic substrate followed by maize bran and FYM for the mass multiplication of *T. hamatum*-H, *T. harzianum* (SMA-4), *T. harzianum*-H, *Trichoderma* sp., *T. koningii* (JMA-11) and *T. viride*-H. Wheat bran + FYM mixture in the ratio 4:1 was the best medium for the mass multiplication of *T. hamatum*-H, *T. harzianum* (SMA-4), *T. harzianum*-H and *T. koningii* (JMA-11) whereas, maize bran + FYM mixture (4:1) was the best medium for the mass multiplication of *T. viride*-H. However, wheat bran + FYM mixture (2:1) was the best medium for the *Trichoderma* sp. Wheat bran amended vermicompost (3:1) was found to be the best medium for the mass multiplication of *T. harzianum* (SMA-4), *T. hamatum*-H, *T. koningii* (JMA-11) and *T. viride*-H. *T. harzianum* (SMA-4) showed maximum antagonistic activity against soilborne pathogens *Rhizoctonia solani*, *Sclerotium rolfsii* and *Fusarium solani* f. sp *pisi* under *in vitro* conditions. Minimum Fusarium pea root rot incidence (11.11%) was observed with *T. harzianum* (SMA-4) which was statistically at par with the mixture [*T. harzianum* (SMA-4) + *T. viride*-H + *T. hamatum*-H + *Trichoderma* sp.] (20.00%) under *in vivo* conditions.

Under field conditions, minimum disease incidence (20.55%) was observed with the wheat bran based formulation of *T. harzianum* (SMA-4) amended with vermicompost followed by mixture [*T. harzianum* (SMA-4) + *T. viride*-H] (29.44%). Rhizoctonia pea root rot incidence was significantly reduced by *T. harzianum* (SMA-4) followed by the mixture [T. *harzianum* (SMA-4) + *T. viride*-H + *T. koningii* (JMA-11) + *Trichoderma* sp.]. Similarly wheat bran based formulation of *T. harzianum* (SMA-4) amended with vermicompost resulted in minimum Rhizoctonia pea root rot incidence followed by mixture [*T. harzianum* (SMA-4) + *T. koningii* (JMA-11)] whereas, minimum collar rot incidence (*S. rolfsii*) was found with the application of mixture of [*T. harzianum* (SMA-4) + *T. viride*-H] under polyhouse conditions. *T. harzianum* (SMA-4) was also found to be the most effective bioagent against foliar pathogens *Pyricularia grisea* and *Bipolaris maydis* whereas *T. viride* (H) was most effective against *Colletotrichum capsici*. *Trichoderma* sp. was found most antagonistic bioagent against *Alternaria brassicae* followed by *T. viride*-H under *in vitro* conditions. Maximum control of anthracnose of chilli (*C. capsici*) was found with *T. viride*-H whereas *T. harzianum* (SMA-4) was most effective against maydis blight (*B. maydis)* and rice blast (*P. grisea).* Maximum Alternaria blight (*A. brassicae)* control was achieved by *Trichoderma* sp. under polyhouse conditions.

2. Name: Ms Sujata Saini (A2007-30-23**) Major Advisor: Dr. Suman Kumar**

Title : Investigations on Fruit rots of Brinjal in Himachal Pradesh

Abstract : The isolations made from the diseased samples revealed the presence of *Phomopsis vexans, Colletotrichum capsici, Phytophthora nicotianae* and *Fusarium moniliforme* to be the major pathogens associated in causing fruit rot of brinjal. The distribution of these pathogens was observed variable in different locations of H.P. and their occurrence depends upon climatic conditions. Among all the fruit rot pathogens the highest incidence of *Colletotrichum capsici* (37.1%) from Una and *Fusarium moniliforme* (27.3%) from Chamba was noticed and their occurrence is being reported for the first time under Himachal Pradesh conditions. In district Kangra all the four pathogens *Phomopsis vexans, Colletotrichum capsici, Phytophthora nicotianae* and *Fusarium moniliforme* were found associated with higher incidence of *Phytophthora nicotianae* (24.6%) followed by *Phomopsis vexans* (22.5%). Fruits inoculated using pin prick method was found best in producing disease symptoms. The post inoculation exposure of brinjal fruits to 25ºC temperature, 90-100% relative humidity offered minimum time for expression of disease with 5-15 day old fruits and 7 day old culture of the isolated pathogens. Spraying of brinjal crop with Mancozeb, Ridomil MZ and Polyram @0.25% alone or in combination with Bavistin was better in combating the fruit rot disease of brinjal.

3. Name: Karishma Chauhan (A2007-30-21) **Major Advisor**: **Dr. A.K. Sood**

Title: Evaluation of plant extracts against *Ralstonia solanacearum* causing bacterial wilt.

Abstract: Aqueous and organic plant extracts of 14 botanicals were evaluated *in vitro* and *in vivo* along with five essential oils against bacterial wilt of tomato caused by *Ralstonia solanacearum*. Out of 14 plant extracts, the extracts of peppermint and eucalyptus were found most inhibitory against the bacterium at 100 and 50 per cent concentrations, followed by the extracts of ageratum and guava under *in vitro* conditions. Six out of 14 aqueous and organic extracts were evaluated under *in vivo* conditions. The survivability of seedlings was found maximum for 22.7 days after 60 minutes dip and 18.0 days after 30 minutes dip at 100 per cent concentration followed by eucalyptus and guava. Among essential oils used, terpind was most inhibitory to *R.*

solanacearum at all three concentrations *viz;* 100, 50 and 25 per cent with 13.33, 9.37 and 3.60 mm of inhibition zones respectively followed by citronella, lemon grass and palmarosa oils as compare to control. Fractionation of organic plant extracts by TLC revealed the presence of a variety of antibacterial components against *R. solanacearum*.

4. Name: Shalika (A2007-30-22) Major Advisor: Dr. Y.S. Paul

Title: Non-chemical management of stalk rot of cauliflower caused by *Sclerotinia sclerotiorum* (Lib.) de Bary.

Abstract: Seven bioagents viz., Trichoderma spp. (SAT-1, SAT-2), two to Penicillium spp. (SAP-1, SAP-2) and three were bacterial isolates (SAB-1, AB-2, and SAB-3) were isolated from soil samples collected from cauliflower growing areas of district Kangra. *T. Koningii* (JMA-11, DMA-8) and *Trichoderma hamatum* (H1) caused complete mycelia inhibition of *S. sclerotiorlum*. The results of bioefficacy of solvent extracts of *Melia azadirach* against the test pathogen showed that Isopropyl alcohol-1 extract provided maximum mycelia inhibition of the test pathogen. Among the ten aqueous botanical extracts, *Ocimum basilicum and Vitex negundo* completely inhibited the growth of *S. sclerotiorum*. Out of twelve organic inputs tested, eight viz. biosol, matka khad, agnihotra ash+cow urine (A.A+C.U), Panchgavya, vermicompost, cow pat pit compost, Nadep compost and biodynamic compost (unautoclaved) showed complete mycelia inhibition of *S. sclerotiorum* without autoclaving Organic inputs like matka khaad, A.A+C.U and panchgavya were most effective in inhibiting mycelia growth of the pathogen (100%) even after autoclaving. Sclerotial dipping in organic inputs for different durations i.e. 1h, 4h and 24h showed that *T. koningii* (JMA-11) and fermented butter milk (F. B.M) provided complete inhibition of sclerotial germination at all the three dipping durations. Evaluation of organic inputs against stalk rot of cauliflower revealed that biosol as seed treatment was most effective treatment with minimum pre emergence infection and no post emergence infection. Field evaluation of organic inputs for the management of stalk rot of cauliflower revealed that Eupatorium powder, A.A+C.U and panchgavya were the best treatments with minimum disease incidence and disease severity with minimum CODEX value. Panchang control was found to the better than non-panchang control with significantly lower disease severity and CODEX value.

5. Name: **Surinder Singh (A2007-30-24) Major Advisor: Dr. K.S.Rana**

Title: Integrated management of Fusarium wilt of chillies

Abstract: The incidence of Fusasium wilt of chillies varied from 7 – 90 % in four Districts of Himachal Pradesh with highest incidence in Paonta Sahib area of Distt. Sirmour and lowest in Kotkwala area of district Kangra. Using water culture technique of testing pathogenicity, wilt incidence was 100% with slant cut and 96.60% with pin prick injury. Variety DKC-8 was resistant to disease. Among the 7 bio-agent tested against the pathogen, *Trichoderma koningii* (DMA-8) caused maximum mycelial growth inhibition of *Fusarium oxysporum f. sp. capsici.* whereas Achook was most effective bio-pesticide. Among eight fungicides tested against the pathogen in vitro, Bavistin gave 100% growth inhibition even at 0.05% concentration.In the integrated management of disease in the field, combination of ridge planting + T. koningii (0.4%) + drenching with Achook (0.4%) and Bavistin (0.2%) was most effective with maximum disease control.

Ph.D

1. **Name: Prachi Sharma, (A-2006-40-05) Major Advisor: Dr. P.N. Sharma**

Title of the thesis: Coat protein diversity in Bean Common Mosaic Virus and elucidation of R-genes in Indian landraces of *Phaseolus vulgaris* L.

Abstract: Present investigations on bean mosaic disease caused by *bean common mosaic virus* (BCMV), a member of family *Potyviridae* were undertaken to study the molecular diversity different strains of the virus using 3' terminal region and to elucidate the presence of R-genes to find out durable sources of resistance. Symptomatology of different isolates belonging to 4 strains *viz.*, NL-1, NL-1n, NL-7 and NL-7n consisted of mosaic, blistering, downward leaf rolling, green vein banding, thickening of leaves, reduction of leaf lamina and leaf deformation. Severity of symptoms was more in seed borne infected plants as compared to sap inoculated plants. Identity of the virus was established by DAS-ELISA and RT-PCR while strains were identified on the basis of International bean differential set. Total genomic RNA was subjected to RT-PCR generating an amplicon of ~1300 bp, eluted, cloned in pGEMT easy vector and transformed in DH5α strain of *E. coli*. Colony PCR of positive clones confirmed the presence of insert and thus plasmid containing positive insert was isolated, lyophilized and custom sequenced. Sequences of various isolates comprised of partial NIb, complete cp and 3' UTR and were submitted in NCBI genbank. Sequence homology, multiple alignment and evolutionary divergence of 3' terminal region could not differentiate the test isolates as per the pathogenic strain groups, thereby indicating least role of this region in characterization of strains of the same virus. However, this region clearly distinguished the virus species. Similar analysis of individual components of 3' terminal region also exhibited the same pattern. Out of 347 common bean accessions, 91 accessions were found resistant to NL-1 and NL-1n strain. Prediction of resistance genes in 31 resistant accessions using tightly linked markers showed that 3 R-genes *viz., I, bc-1*^{2} and *bc-3* genes were present in 19, 20 and one cultivar respectively. In order to characterize the pathogenic strains of the virus under study other regions of the viral genome need to be exploited for their involvement in the pathogenicity trait of the virus. 3' terminal region did not exhibit any variation which could be exploited for the development of PCR based diagnostic kits except use of coat protein gene in virus specific antisera production. The resistant sources identified against the prevalent strains can be exploited in disease resistance breeding programme using marker assisted selection (MAS) approach. The tightly linked markers can also be used after their validation in MAS.

2. RESEARCH

Survey and surveillance

Wheat: Surveys conducted in Kangra, Kullu, Mandi, Solan and Shimla districts revealed the presence of yellow rust on all the varieties viz., HPW42, HPW184, HPW251, HS240, HS277, HS295, HS420, VL616, VL738, VL 829, PBW 343, PBW373, PBW 502, UP2338 and Sonalika with varying severity (40 to 80S) whereas HPW155, HPW89, HPW236, HS490, VL804 and VL892 recorded less than 20S severity. Leaf Rust with severity TS to 40S was recorded on VL829, VL616, PBW343, HPW249, VL892, HS420, HS295, HPW42 and PBW373. Powdery mildew

was recorded on all the cultivated varieties with moderate to high severity (5-8 on 0-9 scale) at many locations. Loose smut incidence varying from 0.5 to 5.0 per cent was recorded at some locations. The incidence of flag smut varied from 5-27 per cent in foot and mid hills of Himachal Pradesh with high incidence on varieties PBW343 and PBW502 in Una district. Karnal bunt was recorded in 5 seed lots out of 51 collected from different locations in districts Kangra, Chamba and Mandi which ranged from 0.5 to 0.78 per cent. In district Sirmour, Karnal bunt was not recorded from any farmers' fields however, YR severity ranged between 20S to 40S in recommended varieties.

Barley: The severity of yellow rust varied from 20-60S at few locations in districts Kangra, Kullu and Mandi. The incidence of loose smut and covered smut ranged between 0.5-2.0 and 1.0- 3.0 percent respectively.

Rice: Incidence of seedling rot (*Sclerotium oryzae*) was found in the range of 0.5-30.0 percent at six locations in district Kangra. High severity (20-80%) of leaf blast was recorded in some areas of Kangra and Mandi. Among improved varieties, no disease was observed on HPR2143 whereas on HPR1068, it was recorded 2-10 percent and RP2421 recorded 2-25 percent severity. Overall severity of leaf scald ranged from 5-70 percent at different locations in district Kangra. Sheath blight was also recorded at few locations and was quite severe (50-70%) on a local cultivar. Bacterial leaf blight with severity 2-50 percent was recorded at Bagroo, Puhara, Kohala, Lower Rehlu, Ladwara/ Rajol, Samloti, Jia, Lahla Chowk and Andretta on Sabarmati and other varieties. Moderate to high incidence of neck blast and glume discoloration was recorded on few varieties at some locations in Kangra and Mandi districts. Incidence of false smut was low to moderate however, it was high (10-25%) on hybrids.

Maize: In Sirmour district, Erwinia stalk rot incidence ranged from 10-25 percent whereas BSDM, BLSB and MLB ranged from 1-2.5, 1-4 and 13 percent respectively.

Soybean: Mainly three diseases viz., target spot (*Corynespora cassicola*), pod blight (*Colletotrichum truncatum*) and mungbean yellow mosaic virus (MYMV) were found to occur in areas surveyed in Kangra and Mandi districts where soybean is mainly grown.

Rapeseed - mustard: Alternaria blight severity rapeseed-mustard ranged from 10-30 percent. Similarly 10-20 percent incidence of white rust recorded in the mustard crop.

Sclerotinia rot in brown sarson, mustard and gobhi sarson crops ranged from 5-10 percent

Linseed: Rust, wilt and powdery mildew remained the major diseases of linseed in major linseed growing areas. Wilt incidence (5-10 %) was recorded in the variety Kangra local in Nagrota, Malan, Chamunda, Zia and Baijnath areas. Linseed rust severity (10-25%) was recorded on variety Kangra local at the in Kangra, Nagrota Bagwan and Palampur areas. However disease severity was higher (up to 75%) in Baijnath and Jogindernagar areas. Severity of powdery mildew ranged from 10-25 percent in the lower elevations

Sesame: Phytophthora blight, Cercospora leaf spot and pod blight remained major diseases of sesame. Phytophthora blight (10-25%) was recorded at the seedling stage in Nagrota Surian area. Similarly Cercospora leaf spot (10-25%) disease was recorded in districts Bilaspur, Kangra and Una.

Lentil: The severity of rust was less on lentil whereas; there was increased incidence of Stemphyllium blight.

Chickpea: Chickpea rust observed in severe proportions at HAREC on research material.

Rajmash: In Leo and Sangla most of the released varieties viz. Baspa, Jawala and Triloki recorded high incidence of BCMV(40-60%), Angular leaf spot and Fusarium rot, whereas in variety Kailash lower incidence (2-3%) was recorded.

Pea: In Mandi district, predominant diseases on pea were powdery mildew, rust and root rot, whereas in Sirmour district, white rot (5-10%), Ascochyta blight (0-5%), root rot complex (20-50%) and powdery mildew (5-10%) were the main diseases on pea.

Potato: High incidence of late blight and early blight were observed in Zone I and II. Bacterial wilt was also observed in some pockets of Zone II. In district Kangra severe incidence of Phoma leaf spot was found in few pockets.

Tomato: Bacterial wilt was predominant (5-20%) in Mandi and Sirmour districts.

Ginger: Rhizome rot (*Pythium* spp., *Fusarium oxysporum* f sp. *zingiberi*, Phyllosticta leaf spot, Rhizoctonia leaf blight, bacterial wilt (*Ralstonia solanacearum)* were the major diseases of ginger.

Fodder crops: Wilt/root rot, anthracnose/stem rot, leaf spot and blight were predominant (10-40%) on cowpea, whereas on maize, it was blight and BLSB. In Berseem and Lucerne leaf spots were the main diseases (10-15%).

Poly house: In Mandi district, under protected cultivation, high incidence of root rot/collar rot in capsicum and tomato, powdery mildew in capsicum, bacterial wilt, Cercospora leaf spots, grey mold, and viral diseases were found.

1. Cereals

Wheat

Germplasm evaluation

During 2009-10, out of 1558 wheat entries evaluated for resistance to YR under artificial epiphytotic conditions at RWRC, Malan, 1029 entries were found free from YR. Similarly 541 entries comprising AVT-II, AVT-I and NIVT materials, were screened for resistance to YR under artificial epiphytotic conditions. Of these, 56 entries from AVT-II (108), 91 from AVT-I (140) and 108 from NIVT (293) remained free from YR. 113 entries were evaluated for resistance to powdery mildew under artificial epiphytotic conditions. Of these, 5 entries viz. TL2934, TL2942, HW1095, DDK1009 and DDK1029 were found immune scoring 0 on 0-9 scale. Five entries viz. HS490, UP2744, K0307, HI977 and CoW were moderately resistant and scored 5 on 0-9 scale at both locations (Malan & Dhaulakuan).

Forty three wheat entries comprising AVT-I & II (NHZ) material were evaluated for resistance to *Tilletia caries* and *T. foetida* by inoculating the seeds of individual entry with teliospores @ 5.0 % (W/W) before sowing. Of these, 12 entries viz., HPW339, HS490, HS514, HS533, TL2942, TL2968, TL2969, VL925, VL907, VL944, VL946 and UP2799 remained free from the disease and 11 entries recorded resistant reaction (below 10 %). At Bajaura, 51 entries were evaluated against hill bunt under artificially inoculation conditions. Three genotypes viz., TL-2942, TL-2968 and TL-2969 were found free from hill bunt infection.

Under All India Coordinated Wheat and Barley Improvement Project, 125 wheat entries were evaluated against local isolates of *Tilletia indica* under artificial inoculation conditions. Three entries namely; HS 513, DDW 12 and DBW 52 were resistant to Karnal bunt.

One hundred forty entries were screened by artificial inoculation of head scab pathogen, fifteen entries; HS 513, DBW 50, PBW 621, PBW 629, PDW 315, UP 2747, WHD 943, HD 2997, RSP 561, HI 8691(d), MP 4106, HPW 316, HPW 348, VL 914 and DBW 55 were found resistant to head scab.

Out of 102 genotypes evaluated against yellow rust, brown rust, Karnal bunt and powdery mildew, six genotypes namely ; TL 2955(T) , HPW 285, HW 5044,

HW 2308, DDK 1033(Dic.) and MACS 2980(Dic.) showed multiple disease resistance.

At HAREC, Bajaura wheat lines/ genotypes received from Directorate of Wheat Research under PPSN AVT II, PPSN AVT I and PPSN NIVT/ Special Trials comprising 108, 140 and 293 entries, respectively were evaluated for resistance to yellow rust. Twenty six, 57 and 145 genotypes were found free from yellow rust infection in PPSN AVT II, PPSN AVTI and PPSN NIVT/ Special Trials, respectively.

Monitoring of yellow rust pathotypes

Yellow rust samples collected from Sirmour and Kangra districts were sent to ICAR Regional Station, Flowerdale for pathotype analysis. Presence of two pathotypes was revealed namely; 46 S119 and 78 S 84. Similarly, leaf samples of wheat sent by scientists from Rice and Wheat Research Station, Malan indicated the prevalence of leaf rust pathotypes; 104-2, 104-3 and 77-5.

Management

Management of Karnal bunt by seed dressing fungicides: The data (Table 1) indicate that most of the test fungicides improved germination (≥ 90%). Vitavax resulted in 100% control of Karnal bunt followed by F100 and carbendazim.

Table 1. Effect of seed dressing fungicides on the incidence of loose smut and Karnal bunt of wheat

Treatment	Germination (%)	LS infected ears (%)	KB incidence (%)	Yield /plot (kg)
F100 @2.5g/kg	95	0.78	0.01	1.050
F100 @ 3.0 g / kg	90	0.68	0.50	0.925
F100 @ 3.5g / kg	90	0.10	0.00	1.110
Carbendazim @ 2.0 g/kg	95	0.20	0.01	1.000
Mancozeb @2.5 g/ kg	90	3.50	0.02	0.672
Vitavax @2.5 g/kg	90	0.00	0.00	1.200
Thiram @2.5 g /kg	90	4.65	0.05	0.680
Vitavax power @ 3.0 g / kg	90	0.80	0.03	0.950
Check	85	5.28	1.01	0.725

Plot size: 1x1m, LS= Loose smut, KB= Karnal bunt

Evaluation of Tebuconazole 060 FS (W/V) as seed treatment against loose smut and flag smut: The data (Table 2) reveal that Tebuconazole @ 0.15g a.i /10 kg seed resulted in complete control (100%) of loose smut and flag smut of wheat at all the four locations which was followed by Tebuconazole 2% DS (0.25 g a.i./ 10kg seed). Tebuconazole @ 0.20g a.i /10 kg seed was also effective against flag smut at all the three locations.

Table 2. Efficacy of Tebuconazole 060 FS (W/V) (Raxil 060 FS) against loose smut and flag smut of wheat

Treatment	Dose g a.i. / 10 kg	Loose smut				Flag smut		
		S. nagar	P.pur	D.kuan	Malan	S. nagar	Una	D. kuan
Tebuconazole 060 FS (Raxil 060 FS)	0.1	0.05	0.2(1.1)	0.10	0.08	1.33	8.0 2.98)	2.00
	0.15	0.00	0.0(1.0)	0.00	0.00	0.66	5.3(2.51)	1.33
	0.20	0.00	0.0(1.0)	0.00	0.00	0.33	4.0(2.23)	0.00
Tebuconazole 2% DS (Raxil 2 DS)	0.25	0.00	0.2(1.1)	0.20	0.00	3.33	9.3(3.10)	4.00
Vitavax	15.0	0.5	0.4(1.2)	0.00	0.81	0.00	11.6(3.54)	3.66
Bavistin	10.0	0.5	0.7(1.3)	0.10	0.32	0.05	13.3(3.77)	3.00
Control	-	2.0	8.0(3.0)	6.33	3.76	6.66	18.3(4.38)	5.66
CD (5%)			0.23				0.56	

Figures in parentheses are square root transformed values

Evaluation of Trifloxystrobin + Tebuconazole 20-080 FS (W/V) against loose smut and Karnal bunt of wheat: The data presented (Table 3) indicate ready mixture of trifloxystrobin and tebuconazole (@ 0.75 a.i. /10kg seed) and Tebuconazole 2% DS (@ 0.25 g.a.i. /10kg seed) gave least incidence of loose smut and Karnal bunt at all the locations.

Table 3. Efficacy of combination of trifloxystrobin 60 + tebuconazole 20- 080 FS W/V) against Karnal bunt and loose smut of wheat

Treatments	Dose g a.i. / 10 kg	Loose smut				Karnal bunt		
		S. nagar	P.pur	D. kuan	Malan	S.nagar	D.kuan	Malan
Trifloxystrobin 60 + Tebuconazole 20-080 FS	0.45+0.15	0.0	0.4(1.19)	1.0	0.52	0.0	0.9	13.80
	0.60+0.20	0.0	0.0(1.0)	0.5	0.08	0.0	0.5	2.79
	0.75+0.25	0.0	0.0(1.0)	0.1	0.06	0.0	0.1	2.02
	0.75	0.0	0.2(1.09)	0.3	3.97	0.05	0.2	1.08
Tebuconazole 2% DS (Raxil 2 DS)	0.25	0.0	0.4(1.19)	0.1	0.07	3.33	1.5	0.0
Vitavax	15.00	0.50	1.1(1.44)	0.0	1.98	0.0	1.2	1.92
Bavistin	10.00	0.05	1.3(1.51)	0.1	1.03	0.05	1.8	0.73
Untreated control	-	2.00	11.3(3.51)	8.5	3.67	6.66	2.09	0.20
CD(5%)			0.24					

Evaluation of foliar sprays of Trifloxystrobin +Tebuconazole 75 WG (Nativo 75 WG) against yellow rust of wheat: The data (Table 4) indicate that two foliar sprays of Nativo 75 WG (@ 75 + 100 g a.i./ 10 l) resulted in complete control of yellow rust at Dhaulakuan and Sundernagar and was also effective at other locations. This fungicide also gave good control of powdery mildew and rated almost at par with Tilt.

Table 4. Efficacy of foliar sprays of Trifloxystrobin 25% + Tebuconazole 50% against yellow rust, loose smut and powdery mildew of wheat

Treatment	Dose g a.i. / 10 l	Yellow rust				Powdery mildew			
		S.nagar	D.kuan	Malan	Bajaura	S.nagar	P.pur	D.kuan (score)	Malan
Nativo 75 WG	50 +100	8.33	0.0	Ts	80.0 (9.17)	8.33	8.7(17.1)	4	62
	62.5+125	6.66	0.0	5S	16.6 (4.25)	5.33	7.3(15.7)	2	58
	75 +150	1.67	0.0	0	8.3 (2.93)	1.67	6.3(14.5)	2	57
Trifloxystr-obin 50 WG	75	10.0	5S	20S	18.3 (4.32)	18.33	8.7(17.1)	4	65
Tebuconaz-ole 250 EC	150	6.67	5S	5S	15.0 (3.97)	13.33	9.3(17.7)	6	39
Contaf 50 EC	37.5	6.67	5S	20S	23.3 (4.69)	3.67	7.3(15.7)	3	55
Tilt 25 EC	125	8.33	Tr	10S	26.7 (5.47)	16.66	11.3(19.6)	2	34
Untreated (water spray)	-	70.0	50S	30S	11.6 (3.62)	36.66	66.3(54.5)	9	73
CD (5%)		8.08			0.61		2.4		

Evaluation of Opera (BAS 512 00F) 18.3% w/v SE against yellow rust and powdery

mildew of wheat : Field experiments conducted at two locations; Malan and Bajaura on the efficacy of Opera 18.3% w/v against yellow rust and powdery mildew showed it very effective in controlling both the diseases at all the doses evaluated (Table 5) . Apart from this other fungicides; Opus, Insignia, Hexaconazole and Propiconazole evaluated also showed effectiveness in managing both the diseases.

Compatibility of seed dressing fungicides, biocontrol agent and insecticides: All the seed dressing fungicides were found compatible with endosulfan, chloropyriphos and biocontrol agent *T. viride*. There was no adverse effect on seed germination and disease control efficiency of the fungicides. The data (Table 6) indicated that seed treatment with fungicides + insecticides followed by one spray of Tilt and insecticide gave significant reduction in loose smut, Karnal bunt, yellow rust, termites damage, aphids population and resulted significant increase in grain yield. However, seed treatment with Vitavax / Bavistin + Chloropyriphos + one foliar spray of Tilt and Chloropyriphos was found best treatment for the control of diseases and insect pests of wheat.

Table 5. Evaluation of Opera (BAS 512 00F) 18.3% w/v SE against yellow rust and powdery mildew of wheat

Treatment	Dose g a.i./ha	Yellow rust severity (%)		Powdery mildew	Average yield (q/ha)	
		Bajaura	Malan	Malan (0-9)	Bajaura	Malan
Opera 18.3% w/v SE (Epoxiconazole 5% + Pyraclostrobin 13.3%)	91.5	11.7 (3.54)	0	0.9	38.1	19.73
Opera 18.3% w/v SE (Epoxiconazole 5% + Pyraclostrobin 13.3%)	137.25	16.6 (4.19)	0	0.7	32.6	20.00
Opera 18.3% w/v SE (Epoxiconazole 5% + Pyraclostrobin 13.3%)	183	16.6 (4.19)	0	0.0	31.1	20.76
Opus (Epoxiconazole 7.5%)	112.5	23.3 (4.91)	0	0.0	27.5	21.10
Insignia (Pyraclostrobin 20%)	100	33.3 (56.84)	0	1.8	30.8	20.16
Hexaconazole 5 EC	50	26.7 (5.24)	0	0.0	25.3	22.83
Propiconazole 25 EC	125	8.3 (3.03)	0	0.0	35.8	22.67
Control	-	76.7 (8.81)	40S	7.0	19.2	23.56
CD (5%)		0.23			0.16	

Table 6. Disease and pest management in wheat through fungicides, insecticides and biocontrol agents

Treat-ment	Germinati-on (%)	Loose smut incidence (%)	Karnal bunt incidence (%)	Yellow rust severity	Termite damaged shoots (%)	Average aphid population per tiller	Yield/ Plot (kg)
T1	90	0.01	0.05	20S	5.08	4.50	1.250
T2	90	0.00	0.00	40S	4.15	8.00	1.416
T3	90	0.02	0.02	20S	7.00	6.15	1.450
T4	85	0.01	0.01	0	0.00	0.00	1.500
T5	85	0.00	0.00	0	0.00	0.20	1.516
T6	90	0.00	0.01	0	0.00	0.00	1.533
T7	80	0.00	0.05	0	0.00	0.00	1.466
T8	95	0.00	0.00	0	0.00	0.20	1.650
T9	90	0.02	0.08	0	0.00	0.05	1.433
T10	90	0.05	0.28	20S	9.50	0.10	1.333
T11	85	0.01	0.20	40S	0.00	9.56	1.333
T12	90	0.00	0.01	0	0.00	7.26	1.466
T13	80	1.98	1.08	80S	12.45	0.00	1.033
CD(P=0.05)	NS	0.11	0.32	-	0.97	0.88	

Figures are square root transformed values before analysis, Plot size: 2x2 m
T1=Raxil 2 DS @1gm/kg seed
T2=Vitavax 75 WP @ 2.5 gm/kg
T3= Bavistin 50 WP @ 2.5gm/kg
T4= Raxil + Endosulfan @1gm+5ml/kg +Tilt spray @0.1%+Endosulfan spray @2.5ml /litre
T5= Vitavax + Endosulfan @ 2.5g + 5ml/ kg +Tilt spray @ 0.1% + Endosulfan spray @ 2.5 ml/ litre

Management of yellow rust of wheat

A field trial consisting of eight treatments was conducted for the management of yellow rust of wheat on susceptible variety Sonalika with fungicides in RBD with 3 replications during *Rabi*, 2009-10 at Bajaura. All the treatments were found superior over the control. However two sprays of Tilt @ 0.1% at 15 days interval was found most effective in controlling yellow rust (Table 7).

Table 7. Management of yellow rust of wheat through fungicides

Treatment	Dosage (%)	Yellow rust severity (%)	Disease control (%)	Yield (q/ha)
Tilt (1 spray)	0.1	11.6 (19.8)	84.8	36.9
Tilt (2 sprays)	0.1	4.6 (12.4)	94.0	47.1
Mancozeb (3 sprays)	0.25	53.3 (46.9)	30.0	17.0
Folicur (1 spray)	0.1	18.3 (25.2)	76.1	30.7
Bayleton (1 spray)	0.1	23.3 (28.7)	69.6	28.2
Bavistin (1 spray)	0.1	33.3 (35.2)	56.5	23.0
Bavistin (2 sprays)	0.1	23.3 (28.7)	69.6	27.8
Control	-	76.7 (61.2)	-	14.4
CD (0.05)		(6.4)		5.8
CV		11.4		11.7

Management of powdery mildew: A replicated field trial on the assessment of losses due to powdery mildew of wheat was conducted at RWRC, Malan during *Rabi* 2009-10 by using a susceptible variety PBW 343 and 5 fungicides (Table 8). First spray of all the treatments was given at the initiation of the disease and second spray of fungicides viz. Tilt, Bavistin, Karathane and Contaf was given after 15 days interval. Whereas, , second spray of Sulfex was given after 10 days of first spray and third one after 10days of second spray. All the treatments were found effective over the check in controlling the powdery mildew. However, two sprays of Contaf 5EC @ 0.1% at 15 days interval was the most effective treatment giving 68 percent control of the disease and followed by two sprays of Tilt 25EC @ 0.1%. Highest yield of 31.8 q/ ha was obtained in case of two sprays of Tilt (0.1%) and followed by 30.4 q/ ha in case of two sprays of Contaf (0.1%).

Assessment of losses caused by powdery mildew of wheat

A field trial on the assessment of losses due to powdery mildew was conducted at Dhaulakuan using six fungicidal treatments on wheat variety PBW 343. The data (Table 9) indicated that all the test fungicides were effective in controlling powdery mildew; however, maximum disease control was achieved with two sprays of Tilt and Bavistin. Yield losses varied in different treatments and maximum loss of 19.80 percent was recorded in check plots

Table 8. Chemical management of powdery mildew of wheat

Treatment	Disease score (0-9 scale)	Grain yield (q/ ha)	Disease control (%)
Tilt @ 0.1% (1 spray)	6.15	29.18	16.10
Tilt @ 0.1% (2 sprays)	5.32	31.80	27.42
Bavistin @ 0.1% (1 spray)	6.24	27.46	14.87
Bavistin @ 0.1% (2 sprays)	6.12	22.51	16.51
Sulfex @ 0.3% (3 sprays)	6.40	23.69	12.69
Karathane @ 0.05% (2 sprays)	6.38	26.24	12.96
Karathane @ 0.1% (1spray)	6.37	24.04	13.10
Contaf @ 0.1% (1 spray)	6.12	27.23	16.51
Contaf @ 0.1% (2 sprays)	2.34	30.39	68.10
Control (No spray)	7.33	22.41	
CD (P=0.05)	0.25	5.59	

Table 9. Assessment of losses caused by powdery on wheat variety PBW 343

Treatment	Average powdery mildew score	Yield (q/ha)	Yield loss (%)
1Spray of Tilt @ 0.1%	7.3	27.77	7.43
2 Sprays of Tilt @ 0.1%	6.0	30.00	0.00
1 Spray of Bavistin @ 0.1%	7.6	27.77	7.43
2 Sprays of Bavistin @ 0.1%	5.6	30.00	0.00
3 Sprays of Sulfex @ 0.3%	7.3	28.13	6.23
2 Sprays of Karathane @ 0.05%	7.6	25.91	13.63
Control (No spray)	9.0	24.06	19.80

Plot size : 6 rows 3 meter length (3.0 x 1.5 m)

Barley

Germplasm evaluation

During *Rabi* 2009-10, barley genotypes received from Directorate of Wheat Research under NBDSN, EBDSN and IBDSN comprising 127, 72 and 308 entries, respectively were evaluated against yellow rust. Sixty, 104 and 180 genotypes were found free from yellow rust infection in EBDSN, NBDSN and IBDSN, respectively.

Management of stripe rust of barley

A field trial consisting of five treatments was conducted for the management of yellow rust of barley (var. Dolma) with fungicides in RBD with 3 replications during *Rabi*, 2009-10. Three sprays of test fungicides were given at 15 days interval starting with the appearance of disease. All other treatments were found superior to the control. Three sprays of Tilt @ 0. 1% at 15 days interval was found most effective in controlling yellow rust (Table 10).

Rice

Germplasm evaluation

729 rice germplasm entries were screened under natural epiphytotic conditions at Malan for leaf blast resistance out of which 51 entries were found promising at the station and 38 nationally. Other 244 entries from various national nurseries viz.,

National Screening Nursery- Hills (86 entries) and Donor Screening Nursery (75 entries) were also evaluated for resistance to leaf and neck blast while 83 entries under National Hybrid Screening Nursery were evaluated for leaf blast resistance only.

Table 10. Chemical control of yellow rust of barley

Treatment	Rust severity (%)	Disease control (%)	Yield (q/ha)
Seed treatment with Vitavax @ 3 gm/kg	66.7 (54.7)	8.6	9.7
Seed treatment + Tilt spray @ 0.1%	6.7 (14.7)	90.8	18.1
Folicur spray @ 0.1%	13.3 (21.3)	81.8	14.9
Seed treatment + Folicur spray @ 0.1%	13.3 (21.3)	81.8	14.8
Control	73.3 (58.9)	-	8.8
CD (0.05)	(6.4)		2.9
CV	10.0		11.6

Angular transformed values in the parentheses.

Highly resistant entries against leaf blast (Score 0-3) were:

NSN-H: HPR 2625, VL 31450, VL 31452, RCPL 1-116, HPR 2558, VL 7702, VL 8166, VL 31329, VL 31335, UPRI 2005-15, VL 30919, RCM 21, UPR 2805-14-1-2, VL 30922, VL 31339, HPR 2598, HPR 2559, UPRI 2006-1, Sukaradhan-1, IR 64, HPR 2543, HPR 2589, HPR 2604, SKAU 353, VL 31451, VL 7852, HPR 2529-2, HPR 2605, VL 7845, HPR 2557, HPR 2633, VL 31228, VL 31284, VL 31449, VL 30560, VL 7620, VL 30569, HPR 2538, SKAU 292, HPR 2512, SKAU- 389, HPR 2555, Vivekdhan 82, Vivekdhan 154, VL 7954, HPR 2143, RP 2421, IR 50.

DSN: CB 05-169, CR 2652-14, CR 2619-5, CR 2619-6, CR 2620-3, VL 31296, VL 31320, TNRH 135, TNRH-174, IR 64, CR 2619-2, CR 2619-7, CR 2619-8, CR 2619-9, CR 2620-1, CR 2620-2, VL 30779, VL 30921, VL 31290, CB 05-501, CB 06-535, CB 06-135, CB 05-754, CB 05-755, Ajaya.

NHSN: IRH-52, 27P31, R-6304, US-334, US-336, TNRH-192, CRHR-49, RH-1531, BRH-2, JRH-16, US-332, NK-6704, HRI-170, GK-5011, ANS-2423, HRI-168, US-310, PA 6129, Ajaya. Among 86 entries from NSN-H, HPR 2625, HPR 2598, HPR 2555 and HPR 2543 were found most promising nationally.

For neck blast, entries showing immune response (healthy panicles) were:

NSN-H: HPR 2625, VL 31450, VL 31452, UPR 3281-3-1-1, SKAU 353, VL 31451, RCPL 1-115, RCPL 1-116, HPR 2605, HPR 2633, VL 31335, HPR 2303, HPR 2538, RCM 21, UPR 2805-14-1-2, VL 30922, HPR 2598, HPR 2143, Sukaradhan-1, RP 2421;

DSN: CR 2649-7, CR 2646-4, CR 2652-14, VL 30685, VL 30687, VL 31320, VLPR-1, VLPR-4, VLPR-7, VLPR-8, VLPR-9, VLPR-10, CB 06-550, CB 06-535, CB 06-

555, CB 06-564, CB 05-754, TNRH 135, TNRH 174, TNRH 175, TNRH 180, TNRH 192, TNRH 193, TNRH 199, Rasi, IR 64

Management

Evaluation of fungicides against blast: Three fungicides namely, Metominostrobin 20 SC (0.5, 1.0, 2.0 ml/ L), isoprothiolane 40 EC (Fuji-One) @ 1.5 ml/L and propiconazole 25 EC (Bumper) @ 1.0 ml/L along with standard checks carbendazim 50 WP (bavistin) and tricyclazole 75 WP (beam) @0.6 g/L were evaluated in RBD with 8 treatments including control and 3 replications against blast. A highly susceptible variety 'Himalaya 2216' was planted in 2.85 x 2.00 m^2 plots. Three sprays of fungicides were applied at 10 to 15 days interval starting from the date of disease appearance on 26th August, 2009. None of the treatments surpassed standard check tricyclazole 75 WP (Beam) which was most effective against neck blast with 97 (%) disease control and 62 (%) increase in grain yield over check. However, isoprothiolane 40 EC (Fuji-One) and metominostrobin 20 SC resulted in 89% and 70% disease control over check, respectively and significant increase in grain yield also (Table 11).

Table 11. Evaluation of new fungicides for the management of rice blast

Treatment	Conc. (%)	Neck blast incidence (%)	Disease control (%)	Grain yield (kg/plot)
Metominotrobin 20 SC	0.05	17.30 (24.03)	49.54	2.65
Metominotrobin 20 SC	0.1	13.72 (21.70)	59.98	3.15
Metominotrobin 20 SC	0.2	10.12 (18.47)	70.48	3.37
Isoprothiolane 40 EC (Fuji-One)	0.15	3.51 (9.63)	89.76	3.61
Propiconazole 25 EC (Bumper)	0.1	13.17 (21.07)	61.59	3.10
Tricyclazole 75 WP (Beam)	0.06	0.82 (4.88)	97.60	3.90
Carbendazim 50 WP (Bavistin)	0.1	13.41 (21.27)	60.89	3.43
Check	-	34.29 (35.67)	-	2.40
CD (P=0.05)	-	8.15		0.69

Figures in parentheses are arcsine transformed values

Management of leaf scald with fungicides: In a field trial, six fungicides viz., Propiconazole 25 EC (Bumper) @ 0.1%, tricyclazole 75 WP (Beam) @0.06%, hexaconazole 5 EC (Contaf) @ 0.1%, carbendazim 50 WP (Bavistin) @ 0.1%, Dithane M-45 @ 0.2% and copper oxychloride (Blitox 50) @ 0.3% were evaluated in RBD with 3 replications each against leaf scald. A susceptible variety (Kasturi) was planted in 2.85 x 2.0 m^2 plots. Three sprays of fungicides were applied at 15 days interval starting from the date of disease appearance i.e. 26th August, 2009. The results indicated hexaconazole 5 EC highly effective in reducing the leaf scald severity with 57 percent disease control over check followed by tricyclazole 75 WP

(Table12). However, tricyclazole provided the maximum grain yield resulting 28 percent increase over check followed by hexaconazole.

Table 12: Management of leaf scald of rice with fungicides

Treatment	Conc. (%)	Leaf scald severity (%)	Disease control (%)	Grain yield (kg/plot)
Propiconazole 25 EC (Bumper)	0.1	22.00 (27.91)	38.59	3.43
Tricyclazole 75 WP (Beam)	0.06	20.33 (26.78)	43.25	3.80
Hexaconazole 5 EC (Contaf)	0.1	15.33 (22.99)	57.21	3.61
Carbendazim 50 WP (Bavistin)	0.1	24.00 (29.31)	33.01	3.51
Dithane M-45	0.2	23.33 (28.86)	34.88	3.46
Copper oxychloride (Blitox-50)	0.3	33.33 (35.24)	6.97	3.31
Check	-	35.83 (36. 73)	-	2.96
CD (P=0.05)	-	2.50		0.24

Figures in parentheses are arcsine transformed values

Maize

Germplasm evaluation

Maize disease trap nursery: Trap nursery comprising 11 inbred lines was planted in isolation and observed for appearance of various diseases under natural epiphytotic conditions. Erwinia stalk rot (ESR), brown stripe downy mildew (BSDM), banded leaf and sheath blight (BLSB), Maydis leaf blight (MLB), Curvularia leaf spot (CLS) and brown spot were observed in these lines. Genotypes CM136, CM151 and HKI163 were highly resistant to ESR. Genotypes HKI163, CM125 and CM138 were resistant to BSDM, BLSB, MLB, CLS and brown spot. While at Bajaura maximum disease incidence of TLB and MLB were recorded on CM-128 and HKI-193-1. Maximum incidence of BLSB and Curvularia leaf spot was observed on HKI-163 and CM-145, respectively.

Evaluation of inbred lines: Three hundred thirty seven inbred lines received from CIMMYT were screened artificially against BLSB. Out of which 61 inbred lines were found resistant to this disease.

Evaluation of hybrids: Ten hybrids of private sector were screened artificially against ESR and BSDM. Hybrids Hishell and PMZ-4 were found highly resistant and 900 MGold, DKC 7074, HP337 and 32T25 were resistant to ESR whereas, hybrids Hishell, PMZ-4, 900 MGOLD, DKC7074, 30R77, 32T25 and BISCO 1840 were found resistant to BSDM.

Evaluation against turcicum and maydis leaf blights: During Kharif 2009, at Bajaura, 216 genotypes of different maturity groups (were screened against turcicum leaf blight (TLB) and maydis leaf blight (MLB) under artificial inoculation conditions. Among these genotypes, 63 genotypes showed resistant reaction to TLB,

where as 164 genotypes were found resistant against to MLB. A large number of genotypes showed resistance to MLB, but most of these were highly susceptible to TLB.

Among full season maturing genotypes, CMH 08-154, CMH 08-156, CMH 08-282, NK-6617, JCY 2-7 x HKI163-1, Laxmi-288, PAC-799, PRO-377, BH-417135, GK-3059, PAC- 745, SMH-4502, KMH-3669, KMH SUPER-244, MCH-38 were found resistant to TLB and MLB. Similarly in medium maturity group, genotypes BML-7x HKI 163-1, HKI 1128x HKI163-1, X8B691, MCH-41, KH-717, KH-9452, BL-2802, KDMH-1001, BISCO-111 were found resistant to both these diseases.

In early maturity group, EHL-162508, EH-2005, EH-1992 were found resistant to TLB and MLB, whereas in extra early maturity group FH-3483, FH-3463, FH-3464, VIVEK Hybrid-17 showed resistance against these diseases. Quality protein maize genotypes were also evaluated for resistance against TLB and MLB. QPM genotypes ECQ-3152, VEHQ-3019, BQPMH-282, JHQPM-304 were found resistant.

Management of banded leaf and sheath blight of maize: A field trial was conducted on the management of BLSB using cultural practices, bioagents and fungicides. Out of 11 treatments, minimum disease intensity (1.27 on 1-5 scale) and maximum yield (41.34 q/ha) was found in the case of foliar spray of Validamycin (0.25%) followed by Tilt (0.1%) and Bavistin (0.1%) (Table 13).

Table 13: **Management of banded leaf and sheath blight of maize with chemicals, biocontrol agents and cultural practices**

Treatment	Average disease (1-5 scale)	Yield(q/ha)
Weeding-(clean plot) and removal of old leaves	3.62	29.12
Removal of lower leaves and no removal of weeds	4.14	26.65
Seed treatment with *Trichoderma viride* (16g/kg seed)	3.43	31.32
Seed treatment with *P. fluorescens* (16g/kg seed)	3.49	31.10
Spray of Contaf (0.1%)	2.12	37.20
Spray of Tilt (0.1%)	1.31	39.10
Spray of Validamycin (0.25%)	1.27	41.34
Spray of Saaf (0.25%)	2.33	37.42
Spray of Indofil M-45 (0.25%)	2.82	33.44
Spray of Bavistin (0.1%)	1.61	38.52
Check	4.65	25.41
CD at 5%	0.29	3.62

II. Pulses

Germplasm evaluation

Rajmash : 447 genotypes/ lines were evaluated for resistance to major diseases of Rajmash at Sangla out of which 145 entries were found resistant to BCMV and angular leaf spot.

Lines selected on the basis of performance from germplasm evaluation were sown for conducting IVT trial. Lines KR50-3, KR62 and KR256-3 were found resistant to BCMV, whereas KR15, KR50-3, KR101, KR63, and KR188& KR293 were resistant to angular leaf spot.

Lentil: 550 entries comprising NBPGR germplasm (300), IVT small seeded (20), IVT large seeded (20), AVT (9), plant pathological screening nursery (51), NGSN (100) were evaluated against rust. Out of these, entries IC 560194, IC 560112, IC 560326, IC 560117, IC 560327, IC 560119, IC 560124, IC 560125, IC 560127, IC 560128, IC 560129, IC 560133, IC 560344, IC 560341, IC 560226, IC 560263, IC 560325, IC 560222, IC 560052, IC 560305, IC 560195, ET 122457, IC 560176, ET 122480, ET 123429, IC 560148, ET 123567, ET 123626, ET 12363I, IC 560325, IC 20336, L 9-714, 719, 730, 733, 735, 736, L 9-12, Vipasha, L 7-757, DPL 61, HPCL 617, L9-761, L 9-764, L 9-765, L 9-766, L 9-802, 808, 809, 810, 816, 822, 824, 826, 827, 828, 819, L 403, L 610, P 602, 603, 604, 607, 615, 617, 618, 620, 661, 666, 670, EC 1, were free from the rust.

Field pea: Out of more than 150 entries PPSN and NGSN, genotypes P 551, 553, 554, 554, 555, 561, 571, 574, 521, 525 were free from rust and genotypes RILFH 4, P 154, P 157, P 146, P 163, P 153, Pant P 14, P 155, P 147, P 165, HFP 4 were highly resistant (DR≥ 2). Entries NBP 368, IC 311063, FC 1, RILHF 2, 5, 6, P 117, P 127, P 134, P 140, P 141, 5R1, 20R1, P 156, P 45, P 162, P 151, P 164, P 150. IC 28312 and IC 267127 were resistant (DR≥ 3) to the disease.

Chickpea: 310 entries comprising advanced varietal trials (140) IIPR Kanpur, kabuli chickpea (60) ICARDA, IABN (30) ICRISAT, NBPGR (80) NGSN (11) were evaluated under artificial epiphytotic conditions against Ascochyta blight. Entries 8A 6 was highly resistant whereas, entries P 9, P 41, NNA 1, NNA 2, 8A 5, 8A 7 were resistant. Whereas, only one genotype P 81 was free from rust and entries P 14, P 83 and PBG 5 were highly resistant. In Kabuli chickpea 52 entries were found resistant to Ascochyta blight.

Mungbean: Out of 133 entries received from PC MULLaRP genotypes CO 6, MH 709, SG 63-1, GM 04-02, SAMRAT, ML 1299 MH 98-1, ML 1194, ML 1450, ML 1451, MH 562, MH 565, Basant, Satya, MH 421, TRCM 16-81-1, MH 521, COGG 972, SG 58-23, Pusa 0672, MH 564, RMG 1000, RMG 1001, IPM 09-1, IPM 09-2, IPM 09-3, IPM 02-1, IPM 03-1, IPM 03-2 were free from MYMV

At Bajaura, 38 lines/ genotypes were evaluated against Cercospora leaf spot. Only line P-1004 was found resistant. However, entries RA 4, P-1011, P-1008, RA-3, P-1034, P-1012, P-1016, P- 1016, P-1033 and RA-2 were found moderately resistant.

Urdbean: Out of 100, genotypes UH 04-04, KU 99-19, UH 4-06, IPU 02-33, VBG 04-008, Pant U 30, PU 31, DPU 88-31, IPU 94-1, UL 417, IPU 2000-01, IPU 05-13, UH 04-6, IPU 02-43, UH 04-4, KU 99-33, IPU 02-33, SB 27-3, UH 07-31, UH 07-33, UH 07-43, UH 04-07, UH -07- 5, UH -07-6, UH -07-11, UH -07-15, UH -07-16, UH -07- 17, KUG 540, UG 173, KUG 99-05, KU 99-07, KU 99-20, KU 99-21 showed combined resistance to MYMV and anthracnose.

At HAREC, Bajaura, 25 lines/ genotypes of urdbean were evaluated against Cercospora leaf spot. None of the entry was found resistant however, entries P-2024, P-2020, P-2023, P-2006, P-2008, and P-2018 were found moderately resistant.

Management

Fungicidal management of the foliar diseases of mash: Fungicides score 25 EC (0.05%), tilt 25EC, carbendazim, hexaconazole (0.1%) and Chlorothalonil (0.2%) applied as two foliar sprays resulted in significant reduction in disease severity of web blight and powdery mildew as compared to check (57.1% and 61.3%). These fungicides also resulted in enhanced yield as compared to check (444.0 kg/ha).

III. Oilseeds

Germplasm evaluation

Rapeseed-mustard: Forty five entries of rapeseed-mustard were screened against Alternaria blight and white rust diseases in this trial. Most of the entries showed lower disease severity and 27 entries remained free from staghead infection. Under artificial inoculation conditions, lowest disease severity of Alternaria blight (38.2%) was recorded on SBG-09-14 and SBG-09-28. The severity of white rust varied from 0 (SBG-09-44) to 33.4 % (SBG-09-38).

Uniform Disease Nursery Trial: Forty three entries of rapeseed-mustard were screened against Alternaria blight and white rust diseases under artificial inoculation

conditions. The lowest severity of Alternaria blight on pods (15%) was observed in UDN-09-40 followed by UDN-09-31(15.9%).

The entries like UDN-09-4 UDN-09-5, UDN-09-8, UDN-09-26, UDN-09-33, UDN-09-37, UDN-09-39 and UDN-09-40 remained free from white rust. All the entries except UDN-09-2, UDN-09-11, UDN-09-14, UDN-09-21, UDN-09-22, UDN-09-23, UDN-09-34 and UDN-09-43 didn't show any staghead infection.

National Disease Nursery for white rust resistance: Out of 20 entries of rapeseed-mustard evaluated for resistance to white rust, 2 entries namely; NDN-09-17 and NDN-09-29 remained free.

Linseed: 200 entries of linseed were screened against prevailing diseases under natural epiphytotic conditions at Kangra. Entries observed highly resistant/ resistant to rust are given below.

Highly resistant(41 entries): SJKO-17, SJKO-19, SJKO-33**,** EC-1996, SJKO-41, SJKO-44, SJKO-49, SJKO-50, SJKO-59, Nulu, SJKO-64, SJKO-70, BRM-1, BRM-2, Kiran, EC-41606, Exotic-3, RSJ-8, RSJ-9, RSJ-10, RSJ-14, RSJ-17, RSJ-18, EC-41481, RSJ-21, RSJ-36, KL-214,KL-216, KL-217, KL-218, KL-219, KL-223, KL-226, KL-227, OLC-42, RKY-1, RKY-2, RKY-3, RKY-17, RKY-19 and EC-1569

Resistant (19 entries): SJKO-27, SJKO-36, SJKO-39, EC-22799, SJKO-52, SJKO-61, SJKO-62, SJKO-65, SJKO-71, BRM-5, RSJ-11, RSJ-12, RSJ- 15, RSJ-19, KL-215, KL-225, RKY-14 and RJK-7.

Seventeen entries namely SJKO-17, SJKO-19, EC-1996, SJKO-36, SJKO-44, SJKO-49, SJKO-50, SJKO-62, SJKO-65, RSJ-12, RSJ-14, RSJ-15, KL-214, KL-216, RKY-3, RKY-14 and RJK-7 also showed resistance to wilt under natural conditions.

Under Uniform Disease Nursery Trial (natural conditions), 56 entries were evaluated for resistance to rust, wilt and powdery mildew disease. Entries UDN-1, UDN-2, UDN-5, UDN-16, UDN-20, UDN-21, UDN-22, UDN-23, UDN-24, UDN-26, UDN-31, UDN-37, UDN-42, UDN-44 and UDN-55 showed highly resistant reaction to rust as well as wilt under natural conditions whereas , 21entries showed resistance to powdery mildew.

Soybean: Twenty promising genotypes of soybean were screened against yellow mosaic at Kangra. Varieties P-12-1-1-1, P-7-2-4-1, P-12-3-3 and P-1-4 showed resistance to the disease, whereas NPC-95-03-01, P2-11-1-1-1 and Shivalik were moderately resistant. Thirty eight lines comprising initial varietal trial (IVT) in coded numbers were evaluated at Palampur and code nos. 1, 3-8, 11-12, 18-24, and 26-37

were found free of pod blight and 1, 8,15-16, 18,20, 26 and 31 were free of target spot while code nos. 1, 8, 18, 20, 26, 31 were free of both the diseases.

Management

Chemical control of Alternaria blight in rapeseed-mustard

A field experiment was conducted to evaluate eight different fungicides (Table 14) against Alternaria blight on variety Neelam of gobhi sarson. Three sprays of each fungicide were applied on 60, 80 and 100 days after sowing. Disease severity of Alternaria blight on leaves was lowest (10.7%) in case of Score (0.05%) followed by Tilt (12.1%). Similarly, the lowest severity of disease on pods was also observed in Score. However, no significant differences were observed in disease severity on pods between Score and Tilt. Highest seed yield of 2531 kg/ha was recorded in case of Score followed by Tilt (2386kg/ha).

Table 14. Chemical control of Alternaria blight of gobhi sarson

Treatment	Disease severity (%)		Yield (kg/ha)
	Alternaria blight (leaves)	Alternaria blight (pods)	
Tilt (0.1%)	12.1(20.3)	17.6(24.8)	2386
Indofil M-45 (0.25%)	23.2(28.8)	21.0(27.3)	2268
Companion (0.2%)	22.6(28.4)	21.2(27.4)	2250
Ridomil MZ (0.25%)	19.0(25.8)	21.0(27.2)	2278
Score (0.05%)	10.7(19.1)	17.2(24.5)	2531
Contaf (0.1%)	18.3(25.3)	20.6(27.0)	2346
Blitox (0.25%)	25.5(30.3)	24.8(29.9)	2228
Antracol (0.2%)	19.9(26.5)	20.8(27.1)	2324
Unsprayed	37.4(37.7)	34.6(36.0)	1984
CD(P=0.05)	1.0	1.4	216

Figures in parentheses are arc sine transformed values

Evaluation of components of integrated disease management in gobhi sarson

A field experiment was conducted on the management of Alternaria blight of gobhi sarson. Three components of disease management viz., row spacing (30cm and 45cm), artificial defoliation (removal of 2-3 lower leaves on 80 DAS and 80, 100 DAS) and fungicidal spray of Companion (0.2%) after removal of leaves were used. Severity of Alternaria blight was low in both leaves and pods in 45 cm row spacing. Low infection of disease was observed when 2-3 lower leaves were removed twice on 80 and 100 days after sowing (Table 15). Disease severity on leaves as well as pods was significantly reduced as a result of fungicidal spray with Companion (0.2%).

Effect of seed treatment on Phytophthora blight in sesame

A field experiment was conducted during *Kharif* season of 2009 on the management of Phytophthora blight of sesame by various fungicidal seed treatments. There was significant reduction in severity of Phytophthora blight as a result of seed

treatments. Lowest disease severity (8.5%) and highest yield (172kg/ha) was observed in case of Metalaxyl (Table 16).

Table 15. Effect of row spacing, artificial defoliation and fungicidal spray on Alternaria blight in gobhi sarson

Treatment	Alternaria blight severity (%)		Yield (kg/ha)
	Leaves	Pods	
Row spacing			
30cm	30.5	31.3	2171
45cm	29.0	29.4	2271
CD (P=0.05%)	0.6	0.5	64
Artificial defoliation			
No defoliation	30.2	31.8	2183
Removal of 2-3 lower leaves on 80 DAS	30.2	31.1	2181
Removal of 2-3 lower leaves on 80,100 DAS	28.7	28.2	2299
CD (P=0.05%)	0.8	0.6	79
Fungicidal spray			
No spray	32.2	32.8	2128
Companion (0. 2%)	27.2	27.9	2314
CD (P=0.05%)	0.6	0.5	64

Table 16. Effect of chemical seed treatment on Phytophthora blight of sesame

Treatment	Disease severity (%)	Yield(kg/ha)
Carbendazim 50%WP (3g/kg seed)	25.3(30.2)	139
Thiram 75%WP(3g/kg seed)	17.1(24.4)	139
Captan 50%WP(3g/kg seed)	14.1(22.1)	150
Metalaxyl 35 SD(3g/kg seed)	8.5(17.0)	172
Carbendazim + Thiram (3g/kg seed)	15.2(22.9)	144
Control	27.7(31.8)	117
CD(P=0.05)	2.3	22

Figures in parentheses are arc sine transformed values

Assessment of avoidable yield losses due to linseed rust

To assess yield losses due to rust in seven different varieties of linseed keeping protected and unprotected plots, repeated sprays of Propiconazole (Tilt 0.1%) were applied in the protected plots. The yield losses due to rust were highest in Chambal (11.2%) followed by T-397 and Kiran (7.6%) (Table 17).

Table17. Assessment of yield losses due to linseed rust

Treatment	Disease severity (%)	Yield(kg/ha)	Yield loss (%)
J-23 (UP)	21.3(27.5)	901	5.9
J-23 (P)	2.1(8.4)	957	
Kiran (UP)	26.7(31.1)	667	7.6
Kiran (P)	3.7(11.1)	722	
R-552 (UP)	17.9(25.0)	481	6.1
R-552 (P)	1.9(7.8)	512	
T-397 (UP)	20.3(26.7)	679	7.6
T-397(P)	1.1(4.8)	735	
Nagarkot (UP)	1.9(7.8)	1012	0.7
Nagarkot (P)	0(0)	1019	
Chambal (UP)	31.5(34.1)	302	11.2
Chambal (P)	2.1(8.4)	340	
Kangra local (UP)	16.3(23.8)	623	5.6
Kangra local (P)	1.1(4.8)	660	
CD (P=0.05%)	3.3	118	

Figures in parentheses are arc sine transformed values

IV. Vegetables

Germplasm evaluation

317 pea cvs / lines were evaluated for resistance to powdery mildew for three cropping seasons under field conditions and for one year in the net house. The average data on disease severity under field and net house revealed that only 7 cvs / lines were resistant to powdery mildew and 66 lines gave moderately resistant reaction (Table 18).

Table 18. Evaluation of pea germplasm for resistance to powdery mildew

Reaction	Infection type	Germplasm
R	0 & 1	DPP 362 ,PP-11304, KS-221, IC-208378, JP-501-A/2, DPP-1542EP and JI-1766
MR	2	FP-180, FP-184, FP-211, FP-258, FP-206, FP-259, FP-218, Green Arrow, CHP-1, KTP-4, JP Ajjila, VRPMR-9, Kukumseri Selection-6, DPP -54, DPP-19,DPP-9414, C-96, PMR-4, ,DPP-107, CHPM-2**,** JP-50 A/2, DPP-80, DPP-13, Acacia, DPP-102-T, PMR-21, CHP-2, DPP-62, HFP-4, IC-374352, IC-208386, EC-381866-1, IC-208369, EC-499762, IC-267733, EC- 538008, EC- 538007, EC- 328786,NIC-11181, Rachna, EC- 292164, EC- 313635, EC- 292166, EC- 499761, IC- 243389, IC- 267732, DPR- 62, KDMR- 606, IPFP- 2-6, HFP- 8909, KDMR- 675, IPF- P- 2-5, HMQ-22, P- 212B, DMR- 49, KPMR-523, KMNR- 894, KMMR- 896, DPP-13 T, DPP-3, FC-2, DPP-127-R, DPP-11-2, DPP-120**,** IC-296678 and DPP-25G

Pathogenic specialization

The virulence pattern of 36 isolates of *E. pisi* on pea differential set along with Lincoln was studied. 36 isolates were grouped into 19 different pathotypes. Of the 36 isolates, 5 isolates were placed in pathotype PMP-1, 4 in pathotypes PMP-2, 3 in pathotypes PMP-3, 2 each in pathotypes PMP-4, PMP-5, PMP-6, PMP-7, PMP-8, PMP-9, PMP-10 and PMP-11 and one each in pathotypes PMP-12 to PMP-19.

Inheritance and host range studies of *Erysiphe pisi*

For studying inheritance of resistance, six crosses *viz*., Lincoln × JI-1159, Lincoln ×JI-2480, Lincoln × IPF-2-5, Lincoln × DPP-13, Lincoln × DPP-25G, Lincoln ×DPP-1542EP in F_2 population was selected for resistance evaluation and it was concluded that inheritance of resistance to powdery mildew is governed by a single recessive gene (*er*). Pea isolate of *E. pisi* was found pathogenic on 9 out of 25 hosts tested. Sporulating colonies of this isolate on *Trigonella foenum- graecum, Robinia pseudoacacia, Melilotus indica, Cassia tora, Vicia faba, V. sativa, Lathyrus aphaca* and *Lathyrus sativa* were observed.

Management

Management of root rot complex of pea through seed dressing fungicides: The data (Table19) indicate that all the seed dressing fungicides were effective in controlling root rot complex over check, however, Vitavax (2.5g/kg) was the most

effective fungicide followed by F-100 (7g/kg) and Bavistin (2.5g/kg). Vitavax and F-100 were rated at par in their efficacy. Thiram was the least effective.

Table 19. Effect of seed dressing fungicides on germination, plant stand, root rot complex and yield of pea

Treatment	Root rot complex incidence (%)	Dry grain yield (g)/ plot
F-100 @2.5g/kg	5.66	583
F-100 @ 7.0 g/kg	2.00	666
Vitavax @2.5 g/kg	0.50	750
Vitavax power @2.5g/kg	3.00	683
Bavistin @ 2.5g/kg	3.33	633
Thiram @3.0 g/kg	4.66	533
T. viride 2.5g/kg	4.33	566
Indofil M-45 @2.5 g/kg	4.66	516
Check	7.33	498
CD (0.05)	1.05	64

Plot size: 3x2m

Management of pea root rot/wilt complex with bio-agents

Results indicate that all the treatments resulted in less pre-emergence infection as compared to control (Table 20). However, treatment with formulation C gave highest control (50.0%) followed by A (49%), B (37.2%), D (35%) and mixture of four formulations (34.0%) respectively as compared to recommended seed treatment with Bavistin @ 2 g / kg seed (19.1%). In case of post emergence infection, treatment C was the most effective giving 28.9 percent disease control followed by A (28.3%).

Table 20. Effect of different bio-formulations on wilt/root rot of pea

Treatment	Dose (g/kg)	Pre-emergence			Post- emergence		
		Germination (%)	Mortality (%)	Disease control (%)	Germi-nation (%)	Mortality (%)	Disease control (%)
T. harzianum (A)	4.0	84.0	16.0	49.0	65.3	34.7	28.3
T. harzianum (B)	4.0	80.3	19.7	37.2	63.6	36.4	24.7
T. koningii (C)	4.0	84.3	15.7	50.0	65.6	34.4	28.9
T. koningii (D)	4.0	79.6	20.4	35.0	64.6	35.4	26.8
A+B+C+D	1:1:1:1	79.3	20.7	34.0	62.6	374	22.1
Bavistin (check)	2.0	74.6	25.4	19.1	57.0	43.0	11.1
Control	-	68.6	31.4	-	51.6	48.4	-
CD(p=0.05)		9.3	9.3		NS	NS	

In both pre and post emergence infection, combination of four bio formulations (1:1:1:1:1) was least effective which might be due to antagonistic activities of bioagents among themselves.

Another field trial was laid at Organic Agriculture farm with the same four bio formulations (A, B, C, D) of bioagents received from IARI, New Delhi. All the

treatments showed less pre and post -emergence infection compared to control however, none of the treatments significantly managed the disease (Table 21).

Table 21. Effect of different bio–formulations on pea root rot /wilt complex

Treatment	Pre-emergence		Post-emergence	
	Germination (%)	Mortality (%)	Germination (%)	Mortality (%)
A	58.6	41.3	67.3	32.6
B	59.0	41.0	67.6	32.3
C	60.3	36.3	60.6	39.3
D	67.6	32.3	68.0	32.0
A+B+C+D	63.3	36.6	65.0	35.0
Bijamrit	47.3	52.6	59.3	40.6
A+B	58.3	41.6	65.0	35.0
B+C	50.3	49.6	65.6	34.3
C+D	59.3	40.6	66.6	33.3
Control	47.6	52.3	55.0	45.0
CD(p=0.05)	NS	NS	NS	NS

Tomato

Organic management of diseases of tomato – cauliflower – pea cropping system

A field trial was laid out on tomato (hybrid 7730) in RBD consist of 7 treatments each replicated thrice to evaluate Panchgavya @ 2%, 3%, 4% and *Trichoderma* @ 4 gm/l, 6 g/l and 8 g/l for the management of fruit rot and foliar blight of tomato. Two sprays of these organic and bio-control agents were given at 15 days interval. Incidence of fruit rot was calculated on the basis of total number of fruits per plot and those infected with the pathogen. Similarly severity of Alternaria blight was assessed by using 1-9 scale. None of the treatments was found effective in controlling fruit rot and foliar blight of tomato.

Another field trial was laid out on cauliflower in RBD, to evaluate the same treatments as given for tomato. There was no significant difference in treatments. In third trial on peas consisting of the same 7 treatments, severity of Ascochyta blight was calculated by using 1-5 scale. None of the treatments showed any effect on blight and yield.

Management of tomato early blight through new fungicides: A field trial conducted on the efficacy of a ready mixture of Trifloxystrobin 25%+ tebuconazole 50% -75 WG against early blight of tomato revealed that the product significantly managed the disease even at 250 g/ ha and increased yield by 51.35 percent (Table 22). Trifloxystrobin 50 WG alone @(175 g/ ha) and Tebuconazole (700 ml/ha) were also effective as compared to standard check Mancozeb.

Table 22. Evaluation of Trifloxystrobin 25%+ tebuconazole 50% -75 WG against tomato early blight

Treatment	Dosage	Disease severity		Yield	
	Formulation (ml or g/ha)	% severity	(%) Control	Yield (q/ha)	(%) increase
Control	-	62.75(7.98)		94.25	-
Trifloxystrobin + tebuconazole 75 WG	250	5.00(2.44)	92.03	193.75	51.35
Trifloxystrobin + tebuconazole 75 WG	300	4.00(2.23)	93.62	217.5	56.67
Trifloxystrobin + tebuconazole 75 WG	350	3.75(2.16)	94.02	226.25	58.34
Trifloxystrobin 50 WG)	175	15.75(4.09)	74.90	182.5	48.35
Tebuconazole	700	31.25(5.67)	50.19	135.75	30.57
Tebuconazole	750	28.75(5.45)	54.18	117.5	19.78
Mancozeb 75 WP	1250	40.00(6.40)	36.25	137.5	31.45
CD (p = 0.05)		0.34	-	1.08	-

Cabbage

Management of cabbage root rot disease

A field experiment was laid out at Kangra to test the efficacy of different bioagent formulations against root rot of cabbage. All the treatments resulted in reduced pre-emergence infection as compared to control (Table 23). However, treatment D gave the best control (66.4%) followed by four formulation mixture + botanical No.1 (45.2%), B (39.6%), A (32.0%) as compared to recommended seedlings dip in Bavistin (13.9%).

Table 23. Effect of different bio-formulations on cabbage root rot

Treatment	Seedling stage			
	Conc. (g /l water)	Germination (%)	Mortality(%)	Disease control(%)
A	4.0	62.6	40.4	32.0
B	4.o	64.0	36.0	39.6
C	4.0	50.6	49.4	28.9
D	4.0	80.0	20.0	66.4
A+B+C+D	1:1:1:1	58.6	41.4	30.7
Bavistin (standard check)	2.0	41.6	58.4	2.17
A+B+C+D+Botanical No.1	1:1:1:1	67.3	32.7	45.2
A+B+C+D+Botanical No.2	1:1:1:1	48.6	51.4	13.9
Control	-	40.3	59.7	-
CD(p=0.05)		19.3	19.3	

Chilli

Germplasm evaluation

195 *Capsicum* accessions procured from diverse sources evaluated for resistance to *Colletotrichum capsici* and *C. gloeosporides*. Out of 195 accessions, 134 germinated and were evaluated against 52 isolates. 15 genotypes showed resistance to more than 8 isolates of *C. capsici* whereas 11 genotypes were found

resistant to *C. gloeosporioides* isolates. An exotic accession EC 631751 (*Capsicum chinense)* showed resistance to 24 isolates. However, some of the genotypes like Surajmukhi, California wonder, EC631750, EC631751, EC631755, EC631757, EC631758, EC631760, and EC631761 were found highly resistant to both the pathogen species.

Garlic and onion

Management of Stemphylium blight: A field trial consisting of 8 treatments was conducted for the management of stemphylium blight of garlic with six fungicides viz. Indofil M-45 (mancozeb @ 0.25%) , Companion (carbendazim 12% + mancozeb 63% @ 0.25%), ZH (Zineb + Hexaconazol @ 0.2%), Score (difenconazol @0.01%), Contaf (hexaconazol @ 0.1%), and Indofil Z-78 (0.25%) and their combinations were evaluated in RBD with 3 replications. Three sprays were given at 15 days interval starting with the appearance of the disease. Data on disease were taken using 1-5 scale. All the spray schedules were found superior to control. Spray schedule of Companion- Score- Indofil M45 and Zineb + Contaf- Score- Indofil M45 were found most effective in controlling Stemphylium blight giving 91.6 percent and 88.4 percent disease index, respectively. Similar trends were also observed in garlic yield (Table 24).

Table 24. Evaluation of fungicides against Stemphylium blight of garlic

Spray schedule	**(PDI)**	**Disease control (%)**	**Yield (q/ha)***
Companion- Score- Indofil M45	6.2 (14.42)	91.5	261.6
Companion- Contaf- Indofil M45	18.5 (25.47)	74.9	237.6
Companion- Zineb + Contaf-Indofil M45	21.8 (27.83)	70.4	227.3
Zineb + Contaf- Score-Indofil M45	8.5 (16.95)	88.4	251.4
Zineb-Score-Companion	15.6 (23.26)	78.8	241.2
Score- Indofil M45- Companion	23.5 (29.00)	68.2	234.8
Indofil M45- Indofil M45- Indofil M45	38.7 (38.47)	47.5	198.6
Companion- Companion- Companion	35.4 (36.51)	52.1	215.5
Control	73.8 (59.21)	-	167.0
CD (p=0.05)	3.73		11.3

Figures in the parentheses are angular transformed values

Management of purple blotch of onion

A field experiment for the management of onion purple blotch was conducted at farmer's field. A new combination product (Trifloxystrobin + tebuconazole 75 WG) was evaluated in RBD at different doses along with other fungicides.

Table 25. Efficacy of new fungicides against purple blotch disease of onion

Treatment	Dose (g or ml/l)	Terminal disease severity %)	Control (%)	Mean yield (q/ha)	Increase in yield (%)
Trifloxystrobin + tebuconazole (75 WG)	0.4	11.67	53.32	96.00	22.03
	0.5	6.67	73.32	104.00	32.2
	0.6	4.00	84.00	105.33	33.89
Trifloxystrobin (50WG)	0.3	8.33	66.70	89.33	13.55
Folicur	1.2	6.67	73.32	92.00	16.94
	1.0	13.33	46.68	89.33	13.55
Contaf	1.5	8.33	66.70	101.33	28.8
Control	-	25.00	-	78.67	-
C.D. (5%)	-	5.71	-		

The disease severity data (Table 25) revealed that two sprays of the product of new fungicides were found effective against purple blotch of onion.

Ginger

Management of rhizome rot: Efficacy of F 100 as seed dip treatment once, twice and thrice in the same fungicidal solution was worked out with some promising fungicides (Table 26). Seed dip treatment with mancozeb + Bavistin @ 0.25%+0.1 % resulted in least incidence (28.61%) followed by treatment with mancozeb + Bavistin @ 0.25% + 0.1 % and drenching with bleaching powder @20kg/ha. All the treatments except second and third rhizome dip resulted in more yield as compared to check (72.22 q/ha).

Table 26. Management of rhizome rot of ginger though chemicals and bioagents

Fungicide	Conc.	Rhizome rot severity (%)	Yield (kg/ha)		New/old ratio
			New	Old	
Ridomil +Bavistin	0.4+0.1	28.41 (32.03)	6555.6	1555.6	4.2
F 100 (1 dip)	0.4	36.92 (37.35)	6166.7	1333.3	4.6
F 100 (2 dip)	0.4	31.46 (34.06)	4444.4	1166.7	3.8
F 100 (3 dips)	0.4	53.75 (47.14)	3694.4	455.6	8.1
Recommended		23.04 (28.61)	7555.6	1333.3	5.7
Recommended+BP	20kg/ha	24.06 (28.83)	7833.3	1277.8	6.1
BCA (TV))Palampur)+	4g/kg+ST	23.85 (29.17)	7222.2	1388.9	5.2
Control		53.95 (47.25)	5222.2	722.2	7.2
CD (0.05)		7.71	806	34.6	
CV (%)		12.41	7.56	17.14	

Figures in parentheses are angular transformed values

V. Forage crops

Germplasm evaluation

Five entries of AVTIC -2 and 9 of IVTC-1 of cowpea were evaluated against root rot complex and none was found resistant. Out of 38 entries of oats evaluated against powdery mildew under different experiments of oats, 23 were found resistant.

Management

Integrated disease management of fodder maize: The experiment was conducted for the integrated management of brown spot, leaf blights and BLSB fodder maize with ten treatments and three replications. It was observed that seed treated with Vitavax power @ 2 g/kg seed + three sprays of Indofil M-45 @ 0.25% gave minimum disease incidence i.e. 1.0, 3.1 and 0.9 per cent brown spot, leaf blights and BLSB respectively, with maximum yield (320.7/ha) as compared to 6.5, 17.4 and 3.0% incidence in control, respectively with an yield of 299.9 q/ha (Table-27). Soaking of seeds in PGPR (*Pseudomonas fluorescens*) suspension followed by three sprays of *P. fluorescens* also found effective for the management of maize diseases as compared to control.

Table 27. Integrated disease management of fodder maize

Treatment	Disease severity / incidence (%)			Green fodder (q/ha)
	Brown spot	Leaf blight	BLSB	
Seed treatment with Vitavax power @ 2 g/kg seed (T_1)	3.2	6.2	1.2	315.5
Seed treatment with *T. viride* @ 5 g/kg seed (T_2)	5.4	11.4	2.3	303.9
Soaking of seeds in PGPR (*Pseudomonas fluorescens*) suspension @ 10^9 cfu/ml for 1 hr(T_3)	5.4	13.2	2.6	304.2
T_1+3 sprays of Indofil M-45 @ 0.25%	1.0	3.1	0.9	320.7
T_2+3 sprays of Indofil M-45 @ 0.25%	3.1	6.4	1.1	313.5
T_3+3 sprays of Indofil M-45 @ 0.25%	3.2	6.6	1.1	314.3
T_1+3 sprays of *P. fluorescens* @ 10^7 cfu/ml	3.0	6.1	1.5	317.9
T_2+3 sprays of *P. fluorescens* @ 10^7 cfu/ml	4.7	11.3	1.4	313.0
T_3+3 sprays of *P. fluorescens* @ 10^7 cfu/ml	4.5	10.5	2.1	310.3
Control	6.5	17.4	3.0	299.9
CD (P=0.05)	0.46	1.19	0.34	10.56

Management of cowpea sucking pests and YMV in seed crop

The experiment was conducted with nine treatments and three replications for the management of sucking pests and yellow mosaic virus of cowpea. The combination of imidacloprid with NSE and biocontrol agent *Verticillium leccani* as seed treatment followed by imidacloprid sprays showed maximum seed germination (92.6%) with only 2.5 percent YMV incidence and lesser number of sucking pests (1.5/leaf) and 61

q of fodder yield as compared to 89.8 percent , 6.9, 7.2 percent and 49.8 q/ha, respectively in control (Table 28).

Table 28. Management of cowpea sucking pests and YMV in seed crop of cowpea

Treatment	Germination (%)	No. of sucking pests/leaf	YMV incidence (%)	Green fodder yield (q/ha)
Seed treatment with imidacloprid WS @ 5g/kg of seed (1)	90.2	4.0	4.2	53.7
Spray of NSE 5% at 10 days interval (2)	92.0	3.5	4.2	56.2
Spray of *Verticillium leccani* @ 5g/l at 10 days interval (3)	89.3	5.6	4.3	56.9
Spray of imidacloprid @ 0.3ml/l at 15 days interval (4)	92.2	3.5	3.8	56.7
1 +2	87.3	2.6	4.1	56.1
1+ 3	92.6	3.1	4.1	56.9
1+ 4	93.5	2.6	3.4	59.4
1 +2 + 3	92.6	1.5	2.5	61.0
Untreated control	89.8	6.9	7.2	49.8
CD (P=0.05)	NS	0.96	0.79	4.43

Integrated disease management in white clover

Seed treatment with Bavistin @ 2 g/kg and *Trichoderma viride* @ 5g/kg seed followed by alternate sprays of Bavistin and Contaf provided best management of powdery mildew (4.2%) and clover rot (1.1%) with maximum seed yield (3.5q/ha) as compared to control with 46.4 percent powdery mildew 4.3 percent clover rot and 2.2 q/ha seed yield (Table 29).

Table 29. Integrated disease management in white clover (*Trifolium repens)*

Treatment	Disease severity (%)		Yield (q/ha)
	Powdery mildew	Clover rot	
T_1 - Seed treatment with Bavistin @ 2 g /kg seed	37.2 (37.5)	1.3	2.6
T_2 - Seed treatment with *Trichoderma viride* @ 5g/kg seed	40.8 (39.7)	2.9	2.3
T_3 - T_1 + foliar spray of Bavistin (0.5%)	21.9 (27.9)	0.7	2.2
T_4 – T_2+ foliar spray of Bavistin (0.5%)	28.5 (32.3)	2.3	3.0
T_5 - T_1+ foliar spray of Contaf (0.04 %)	10.4 (18.7)	1.1	3.1
T_6 - T_2 + foliar spray of Contaf (0.04 %)	9.5 (17.9)	3.6	2.7
T_7 - T_1 + foliar spray of Bavistin followed by Contaf	6.3 (14.5)	1.1	3.2
T_8 – T_2+ foliar spray of Bavistin followed by Contaf	6.3 (14.4)	3.6	3.1
T_9 - T_1+ T_2 + foliar spray of Bavistin followed by Contaf	4.2 (11.7)	1.1	3.5
T_{10} - Untreated control	46.4 (42.8)	4.3	2.2
CD (5%)	0.87	0.36	0.20

Figures in parentheses are angular transformed values

VI. Seed pathology

Monitoring and detection of rice bunt, false smut and bacterial leaf blight in farmers' seed samples of Himachal Pradesh

There was no bunt infection in 176 samples collected from 6 districts (Kangra, Una, Solan, Sirmour, Mandi and Kullu) except one sample from Changroti (0.2%) and one from Fatehpur (0.4%) from Kangra district. The infection was within certification limits. 318 rice fields of farmers in 6 districts were surveyed for recording false smut and bacterial leaf blight incidence. Maximum incidence of false smut was in hybrid rice at the score of 3 in the rating scale of 0-9. Highest BLB infection was scoring 5 in Kangra var. Sabarmati.

Studies on the seed health status of farmer's own saved seed

Out of 101 samples collected from 9 districts, loose smut was detected from 13 (12.87%) samples. It was maximum (1.2%) in variety 227 in Jonta in Sirmour district followed by Chandrika and VL 616 (0.9%) in Kullu district. Karnal bunt infection was detected from 3 samples out of 191 samples during under report but was within certification standards.

Studies on the efficacy of commercial formulations and chemicals against seed and seedling disease of soybean

Germination of seeds was more than 95 percent in all treatments. Though *Trichoderma harzianum* and *T. harzianum* + *P. fluorescens* @ 6 g/kg seed resulted in least seed rot but none was superior to standard check (thiram + carbendazim) (Table 30).

Table 30. Efficacy of commercial formulations of bioagents and chemicals against seed and seedling diseases of soybean

Treatment	Dose (g/ kg seed)	Germination (%)	Seed rot (%)	Seedling blight (%)
P. fluorescens	6	95.50	1.5	0.5
P .fluorescens + T. viride	6	95.25	1.5	0
T. viride	6	96.25	2.0	0
T. harzianum	6	95.75	0.75	0.25
T. harzianum + P.fluorescens	6	96.75	1.0	0.25
Thiram + carbendazim	2	96	0.5	0
Control	-	96.25	1.25	0.5
CD (p= 0.5)	-	NS	0.38	NS

Variety = PK472

Standardization of seed coating technique with botanical and synthetic polymers for seed quality enhancement in maize

Seed germination gradually decreased with the passage of increasing period of storage especially after 6 months irrespective of packing material. Seed heath studies

revealed that fungi were invariably detected from treatments T6- PB (Primed and dried to original moisture content), T0-CB (Untreated control), T3-PB (T_1 + Imidachloprid @ 6 ml/kg and T5-CB (T_1 + + Vitavax 200 @ 2g/kg (Table 31)

Table 31. Effect of packaging on the germination and seed health of polymer coated maize seeds during storage period

Treatment	Germination (%)						Seed health (%)					
	Storage duration (months)						Storage duration (months)					
	2	4	6	8	10	12	2	4	6	8	10	12
T_0- CB	88.9	95.7	100	95.7	98	98.4	0	0	0	0	0	0
T_1- CB	93.4	92.9	100	97.1	84	98.4	0	0	0	0	0	0
T_2-CB	100	97.2	100	100	94	95	0	0	0	0	0	0
T_3-CB	91.7	94.3	91.6	97.1	86	93.4	0	0	0	0	0	0
T_4-CB	76.7	90	91.6	92.9	84	96.7	0	0	0	0	0	0
T_5-CB	96.7	91.4	100	98.6	82	96.7	0	2.9^A	0	1.6^R	0	0
T_6-CB	88.9	95.7	96.6	87.2	88.7	72	0	1.4^A	1.7^A	0	4^A	0
T_7-CB	78.4	92.9	100	78.6	77.3	76	0	0	0	0	2^A	0
T_0-PB	95	90	98.4	90	82	85*	0	0	1.7^A	2.8^R	2^R	0
T_1-PB	95	95.7	100	95.7	78	85	0	0	0	0	0	0
T_2-PB	95	97.1	98.4	98.5	90	98.4	0	0	0	0	0	0
T_3-PB	91.9	88.6	87.2	97.1	88	93.3	0	0	3.3^F	0	0	1.7^F
T_4-PB	95.2	90	96.7	97.1	90	89.3	0	0	0	0	0	0
T_5-PB	91.9	92.9	98.4	98.5	86	100	0	0	0	0	0	0
T_6-PB	80	90	91.3	86.7	77.3	76.7*	0	1.4^A	0	5.7^R	2^R	8.3^R
T_7-PB	93.4	88.6	95	90.7	79.3	77.3	0	0	0	0	0	0

A= *Aspergillus*; F = *Fusarium*; R = *Rhizopus;* * Insect damage ;T_0= Untreated control, T_1= Polykote @ 3ml/kg seed; T_2 = T_1 + Flowable Thiram @ 2.5ml/kg; T_3 = T_1 + Imidachloprid @ 6 ml/kg; T_4 = T_1 + Flowable Thiram @ 2.5ml/kg + Imidachloprid @ 6 ml/kg; T_5 = T_1 + + Vitavax 200 @ 2g/kg ; T_6 = Primed and dried to original moisture content ; T_7 = T_6 + T_4 ; CB= Cloth bag; PB = 700 gauge Polythene bag

Management of soybean mosaic virus disease through organic manipulations

Preliminary trials revealed that sour butter milk has no effect on the incidence of soybean mosaic, however cow urine (seed dip in 15 days old cow urine for 20 minutes + 2 sprays of 15 days old cow urine (diluted in ratio of 1:20 v/v with water) at 15 days interval has reduced the disease appreciably (Table 32). The main drawback of soybean seed treatment is that its seed coat gets ruptured immediately after putting in the solution.

Table 32. Effect of seed treatment on the incidence of SMV disease

Treatment	Disease incidence
Seed dip in sour butter milk (lassi) kept in copper utensil for 20 minutes + 2 sprays of sour butter milk (diluted in ratio of 1: 20 v/v with water) at 15 days interval	71.4
Seed dip in 15 days old cow urine for 20 minutes + 2 sprays of 15 days old cow urine (diluted in ratio of 1:20 v/v with water) at 15 days interval	37.5
Control	77.1

VII. Molecular plant pathology

Molecular tagging of resistance specificity in KRC 5 cv. of kidney bean against *Colletotrichum lindemuthianum*

Development of RILs and F_2 population, their evaluation against *C. lindemuthianum* and inheritance of resistance: Out of the 142 RILs, 77 were found resistant and 65 were susceptible. The chi -square test used for testing the goodness of fit showed a ratio of 1:1 for resistant and susceptible RILs. Out of 97 F_2 plants germinated, 19 were found susceptible while 78 plants showed resistance. A good fit in the ratio of 3 resistant to 1 susceptible in F_2 generation revealed that a single dominant gene governed the resistance in KRC 5 against race 3. This mapping population will also be used for the tagging of resistant gene.

Polymorphism survey of RILs using Simple sequence repeats (SSRs) and Random Amplified Polymorphic DNA (RAPD) markers: A total of 154 RAPD and 66 common bean SSR primers, were screened for the polymorphism survey of the parental genotypes 'Jawala' and 'KRC .Out of the 66 SSR primers, 15 SSR primers *viz*., BMd 41, BMd 42, BMd 43, BM 157, BM 166, BM 140, BM 172, BM 187, BM 53, BM 143, BM 146, PVgtat-001, PVatt-004, PVct-002, and PVtaca-001 were found polymorphic between the parental genotypes Thirty RAPD primers namely, OPJ 17, OPJ1, OPL9, OPX 3, OPX 9, OPX 15, OPX16, OPX18, OPY7, OPY15, OPY17, OPY20, OPF1, OPF9, OPF8, OPF11, OPK5, OPK6, OPU15, OPL5, OPL8, S 1004, S 1005, S 1009, S1013 S1019, S148, S154, S160,and S1472 showed polymorphism between the resistant and susceptible parents.

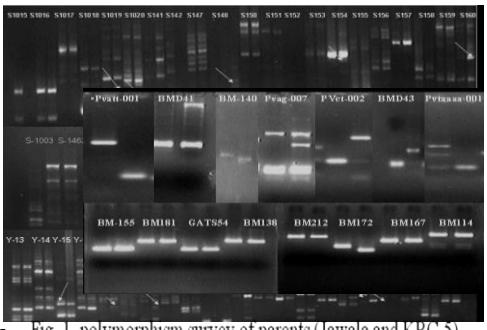

Fig. 1. polymorphism survey of parents (Jawala and KRC 5) using RAPD and SSR markers

Assessment of genetic diversity in *Colletotrichum capsici* using molecular markers and evaluation of resistance in capsicum

DNA Fingerprinting

Genomic DNA of 79 isolates of ***C. capsici*** (67) and ***C. gloeosporioides*** (12) extracted by CTAB method was quantified through agarose gel electrophoresis and then were used for fingerprinting studies. A total of 16 microsatellites comprising eight ISSRs and SSRs each were finally selected for studies. Seventy nine isolates of *C. spp*. were subjected to ISSR fingerprinting and 67 isolates of *C. capsici* were used

in SSR based fingerprinting studies. Diversity analysis of 79 isolates using different molecular markers revealed wide diversity among the test isolates collected from various chilli growing areas of H.P.

SSR analysis of *Colletotrichum capsici* isolates (67) by Darwin software, grouped various isolates into four major clusters (Fig. 2). In cluster I and III, four sub clusters were formed accommodating a total of 25 isolates each while in cluster II, 10 isolates were subdivided into four sub clusters, however, in cluster IV only 7 isolates were grouped indicating a wide variation the pathogen.

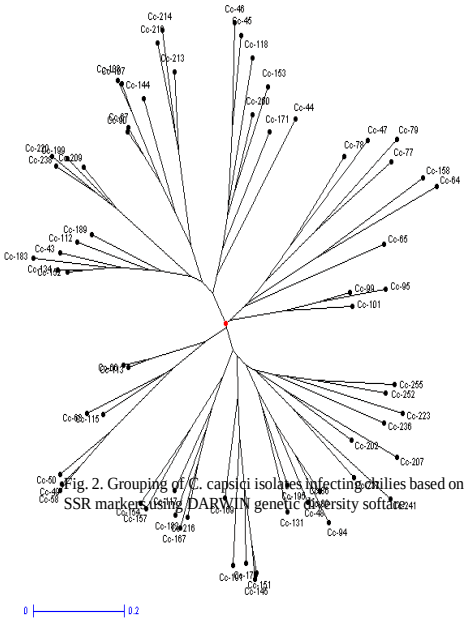

Fig. 2. Grouping of C. capsici isolates infecting chilies based on SSR markers using DARWIN genetic diversity software

ISSR analysis of *Colletotrichum spp*. by NTSYS software divided the 79 isolates into two major clusters comprising 18 and 61 isolates respectively with further 2 sub clusters each.

C. gloeosporioides isolates and predicted *C. acutatum* isolates were categorized into two groups using ISSR primers. However, ERIC primer set categorized them more clearly as compared to BOX-AIR and ISSR primer. Four isolates *viz.*, Cg-253, Cg-70, Cg-165 and Cg244 showed 100 percent similarity, though no congruence was observed with respect to their pathogenicity.

Studies on molecular characterization and management of BCMV

Identification of sources of resistance to BCMV in common bean

347 common bean accessions consisting of local landraces, recommended cultivars and exotic collections were evaluated under glasshouse conditions against two widely prevalent strains (NL-1 and NL-1n) of BCMV in Himachal Pradesh to find out durable sources of resistance. Out of 347 accessions, 91 accessions were found resistant to both the strains whereas 256 showed susceptibility towards NL-1 and NL-1n strains of BCMV. The resistant accessions included indigenous collections (31 local lines), snap beans (15), exotic collections (42) and recommended cultivar (1 dry bean and 2 snap beans). It was interesting to note that varieties exhibiting resistance to strain NL-1 also showed identical reaction to NL-1n.

Molecular variability of *Erysiphe pisi*

RAPD analysis of 5 race groups *of E. pisi* by UPGMA using NTSYS software grouped them into two clusters where PMP-2, PMP-3, PMP-10, PMP-11 were grouped together while PMP-11 formed a separate cluster. Two races; PMP-3 & PMP-10 showed 100 percent similarity but they were pathogenically different. However, other race groups were clearly separated from each other by RAPD markers whereas ISSR marker divided five race groups into two clusters i.e. PMP-2, PMP-3, PMP-11(Karga) and PMP-10, PMP-11 (Jahalma). Two races in each group PMP-3, PMP-11(Karga) and PMP-10, PMP-11 (Jahalma) showing 100 percent similarity (Fig 3).

VIII. Mushrooms

Culturing of fleshy fungi of western- Himalayan region for bioactive molecules

A collection of 350 fleshy fungi belonging to nearly 170 species of more than 45 genera were made from various localities of Kangra, Chamba and Mandi districts. The species of *Amanita, Auricularia, Vascellum, Coprinus, Lepiota, Lactarius, Russula, Hebeloma, Lycoperdon,, Laccaria, Conocybe, Marasmius, Inocybe, Mycena, Oudmansiella, Schizophyllum, Tyromyces, Schizophyllum, Tyromyces, Ganoderma, Polyporus, Tremella, Exidia, Auricularia, Hydnum, Lentinus, Cantherellus, Asterisk, Xylaria, Daldinia ,Ramaria, Thelephora, Tricholoma, Bovista, Coriolus Hypholoma, Stereum, Flammulina, Inonotus, Termitomyces ,Ichnoderma, Scleroderma, Calvatia, Phellinus, Lenzites, Hymenochaete, Spongipellis, Corticium, Pleurotus, Phelbiopsis, Gloeophyllum ,Peniophora, Bjerkandera, Incrustoporia, Rhizopogon, Hyphodontia, Xylobololus, Morchella, Peziza, Oxyporus, Cortinarius, Mycroporus, Tricholomopsis, Omphalina, Psathyrella, Collybia* and *Tyromyces,* etc. were identified and cultured.

Majority of the cultures grew optimally between pH 6.5 to 7.5 at 24±1ºC on medium 'B'. The cultures were processed for lyophilization following a standard protocol. Culture extracts of 16 isolates were deposited with the specified laboratories for further evaluation of bioactivity. Mother cultures of 92 isolates have been deposited with the Institute of Microbial Technology (IMTECH), Chandigarh. One culture extract (FHKV-IHB 89 MB) has been found active for anti-psychotic activity in *in vitro* screening at ITRC, Lucknow.

Fourteen cultures were reported to possess one or the other activity and were processed again as per new protocol suggested by the IMTECH for confirmation. Culture FHKV-IHB 240 MB has been ascertained to possess a very high anti –psychotic activity as per new protocol.

3. EXTENSION EDUCATION

The extension activities undertaken by the teachers/scientists and extension specialists of the department at the main campus, research stations and KVKs during 2009-2010 are described as below.

On farm trials: About 70 on farm trials on the management of different diseases of wheat and maize, anthracnose of soybean, colocasia blight, rhizome rot of ginger, powdery mildew of cucurbits and pea, fruit rot and early blight of tomato, early blight and late blight of potato, Ascochyta blight of chickpea, Alternaria blight of mustard, collar rot and wilt of gram, Phytophthora blight of arhar etc. were conducted during the year.

Field demonstrations: Field demonstrations on management practices of important diseases were conducted and monitored by the teachers/scientists/extension specialists. During 2009-10, about 400 demonstrations on different cereals, oilseeds and vegetable crops were conducted at different locations.

Training programmes: Scientists/extension specialists organized/ participated in about 180 off-campus, 85 on-campus, 14 in-service and 32 vocational trainings in which more than 7500 participants received training. These trainings were organized for the benefit of farmers, farmwomen, rural youth, unemployed graduates and officers of different departments of H.P. and extension personnel. Scientists imparted specialized training on diagnosis and management of diseases of various crops. They also imparted training to different beneficiaries by participating and delivering specialized lectures organized by other agencies.

Scientists of the department also imparted 12 training programmes on mushroom cultivation and benefited about 502 farmers. Besides this, 5600 kg quality spawn of mushrooms was produced in the Spawn Laboratory during the year.

Adaptive research: Scientists conducted 48 adaptive research trials at farmers' fields on the management of different diseases.

Kisan Melas/Kisan Divas/Field days: The teachers/scientists/extension specialists participated in the Kisan melas/ divas, field days etc from time to time whenever they were held during the year. They organized/participated in about 30 Kisan melas/field days/divas in which about 4000 farmers attended who were familiarized with various crop diseases and their management. Scientists also participated in different crop seminars in which a large number of farmers participated.

Workshops: The scientists participated in the deliberations of Agricultural Officers Workshops (*Kharif* and *Rabi*) organized by Directorate of Extension Education, CSK HPKV, Palampur. The queries posed by various Govt. officers and farmers during the deliberations were attended to by the experts. The scientists also attended different workshops and delivered lectures.

Farmers' advisory service: A large number of disease and seed samples of various crops received from farmers, extension personnel from Department of Agriculture and University were diagnosed and suitable remedial measures suggested. During the field visits and survey tours, this service was also extended to the farmers. A large number of trainees were trained in compost making and mushroom growing.

Lectures: The teachers/scientists/extension specialists delivered about 500 lectures to different beneficiaries in different trainings and workshops etc.

TV/ Radio talk

i. Radio talk : 5

ii. Television talk : 6

Extension publications

i. Electronic media/DVD

Yadav, D.S., Singh, A., Singh, Amar, Choudhary, A.K., Rahi, S. and Arya, K. 2009. Cultivation of coloured capsicum under protected conditions (in Hindi). *Electronic scroll board* No. 1, KVK, Sundernagar (H.P.).

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ii. Extension articles

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Gartan, S.L., Kalia, V, Singh, Akhilesh. and Garg, R. 2009. Kharif faslon mein uttam beej utpadan. Booklet Aug, 09: 20.

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iii. Pamphlets **:** 13

Publications

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Basandrai, A.K**,** Sharma, B. K**.** and Basandrai, Daisy. 2009. Fungicidal management of multiple diseases in wheat.*Pl.Dis.Res.***24** :82-83.

Chandel, R.S., Banyal, D.K., Singh, B.P., Malik, Kamlesh and Lakra, B.S.2010. Integrated management of whitefly, *Bemisia tabaci* (Gennadius) and potato apical leaf curl virus in India. *Potato Research* (DOI: 10.1007/s11540-010-9152-3).

Choudhary, A.K., Yadav, D.S**.** and Singh, Amar. 2009. Technological and extension yield gaps in oilseeds in Mandi district of Himachal Pradesh. *Indian Journal of Soil Conservation*. **37**: 224-229.

Datt, N., Singh Amar, Dubey, Y.P. and Rana, M.C. 2009. Response of Rhizobium inoculation, phosphorus and carbendazim seed dressing in some raj mash cultivars. *Him. J. Agri. Res.* **35** : 165-167.

Dev, J., Anand, D., Kumari, V., Sood, V.K., Singh, A., Singh, A., Kaushal,R.P., Jhenjia,J. K., Sood, O.P. 2009. Genotype x environment interaction for yield and maturity in soybean. *Crop Improvement*. **36**:59-63.

Dev, J., Chahota, R.K., Guleria, S. K., Swarnalata, Kalia, V., Singh, Anand**,** Kumari,V, Jenjhia J.K. and Sood, B.C. 2009. Phenotypic stability analysis of maize hybrids 2005. *International J. Agric. Sci.* V :239-242.

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Singh, Akhilesh.2009. Evaluation of fungicides against Phytophthora blight of Colocasia. *Annals of Pl. Prot. Sci.* **17**: 262-263.

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Kapoor, A.S., Sugha, S.K., Basandrai, A.K., Sharma, B.K., Singh, A and Develash, R 2010. Fungicidal management of Phytophthora blight of Colocasia**.** *Him. J. Agri. Res.*

Papers presented in symposia/conferences

Atri, N.S., Kumari, D., Kumar, Sapan, Sharma, B.M. and Gulati, A. 2010. Cultivation studies on wild species of *Lentinus conatus* Berk. Paper presented in"National Symposium on "Botanical Researches-Present Scenario" organized by Botany Department, Punjabi University, Patiala**,** from Feb., 18-19, 2010.

Basandrai, A.K., Garg, Rajesh, Basandrai, D., Paliyal, S. S., Thakur, H.L., and Kalia,V. 2009. Integrated disease management of important spice crops of Himalayan region with special reference to ginger. Paper presented in National Seminar on Spices at SKAUST, Jammu from Oct. 22-24, 2009.

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Basandrai, A.K., Kaur, L., Basandrai, D., Pande, S., Gaur, P.M., Thakur, H.L., Thakur, Sanjay K. and Sharma, M. 2009. Pathotype specific seedling and adult-plant resistance sources to *Ascochyta rabiei* in chickpea (*Cicer arietinum* L.). Paper presented at II International Ascochyta Workshop held at Washington State University, Pullman from June 28-July 2, 2009.

Choudhary, A.K., Singh, A., Singh, Amar and Sood, P. 2010. System of Rice Intensification- A boon to enhance rice productivity in wet temperate north-western Himalayas. Research Paper accepted for presentation in 28th International Rice Research Conference of 3rd International Rice Congress held at Hanoi, Vietnam from Nov., 8-12, 2010.

Gaur, P.M., Pande, S., Khan, T., Tripathi, Shailesh, Sharma, M., Clarke, Heather, Sandhu, J.S. Kaur, L., Basandrai, A.K., Basandrai, D., Gowda, C.L.L. and Siddique, K.H.M. 2009. Breeding for Ascochyta resistance in desi chickpea. Paper presented at II International Ascochyta Workshop held at Washington State University, Pullman from June 28-July 2, 2009.

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Kumar, S. 2009. Records on the Distribution of Fungal Pathogens Associated with Fruit Rot of Brinjal in Himachal Pradesh poster paper presented in 5th International Conference on "Plant Pathology in the Globalized Era" organized by Indian Phytopathological Society at IARI, New Delhi, from Nov.,10-13, 2009.

Nasir, A., Singh, V.K. and Singh, Akhilesh. 2009. Fungicidal management of leaf blight of maize. Paper presented in ISMPP (NZ) annual Meeting and Symposium on **"Rational** use of fungicides in the management of horticultural crop diseases" held at YSP UHF, Solan from July 8-9, 2009.

S. Pande, Sharma, M., Kaur, L., Basandrai, A.K., Gaur, P.M., Khan, T., Siddique, K.H.M. and Gowda, C.L.L. 2009. Development of screening techniques and identification of additional sources of resistance to Ascochyta blight disease of chickpea. Paper presented at II international Ascochyta Workshop held at Washington State University, Pullman from June 28-July 2, 2009.

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Sharma, K. C. Verma, S., Devlash, R. and Thakur, H. L.2009. Evaluation of some tomato lines and their F_1 hybrids for Ralstonia wilt under mid-hill sub-humid conditions of Himachal Pradesh. Paper presented in ISMPP (NZ) annual Meeting and Symposium on **"** Rational use of fungicides in the management of horticultural crop diseases" held at YSP UHF, Solan from July 8-9, 2009.

Sharma, P. N., Sharma, Prachi and Sharma, O. P. 2009. Molecular biology of BCMV resistance and its exploitation in India. Paper presented in 5th International conference on "Plant Pathology in the Globalized Era" organized by Indian Phytopathological Society at IARI, New Delhi, from Nov.,10-13, 2009.

Sharma, Prachi, Sharma, P. N. and Sharma, O.P. 2009. Coat protein gene analysis of BCMV strains prevalent in Himachal Pradesh. Paper presented in 5th International Conference on "Plant Pathology in the Globalized Era" organized by Indian Phytopathological Society at IARI, New Delhi, from Nov.,10-13, 2009.

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Singh, Akhilesh.. 2009. Evaluation of fungicides against Taphrina leaf spot of turmeric. Paper presented in ISMPP (NZ) annual meeting and symposium on **"** Rational use of fungicides in the management of horticultural crop diseases" held at YSP UHF, Solan from July 8-9, 2009.

Singh, Akhilesh., Singh, D and Kalia, V. 2009.Screening of maize germplasm against important diseases. Paper presented in ISMPP (NZ) annual meeting and symposium on **"**Rational use of fungicides in the management of horticultural crop diseases" held at YSP UHF, Solan from July 8-9, 2009.

Singh, D. and Singh, Akhilesh.2009. Eco-friendly management of black scurf of potato. Paper presented in ISMPP (NZ) annual meeting and symposium on **"**Rational use of fungicides in the management of horticultural crop diseases" held at YSP UHF, Solan from July 8-9, 2009.

Singh, Dhanbir and Kalia, V. 2009. Management of brown leaf spot of paddy through fungicides. Paper presented in 5th International conference on "Plant Pathology in the Globalized Era" organized by Indian Phytopathology Society, at IARI, New Delhi, from Nov.,10-13, 2009.

Singh, Dhanbir and Kalia, V.2009. Eco-friendly management of Karnal bunt of wheat. Paper presented in 5th International conference on "Plant Pathology in the Globalized Era" organized by Indian Phytopathology Society at IARI, New Delhi from Nov.,10-13, 2009.

Singh, Dhanbir and Singh, A. 2009. Eco-friendly management of black scurf of potato. Paper presented in National Symposium on "Rational use of fungicides in the management of Horticultural crop diseases" held at Dr. Y.S. Parmar University of Horticulture and Forestry Nauni , Solan (H.P) from July 8-9,2009.

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Upmanyu, S. and Gupta, S. K. 2009. Physiological variation among french bean isolates of *Rhizoctonia solani* Kuhn. Paper presented in ISMPP (NZ) annual meeting and symposium on "Rational use of fungicides in the management of horticultural crop diseases" held at Dr. YSP UHF, Solan, from July 8-9, 2009.

Book chapter

Weidong Chen, Basandrai, A.K. Basandrai, D., Banniza , Sabine, Bassam Bayaa, Lone Buchwaldt, Jenny Davidson, Richard Larsen, Diego Rubiales, and Paul Taylor. 2009. Lentil diseases and their management. (Chapter 17) In: The Lentil (Erskine, W., Muehlbauer, F.J., Sarker, A. and Sharma, B. Eds.), CAB International pp. 262-281

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Singh, Yogendra and Singh, Akhilesh. 2009. Fasal, sabji evam fal : lakshan evam prabandhan. GBPUAT Pantnagar.

Miscellaneous activities

Editorial Board

- Dr. B. M. Sharma was nominated as the member, Editorial Board, 'Mushroom Research' and 'Himachal Journal of Agricultural Research' and Peer reviewer of 'Mycotaxon'-an International Journal of Fungal Taxonomy.
- Dr. A. S. Kapoor was nominated as member, editing/compiling committee for annual report of the University for 2008-09.

Seminars/symposia/workshop attended

- Dr. A. S. Kapoor attended **25th** Annual Group Meeting (NSP) at CRIJAF, Barrackpore (WB) w.e.f. May 4-6.2010.
- Dr. R. P. Kaushal attended Annual Group Meet of AICRP on MULLaRP & Pigeon-pea workers (ICAR) held at CSKHPKV, Palampur from May16-18, 2010 and chaired the Plenary Session of the workshop on urdbean, mungbean and pigeonpea pathology.
- Dr. R. P. Kaushal attended II RAC meeting held at CITH (Central Institute for Temperate Horticulture), Srinagar wef Oct., 22-24, 2009.
- Dr. Ashok Kumar attended the Annual group meeting of Linseed and Safflower held at Orissa University of Agriculture and Technology, Siripur, Bhubaneshwar from Sept. 3-5, 2009.
- Dr. B.M. Sharma delivered a lecture on 'Mushrooms in Human Health' in a 'National Seminar on Fungal Biodiversity and Bioprospecting in the Age of Global Warming' organized by Botany Department, Goa University, Goa**,** from Oct. 29-30, 2009.
- Dr. B. R. Thakur attended a workshop on "Revival of tea industry in Himachal Pradesh" on organized by Tea Board of India at CSKHPKV, Palampur, on 27th March 2010.
- Dr. Dhanbir Singh and Dr. S. K. Rana attended 48 th All India Coordinated Wheat and Barley workers' meet held at IARI, New Delhi w.e.f. August 28 – 31, 2009.
- Dr. Akhilesh Singh, Dr. Suman Kumar, Dr. P. N. Sharma and Dr. Dhanbir Singh attended 5th International Conference on Plant Pathology in Globalized Era held at IARI, New Delhi wef. November 10-13, 2009.
- Dr. A. K. Basandrai attended II International Ascochyta Workshop held at Washington State University, Pullman from June 28-July 2, 2009 and organized Annual Group meet of AICRP on MULLaRP & Pigeonpea workers (ICAR) held at CSKHPKV, Palampur from May16-18, 2010.
- Dr. Akhilesh Singh, Dr. R. Develash, Dr. P. N. Sharma, Dr. Sachin Upamanyu and Dr. Dhanbir Singh attended national symposium on 'Rational Use of Fungicides in the Management of Horticultural Crop diseases' organized by ISMPP (NZ) at Dr. Y.S.P. UHF, Nauni, Solan on July 8-9, 09.
- Dr. Akhilesh Singh attended 53rdAnnual Maize Workshop at SKUAST, Srinagar, on April 10-12, 2010
- Dr. Anand Singh attended national conference of KVKs at Coimbatore, Tamilnadu from Nov.8-10, 2009; meeting cum workshop on Integrated Farming System held at Zonal Project Directorate, P.A.U. Campus, Ludhiana on 4.3.2010; Zonal Workshop of KVKs of Zone 1 at Jammu from Nov, 15-17, 2009 and Annual Group meet of AICRP on MULLaRP & Pigeonpea workers (ICAR) held at CSKHPKV, Palampur from May16-18, 2010.
- Dr. D. K. Banyal participated in annual group meeting – Rabi 2009 of All India Co- ordinated Research Project on forage crops at UAS, Bangalore, from 18-20 Sept., 2009 and annual group meeting – Kharif 2010 at GBPUA&T, Pantnagar on 21-23 May, 2010.
- Dr. Sachin Upamanyu attended 45th All India Rice Research Group Meeting and Annual Rice Workshop from April 4-6, 2010 at Anand Agricultural University, Anand, Gujarat.

Editorial board

- Dr.A.S. Kapoor was nominated member of the committee for editing/compiling annual report of the university for the 2008-09

Liaison/ collaboration with National/ International bodies/agencies

- Dr. A. K. Basandrai collaborated with ICARDA on identification and characterization of resistance to rust (*U. viciae fabae*) in lentil and Ascochyta blight (*A. rabiei*) in chickpea; with ICRISAT on identification and characterization of Ascochyta blight resistance and cold tolerance in chickpea; with AVRDC, Taiwan on popularization of short duration moonbeam in Himachal Pradesh; with NBPGR on chickpea Ascochyta blight studies, lentil rust and MYMV of mash and with Centre for Arid legumes CAZRI, Jodhpur for evaluation of cowpea germplasm.
- Dr. B. M. Sharma collaborated with IHBT, Palampur, on identification and evaluation of bio- molecules from fungal resources.
- Dr. Suman Kumar was nominated as a member of Kangra Potato and Paddy Pest Management Committee.

SUMMARY

The department is engaged in teaching, research and extension activities pertaining to plant diseases and mushrooms. The significant findings for the year 2009-10 are summarized below.

Teaching

The department offered 10 undergraduate and 17 postgraduate courses including minor courses. Five students in M.Sc. and three students in Ph. D programmes were admitted during the period. Five M.Sc. and one Ph. D student successfully completed their respective degrees.

Research

Cereals

- Most of the wheat varieties recorded high yellow rust severity (40-80S.) However, in some varieties; HPW155, HPW89, HPW236, HS490, VL804 and VL892 recorded < 20S severity. Leaf rust severity ranged from TS to 60S and powdery mildew was recorded on all the cultivated varieties with moderate to high severity. The overall incidence of flag smut varied from 5-27 per cent in foot and mid hills whereas loose smut incidence varied from 0.5 to 5.0 per cent. Karnal bunt was not recorded from any area.
- Incidence of rice seedling rot was found in the range of 0.5-30 percent in district Kangra. High severity (20-80%) of leaf blast was recorded in some areas of districts Kangra and Mandi. Overall severity of leaf scald ranged from 5-70 percent at different locations in district Kangra.
- Two pathotypes 46 S119 and 78 S 84 of YR and three of LR; 104-2, 104-3 and 77-5 were found predominant in the state.
- In Sirmour district, Erwinia stalk rot incidence ranged from 10-25 percent whereas BSDM, BLSB and MLB ranged from 1-2.5, 1-4 and 13 percent respectively.
- A total of 1029 wheat entries were found free from YR. Three genotypes viz., TL-2942, TL-2968 and TL-2969 were found free from hill bunt. Six genotypes namely; TL 2955(T) , HPW 285, HW 5044, HW 2308, DDK 1033(Dic.) and MACS 2980(Dic.) showed multiple disease resistance.
- Seed treatment Vitavax @ 2.5g/ kg seed resulted in excellent plant vigour and completet control of loose smut and Karnal bunt followed by F100 and carbendazim.
- A ready mixture of trifloxystrobin and tebuconazole (@ 0.75 a.i. /10kg seed) and Tebuconazole 2% DS (@ 0.25 g.a.i. /10kg seed) gave least incidence of loose smut and Karnal bunt.
- Two foliar sprays of Nativo 75 WG (@ 75 + 100 g a.i./ 10 l) resulted in complete control of yellow rust at Dhaulakuan and Sundernagar and was also effective at other locations.
- New fungicides isoprothiolane 40 EC and metominostrobin 20 SC were found effective in controlling rice blast.
- Hexaconazole 5 EC was found highly effective in reducing the leaf scald severity followed by tricyclazole 75 WP.
- Foliar spray of Validamycin (0.25%) / Tilt (0.1%) was found most effective in controlling BLSB of maize.

Pulses

- Chickpea rust was observed in severe proportions at HAREC on research material.
- Out of 447 genotypes/ lines screened under natural conditions against major diseases of Rajmash at Sangla, 145 entries were found resistant to BCMV and angular leaf spot.
- Out of more than 150 entries of field peas PPSN and NGSN, genotypes P 551, 553, 554, 554, 555, 561, 571, 574, 521, 525 were free from rust.

- The severity of rust was less on lentil whereas there was higher incidence of Stemphyllium blight.
- At Bajaura, 38 lines/ genotypes of mungbean were evaluated against Cercospora leaf spot. Only line P-1004 was found resistant to Cercospora. However, entries RA 4, P-1011, P-1008, RA-3, P-1034, P-1012, P-1016, P- 1016, P-1033 and RA-2 were found moderately resistant.
- Score 25 EC (0.05%), tilt 25EC, carbendazim, hexaconazole (0.1%) and chlorothalonil (0.2%) applied as two foliar sprays resulted in significant reduction in disease severity of web blight and powdery mildew of mash as compared to check (57.1% and 61.3%).

Oilseeds

- Alternaria blight severity of rapeseed-mustard ranged from 10-30 percent. Similarly 10-20 percent incidence of white rust recorded in the mustard crop. Sclerotinia rot in brown sarson, mustard and gobhi sarson crops ranged from 5-10 percent.
- Linseed rust severity (10-25%) was recorded on Kangra local in Kangra, Nagrota Bagwan and Palampur areas. However, disease severity was higher (up to 75%) in Baijnath and Jogindernagar areas. Severity of powdery mildew ranged from 10-25 percent at the lower elevations.
- Phytophthora blight, Cercospora leaf spot and pod blight remained major diseases of sesame. Phytophthora blight (10-25%) was recorded at the seedling stage in Nagrota Surian area.
- The rapeseed-mustard entries UDN-09-4 UDN-09-5, UDN-09-8, UDN-09-26, UDN-09-33, UDN-09-37, UDN-09-39 and UDN-09-40 remained free from white rust. All the entries except UDN-09-2, UDN-09-11, UDN-09-14, UDN-09-21, UDN-09-22, UDN-09-23, UDN-09-34 and UDN-09-43 didn't show any staghead infection.
- Twenty promising genotypes of soybean were screened against yellow mosaic virus disease at Kangra. Varieties P-12-1-1-1, P-7-2-4-1, P-12-3-3 and P-1-4 showed resistance to the disease whereas NPC-95-03-01, P2-11-1-1-1 and Shivalik were found moderately resistant.
- Three sprays of Tilt (0.1%) or Score (0.05%) significantly reduced the Alternaria blight of Gobhi Sarson. Similarly, the lowest severity of disease on pods was also observed in case of Score.
- Seed treatment with Metalaxyl 35SD @ 3g/kg seed significantly managed Phytophthora blight of sesame.
- The yield losses due to rust were highest in Chambal (11.2%) followed by T-397 and Kiran (7.6%).

Vegetables

- In Mandi district, predominant diseases on peas were powdery mildew, rust and root rot, whereas in Sirmour district, white rot (5-10%), Ascochyta blight (0-5%), root rot complex (20-50%) and powdery mildew (5-10%) were the main diseases.
- In potato high incidence of late blight and early blight were observed in Zone I and II. Bacterial wilt was also observed in some pockets of Zone II.
- In tomato, bacterial wilt was predominant (5-20%) in Mandi and Sirmour districts.
- Rhizome rot (*Pythium* spp., *Fusarium oxysprum* f sp. *zingiberi*,), Phyllosticta leaf spot, Rhizoctonia leaf blight, bacterial wilt (*Ralstonia solanacearum)* were the major diseases of ginger.
- A total of 317 pea cvs / lines were screened against powdery mildew for three cropping seasons under field condition and from one year in the net house. The average data on disease severity under field and net house conditions revealed that only 7 cvs / lines gave resistant reaction against powdery mildew and 66 cvs/lines gave moderately resistant reaction.
- The virulence pattern of the 36 isolates of *E. pisi* on differential set along with Lincoln was grouped into 19 different pathotypes. Five isolates were placed in

pathotypes PMP-1, 4 in pathotypes PMP-2, 3 in pathotypes PMP-3, 2 each in pathotypes PMP-4, PMP-5, PMP-6, PMP-7, PMP-8, PMP-9, PMP-10 and PMP-11 and one each in pathotypes PMP-12 to PMP-19.

- Isolate of *E. pisi* formed sporulating colonies on *Trigonella foenum- graecum*, *Robinia pseudo-acacia*, *Melilotus indica*, *Cassia tora, Vicia faba, V. sativa, Lathyrus aphaca* and *Lathyrus sativa.*
- Seed dressing with Vitavax (2.5g/kg) was the most effective followed by F-100 (7g/kg) and Bavistin (2.5g/kg) in controlling pea root rot complex.
- Treatment with formulation C (*Trichoderma* spp.) gave highest control (50%) of root rot complex of pea followed by formulations A (49%), B (37.2%), D (35%) and mixture of four formulations (34%) as compared to recommended seed treatment with Bavistin @ 2 g / kg seed (19.1%).
- A ready mixture of Trifloxystrobin 25%+ tebuconazole 50% -75 WG significantly managed early blight of tomato at 250 g/ ha increasing yield by 51.35 %.Trifloxystrobin 50 WG alone (@175 g/ ha) and Tebuconazole (700 ml/ha) were also effective as compared to standard check Mancozeb.

Miscellaneous crops

- Capsicum genotypes like Surajmukhi, California wonder, EC631750, EC631751, EC631755, EC631757, EC631758, EC631760, and EC631761 were found highly resistant to *Colletotrichum capsici* and *C. gloeosporides*
- Spray schedule of Companion-Score-Indofil M45 and Zineb + Contaf-Score-Indofil M45 were found most effective in controlling Stemphylium blight of garlic giving 91.6 percent and 88.4 percent disease control , respectively.
- Two sprays of a new combination product fungicide (Trifloxystrobin + tebuconazole 75 WG) was found effective against purple blotch of onion.
- Seed dip treatment with mancozeb + Bavistin @ 0.25%+0.1 % resulted in least rhizome rot incidence (28.61%) followed by treatment with mancozeb + Bavistin @ 0.25%+0.1 % and drenching with bleaching powder @20kg/ha.
- Out of 38 entries of oats evaluated against powdery mildew under different experiments of oats, 23 were found resistant.
- Seed treated with Vitavax power @ 2 g/kg seed + three sprays of Indofil M-45 @ 0.25% gave minimum disease incidence i.e. 1.0, 3.1 and 0.9 per cent brown spot, leaf blights and BLSB respectively in fodder maize, with maximum yield (320.7/ha) as compared to 6.5, 17.4 and 3.0% incidence in control, respectively with an yield of 299.9q/ha.
- Seed treatment with *Trichoderma viride* @ 5g/kg seed followed by alternate sprays of Bavistin and Contaf provided best management of powdery mildew (4.2%) and clover rot (1.1%).

Seed pathology

- Bunt infection was almost nil in 176 samples collected from 6 districts (Kangra, Una, Solan, Sirmour, Mandi and Kullu) except one sample from Changroti (0.2%) and one from Fatehpur (0.4%) from Kangra district.
- A total of 318 rice fields of farmers of 6 districts surveyed revealed maximum false smut incidence in hybrid rice (score of 3 in the rating scale of 0-9) and highest BLB infection of 5 in Kangra on variety Sabarmati.
- Out of 101 samples collected from 9 districts, loose smut was detected from 13samples. It was maximum (1.2%) in variety 227 in Jonta (Sirmour district) followed by Chandrika and VL 616 (0.9%) in Kullu district. Karnal bunt infection was detected from only 3 samples out of 191 samples but was within certification standards.
- Though *Trichoderma harzianum* and *T. harzianum + P .fluorescens* @ 6 g/kg seed resulted in least soybean seed rot but none was superior to standard check (thiram + carbendazim)**.**

- Preliminary studies revealed that sour butter milk has no effect on the incidence of soybean mosaic , however cow urine (seed dip in 15 days old cow urine for 20 minutes + 2 sprays of 15 days old cow urine (1:20 v/v with water) at 15 days interval has reduced the disease appreciably.

Molecular plant pathology

- In kidney bean, out of the 142 RILs, 77 were found resistant to anthracnose. A good fit in the ratio of 3 resistant to 1 susceptible in F_2 generation revealed that a single dominant gene governed the resistance in KRC 5 against race 3.
- Diversity analysis of 79 isolates of *C. capsici* (67) and *C. gloeosporioides* (12) using different molecular markers revealed wide diversity among the test isolates collected from various chilli growing areas of H.P.
- Out of 347 accessions of common bean, only 91 accessions were found resistant to both the strains (NL-1 and NL-1n) of BCMV.
- RAPD analysis of 5 race groups *of E. pisi* by UPGMA using NTSYS software grouped them into two clusters where PMP-2, PMP-3, PMP-10, PMP-11 were grouped together while PMP-11 formed a separate cluster.

Mushrooms

- A total of 350 collections of the fleshy fungi belonging to nearly 170 species of more than 45 genera were made from various localities of districts Kangra, Chamba and Mandi during the period under report.
- Majority of the cultures grew optimally between pH 6.5 to 7.5 at 24±1ºC on medium 'B'.
- Culture FHKV-IHB 240 MB has been confirmed to possess a very high anti – psychotic activity as per new protocol.

Extension

- Seventy on farm trials on the management of diseases of cereals, vegetables and pulses were conducted.
- Four hundred field demonstrations on important diseases, their management practices and on other crop management technologies were conducted at different locations.
- Organized / participated in about 180 off-campus, 85 on-campus, 14 in-service and 32 vocational trainings in which a more than 75000 participants received training. Imparted 12 training programmes on mushroom cultivation. Besides this, 5600 kg quality spawn of mushrooms was produced.
- Conducted 48 adaptive research trials at farmers' fields on the management of different diseases.
- Five radio and 6 television talks were delivered and 9 popular articles were published by the scientists.

Publications

- Thirty four scientific papers were published, 3 papers were accepted for publication, one book chapter contributed and 24 papers were presented in different symposia and workshops.