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 the Hill Agriculture Research and Extension Centres (Bajaura, Dhaulakuan and Kukumseri); Mountain Agriculture Research and Extension Centre (Sangla); Shivalik Agriculture Research and Extension Centre (Kangra) ; Research Stations (Malan, Berthin and Lari) and Research Sub-Stations located in different agro-climatic zones of Himachal Pradesh. Research on wheat diseases is being carried out at Malan, Dhaulakuan and Bajaura. The work on rice diseases is exclusively carried out at Malan and Palampur and on maize diseases at Bajaura and Dhaulakuan, whereas 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, *Ascochyta* blight and 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. Research on biological control of soil borne diseases especially under organic agriculture is also carried out.

The department also carries out research on different aspects of mushroom cultivation. The spawn laboratory at present is meeting the demand of the State Department of Horticulture and the 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 adhoc research projects are being carried out in the department with financial support from the Indian Council of Agricultural Research, Council of Scientific and Industrial Research, Department of Science and Technology, Department of Biotechnology, Govt. of Himachal Pradesh, and the fungicide companies.

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

STAFF POSITION

TEACHING	
Professor & Head	Dr. S. K. Sugha
Professor/Senior Scientist	Dr. A. K .Sood Dr. Y. S. Paul Dr. B .M. Sharma Dr. P. N. Sharma
RESEARCH	
Palampur Campus	
Professor Sr. Scientist Scientist	Dr. R. P. Kaushal Dr. A. S. Kapoor Dr. J. Pal 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
Shivalik Agricultural Research & Extension Centre,Kangra	
Sr.Scientist	Dr. Ashok Kumar
Rice and Wheat Research Station, Malan	
Sr. Rice Pathologist Sr.Scientist	Dr. G. K. Sood Dr. S. K. Rana
Mountain Agricultural Research & Extension Centre Sangla (Kinnnaur)	
Assistant Scientist	Vacant
Research Sub-Station, Berthin	
Sr. Scientist	Dr. C. L. Bhardwaj
Research Sub-Station, Sundernagar	
Assistant Scientist	Dr. Amar Singh
Research Sub-Station, Salooni (Chamba)	
Assistant Scientist	Vacant
Research Sub-Station, Lari (Spiti)	
Assistant Scientist	Vacant
EXTENSION EDUCATION	
Sr. Extension Specialist Sr.Scientist Scientist Asst Ext. Specialist	Dr. K.S. Rana (DEE Palampur) Dr. A. Singh (KVK Mandi) Dr. V.K. Rathi (KVK Dhaulakuan) Dr. B. K.Sharma (KVK, Una) Dr. A. K. Sud (KVK, Kangra) Dr. Suman Kumar (DEE Palampur Dr. Pardeep Kumar(KVK, Kukumseri)

FINANCIAL OUTLAY AND STAFF POSITION IN DIFFERENT SCHEMES OF THE DEPARTMENT (1.4.2007 TO 31.3.2008)

Name of the scheme	Budget allocation (Lac Rs.)	Expenditure	Staff
APL-010-17 "Facilities for Teaching in the College of Agriculture and creation of facilities for Postgraduate Studies" in the Department of Plant Pathology, CSKHPKV, Palampur	10.54	14,03,005	Dr. B. M. Sharma, Professor Sh. Partap Raj Sharma, Supdt.Gr.II(EC) (w.e.f 10.03.08) Sh.Swami Ram,Tech.Asstt.(Gr.II) Sh.Guldev Singh, Jr.Technician Sh.Vijay Kumar, Chowkidar
APL-001-17 Creation of facilities for PG studies in the Department of Plant Pathology", CSKHPKV, Palampur	21.21	31,16,648	Dr. A. K. Sood, Sr.Scientist Dr. S.K. Sugha, Professor Dr.Y.S. Paul, Professor Dr. P.N. Sharma, Professor Smt. Shashi Sharma, Sr.Asstt. Sh. M.S Nag, Jr.Scale Stenographer Gr-I (w.e.f.14.08.07) Sh. Prem Chand, Jr.Technician Sh. Kishori Lal, Lab.Asstt.
APL-59-17 "Facilities for research in the Department of Plant Pathology" CSKHPKV, Palampur	6.92	11,35,253	Dr. R. P. Kaushal, Professor Sh. R. S. Rana Sh.Dharam Chand, Beldar Sh.Hem Raj, Beldar Sh. Kehar Singh, Peon
APL-21-17 "Strengthening of facilities for research in the Department of Plant Pathology" CSKHPKV, Palampur	10.23	11,75,423	Dr. J. Pal, Sr.Scientist, Sh. Ramesh Kumar, Beldar Sh. Dalip Kumar, Beldar Sh. Hans Raj, Beldar Sh. Desh Raj, Beldar Sh. Madho Ram, Beldar.
ICAR-017-17 Pt.III "All India Coordinated Research Project on Seed Technology Research" under NSP	7.00	10,83,808	Dr. A.S. Kapoor Professor Sh. Amar Nath Walia, Sr.Tech.Asstt. Gr-I Sh. Himat Ram, Lab.Asstt

Adhoc Projects

Sr. No.	Name of the scheme	Budget allocation (Lac Rs.)	Expenditure	Staff
1.CSIR-614-17	Collection, identification & culturing of fleshy fungi prevalent in Western Himalayan region of Kangra District and adjoining area of HP (CSIR)	4,79,090	4,34,902	Dr.B.M. Sharma (PI) Dr. R. K. Singh, RA Sh. Tilak Raj Field Assistant
2.GOI-359-17	Improvement and transfer of oyster mushroom cultivation technology for income generation among rural women of Kangra valley in H.P. (DST)	1,39,000	1,38,956	Dr Deepika Sud, (PI)
3.GOI-361-17	Empowerment of rural women through transfer of mushroom cultivation technology	-	20,917	Dr. J. Pal (PI) Sh. Ravi Kumar, Field Helper
4.GOI-381-17	Extraction of biologically active compounds from edible mushroom especially *Pleurotus* spp.	4,04,000	3,92,088	Dr. Savita (PI)
5.ICAR-200-17	Assessing diversity in Ascochyta blight complex of pea using molecular markers and its management through host resistance	2,54,430	2,17,351	Dr.R. P. Kaushal (PI) Mr. Vikas Kapoor SRF
6.Misc.-887-17	Evaluation of antifungal potential of Panchgavya against soil borne pathogens	40,232	36,431	Dr. S. K. Sugha (PI)
7.Misc.887-17	Management of foot rot and seedling blight of barley in Spiti Valley	50000	20102	Dr. Suman Kumar (PI)
8.Misc.-898-17	Refinement of management schedule for late blight of potato	25,000	23,388	Dr. D.K. Banyal (PI)
9.GOI-417-17	Characterization of variability in Erysiphe pisi on pea	11,46,800	11,03,475	Dr. D.K. Banyal (PI) Dr. S. Upmanyu JRF Mrs. Nisha Kumari JRF
10.GOI-428-17	Assessment of genetic diversity in *Colletotrichum capsici* using molecular matrkers and evaluation of resistance in capsicum.	9,82,000	6,94,853	Dr. P.N. Sharma (PI)
11.GOI-432-17	Molecular tagging of resistance specificity in KRC 5 Cv. Of Kidney bean against Colletotrichum.	11,92,000	5,57,214	Dr. P.N. Sharma (PI) Sh.VikasKapoor, JRF Sh. Sanjeev Naryal, JRF Sh.RajKumar,FH
12.Misc.-958-17	Production of substrate and spawn and training of entrepreneurs for mushroom cultivation in H.P/	4,80,000	4,75,094	Dr. B. M. Sharma (PI)
13.Misc.-626-17	Testing of fungicides	-	78,197	Dr.S.K. Sugha (PI)
14.Misc.-790-17-758-17	Soybean Pathology	10,000 20,000	7,275 8,947	Dr.R.P. Kaushal (PI)
15.GOI-354-17	Plant Quarantine	40,000	16,000	Dr.A.K.Sood(PI)

1. TEACHING

Courses taught: The following courses were taught during the year under report:

Course No.	Course title	Cr. Hrs.	Name of Instructor
FIRST SEMESTER			
Pl. Path. 231	Introductory Plant Pathology	1+1	Dr.Y.S. Paul
Pl. Path. 232	Mushroom Cultivation	0+1	Dr. J. Pal
PC -301	Plant Clinic-I	0+1	Dr.Y.S. Paul
Pl. Path. 501	Systematic Mycology	2+1	Dr.B.M. Sharma
Pl. Path. 511	Principles of Plant Pathology	3+1	Dr.S.K.Sugha/Dr.D.K.Banyal
Pl. Path. 512	Plant Pathological Techniques	0+2	Dr. A. K. Sood
Pl. Path. 515	Plant Disease Epidemiology	2+1	Dr. A. S. Kapoor
Pl. Path. 517	Biological Control of Plant Diseases	1+1	Dr. Y. S. Paul
Pl. Path. 521	Biotechnological & Mol. Plant Pathology	2+1	Dr. P. N. Sharma/Dr. R.P. Kaushal
Pl. Path.611	Mechanism of Pathogenesis	2+0	Dr. A. K. Sood
Pl. Path 641	Advanced Virology	2+1	Dr. P.N. Sharma
Pl. Path. 591/691	M.Sc./ Ph.D Seminar	1+0	Dr. B. M. Sharma
RAWE	Rural Agri. Work Experience	0+2	Drs. Y.S. Paul & D. K. Banyal
SECOND SEMESTER			
Pl. Path. 241	Crop Protection-I(Plant Pathology)	0+1	Dr. R. P. Kaushal
Pl. Path. 243	Crop Diseases & Management	2+2	Dr. Y. S. Paul/Dr. B. M. Sharma
PC. 302	Plant Clinic-II	0+1	Dr.Y.S.Paul
Pl.Path. 484	Mushroom Cultivation	1+2	Dr.J.Pal/ Dr.B.M.Shama
Pl.Path. 514	Principles of Plant Disease Management	2+1	Dr.A.S.Kapoor
Pl.Path. 513	Fungal Diseases	2+1	Dr. D.K. Banyal
Pl.Path. 518	Plant Disease Resistance	2+1	Dr. R.P.Kaushal
Pl.Path. 531	Plant Bacteriology	2+1	Dr. A.K. Sood
Pl.Path. 541	Plant Vriology	2+1	Dr. P.N.Sharma
Pl.Path.612	Advanced Plant Disease Epidemiology	2+1	Dr.A.S.Kapoor
Pl.Path.613	Advances in Plant Disease Management	2+1	Dr.A.K.Sood/Dr.A.S.Kapoor /Dr.P.N.Sharma
Pl. Path 614	Advances in Plant Disease Resistance	2+0	Dr. P.N.Sharma
Pl.Path 621	Chemicals in Plant Disease Control	2+1	Dr. SK. Sugha
Pl.Path. 591/691	M.Sc./ Ph.D Seminar	1+0	Dr. Dr.B.M.Sharma

STUDENTS ADMITTED

The following students were admitted to the P.G. programme during 2007-08

Name	Admission No	Advisor
M.Sc.		
Ms. Krishma Chauhan	A-2007-30-21	Dr. A.K.Sood
Ms. Shalika	A-2007-30-22	Dr. Y.S.Paul
Ms. Sujata	A-2007-30-23	Dr. Suman Kumar
Mr. Surinder Singh	A-2007-30-24	Dr. K.S.Rana
Ph.D.		
Ms. Rishu Sharma	A2007-40-04	Dr. B.M. Sharma
Mr. Vivek Kumar Pandey	A2007-40-04	Dr. Y.S.Paul
The following students completed their M.Sc./Ph.D. programme during 2007-08 :		
M.Sc		
Ms. Richa	A-2005-30-25	Dr. R.P.Kaushal
Ms. Rishu Sharma	A-2005-30-25	Dr. B.M. Sharma
Ph.D.		
Ms.Renu Kapil	A-2000-40-12	Dr. O.P.Sharma

THESES ABSTRACTS

Richa (A-2005-30-24) Major Advisor: Dr.R.P.Kaushal

Title: Etiology and management of root rot complex of chickpea

Fusarium solani was found to be a predominant pathogen among three fungi isolated from the infected roots of chickpea**.** It was found to perpetuate through seed, soil and plant debris. 7.5 x10^6 was the optimum spore concentration to cause maximum disease. Bavistin, Companion and Thiram were highly effective in inhibition of mycelial growth of the pathogen. Thiram and Bavistin gave best control of chickpea root rot complex under field conditions. *In vitro* studies conducted to find the efficacy of biocontrol agents against the soil borne pathogen *F. solani* revealed maximum inhibition of mycelial growth in dual culture with *Trichoderma harzianum* (JMA4) and *T. harzianum* (SMA5). Among commercially available biocontrol agents, Sanjivani proved the best inhibiting mycelial growth of *F. solani*. Neem based bio-fungicides tested *in vitro*, Tricure and Achook were found significantly superior in inhibiting the mycelial growth. Bhang provided maximum mycelial inhibition (31.27%) at lowest concentration (20%). The results on the inhibitory activity of botanicals showed that Eucalyptus provided the maximum mycelial inhibition (66.29%). Among different organic amendments, biogas slurry was found the most effective for the control of root rot of chickpea. No disease control was observed when soil was amended with poultry manure. On the other hand, it was found to increase the pathogen population leading to the increase in disease incidence. Chickpea germplasm was evaluated against root rot under natural epidemic conditions during two crop seasons of 2005-06. Different germpalsm lines were categorized into five classes on the basis of their reaction to pathogen based on 2005 season as disease incidence during 2006 was very low. Line BGD113 exhibited highly susceptible reaction while HPG 17 and ICC x 81800 were found resistant.

Rishu Sharma (A-2005-30-25) Major Advisor: Dr. B. M. Sharma

Title: Molecular characterization of *Pleurotus* spp. using molecular markers

Pleurotus mushroom is referred to as 'Oyster Mushroom' and is a lignocellulosic fungus growing naturally in the temperate and tropical forests on dead and decaying wooden logs or sometimes on drying trunks of deciduous or coniferous trees. In the present study, a total of 21 *Pleurotus* isolates were procured/collected from different sources. The present investigations were conducted on morphological aspects, molecular characterization and protein estimation and the results obtained are summarized as follows: A temperature range of was 25-28^{o}C recorded to be optimum for majority of the *Pleurotus* isolates. The experimental fruiting of all the 21 isolates, revealed that faster spawn run and pinning in *Pleurotus* sp. III. *P. flabellatus* I gave a maximum biological efficiency in terms of yield of fructified isolates. Morphological studies including shape, shape, and colour of the

pileus showed considerable variations among all the isolates. The colour of the spore print varied from creamish to white and size of basidiospores ranged from 6.5-9.5X3.0-4.5 to 8.0-11.0X3.0-6.0 μm showing no significant variation. Random amplified polymorphic DNA (RAPD) and PCR-RFLP of ribosomal DNA were used to determine the genetic diversity among *Pleurotus* isolates. For RAPD analysis, out of 150 primers screened, 10 primers (OPD-03, OPD-05, OPD-08, OPA-13, OPA-16, OPQ-15, OPQ-16, OPQ-18, S-1461 and S-1462) showing polymorphism, were selected for amplification. Cluster analysis of scorable RAPD bands generated a dendrogram revealing high genetic diversity in *Pleurotus* species/strains and categorized 21 isolates into three clusters using 16 per cent similarity as a cut-off point. However, RAPD was unable to differentiate the various *Pleurotus* species into distinct clusters. Amplification of 5' portion of 26S ribosomal DNA of *Pleurotus* species/strains using pair primers LROR and LR7 yielded a fragment of 1460 bp in all the 21 isolates of *Pleurotus*. Restriction analysis of the amplified product was done using six restriction enzymes viz. *Msp* I, *Alu* I, *Taq* I, *EcoR* I, *Sac* I and *Sal* I. Cluster analysis of scorable bands generated a dendrogram revealing high genetic diversity in *Pleurotus* species / strains and nine *Pleurotus* species were broadly divided into two clusters using 45 per cent similarity as a cut-off point. A total of five haplotype groups were obtained, of these two were having 100 per cent similarity. The protein content among all isolates was minimum (23.0%) in *Pleurotus* sp. II and maximum (33.7%) in *Pleurotus* sp.III.

Renu Kapil (A-2002-40-12) **Major Advisor: Dr. O. P. Sharma**

Title: Molecular characterization of BCMV strains infecting *Phaseolus vulgaris L.* and evaluation of resistance

Present investigation on bean common mosaic virus was undertaken to determine the pathogenic and molecular variability and to evaluate the common bean germplasm to find out the durable sources of resistance against the prevalent strains of the virus. Extensive surveys of commercial common bean growing areas of Himachal Pradesh revealed the occurrence of disease in almost all the potential bean growing areas of the state with disease incidence ranging from 0.50-77.00 per cent. 107 samples of bean mosaic infected common bean plants showing characteristic mosaic, leaf distortion and stunting type of symptoms were collected and categorized into distinct twenty four isolates on the basis of symptomatology. The electron microscopy of different isolates revealed the presence of flexuous rod shaped virus particles measuring ~ 750 X 15 nm typical of potyvirus group. In DAS-ELISA, the test isolates reacted positively with BCMV polyclonal antiserum only. RT-PCR amplification of coat protein gene using degenerate primers amplified a PCR product of ~ 1000 bp identical to BCMV cp gene. Results of pathogenic variability studies revealed the existence of two pathogroups viz, PG I and PGII and four strain groups (Ia, Ib, IIa and IIb) of BCMV in Himachal Pradesh. Out of these four strain groups two (Ia and IIa) are identical to the previously described strains i.e NL-1 and NL-7, respectively, whereas the other two are different or new. Two strain groups NL-1n (Ib) and NL-7n (IIb) constitute the first record of their occurrence. Reverse phase HPLC peptide profiling of coat protein of BCMV strains revealed that the strain groups under investigation are distinct strains and thus further confirming the results of pathogenic variability. Cloning and sequencing of the test strain NL-1n revealed that the test sequence consisted of 883 bp and was submitted to NCBI gene bank Nucleotide Database under accession number EF036694. Blasted nucleotide sequence showed that the test sequence comprised of partial NIb (1-551 bp) and coat protein (552-883 bp) region which after multialignment and phylogenetic analysis showed maximum homology with BCMV NL-1 strain. Sequence of the test NL-1n strain (EF036694) when compared with the sequence of previously characterized NL-1 (EF036693) strain showed that they have the dissimilarity at the 3' terminal region of coat protein by five nucleotide bases, thereby, differentiating the two strains at molecular level, which were earlier differentiated pathologically and through the coat protein profiles. Twenty two accessions comprising of local land races, recommended cultivars and exotic genotypes were found resistant to two pathogroups (PG I and PG II) and some of the important sources of resistance include cultivars Hans, KRC-22, Kentuky Wonder, Premier, Contender, KRC-4, Kailash, Amanda, Improved Tendergreen 4001 and Black Turtle Soup, Monroe, Great Northern UI 123, Sanilac and contender.

2. RESEARCH

Survey and surveillance

Wheat: Yellow rust was found in traces at a few locations in Kangra, Hamirpur and Bilaspur districts. Loose smut incidence of 0 to 0.5% was recorded in Kangra, Hamirpur and Bilaspur districts only. Very high incidence (10-15%) of hill bunt (*Tilletia caries* and *T. foetida*) was recorded in some fields at Sulah-Nanon (3000' amsl) areas of Kangra district during May, 2008 which was quite interesting since this disease was previously thought to occur in areas with > 4000' (1200m) above mean sea level.

Rusts (YR and LR) appeared late in the season in different parts of districts Kangra and Mandi and were recorded in the end of March. On susceptible wheat varieties viz. Sonalika, HS240, HS277, HS295, HS420, VL616, VL738, UP2338 etc. the severity of YR ranged from 40S-80S. On other improved varieties viz. HPW 42, HPW 155, HPW 251, VL 829 its severity ranged from 5S to 40S. YR was also observed on PBW 343 at Sundernagar in TPN and severity was 60S. Yellow rust was more severe in Kullu and Balh (Sundernagar) valley whereas, brown rust was more severe in Kangra valley. The LR severity in HPW 184, HS 295, HS 420, PBW 343, HS 277, VL 829 and Sonalika ranged from 5S-60S. Powdery mildew was recorded in moderate to severe form (5-8 on 0-9 scale) depending upon the location and variety. The overall incidence of loose smut ranged from 2-4% during this year. Flag smut was recorded in Balh valley (Sundernagar area) and incidence ranged 1-5%.

In district Sirmour, yellow rust was 10-60 S on cvs. PBW 343, HS 240 and UP 2338. In PBW 343 and HPW 155, brown rust ranged between 10-20%. In Raj 3777and Raj 3765 and UP 2338, powdery mildew ranged between 50-90% and flag smut between 10-40%. Karnal bunt in HD 2380 and HS 295 was 0.06- 2.6%.

Rice: In rice, during survey conducted in Sirmour district (Table1), brown spot on PR 116 was found to occur 40%; on hybrid rice, false smut was (2-10%) while in Basmati, leaf and neck blast was (5-10%). During survey in district Mandi blast, leaf and sheath banded blight and brown spot were of major occurrence while bacterial blight was of moderate severity. Disease surveillance conducted in paddy area of different blocks of district Kangra revealed higher incidence of rice blast in some pockets of Nagrota Bagwan block.

Maize: In Mandi district, leaf and sheath banded blight was of major nature while, brown spot and maydis leaf blight were minor. In Sirmour, maydis blight and leaf and sheath banded blight were major while *Erwinia* blight and brown stripe and downy mildew were minor.

Barley: In barley, the severity of yellow rust was high in parts of s Mandi and Kullu and in general varied 10-60S. LR with severity 10-20 S was recorded at Sundernagar. The incidence of loose smut and covered smut ranged from 1-2 % and 1- 3 %, respectively.

Rajmash: Floury leaf spot and anthracnose were moderate to high especially in Zone III whereas angular leaf spot in Mandi district was of moderate intensity.

Mash and mung: In Mandi district, anthracnose and yellow mosaic were of moderate to high intensity while *Cercospoora* leaf spots and leaf crinkle were of low intensity. In district Sirmour, anthracnose and web blight, *Cercospora* leaf spots, leaf crinkle and powdery mildew were of low intensity. In Kullu, *Cercospora* leaf spot was of high intensity.

Gram: Collar rot, black root rot and stem rot were of major occurrence while wilt and grey mould were minor occurrence in Mandi district. In district Sirmour, major diseases were *Ascochyta* blight, root rot, wilt and stem rot while rust was minor.

Lentil: In Sirmour, *Stemphyllium* blight, rust and wilt were major diseases while powdery mildew was of minor importance.

Table 1. Occurrence of diseases of major crops in Sirmour district

Crop	Variety	Disease	Incidence/ severity (%)
Paddy	PR 116	Brown leaf spot	40 %
	Hybrid	False smut	2-10 %
	Basmati	Leaf and neck blast	5-10 %
Chilli	Local	Fusarium wilt	20 %
Capsium	Califonia wonder	Sclerotium collar rot	5-20 %
Tomato	Hybrid	Bacterial wilt	10-40 %
Potato	Kufri Jyoti	Late blight	20 %
		Early blight	5-40 %
Pea	Arkel	White rot	5-20 %
	Lincoln	Ascochyta blight	5-40 %
	Arkel	Root rot complex	10-30 %
	Palam Priya	Powdery mildew	5- 60 %
	Lincoln		
Wheat	PBW 343	Yellow rust	10-60 S
	HS 240		
	UP 2338		
	HPW 155		
	PBW 343	Brown rust	10-20 %
	Raj 3777		
	Raj3765	Powdery mildew	5-9 Score
	UP 2338	Flag smut	10-40 %
	HD 2380		
	HS 295	Karnal bunt	0.06 - 2.6 %
Onion & Garlic	Local	Downy mildew and Purple blotch	Traces 60-70 %

Rapeseed-mustard: Light rains during the second week of December favoured the appearance of disease like *Alternaria* blight and white rust during the last week of December and first week of

January, respectively. However, extremely low minimum temperature (1.8°C) during the month of January was unfavorable for further progress of these diseases at the leaf stage.

The severity of *Alternaria* blight remained low to moderate (10-30%) in mustard and brown *sarson* and low (below 10%) in *gobhi sarson* and *karan rai* at the farmer's fields. Similarly, very low severity of white rust (below 10%) was observed in the mustard crop.

Linseed: Hundred per cent severity of linseed wilt was observed in the susceptible cultivars like Chambal at Kangra in university fields where linseed is grown continuously for the last many years. However, 10-15 % incidence was recorded in the variety Kangra local at the farmer's fields. The wilt ncidence remained low (<5%) in the improved varieties of linseed viz. Nagarkot, Jeewan and Him Alsi-2 at the research farm as well as farmer's fields. Linseed rust appeared in the susceptible varieties like Chambal and Kangra local during the first week of March. The weather conditions in March, 2008 were quite congenial for the progress of rust. Rust (100% severity) was observed in the susceptible variety Chambal at Kangra. However, the disease intensity was low to moderate (10-25%) at the farmer's fields in Kangra, Nagrota Bagwan and Palampur areas, where variety Kangra local was grown.

Sesame: In sesame, *Phytophthora* blight, *Cercospora* leaf spot and *Alternaria* blights remained the major disease problems. *Phytophthora* blight appeared at the seedling stage and 10-50% disease severity was recorded in some of the locations. Leaf spots predominantly caused by *Cercospora* spp. and *Alternaria sesami* appeared at the flowering stage and 25-50% severity was recorded at the leaf stage, whereas 10-25% disease severity was observed on the capsules. Besides these diseases, low incidence of sesamum phyllody (below 5%) was also recorded at some locations.

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. Hara Soya was mostly grown in majority of soybean growing areas in HP. Target spot and pod blight were mainly observed. Mungbean yellow mosaic virus was mainly confined to Kangra district.

Pea: Root rot /wilt of pea in farmers fields was observed in Lahaul valley during 2007 season. It was noticed in traces at higher elevations of Khanjjar, however its incidence was low at Chhalling, Udgosh and Goushal. In Pattan valley, maximum incidence (25-50%) was found at Tandi although at other places the incidence varied from 10-40 %.

In Mandi district, wilt/root rot of pea and powdery mildew were the major diseases while rust and *Ascochyta* blight were of minor importance. In Sirmour district, Arkel and Lincoln cvs. had white rot incidence upto 5-20% and the Arkel and Palam Priya cvs. had *Ascochyta* blight (5-40%) and root rot complex (10-30%) while Lincoln variety had powdery mildew up to 60%.

Potato: High severity (40-60%) of late blight was recorded in some of the areas falling under Bhawarna, Bhedu mahadev and Rait blocks of Distt. Kangra.

Tomato: Tomato suffered from Fusarium wilt, buckeye rot and Phytophthora collar rot in different areas surveyed in Sirmour district while in some areas bacterial wilt was up to 40%. In Mandi district the major diseases were wilt, tomato leaf curl, late blight and mosaic whereas *Septoria* leaf spot was of minor importance. Moderate to high incidence of bacterial canker and wilt (*Clavibacter michiganense pv. michiganense*) was observed in Lathiyani (Hamirpur) area. In another survey conducted in the month of May, 2008 low to moderate incidence of *Phytophthora* blight and bacterial wilt of tomato (var. 77-11 i.e. Avtar) was observed in Bangoli and Bhatoli areas of Dehra tehsil of Kangra district.

Brinjal: In Mandi district bacterial wilt was the major disease while, *Phomopsis* blight was of moderate intensity. Little leaf was of minor importance.

Capsicum: Bacterial wilt (*Ralstonia solanacearum*) incidence of capsicum to the tune of 10-15% was observed under protected (polyhouse) cultivation in Dohag and Sainthal (Joginder Nagar) localities of Mandi district during May, 2008. Likewise, the disease was also reported from Rangas and Bharoli areas of Hamirpur district during May-June. California Wonder variety suffered from *Sclerotium* collar rot from 5-20%. Chillies suffered from *Fusarium solani*, *Colletotrichum* spp. and leaf curl as major diseases while mosaic was of minor intensity in Mandi district.

Ginger: *The crop suffered from rhizome rot, Phyllosticta* leaf spot, bacterial wilt and *Rhizoctonia* leaf blight in command areas of Sirmour district.

Fodder crops: During *kharif* 2007, wilt/root rot, anthracnose/stem rot, and blights of cowpea, blight of maize, *Helminthosporium* blight of bajra and sorghum were observed as the main diseases. In *rabi* 2007 season, oat crop was affected by powdery mildew whereas leaf spot was observed in berseem and Lucerne.

Tea: Blister blight of tea assumed epiphytotic proportions in the mid of August, 2007. Grey and brown blights appeared with low disease intensities, whereas sooty mould became a problem due to mealy bug infestation in tea plantations. Red rust of tea also appeared in the rainy season although, it was present in traces.

Plant disease situation in the organic farm

Major diseases recorded were root rot of pea and lentil (15-20%), powdery mildew of pea (60-65%), early blight of potato (17-22%) and downy mildew of onion (8-12%). Strawberry was found to be infected with leaf sport up to 5-8%. No disease was however, observed in tomato planted in the plot near Triambecum and Agnihotra hut while 15-20% fruit rot and insect attack were recorded in the tomato plants kept in experimental area of forestry department (Table 2).

Table 2. Prevalence of diseases in organic farm

Crop	Disease/ pathogen	Disease icidence/severity %
Wheat	Powdery mildew (*Erysiphe graminis*)	2-5
Gram	Southern blight *(Sclerotium rolfsii)*	2-5
Lentil	Root rot (*Fusarium solani*)	15-20
Pea	Root rot (*Fusarium solani, Fusarium oxysporum)* Powdery mildew (*Erysiphe pisi)* Ascochyta blight (*Ascochyta pinodes*) New blight (*Ascochyta pisarum*)	15-20 60-65 8-10 2-4
French bean	White rot (*Sclerotinia sclerotiorum*)	4-6
Gobhi Sarson	Alternaria blight (*Alternaria brassicae*)	Traces
Potato	Early blight (*Alternaria solani*) Ozone injury	17-22 28-37
Onion	Downy mildew (*Peronospora destructor*)	8-12
Cabbage	Black rot (*Xanthomonas campestris pv campestris)*	Traces
Strawberry	Mycosphaerella leaf spot (*Mycosphaerella fragariae*)	5-8
Aloe vera	Blight	10-15

I Cereals

Wheat

Germplasm evaluation

During 2006-07, 2386 entries were screened under artificial inoculation conditions against major diseases in various plant pathological nurseries and 84, 483, 1096 and 7 entries were found resistant to Karnal bunt, yellow rust, brown rust and powdery mildew, respectively .

Under the All India Coordinated Wheat and Barley Improvement Project, 120 wheat entries were evaluated under artificial inoculation conditions against local isolates of *Tilletia indica* causing Karnal bunt. Seven entries namely; HW 1095, PBW 596, PBW 593, HD 4717, VL 900, HI 8638 (D) and HPW 233 were found resistant.

Out of 130 wheat genotypes, TL 2934 (T), DDK 1025 (Dic), TL 2949 (T), TL 2942 (T) and TL 2942 (I) were resistant to powdery mildew. One hundred twenty six wheat entries were screened by artificial inoculation of head scab pathogen and 17 entries namely ; HS 490, HS 491,VL 900, RAJ 4164, VAS 304, GW 393, HP 1912, MP 1212, K 0607, KO 617, UP 2691, WH1046, HVW 609, VAS 415 (D), PBW 596, HW 1095 and KRL 238 were found resistant. Out of 40 additional genotypes evaluated against yellow rust, brown rust, Karnal bunt and powdery mildew, seven genotypes namely ; WH 1021, DBW 31, DBW 41, CDW 04 (D),TL 2945 (T) TL 2949 (T) and MACS 6215 showed multiple disease resistance.

Fifteen wheat varieties were sown on 15th November and 5th December did not show any significant difference in the occurrence and incidence of yellow rust, brown rust, Karnal bunt and powdery mildew under natural conditions in the field. However, grain yield was significantly reduced under late sown conditions (Table 3). Raj 3777 and HPW 211 showed least incidence under both the sowing conditions. Out of 45 yellow rust samples collected and analyzed, the occurrence of two pathotypes namely; 46 S119 and 78 S 84 was most prevalent on wheat in Sirmour district.

Wheat lines/ genotypes received from the Directorate of Wheat Research under PPSN AVT II, PPSN AVTI and PPSN NIVT/ Special Trials comprising 112, 126 and 294entries, respectively were evaluated against yellow rust. Thirty six, 62 and 198 genotypes were found free from yellow rust infection in PPSN AVT II, PPSN AVTI and PPSN NIVT/ Special Trials, respectively. The wheat lines/ genotypes received from Directorate of Wheat comprising 130 entries were evaluated against powdery mildew. Ninety two genotypes were found free from powdery mildew.

Trap nursery was received from Regional Station, Directorate of Wheat Research (ICAR), Flowerdale, Shimla to monitor the appearance and progress of yellow rust. A total of 20 lines were planted in this nursery and yellow rust appeared in 19 lines.

Table 3. Reaction of wheat to different diseases under natural conditions in early and late sown

	Early sown (15-11-2006)					Late sown (5-12-2006)				
	YR	**BR**	**PM**	**KB**	**Yield (g/plot)**	**YR**	**BR**	**PM**	**KB**	**Yield (g/plot)**
VL616	0	T	6	0.21	850	0	T	6	0.05	650
VL829	20S	0	7	0.12	795	20S	0	7	0.00	700
HS420	60S	10S	9	0.30	690	60S	10S	8	0.20	550
HPW89	0	0	9	0.08	675	0	0	9	0.00	550
HPW184	40s	10S	8	0.30	750	50S	10S	9	0.15	500
HPW155	10s	5S	8	0.25	590	5S	5S	9	0.10	450
HPW211	5S	5S	5	0.06	600	5S	5S	3	0.05	475
HS240	T	T	9	0.40	800	5S	T	9	0.10	500
RAJ3777	T	T	7	0.00	800	5S	T	7	0.00	600
HPW 42	5S	0	9	0.00	650	10S	0	9	0.00	650
RAJ 3765	0	5S	9	0.12	700	T		9	0.08	500
Sonak	60S	0	9	0.48	750	60S	0	8	0.30	550
PBW343	20S	5S	9	0.78	750	20S	5S	9	0.80	600
HS 295	5S	T	9	0.20	700	20S	T	9	0.30	450
PBW 502	60S	T	9	0.40	750	50S	T	9	0.36	550

YR=Yellow rust, BR=Brown rust, KB=Karnal bunt, PM=Powdery mildew, Plot size=2 x1m

Forty two wheat entries comprising of AVT-I & II (NHZ) material, were screened against *Tilletia caries* and *T. foetida* by inoculating the seed of individual entry with teliospores @ 5.0 % (W/W) before sowing. Of these, 2 entries viz. TL 2959 and VL 925 remained free from the disease whereas one entry

viz. TL 2942 recorded resistant reaction (1.82%). Rest of the entries, were susceptible to the disease scoring above 10% incidence.

A trial comprising of 20 wheat lines was planted at SAREC, Kangra and KVK Sundernagar. YR and LR infection under natural conditions was recorded and rusts samples were sent to DWR Regional Station, Flowerdale for identification of races. At KVK Sundernagar, yellow rust was recorded on 18 entries and two entries viz. HD2160 and WH896 remained free from the disease. Leaf rust was not observed at Sundernagar. At SAREC Kangra, LR was recorded on 4 entries viz. Agra Local, Lal Bahadur, C306 and PBW343 and rest of the entries remained free from the disease. YR was recorded on 7 entries viz. WL711, HD2329, Agra Local, Lal Bahadur, HW2021, Kharchia Mutant and Lr24 and rest of the entries remained free from the disease. The pathotypes recorded by DWR Regional Station, Flowerdale on the rust samples sent by this centre for identification of races, were 21 R 55 (104-2) of LR and 46 S 119 and 78 S 84 of YR.

Management of loose smut and Karnal bunt by seed dressing fungicides

The data presented (Table 4) indicated that most of the test fungicides resulted in good germination and plant vigour. All the systemic fungicides gave significant reduction in loose smut. Vitavax and Vitavax power resulted in complete control of loose smut. Carbendazim and F-100 gave 0.40 and 0.53 percent disease, respectively. Karnal bunt did not appear in any of the plots including check.

Table 4. Effect of seed dressing fungicides on the incidence of loose smut and Karnal bunt of wheat

Treatment	Germination (%)	Seedling vigour	Infected ears (%)	Yield /plot (g)
F100 @2.5g/KG	85.00	Good	0.86	1.050
F100 @ 3.0 g / kg	88.33	Good	0.86	0.850
F100 @ 3.5g / kg	86.66	Good	0.53	1.050
Carbendazim @ 2.0 g/kg	90.00	V. Good	0.40	0.950
Mancozeb @2.5 g/ kg	88.33	Fair	5.93	0.716
Vitavax @2.5 g/kg	90.00	Excellent	0.00	1.083
Thiram @2.5 g /kg	88.33	Good	7.83	0.866
Vitavax power @ 3.0 g / kg	88.33	Excellent	0.00	0.983
Check	86.66	Fair	5.51	0.750
CD(P=0.05)	NS	1.09		0.250

Compatibility of seed dressing fungicides, biocontrol agent and insecticides for use in IPM

All the seed dressing fungicides were found compatible with Endosulfan, Chlorpyriphos and biocontrol agent *T. viride*. The data presented (Table 5) indicated that seed treatment with fungicides + insecticides followed by one spray of Tilt and insecticide gave significant reduction of loose smut, Karnal bunt, yellow rust, termites damage, aphids population and resulted in significant increase in

grain yield. However, seed treatment with Vitavax / Bavistin and Chlorpyriphos followed by one spray of Tilt and Chlorpyriphos was the best treatment for controlling diseases and insect pests of wheat.

Table 5. Disease and pest management in wheat through fungicides, insecticides and biocontrol agents

Treatment	Germination (%)	Loose smut incidence ((%)	Karnal bunt incidence (%)	Yellow rust severity	Percent termites damaged shoots per meter row after 5 wks.	Average aphid population per tiller	Yield/ plot(kg)
T1	95.00	0.02	0.98	30S	10.05	6.28	0.850
T2	90.66	0.00	0.58	50S	6.25	9.00	0.750
T3	85.00	0.00	0.75	40S	8.02	7.52	0.750
T4	90.00	0.00	0.01	5S	0.00	1.05	0.800
T5	93.33	0.01	0.00	0	0.00	0.50	0.850
T6	90.00	0.00	0.02	5S	0.00	0.05	0.783
T7	85.00	0.00	0.08	0	0.00	0.57	1.110
T8	85.00	0.00	0.00	0	0.00	0.08	1.033
T9	85.66	0.01	0.06	0	0.00	0.10	0.975
T10	85.00	0.08	0.58	40S	11.10	10.34	0.883
T11	85.66	0.00	0.23	50S	0.00	8.36	0.700
T12	90.00	0.02	0.05	0	0.00	0.00	0.900
T13	80.00	1.08	1.50	90S	18.44	11.05	0.698
CD(P=0.05)	NS	0.21	0.43		1.01	1.09	0.073

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
T6 = Bavistin +Endosulfan @ 2.5 g +5ml / kg +Tilt spray @0.1 % + Endosulfan spray @2.5 ml/ litre
T7 = Raxil + Chloropyriphos @ 1g + 5ml/ kg +Tilt spray @ 0.1% + Chloropyriphos spray @ 1.5 ml/ litre
T8 = Vitavax + Chloropyriphos @ 2.5 g + 5 ml/ kg + Tilt spray @ 0.1% + Chloropyriphos spray @ 1.5 ml/ litre
T9 = Bavistin+ Chloropyriphos @ 2.5 gm+5 ml/ kg + Tilt spray @ 0.1% + Chloropyriphos spray @ 1.5 ml/ litre
T10= *Trichoderma viride*@ 5gm/kg
T11= Tv +Endosulfan @5gm+5ml/kg
T12=Tv+Bavistin +Endosulfan @5gm+1.5gm+5ml/kg+Tilt spray @ 0.1%+Endosulfan spray @ 2.5ml/litre
T13=Control (No treatment)

Management of loose smut and Karnal bunt through biocontrol agents in the production of organic wheat

A field trial on control of loose smut and Karnal bunt conducted by using biocontrol agents at the organic farm Dakwala indicated that *Trichoderma viride* resulted complete control of loose smut as well as Karnal bunt (Table 6). However, *T. harzianum* gave 0.50 and 0.89 percent infection of loose

smut and Karnal bunt, respectively. *Trichoderma hamatum* was least effective in controlling both the diseases.

Table 6. Control of wheat diseases in the production of organic wheat through biocontrol agents

Treatment	Loose smut incidence (%)	Karnal bunt incidence (%)	Yield / plot (g)
Trichoderma viride	0.00	0.00	210
T. harzianum	0.50	0.89	170
Pseudomonas fluorescens	0.75	0.92	160
Bacillus subitilis	0.75	0.95	130
T. hamatum	1.50	1.00	130
Check	1.50	1.04	110
CD (P= 0.05)	0.23	0.0.9	48

Figures are square root transformed before analysis, Plot size : 2.0 x 1.25

Management of Karnal bunt by different formulations of *Trichoderma viride*

All the formulations of *T. viride* resulted significant reduction in Karnal bunt incidence except Sanjeevani (Table 7). However, Ecoderma and Ecoguard gave minimum Karnal bunt infection (0.01%) followed by Trichoguard (0.18%) and Tricho-X (0.24%).

Table 7. Management of Karnal bunt of wheat with formulations of *T. viride*

Treatment	Karnal bunt incidence (%)	Yield / plot (g)
Ecoderma	0.01	560
Sanjeevani	1.78	485
Ecoguard	0.01	656
Trichoguard	0.18	550
Trico - X	0.24	495
Check	1.89	450
CD (P= 0.05)	0.56	105

Plot size 2.0 x 1.75 m; Figures are square root transformed before analysis

1st spray of biocontrol agent @ 5g/l was given at flag leaf stage followed by another spray at 50% emergence of ears i.e. 10days after 1st spray. Biocontrol agents were applied as seed treatment and foliar spray given at 50 percent emergence of ears.

Evaluation of fungicides formulations for the control of loose smut and hill bunt

A replicated field trial on the evaluation of fungicides formulations for the combined control of loose smut and hill bunt was conducted at RWRC, Malan during *rabi* 2007-08. The trial consisted of 10 treatments viz. Fungicide 100 WS @ 0.25, 0.30 and 0.35%, Carbendazim 0.20%, Mancozeb 0.25%, Carboxin 0.25%, Thiram 0.25%, Vitavax Powder 0.30%, F-100 0.70% and a check and three replications of each. These formulations were tested by giving dry seed treatment of each formulation before sowing.

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Table 8. Evaluation of fungicide formulations for the control of loose smut and hill bunt

Sr. No.	Treatment	Conc. @ g/kg seed	RI		RII		RIII		Yield (kg)
			L.S	H.B	L.S	H.B	L.S	H.B	
1	Fungicide 100 WS	2.5	-	0.84	-	2.5	0.51	0.55	0.550
2	--do----	3.0	3.1	6.98	3.38	3.0	1.45	1.81	0.375
3	--do----	3.5	0.75	-	0.38	3.5	2.30	0.70	0.425
4	Carbendazim	2.0	0.67	-	1.55	2.0	3.61	1.80	0.400
5	Mancozeb	2.5	0.52	1.05	0.52	2.5	3.64	1.95	0.300
6	Carboxin	2.5	-	2.60	2.13	2.5	3.91	0.25	0.350
7	Thiram	2.5	1.83	0.61	0.82	2.5	1.66	0.42	0.400
8	Vitavax Powder	3.0	-	-	0.62	3.0	-	2.30	0.380
9	F- 100	7.0	-	1.0	2.39	7.0	2.05	0.24	0.370
10	Control		-	32.10.	1.52		24.6	2.10	0.275

L.S---Loose smut (% incidence), H.B—Hill bunt (% incidence)

The results (Table 8 and 9) obtained were highly inconsistent due to low disease pressure of loose smut during 2007-08. However, all the fungicides were effective in controlling hill bunt when compared with check. When compared with Vitavax 0.30%, none of the treatments were found effective in controlling the disease except Fungicide 100 WS 0.25%.

Table 9. Evaluation of fungicides against loose smut of wheat

Fungicide	Dose (gm/ Kg seed)	Loose smut incidence (%)	Yield (q / ha)	Increase in yield over control (%)
F- 100	2.5	4.12 (11.68)	47.99	45.91
F-100	3.0	4.04 (11.57)	46.72	39.73
F-100	3.5	3.05 (10.02)	45.68	38.87
F-100	7.0	2.51 (9.08)	46.72	42.04
Carbendazim	2.0	2.68 (9.32)	48.21	46.58
Carboxin	2.5	0.43 (3.77)	54.53	65.79
Mancozeb	2.5	9.88 (18.28)	39.84	21.13
Thiram	2.5	8.20 (16.60)	43.74	32.98
Vitavax power	2.5	0.97 (5.57)	50.26	62.81
Control		21.55 (22.62)	32.89	-
CD (0.05)		(1.26)	4.45	-

*Angular transformed values in the parentheses

Barley

Germplasm screening

Out of 424 entries of barley in EBDSN, NBDSN and IBDSN, 263 entries were found resistant to yellow rust under artificial inoculation conditions in field.

Rice

Germplasm evaluation

Fifteen genotypes were screened against rice diseases under natural infection conditions and two genotypes viz. HKR 126 and HRI 152 were found resistant to brown leaf spot and blast (Table 10). Pusa Sungandh and Pusa Basmati were free from false smut. Most of the genotypes were free from neck blast and leaf scald.

Table 10. Reaction of rice genotypes to different diseases

Genotype	Brown leaf intensity (%)	Leaf blast intensity (%)	Neck blast incidence (%)	False smut incidence (%)	Glume blotch intensity (%)	Leaf scald incidence (%)
IR 64	40.0	2.5	0.5	1.0	0.0	4.0
HPR 2041	30.0	T	0.0	0.0	0.0	6.0
HPR 2321	40.0	5.0	1.5	0.0	10.0	5.0
HPR 2323	30.0	5.0	2.0	5.5	2.0	4.0
HPR 2344	20.0	2.0	0.0	2.5	2.50	0.0
PR 108	20.0	0.0	2.5	3.5	5.0	0.0
HKR 126	T	5.0	0.0	4.0	T	0.0
HRI 152	T	T	0.0	3.0	2.5	0.0
BPT 5202	15.0	T	0.0	2.0	10.0	0.0
Pusa sungandh	60.0	10.0	0.5	0.0	10.0	3.0
Super basmati	30.0	20.0	0.0	1.0	5.5	2.0
Pusa basmati	10.0	10.0	1.0	0.0	2.0	1.0
Basmati mutant	30.0	5.0	2.0	1.0	10.5	0.0
Basmati	40.0	2.0	5.0	1.0	5.0	0.0
Kasturi basmati	40.0	10.0	2.0	1.0.	0.0	0.0

T=Traces

Chemical control of rice diseases

Nine fungicides were evaluated against major diseases and incidence data are presented in Table 11. Two sprays of Tilt @ 0.1 % after 45 and 60 days of transplanting resulted maximum reduction of brown leaf spot. However, Controll 5 EC and Bavistin gave best reduction of leaf and neck blast. Blitox-50 gave good control of false smut.

Table 11. Chemical control of rice diseases

Treatment	Conc. (%)	Brown leaf spot intensity (%)	Leaf blast intensity (%)	Neck blast intensity (%)	False smut incidence (%)	Grain yield (kg)/plot
Indofil M45	0.25	10.66	10.00	1.00	1.00	2.200
Blitox50	0.30	22.33	8.00	2.00	0.50	2.000
Bavistin 75WP	0.10	52.00	2.33	0.33	5.00	2.000
Controll 5EC	0.10	10.33	3.23	2.66	2.00	2.600
Tilt 5EC	0.10	5.33	2.66	2.00	4.33	2.500.
Result 5EC	0.10	20.00	3.33	3.66	3.00	2.200
Antracol 75 WP	0.25	29.33	6.66	4.00	5.66	2.200
Contaf 5EC	0.10	36.66	4.33	4.33	3.00	2.500
Ridomil MZ72 WP	0.25	50.00	12.00	5.00	6.66	2.250
Check	-	50.33	13.00	8.33	7.33	1.125
CD (P=0.05)	-	5.08	1.58	0.48	0.45	0.200

Figures are angular transformed before analysis Plot size= 3x3 m

Effectiveness of different *Xa* genes against *Xanthomonas oryzae* pv. *oryzae* population causing bacterial blight of rice in mid hills of HP

The study was repeated during *kharif* 2007 to identify bacterial blight genes and hill rice varieties & landraces showing resistance to the Rajiana isolate of BB in the mid-hills of Himachal Pradesh. The results were consistent with the findings of previous year. Reactions of genotypes were almost identical to the previous year except minor variations. The results showed that recessive genes xa 5, xa 8 and xa 13 and dominant gene Xa 21 imparted resistance to the prevailing isolate. Among different varieties of rice released in the state, seven viz., Himalaya 2, HPU 741, HPU 2216, HPU 957, HPR 1068, HPR 1156 and RP 2421 were found to be resistant. The 14 traditional cultivars of HP, six hill rices from J&K and six japonica varieties tested were all found to be susceptible. Four out of 11 hill varieties from Almora viz., VL 25867-2-2, VL 30424, VL 30425 and VL 81 showed resistance to this isolate.

Maize

Germplasm evaluation

Trap nursery comprising 10 inbred lines received from DMR, New Delhi was planted in isolation and observed for appearance of various diseases under natural epiphytotic conditions. *Erwinia* stalk rot (ESR), brown stripe downy mildew (BSDM), and *Maydis* leaf blight (MLB) and banded leaf and sheath blight (BLSB) were observed in these lines. Genotypes CM 145 and CM 426 remained free from ESR , whereas, genotypes CM 119, CM 444 and CM 460 were highly resistant (disease incidence >10%). Genotypes V 346, CM 145, C M 119, C M 115 and CM 118 were free from brown stripe downy

Two hundred six entries of advanced breeding material comprising early, medium and full season maturity group (IET and AVT) were evaluated against ESR, BSDM, BLSB and MLB. The entries were artificially inoculated with the cell suspension of locally available isolate of E. *chrysanthemi pv zeae*. The stocks were also evaluated against BSDM, MLB and BLSB under natural epiphytotics. JH 11180, MDMH 101and MCH 33were free of *maydis* leaf blight.

Twenty one entries viz. JH 31153, KDMH 1001, CP 828, JH 11422, JH 11433, BH 40709, BH 40712, X 6B 269, Sindhu 333, PRO 372, Bio 9681, MCH 36, PRO 371, PRO 365, PHS 54, PRO 311, 807, FH 3352, FQH 4567 showed multiple disease resistance against ESR, BSDM and MLB.

Thirty three inbred lines received from HAREC Bajaura were evaluated against ESR under artificial epiphytotic conditions, and MLB, BLSB and BSDM under field conditions. Inbred lines CM 145, CM 426, DKI 106, JH 6618, 95088, and KNG 10 were free from ESR whereas, lines DKI 101, DKI 103, DKI 113, KNG 1, and KNG 9 were resistant. Inbred lines DKI 101, 106, 103, 110, JH 6615, B 57, KNG 9 were resistant to MLB and lines CM 115, 119, DKI 106 and B 57 were resistant BLSB. 15 lines received from Deptt. of Plant Breeding were evaluated for its performance under natural condition. *Helminthosporium* leaf spot and leaf and sheath banded blight was the main disease and none

of the line found resistant against these diseases. However, PMZ 4, DKC 7074 (Monsento Co.), X 717, X121 and X789 (Kanchan seeds Co.) showed moderate reaction.

Two hundred five additional genotypes of different maturity groups received from Directorate of Maize Research (Trials no. 61,62,63,64,75,76,77,78) were also screened against *turcicum* leaf blight (TLB) and *maydis* leaf blight (MLB) pathogen under artificial inoculated conditions. All these genotypes were also evaluated against Banded leaf & sheath blight (BLSB) under natural disease conditions. Disease severity was recorded using 0-5 scale. Eleven, 53 and 75 lines were free from TLB, MLB and BLSB, respectively. JH-11433, BH-40708, BH-407013, Kaveri 2288 Super, G-Tech 5101, PRO-373, C.P. 808, JH-11508, BH-40704 were found free from TLB and MLB under artificially inoculated conditions. Maize disease trap nursery consisting of 10 lines was planted to determine the prevalence of different diseases of maize. Maximum disease incidence of TLB and MLB were recorded on V-335. Maximum incidence of BLSB and brown spot were observed on CML-145 and CML-444, respectively.

Management of banded leaf and sheath blight of maize

Three seed dressing fungicides viz. Carbendazim (2.5 gm / kg seed), Vitavax Power (3.0 gm / kg seed) and Thiram (3.0 gm / kg seed) were evaluated against Banded Leaf and Sheath Blight (BLSB). All the fungicides were found superior over control. Thiram was found more effective in reducing lodging caused by BLSB. Similar trends were also observed in yield where seed treatment with Thiram gave 59.79% increase in yield over control. Seed treatment with these fungicides also improved the germination as compared to control by reducing incidence of pre-emergence seed rot by soil borne fungi (Table 12).

Table 12. Management of banded leaf and sheath blight with fungicides

Treatment	Germination* (%)	Lodging* (%)	BLSB Score* (0-5 scale)	Yield* (q/ha)	Yield increase (%)
Seed treatment with Carbendazim @ 2.5 gm/ kg seed	79.80 (63.30)	9.42 (17.84)	2.5	58.50	47.46
Seed treatment with Vitavax power @ 3.0 gm/ kg seed	81.77 (64.81)	11.87 (20.09)	2.5	56.80	43.18
Seed treatment with Thiram @ 3.0 gm/ kg seed	79.70 (63.26)	7.24 (15.54)	2.5	63.39	59.79
Control	72.50 (58.39	16.11 (23.64)	4.5	39.67	-
CD (0.05)	(1.56)	(0.61)	-	6.51	-

***** Average of four replications. Angular transformed values in the parentheses

Management of *Erwinia* stalk rot of maize using bactericides Stanes bacteriomycin plus (Immuno-modulator)

A trial was conducted on the management of ESR using a commercially available bactericide Stanes bacteriomycin (Bromorol -2 bromo-2 nitropropone-2, 3 diol). It is an immuno-modulator. Bacterimycin

was applied @ 0.1% and 0.05% as 2 and 3 drench applications. It resulted in significantly low disease incidence compared with the no treatment control. The yield was also statistically more in all the treatments except in case of application of ampicillin @ 200 ppm. The highest yield (61.1 q/ha) was recorded in plots with two applications of bacteriomycin @ 0.1% (Table 13).

Table 13. Management of Erwinia stalk rot of maize with bacteriomycin

Chemical	No. of applications	Mean ESR incidence (%)	Yield q/ha
Control		24.7 (29.7)	42.8
Bacteriomycin @ 0.05 %	3	22.6 (28.4)	54.3
Bacteriomycin 0.1	3	12.5 (20.6)	51.1
Recommended bleaching powder @16.5kg/ha	3	12.7 (20.6)	51.1
Streptocycline 200ppm	3	15.5 (22.9)	56.1
T2	2	17.4 (24.7)	52.8
T3	2	12.4 (20.5)	61.1
Ampicillin 200ppm	3	18.5 (25.5)	47.2
CD (0.05)		(4.4)	8.01

Values in parentheses are arc sine values

Fungicidal management of foliar diseases of maize

Eight fungicides were evaluated as two foliar sprays for the management of Maydis leaf blight and banded leaf and sheath blight. The disease reaction for MLB and BLSB was statistically at par in all the treatments, however, as compared with the check the % incidence of BLSB was statistically less in all the treatments except in two sprays of kavach 50 WP @ 0.2% (Table 14). Two foliar sprays of fungicides mancozeb resulted in significantly lower disease incidence followed by bavistin 50 WP. The highest yield was recorded in plots treated with companion @ 0.4% (59.3 q/ha) followed by bayleton @% EC 0 .1% (56.2 q/ha).

Table 14. Fungicidal management of foliar diseases of maize

Fungicide		Reaction to			
	Conc.(%)	MLB (1-5)	BLSB (1-5)	BLSB (Inci. %)	
Bavastin 50WP	0.1	1.97	2.6	10.0 (18.37)	49.3
Kavach 50WP	0.2	2.73	3.2	31.66 (34.19)	40.9
Companion	0.4	1.70	2.3	11.66 (19.86)	59.3
Bayleton 25 EC	0.1	2.37	2.5	10 (18.37)	56.2
Mancozeb 70 WP	0.25	1.93	2.7	8.33 (16.72)	51.0
Tilt 25 EC	0.1	2.23	3.2	12.33 (20.5)	53.8
Contaf 25 EC	0.1	2.33	2.9	12 (20.2)	50.3
Score 25 EC	0.05	1.83	2.2	25 (29.9)	46.2
Control		1.97	3.2	28.33 (32.1)	40.9
CD (0.05)		NS	NS	(4.26)	5.99
CV%		29.12	23.8	10.55	6.96

Management of *turcicum* leaf blight of maize

Spray with mancozeb and carbendazim alone or in combination with seed treatment were found effective against TLB and gave 39.12% and 33.17% increase in yield over control. However, seed treatment alone had no effect on the disease except to improve seed germination (Table 15).

Table 15. Management of *turcicum* leaf blight (TLB) with fungicides

Treatments	TLB Score* (1 – 5 scale)	Yield* (q/ha)	Increase in Yield over control (%)
Seed treatment with Carbendazim @ 2.5 gm/kg seed	3.5	55.17	20.80
Seed treatment with Vitavax Power @ 3.0 gm/kg seed	3.5	59.50	30.82
Seed treatment with Thiram @ 3.0 gm/kg seed	3.5	59.18	29.58
T1 + single spray of Mancozeb @ 0.25%	2.1	63.54	39.12
T2 + single spray of Mancozeb @ 0.25%	2.6	57.24	25.33
T3 + single spray of Mancozeb @ 0.25%	2.5	57.37	25.61
T1 + single spray of Carbendazim @ 0.1%	2.3	59.25	29.73
T2 + single spray of Carbendazim @ 0.1%	2.6	58.32	27.69
T3 + single spray of Carbendazim @ 0.1%	2.6	60.82	33.17
T1 + single spray of Copper oxy chloride @ 0.3%	2.8	57.12	25.07
T1 + single spray of Copper oxy chloride @ 0.3%	3.1	56.14	22.92
T1 + single spray of Copper oxy chloride @ 0.3%	3.3	54.20	18.67
Single spray of Mancozeb @ 0.25%	2.8	60.89	33.32
Single spray of Carbendazim @ 0.1%	2.3	60.53	32.53
Single spray of Copper Oxy Chloride @ 0.3%	3.3	55.47	21.45
Control	4.8	45.67	-

II. Pulses

Mash

Germpalsm evaluation

During Kharif 2007, about 400 promising germplasm lines received from NBPGR, New Delhi were evaluated against MYMV (mungbean yellow mosaic virus). Ninety six lines were free and 88 were found resistant under natural epiphytotic conditions. Fifty genotypes of *mash* received from IIPR Kanpur were evaluated under natural epiphytotic conditions at Dhaulakuan and 10 genotypes were found resistant to powdery mildew and 7 to *Cercospora* leaf spot, 26 genotypes were highly resistant to MYMV, 9 lines were resistant to anthracnose. In another germplasm evaluation trial at Sunder nagar, out of 12 germplasm lines evaluated, six were found resistant to anthracnose and 4 were resistant to web blight.

Disease management

A field trial was conducted to evaluate efficacy of 12 fungicides as two foliar sprays using variety UL 338 for the management of foliar diseases of mash. The data were recorded for two diseases

viz. anthracnose (*Colletotrichum truncatum*) and web blight (*Rhizoctonia solani*). Application of all the fungicides resulted in significantly less disease incidence (Table 16) of web blight as compared to check (43.64%).

Table 16. Efficacy of fungicides for the management of foliar diseases of urdbean

Treatment	Fungicide	Dose	Web blight Incidence (%)	Yield (q/ha)
T1	Bavastin 50 WP	0.1	13.3 (21.39)	9.23
T2	Indofil M 45 70 WP	0.25	28.0 (31.9)	10.09
T3	$CuOCl_2$ 50 WP	0.3	16. 7 (24.08)	10.99
T4	Bavastin + Indofil M 45	0.1+0.25	21. 7 (27.72)	10.40
T5	Tilt 25 EC	0.1	25.0 (29.97)	7.593
T6	Score 25 EC	0.05	13.3 (21.36)	9.41
T7	Contaf 5 EC	0.1	21. 7 (27.58)	8.83
T8	Antracol 70 WP	0.4	11. 7 (19.98)	8.64
T9	Kavach 50 WP	0.2	16.6 (23.97)	11.11
T10	Ridomil	0.2	33.3 (35.20)	9.14
T11	F 100	0.1	25.0 (29.91)	10.25
T12	Bayleton 25 EC	0.1	11.0 (19.28)	11.88
T13	Control		47. 7 (43.64)	6.67
	CD (0.05)		(4.13)	2.52
	CV %		8.96	13.3

Two sprays of Bayleton 25EC @ 0.1% resulted in minimum disease intensity (19.28%) followed by Antracol 70 WP (19.98), Score 25 EC (21.38%) and Bavistin (21.39). All the treatments resulted in more yield as compared to check (6.67 q/ha). The highest yield was recorded in Bayleton 25EC followed by Copper oxychloride (0.3%).

Mungbean

Out of 70 genotypes evaluated for resistance under natural epiphytotic conditions, 26 lines were found resistant to MYMV and 6 lines were resistant to anthracnose.

Kulthi

Out of 20 lines evaluated for MYMV, three lines were resistant to mosaic.

Chickpea

One thousand two hundred entries from various sources were evaluated under artificial epiphytotic conditions against *Ascochyta rabiei*. Twenty lines were found resistant. Seven lines were found free from stem rot. Out of 408 entries received from NBPGR were evaluated for resistance to *Ascochyta* blight. Thirteen lined were found resistant to the disease. Eighty five lines were resistant to stem rot. International *Ascochyta* blight Nursery (Desi) was evaluated for resistance to *Ascochyta* blight and fifteen lines were found resistant to the disease. In another trial conducted at Sundernagar, out of 16 entries received for evaluation, three lines were resistant to root rot and seven were resistant to viral diseases.

Lentil

Four lines were found resistant to the rust in Dhaulakuan. In Sundernagar, 18 lines were evaluated for resistance to root rot and rust, no line was found resistant.

III. Oilseeds

Rapeseed-mustard

Germplasm evaluation

Thirty two entries of rapeseed-mustard were screened against *Alternaria* blight and white rust diseases under natural conditions. The severity of former varied from 14.7 % (SBG-07-25) to 51.1 % (SBG-07-40). Entries coded SBG-07-39 and SBG-07-43 showed low infection (below 25%) on leaves. Severity on pods ranged from 17.1% to 43.3%. Minimum disease severity (17.1%) was observed in SBG-07-25. Few entries like SBG-07-31, SBG-07-33 and SBG-07-39 also showed less infection (below 25%) on pods.

Highest disease severity of white rust (33.6%) was recorded in SBG-07-43. Entries SBG-07-3, SBG-07-8, SBG-07-13 to 17, SBG-07-19 to 20, SBG-07-25 to 26, SBG-07-30, SBG-07-34 and SBG-07-41 remained free from white rust. Disease severity was also below 10% in SBG-07-6, SBG-07-7, SBG-07-31, SBG-07-33, SBG-07-36, SBG-07-38, SBG-07-39 and SBG-07-40. Staghead infection was observed in five entries viz. SBG-07-4, SBG-07-5, SBG-07-31, SBG-07-37 and SBG-07-42.

Thirty eight entries of rapeseed-mustard were also screened against *Alternaria* blight and white rust diseases in Uniform Disease Nursery trial under artificial inoculation conditions. Minimum infection was recorded in UDN-07-17 (18.2%). Disease severity on leaves was also below 25 % in entries coded UDN-07-16, UDN-07-20 and UDN-07-29. Disease severity of Alternaria blight on pods varied from 4.2% in UDN-07-20 to 43.3% in UDN-07-17. Few more entries coded UDN-07-29, UDN-07-31, UDN-07-50, UDN-07-58 and UDN-07-59 showed low infection (below 25%) on pods.

The severity of white rust ranged from 0-29.3%. The entries like UDN-07-1, UDN-07-3, UDN-07-7, UDN-07-11, UDN-07-12, UDN-07-16, UDN-07-17 and UDN-07-20 remained free from white rust infection. Staghead infection was only recorded in two entries viz. UDN-07-26 and UDN-07-27.

Thirty nine entries of rapeseed-mustard were screened in National Disease Nursery. The severity of *Alternaria* blight on leaves ranged from 21.0-46.9%. Lowest disease severity on leaves (21.0%) was observed in NDN-07-101. *Alternaria* pod blight severity ranged from 14.4 to 47.6%. Disease severity on pods was below 25% in NDN-07-68, NDN-07-74, NDN-07-82, NDN-07-95, NDN-07-96, NDN-07-97, NDN-07-98 and NDN-07-103. The entries like NDN-07-61, NDN-07-62, NDN-07-67, NDN-07-70, NDN-07-84, NDN-07-92 and NDN-07-106 remained free from white rust infection. Few entries like RMQ-07-8, RMQ-07-9, RMQ-07-10 and RMQ-07-11 showed low infection (below 25%) of *Alternaria* blight on leaves. Minimum disease on pods (28.0%) was recorded in RMQ-07-27. The entries RMQ-

07-1, RMQ-07-2, RMQ-07-9, RMQ-07-10, RMQ-07-11 and RMQ-07-18 remained free from white rust disease. There was no staghead formation in any of the entry.

Chemical control of *Alternaria* blight and white rust of mustard

A field experiment was conducted during 2007-08 to evaluate nine different fungicides against *Alternaria* blight and white rust diseases of mustard using susceptible variety Varuna. Three sprays of each fungicide were applied on 60, 80 and 100 days after sowing. Data on severity of diseases, yield and 1000 seed weight were recorded (Table 17).

Table 17. Chemical control of *Alternaria* blight and white rust of mustard

Treatments	Disease severity (%)					
	Alternaria blight (leaves)	*Alternaria* blight (pods)	White rust	Staghead	Yield (kg/ha)	1000 seed wt.(g)
Tilt (0.1%)	13.9(21.9)	5.0(12.9)	29.8(33.1)	1.9(7.9)	1778	2.93
Indofil M-45(0.25%)	23.0(28.6)	6.1(14.3)	18.5(25.4)	0.5(4.0)	1802	3.00
Companion (0.2%)	28.7(32.4)	8.2(16.6)	17.0(24.3)	0.7(4.8)	1741	3.03
Ridomil MZ (0.25%)	29.6(33.0)	6.4(14.6)	0.4(2.0)	0(0)	2123	2.97
Score (0.05%)	3.3(10.4)	1.9(7.8)	22.7(28.4)	0.6(4.3)	2296	3.17
Contaf (0.1%)	13.2(21.3)	4.7(12.4)	26.1(30.7)	0.8(5.2)	1770	3.00
Blitox-50(0.25%)	27.4(31.6)	6.2(14.4)	22.4(28.2)	0.7(4.7)	1751	3.03
Antracol (0.2%)	26.8(31.2)	5.1(13.0)	18.5(25.4)	0.5(4.1)	1802	3.13
Indofil Z-78(0.25%)	33.7(35.5)	7.1(15.4)	19.0(25.9)	0.6(4.3)	1738	2.97
Unsprayed	46.1(42.7)	16.8(24.2)	33.4(35.3)	1.6(7.3)	1491	2.80
CD(P=0.05)	1.6	1.5	2.7	0.5	133	0.13

Figs in parentheses are arc sine transformed values

The severity of *Alternaria* blight on leaves as well as pods was lowest (3.3, 1.9%) in case of Score (0.05%). Lowest severity of white rust on leaves (0.4%) was observed in case of Ridomil MZ (0.25%). There was no staghead formation in case of Ridomil MZ. Highest yield (2296kg/ha) and 1000 seed weight was also highest (3.17g) in this treatment.

Efficacy of different doses of Tilt, Score and Contaf against *Alternaria* blight of mustard

Three sprays of fungicides were applied on 60, 80 and 100 days after sowing. Data on disease severity, yield and 1000 seed weight were recorded (Table 18). The severity of *Alternaria* blight on leaves as well as pods was lowest (6.0, 3.8%) in case of Score (0.1%) followed by 7.6 and 6.3% in Score (0.05%). Highest yield of 1436kg/ha was recorded in case of Score (0.1%) followed by 1420 kg/ha in Score (0.05%), 1365 kg/ha in Tilt (0.1%) and 1349 kg/ha in Contaf (0.1%). Highest 1000 seed wt. (3.48g) was recorded in case of Score (0.05%). No significance difference in yield and 1000 seed weight was observed among Score (0.1%, 0.05%), Tilt (0.1%) and Contaf (0.1%).

Table 18. Efficacy of different doses of Tilt, Score and Contaf against *Alternaria* blight of mustard

Treatment	Dose (%)	Disease severity (%)		Yield (kg/ha)	1000 seed wt.(g)
		Alternaria blight (leaves)	*Alternaria* blight (pods)		
Tilt 25EC	0.1	14.4(22.3)	6.5(14.8)	1365	3.46
Tilt 25EC	0.05	23.2(28.7)	10.6(19.0)	1286	3.34
Tilt 25EC	0.025	29.0(32.6)	15.8(23.4)	1119	3.17
Score 25EC	0.1	6.0(14.2)	3.8(11.2)	1436	3.46
Score 25EC	0.05	7.6(15.9)	6.3(14.5)	1420	3.48
Score 25EC	0.025	14.4(22.3)	13.5(21.5)	1278	3.19
Contaf 5EC	0.1	13.9(21.9)	13.0(21.2)	1349	3.44
Contaf 5EC	0.05	19.4(26.0)	16.1(23.6)	1230	3.37
Contaf 5EC	0.025	24.4(29.6)	18.7(25.6)	1135	3.18
Indofil M-45	0.25	20.7(27.1)	15.6(23.2)	1254	3.17
Control		35.0(36.3)	23.1(28.7)	960	2.93
CD(P=0.05)		1.8	1.7	135	0.09

Figs in parenthesis are arc sine transformed values

Evaluation of plant extracts against the foliar diseases of mustard

Fresh extracts (1%) from leaves of *Eucalyptus, Datura, Agave americana, Ipomea cornea* and bulbs of garlic were evaluated along with the recommended fungicide Indofil M-45 against *Alternaria* blight and white rust diseases of mustard using susceptible cultivar Varuna. Three sprays of extract were applied on 60, 80 and 100 days after sowing in case of leaf extracts whereas garlic extract was tested as seed treatment, foliar spray and as seed treatment in combination with foliar sprays. There was a significant reduction in the severity of *Alternaria* blight and white rust as a result of sprays (Table 19). Severity of *Alternaria* blight on leaves, white rust and staghead infection was least (27.3, 22.6 and 1.3%, respectively) in case of Indofil M-45. Among the various plant extracts tested, lowest severity of *Alternaria* blight on leaves (29.7%) was recorded in case of *Agave americana,* which remained statistically at par with *Eucalyptus* and *Ipomea*. Lowest severity of *Alternaria* blight on pods was observed in case of *Eucalyptus* followed by *Agave*. Among the plant extracts, lowest severity of white rust was observed in case of garlic seed treatment combined with its foliar sprays followed by *Eucalyptus* and *Agave*. These treatments had also low staghead infection.

Table 19. Bio efficacy of plant extracts in the management of foliar diseases of mustard

Treatment	Disease severity (%)				Yield (kg/ha)	1000 seed wt.(g)
	AB (Leaves)	AB(Pods)	White rust	Stagheads		
Eucalyptus	31.0(33.8)	7.5(15.8)	26.9(31.2)	1.6(7.3)	1728	2.79
Datura	31.4(34.0)	8.6(17.0)	29.2(32.7)	2.4(8.9)	1585	2.55
Agave	29.7(33.0)	8.0(16.4)	26.9(31.2)	1.4(6.9)	1647	2.74
Ipomea	31.0(33.8)	11.0(19.4)	31.2(33.9)	2.1(8.3)	1573	2.61
Garlic ST	34.9(36.2)	12.1(20.4)	29.9(33.1)	2.2(8.4)	1486	2.46
Garlic (foliar sprays)	32.7(34.9)	8.9(17.4)	28.4(32.2)	2.0 (8.2)	1516	2.56
Garlic(ST + foliar sprays)	31.6(34.2)	8.8(17.2)	26.3(30.9)	1.7(7.5)	1545	2.66
Indofil M45 (0.25%)	27.3(31.5)	8.8(17.2)	22.6(28.3)	1.3(6.5)	1733	3.10
Control	38.3(38.2)	16.2(23.7)	35.1(36.3)	3.4(10.6)	1333	2.40
CD(P=0.05)	1.5	1.6	2.2	0.9	182	0.08

Figs in parentheses are arc sine transformed values

The highest seed yield of 1733 kg/ha was also observed in case of Indofil M-45 closely followed by *Eucalyptus* (1728 kg/ha) and *Agave* (1647 kg/ha). 1000 seed weight was highest in case of Indofil M-45(3.10g).

Effect of sowing dates on major diseases of mustard

Two recommended varieties of mustard (Varuna and RCC-4) were planted on ten dates starting from Oct.1 onwards at weekly interval. The data (Table 20) revealed that severity of *Alternaria* blight on leaves; downy mildew and staghead infection were significantly low in variety RCC-4 as compared to Varuna. There was no significant effect of sowing dates on white rust severity and pod infection of *Alternaria* blight in the two varieties. Although, 1000 seed wt. was slightly lower in RCC-4 in comparison to Varuna yet RCC-4 yielded significantly higher (1223kg/ha) as compared to Varuna 897kg/ha). Severity of *Alternaria* blight on leaves was lowest (35.5%) on Oct.1 sown crop and there was a gradual increase in the disease severity on sowing beyond this date up to Nov.12. A slight decline in disease severity was recorded again beyond this date. Comparatively, lower infection of *Alternaria* blight on pods was observed on early sowing dates viz. Oct.1and Oct.15. Severity of *Alternaria* blight on pods was maximum (39.2%) in Oct.29 sown crop and a significant reduction in disease severity on pods was noticed after this date. Lowest severity of white rust on leaves (12.3%) was observed in the Oct.1 sown crop. There was a remarkable increase in white rust severity with delay in sowing time. Highest disease severity (43.9%) was recorded on Nov. 5 sown crop and a slight decline in disease severity was noticed beyond this date. Severity of downy mildew was highest (46.5%) in the October 29 sown followed by Nov. 5 sown (43.2%). Disease was remarkably less in the sowing dates prior and after these dates.

Table 20. Effect of sowing dates on major disease of mustard

Treatment	Disease severity (%)*					1000 seed wt (g)	Yield (kg/ha)
	AB (leaves)	AB (pods)	White rust	Downy mildew	Stagheads		
Variety							
Varuna	45.0	37.6	32.1	31.8	8.0	3.0	897
RCC-4	43.9	35.7	33.2	23.8	6.7	2.9	1223
CD (P=0.05%)	0.4	NS	NS	0.6	0.5	0.1	58
Date of sowing							
1Oct.	35.5	36.9	12.3	28.7	0	3.3	1011
8Oct.	42.7	38.4	17.6	29.1	0	2.9	1056
15Oct.	46.6	35.1	20.2	29.4	0	2.8	1330
22Oct.	48.4	38.5	30.0	29.8	8.4	3.0	1204
29Oct.	48.3	39.2	36.1	46.5	8.8	2.9	1081
Nov.05	47.7	36.0	43.9	43.2	9.8	3.0	1037
Nov.12	48.2	37.3	43.0	27.2	10.9	2.9	1074
Nov.19	43.6	36.2	42.7	17.0	12.7	2.9	1000
Nov.26	40.9	35.2	41.6	16.0	11.2	2.8	944
Dec.3	42.3	34.2	39.2	10.6	11.4	2.8	866
CD (P=0.05%)	1.6	1.5	1.9	1.8	0.7	0.1	98

The crop sown by Oct.15 escaped staghead infection. Lowest staghead infection (8.4%) was observed in Oct.22 sown crop and its severity increased with delay in sowing, being highest (12.7%) in Nov. 19 sown crop. Highest 1000 seed weight was recorded in Oct.1 sown crop. Seed yield was highest (1330kg/ha) in 15 October sown crop followed by 22 October (1204kg/ha).

Chemical management of *Alternaria* blight of mustard

Fungicides score 25 EC, tilt 25 EC and contaf 5EC were highly effective as 3 foliar sprays at 15-20 days interval for the management of Alternaria blight, hence spray schedule was worked out as 2, 3 and 4 sprays of these fungicides at 15 days interval using mustard variety Varuna. The data on leaf blight intensity, white rust intensity and yield are given in Table 21. All the fungicides reduced Alternaria blight severity on leaves and more yield as compared with the no spray check. Three foliar spays of Contaf 5EC @ 0.1% resulted in the least leaf infection (20.4%) followed by 3 sprays of Score 25EC (22.14%). The yield was the highest in plots with 4 sprays of score 25EC (10.64 q/ha) followed by four sprays of Contaf 5EC (10.49 q/ha). White rust was recorded in all the plots sprayed with sterol biosynthesis inhibitors.

Table 21. Spray schedule of Score @% EC, Tilt 25 EC and Contaf 5 EC for the management of leaf blight of mustard

Fungicide (conc.)	No. of sprays	Alternaria blight on Leaf	White rust	Yield (q/ha)
Tilt 25EC (0.1)	2	34.8 (36.12)	27.1 (31.02)	895.1
Tilt 25EC (0.1)	3	18.9 (25.56)	28.2 (32.05)	1018.5
Tilt 25EC (0.1)	4	31.9 (34.18)	25.0 (30.03)	1034.0
Contaf 5EC(0.1)	2	12.1 (20.40)	30.4 (33.38)	895.1
Contaf 5EC (0.1)	3	13.9 (21.85)	32.9 (34.98)	1018.5
Contaf 5EC (0.1)	4	23.4 (28.35)	32.3 (34.59)	1049.4
Score 25EC (0.05)	2	18.7 (25.53)	32.9 (34.89)	956.8
Score 25EC (0.05)	3	14.4 (22.14)	35.1 (36.16)	1003.1
Score 25EC (0.05)	4	15.6 (23.13)	33.4 (35.21)	1064.8
Indofil M 45 (0.25)	4	33.8 (35.41)	20.4 (26.86)	956.8
CuOCl2 (0.3)	4	35.8 (36.56)	19.3 (26.02)	935.2
Control		49.8 (44.74)	22.4 (28.12)	709.9
		(8.73)	(6.72)	170.3
		17.39	12.43	10.46

Linseed

Germplasm evaluation

Out of 200 entries of linseed, 52 entries were found highly resistant (disease score 0) to rust and 47 entries were observed resistant (disease score 1) to wilt. 21 entries namely LCK-9420, LCK-9436, LMH-43, LMH-90-7, LMH-91-24, NL-24, NL-93, RLC-40, RLC-59, RSJ-6, EC-399085, EC-397760, BSL-11, BSL-12, 5/3, 4/4721/4K, GLC-36, LC-134, LC-268, KL-160 and Punjab Flax were observed resistant to both the diseases. Out of 72 entries, UDN-2, UDN-3, UDN-5, UDN-14, UDN-16, UDN-18, UDN-19, UDN-36, UDN-37, UDN-38, UDN-47, UDN-58, UDN-70 and UDN-71 were observed resistant to rust as well as wilt. Out of 84 entries, IDSN-4, IDSN-5, IDSN-7, IDSN-11, IDSN-12,

IDSN-17, IDSN-32, IDSN-37, IDSN-49, IDSN-51, IDSN-53, IDSN-56, IDSN-59, IDSN-62, IDSN-63, IDSN-64, IDSN- 66, IDSN-67, IDSN-68, IDSN-69, IDSN-73, IDSN-75 and IDSN-76 showed resistance to both rust and wilt.

Chemical control of linseed rust

Severity of rust was significantly lowered in all the treatments. Minimum disease severity (10.2%) and maximum yield (759 kg/ha) was recorded in case of Propiconazole (0.1%) on variety Chambal (Table 22).

Table 22. Chemical control of linseed rust

Treatment	Disease severity (%)	Yield(kg/ha)	1000 seed wt.(g)
Propiconazole (0.1%)	10.7 (19.0)	759	5.24
Hexaconazole (0.1%)	12.7 (20.8)	708	5.27
Difenconazole (0.05%)	21.3 (27.5)	745	5.10
Chlorothalonil (0.2%)	26.0 (30.6)	597	5.10
Companion (0.1%)	24.7 (29.7)	648	5.18
Dithane M-45 (0.25%)	24.0 (29.3)	606	5.17
Dithane Z-78 (0.25%)	32.0 (34.4)	602	4.89
Control	44.7 (41.9)	542	4.52
CD (P=0.05%)	3.3	55	0.35

Sesame

Sixty five entries of sesame received from AICRIP sesame were evaluated against prevalent diseases of sesame All the entries were free except IVT07-2, 8, 12, AVT 6, 9, 10 of phyllody. A few lines were resistant to *Cercospora* leaf spot.

Fungicidal management of *Phytophthora* blight of sesame

All the treatments except seed treatment with Kavach @ 4gm/kg resulted significantly less Phytophthora blight incidence (%) as compared with check. The least disease incidence was recorded (Table 23) in seed treated with Ridomil MZ (20.49 %) followed by Metalxyl @ 6.0g/kg (21.26 %).

Table 23. Efficacy of seed treating fungicides for the management of Phytophthora blight of sesame

Treatment	Fungicide (dose)	Disease incidence (%)
T1	Ridomil MZ (4gm/kg)	12.33 (20.49)
T2	Metalaxyl 35 WP (6gm/kg)	13.33 (21.26)
T3	F 100 (4gm/kg)	18.33 (25.28)
T4	Captan (3gm/kg)	20.00 (26.46)
T5	Bavastin 50 WP (3gm/kg)	20.00 (26.44)
T6	Metalxyl 35 WP+Bavistin 50WP (3+3 gm/kg)	18.33 (25.32)
T7	Vitavax power (4gm/kg)	16.67 (24.01)
T8	Thiram (3gm/kg)	17.67 (24.81)
T9	Trichoex (6gm/kg)	18.33 (25.32)
T10	Pseudocel (6gm/kg)	25.00 (29.91)
T11	Kavach (4gm/kg)	31.67 (34.16)
	Control	35.00 (36.22)
	CD (0.05)	(4.01)

Soybean

Germplasm evaluation

Thirty two entries IVT and AVT received from Department of Plant Breeding, CSKHPKV, Palampur, were evaluated against soybean mosaic virus. The entries P 5-1 (RKS 211 X PK 472)**,** P 12-1-1 (SL 284 X PB 1)**,** P 7-2-4-1 (SL 284 X PB1)**,** P 1-1-1-1(PK1053 X P 71-1)**,** P 12-2-1 (SL 284 X BRAGG)**,** P 1-4 (SL 284 X BRAGG) and P 69-3-1-1-1(PK 1053 X HIMSO 107) were highly resistant to soybean mosaic virus.

Thirty nine lines comprising initial varietal trial (IVT) in coded numbers were received from NRCS, Indore for evaluation under natural hot spot conditions. Each line was sown in three rows of 5m each. The data were recorded based on 0-9 scale and percent disease index was calculated. The percent disease index was calculated as per the standard method. The entries with code nos.9, 20, 21, 32, 36 were free of target spot while, 1, 2, 15, 16, 19, 34, 37 and 38 were free of pod blight. Many such entries 4-9, 11-13, 14, 19-26, 27-29, 31, 35 and 39 were late maturing and therefore escaped the disease. The entries 1, 3, 5, 9, 10, 14, 15, 24, 27, 29 and 37 were high yielder.

Three rows of 3 m each of seven lines including three checks of soybean germplasm comprising AVT I and AVT II were sown in the Department of Plant Breeding and Genetics each consisting of four replications under RBD design. The data of disease incidence were recorded at terminal disease severity using 0-9 scale. The percent disease index was calculated as laid down in the technical programme. The average yield (g/plot) of each line was calculated by pooling the yield of four plots in each case. All the test entries gave statistically higher yields as compared to the check entries. VLS 63 was resistant to target spot and pod blight. VLS 64 was resistant to target spot while VLS 67 was resistant to both target spot and pod blight diseases. However, VLS 59 and VLS 63 gave highest yields among all lines (Table 24).

Table 24. Evaluation of AVT (I & II) entries for resistance to prevailing diseases in HP

Entry	Percent disease index			Mean yield (g/plot)
	Brown spot	Target spot	Pod blight	
VLS 59	11.11	11.11	0	1737.50
VLS 63	11.11	0	0	1772.50
VLS 64	33.33	0	33.33	1175.00
VLS 67	11.11	0	0	1496.25
Bragg ©	33.33	33.33	11.11	1511.25
VLS 47©	55.55	0	11.11	1410.00
JS 335 ©	55.55	0	0	1080.00
CD (5%)				249.37
CV (%)				11.54

IV. Vegetables

Pea

Germplasm evaluation

Powdery mildew

Out of 482 lines screened during 2007 at Palampur, 98 cvs. / lines were selected and planted at Kukumuseri. Sixteen lines viz; DPP-13, IC-218985, IC-424893, IC-208375, Sugar Giant, EC- 538007, Mr. Big, EC- 292171, EC- 507770, IC- 243389, JI- 1559, HFP-8909, JI-1766, DPP-25G, DPP-13 T and DPP-1542 EP gave resistant reaction. During 2007-08, 314 lines were again screened at Palampur. Twenty seven entries viz. DPP-19, DPP-362, DPP-80, DPP-13, PMR-21, VN-53, IC-267733, DPP-62, EC- 538008, DPR- 62,IPFP- 2-6,P- 212B, DMR- 49,Mr. Big, MNR- 894, KMMR-896,JP-15-1,JP-501-A/2,JI-1766, PB29B, DPP-9411, DPP-25G,DPP-13T,FC-2,Pb-89,DPP-127-R and DPP-120 gave resistant reaction.

Ascochyta blight complex

Two hundred and sixty nine pea germplasm lines procured from different sources were evaluated for resistance under laboratory conditions against two major *Ascochyta* species. The lines were evaluated using detached leaf method. Leaves with 0-5 mm lesion diameter were categorized as resistant while those showing more than 5mm were categorized as susceptible. None of the germplasm lines showed resistance to the two isolates of *Ascochyta* blight complex.

Selection of differentials to study pathogenic variability in *Erysiphe pisi*

For the selection of host differentials, pea germplasm collected from different sources was screened against powdery mildew under field conditions at different locations. Out of the screened lines, 98 genotypes were selected on the basis of their reaction against powdery mildew and further evaluated under laboratory conditions for the selection of differentials in order to study the pathogenic variability. Depending upon the differential reaction of 98 pea germplasm against powdery mildew isolates *in vitro*, 34 lines were further selected and screened with 26 isolates. On the basis of reaction of these lines, 13 lines viz., JP-825, EC-334160, NIC-11181, EC- 292164, EC- 313635, EC- 329561, JI- 1559, JI- 2480, PB29B, EC-292166, JI 2302, EC- 538008 and Lincoln were selected to devise a standard differentials set for identification of races in future.

Inheritance of resistance in powdery mildew

Among all the genotypes, six lines showing resistance to powdery mildew viz., JI-1559, JI-2480, IPF- P- 2-5, DPP-13, DPP-25G, DPP-1542 EP along with one susceptible line 'Lincoln' were selected. These genotypes were crossed in diallel mating design. Hybridization was carried out between resistant x susceptible lines with reciprocals. The crosses among resistant x resistant were also attempted.

Study on molecular variability of *Erysiphe pisi*

Conidial mass of 25 pea powdery mildew isolates was harvested with a fine camel hair brush carefully in eppendorf tubes. Only single isolate was harvested in a day and then stored in deep freezer at -80^{0}C. DNA of these isolates was extracted by grinding conidial mass with liquid nitrogen using a micro-pestle. A known amount of DNA of 25 isolates was loaded in gel stained with Ethidium bromide solution to visualize the presence of isolated DNA. The isolated DNA was stored in a deep freezer for further screening work. The extracted DNA of these isolates was also used for selection of primers with PCR-RAPD technique. Twenty two primers viz., OPA-13, S1461, S1462, S1464, S1467, S1469, S1470, S1472, S1477, S143, S144, S149, S1013, S1014, S1018, S1020, OAK-20, OPA-4, OPA-9, POQ-3, OPD-10 and OPA-14 were selected for studying polymorphism in pea powdery mildew isolates.

DNA fingerprinting of Ascochyta blight isolates

DNA fingerprinting of *A. pisi* and *M. pinodes* isolates was performed by Random Amplified Polymorphic DNA (RAPD) technique of Williams *et. al*. (1990) as described below: Total genomic DNA of individual isolate was extracted following the procedure of Sharma *et al*. (2005). DNA samples were quantified spectrophotometrically (Smartspec 3000, BIORAD, USA) at 260 nm. The samples were diluted to a first concentration of 10 µg/µl with TE (10 mm Tris-HCl, pH 8.0, 1 mM EDTA) and in equal amounts to form three DNA bulks.

DNA fingerprints

The RAPD profiles generated by different primers were compared to determine relationship among 40 isolates. The presence or absence of each RAPD band of a particular molecular weight in all the isolates was scored manually and binary matrix was generated. Initially 150 primers were used for PCR amplification of DNA of two fungal isolates. Of these, eight viz., OPA-02, OPA-13, OPA-09, OPQ-13, OPD-11, OPQ-18, S-144 and S-1466 giving consistent banding pattern were selected for RAPD analysis of 39 isolates of *Ascochyta* species as number of missing values in one isolate were quite high. The number of scorable and polymorphic bands obtained with each primer is given in Table 25. The number of bands obtained with different primers ranged from 4 to 7 of which 4 to 6 were polymorphic. A total of 43 RAPD bands were obtained with all the primers of which 41 (95.4%) were polymorphic. Cluster analysis of the RAPD bands generated a dendrogram with a co-phenetic correlation coefficient of 0.84, which substantiates the accuracy of dendrogram. The dendrogram analysis of 39 isolates revealed a high genotypic diversity within *Ascochyta* population. Most of the isolates were clustered into two major groups Group I and Group II with 16 and 18 isolates respectively at a similarity coefficient of 0.62.

Table 25. Number of scorable and polymorphic RAPD bands obtained by PCR amplification of DNA of 40 isolates of *Ascochyta* species

Primer	Scored bands	Polymorphic bands	Polymorphism (%)
OPA-02	5	5	100
OPA-13	5	5	100
OPA-09	5	6	100
OPD-11	4	4	100
OPQ-13	6	6	100
OPQ-18	6	6	100
S-144	7	5	71.5
S-1466	5	5	100
Total	43	41	95.4

This confirms the two species to be present in this region as inferred on the basis of morphological traits. However, the RAPD was unable to differentiate the two species as both the *Mycosphaerella pinodes* isolates clustered into two different groups i.e. As 27 in Group I and As 34 in Group II. This necessitates trying more primers and generating a dendrogram based on a larger matrix. Moreover, there were 5 such isolates which didn't group in any of the two groups. This indicates the possibility of a third species.

To overcome this ambiguity other molecular markers are needed for better results. Two REP-PCR primers viz, ERIC 1 and BOX-AIR primers were also used however, these primers didn't show much variability and therefore twelve ISSR were tried. Out of these 12 ISSR, 4 primers have given good polymorphism and so more primers are needed to generate a binary matrix with enough bands to generate an accurate dendrogram. One of the best approaches applied to differentiate the fungal species is the ribosomal DNA analysis. The ITS and IGS region of the rDNA was amplified and restriction digestion with various enzymes was tried to differentiate the isolates into species. Three primer pairs ITS 1 and ITS 4, PN 11 and PN 22 and LR 0R and LR 07 were used to amplify the internal transcribed spacer, inter-generic spacers, ITS2 and part of 5.8 S regions. Several four base pair cutter restriction enzymes viz., Taq I, EcoR I, Sac I, Sau 3a were tried for cleaved amplified polymorphism. Very little success was achieved as agrose gel electrophoresis could not resolve the bands with slight variation in molecular weight and thus restriction product is needed to be run on 12 % PAGE. The work on restriction analysis is still in progress.

Disease management of pea

Effect of seed treatment and foliar spray of different organic products on pea diseases

The incidence of root rot complex ranged between 4.2 to 33.0% while powdery mildew and ascochyta blight were found in traces on all the treatments. Seed treatment and foliar spray with Himbio was most effective and reduced the wilt / root rot complex incidence to 4.2% as compare to control (10.3%) followed by seed treatment with Himbio and foliar spray with vermiwash (6.9%), Himbio seed treatment and foliar spray of Mataka khad (7.2%) and compost tea (7.4%).The treatments were

statistically at par with each other. However seed treatment and foliar sprays of Agnihotra ash had a negative effect on the disease, registering 33.0% disease incidence as compared to 10.30 % control (Table 26).

Table 26. Effect of seed treatment and foliar spray on pea diseases

Treatments	Wilt/root rot complex		Powdery mildew	Ascochyta blight
	incidence	% control		
Biosol10% (SD)+Biosol 10%(FS)	17.3 (24.4)	-67.9	-	Traces
Biosol 10% (SD)+Compost tea10%(FS)	12.5 (20.6)	-21.3	-	-
Agnihotra ash 4g/kg(ST)+ Agnihotra ash 0.5%(FS)	33.0 (35.0)	-220.3	Traces	-
Himbio 4g/kg(SD) + Himbio0.5% (FS)	04.2 (11.6)	59.2	-	Traces
Himbio4g/kg(SD) +Vermi wash10%(FS)	06.9 (15.2)	33.0	-	-
Himbio4g/kg(SD)+ Compost tea10%(FS)	07.4 (15.6)	28.1	-	Traces
Himbio(SD) 4g/kg + Matka khad 10%(FS)	07.2 (15.5)	30.0	-	-
Control	10.3 (18.6)	-	Traces	Traces
CD at 5 %	4.5 (3.9)			

FS= Foliar spray; SD= Seed treatment

Evaluation of biocontrol agents and fungicides against root rot complex and foliar diseases of pea

The data (Table 27) revealed that seed treatment with biocontrol agents resulted significant reduction in root rot and white rot incidence over check. However, local isolates of *T. harzianum* and *T. viride* resulted in maximum reduction of root rot complex. *Trichoderma harzianum* seed treatment followed by one spray of Bavistin gave complete control of white rot and powdery mildew. *Trichoderma viride* seed treatment + Bavistin spray also resulted good control of foliar diseases of pea except rust. However, foliar spray of Folicur gave complete control of pea rust.

Table 27. Relative efficacy of bio-control agents and fungicides against soil borne and foliar diseases of pea

Treatment	Disease severity (%)					Seed Yield/plot(g)*
	RR	**WR**	**AB**	**Rust**	**PM**	
T. harzianum ST @5g/kg +Bavistin spary@0.1%	4.66	0.00	5.00	10.66	0.00	250.00
T.viride ST @5g/kg +Bavistin spary@0.1%	3.66	1.66	2.33	15.00	0.66	233.33
Ecoderma @5g/kg ST+Tilt spary@0.1%	6.33	2.33	12.33	8.33	2.66	208.33
Sanjeevani @5g/kg ST+ Folicur spary @0.1%	12.33	6.33	10.33	0.00	7.00	291.16
KaliSena @5g/kg ST +Blitox-50 spary@0.3%	7.66	9.33	4.33	9.33	6.66	183.33
Thiram ST @ 3g/kg seed+Contaf spary @0.1%	5.33	10.33	3.00	9.66	0.00	266.66
Bavistin ST @1g/kg seed +Contaf spary @0.1%	4.00	1.66	7.33	1.33	0.00	286.33
Check (No treatment)	18.33	1066	9.33	12.66	7.66	150.00
CD (P=0.05)	1.68	1.05	2.61	5.27	2..05	12.48

RR=Root rot, WR=White rot, AB=Ascochyta blight, PM=Powdery mildew, ST=Seed treatment

Effect of bioagent + Agnihotra application on root rot/wilt complex of Pea

The data on effect of bioagent application with Agnihotra ash on root rot of pea are presented in Table 28. All the treatments were significantly effective in the management of root rot/ wilt complex on pea. Seed treatment and soil application of Himbio and Agnihotra ash proved highly effective reducing the root rot incidence to 15.7 % comparison to 24.3% in control. This treatment was followed by seed treatment of Himbio and Agnihotra ash (15.9%) and seed treatment of Himbio and soil application of Agnihotra ash (16.8%) respectively. The treatments were statistically at par with each other and the former.

Table 28. Effect of bioagent + Agnihotra application on root rot/wilt complex of pea

Treatments	Root rot/wilt complex	
	Incidence	% control
Himbio+Agnihotra (0.5%) ST	15.9(23.4)	34.5
Himbio (0.5%) ST +SA (Agnihotra)0.5%	16.8(24.0)	30.8
Agnihotra (0.5%) ST + Himbio (0.5%) SA	19.4(26.0)	20.1
Himbio + Agnihotra (0.5%) SA	19.5(26.1)	19.7
Himbio +Agnihotra (0.5%) ST + Himbio + Agnihotra (0.5%) SA	15.7(23.2)	35.3
control	24.3(29.4)	
CD at 5 %	(2.42)	

Figures in parentheses arc sine transformations. ST=Seed treatment SA=Soil application

Evaluation of carbendazim 25% +mancozeb 50% (75WS)) against root rot wilt complex of peas

A field trial consisting of 12 treatments was conducted at Palampur on peas to study the effect of seed treatment with fungicides against root rot/ wilt complex of peas in RBD with 3 replications. Carbendazim (25%) + mancozeb (50%) 75WS was evaluated with three concentrations alongwith 8 fungicides viz. carbendazim 50 WP (Benfil), mancozeb 75 WP (Indofil M-45), carboxin 75 WP (Vitavax) and carboxin 37.5% + Thiram 37.5% (Vitavax power), carbendazim 12%+mancozeb 63%, (Companion), Tebuconazole 2 DS (Tilt) and metaxayl 8% + mancozeb 64% (Matco). The test fungicide (carbendazim 25% + mancozeb 50% 75WS) at all the tested concentrations gave maximum disease control (53.7 to 60.8%) with maximum green pod yield increase over check (25.1 to 45.9%). Hence the test fungicide was found quite effective as seed dressing against root rot of peas (Table 29).

Another field trial consisting of 9 treatments was conducted at Kukumuseri on pea's variety Azad P-1 where all the fungicides were found effective in controlling the disease as compared to control. Raxil @ 2 gm and carbendazim @ 2.5 gm were statistically at par in reducing the wilt incidence and improved the yield. Invitro evaluation of these fungicides on seed germination, root and shoot length after 7 days of germination, were conducted with 50 seeds per treatment per replication. The seed germination in all the treatments were statistically at par. The root and shoot length after 7 days of germination varied

from 4.73 cm (F 100 WS @ 3.0 gm / Kg of seed) – 9.82 cm (Raxil @ 2.0 gm / Kg of seed) and 2.10 cm (F 100 WS @ 2.5 gm / Kg of seed) to 3.65 cm (Control no seed treatment), respectively (Table 30).

Table 29. Comparative efficacy of Carbendazim 25% +Mancozeb 50% (75WP) against root rot wilt complex of pea

Fungicide	Dose (g/kg)	Root rot		Yield	
		Incidence (%)	Control (%)	Q/ha	Increase (%)
Carbendazim + mancozeb 75 WP	2.5	18.3	53.7	25.9	25.1
Carbendazim + mancozeb 75 WP	3.0	16.5	58.2	28.7	38.6
Carbendazim + mancozeb 75 WP	3.5	15.5	60.8	31.6	52.7
Carbendazim 50 WP	2.0	19.3	51.1	30.2	45.9
Mancozeb 75 WP	2.5	28.4	27.8	26.4	27.5
Carboxin 75 WP	2.5	28.5	27.8	26.1	26.1
Thiram 75 WP	2.5	28.3	28.4	27.2	31.4
Carboxin 37.5% + Thiram 37.5%	3.0	25.6	35.2	26.7	29.0
Carbendazim 12% + mancozeb 63%	2.5	18.5	53.2	26.4	27.5
Tebuconazole 2 DS	1.0	21.7	45.1	23.8	15.0
Tebuconazole 2DS	2.0	21.3	46.1	24.5	18.4
Metalaxyl 8% + macozeb 64%	2.5	24.6	37.7	24.6	18.8
Check	-	39.5	-	20.7	-
CD (P=0.05)		1.4		1.6	

Table 30. Fungicidal management of root rot/ wilt complex of peas (Variety AP-1)

Fungicides	Rate (gm/ Kg seed)	Wilt incidence (%)	Disease control (%)	Root length (cm)	Shoot length (cm)
Carbendazim + mancozeb 75 W	2.5	14.08 (22.02)	60.89	4.93	2.1
Carbendazim + mancozeb 75 W	3.0	11.82 (20.08)	67.17	4.73	2.26
Carbendazim	2.5	9.57 (17.97)	73.42	6.40	2.45
Mancozeb	2.5	23.48 (28.97)	34.79	6.05	3.37
Carboxin	2.5	16.56 (24.01)	54.01	4.99	2.38
Raxil	2.0	9.81 (18.22)	72.75	9.82	3.15
Vitavax power	2.5	15.83 (23.44)	56.04	5.88	2.80
Thiram	2.5	24.25 (28.48)	32.65	5.50	3.22
Control	-	34.62 (36.01)	-	7.95	3.65
CD (0.05)		(0.98)		2.60	ns

Angular transformed values in the parentheses.

Another experiment consisting eight seed dressing treatment comprising of seven chemical fungicides one bio-agent for the management of root rot/wilt complex of pea was also laid out in Seraj valley of the Mandi district during rainy season 2007. Data on the disease incidence/severity was recorded

and presented in the Table 31. Carbendazim gave highest disease control (71.1 per cent) followed by Raxil (64.5) and Vitavax Power (64.2).

Table 31. Evaluation of different fungicides seed treatment for the management of root rot wilt complex of pea

Sr. No.	Fungicide	Dose	Germination (%)	Plant stand/ plot	Infected plant (%)	Disease control(%)
1	F 100	3 g/kg	76.6	275.7	15.3	59.4
2	Carbendazim	2.5g/kg	80.8	291.0	10.9	71.1
3	Raxil	2.0g/kg	76.7	276.0	13.4	64.5
4	Vitavax	3.0g/kg	80.0	288.0	14.9	60.5
5	Vitavax power	3.0g/kg	78.7	283.7	13.5	64.2
6	Thiram	3.0g/kg	74.6	268.7	20.7	45.1
7	Mancozeb	3g/kg	72.8	262.3	20.8	44.8
8	Bio-agent	8g/kg	70.8	254.7	28.6	24.1
9	Control	-	70.2	253.0	37.7	-
	C.D(0.05)	-	-	-	3.53	-

In another trial on management of pea diseases was conducted at Kukumuseri and the data (Table 32) revealed that root rot/ wilt incidence was comparatively lower at 30 DAS than in 65 DAS. Soil application of bioagent was found most effective in checking the disease incidence both at 30 DAS and 65 DAS, although other treatments show the effect at par with each other. The effect of seed treatment with Bavisitin alone seems to have been declining at 30DAS. Disease incidence is also less in treatment T2 where the seed was dressed with the bioagent alone and its effect is quite persistent. This treatment increased the yield by 21% when compared with the yield of control. Treatment T5 was found quite effective both in respect of reducing the disease incidence and increasing the yield up to 36.9% over the control.

Table 32. Disease incidence, yield and % increase in yield of the four on farm trials on Integrated Management of root rot/wilt of pea in Lahaul valley

Treatments	% Disease incidence (Mean)		Yield (kg / ha)	% increase in yield over control
	30 DAS	65 DAS		
T_1 Seed treatment with Bavistin	2.55 (7.70)*ab	5.85 (11.50)b	14627 a	21.9
T_2 Seed treatment with bio-agent	2.02 (6.88)ab	3.63 (8.80)ab	14516 a	21.0
T_3 Soil application of bio-agent	1.49 (5.79)a	3.19 (8.31)a	15075 a	25.7
T_4 Seed treatment with Bavistin and soil application of bio-agent	3.05 (9.13)abc	4.46 (10.01) ab	15521 a	29.4
T_5 Seed treatment with bio-agent and soil application of bio-agent	2.10 (7.78)ab	4.35 (9.38) ab	16426 a	36.9
T_6 Control (untreated seed)	6.17 (12.43) c	14.23 20.42)c	11998 b	
CD (P=0.05)	3.72	2.72	2449	

Figures in parentheses are the means of transformed values

Management of root rot complex of pea through seed dressing fungicides at farmers field in Haripurdhar

A field trial conducted for the management of pea diseases in a farmer's field at Haripurhhar during August, 2007 revealed that seed treatment with Vitavax resulted in minimum incidence of root rot followed by Vitavax power and Thiram (Table 33). These treatments also gave good plant stand and significant increase in green pod yield.

Table 33. Effect of seed dressing fungicides on germination, plant stand, root rot complex and green pod yield of pea at Haripurdhar

Treatment	Germination (%)	Plant stand / plot	Root rot (%)	Green pod yield /plot (kg)
F-100 @ 2.5g/kg	64.00	115.66	1.97	2.166
Carbendazim @2.0g/kg	65.66	123.66	1.59	2.466
Raxil @ 2.0g/kg	39.66	75.33	4.64	1.750
Vitavax @ 2.5g/kg	75.00	142.66	0.64	2.900
Vitavax power @ 2.5g/kg	69.00	128.33	0.69	2.900
Thiram @2.5g/kg	62.83	127.33	0.77	2.430
Mancozeb @2.5g/kg	52.83	107.33	1.03	1.566
Bioagent @5g/kg	43.00	82.33	4.58	1.583
Check	43.00	81.66	5.05	1.360
CD (P= 0.05)	12.05	8.72	1.68	0.410

Figure are angular transformed before analysis

Control of root rot of pea through seed dressing fungicides at Dhaulakuan

The data presented (Table 34) indicate that seed treatment with Vitavax @ 2.5g/kg seed resulted least root rot incidence. However, F 100 @ 7g/kg gave maximum plant stand, less incidence of root rot and significant increase in grain yield.

Table 34. Effect of seed dressing fungicides on germination, plant stand, root rot complex incidence and dry grain yield of pea at Dhaulakuan

Treatment	Germination (%)	Plant stand per plot	Rot rot complex incidence (%)	Dry grain yield / plot (g)
Carbendazim @2.5g/kg	78.33	108.66	3.12	300.00
Mancozeb @2.5g/kg	80.00	103.66	4.53	278.66
Vitavax@2.5g/kg	78.33	131.33	1.46	316.66
F-100 @2.5g/kg	80.00	123.66	2.44	250.00
F-100 @3.0g/kg	81.66	132.00	2.69	258.33
F-100@3.5g/kg	80.00	149.23	2.87	333.33
F-100 @7.0g/kg	81.66	152.00	1.51	353.33
Check	78.66	104.00	4.85	283.33
CD (P=0.05)	NS	15.89	1.09	105.46

Figure are angular transformed before analysis

Integrated management of root rot/ wilt complex on farmers field

A field trial with 6 treatments viz. T_1=Seed treatment with Bavistin, T_2=Seed treatment with bio-agent, T_3=Soil application of bio-agent, T_4=Seed treatment with Bavistin and soil application of

bio-agent, T_5=Seed treatment with bio-agent and soil application of bio-agent and T_6=-Control was conducted at village Tailling, Goushal, Tingret and Trilokinath.

At Tailing significantly highest disease incidence was recorded from untreated check while the lowest disease incidence at 65 DAS was recorded from T_3 (soil application of bioagent) though it was at par with all other treatment where either the seed was treated with fungicide or bioagent was applied to the soil (T_1, T_2, T_4 and T_5). The green pod yield was also highest and gave 33.3% increase in yield over the check. A very little beneficial effect of either seed treatment or soil application or both in checking the disease was observed at Goushal.

At Tingret, disease incidence was not significantly affected by various treatments at 30 DAS while at 65 DAS, all the treatments in which either seed was treated with Bavistin or bioagent was applied to the soil or both proved to be significantly better than the check where untreated seed was used Regarding green pod yield, treatment in which the seed was treated with bioagent along with application of bioagent to the soil proved to be the best giving as yield increase of 72.3% over heck, though this treatment was at par with the treatment in which only seed was treated with bioagent.

Different treatments at Trilokinath involving seed treatment or soil application or both of fungicide and bioagent had no significant effect on disease incidence at 30 DAS as the treatments were at par with the untreated check (T_6). However, at 65 DAS, the untreated check showed significantly highest disease incidence as compared to other treatments, all other treatments remaining at par with each other. Green pod yield, treatment in which seed was treated with bioagent and soil application of bioagent (T_5) gave significantly highest yield though it was at par with treatment T_1 , T_4 and T_2. The untreated check gave significantly lowest yield.

Potato

Evaluation of biocontrol agents and fungicides as seed treatment against black scurf of potato

The data presented in Table 35 indicated that tuber treatment with F 100 @ 7g/kg seed gave minimum black scurf incidence, disease index and resulted significant increase in tuber yield. This treatment rated at par with combined application of *T. viride* in soil and tuber treatment with *T. viride*.

Evaluation of F-100 (carbendazim 25% +mancozeb 50% (75WS)) against black scurf and late blight of potato

To study the effectiveness of new fungicide i.e. carbendazim 25%+mancozeb 50% (75 WS) as tuber treatment against black scurf and late blight of potato, trials were conducted at Una and Palampur, respectively. The test fungicide was evaluated at four different concentration alongwith carbendazim (Benfil), mancozeb (Indofil M-45) & Emissan-6. The tubers were treated for 30 min before sowing. The data presented in Table 36 revealed that test fungicide @3 and 3.5g/l were most effective and provided

73.4 & 72.3% disease control with 11.8 & 12.3% increase in yield, respectively with non-significant differences.

Table 35. Effect of tuber treatment on germination, black scurf incidence, and disease index and tuber yield of potato

Treatment	Germination (%)	Disease incidence (%)	Disease index (%)	Tuber yield (kg)
T1 = Ecoderma (soil application)@40g/plot	78.33	18.33	14.75	6.800
T2 = Ecoderma tuber treatment @ 5g/l	80.00	17.33	12.16	7.133
T3 = T1+ T2	83.33	10.33	9.50	7.266
T4 = Boric acid tuber treatment @3g/l	80.00	12.00	9.33	6.300
T5 = Emisan tuber treatment @2.5g/l	81.66	14.00	8.08	5.600
T6 = F-100 tuber treatment @3.5g/l	80.00	13.33	7.66	5.500
T7 = F-100 tuber treatment @7g/l	80.00	10.33	6.75	6.733
Check	73.33	40.00	25.41	5.133
CD (P=0.05)	NS	5.06	2.10	0.410

Figures are angular transformed before analysis

Table 36. Effectiveness of Carbendazim 25% + Mancozeb 50% (75 WS) against black scurf (*R. solani*) of potato

Fungicide	Conc. (g/l)	Black scurf		Yield	
		Incidence (%)	Control (%)	Q/ha	Increase (%)
Carbendazim + mancozeb 75 WS	2.0	4.6	51.1	134.9	6.8
Carbendazim + mancozeb 75 WS	2.5	3.3	64.9	130.9	3.6
Carbendazim + mancozeb 75 WS	3.0	2.5	73.4	141.2	11.8
Carbendazim + mancozeb 75 WS	3.5	2.6	72.3	141.8	12.3
Carbendazim 50 WP	2.0	4.2	55.3	136.3	7.9
Mancozeb 75 WP	2.5	6.6	29.8	134.8	6.7
Emisan-6	3.0	3.1	67.0	147.3	16.2
Check	-	9.4	-	126.3	-
CD (P=0.05)		0.7		6.2	

The data in Table 37 showed that appearance of late blight of potato was delayed for l0 days as compared to control by the test fungicide at 3 g/l and above concentration. Test fungicide at 3 g/l and 3.5 g/l provided maximum i.e. 67.1% & 56.5% disease control with 26.9 and 28.5% increase in yield, respectively. In general the tuber treatment with test fungicide was effective against black scurf and late blight and comparable with recommended fungicides.

Table 37. Effectiveness of Carbendazim 25% +Mancozeb 50% (75 WS) against late blight of potato

Fungicide	Conc. (g/l)	Late blight		Days after disease appear over check	Yield	
		Severity (%)	Control (%)		Q/ha	Increase (%)
Carbendazim + mancozeb 75 WS	2.0	5.3	37.6	10	171.7	18.7
Carbendazim + mancozeb 75 WS	2.5	4.2	50.6	11	169.3	17.0
Carbendazim + mancozeb 75 WS	3.0	2.8	67.1	11	183.6	26.9
Carbendazim + mancozeb 75 WS	3.5	3.7	56.5	11	186.0	28.5
Carbendazim	2.0	4.2	50.6	5	172.0	18.9
Dithane M-45	2.5	6.1	28.2	4	168.9	16.7
Emisan-6	3.0	7.4	12.9	4	158.3	9.4
Check	-	8.5	-	-	144.7	-
CD (P=0.05)		0.4			3.9	

Tomato

Efficacy of *barein* (*Acorus calamus*) against *Ralstonia solanacearum* causing bacterial wilt of solanaceous vegetables

The antibacterial activity of aqueous extract of *barein* (*Acorus calamus*) at 100%, 50% and 25% concentrations was determined against *Ralstonia solanacearum* by paper disc method. The data (Table 38) revealed that *barein* was not at all effective against *Ralstonia solanacearum* even at 100 per cent concentration.

Table 38. Efficacy of *barein* (*Acorus calamus*) against *Ralstonia solanacearum*

Treatment	Treatment/concentration	Inhibition zone* (mm) after hrs of incubation	
		22hr	44hr
T_1	*Barein* 100%	0.00	0.00
T_2	*Barein* 50%	0.00	0.00
T_3	*Barein* 25%	0.00	0.00
T_4	Streptocycline 100µg ml^{-1}	7.37	6.68
T_5	Streptocycline 50µg ml^{-1}	4.75	4.81
T_6	Streptocycline 25µg ml^{-1}	3.06	2.87
T_7	Streptocycline 12.5µg ml^{-1}	0.00	2.00
T_8	Copper oxychloride 100µg ml^{-1}	10.81	12.50
T_9	Copper oxychloride 50µg ml^{-1}	9.68	12.00
T_{10}	Copper oxychloride 25µg ml^{-1}	9.62	10.31
T_{11}	Copper oxychloride 12.5µg ml^{-1}	7.25	6.90
T_{12}	Control	0.00	0.00

*Average of eight replications

Copper oxychloride exhibited maximum inhibitory effect against the bacterium followed by streptocycline at all the concentrations. Higher the concentration of the fungicide or the antibiotic, greater was the inhibition zone. The study revealed that the concentration of the active substance

present in 5 per cent aqueous extract of *barein* was too low to exhibit any inhibitory effect on the growth of *Ralstonia solanacearum*.

Performance of tomato hybrids against bacterial wilt under protected cultivation

The performance of 11 tomato hybrids and the open pollinated variety Palam Pink (check) was determined against bacterial wilt disease in a polyhouse during summer season of 2008. Each variety was replicated thrice. The incidence of disease was recorded at weekly intervals. The varieties Shreshta, Tejus, Arka Abhijeet, Naveen, Arka Ananya, Surya, Palam Pink, VNR and F1 were found completely free from bacterial wilt. However, the incidence in Rakshak, Him Sona and 7730 was found to be 22.9%, 4.2% and 10.4%, respectively. The tomato hybrid VNR was 100% infected with TMV.

Incidence of bacterial wilt in tomato variety 7711 in organic farming system

The wilt incidence varied from 11.6 % (vermin-compost alone) to 17.5 % (FYM enriched with Rock phosphate + Vermi-compost (50:50). Incidence of *Alternaria* blight and buck eye rot was also observed (Table 39).

Table 39. Incidence of bacterial wilt in tomato variety 7711 organic farming system.

Treatment	Bacterial wilt incidence
Vermi-compost alone	11.6
FYM enriched with Rock phosphate	11.8
FYM + Vermi-compost (50:50)	15.2
FYM enriched with Rock phosphate + Vermi-compost (50:50)	17.5
Control	13.0

Capsicum

Collection of fungus isolates

Twenty five isolates of *Colletotrichum capsici* were collected from Kullu, Sirmour and Kangra districts of Himachal Pradesh, cultured on PDA and 15 isolates purified by single spore isolation technique and maintained on Mathur's medium for further studies.

Collection of Germplasm

About 90 germplasm lines of chilli/ bell pepper have been procured from NBPGR and Nun Hems Seed Company, Bangalore and department of Vegetable and Floriculture, CSK HPKV, Palampur. Efforts are being made to import seed from AVRDC, Taiwan for screening purpose. Germplasm lines procured from different sources are being grown for seed multiplication under net house conditions for evaluation purpose.

Genetic Diversity studies

DNA Extraction, Primer Synthesis and Screening of Primers

DNA of 50 ISSR and 10 *C. capsici* specific SSR markers have been custom synthesized for molecular diversity study. Fungus isolates are being multiplied on Potato dextrose broth for isolation of DNA for molecular diversity study. Work on screening of microsatellite markers is in progress.

Colocasia

Fungicidal management of *Phytophthora* blight of Colocasia

One systemic (Ridomil MZ) and 4 protectant (Blitox, Dithane-M45, Cholorothalonil, and Antracol) fungicides were evaluated alone and in different spray schedules under field conditions at four locations (Table 40). At all the locations three sprays of Ridomil MZ (0.25%) at 15 days interval was found most effective in managing the blight disease. The perusal of the data revealed that all the treatments reduced the disease significantly in comparison to control plots. However, in spray schedules, wherever one spray of Ridomil was given, the disease was invariably reduced significantly then the sprays schedules without Ridomil MZ. Yield data (available from 2 locations only) also revealed that Ridomil improved the yield at Dhaulakuan location significantly and also spray schedules wherever Ridomil MZ was sprayed invariably increased the yields.

Table 40. Fungicidal management of Phytophthora blight of colocasia

Treatment	Dose	Disease severity (%)				Yield q /ha	
		Bajaura	Una	D.kuan	S.nagar	Una	D.kuan
T_1 Ridomil MZ	0.25	6.73 (15.03)	3.83 (2.20)	11.8 (19.9)	13.3 (21.33)	277.8	298.3
T_2 Blitox	0.25	15.40 (23.10)	7.17 (2.85)	27.8 (31.8)	43.3 (41.14)	263.4	218.3
T_3 Dithane M-45	0.25	16.73 (24.14)	8.77 (3.12)	32.9 (34.9	23.3 (28.84)	267.5	216.7
T_4 Cholorothalonil	0.20	17.40 (24.64)	9.17 (3.18)	18.1 (25.1)	15.0 (22.78)	525.4	251.1
T_5 Antracol	0.25	18.3 (25.34)	10.9 (3.45)	27.0 (31.2)	22.8 (27.98)	244.9	205.6
T_6 Ridomil MZ– T_2	0.25-0.25	13.27 (21.36)	3.73 (2.17)	19.8 (26.3)	28.3 (32.13)	238.7	256.1
T_7 Ridomil MZ– T_3	-do-	13.40 (21.47)	4.33 (2.31)	15.8 (23.4)	26.67 (31.06)	271.6	243.3
T_8 Ridomil MZ– T_4	0.25-0.20	14.47 (22.35)	6.57 (2.75)	33.9 (35.6)	21.7 (27.70)	254.6	212.8
T_9 Ridomil MZ– T_5	0.25-0.25	15.07 (22.84)	6.27 (2.70)	31.2 (33.9)	23.3 (28.84)	251.7	235
T_{10} Blitox –T_1-T_2	As per the doses	14.06 (22.03)	2.67 (1.91)	14.0 (21.6)	30.0 (33.20)	296.4	268.3
T_{11} Dithane M-45- T_1- T_3	As per the doses	15.17 (22.92)	21.17 (1.78)	13.4 (21.4)	28.3 (32.13)	294.9	253.9
T_{12} Cholorothalonil- T_1-T_4	As per the doses	15.20 (22.94)	4.0 (2.34)	18.5 (25.4)	26.7 (31.06)	279.2	276.1
T_{13} Antracol – T_1- T_5	As per the doses	15.57 23.24)	4.3 (2.30)	35.2 (36.3)	25.0 (29.99)	271.6	209.4
T_{14} Control	--	47.26 (43.37)	19.3 (4.51)	44.8 (42.0)	78.3 (62.26)	186.6	183.9
CD (p=0.05)		(1.75)	(0.19)	(5.5)	(3.97)	13.7	8.44

Sponge gourd

Management of sudden wilt of sponge gourd

Five insecticides and one bactericide (Table 41) were evaluated in different spray schedules for the management of sudden wilt of sponge gourd at 4 locations in Kangra district in farmers' fields. The T_1 (T_1 = Roket (1 ml / l) – Endosulfan (2 ml / l)- Sevin (2 g / l) was least effective among the treatments at Dhanot but was moderately effective at other 3 locations. T_2 to T_6 were most effective at three locations but varying degree of management was observed at Dhanot location. Disease pressure at this location was very high, where Bactrimycin (0.03 %), T_6 to T_7 resulted in 40 percent incidence whereas T_5 showed 20 percent diseases when three sprays at 15 days interval were given. as compared to 1200 percent in control plots.

Table 41. Management of sudden wilt of sponge gourd

Treatment	Sudden wilt incidence (%)			
	Dhanot	Kotkwala	Samloti	Gummar
T_1 = Roket (1 ml / l) – Endosulfan (2 ml / l)- Sevin (2 g / l)	100	40	20	20
T_2 = Sevin – Endosulfan - Cypermethrin (1 ml/ l)	100	0	0	0
T_3 = Profenofos (1 ml/l)- Endosulfan - Cypermethrin	80	0	0	0
T_4 = Bacterimycin (0.3 g/ l)	40	0	0	0
T_5 = T_1 + T_4	20	0	0	0
T_6 = T_2 + T_4	40	0	0	0
T_7 = T_3 + T_4	40	0	0	0
T_8 = Control (Plan water spray)	100	100	100	80

Garlic

Management of leaf blight complex of garlic

Two field experiments viz. effect of fungicidal seed treatment and foliar application of fungicides were conducted. In seed treatment trial eight fungicides were tested, seed bulb-lets were treated for half an hour. The data was recorded for the first appearance of the disease and severity (Table 42). Vitvax power and Kavach as clove treatment proved effective in minimizing the disease.

Table 42. Evaluation of different fungicides as seed treatment against garlic leaf blight complex

Fungicide	Dose	% leaf blight
Indofil M-45 (mancozeb)	2.5g/kg	18.3
Thiram	2.5g/kg	21.7
Antracol	2.5g/kg	18.3
Vitavax	2.5g/kg	21.7
Vitavax power	2.5g/kg	16.7
Raxil	1.0g/kg	21.7
Bavistin (carbendazim)	2.5g/kg	18.3
Kavach (chlorothalonil)	2.5g/kg	16.7
T 100	2.5 g/kg	21.7
T 100	3.0g/kg	18.3
Control	-	26.6
C.D(0.05)	-	5.16

Eight fungicides were sprayed three times at 10 days interval and data were recorded on disease severity (Table 43). Spray with Ridomil MZ was found most effective in managing the disease followed by Companion.

Table 43. Evaluation of different fungicide spray on the management of leaf blight complex disease of garlic

Fungicide	Dose (%)	Leaf blight (%)
Indofil M-45 (mancozeb)	0.25	13.3
Bavistin (carbendazim)	0.1	11.7
Captan	0.25	16.7
Companion	0.25	10.0
Propiconazole	0.04	12.0
Sitara	0.04	16.7
Tebuconazole	0.04	16.7
Ridomil MZ-72	0.25	5.0
Control	-	36.7
C.D(0.05)	-	4.57

Forage crops

Evaluation of breeding material

During *Kharif* the material of maize, cowpea and cluster bean were evaluated against different diseases and 10 entries of maize were observed resistant to leaf blights, one entry of cluster bean and no entry of cowpea was observed resistant to root rot (Table 44). During *Rabi* the material of oats and berseem were evaluated and 22 entries of oats were found resistant against powdery mildew & due to low disease incidence all entries of berseem gave resistant reaction to root rot.

Table 44. Field screening of *Kharif* & *rabi* breeding material

Crop	Name of Trial	Entries	Resistant
Maize (leaf blights)	Evaluation of IVTM	8	IM-1,2,3,4,5,7 & 8
	Evaluation of AVTM	11	Am 7,10 & 11
Cowpea (root rot complex)	Evaluation of AVTC 1+2	6	nil
	Evaluation of AVTC-2 Seed	4	nil
Cluster bean (root rot complex.)	Evaluation of AVT (Cluster Bean)	5	nil
	Evaluation of AVT (Cluster Bean) Seed	5	AG-2-3
Oats (powdery mildew)	Evaluation of IVTO (SC)	16	IOS-1, 2, 3, 4, 5,7,10,11,13 &15
	Evaluation of AVTO (SC-1)	10	AOS-1
	Evaluation of IVTO (MC)	12	IOM-1,5,6,7 & 8
	Evaluation of AVTO (SC-2)	6	AOS-2-3,4 &5
	Evaluation of AVTO-2 SC-2 (Seed)	6	OSS-1,2 & 4
White clover (powdery mildew)	Evaluation of VTWC (P-2005)	6	nil
Berseem	Because of low disease incidence all entries of IVTB & AVTB 1gave resistant reaction.		

Root rot and stem rot disease management of berseem

For the validation of the given technology an experiment for the root rot and stem rot of berseem an experiment with 2 treatments having 3 replications each was conducted on large plots. The given technology i.e. Biopriming of seed with *Trichoderma*+ neem cake 400 kg/ha the disease incidence of stem rot and root rot was significantly reduced i. e. 7.0 and 11.3 %, respectively as compared to control i.e. 15.7 and 27.0 %, respectively (Table 45). This treatment also provides maximum yield (208.3q/ha) as compared to control (167.7 q/ha).

Table 45. Validation of management technology for the root and stem rot in berseem

Treatment	Disease incidence (%)		Yield (q/ha)
	Root rot	Stem rot	
T_1= Biopriming of seed with *Trichoderma*+ neem cake 400 kg/ha	7.0	11.3	208.3
T_2= Untreated control	15.7	27.0	167.7
CD (5%)	1.4	2.9	19.6

Refinement of diseases management technology for seed production in oat

During the season an experiment with 8 treatments and 3 replications was conducted to control the powdery mildew (*Erysiphe graminis* f.sp. *avenae*), leaf blight (*Helminthosporium* sp.) and loose smut (*Ustilago avenae*) of oat. The data shows that seed treatments with Vitavax @ 2.5g/kg seed + *Trichoderma viride* @ 5g/kg seed followed by two sprays at 15 days interval of the propiconazole @ 0.01% gave minimum severely/incidence of the powdery mildew (7.0%), leaf blight (3.0%) and loose smut (0.3%) as compared to 51.7%, 17.3%, 6.7% respectively in control. The treatment also gave maximum grain (17.5 q/ha) and strain yield (63.3 q/ha) as compared to control i.e. 15.2 & 53.5 q/ha, respectively (Table 46).

Table 46. Refinement of diseases management technology for seed roduction in oat

Treatment	Disease severity (%)			Yield (q/ha)	
	Powdery mildew	Leaf blight	Loose smut	Grain	Straw
T_1 - Seed treatment with Vitavax @ 2.5 g /kg seed,	44.0(41.5)	14.0	0.7(1.2)	16.3	59.5
T_2 - Seed treatment with *T. viride* @ 5g/kg seed,	50.0(45.0)	16.0	2.3(1.8)	16.1	58.9
T_3 -Foliar spray of propiconazole @ 0.01%	10.3(18.7)	5.0	5.0(2.4)	17.0	61.4
T_4 - T_1+T_2	41.7(40.2)	15.3	0.3(1.1)	15.9	58.6
T_5 - T_1+T_3	8.0(16.3)	4.0	0.7(1.3)	17.4	62.2
T_6 - T_2+T_3	9.7(18.0)	4.7	2.0(1.7)	17.1	62.0
T_7 - T_1+T_2+T_3	7.0(15.2)	3.0	0.3(1.1)	17.5	63.3
T_8 - Untreated control	51.7(45.9)	17.3	6.7(2.8)	15.2	53.7
CD (5%)	1.3	2.2	0.4	0.9	2.1

Bio-intensive pest and disease management in cowpea

The experiment was conducted with nine treatments and three replications for the management of collar/root rot *(Fusarium, Rhizoctonia, Sclerotium*) of cowpea. In this experiment for the management of cowpea diseases only bio agent/ bio products i.e. *Pseudomonas fluorescens, Trichoderma viride,* Panchgavya and neem seed kernel extract were used along with seed treatment with carbendazim as chemical check. It was concluded from the data (Table 47) that when seed treated with Seed soaking in Panchgavya @ 10%for 1hr + foliar spray of neem seed kernel extract @3% give minimum disease incidence i.e.6.9% after 60 DAS with maximum yield (58.5q/ha) as compared to 12.8% incidence in control with an yield of 46.3q/ha. The above treatment was followed by seed treatment with *Trichoderma viride* @ 5g/kg seed + foliar spray of neem seed kernels extract @3% with 7.1% disease incidence and 57.0 q/ha yield. However, chemical check provided minimum disease incidence among all the treatments.

Table 47. Bio-intensive pest and disease management in cowpea

Treatment	Average number of plants/row	% plant mortality (8 DAS)	Disease incidence at 20 DAS (%)	Green fodder yield (q/ha)	Dry fodder yield (q/ha)
Seed treatment with *Pseudomonas flourescens* @ 5g/kg seed.	16.3	27.2(31.4)	17.3	50.5	16.2
Seed treatment with *Trichoderma viride* @ 5g/kg seed.	17.0	25.5(30.3)	16.3	48.8	16.3
Seed soaking in Panchgavya @ 10% for 1 hr.	19.7	22.4(28.2)	16.4	49.3	16.1
foliar spray of neem seed kernel extract @3%	16.0	30.5(33.5)	15.3	52.4	16.0
T_1 +T_4	16.0	27.4(31.5)	13.2	55.5	16.2
T_2+T_4	17.3	25.5(30.3)	12.6	57.0	16.4
T_3+T_4	18.3	22.4(28.2)	12.5	58.5	16.1
Seed treatment with carbendazim @ 3%	21.7	16.6(24.0)	10.2	54.2	16.0
Control	15.0	30.8(33.7)	21.3	46.3	15.7
CD (P=0.05)	2.0	1.5	1.2	3.8	NS

Validation of non– chemical management of pests of cowpea and maize

For the validation of the given technology an experiment for the pest management of maize and cowpea 2 treatments having 3 replications each was conducted on large plots. The data (Table 48) revealed that maize blight and cowpea diseases i.e. wilt/root rot, Phytophthora blight and anthracnose were significantly reduced by the given technology i.e. seed treatment with *Trichoderma* viride @ 5g/kg + FYM @ 4t/ha. + Need seed extract foliar spray @3% in 30 and 45 days crop have 15.4% maize blight, 25.5% cowpea wilt/root rot 16.0% cowpea Phytophthora blight and 27.5% cowpea anthracnose as compared to control i.e. 27%, 50.1%, 39.5% and 46.4%, respectively. The treatment gave 333q/ha

and 60.6 q/ha yield of maize and cowpea, respectively as compared to control i.e.286.1 and 46.8 q/ha, respectively.

Table 48. Non-chemical pest management in cowpea and maize

Treatment	Disease severity/ incidence (%)				Green fodder yield q/ha	
	Blight of maize	Wilt/root rot of cowpea	Phytophthora blight of cowpea	Anthracnose blight of cowpea	Maize	Cowpea
T_1 -Seed treatment with *Trichoderma* viride @ 5g/kg + FYM @ 4t/ha. + Need seed extract foliar spray @3% in 30 and 45 days crop.	15.4	25.5	16.0	27.5	333.0	60.6
Control	27.0	50.1	39.5	46.4	286.1	46.8
CD (P=0.05)	4.3	1.3	2.0	3.0	6.0	7.7

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 (Table 49) that when seed treated with Seed treatment with Vitavax power @ 2 g/kg seed + three sprays of Indofil M-45 @ 0.25% give minimum disease incidence i.e.2.7, 9.7, and 3.5 % of brown spot, leaf blights and BLSB respectively, with maximum yield (329.7/ha) as compared to 5.4, 20.8 and 8.7% incidence in control with an yield of 271.1/ha (Table-5). As boil-control soaking of seeds in PGPR (*Pseudomonas fluorescens*) suspension followed by three spray of *P. fluorescens* also found effective for the management of maize diseases as compared to control but least effective as compared to chemical control.

Table 49. Integrated disease management of fodder maize

Treatment	Disease severity / incidence (%)*			Green fodder (q/ha)
	Brown spot	Leaf blights	BLSB	
Seed treatment with Vitavax power @ 2 g/kg seed	3.7	13.3	4.2	308.6
Seed treatment with *T viride* @ 5 g/kg seed	4.7	15.8	6.3	295.1
Soaking of seeds in PGPR (*Pseudomonas fluorescens*) suspension @ 10^9 cfu/ml for 1 hr	4.4	16.7	6.9	295.9
T1+ 3 spray of Indofil M-45 @ 0.25%	2.7	9.7	3.5	329.7
T2+3 spray of Indofil M-45 @ 0.25%	3.2	10.5	4.8	304.8
T3+3 spray of Indofil M-45 @ 0.25%	3.2	11.2	5.1	311.6
T1+3 spray of *P. fluorescens* @ 10^7 cfu/ml	3.4	12.1	4.0	313.3
T2+3 spray of *P. fluorescens* @ 10^7 cfu/ml	4.2	15.2	5.7	292.8
T3+3 spray of *P. fluorescens* @ 10^7 cfu/ml	4.5	15.6	6.0	290.4
Control	5.4	20.8	8.7	271.1
CD (P=0.05)	0.4	1.4	0.4	9.4

Tea

Evaluation of Kangra tea hybrids against blister blight

Fifty four developed Kangra tea hybrids were evaluated for their reactions/performances against blister blight under natural field conditions. Thirty seven hybrid genotypes were recorded with low disease pressure as compared to highly susceptible hybrid genotype 24.10 (Table 52). Out of 37 hybrid genotypes, 15 were found phenotypically excellent in their performances which can further be multiplied for evaluation in breeding programme. Hybrid genotypes 4.21, 6.14 and 9.8 remained disease free.

Germination of basidiospores of *Exobasidium vexans* at different temperature range

Germination of basidiospores of *E.vexans* in sucrose solution (1.0 %) were recorded at different temperature range keeping 100% R.H. Maximum basidiospore germination was found at 19^{o}C (Table 50). Cent per cent inhibition was recorded at 5 ^{o}C and 35 ^{o}C .

Table 50. Germination of basidiospores of *Exobasidium vexans* at different emperature at 100% R.H.

Temperature (^{0} C)	Basidiospores of *Exobasidium vexans*	
	Germination (%)	Inhibition over control (%)
5	0.00	100.00
10	7.33	91.03
15	36.14	55.78
17	65.57	19.77
19	81.73	-
21	75.46	7.67
23	62.84	23.11
25	42.15	48.43
30	4.10	94.98
35	0.00	100.00

Effect of shade intensities on blister blight in tea plantations

Effect of shade intensities on blister blight incidence (Table 51) reveals that low shade intensity of *Albizzia* spp .following lopping technique of undesired branches of *Albizzia* spp. or dense shade tree species has been proved to be appropriate shade intensity to minimize the attack of blister blight and sun - scorch injuries.

Table 51. Effect of shade intensities on blister blight of tea in t ea plantations

Shade intensity	*Exobasidium vemans*	
	Incidence (%)	Severity (%)
Nil	10.14	3.49
Low	14.57	5.86
Moderate	21.76	11.37
High	26.52	17.34
Brooks	29.69	24.33

VI. Seed Pathology

Monitoring and detection of rice bunt, false smut and bacterial leaf blight disease in seed samples

57 rice samples of different varieties collected from farmers of 6 districts (Sirmour, Solan, Mandi, Kullu, Kangra and Una) were analysed for detecting rice bunt. Rice bunt was detected from one sample of each district; Sirmour, Mandi, Kullu and two samples from Kangra district. Infection ranged from 0-01 percent with average of 0.006 percent which is quite below the certification standard. However no rice bunt was detected from the four rice samples drawn from three Govt Seed Multiplication Farms.

The district and variety wise incidence of false smut of rice in seed samples collected from farmers of above said five districts false smut infection was detected only from three samples; one from Sirmour on variety Hybrid-6444 (0.05%) and two from Kangra on variety HR-152 (0.15%) and Parmal local (0.05%)

For district and variety wise incidence of rice false smut and bacterial leaf blight (BLB) in farmers' fields, 6 districts were surveyed. False smut incidence ranged from traces to 5 percent. However, it was exceptionally very high on variety HPR-1068 (1-2 %), HR-152 (1-5 %).

Studies on the wheat seed health status of farmer's own saved seed as compared to certified seeds

Sixty wheat seed samples (certified & farmers' own saved seed) were evaluated for loose smut incidence under field conditions. The over all incidence of loose smut ranged from 0- 2.6 per cent. Eleven samples were having loose smut more the certification standard (0.5%) however, average incidence was 0.11 percent.

Standardization of seed coating technique with botanicals and synthetic polymers for seed quality enhancement

Polycot coated maize seeds alone or in combination with fungicides /and insecticides treated seeds stored in different packaging materials (cloth bags & polythene bags) for different durations were analysed for seed germination and seed rot incidence. Seed germination remained above 90 percent in all the treatments even after 10 months of storage as compared to T_0 (PB). Seed rot incidence varied with passage of storage period in T_0 (CB & PB). Treatment T_5 (Polykot @ 4g/kg) + Vitavax 200 @ 2g /kg) was comparatively most effective in both types (CB & PB) of packaging in reducing the seed rot followed by T_4 (polykot + Thiram and Imidachlorid) (Table 52).

Certification of seeds

Four rhizome samples of ginger, 7 of turmeric, 3 of sarson and 24 of wheat received from different progressive farmers through the state department of agriculture were analysed for the presence of specified pathogens and acceptance or rejections were made based on certification standards.

Table 52. Effect of packaging on the germination and seed health of polymer coated maize seeds during storage period

Treatment	Germination (%)					Seed rot incidence (%)				
	Storage duration (months)					Storage duration (months)				
	4	6	8	10	12	4	6	8	10	12
T_0- CB	75	94	83.3	96.5	93.3	2	8.1	10.6	4.3	1.7
T_1- CB	100	100	93.7	96.5	85.0	2	0	4.0	1.4	0.0
T_2-CB	100	96.5	100	96.5	78.3	0	6	0	4.3	0.0
T_3-CB	100	100	100	96.5	93.6	0	0	0	2.1	0.0
T_4-CB	100	96.5	96.5	90.5	95.0	0	0	0	1.4	0.0
T_5-CB	100	100	96.5	100	95.0	0	0	0	0	0.0
T_0-PB	75	90	96.5	73.9	76.7	7.5	4.7	6.6	20.3	31.7
T_1-PB	80	96.5	90.0	98.3	86.7	2	0	0.0	0	0.0
T_2-PB	100	96.5	96.5	91.6	91.7	0	6.2	0	2.9	0.0
T_3-PB	100	96.5	100	97.9	85.0	0	0	0	1.4	0.0
T_4-PB	100	96.5	83.3	96.3	93.3	0	4.0	0	1.4	0.0
T_5-PB	80	96.5	96.5	97.7	85.0	6	1.8	2.2	0	0.0

T_0= Untreated control, T_1= Polykote @ 4g/kg seed; T_2 = T_1 + Thiram 75% WDP @ 2.5kg/kg; T_3 = T_1 + Imidachlorid @ 4 ml/kg ; T_4 = T_1 + Thiram 75% WDP @ 2.5kg/kg + Imidachlorid @ 4 ml/kg ; T_5 = Polykote @ 4g/kg + Vitavax 200 @ 2g/kg CB= Cloth bag; PB = 700 gauge Polythene bag;

VII. Molecular Plant Pathology

Assessing diversity in *Ascochyta* blight complex of peas using molecular markers

DNA fingerprinting of *Ascochyta* blight isolates

DNA fingerprinting of *A. pisi* and *M. pinodes* isolates was performed by Random Amplified Polymorphic DNA (RAPD) technique of Williams *et.al.* (1990) as described below:

Total genomic DNA of individual isolates was extracted following the procedure of Sharma *et al.* (2005). DNA samples were quantified spectrophotometrically (Smartspec 3000, BIORAD, USA) at 260 nm. The samples were diluted to a first concentration of 10 µg/µl with TE (10 mm Tris-HCl, pH 8.0, 1 mM EDTA) and in equal amounts to form three DNA bulks.

DNA fingerprints

The RAPD profiles generated by different primers were compared to determine relationship among 40 isolates. The presence or absence of each RAPD band of a particular molecular weight in all the isolates was scored manually and binary matrix was generated. Initially 150 primers were used for PCR amplification of DNA of two fungal isolates. Of these, eight viz., OPA-02, OPA-13, OPA-09, OPQ-13, OPD-11, OPQ-18, S-144 and S-1466 giving consistent banding pattern were selected for RAPD analysis of 39 isolates of *Ascochyta* species as number of missing values in one isolate were quite high. The number of scorable and polymorphic bands obtained with each primer is given in Table 53. The number of bands obtained with different primers ranged from 4 to 7 of which 4 to 6 were

polymorphic. A total of 43 RAPD bands were obtained with all the primers of which 41 (95.4%) were polymorphic.

Cluster analysis of the RAPD bands generated a dendrogram with a co-phenetic correlation coefficient of 0.84, which substantiates the accuracy of dendrogram. The dendrogram analysis of 39 isolates revealed a high genotypic diversity within *Ascochyta* population. Most of the isolates were clustered into two major groups Group I and Group II with 16 and 18 isolates respectively at a similarity coefficient of 0.62. This confirms the two species to be present in this region as inferred on the basis of morphological traits. However, the RAPD was unable to differentiate the two species as both the Mycosphaerella *pinodes* isolates clustered into two different groups i.e. As 27 in Group I and As 34 in Group II. This necessitates trying more primers and generating a dendrogram based on a larger matrix. Moreover, there were 5 such isolates which didn't group in any of the two groups. This indicates the possibility of a third species. To overcome this ambiguity other molecular markers are needed for better results. Two REP-PCR primers viz, ERIC 1 and BOX-AIR primers were also used however, these primers didn't show much variability and therefore twelve ISSR were tried. Out of these 12 ISSR, 4 primers have given good polymorphism and so more primers are need to generate a binary matrix with enough bands to generate an accurate dendrogram.

One of the best approaches applied to differentiate the fungal species is the ribosomal DNA analysis. The ITS and IGS region of the rDNA was amplified and restriction digestion with various enzymes was tried to differentiate the isolates into species. Three primer pairs ITS 1 and ITS 4, PN 11 and PN 22 and LR 0R and LR 07 were used to amplify the internal transcribed spacer, inter-generic spacers, ITS2 and part of 5.8 S regions. Several four base pair cutter restriction enzymes viz., Taq I, EcoR I, Sac I, Sau 3a were tried for cleaved amplified polymorphism. Very little success was achieved as agrose gel electrophoresis could not resolve the bands with slight variation in molecular weight and thus restriction product is needed to be run on 12 % PAGE. The work on restriction analysis is still in progress.

Table 53. Number of scorable and polymorphic RAPD bands obtained by PCR amplification of DNA of 40 isolates of *Ascochyta* species

Primer	Scored bands	Polymorphic bands	Polymorphism (%)
OPA-02	5	5	100
OPA-13	5	5	100
OPA-09	5	6	100
OPD-11	4	4	100
OPQ-13	6	6	100
OPQ-18	6	6	100
S-144	7	5	71.5
S-1466	5	5	100
Total	43	41	95.4

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

Development of RIL and segregating population (F_2s)

The resistance and susceptible parents were sown under green house conditions. Crosses were attempted under green house conditions at Palampur between susceptible variety Jawala and resistant parent KRC-5 to get F_1 seed. About 10 F_1 seeds and 103 RILs (JK5) F6:7 were sown in May at Sangla to obtain F_2 and F_7 population to be used for segregation analysis and tagging of resistance gene in land race KRC 5. About 160 RILs (F_4) were advanced at Palampur under net house condition to get F_5 generation.

Maintenance of *C. lindemuthianum* culture

Pure culture of two isolates of race3 (186a and 186b) of *Colletotrichum lindemuthianum* avirulent on KRC-5 and virulent on susceptible parent Jawala has been established. In addition pure culture of three races 529, 513 and 935 were also established with a view to tag additional gene in the above parent combination. The reaction pattern of both the parents (KRC 5 and Jawala) against race 3 was confirmed by under controlled conditions.

Polymorphism survey

DNA of resistant and susceptible parents was extracted by CTAB method. About 60 SSR primers from common bean genome were custom synthesized. PCR conditions for SSR screening were standardized with initial denaturization at 92^{o}C for 5 min, followed by 30 cycles of 92^{0C} for 1 min, annealing for 1 min, extension at 72^{o}C for 2 min and final extension at 72^{o}C for five minutes. The reaction mixture (25.0µl) contained DNA template (20ng) 2.0 µl, dNTPs (0.2mM each) 2.0 µl, *Taq* DNA polymerase (5U/µl) 0.2 µl, 10 x PCR buffer, 2.5 µl, Primer Forward (5µM) 0.5 µl, Primer reverse (5µM) 0.5 µl, deionized sterilized water17.3 µl.

Polymorphism survey was done with resistant and susceptible parents. Out of sixty SSRs, six primers viz., BMd 41, BMd 42 BMd 43 BM 157 BMd 166, BM 140, BM 172 showed polymorphism between the resistant and susceptible parent and were selected for further analysis (Fig 1).

PCR conditions for ISSR were standardized with initial denaturation at 94^{0}C for 5 min, followed by 30 cycles of 94^{oC} for 1 min, annealing at 47^{o}C for 1 min, at extension at 72^{o}C for 2 min and final extension at 72^{o}C for five minutes. Out of 49 ISSRs used in polymorphism survey of two parents, only ISSR 814 exhibited polymorphism (Fig 2).

Molecular characterization studies on BCMV and evaluation of resistance

Primer designing and synthesis

BCMV specific primers were designed for the simultaneous detection as well as the amplification of coat protein region of BCMV, with the aid of primer3 program available online. These

primers were developed from NIb region and 3'UTRs of the BCMV sequences available in NCBI database with the view of obtaining the amplification of whole coat protein (cp). The sequence of the primers includes:

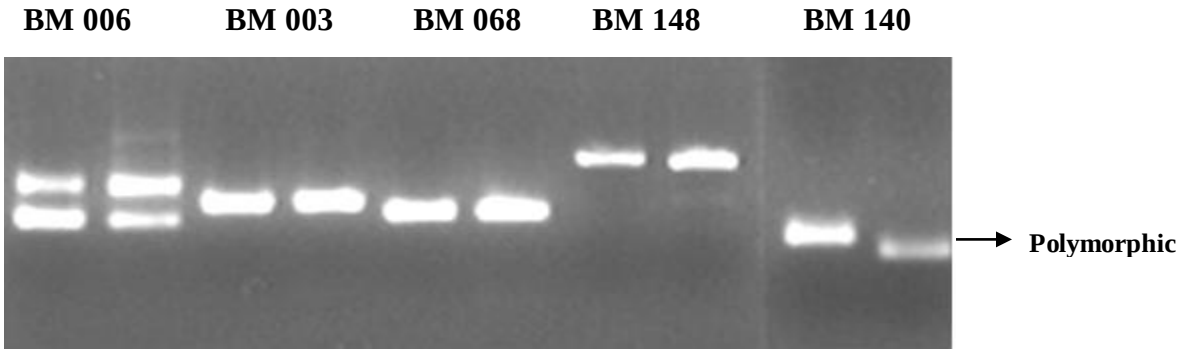
F: tgg ctg ctt gag aga gat ga; R: atcactctgcatgtcctcac

Molecular characterization

An attempt was made to characterize the coat protein gene of NL-1 strain of BCMV using BCMV specific primers. cDNA was synthesized by using oligo dT primer and M-*MuLV* reverse transcriptase enzyme. RT-PCR analysis using primer pair F: tgg ctg ctt gag aga gat ga; R: atcactctgcatgtcctcac amplified a product of ~1300bp. The amplicons (~1300 bp) generated were cloned in pGEMT -Easy vector, transformed in *E. coli* bacteria (strain DH5α) and subsequently plasmids containing inserts purified by alkali lysis method were custom sequenced. The sequence were submitted to NCBI Genbank vide accession number EU492546. Sequences were subjected to nucleotide blast analysis results of which revealed that coat protein (cp) region of Indian NI1 strain showed maximum homology of 92 per cent with US-I, NL-1 and US-7 strains of BCMV. Sequences showed.. Sequencing analysis revealed that the nucleotide sequences of NL-1 consisted of 1243 bp comprising of partial NIb and full coat protein and 3' UTR region after BLAST analysis (Fig.3). Blasted nucleotide sequence analysis revealed the amplification of partial NIb (137 bp), cp (862 bp) and 3'UTR region (244bp) of NL-1 strain. Blastn with different BCMV strains and related potyviruses revealed maximum homology with NL-1 strain (Denovan *et al.*, 2002), thus confirmed the existence of NL-1n strain of BCMV in Himachal Pradesh.3'UTR region also showed 98% homology with the test NL-I strain with US-1 and NL-1n Ind strains of BCMV.

Detection of *I* gene

A recommended cultivar Hans possessing resistance to different strains of BCMV prevalent in Himachal Pradesh was found to possess single dominant resistance gene during study on inheritance of resistance. Since in common bean only one dominant gene called "*I*" gene has been reported to govern resistance against BCMV, so an attempt was made to elucidate the nature and identity of the R gene present in cv. Hans using I gene specific SCAR marker $SW13_{690}$. The SCAR marker $SW\ 13_{690}$ resulted in the amplification of 690 bp DNA fragment in cultivar Hans and Contender along with Jubila and Widusa known to carry dominant *I* gene (Fig. 1). However, no amplification was observed in susceptible cultivar Jawala after repeated testing. Similarly no amplification was in resistant cultivar KRC 22 having a recessive gene, thereby establishing the presence of *I* gene in the Indian subcontinent.



]

Fig 1. Polymorphism survey with susceptible (Jawala) and resistant (KRC-5) parents with SSR markers

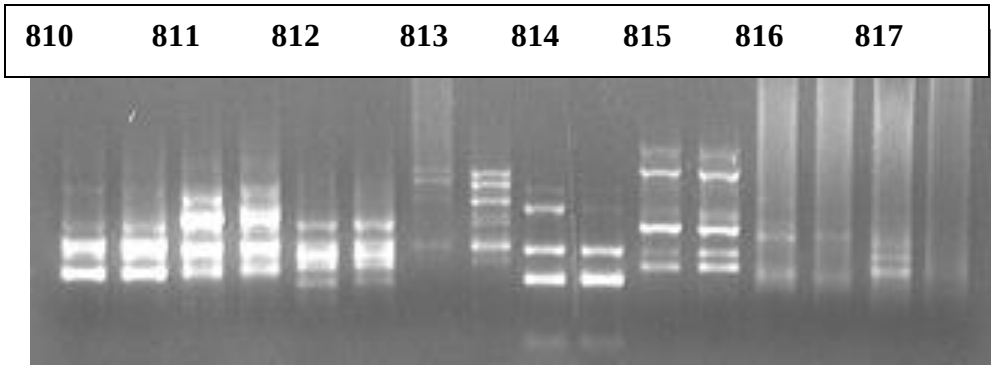


Fig 2. Polymorphism survey with susceptible (Jawala) and resistant (KRC-5) parents with ISSR Markers

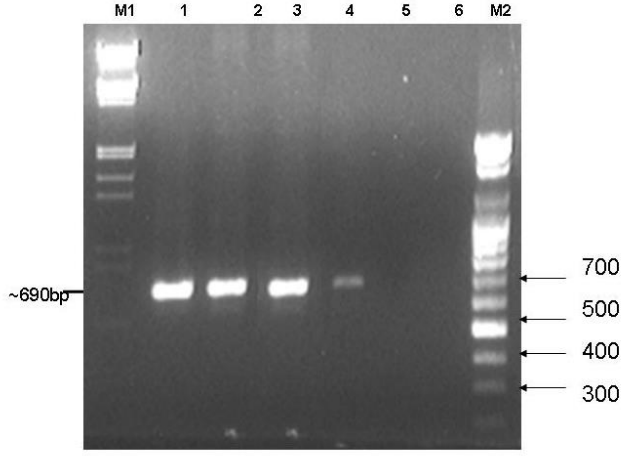


Fig. 3. Amplification of common bean cultivars genomic DNA using SCAR marker SW 13_{690} linked with *I* gene. M1: *λ DNA/ EcoR I + Hind III* DNA marker, Lane 1: Hans, 2; Jubila, 3: Widusa, 4: Contender, 5: KRC 22, 6: Jawala, M2: 100bp ladder

ggaatccgatttggctgcttgagagagatgagctgagagagattgcagctagtggaggagccccatacatagcagagtcagcacttaaaactctttata
ctaataagaaaacaaggattgaagagttagcgaaatatCTGGAAGTGCTCGACTTTGACTACGAGGTAGGATGCG
GAGAATCTGTGCACCTACAATCAGGACCTGGACAGCCACAGCCACCAATAGTAGATGCTG
GTGTGGGATCTGGGAAGGACAAGAAAGAGAAAAGCAACAAAGGAAAGGACCAAGAAAGT
AGGGAAGGGGCAGGAAACAACAACCGTGGTGCAGGGAATTCGGCAATGAGAGACAAAGA
TGTGAATGCAGGTTCCAAAGGGAAGGTTGTTCCTCGGCTTCAAAAGATCACAAAAAGGAT
GAATTTGCCCATGGTGAAAGGGAATGTGATTTTAAATTTAGATCATCTATTGGATTACAAG
CCAGAACAAACTGATCTTTTTAACACAAGAGCAACAAAGATGCAGTTTGAAATGTGGTAC
AATGCTGTGAAGGCTGAGTATGAGATAGATGATGATCAGATGTCAATTGTAATGAACGGC
TTTATGGTGTGGTGTATTGACAATGGCACTTCACCAGATGTGAACGGCACTTGGGTAATGA
TGGATGGAGATGAGCAAGTGGAATATCCACTTAAACCAATGGTTGAAAATGCAAAGCCAA
CACTCCGGCAAATCATGCACCATTTTTCAGATGCAGCTGAAGCATACATTGAGATGAGAAA
TTCTGAGAGGCCGTATATGCCTAGGTACGGACTACTTCGGAATTTGAGGGATAAAAATCTA
GCTCGCTACGCTTTTGATTTCTATGAAGTAACATCCAAAACATCGGATCGAGCAAGAGAAG
CAGTAGCACAGATGAAGGCAGCAGCCCTCAGCAACGTTAGCAGCAAGTTGTTTGGACTTG
ATGGTAACGTGGCAACAACCAGCGAGAATACTGAAAGGCACACTGCAAGGGACGTCAATC
AGAACATGCACACACTTCTTGGCATGGGTCCTCCGCAGTAAAGGTTAGGTAAACTGACCAC
AGTTAGCATCTCGCGTCGCTGAATAGTTTCATATAGTAATCTTTTATGTTCTCTTTAGTTTC
AGTGTGGTTCTACCACCTTTGTGTTACTATTGTGATAGTGTGGTTGGTCCACCAACATATTG
TGAGTACTTTATGTTTATGAGTAGGCCGGAAGAACCATTAA

Fig. 4. Nucleotide sequence of partial Nib (gg), complete CP gene (CT) and 3'UTR region (5'-3') of NL-1 strain of BCMV

VIII. Mushrooms

Collection, identification and culturing of fleshy fungi of western Himalayan region for bioactive molecules (CSIR funded)

Forest surveys for the collection of fleshy fungi (Agaricales and Gasteromycetes) were regularly conducted to various localities of Kangra and Mandi districts. As many as 730 collections of the fleshy fungi belonging to nearly 290 species of more than 65 genera were made from various localities after thorough exploration during the period under report. The species of genera *viz Agaricus, Amanita, Auricularia, Vascellum, Coprinus, Lepiota, Lactarius, Russula, Hebeloma, Lycoperdon, Cyathus, Laccaria, Conocybe, Marasmius, Inocybe, Mycena, Oudmansiella, Schizophyllum, Tyromyces, Ganoderma, Polyporus, Tremella, Exidia, Auricularia, Hydnum, Lentinus, Cantherellus ,Asterisk, Xylaria, Daldinia, Ramaria, Thelephora, Tricholoma, Bovista, CoriolusHypholoma,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, Suillus,* and *Tyromyces,* etc.were collected, identified and cultured.

Nearly 240 isolates were obtained in pure culture from fresh specimens despite repeated efforts on culturing of all the collected isolates. The success rate was low because of mycorrhizal nature of most of the fleshy fungi growing in the forests. Thus out of total of 730 collections made, only 240 isolates could be brought in culture and 196 of them were successfully maintained and processed further during the period under report. 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 standard protocols. The pure cultures were grown in shake cultures in 30 ml liquid 'B' medium. At the close of exponential growth phase, the cultures were chilled, sonicated and centrifuged. The supernatants obtained was lyophilized and sealed under the original vacuum.

The culture extracts of 196 isolates have already been deposited with the specified laboratories for further evaluation of bioactivity. Mother cultures of 186 isolates have been deposited at the Institute of Microbial Technology, Chandigarh. Remaining cultures being maintained in B.O.D incubators and refrigerators are to be further processed for onward transmission to the specified laboratories. One culture extracts has been found to be active for the anti-psychotic activity in *in vitro* screening at ITRC, Lucknow.

Production of substrate and spawn and training of entrepreneurs for mushroom cultivation in Himachal Pradesh

Strengthening of Mushroom Production Unit is being carried out under this new project. A programme on training of entrepreneurs is also being taken up.

Cultivation of new edible mushroom

A wild strain of *Pleurotus eryngii* was successfully cultivated on pasteurized wheat straw under mushroom house conditions following standard procedures. This strain preferred a temperature range of 20-25^{o}C and gave biological efficiency of up to 90. Another wild strain of *Pleurotus flabellatus* collected from logs of mango earlier was tried for its fruiting potential as compared to traditionally grown *Pleurotus ostreatus*. The trials were conducted at two farmers' mushroom houses, one at Kangra and one at Chamunda. Each bag contained two kg dry rice straw.

Kangra	**Total Yield**	**Av.**
50 bags of *Pleurotus ostreatus*	74 kg.	1.48 kg
50 bags of *Pleurotus flabellatus*	98 kg.	1.96 kg
Chamunda		
50 bags of *Pleurotus ostreatus*	77 kg.	1.54 kg
50 bags of *Pleurotus flabellatus*	102 kg.	2.04 kg

Evaluation of wild and agricultural waste substrates for dhingri cultivation in Lahaul valley

The mycelial growth on different locally available grain substrates was observed periodically. Mycelial growth on kathu (*F. tataricum*) was dense, ivory white and better as compared to mycelial growth on wheat grains. Mycelial growth on rajmash and pea grains was slow and less dense than on wheat.

Phoolan grains did not support any mycelial growth and was found unsuitable for dhingri spawn production. Hence for further studies spawn was produced on kathu grains which were chosen because of their availability in local market / villages and its cheaper price than wheat or other grains.

The Table 57 represents the data on production of dhingri on various substrates and substrate combinations which were locally available in Lahaul valley. Wheat straw gave the highest yield but is not available in the Lahaul valley in sufficient quantities. Among the locally available raw material Neurcha performed well though giving less than half the yield as compared to the mean production of on wheat straw which. The lowest yield was observed on willow sticks alone, where the mycelium could not establish itself properly. On Neurcha alone the average yield was 340.0 g which is quite at par with wheat straw + Neurcha (390.0 g). Other substrates and their combinations were found to be poor fruiters for oyster mushroom.

Extraction of biologically active compound(s) from edible mushrooms especially *Pleurotus* species

Various taxa encountered and used in present studies were *Pleurotus ostreatus P.florida, P.sajor caju, P.flabellatus, P.sapidus.*

Nutrient Analysis:

Nutritional estimation of different *Pleurotus* species was done by various methods like Kjeldahl (proteins), phenol sulfuric acid (carbohydrates) and estimation of free fatty acids (fats).

Thin Layer Chromatography

Detection of polysaccharides using thin layer Chromatography (TLC) was conducted by spotting the extract with a micropipette on a silica gel plate as a stationary phase and developing solvent of benzene: glacial acetic acid : methanol (20:20:60). After developing and drying the plates, spraying (naptharesocinol in ethanol and 2% aq. trichloro acetic acid (1:1) at 100^{o}C for 10 minutes were done before observing under UV light. The same principle that was used for detecting amino acids except for the developing solvent (ethanol: water 70:30) and reagent (1% ninhydrin in acetone) at 100^{o}C for 5 minutes were applied before observing under UV light.

All the species of *Pleurotus* were incorporated into the diets of albino rats .Male albino rats 5-6 weeks old were divided into 3 groups and were housed individually. The rats of group A (control group) were fed on hypercholesterolemic diet containing 64% starch, 10 %groundnut oil, 15 %casein protein, 4 %salt mixture, 15% yeast powder, 5 %cellulose and 1%cholesterol. Animals of group B and C were given hypercholesterolemic diet containing 5% or 10% dried *P.florida* powder, respectively. Diet intake and gain in body weight was recorded weekly. After 4 weeks of feedings the rats were sacrificed, their blood was drown by direct cardiac puncture, and pooled. Plasma was separated was separated by centrifugation (3000g for 10min) and stored in a refrigerator till further use. The tissues like lungs, liver, kidney, spleen and heart were removed and washed immediately with normal saline to

remove extraneous matter. After blotting the fresh weight of tissues were recorded and were stored in a deep freezer until further analyzed. A part of the tissue was fixed in 10% formalin for histopathological analysis. Lipid peroxidation of various tissues was determined by determining various thiobarbituric acid (TBA) reacting substances. The haemoglobin and packed cell volume of the whole blood was determined by following the standard hematological procedures.

Lipid changes including total lipids , total cholesterol, high density lipoprotein (HDL)-cholesterol, phospholipids, free fatty acids were determined in plasma. Glyceride levels were calculated by subtracting phospholipid, total cholesterol and free fatty acids values from total lipid values. Cholesterol values of low density lipoprotein plus very low density lipoprotein (LDL+VLDL) was calculated by subtracting HDL-cholesterol values from total cholesterol values.

Species of *Pleurotus* are good source of proteins. It was found that protein content in various *Pleurotus* spp (Table 54) varied from 1.9% to 4.3 % whereas carbohydrate content varied between 3% to 5.2%. Lipid content was higher in the stalks than in the cap irrespective of *Pleurotus* spp. TLC results of amino acid (Table 55) analysis showed the presence of alanine, lysine, and proline in *Flammulina velutipes* with no methionine. Carbohydrates could not be detected in *Flammulina velutipes.*

Table 54. Proximate nutritional composition of *Pleurotus* Species

Pleurotus Spp	Dry matter	Protein	Carbohydrate	Fat	Fibre
P ostreatus	7.1	1.9	3.8	.12	0.9
P sajorcaju	9.8	2.5	5.2	.18	1.1
P sapidus	8.4	4.3	4.3	.14	0.8
P flabellatus	8.0	4.2	4.2	.15	0.8
P florida	6.0	3.0	3.0	.52	0.7

Table 55. TLC spots of amino acids of *Flammulina velutipes* run on ethanol: water (70:30) and spraying with ninhydrin in acetone.

No. of spots	Rf values and colours after spraying with ninhydrin
1	Alanine 0.25 Purple
2	Proline 0.30Pink
3	Lysine 0.45 Purple
4	-(Methionine)

Experiments on rats

The blood plasma profile of rats showed that feeding of 5 % level of *Pleurotus ostreatus* or *Pleurotus florida* reduced cholesterol and BUN (Blood Urea Nitrogen) levels significantly. Out of two *Pleurotus* spp results were more pronounced with *Pleurotus florida*l .Inclusion of dried dhingri (*P.florida*) at 5% .There was decrease in cretinine and bilirubin levels with all the species of *Pleurotus* as compared to control but uric acid levels were not controlled by either of *Pleurotus* species.

Inclusion of *Pleurotus florida* at 5 % or 10% level in the diet of hypercholesterolemic rats resulted in higher food intake as compared to control without any significant effect on gain in body weight. This resulted in decreased food efficiency ratio of diets containing *Pleurotus* sp. The higher food intake shows that *Pleurotus* in diet adds to the palatability of food. Since there was no effect on the organ weight indices of rats fed on hypercholesteromic diets containing *P. florida* it indicates that its inclusion at either of the levels had no untoward reaction even when fed continuously for 4 weeks at high levels. Lipid, cholesterol and glyceride levels in plasma were significantly decreased on feeding dried *Pleurotus* in diet. The reduction of cholesterol was equally reflected in both high density lipoprotein and low and very low density lipoprotein fractions. Lowering of blood cholesterol and lipid through dietary regimens in most suitable approach having least side effects. The feeding of 5% powder of the fruiting bodies of *P. florida* (Table 56) mushrooms to hypercholesterolaemic rats reduced their plasma total cholesterol by approximately 28%, low-density lipoprotein–cholesterol by approximately 25%, triglyceride by approximately 30%.

Table 56. Plasma lipid profile of rats fed on hypercholesterolemic diet containing dried *P.florida* [Values are mean ± SE]

Parameter	Groups		
	A (control)	B	C
Total lipids	512.2 ± 12.51	429.8 ± 15.2	481.5 ± 9.79
Phospholipids	84.61 ± 2.08	76.4 ± 1.20	8.5 ± 3.70
Glycerides	234.0 ± 7.62	204.6 ± 5.70	212.20 ± 8.90
Total cholesterol (TC)	158.9 ± 13.40	112.0 ± 8.2	151.0 ± 10.0
HDL	79.9 ± 2.24	57.5± 1.61	66.2 ± 1.85
(LDL + VLDL)	79.0 ± 3.41	54.4 ± 2.76	84.8 ± 4.57
HDL :TC	0.487 ± 0.035	0.513 ± 0.029	0.438 ± 0.022

A = (control group) hypercholesterolemic diet;
B= hypercholesterolemic diet + 5% dried *P.florida;*
C= hypercholesterolemic diet + 10% dried *P.florida*

3. EXTENSION EDUCATION

The extension activities conducted by the teachers/scientists and extension specialist s of the department at the main campus, research stations and Krishi Vigyan Kendra's during 2007-2008 are described under the following heads.

On farm trials

Fifty one on farm trials on the management of Fusarium wilt of chillies, colocasia blight, rhizome rot of ginger, powdery mildew of cucurbits, pea and bell pepper, fruit rot and early blight of tomato, early blight and late blight of potato, bacterial wilt of tomato, collar rot and wilt of gram, cercospora leaf spot of sesame and Phytophthora blight of arhar were conducted during the year.

Field demonstrations

Field demonstrations on important diseases, their management practices and on other activities were conducted and monitored by the teachers/scientists/extension specialists. During 2006-07 about 469 demonstrations on different cereals, oilseeds and vegetable crops were conducted at different locations. Sixty demonstrations on mushroom were also conducted during the period under report.

Training programmes

Scientists/extension specialists organized 20 off-campus, 87 on-campus, 2 in service and 9 vocational trainings in which about 4240 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 25 trainings programmes on mushroom cultivation and benefited about 1040 farmers by demonstrating practical mushroom cultivation. They also conducted demonstrations at different locations of Himachal Pradesh on the mushroom cultivation methodology. Besides this, 33.49q quality spawns of white button mushroom and dhingri worth Rs. 2, 90,992/- was produced in the Spawn Laboratory during the year.

Adaptive research

During the period under report the scientist has conducted 61 adaptive research trials at farmers fields on the management of different disease. Kisan Melas/Kisan Divas/Field Days: The teachers/scientists/extension specialists of the discipline participated in the State Level Kisan Divas, Field Days, and other days. They organized 33 Field days/Divas in which 4929 farmers attended and were familiarized with various disease problems and their management.

Workshops

The scientists participated in the deliberations of Agricultural Officers Workshops (*kharif* and *rabi*) in the Directorate of Extension Education, CSKHPKV, Palampur. The queries raised by various Govt. officers and farmers during the deliberations were attended to by the experts in the respective fields. The scientists also attended different workshops and delivered expert lectures.

Farmer's advisory service

A large number of disease 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. Mushroom growers were also advised in making there own compost, setting up and running mushroom houses smoothly.

Lectures

The teachers/scientists/extension specialists delivered about 740 lectures to the different beneficiaries in different trainings and workshops etc.

TV/ Radio talk
TV Programme

Live Phone-in and Recorded programmes Telecaste from DD Shimla

S.no	Name of the Scientist	Topic	Date of recording/ telecast
1	A. K. Sood	Live-Phone-in (Studio) on "Pre-sowing seed treatment for field crops & vegetables".	1.10.2007
2	A. S. Kapoor	Practical demonstration of seed treatment of various crops (Recorded)	6.12.2008
3	A. S. Kapoor	Live-Phone-in (Studio) on "Seed treatment for kharif crops".	5.5.2008
4	D. K. Banyal	Diseases of maize and their managemer (Recorded)	30.7.2007
5	D. K. Banyal	Late blight of potato and its management (Recorded)	13.2.2008
6	D. K. Banyal	Live-Phone-in (Studio) on "Pests and Diseases of peas, tomato and capsicum".	10.3.2008
7	Pardeep Kumar	Live-Phone-in (Studio) on "Disease management in pea and potato with special reference to Lahaul valley".	14.4.2008
8	S.K. Rana	Live-Phone-in (Studio) on "Diseases and Insect-Pests Management of Solanaceous Crops".	02.07.2007
9	K. S Rana	Live chat show on "vegetable production in HP".	-

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Sood, G.K., Rana, S.K. and Sharma, P.K. 2007. Comparative efficacy of fungicides against rice blast. Presented in the National Symposium on 'Research Priorities and Strategies in Rice Production System for Second Green Revolution' held at CRRI, Cuttak, from November 20-22, 2007.

Srivastva, A., Parsad, J.S., Kaushik, R.P., Sharma, P.K. and Sud, A.2007.Parasitic Nematode Problem of Rice & Wheat in Malan. Paper presented in the National Symposium on Research Priorties & strategies in Rice Production System for Second Green Revolution held at CRRI, Cuttak ,from Nov., 20 .

Sugha, S. K., Upmanyu, S., and Banyal, D. K. 2007. Antifungal potential of *Acorus calamus, Adhatoda vasica* and *Vitex negundo* dried leaf/ rhizome powders against soil borne fungal pathogens. Presented in National Symposium on Eco-friendly Disease management approaches for Organic Farming in Horticultural Crops held at UHF, Solan from November 16-17, 2007.

Recommendations in Package of Practices

Karnal Bunt of Wheat (For raising general crop of wheat)

1. Treat the seed with Bavistin (2.5g/kg seed)
2. Grow recommended varieties
3. Spray the wheat crop with *Trichoderma viride* (Ecoderma) @ 5g/litre of water (0.5%) at flag leaf stage and repeat the spray at 50% emergence of ears (10 days after the 1st spray).

Karnal Bunt of Wheat (For raising seed crop of wheat)

1. Treat the seed with Bavistin (2.5g/kg seed).
2. Grow recommended varieties.
3. Spray the wheat crop with *T. viride* (Ecoderma) @ 5g/litre of water (0.5%) at flag leaf stage followed by another spray of Tilt 25EC @ 0.1% at 50% emergence of ears (10 days after the 1st spray).

Late Blight of Potato

1. Grow recommended varieties.
2. Use healthy seed tubers for sowing.
3. Fields should be cleaned properly.
4. Treat the cut potato tubers with Mancozeb 75 WP (Indofil M-45) @ 0.25% for 30 minutes before sowing.
5. Follow high ridge culture to avoid tuber infection.
6. In plains, spray the crop thrice with Mancozeb 75 WP (Indofil M-45) @ 0.25%/ Mancozeb 35 SC (Eurofil NT) @ 0.4%/Propineb 70WP (Antracol) @ 0.25%/Chlorothalonil 75WP (Kavach) @ 0.20% at 10 days intervals.
7. In hills, spray the crop twice with systemic fungicide Metalaxyl 8%+ Mancozeb 64% (Ridomil MZ 72WP/ Matco 72WP) @ 0.25% and the non systemic fungicide Mancozeb 75 WP (Indofil M-45) @ 0.25% / Mancozeb 35 SC (Eurofil NT) @ 0.4 %/ Propineb 70 WP (Antracol) @ 0.25 %/ Chlorothalonil 75 WP (Kavach) @ 0.2% alternatively at 15 days intervals.

Miscellaneous activities

DG ICAR Nominee

Dr. R.P.Kaushal, Professor has been nominated by Director –General, ICAR, New Delhi as member, Research Advisory Committee of Central Institute for Temperate Horticulture (CITH), Sri Nagar (J&K) for a period of three years from Sept., 2007 to Aug., 2010.

Editorial Board

- Dr. A.K. Sood was nominated as Associate Editor (Bacteriology) in the Editorial Board (2007) of 'Indian Phytopathology' - the official journal of the Indian Phytopathological Society.
- Dr. B.M. Sharma was nominated as a member of Editorial Board of 'Mushroom Research' and of **'**Himachal Journal of Agricultural Research' and Editor of mycological journal, 'Mycotaxon'.
- Dr. Y.S. Paul was nominated as a member of the university publication committee.

Expert Member Selection/Assessment Committee

Dr.A.K.Sood acted as Expert member Selection Committee at G.B. Pant University of Agriculture & Technology, Pantnagar; and as Expert Member of Assessment Committee at the Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan.

Seminars/Symposia/Workshops attended

Dr. A.K. Sood participated in a training-cum-workshop on the Standard Operating Procedures (SOPs) under Post Entry Quarantine (PEQ) for Designated Inspection Agencies at MANAGE, Rajendra Nagar, Hyderabad on 11.2.2008.

Facilities added

Laboratory equipment like BOD Incubator, electronic balance, heating mantle and mini gel system were added by Dr. Savita out of her project entitled 'Extraction of biologically active compounds from edible mushroom especially *Pleurotus* spp.'

Nomination

Dr.A.K. Basandrai was nominated as Principal Investigator for Moong, Mash, Lentil, Lathyrus, Rajmsh and Peas crops by the Director of IIPR, Kanpur.

Invited lectures

The scientists of the department delivered invited lectures on specialized topics during symposia/seminars/workshops organized in different parts of the country.

Preparation of District Agricultural Plans (DAPs) under National Agricultural Development Programme (NADP

Dr. A.K. Sood and Dr. D.K. Banyal conducted field survey of Chopal Block (Shimla District) and Solan Block, respectively for the preparation of District Agricultural Plans (DAPs) under National Agricultural Development Programme (NADP).

Member of committee for the implementation of IVth Dean Committee report

Dr. Y.S. Paul was nominated as a member of the committee for the implementation of 4th Deans' Committee report.

SUMMARY

The Department of Plant Pathology is actively engaged in teaching, research and extension activitiestaining to plant diseases and mushrooms. The significant findings for the year 2007-2008 are summarized below:

Teaching

The department offered eight undergraduate and 19 postgraduate courses including minor courses. Four students for M.Sc. and two for Ph.D programmes were admitted during the period. Two M.Sc. and one Ph.D student successfully completed their theses and degrees during the period under report.

Research

Cereals