INTRODUCTION

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

The research work in various projects is being carried out in the main department at Palampur and at Hill Agriculture Research and Extension Centre (Bajaura, Dhaulakuan and Kukumseri), Mountain Agriculture Research and Extension Centre (Sangla), Shivalik Agriculture Research and Extension Centre (Kangra) 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 that on maize diseases at Bajaura and Dhaulakuan, whereas the research on diseases of pulses is being carried out at Palampur, Sangla, Berthin and Dhaulakuan and on oilseed crops at Kangra. Among the diseases of Vegetable crops, bacterial wilt and fruit rots of solanaceous crops, powdery mildew, Ascochyta blight and white rot and root rot/wilt complex disease of peas, fungal, bacterial and viral diseases of frenchbean 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 Horticulture department and private mushroom growers. Teachers/scientists/students of the department are actively participating in the various seminars and symposia conducted by different scientific societies from time to time.

Several adhoc research projects are being carried out in the department with financial support from, Indian Council of Agricultural Research, Department of Biotechnology, Govt of Himachal Pradesh, and different fungicide companies.

The department is actively engaged in extension education activities such as advisory service to farmers for diagnosis and control of diseases and participation in district/state level workshops/seminars. The scientists of the department are also actively involved in 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
Associate Professor/Scientist	Dr.P.N.Sharma
Assistant Professor	Dr. K.K. Mondal (on EOL w.e.f 12.12.06)
RESEARCH	
Palampur Campus	
Professor Professor Sr. Scientist Scientist	Dr. O.P. Sharma (up to 16.11.06) Dr.R.P.Kaushal Dr.A.S.Kapoor Dr.Jitendra 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 Plant Pathologist	Dr.A.K.Basandrai Dr.Dhanbir Singh Dr.Akhilesh Singh (on EOL w.e.f 1.6.06)
Hill Agricultural Research & Extension Centre, Kukumseri	
Plant Pathologist	Dr. S. Dhancholia
Shivalik Agricultural Research & Extension Centre,Kangra	
Scientist	Dr. Ashok Kumar
Rice and Wheat Research Station, Malan	
Sr. Rice Pathologist 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 Scientist Asst Ext. Specialist	Dr.K.S.Rana (DEE Palampur) Dr. A. Singh (KVK Mandi) Dr. B. K.Sharma (KVK, Una) Dr. V.K. Rathi (KVK Dhaulakuan) 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 (1.4.2006 TO 31.3.2007)

Name of the scheme	Budget allocation (Lacs)	Expenditure	Staff
ANP-001-17 "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	13.8516	Dr.B.M.Sharma, Professor Dr. K.K. Mondal (on EOL w.e.f 12.12.06) Sh.Braham Chand, Supdt. Gr.II(EC) Sh.Swami Ram,Tech.Asstt.Gr.II w.e.f. 23.9.2004 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	26. 18003	Dr.A.K.Sood, Sr.Scientist Dr.S.K.Sugha, Professor Dr.Y.S.Paul, Professor Dr.P.N.Sharma, Assoc.Prof. Smt.Shashi Sharma, Sr.Asstt. Sh.Raj Mal, Jr.Scale Stenographer Gr-I Sh. Prem Chand, Jr.Technician Sh.Kishori Lal, Lab.Asstt.
ANP-055-17 "Facilities for research in the Department of Plant Pathology" CSKHPKV, Palampur	6.92	9.91558	Dr.R,.P.Kaushal, Professor Sh.R.S. Rana (w.e.f. 22.8.06) Sh.Dharam Chand, Beldar Sh.Hem Raj, Beldar Sh.Kehar Singh, Peon
APL-17-17 "Strengthening of facilities for research in the Department of Plant Pathology" CSKHPKV, Palampur	10.23	9.19164	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	8.86149	Dr.O.P. Sharma (up tp 16.11.06) Dr.A.S. Kapoor Professor(w.e.f. 6.02.7) Sh.Amar Nath Walia, Sr.Tech.Asstt. Gr-I Sh.Himat Ram, Lab.Asstt

Ad-hoc Projects

Sr. No.	Name of the scheme	Budget allocation (Lacs)	Expenditure	Staff
1	Pathogenic variability in bean common mosaic virus and its management through host resistance in French bean (ICAR)	4.5078	4.40077	Dr. O.P. Sharma (PI) Dr.Anju Pathania, RA (up to 28.8.06) Ms. Renu Kapil Ms. Madhu Patial (w.e.f 8.11.06)
2	Collection, identification & culturing of fleshy fungi prevalent in Western Himalayan region of Kangra District and adjoining area of HP (CSIR)	4.296	3.9111	Dr. B.M. Sharma (PI) Dr.R.K.Singh, RA Sh.Balwant Singh, Field Attendant (up to 31.12.06) Sh. Tilak Raj Field Assistant (w.e.f 10.4.07
3	Improvement and transfer of oyster mushroom cultivation technology for income generation among rural women of Kangra valley in H.P. (DST)	2.58	2.40363	Dr Deepika Sud, (PI)
4	Empowerment of rural women through transfer of mushroom cultivation technology	3.7	3.24038	Dr. J. Pal (PI) Dr.(Mrs.) Usha Rana JRF (up to to 8.1.07 Sh.Ravi Kumar, Field Helper
5	Extraction of biologically active compounds from edible mushroom especially *Pleurotus* spp.	3.44	3.98195	Dr. Savita Katoch (PI)
6	Assessing diversity in Ascochyta blight complex of pea using molecular markers and its management through host resistance	11.28662	9.0354	Dr.R.P. Kaushal (PI) Dr. Bilal Ahmed SRF
7	Evaluation of antifungal potential of Panchgavya against soil borne pathogens	1.87244	1.46813	Dr.S.K. Sugha (PI)
8	Management of foot rot and seedling blight of barley in Spiti Valley	1.5	1.17788	Dr. Suman Kumar (PI)
9	Refinement of management schedule for late blight of potato	0.25	0.25681	Dr. D.K. Banyal (PI)
10	Characterization of variability in Erysiphe pisi on pea	21.04	New project sanctioned	Dr. D.K. Banyal (PI) Dr. S. Upmanyu SRF (w.e.f 2.4.07) Dr. Uttam Chand SRF (up to 30.6.07

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. PN Sharma/ Dr.S.K.Sugha
Pl.Path. 512	Plant Pathological Techniques	0+2	Dr.A.K.Sood/Dr.KK Mondala
Pl.Path. 515	Plant Disease Epidemiology	2+1	Dr.A.S.Kapoor/Dr.D.K.Banyal
Pl.Path. 517	Biological Control of Plant Diseases	1+1	Dr.Y.S.Paul
Pl.Path. 521	Biotechnological & Mol. Plant Pathology	2+1	Dr.P.N.Sharma/Dr.R.P.Kaushal
Pl.Path 613	Advances in Plant Disease Management	2+1	Dr. KK Mondal/ Dr. AK Sood
Pl.Path. 591/691	Seminar	1+0	Dr. A.S. Kapoor
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
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.S.K.Sugha
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. 561/541	Plant Vriology	2+1	Dr. P.N.Sharma
Pl. Path 614	Advanced Diseased Resistance	2+0	Dr. P.N.Sharma
Pl.Path 621	Chemicals in Plant Disease Control	2+1	Dr. B.R. Thakur/ Dr. SK. Sugha
Pl.Path. 591/691	Seminar	1+0	Dr. A.S. Kapoor

Students Admitted: The following students were admitted to the P.G. programme during 2006-07

Name	Admission No	Advisor
M.Sc.		
Sh Arvind Kumar	A-2006-30-26	Dr. AS Kapoor
Ms. Ashlesha	A-2006-30-27	Dr. SK Sugha
Sh Pawan Kumar	A-2006-30-28	Dr. DK Banyal
Ph.D.		
Ms. Prachi Sharma	A2006-40-05	Dr. PN Sharma

The following students completed their M.Sc./Ph.D. programme during 2006-07 :

M.Sc		
Ms. Pankaj	A-2004-30-16	Dr. AK Sood
Sunitha Dogra	A-2004 -30-17	Dr. SK Sugha
Puneet Sharma	A-2003-30-25	Dr. AS Kapoor
Ph.D.		
Sh Bilal Ahmad	A-2002-40-11	Dr. PN Sharma

Abstracts of Theses

Ms. Pankaj M.Sc. (A-2004-30-16)

Title: **Efficacy of botanicals against *Ralstonia solanacearum* causing bacterial wilt of solanaceous vegetables**

Bacterial wilt caused by *Ralstonia solanacearum* (E.F. Smith) Yabuuchi *et al.* poses a serious threat to the production of solanaceous vegetable crops in the tropical, sub tropical and warm temperate regions of the world. The integrated management of the disease utilizing various cultural and biological methods has been attempted in the state with a limited success. Identification of additional cost effective components of management for inclusion in the integrated management package will lead to further refinement of technology. Therefore, 18 botanicals along with five neem based formulations and nine plant essential oils were evaluated *in vitro* and *in vivo* against tomato, brinjal and capsicum isolates of *R. solanacearum*.

In vitro evaluation was done by paper disc, spectrophotometer and plate count methods. Irrespective of the method of evaluation and the isolates, in general, the aqueous and organic extract of neem (*Azadirachta indica*) was found most inhibitory followed by jaldhar (*Ranunculus muricatus*) and nila phulnu (*Ageratum houstonianum*) at 100 per cent concentration. These plant extracts were more inhibitory than test chemicals viz. streptocycline (100 µg/ml), copper oxychloride (0.25%) and their combination. In case of neem based formulations, Wanis was found most effective at 100 and 50 per cent concentrations followed by Achook and Neemazal. Out of nine essential oils, neem oil at (20 µg/ml) was most inhibitory followed by mentha and Eucalyptus oils.

The *in vivo* evaluation of plant extracts and organic formulations by Kishun and Chand (1988) method revealed that the aqueous and organic extracts of neem resulted in maximum survivability of tomato seedlings followed by jaldhar (*Ranunculus muricatus*) at 100 per cent concentration after 12 and 6 hr dipping durations. The neem based formulation Wanis showed maximum survivability of seedlings followed by Achook and Neemgold at 100 per cent concentration. The efficacy of plant extracts, neem based formulations and essential oils decreased with decrease in concentration both *in vitro* and *in vivo*.

Sunitha Dogra M.Sc. (A-2004-30-17)

Title: Antifungal potential of Panchgavya against some soilborne pathogens

Antifungal potential of Panchgavya (PG) a unique combination of products of cow (milk, curd, ghee, urine and dung) was evaluated against *Rhizoctonia solani, Sclerotium rolfsii, Fusarium solani, F. oxysporum and Sclerotinia sclerotiorum*-soil borne fungal pathogens. Amongst the two preparations of PG, PG1 and PG2 that differed in their composition and antifungal potential against the test pathogens, PG1 was selected, based on its superior antifungal activity in inhibiting the mycelial growth of the test pathogens. Amendments of PG1 with salt and Baker's yeast further enhanced its antifungal property within a limited period of time, PG1 with common salt and Baker's yeast enhanced its antifungal property within a limited period of time. PG1 with common salt and Baker's yeast @ 20 and 10 g/1 of PG respectively was finally selected for further studies.

Among the two dilutions of PG, 5x and 10x, though 5x was superior being highly concentrated, but the 10x dilution also exhibited the same results with an increase in its age and dip duration. No loss in antifungal activity of PG was noticed even on autoclaving and ageing up to 6 months. There was no significant change in the pH of stored PG over a period of 6 months under lab condition and it remained towards alkalinity. No relation was established with change in pH and antifungal activity of PG. Seed dip in PG above 2 hr duration reduced the germination and tomato seedling drenched with PG at weekly interval showed significant variation in the chlorophyll contents and also improved the quality traits like ascorbic acid, TSS and lycopene contents of tomato fruit.

Tomato seedlings sown in sick soil and drenched with PG at 24 hr, 7 days and 14 days after transplanting gave 94 percent control of collar rot of tomato. Whereas soil drenching with PG 48 hr before sowing gave 80.1 percent control of root rot of pea over untreated check. Carbendazim treated seed sown in infested soil, drenched with PG 48 hr before sowing, resulted 91 and 92 percent control of damping off of okra and cauliflower seedlings. PG plated on YGCA and PSPA showed the presence of five different colonies of bacteria including an actinomycete. Individual colony of bacteria on isolation and multiplication showed strong antifungal activity, against *R. solani, S. rolfsii* and *S. sclerotiorum* and provided good control of collar rot of tomato and this could reason for antifungal potential of PG.

Puneet Sharma, M.Sc. (A-2003-30-25)

Title: Biocontrol potential of *Trichoderma* spp. Against some important soil borne pathogen of vegetable crops

In vitro studies revealed maximum inhibition of mycelial growth in dual culture with *T. harzianum* against *R. solani, Pythium sp., S minor and F. oxysporum* f. sp. *pisi*. However, against *S. rolfsii T. viride* showed maximum inhibition. The results of inhibitory activity of culture filtrate of *Trichoderma* spp. showed maximum inhibition of mycelial growth *of R. solani, Pythium sp., S. minor, F. oxysporum* and *S. rolfsii* in culture filtrate of *T. viride,* followed by *T. harzianum. T. harzianum* was found significantly better in inhibition of conidial germination of *F. oxysporum* f.sp. *pisi* and sclerotial germination of *S. rolfsii* than other bioagents. Mass multiplication of *T. harzianum* was maximum in wheat bran followed by shelled maize cob powder, maize flour and FYM whereas chicken manure and rice husk did not support the growth of the bioagent. Wheat bran was also found best when mixed with FYM in the ratio of 1:1 and 1:2 respectively. Soil application delivery system of *T. harzianum* as wheat bran based formulation @ 2 g/kg was found best followed by seed treatment with same formulation @ 2g /kg seed for controlling the root rot of pea and collar rot of tomato in pot experiments.

Among the different temperatures, 25^0C was found optimum for spore germination, germ tube length and mycelial growth of *T.harzianum* followed by at 20^0C. Thirty per cent soil moisture after 15 days was found to be most suitable for the growth of *T. harzianum* where as pH 5.0 was found to be the most suitable for the mycelial growth of *T. harzianum.* In competitive saprophytic ability of bioagent and the pathogen, *T. harzianum* had more competition for organic matter as compared to pathogen *S .rolfsii*. Herbicide alachlor adversely affected the growth of bioagent whereas pendimethalin was comparatively less toxic at 0.01% concentration. Fungicides carbendazim and mancozeb were found toxic to bioagent even at lowest concentration tested (0.01%) but Captaf was comparatively less toxic. Biopesticide Wanis was found more toxic to the growth of bioagent at all concentrations, but Neemgold was found comparatively less toxic. Insecticides chlorpyriphos and phorate were found both toxic to the bioagent.

Bilal Ahmad Padder, Ph.D (A-2002-40-11)

Title: Molecular variability in *Colletotrichum lindemuthianum* and management of bean anthracnose

Bean anthracnose disease was encountered in almost all the major bean growing areas and the incidence varied between 0.50 to 88.00 per cent at different stages of crop growth. Virulence spectrum of 90 isolates revealed the existence of 29 races in Himachal Pradesh. Race 513 contained maximum number of 16 isolates from diverse geographic regions. Sixteen races namely 101, 103, 115, 119, 195, 537, 551, 581, 598, 613, 615, 631, 639, 707, 775 and 935 were identified for the first time as none of them resembled with previously known races from world over. Out of the 29 races, 24 were virulent on both Andean and Mesoamerican gene pool of *Phaseolus vulgaris*. Race 0 did not infect any of the differential cultivar. Race 2 infected only Andean gene pool whereas races 1, 513 and 515 infected Mesoamerican gene pool. Interaction studies between virulence and the two gene pools of *P. vulgaris* suggested four types of interactions (Type I to Type IV). Ten virulence factors were present among 90 isolates on the basis of virulence behaviour with individual differential cultivar. Random amplified polymorphic DNA (RAPD) based fingerprinting with nine most polymorphic primers categorized 90 isolates into two main clusters using 57 per cent as cut off point. There was no congruence between RAPD pattern and virulence phenogram as the isolates that were identical for virulence were often dissimilar for RAPD marker. Evolution model for *C. lindemuthianum* virulences present in Himachal Pradesh was developed, which categorized 29 races into four evolutionary groups (Group I to Group IV). Races which contain more than six virulence genes may pose a threat to bean cultivation in different regions of Himachal Pradesh. Seventy six germplasm lines screened against 11 races of pathogen showed that majority of genotypes were susceptible to different races of pathogen. Two accessions AB 136 and G 2333 exhibited resistance to all the races. Antagonism activity of three bioagents revealed *Trichoderma viride* as best antagonist as it caused maximum inhibition of mycelial growth and seed borne infection. Among the five biopesticides Wanis applied @ 1000 µl/ml caused maximum inhibition of mycelial growth and also resulted in maximum control of seed borne infection. Field trials on integration of biocontrol, biopesticide, fungicide and resistant variety revealed that seed treatment alone with biocontrol agent, biopesticide and fungicide were not as effective as their combinations with foliar sprays of fungicide or biopesticide. Seed treatment and spray with fungicide and seed treatment with biopesticide and spray with fungicide were most effective in controlling the disease.

2. RESEARCH

Survey and surveillance

Rice

Production oriented survey of rice was conducted in four districts, namely Kangra, Mandi, Kullu and Chamba (Table 1). Incidences of diseases ranged from low to medium except false smut and bacterial leaf blight. In Mandi district in some pockets neck blast incidence on RP 2421 was very high (10-20 %).

Table 1: Prevalence of diseases in Himachal Pradesh

Districts	Diseases								
	BL	NBl	BS	ShBl	FS	LS	GD	NBLS	BLB
Kangra	L-M	L-M	L-M	L-M	L-M	L-M	L-M	L	L
Mandi	L-M	L-M	L-M	L-M	L	L	L	L	L
Chamba	L-M	L	-	-	L	L	L-M	L	-
Kullu	L-M	L	L-M	-	L	L-M	L-M	L-M	-

BL: Leaf blast, NBL: Neck blast, BS: Brown spot, Sh.Bl.: Sheath blight, FS: False smut, LS: Leaf scald , GD: Grain discolouration, NBLS: Narrow brown spot, BLB: Bacterial leaf blight

In Sirmour district maximum incidence (80%) of brown leaf spot was on paddy variety PR 116 in Paonta valley but leaf and neck blast was noticed in traces.

Maize: In an exclusive survey on maize diseases in Sirmour, following diseases recorded

Table 2 : Survey of maize diseases in district Sirmour

Place [No. fields surveyed]	Reaction to						
		MLB (1-5)	TLB (1-5)	BSDM (1-5)	BLSB (1-5)	BS (1-5)	ESR (% incidence)
Navada (5 Aug. 2006) [4]	Local	3	-	3	3		Tr
1	KH 9451	tr	-	-	2		2
Bahral [1]	KH 9451	tr	-	-	2		5
Sangarh (28 aug. 2006) [1]	Local	3	-4	-	2		
Singhpur [1]	KH 9451	1--2	-	-	2--3		2-5%
[8]	Local	3	-	3	3-Feb		Tr
Danda Pagar [1]	Local	2--3	-	3	2--3	3--4	
[2]	KH 9451	Tr	-	-			
Amarkot [2]	KH 9451	1--2	-	-			1--2%
[10]	Local	2--3	-	-	3--4		1%
Dharu Chaleria [10]	Local	3--4	-	-	3--4		

In Mandi district leaf blights and brown spot were predominant which varied from low to medium. Erwinia stalk rot was also observed in few locations though the incidence was low. Incidence of Banded leaf &sheath blight was very high.

Wheat: Yellow rust was observed in severe form in Paonta valley. Maximum intensity of yellow rust was recorded on HS 240 and HS 420 (60S). Flag smut was noticed in traces in late sown crop around Dhaulakuan. Brown rust was also noticed in severe form on wheat variety PBW343 (60s). However, yellow rust intensity recorded up to 40S on PBW 343. Powdery mildew score was 7 to 9 on all the cultivated varieties in Paonta valley except HPW 211 (4). Karnal bunt incidence varied between 0 to 1.32 %. Maximum incidence was recorded on PBW 343 from Navada and Kundiyon in Paonta. Karnal bunt was also noticed on HPW 184 and HPW 155 (O.68%). Raj 3777 was free from Karnal bunt.

In Mandi and Kangra districts wheat, yellow rust was recorded on varieties Sonalika, HS 240, HS 277, HS 295, HS 420, VL 616, VL 738, VL 829, UP 2338, HPW 42, HPW 155, HPW 147 etc. and severity ranged from 20-80S. It was also observed on PBW343 with severity 20S at Kangra in TPN. Leaf rust severity in cultivars HPW 42, HPW 184, HS 295, HS 420, PBW 343, VL 616, VL 738, UP 2338 and Sonalika ranged from 10-60S. Powdery mildew was recorded in severe form (7-8 on 0-9 scale) on HPW 42, HPW 155, HPW 184, HS 295, HS 420, VL 738, PBW 343, Sonalika etc. The overall incidence of loose smut varied 2-5 %. Flag smut was recorded in Balh valley (Sundernagar) and incidence ranged from 2-3%. The severity of Septoria blotch was up to 70% in some pockets and its intensity was 9 on 0-9 scale.

Barley: Yellow rust on barley crop was recorded in traces at the experimental farm of HAREC, Dhaulakuan. However, foliar blights were noticed in severe form. The severity of yellow rust was high in parts of districts Mandi and Kangra and in general varied 40-80S.

Oilseeds

Rapeseed-mustard : Light rains during November and first fortnight of December were congenial for the early outbreak of Alternaria blight and white rust at Kangra and surrounding areas. Floral infection due to white rust and downy mildew remained very low. However, further rains during March were favourable for the pod infection of *A. brassicae* in the October sown crops of gobhi sarson and Karan rai. Apart from these diseases, some incidence (5-10%) of stem rot due to *Sclerotinia* was also observed in mustard and gobhi sarson crops in the second fortnight of March.

Linseed : Low to moderate incidence of bud blight caused by *Alternaria lini* was observed at Kangra. Low to moderate incidence of powdery mildew was observed at Palampur in the susceptible varieties like Himalini. Rust appeared during the first week of February in the linseed crop planted during first week of November at Kangra. Intermittent rains during February and March and maximum temperature (15.6-25.5^{0}C) were favourable for disease progress. 75-100 % rust severity was recorded in the susceptible varieties like Chambal. Weather conditions of Kangra during March were also congenial for infection of *Alternaria lini* at the bud stage. 20-30% incidence of bud blight was observed in some of the varieties. Powdery mildew (10-50%) was recorded during second and third week of March at Kangra and Palampur

Sesame: In sesame, Phytophthora blight, leaf spots and blights caused by *Alternaria sesami, Cercospora* spp. were the major disease problems. 10-25% of Phytophthora blight, 51-75% of Cercospora leaf spot and 10-25% severity of Alternaria blight was recorded

Pulse crops: In Mandi district in mash incidence of Cercospora leaf spots ranged from medium to high , Web blight and Leaf crinkle virus diseases ranged from low to high whereas in rajmash Anthracnose ranged from medium to high. In chickpea stem rot was the predominant disease followed by collar rot.

Vegetable crops

Potato: Incidence of early blight ranged between 2-15 % at different locations. The bacterial wilt was observed in traces at Malan, Lakhamandal and Bhattoo (Table 3). Late blight of potato was more severe at Lakhamandal (65 %) and minimum at Paprola (10 %).

Table 3: Survey of potato diseases in Kangra district during 2006-07

Location	% Disease severity/ incidence		
	Late Blight	Early Blight	Bacterial wilt
Malan	50	15	2
Paprola	10	5	-
Bhawarna	35	7	-
Sulha	40	9	-
Panaper	35	10	-
Chmotoo	55	3	-
Nagrota	55	6	-
Lakhamandal	65	8	Tr
Latwal	25	5	-
Rakh	30	7	-
Nagri,	25	4	-
Jia	40	3	-
Dadh,	45	-	-
Bhatto	50	8	1
Sungal	20	2	-
Mejherna	30	9	-
Panchrukhi	25	-	-
Pahra	20	7	-
Menjha	55	5	-
Chimbalhar	45	8	-

High disease incidence / severity (60-100%) of late blight was recorded in Uthla Gaon of district Kangra only. Incidence of late blight was noticed which varied from low to moderately high in blocks viz. Nagrota Bagwan, Bhawarna and Bhedu mahadev, Rait and Kangra However, the other potato growing areas revealed the severity of early blight comparatively more (7-10%) and late blight in traces. Whereas, early blight was recorded 30 – 40 per cent on Kufri Jyoti and Kufri Chandrimukhi in Paonta valley but, intensity of late blight was 10 percent. In Mandi district also early and late blights were predominant diseases.

Pea: Root rot complex disease was predominant in Mandi district especially in Zone III area. Rust severity up to 60 % was observed on all the cultivated varieties of pea in the vicinity of Dhaulakuan.

Ascochyta blight

Disease was prevalent in almost all the potential pea growing areas with an incidence ranging up to 85 per cent. Maximum disease incidence was recorded in Chamba (62.14%) followed by Mandi (27.72) and Kinnaur (14.16%).

In Mandi district, disease incidence was noticed at Beyord and Upper Rail Chowk up to 80 per cent. Bhulah Jail, Taru, Jinjiahli Bagh and Shala recorded disease incidence of 70, 70, 60, 60, 50 percent, respectively. Potential pea growing areas of Chamba district showed from 15 to 85 per cent with an average of 62.14 per cent. The maximum incidence was recorded at Gurai and Dand (85%) followed by Jilari (75%), Sangni (70 %) and Miyari (60%).

In Kinnaur district, three locations viz., Upper Raksham, Chitkul and Raksham recorded disease respectively whereas remaining area showed no disease incidence. Various locations surveyed during *Rabi*, 2006 in the districts of Solan, Sirmour and Kangra recorded no disease incidence (Table 4).

Table 4: Incidence of Ascochyta blight of pea in Himachal Pradesh

Location	Disease incidence (%)	Location	Disease incidence (%)	Location	Disease incidence (%)
Chamba		**Mandi**		Hamni	18
Dand	85	Aunh	25	Thunagla	7.5
Gurai	85	Sangni	70	Jinjiahli	60
Jilari	75	Langera	45	Taru	60
Sangni	70	Parngal	15	Bhulah	70
Langera	45	Miyari	60	Kutha	20
Parngal	15	Shala	40	Beyord	80
Miyari	60	Tuna	0.8	Upper Rail Chowk	80
Sirmour		Bagh	50	Magru gala	35
Ponda	0.10	Jail	70	Bhulah	70
Kinnaur		Pandav Shila	20	Beyord	80
Upper Raksham	10	Dhawarthach	2	Magru gala	35
Raksham	20	Shauli Khad	1	Dhwas	8
Chitkul	55	Shiva Khad	5		

Tomato: High incidence of bacterial wilt and buckeye rot (20 –50 %) was recorded in tomato hybrids in Rajpur area of Paonta block of Sirmour district. The incidence of bacterial wilt was low to medium in Mandi district whereas in Kangra district it was medium to high.

Chilli : Fusarium rot , Anthracnose and Leaf curl mosaic virus diseases were prevalent in different chilli growing areas of Himachal Pradesh

Garlic/Onion: Incidences of downy mildew, purple blotch and stemphylium leaf blight diseases ranged from medium to high, in Mandi and Kullu districts. Whereas, in Sirmour district, downy mildew of onion was noticed in traces but, high intensity of purple blotch (60 –80 %) was recorded in garlic and onion.

Tea : Blister blight of tea appeared in the second week of August 2006 and remained with low disease pressure due to low initial inoculum build-up. Grey and brown blight appeared with low disease intensities, whereas sooty moulds are becoming a problem due to mealy bug infestation in tea plantations. Red rust also appeared in rainy season and is of minor importance.

Zone IV
Lahaul valley

Incidence of root rot / wilt complex disease was the most predominant disease of pea incidence of which ranged from 28.5 to 52.5 percent (Table 5).

Table 5 : Occurrence of root rots / wilts complex disease of pea in Lahaul valley

Location	Disease incidence (%)	Location	Disease incidence (%)
Udaipur	10-60 (40.4)	Tholang	30-60 (42.6)
Triloknath	20-80 (52.50)	Tandi	20-60 (40.4)
Thirot	30-80 (55.4)	Dalang	20-25 (35.6)
Junda	20-50 (32.6)	Sishu	10-50 (28.5)
Jahalma	20-60 (35.6)	Tehlling	20-60 (40.4)
Phura	10-50 (40.5)	Khokser	30-60 (43.6)
Lote	20-25 (36.6)		

Figures in parentheses are average disease incidence based on the observations taken from five fields in a location.

Spiti valley

High disease incidence / severity of root rot and seedling blight of barley and wheat was recorded in Spiti valley. Systematic studies on the disease were undertaken and it was concluded that shallow sowing, irrigation at weekly intervals, seed treatment with tebuconazole @ 2g/kg, one or two foliar sprays of propiconazole and integration of various components resulted in significantly superior control of disease.

Fodder crops

During *khaki* 2006 it was observed anthracnose/stem rot, wilt/root rot and blights of cowpea, blight of maize, blast of bajra and sorghum were the main diseases. In the *rabi* 2007 season oat crop was severely affected by powdery mildew, whereas leaf spot was observed major disease of berseem and Lucerne.

I. Cereals

Wheat

Germplasm evaluation

One thousand five hundred twenty wheat entries, under initial plant pathological screening nursery (IPPSN) were screened for resistance to yellow rust under artificial epiphytotic conditions at RWRC, Malan. Of these, 482 entries remained free from YR. Similarly 540 entries, comprising AVT-II, AVT-I and NIVT material, were screened for resistance to YR under artificial epiphytotic conditions. Of these, 27 entries from AVT-II (100), 64 from AVT-I (148) and 98 from NIVT (292) remained free from YR.

One hundred four entries were evaluated under powdery mildew screening nursery (PMSN) for resistance to powdery mildew under artificial epiphytotic conditions. Of these, 7 entries viz. TL 2934, TL 2942, TL2949, DDK1009, DDK1029, HI 1539 and HI 8663 were found immune, 9 entries viz. HPW 236, HPW 249, HPW 251, HS 461, C-306, HD 2781, NIDW 295, NW (S) 2-4 and NP 200 were resistant.

Forty six wheat entries comprising of AVT-I & II (NHZ) material, under Hill bunt screening nursery (HBSN) were screened against *Tilletia caries* and *T. foetida* by inoculating the seed of individual/each entry with teliospores @ 5.0 % (W/W) before sowing. Of these, TL 2942, TL 2949, TL 2955, DWR 63, HS 501, SWL34, HS 424 and VL 832, remained free from the disease and HS 461, HS 277, HS 420, VL 804, DWR 62, HPW 285, UP 2694 and UP 2719 were resistant.

Twenty wheat lines under trap plot nursery (TPN) were evaluated for resistance to YR and LR (leaf rust) infection under natural conditions. Five wheat varieties viz. WL1562, HD 2204, C-306, WH 542 and WH 896 remained free from YR whereas 18 varieties remained free from LR and it was recorded only on Agra Local and Lal Bahadur. The pathotypes analysis revealed the presence of races ; 21 R 55 (104-2) of LR and 46 S 119 and 78 S 84 of YR.

During 2006-07 crop season 2395 entries were screened under artificial inoculation condition against major diseases in various plant pathological nurseries and data revealed that out of 2395 entries, 116, 750, 1024 and 20 entries were found resistant to Karnal bunt, yellow rust, brown rust and powdery mildew, respectively (Table 9)

Table 6: Evaluation of wheat stocks for resistance to Karnal, brown rust, yellow rust and powdery mildew in plant pathological nurseries

Nursery	No. of entries	Karnal bunt	Brown rust	Yellow rust	Powdery mildew
Karnal bunt screening nursery (KBSN)	100	5	_	_	_
Plant pathological screening nursery (PPSN)	540	85	240	141	_
Initial plant pathological screening nursery (IPPSN)	1560	_	734	588	_
Powdery mildew screening nursery (PMSN)	104	_	_	_	18
Multiple disease screening nursery (MDSN)	51	21	26	18	1
SAARC nursery	20	3	11	1	_
Trap nursery	20	2	13	2	1
Total	2395	116	1024	750	20

One hundred wheat entries were evaluated for resistance to local isolates of *Tilletia indica* under artificial inoculation conditions. Five entries namely; HPW 233, DDK 1025, TL 2942, TL 2949 and LOK 54 were found resistant to Karnal bunt.

Out of 104 wheat genotypes, eighteen genotypes namely; TL 2934(T) ,DDK 1009 (Dic), DDK 1029(Dic),TL 2949, HPW 249, TL 2942(I), BHS 352, HI 1539, DBW 14, HD 2733, HD 2888, K 8027, K 9107, HW 2004, LOK-1, MP 4010, MACS 3313, MP 3211, HD 2189, COW(W)I and PBW 175 were found resistant to powdery mildew.

One hundred thirty nine wheat entries were screened by artificial inoculation of head scab pathogen and 22 entries namely; TL2949, HUW 598, WH 1021, K 0402, HD 2930, HD 2932, HW 5021, HW 5044, KRL 119, HS 491, HS 493, UP2719, HP 1896, PBW 580, PBW 582, PBW 583, PBW 588, HD 2956, RAJ 4125, MP 1193 and MPO 1204(d) were found resistant to head scab.

Out of 786 entries of barley, 212 entries were found resistant to yellow rust under artificial inoculation conditions in field. Out of 30 yellow rust samples collected and analyzed, occurrence of two pathotypes namely; 46 S119 and 78 S 84 were most prevalent on wheat in Sirmour district.

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

A replicated field trial on the evaluation of fungicide formulations for the combined control of loose smut and hill bunt was conducted during rabi 2006-07. The trial consisted of 12 treatments; Indofil M-45 @ 0.25, 0.30, 0.35, 0.20, 0.25, 0.25, 0.25 and 0.30%, Sivic (0.25%), Gain (0.25%), Raxil (0.10%), a standard recommended fungicide and a check and three replications of each. These formulations were tested by giving dry seed treatment of each formulation before sowing.

The data (Table 7) revealed that none of the formulations of Indofil M-45, Sivic and Gain were effective in controlling loose smut when compared with Raxil, a standard recommended fungicide. However, all the formulations of Indofil M-45, Sivic and Gain were effective in controlling hill bunt when compared with Raxil. Formulations of Indofil M-45 were most effective in controlling hill bunt.

Table 7: Evaluation of fungicidal formulations for control of loose smut and hill bunt

Treatment (conc. %.) Indofil M45	Av. germination (%)	Av. LS incidence (%)	Av. HB incidence (%)	Av. yield (kg)
0.25	68	25.8	0.8	0.283
0.3	77	21.0	1.05	0.307
0.35	82	18.6	0.21	0.300
0.20	73	13.8	0.64	0.340
0.25	73	37.5	2.28	0.263
0.25	80	24.4	1.53	0.300
0.25	73	29.1	4.1	0.237
0.3	77	28.9	1.13	0.260
Sivic (0.25)	73	29.2	4.53	0.190
Gain (0.25)	75	29.8	4.2	0.187
Check	82	36.9	15.1	0.193
Raxil (0.1)	72	6.1	7.0	0.297

LS=Loose smut; HB= Hill bunt

Evaluation of fungicides against loose smut of wheat

Six fungicides; F-100, Carbendazim 50 WP, Mancozeb 75 WP, Carboxin 70 WP, Thiram, and Vitavax Power were evaluated against loose smut as seed treatment. The untreated loose smut infected seed served as control. All the test fungicides were found statistically superior to control. How ever, Carboxin (2.5 gm), Carbendazim (2.0 gm) and F-100 (3.5 gm) were statistically at par (Table 8).

Table 8: Evaluation of fungicides against loose smut of wheat

Fungicides	Dose (gm/ kg seed)	Loose smut incidence (%)	Yield (q / ha)
F- 100	2.5	2.12 (8.12)	51.34
F-100	3.0	1.85 (7.59)	56.81
Carbendazim	2.0	0.76 (4.97)	60.17
Mancozeb	2.5	5.89 (14.01)	19.35
Carboxin	2.5	0.70 (4.74)	58.07
Thiram	2.5	7.62 (15.99)	55.12
Vitavax Power	2.5	2.37 (8.83)	53.02
Control		11.22 (19.57)	46.88
CD (0.05)		1.72	7.97

*Angular transformed values in the parentheses

Management of Karnal bunt using biocontrol agents and epidemiological approach :

The trials were conducted during 2002-03, 2003-04, 2004-05, 2005-06 and concluded that Karnal bunt can be managed effectively by giving two sprays of biocontrol agent *Trichoderma viride* (Ecoderma @ 5g/litre) at two critical growth stages i.e. flag leaf stage and 50% ear emergence. Two sprays of biocontrol agent resulted in 88.95 percent disease control. However, one spray of *T. viride* at flag leaf stage followed by another spray of Tilt at 50% emergence of ear gave complete control of Karnal bunt (Table 9).

Table 9: Management of Karnal bunt using bio -control agents and epidemiological approaches

	Treatment	2002-03	2003-04	2004-05	2005-06	Average KB incidence (%)	Average disease control (%)
T1	Application of T. v.. at Zadoks growth stage 30-39	1.73 (1.65)	0.18 (1.08)	0.37 (1.17)	0.26 (1.12)	0.63 (i.17)	63.37
T2	Foliar sprayof T.v.at growth stage 30-39 followed by another spray at growth stage 41-49	0.50 (1.22)	0.09 (1.04)	0.16 (1.07)	0.10 (1.04)	0.21 (1.10)	87.79
T3	T1+T2	0.33 (1.15)	0.15 (1.07)	0.18 (1.08)	0.12 (1.05	0.19 (1.09)	88.95
T4	Foliar spray of Tilt at Zadok growth stage 41-49	0.80 (1.34)	0.21 (1.10)	0.26 (1.12)	0.22 (1.10)	0.37 (1.17)	78.48
T5	Foliar spray of Tilt at Zadok growth stage 41-49	0.13 (1.06)	0.06 (1.02)	0.11 (1.05)	0.13 (1.06)	0.11 (1.05)	93.60
T6	T4+T5	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	100.00
T7	Foliar spray of T. v. at growth stage 30-39 followed Tilt spray at 41-49	0.10 (1.04)	0.00 (1.00)	0.00 (1.00)	0.09 (1.04)	0.05 (1.02)	97.09
T8	Foliar spray of Tilt at growth stage 30-39 by T.v. spray at 41-49	0.66 (1.28)	0.03 (1.01)	0.21 (1.10)	0.15 (1.07)	0.26 (1.12)	84.88
T9	Control	2.50 (1.87)	1.30 (1.50)	1.47 (1.55)	1.62 (1.61)	1.72 (1.64)	-
	CDat 5%	0.33	0.20	0.17	0.21	-	

Figures in parentheses are square root transformed values

Chemical control of Karnal bunt of wheat

Data revealed that two sprays of Folicur and Tilt @ 0.1 percent gave complete control of Karnal bunt. However, two sprays of Result controlled the disease up to 90.50 % (Table 10).

Table 10: Comparative efficacy of fungicides against Karnal bunt of wheat

Fungicide	Conc. (%)	No. of sprays	Disease incidence (%)	Disease control (%)
Folicur	0.1	1	0.30 (1.14)	69.38
Folicur	0.1	2	0.00 (1.00)	100.00
Result	0.1	1	0.50 (1.22)	48.97
Result	0.1	2	0.10 (1.04)	89.79
Tilt	0.1	1	0.28 (1.13)	91.42
Tilt	0.1	2	0.00 (1.00)	100.00
Check	water spray		CD (p=0.05) 0.22	

Figures in parentheses are square root transformed values

Management of Karnal bunt by seed dressing fungicides and foliar spray of Tilt

The trials were conducted for two consecutive wheat seasons (2005-06 and 2006-07) and data (Table 11) indicate that seed treatment alone was not effective in controlling Karnal bunt. However, seed treatment and foliar spray of Tilt gave effective control of disease.

Table 11: Effect of seed dressing fungicides and foliar spray of Tilt on Karnal bunt

Treatment	2005 -06			2006 -07		
	Karnal bunt incidence (%)	Karnal bunt control (%)	Yield / plot (kg)	Karnal bunt incidence (%)	Karnal bunt control (%)	Yield / plot (kg)
Bavistin @ 2.5 g/kg	1.78 (1.66)	10.10	1.350	0.80 (1.30)	11.11	1.450
Vitavax @ 2.5g /kg	1.92 (1.70)	3.03	1.200	0.80 (1.36)	4.65	1.300
Raxil @ 1g/kg	1.83 (1.68)	7.57	1.400	0.88 (1.37)	2.22	1.500
Foliar spray of Tilt @ 0.1%	0.11 (1.05)	94.44	1.450	0.01 (1.00)	98.80	1.500
Bavistin @ 2.5 g/kg + spray of Tilt @ 0.1%	0.08 (1.03)	95.95	1.300	0.05 (1.02)	94.49	1.400
Vitavax @2.5 g/kg + spray of Tilt	0.11 (1.05)	94.44	1.350	0.07 (1.03)	92.22	1.400
Raxil @ 1g/kg + spray of Tilt @ 0.1%	0.09 (1.04)	95.45	1.340	0.04 (1.01)	95.55	1.400
Check (No treatment)	1.98 (1.72)		1.300	0.90 (1.37)	-	1.200
CD (P=0.05)	0.27	0.186	0.38	0.195		

Figure in parenthesis are square root transformed values plot size= 2 x 2 m

Management of loose smut and Karnal bunt by seed dressing fungicides

The data (Table 12) indicate that most of the test fungicides resulted in significant reduction in loose smut incidence except mancozeb and Thiram. However, minimum incidence of loose smut and Karnal bunt was recorded with F100 @ 3.5 g/kg seed treatment.

Table 12: Effect of seed dressing fungicides on the incidence of loose smut and Karnal bunt

of wheat

Treatment	Germination (%)	Infected ears (%)	Karnal bunt incidence (%)	Yield g /plot
F100@ 2.5g/kG	85.00	2.49	0.16	233.33
F 100 @ 3.0 g / kg	85.00	2.12	0.10	266.66
F 100 @ 3.5g / kg	86.00	1.98	0.06	300.00
Carbendazim @ 2.0 g/kg	86.66	2.98	0.03	266.66
Mancozeb @ 2.5 g/ kg	83.33	24.04	0.06	233.33
Carboxin @2.5 g/kg	88.33	2.00	0.23	350.00
Thiram @2.5 g /kg	86.33	27.88	0.06	275.00
Vitavax power @ 3.0 g / kg	88.33	7.15	0.10	233.33
Check	80.00	30.00	0.23	233.33

Plot size = 1x1 m

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

The previous and this year data revealed that seed dressing fungicides were compatible with endosulfan and chloropyriphos and biocontrol agent *T. viride*. There was no adverse effect on seed germination and disease control efficiency of the fungicides. The data presented in Table 13. indicated that seed treatment with fungicides + insecticides followed by one spray of Tilt and insecticide gave significant reduction in loose smut, karnal bunt, yellow rust, termites damage, aphids population and increase in grain yield. However, seed treatment with Vitavax and Endosulfan followed by one spray of Tilt and Endosulfan was the best treatment for controlling diseases and insect pests of wheat.

Table 13: Integrated pest management in wheat

Treatment	LS incidence (%)	Karnal bunt incidence (%)	YR severity	% termites damaged shoots per meter row after 5 wks.	Average aphid population per tiller	Yield/ plot(kg)
T1	0.05 (1.02)	2.00 (1.73)	40S	9.05 (3.17)	5.27 (2.50)	1.116
T2	0.01 (1.00)	2.66 (1.91)	60S	7.15 (2.85)	10.00 (3.31)	1.133
T3	0.00 (1.00)	3.00 (2.00)	50S	9.02 (3.16)	7.52 (2.91)	1.266
T4	0.00 (1.00)	0.06 (1.02)	5S	0.00 (1.00)	1.05 (1.43)	1.116
T5	0.01 (1.00)	0.06 (1.02)	0	0.00 (1.00)	0.50 (1.22)	1.466
T6	0.00 (1.00)	3.00 (2.00)	5S	0.00 (1.00)	0.05 (1.02)	1.433
T7	0.00 (1.00)	1.33 (1.52)	0	0.00 (1.00)	0.57 (1.25)	1.066
T8	0.00 (1.00)	1.66 (1.63)	0	0.00 (1.00)	0.46 (1.20)	1.466
T9	0.00 (1.00)	1.00 (1.41)	0	0.00 (1.00)	0.80 (1.34)	1.333
T10	0.05 (1.02)	3.00 (2.00)	40S	12.16 (3.62)	9.02 (3.16)	1.050
T11	0.00 (1.00)	1.66 (1.63)	50S	0.00 (1.00)	10.02 (3.31)	1.366
T12	0.00 (1.00)	0.00 (1.00)	0	0.00 (1.00)	0.00 (1.00)	1.433
T13	1.01 (1.41)	3.33 (2.08)	80S	12.43 (3.66)	11.05 (3.47)	0.983
CD (P=0.05)	0.42	0 .98		1.08	1.12	0.112

Figures in parentheses are square root transformed values, 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)

Evaluation of carbendazim 25% + mancozeb 50% (75WS)) on seed germination, incidence of loose smut, Karnal bunt and hill bunt of wheat

In a pot experiment, the effect of test fungicides i.e. carbendazim 25% + mancozeb 50% (75 WS) at 3 concentrations was studied on seed germination, seedling vigour & loose smut incidence at Palampur and compared with carbendazim 50 WP (Benfil), mancozeb 75 WP (Indofil M-45), carboxin 75 WP (Vitavax) and carboxin 37.5% + Thiram 37.5% (Vitavax power). Data (Table 14) revealed that seed germination in both the methods i.e. Petri plate and paper towel was more than 97% in all the treatments including check. No incidence of loose smut was observed when the seeds were treated with test fungicide and carbendazim. However, maximum grain yield i.e. 130 g/pot were obtained with mancozeb followed by 126 g/pot with test fungicide @ 3.5 g/l.

Efficacy of carbendazim 25% + mancozeb 50% (75 WS) was also evaluated under field conditions against loose smut, hill bunt and Karnal bunt of wheat as seed treatment at Malan, Kullu, Una and Dhaulakuan. The test fungicide was evaluated along with carbendazim 50 WP , mancozeb 75 WP , carboxin 75 WP and carboxin 37.5% + Thiram 37.5% at all the locations. All the fungicides enhanced the seed germination .The data revealed that Carbendazim 50 WP was most effective against loose smut with 1.2% disease incidence followed by carboxin (1.3%) and test fungicide (1.6%) at 3.5 g/l concentration. However, Karnal bunt was managed by the test fungicide at 3.5 g/l, carbendazim 50 WP, carboxin 75 WP and carboxin 37.5% + Thiram 37.5% with 0.1% disease incidence. Hill bunt incidence (Table 14) was recorded only at Malan and test fungicide was found very effective at 3.5 g/l concentration followed by carbendazim with 0.2 and 0.8% incidence as compared to 15.1% incidence in control. The average maximum yield was obtained in the treatment, when seeds were treated with carboxin (37 q/ha).

Table 14 : Comparative effectiveness of Carbendazim 25% + Mancozeb 50% (75WS) on seed germination, incidence of loose smut, Karnal bunt and hill bunt of wheat at Malan (L-1), Kullu (L-2), Una (L-3) and Dhaulakuan (L-4)

Treatment	Dose (g/kg)	Av germination (L1to L4) (%)	Av Loose smut Incidence (L1 to L4) (%)	Karnal bunt Incidence L3 &L4) (%)	Hill bunt Incidence (L-1) (%)	Yield (q/ha) (L1 to L4)
Carbendazim + mancozeb 75 WS	2.5	78.4	2.0	0.2	1.0	32.1
Carbendazim + mancozeb 75 WS	3.0	83.9	1.8	0.2	0.8	32.8
Carbendazim + mancozeb 75 WS	3.5	86.2	1.6	0.1	0.2	36.0
Carbendazim 50 WP	2.0	83.3	1.2	0.1	0.6	34.6
Mancozeb 75 WP	2.5	73.8	9.4	0.3	2.2	30.3

Carboxin 75 WP	2.5	85.5	1.3	0.1	1.5	37.0
Thiram 75 WP	2.5	79.8	10.6	0.2	4.0	31.3
Carboxin 37.5% + Thiram 37.5%	3.0	82.9	3.1	0.1	1.3	31.6
Check	-	72.2	14.8	0.9	15.1	27.4
CD (P=0.05)					0.9	

Rice
Germplasm evaluation

Thirty five entries were screened under national screening nursery-hills against rice leaf and neck blast using UBN pattern on 0 to 9 scale. Promising entries are SKAU-292; UPR-2674-23-1-1; HPR-2001 GHS & VL-306878 and against neck blast were ;VL 30278; HPR-2001; GHS; HPR-701; HPR 704; VL Dhan 61.

56 entries were screened against rice leaf and neck blast. Promising entries were IR-7821-19-6-23; IR 78224-22-98; VHC-1329 against leaf blast and against neck blast ; TNRH-142 R; TNRH-142H; TNRH -145H; VOPH-3102; VL-4040; VL30118; HPR2529,HPR-2530; Ajaya. Forty eight entries were evaluated under national hybrid screening nursery against leaf blast. Promising entries were IET No. 19725; 19734; 19740; 19743 and 19760;

Nineteen entries were screened under natural infection conditions and none of the genotypes was free from all diseases. However, two genotypes HPR 2352 and HPR 2353 were resistant to brown leaf spot and blast. HPR 2041 was resistant to all diseases except brown leaf spot (Table 15).

Table 15. 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	10.5	2.5	0.0	2.0	0.0	0.0
HPR 2041	10.5	T	0.0	0.0	0.0	0.0
HPR 2303	5.5	5.0	0.0	0.0	10.0	0.0
HPR 2304	T	5.5	2.0	5.5	2.0	0.0
HPR 2306	5.5	2.0	0.0	10.5	2.50	0.0
HPR 2321	205	0.0	0.0	30.5	5.0	0.0
HPR 2322	T	5.0	0.0	40.0	T	0.0
HPR 2323	T	T	0.0	30.0	2.5	0.0
HPR 2327	15.0	T	0.0	20.0	10.0	0.0
HPR 2331	20.0	10.0	0.0	20.0	10.0	1.0
HPR 2344	T	T	0.0	10.0	5.5	0.0
HPR 2352	0	0.0	0.0	5.0	2.0	0.0
HPR 2353	0	0.0	0.0	2.0	10.5	0.0
PR 109	T	T	0.0	10.0	5.0	0.0
HPR 2143	10.0	15.0	0.0	2.0	0.0	0.0
HRI 5052	T	5.0	0.0	30.0	5.0	0.0
HRI 5045	5.0	15.5	0.0	10.5	0.0	0.0
HRI 5050	10.5	T	T	10.0	10.5	0.0
HRI7508	T	T	0.0	0.0	20.0	0.0

T=Trace

Effect of different *Xa* genes against *Xanthomonas oryzae* pv. *oryzae* causing bacterial leaf blight of rice

A study was conducted during *kharif* 2006 to identify bacterial leaf blight genes showing resistance to the Rajiana isolate of BB in the mid hills of H.P. Eleven near isogenic lines viz. IR-BB 1, IR-BB 3, IR-BB 4, IR-BB 5, IR-BB 7, IR-BB 8, IR-BB 10, IR-BB 11, IR-BB 13, IR-BB 14 and IR-BB 21 in the background of IR 24 containing known genes for resistance to bacterial blight and 11 pyramid lines viz. IR-BB 51 to IR-BB 60 with 2 to 4 genes for resistance were used in the present study. In addition 13 improved varieties of rice recommended for cultivation in the mid hill conditions of HP since 1971, 13 traditional cultivars of HP, 6 japonica varieties, 3 IRRI varieties, 11 hill varieties from Almora and 6 from J&K were tested for their reaction to bacterial blight at RWRC, Malan during Kharif 2006.

One month old seedlings of each test entry were transplanted in two rows, each 3m long. Five plants in each test entry were clip inoculated on 45 DAT (representing maximum tillering to booting stage of the crop) with the bacterial suspension. Leaf segments (2 mm long) collected from naturally infected plants of rice variety Sabarmati were agitated in 100 ml of sterilized distilled water for 30 minutes. The resulting suspension of bacterial ooze was used as inoculum. At least five leaves on each test plant were scored 21 days after inoculation on 0-9 scale.

Out of the 11 isogenic lines evaluated, 6 namely IR-BB 1, IR-BB 3, IR-BB 7, IR-BB 10, IR-BB 11 and IR-BB 14 were found to be susceptible whereas four lines viz. IR-BB 5, IR-BB 8, IR-BB 13 and IR-BB 21 were resistant. Isogenic line IR-BB 4 showed moderately resistant reaction. Three recessive genes *xa5, xa8* and *xa13* and a dominant gene *Xa 21* showed resistance to the isolate. All the pyramid lines were resistant to this isolate. Out of 13 improved rice varieties; Himalaya 741, Himalaya 2216, RP 2421, Palam Dhan 957, HPR 1068 and HPR 1156 were found to be resistant. Himalaya 1 and Himalaya 2 were moderately resistant and 3 aromatic / basmati lines viz. T 23, Hassan Serai and Kasturi and newly released variety HPR 2143 were susceptible. Out of 11 hill rice varieties from Almora, VL25867-2-2, VL 30424 and VL 30425 were found resistant to BB. Three IRRI varieties viz. IR36, IR64 and IR72 were also found to be resistant.

Chemical control

Evaluation of new fungicides against blast

Three sprays of each fungicide were given on 8th, 30th August and 20th September. Leaf blast severity and neck blast incidence were recorded as per standard methods. Yield data was also recorded from each plot. Amongst the five new fungicides evaluated, three sprays of Fillia 52.5 SE (@ 2.5 ml/litre of water, Gain 75WP@ 0.6g /litre and Native @ 0.4

g/litre were found equally effective in controlling leaf and neck blast as compared to untreated check. Similarly the same fungicides were observed statistically at par giving higher yields as compared to check (Table 17).

Table 17. Evaluation of new fungicides for blast control at Malan

Fungicide	Dosage/L.	Leaf blast severity (%)		Neck blast Incidence (%)		Grain yield
		AT	O	ST	O	(kg/ha)
Filia 52.5 SE	1.5 ml	28.3	22.5	3.6	12.8	4190
Filia 52.5 SE	2.0 ml	23.7	16.3	3.5	12.4	4468
Filia 52.5 SE	2.5 ml	17.9	9.5	3.5	12.0	4838
Nativo 75 WP	0.4 g	19.5	11.3	3.4	11.8	4676
Gain 75 WP	0.6 g	16.6	8.3	3.3	11.1	4699
Kasu-B 3 SL	2.5 ml	21.6	13.8	3.6	13.1	4444
Tilt 25 EC	1.0 ml	31.6	27.5	4.2	17.4	3681
Check	Untreated	38.5	38.8	5.2	26.8	28.1
CD (0.05)		3.73		0.58		585.2
CV (%)		10.3		10.4		9.4
Test Variety			T-23			
Sprays (No.)			3			

AT: Arcsin transformed means; ST: Square root transformed means; O: Means of original values.

Evaluation of commercial fungicides against rice blast

A highly susceptible variety HPR 2360 was planted on 6th June, 2006 and transplanted on 12th July. Three sprays of each fungicidal treatment were given on 11th, 21st August and 4th and 20th September. Leaf blast severity and neck blast incidence were recorded as per standard methods. Yield data was also recorded from each plot. Tricyclazole + Mancozeb 80 WP was found significantly superior over all the test formulations in checking both leaf and neck blast infections, though it was not reflected in the grain yield, which was not significant (Table 18).

Table 18: Evaluation of fungicidal formulations against blast

Fungicide	Dosage/L	Leaf blast severity (%)		Neck blast incidence (%)		Grain yield (kg/ha
		AT	O	AT	O	
Hexaconazole + Zineb 72 WP	2.0g	38.5	38.8	35.0	33.0	3625
Hexaconazole + Zineb 72 WP	2.5g	35.5	33.8	34.3	32.0	3563
Tricyclazole + Mancozeb 80 WP	2.0g	17.4	9.0	19.9	11.6	5250
Tricyclazole + Mancozeb 80 WP	2.5g	15.7	7.5	21.0	12.9	5208
Antracol 75 WP	3.0g	21.6	13.8	25.3	18.7	4542
Companion 75 WP	1.5g	22.6	15.0	26.6	20.5	4354
Dhanteam 75 WP	0.6g	20.6	12.5	24.1	16.7	4604
Sheathmar 3 L	2.5ml	25.5	18.8	25.5	19.2	4188
Sitara 5 EC	2.0ml	33.2	30.0	27.8	21.9	3875
Check	Untreated	42.1	45.0	40.3	42.0	3479
CD (0.05%)		4.44		6.23		ns
CV %)		11.2		15.4		21.4
Test variety	HPR2360					
Spray (No.)				4		

Fungicidal management of paddy diseases

Diseases incidence data presented in Table 19 indicated that 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 19: Chemical management of rice diseases and effect on grain yield

Treatment	Conc. (%)	Brown leaf spot intensity (%)	Leaf blast intensity (%)	Neck blast intensity (%)	False smut incidence (%)	Grain yield (kg)/plot
Indofil M-45	0.25	20.66	12.00	3.00	4.00	3.498
Blitox-50	0.30	32.33	10.00	6.00	2.33	3.832
Bavistin	0.10	42.00	3.33	2.33	10.00	4.000
Controll 5EC	0.10	20.33	4.23	3.66	2.00	4.025
Tilt	0.10	4.33	12.66	3.00	9.33	4.200
Result	0.10	22.00	13.33	4.66	7.00	4.100
Antracol	0.25	29.33	16.66	7.00	9.66	4.100
Contaf	0.10	36.66	14.33	8.33	8.00	4.100
Ridomil MZ72 WP	0.25	50.00	12.00	8.00	8.66	3.433
Check	-	60.33	20.00	14.33	10.00	2.985
CD (P=0.05)	-	9.08	2.58	0.98	0.66	0.200

Plot size= 4x3 m

Testing of fungicides against rice diseases

Native 75 WG (Trifloxystrobin 25% + Tebuconazole 50%), a new fungicide at all the concentrations tested (25 + 50, 37.5 + 75 and 50 + 100 g.a.i./l) was found best in controlling both leaf and neck blast, and grain infection and improved the grain yield when compared with control (Table 20).

Though there was no significant difference in the grain yields among the treatments however, calculation of cost benefit ratio revealed that this was more in Native at 25 + 50 g.a.i/l (1: 3.43) followed by Folicur and Native (37.5 + 75) as 1: 2.32 and 1:2.31 respectively (Table 21).During July 2006, disease pressure particularly of rice blast and sheath blight was very less. However, it is concluded that Native is as effective as standard fungicide Tricyclazole (Beam 75 WP) especially against rice blast. This fungicide was found safer to the crop and also no phytotoxicity symptoms were observed even at higher dosages of the treatment.

Table 20 : Efficacy of Native 75 WG against blast (leaf and neck), sheath blight and glume discolouration of rice

Treatment	Dosage Forml/ha (g/ml)	LB (%)	NB (%)	Shb (%)	Gd (%)	% infected grains/ panicle	% chaffy grains/ panicle	1000grain wt. (g)	Yield kg/ha
Native 75 WG	100	0.33 (1.15)	0.33 (1.15)	0.67 (1.29)	10.17 (3.19)	13.63 (3.69)	10.73 (3.28)	22.58	1425
Native 75 WG	150	0.33 (1.15)	0.33 (1.15)	0.33 (1.15)	10.13 (3.18)	12.10 (3.48)	10.93 (3.31)	22.73	1420
Native 75 WG	200	0 (0.03)	0 (0.03)	0.33 (1.15)	11.20 (3.35)	9.60 (3.10)	9.07 (3.01)	22.35	1494
Trifloxystrobin (Flint) 50WG	100	0.33 (1.15)	0.33 (1.15)	0.33 (1.15)	9.27 (3.04)	13.47 (3.67)	11.23 (3.35)	22.85	1150
Tebuconazole (Folicur) 250 EW	625	1.5 (1.22)	1.5 (1.22)	0.33 (1.15)	12.20 (3.49)	11.60 (3.41)	10.73 (3.28)	22.53	1482
Tebuconazole (Folicur) 250 EW	750	0.33 (1.15)	0.33 (1.15)	0.33 (1.15)	10.77 (3.28)	11.20 (3.35)	9.83 (3.13)	24.13	1280
Tricyclazole (Beam) 75 WP	300	0.33 (1.15)	0.33 (1.15)	0.33 (1.15)	11.47 (3.39)	11.07 (3.33)	12.30 (3.51)	23.13	1398
Propiconazole (Tilt) 25 EC	500	1.5 (1.22)	1.6 (1.26)	1.5 (1.22)	10.83 (3.29)	15.17 (3.89)	10.80 (3.29)	22.76	1110
Control (untreated)		5.2 (2.28)	4.4 (2.10)	2.60 (1.61)	13.17 (3.63)	19.80 (4.45)	17.60 (4.20)	20.70	1047
CD (p ≤ 0.5)		0.67	0.56	NS	NS	0.47	NS	NS	NS

Figures in parentheses are square root transformed mean valuesLB; leaf blast, NB; neck blast, Shb; sheath blight, Gd; grain discolouration

Table 21: Cost benefit ratio of Native 75 WG

Treatment	a.i./ha (g)	Cost of fungicide (Rs. kg/l)	Quantity used (ml/kg)	Cost of two sprays (Rs.)	Grain yield kg/h	Income @ Rs. 6/kg of grain	Income above control (Rs)	Cost benefit ration
Native 75 WG	25+50	3300	100	660	1425	8550	2268	1:3.43
Native 75 WG	37.5+75	3300	150	967	1420	8520	2238	1:2.31
Native 75 WG	50+100	3300	200	1320	1494	8964	2682	1:2.03
Trifloxystrobin (Flint) 50WG	50	2500	100	500	1150	6900	618	1:1.25
Tebuconazole (Folicur) 250 EW	156.25	900	625	1125	1482	8892	2610	1:2.32
Tebuconazole (Folicur) 250 EW	187.5	900	750	1350	1280	7680	1398	1:1.04
Tricyclazole (Beam) 75 WP	225	2800	300	1680	1398	8388	2106	1:1.25
Propiconazole (Tilt) 25 EC	125	1100	500	1107	1110	6660	378	-----
Control	--	--	--	--	1047	6282	--	--

Evaluation of biopesticides against blast

The test variety HPR 2360 was sown at Malan on 6th June and transplanted on 4th July. Four sprays were given as per the schedule in August (10th and 18th) and September (4th and 20th). The crop was harvested on 23 rd October and grain yield data were taken. The standard check fungicide was found significantly superior over all the test bio-pesticides in checking the blast infection, though grain yield data were found non- significant. However, among the bio-pesticides, Biotos and Trichozen-T checked the disease. No phytotoxicity and symptoms were observed on application of any of the bio-pesticides (Table 22).

Table 22: Evaluation of biopesticides against blast at Malan

Fungicide	Dosage/L.	Leaf blast severity (%)		Neck blast severity (%)		Grain yield (Kg/ha)
		ST	O	ST	O	
Biofer	1.5ml	5.3	28.7	6.2	38.6	4467
Biotos	2.5ml	3.7	13.7	4.1	17.0	5185
Defender	2.5ml	4.6	21.2	5.1	26.2	5092
Ecomonas	10.0g	4.7	22.5	4.1	17.4	4953
Florezen-P	2.5g	4.4	20.0	4.9	24.4	4953
Trichozen-T	5 kg/ha*	3.3	11.2	4.3	18.6	5185
Bavistin 50 WP	1.0g	2.8	8.7	3.0	9.7	5300
Check	Untreated	6.2	38.7	6.0	36.0	4699
CD (0.05)		0.72		0.67		Ns
CV (%)		11.2		9.6		10.1
Test Variety				HPR 2360		
Sprays (No.)				4		

* Soil applications; ST: square root transformed means; O: Means of original values

Comptibility of selected fungicides and insecticides against blast and whorl maggot.

The test variety was sown on 6th June and transplanted on 18th July. The data on leaf blast, neck blast, whorl maggot and grain yields were analysed and presented in (Table 23.)

Table 23 :Pesticide compatibility trial in *Kharif*, 2006

Treatment	Dose/L	Leaf blast severity (%)		Neck blast incidence (%)		Whorl maggot infested leaves (%)		Grain yield (Kg/ha)
Sivic 75 WP	0.6g	14.8	6.7	2.4	5.9	4.3	18.2	4343
Kitazin 48 EC	2.0ml	19.9	11.7	2.3	5.4	4.3	18.4	4639
Indoxacarb 15 EC	0.4ml	29.9	25.0	3.9	15.0	3.4	11.4	4657
Caldan 50 SP	1.6	34.2	31.7	3.9	15.4	3.6	13.1	4519
Sivic 75 WP+ Indoxacarb 15 EC	0.6g+ 0.4ml	14.8	6.7	2.2	5.0	3.5	11.9	4694
Sivic 75 WP + Caldan 50 SP	0.6g+ 1.6g	18.0	10.0	2.2	4.7	3.7	13.7	4824
Kitazin 48 EC+ Indoxacarb 15 EC	2.0ml+ 0.4ml	22.6	15.0	2.2	4.7	3.6	13.4	4537
Kitazin 48 EC + Caldan 50 SP	2.0ml+ 1.6g	24.0	16.7	2.1	4.2	3.5	12.4	4543
Check	Untreated	37.2	36.7	4.2	17.7	4.6	21.5	4102
CD (0.05)		6.05		0.54		0.40		ns
CV (%)		14.6		11.2		61		7.6
Test variety					HPR 957			
Sprays (No.)					3			

ST:SQRT Transformed means, AT: ARCSIN Transformed means; O: Means of original values.

Leaf blast incidence data revealed that the two blasticides recorded significantly lower leaf blast incidence (6.7 to 11.7%) than the untreated control (36.7%). The insecticide treatments exhibited leaf blast incidence (29.9 to 34.2%) similar to untreated control (36.7%). The combination treatments with Sivic 75WP + indoxacarb (6.7%) while Kitazine(improbenphos) + indoxacarb (15%) and Kitazine (iprobenphos) + Caldan 50 SP (16.7%) exhibited the leaf blast incidence similar to independent Kitazine treatment (11.7%) and significantly better than untreated control (36.7%)

The whorl maggot data revealed that the two insecticides Indoxacarb and Caldan (cartop hydrochloride) recorded significantly lower whorl maggot incidence (11.4 to 13.1%) than untreated control (21.5%). The treatments involving fungicide sprays only recorded whorl maggot incidence (18.2 to 18.4%) similar to untreated control (21.5%). However, the combination treatments also registered whorl maggot incidence (11.9 to 13.7%) at par with insecticide treatments. This revealed that the fungicides and the insecticides utilized in the trial are compatible for management of insect pests, also. Phytotoxicity symptoms were not observed in any of the treatment.

Maize

Germplasm evaluation

During Kharif 2006, 215 lines/ genotypes of different maturity groups received from Directorate of Maize Research were screened against turcicum leaf blight pathogen under artificial inoculated conditions. All these genotypes were also evaluated against MLB and BLSB under natural disease conditions. Disease severity was recorded as per 1-5 scale. Fifty one, 84 and 48 lines were resistant to TLB, MLB and BLSB, respectively. NAH-2049, BH-4070, SMH-3904, HKH-1602, HKH-1606, X-5313, NAH-2049, FH-3245 were found resistant to all three diseases.

Maize disease trap nursery

Maize disease trap nursery consisting of 10 lines was planted to determine the prevalence of different diseases of maize. Maximum disease incidence of TLB was recorded on CM-111, CM-400 and CM-600. MLB and BLSB were shown maximum disease on CM-400 and CM-122, respectively

Evaluation of QPM Maize

During Kharif 2006, 34 lines/ varieties of QPM maize were evaluated against Turcicum leaf blight, maydis leaf blight and Banded leaf &sheath blight. Seventeen, eighteen and fifteen lines were found resistant to TLB, MLB and BLSB, respectively. HQPM-5, HQPM-12 and HQPM-15 were found resistant to all the three diseases.

Erwinia stalk rot (ESR)

233 entries of 11 trials were evaluated against ESR. None of the entries was free, 10 stocks were highly resistant and 17 were resistant .The material was also evaluated against BSDM, MLB and BLSB. The resistant entries are depicted below. Forty four entries free from BSDM 11 were free from Maydis leaf blight. Twenty seven entries including local showed multiple resistance against ESR, BSDM and MLB.

Evaluation of maize inbred lines

Twenty inbred lines were evaluated against ESR, BSDM and MLB. Two inbred lines HKI 295 and HKI 1352-58-9 were free from ESR and two were highly resistant. Fifteen entries were free from BSDM .

Trap nursery

Out of nine trap nursery entries none was resistant to ESR and two entries (CM 111, CM 115) were resistant to BSDM and MLB .

Management of Erwinia stalk rot of maize using new bactericide

New bactericide Bacteriomycine was evaluated as drenching at halod and tassel initiation and 15 days thereafter and only at halod and tassel initiation (Table 24). None of the treatment was superior to recommended practice.

Table 24. Management of Erwinia stalk rot of maize using variety KN 9451.

Treatment	Detail	Mode of application	ESR incidence (%)	Yield (q/ha)
T1	Control	-	33.3 (35.09)	36.8056
T2	Recommended	Three doses @ 16.5kg/ha at sowing, halod and tassel initiation	25.23 (30.12)	43.75
T3	Bacteriomycine (0.05%)	Three doses @ at halod, tassel initiation and 15 days thereafter	24.53 (29.49)	47.0139
T4	Bacteriomycine (0.1%)	Three doses @ at halod, tassel initiation and 15 days thereafter	32.63 (34.45)	50.8333
T5	Strptocycline (200 ppm)	Three doses @ at halod, tassel initiation and 15 days thereafter	31.5 (33.99)	43.0556
T6	T3 at halod and ear emergence		26.83 (30.93)	44.0972
T7	T4 at halod and ear emergence		41.1 (39.69)	49.3056
	CD (0.05)		NS	NS

II. Pulses

Mash

Germplasm evaluation

Twenty three entries of mash were evaluated against different diseases under natural conditions. Three diseases namely anthracnose, leaf crinkles and web blight were observed. DKM, 7, 3, 4, 7, 12, 14, KU 59, KU 154 were found resistant to anthracnose, DKM 3, 5, 6, 7, 14, 16, 18, 19 KU 59 to leaf crinkle and DKM 1, 2, 6, 7, 12, 13, 14, KU 59 to web blight .

In a trial conducted during *Kharif* 2006 at HAREC, Bajaura, 109 lines/ varieties of urdbean were evaluated against leaf spot caused by *Cercospora canescens* and *Cercospora* *cruenta*, powdery mildew and virus diseases viz. leaf crinkle virus, mung bean yellow mosaic virus under natural conditions. Six lines/ varieties were moderately resistant to *cercospora* leaf spot. Thirty five lines were found free from powdery mildew. Out of 109 lines, 16 lines/ varieties were found free from leaf crinkle virus, others showed incidence ranging from 0.8% to 12.5%. VB-17 showed infection of mung bean yellow mosaic virus to the tune of 1.67%, where as 108 lines/ varieties were free from this disease.

Fifty two genotypes of mash comprising IVT, PPSN 2006 and Advance Station Trial were evaluated against Mungbean yellow mosaic virus, anthracnose and powdery mildew under field conditions (Table 25).

Table 25: Urdbean genotypes showing resistance to MYMV, anthracnose and powdery mildew

Genotype	Reaction to		
	MYMV	Anthracnose	Powdery mildew
IVT (17)	Free: KU6 351, 353, 358, 363, 368, 370, 371, Resiatant>10%:KU6 353, 354, 367, 378	Resistant (DR=>2): 365, 368, 369	Resistant ((≥2): 356, KU 311
AVT (18)	Free: HPBU 206, KU 7, 53, 59, Resistant (>10%): KU 102, 150, 154, LU 1125	Free: KU 7, KU 59 Resistant (DR=>2): KU 102, 154	Resistant (≥2): KU 7
PPSN(17)	Free: P 702, 712, 713, Resistant (>10%): P 708, 711, 709, 715,722	Resistant: P 704, P711	Free; P 720 Resistant: P 709, P 711, P 713, P 715, 716, 722, 723

Cowpea

Germplasm evaluation

In cowpea, 12 entries received from RSS, Dhaulakuan were evaluated against different diseases. Yellow mosaic, cowpea mosaic mottle and web blight were observed. However, out of 12 entries, DKCO 5, DKCO 7, DKCO 12, DKCO 13, and DKCO15 remained free from all the diseases.

Management

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 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.31.2% after 60 DAS with maximum yield (57.5q/ha) as compared to 63.6% incidence in control with an yield of 46.7q/ha (Table26). The above treatment was followed by seed treatment with *Trichoderma viride* @ 5g/kg seed + foliar spray of neem seed kernels extract @3% with 40.9% disease incidence and 54.2q/ha yield. However, chemical check provided minimum disease incidence among all the treatments.

Table 26: Bio- intensive pest and disease management in cowpea

Treatment	Per cent plant mortality (8 days after sowing)	Terminal disease incidence (%)	Green fodder yield (q/ha)	Dry fodder yield (q/ha)
Seed treatment with *Pseudomonas flourescens* @ 5g/kg seed.	27.7 (31.8)	49.3 (44.6)	50.3	16.2
Seed treatment with *Trichoderma viride* @ 5g/kg seed.	22.5 (28.2)	47.6 (43.6)	52.1	16.2
Seed soaking in Panchgavya @ 10%for 1 hr.	21.1 (27.3)	34.8 (36.1)	55.3	16.5
foliar spray of neem seed kernel extract @3%	30.4 (33.4)	40.8 (39.7)	52.2	16.3
T_1 +T_4	27.3 (31.4)	44.7 (42.0)	52.0	16.2
T_2+T_4	22.2 (28.1)	40.9 (39.8)	54.2	16.5
T_3+T_4	20.2 (26.7)	31.2 (33.9)	57.5	16.8
Seed treatment with carbendazim @ 3%	16.3 (23.8)	30.9 (33.7)	54.2	16.4
Untreated control	31.8 (34.3)	63.6 (52.9)	46.7	15.3
CD (P=0.05)	1.2	1.9	2.7	0.5

Lentil

Germplasm evaluation

Forty six, 120, 70 and 18 entries of IVT, ICARDA material, PPSN and station trial entries were evaluated against rust (*Uromyces viciae fabae*) and Ascochyta blight. Artificial epiphytotics of rust were created by frequently spraying the aecio- and uredosporic suspension of locally available isolate starting from the first week of February. A number of resistant entries were identified to both rust and blight.

Management

Fungicidal management of lentil rust (*Uromyces viciae fabae*)

Seven fungicides Mancozeb, Indofil Z -78 @ 0.25%, Copper oxychloride (0.3%), and difenconazole @ 0.05 and 0.1%, Propiconazole 0.1%, Hexaconazole 5 EC (0.1 and 0.5), Triademinol and Bitertanol @ 0.1% were evaluated as three foliar sprays for the management of lentil rust using a susceptible variety L 6183 (Table 27). Three foliar sprays of fungicides Tilt 25 EC, Bayleton 25 EC @ 0.1%, Contaf 5 EC and Score 25 EC @ 0.05 and 0.1%, Indofil M 45 (0.25) and Indofil Z -78 (0.25) resulted in significantly lower disease severity and significantly higher yield as compared to the control. The low disease severity was recorded in plots with foliar sprays of score @0.05 and 0.1% and the highest yield was recorded in three sprays of score 25 EC @ 0.05% (475.56 kg/ha) followed by score 25 EC @ 0.1% (435.56).

Table 27: Efficacy of fungicides for the management of lentil rust (*Uromyces viciae fabae*)

Fungicide (dose %)	Rust (disease severity %)	Yield (kg/ha)
Tilt 25EC (0.1)	36.67 (37.21)	426.67
Contaf 5EC (0.1)	25.00 (29.91)	244.44
Score 25EC (0.05)	20.00 (26.06)	475.56
Indofil M 45 (0.25)	24.67 (47..20)	302.22
Indofil Z 78 (0.25)	93.33 (81.11)	44.44
Score 25EC (0.1)	20.00 (26.06)	435.56
Bayleton 25EC (0.1)	43.33 (41.14)	208.89
Contaf 5EC(0.05)	93.33 (81.11)	53.
Baycor(0.1)	100 (89.96)	53.33
Control	100 (89.96)	37.77
Copper oxychloride (0.3)	93.33 (81.11)	71.11
CD (0.05)	21.65	75.1
CV (%)	19.87	22.7

Moong, kulthi and cowpea

Out of 83, 17 and 24 germplasm lines of moong, kulthi and cowpea evaluated against MYMV, anthracnose and powdery mildew, the resistant entries are enlisted in Table 28.

Table 28: List of urdbean, moong, kulthi nad cowpea genotypes showing resistance to MYMV, anthracnose and powdery mildew

Nursery	Reaction		
	MYMV	Anthracnose	Powdery mildew
IVT (28)	Free: KM6 205, 210, 212, 214,216, 217, 219, 220, 230, 231 Resistant (≥10%): KM 203, 221, 228	Free: KM 6 201, Resistant (≥2): KM6 203, 204, 217, 219, 220, 222, 225, 229, Shining moong 1	Free: KM6 201, 204, 210, Shining moong 1
PPSN (17)	Free: P 601, P 605, 606, 608, 619, Resistant (≥10%): 602, 607, 610, 612, 613, 614, 619, 620, 621, 622, 623, 625, 626, 627, 628, 632, Saketi	Resistant (≥3): 602, 606, 620, 627, 628, Moderately resiatant (≥5):601, 605, 607, 609, 610, 612, 614, 619, 625, 626, 629, 630, Saketi	
Germplasm (38)	Out of 35 all free from mosaic except Moong shining no. 1	M 2, 7, 9, 10, 11, 13, 44, 50, 55, 60, 62, NM 92, SSM 26, SM 31, SML 668, Saketi	

Kulthi

Nursery	Reaction	
	MYMV	Anthracnose
IVT (17)	Free: All except HG 3, 9, 10 which are resistant (≥10%):	Resistant (≥2): HG 1, 2, 3, 4,

Cowpea

	MYMV	Web blight	Cercospora leaf spot
IVT (24)	Free: CP 1, 4, 5, 8, 9, 10, 11, 12, 16, 17, 18, 21, 24 Resiatant (≥10%): 2, 3, 6, 15, 19, 20, 22, 23	Highly resistant (≥10%): CP 1, 15, C 475	All except CP 5

Chickpea

Germplasm evaluation

Thirty entries of chickpea received from ICRISAT, Patancheru were evaluated against wilt and root rot complex at Dhaulakuan. However, due to severe epidemic of Ascochyta blight, all the entries got severely infected and no wilt/ root rot data could be differentiated.

During rabi 2006-07, about 1100 genotypes of chickpea comprising International Ascochyta blight nursery (66), PPSN IIPR (86), resistant germplasm from ICRISAT (340), resistant stable lines from ICRISAT (300), Initial evaluation trial (IVT) north hill zone (23) and collections from NBPGR (505) Dhaulakuan isolate of *A. rabiei* was used to create artificial epiphytotic conditions.

Twenty germplasm of chickpea were found free from *Ascochyta* at Berthin. The genotypes interacted differentially for *Fusarium* wilt. No incidence of *Fusarium* wilt was observed genotypes viz. ICCV-4531, IHPG-17, PBG-1 x PB-7 and ICCV-10448 x HPG-17-10-B.

Management

Chemical management of wilt /root rot of chickpea

The terminal incidence indicated that all the ten fungicides resulted in significantly less root rot incidence. The least incidence was recorded in seed treated with Captan (3g/kg) followed by Companion (3g/ha). The Beyleton was phytotoxic to chickpea when used as seed dresser (Table 29).

Table 29: Management of wilt and root rot complex of chickpea through seed treatment.

Fungicide	Dose (g/kg)	Wilt/root rot incidence (%)
F 100	2.5g	29.3 (32.7)
F 100	3g	37.1 (37.5)
F 100	3.75g	20.0 (26.5)
Carbendazim	2g	35.3 (36.4)
Mancozeb	2.5g	18.2 (25.2)
Carboxin	2.5g	22.2 (28.0)
Thiram	2.5g	20.7 (27.0)
Vitavax powder	3g	29.0 (32.5)
Companion	2.5g	15.2 (22.9)
Raxil	1g	16.4 (23.7)
Raxil	2 g	31.3 (34.0)
Captan	3g	14.5 (22.2)
Control		41.7 (40.2)
Beyleton	3g/kg	-
CD (0.05)		4.4
CV (%)		8.82

Values in parentheses are angularly transformed values

Evaluation of elite genotypes under ICSN- *desi* with and without fertilizers against different biotic and abiotic stress factors

The trial was laid out in paired plot with and without fertilizer in CRBD design replicated twice. The trial was sown on 11.11.96 and a plot size of 3.6 m^2 was kept in each treatment, keeping 30cm space between rows. The cultivar ICCV-04111 was rated best possessing higher potential for dry-biomass and dry-grain yield as well as relatively high degree of resistance against *Ascochyta* blight and *Fusarium* wilt. However, differences were non-significant for fertilized and unfertilized plots indicating that selection can be made for both the characters owing to differential interaction of the characters. Similarly, genotypes interacted differentially for susceptibility to *Ascochyta* blight and *Fusarium* wilt. Incidence of *Ascochyta* was observed to be influenced by fertility status which was genotype specific. Varieties ICCV-03203, 06104, 06105, 06102, 05106 and two check varieties JG-11 and HPG-17 showed resistant reaction under fertilized and unfertilized conditions. The varieties, viz. ICCV-03203, ICCV-06164, ICCV-06105, ICCV-05106 as well as check varieties HPG-17 and JG-11 were free from wilt incidence. The range of 50 % flowering varied between 88 days for ICCV-06109, ICCV-06104, ICCV-04105 and 99 days for HPG-17, ICCV-04109, ICCV-06108. The range of days 75 % maturity varied between 152 days for ICCV-06109, ICCV-06104 and 162 days for HPG-17, ICCV-04109 and ICCV-06108, indicating narrow variation for maturity period.

Evaluation of elite genotypes under ICSN-*kabuli* with and without fertilizers against different biotic and abiotic stress factors

Out of twenty cultivars, ten responded better growth under no fertilizer application for dry biomass and dry grain production. The cultivars ICCV-04305 recorded highest dry-biomass (34.85 q/ha) followed by ICCV-06301 (28.64 q/ha) compared to *desi* check variety HPG-17 (31.25 q/ha), whereas highest dry grain-yield was recorded in ICCV-06301 (6.77q/ha) followed by ICCV-06304 (5.20 q/ha) compared to *desi* check variety HPG-17 (7.29 q/ha). Differences were non-significant for fertilized and unfertilized plots indicating that selection can be made for both the characters owing to differential interaction of the characters. Incidence of *Ascochyta* was observed to be influenced by fertility status which was genotype specific. The Ascochyta disease incidence was highest on ICCV-04301 (37.5%) and 17.5% in fertilized and non-fertilized plots respectively) which was zero in HPG-17 showing resistant reaction under fertilized and unfertilized conditions. The variety ICCV 06305 (9,1%) was most susceptible followed by ICCV-05303 (8.0%) amongst other *kabuli* varieties. The *desi* check variety HPG-17 was free from wilt incidence.

III. Oilseeds

Evaluation of germplasm

Rapeseed-mustard

Forty three entries of mustard were screened against Alternaria blight and white rust diseases in this trial. The severity of Alternaria blight ranged from 31.7 to 62.7% on leaves and 15.9-48.4% on pods. Entries; SBG-06-2 and SBG-06-11 showed lowest disease severity on leaves (31.7%) whereas disease severity on pods was lowest (15.9%) in case of SBG-06-39. The entries SBG-06-34 to 38 and SBG-06-41 remained free from white rust disease. Few entries like SBG-06-23, SBG-06-26, SBG-06-28to33 and SBG-06-40 showed resistant reaction to white rust (disease severity<10%).

Forty entries of rapeseed-mustard were screened against Alternaria blight and white rust diseases in Uniform Disease Nursery trial. Severity of Alternaria blight on leaves ranged from 34.2% in UDN-06-3 to 61.8% in UDN-06-33. The highest severity of disease on pods (49.2%) was recorded in UDN-06-32, whereas minimum disease on pods (14.2%) was recorded in UDN-06-23. The entries like UDN-06-6, UDN-06-37 and UDN-06-38 remained free from white rust infection. Disease was also low (<10%) in the entries like UDN-06-1, 17, 18, 21, 22, 23, 27 and 29 to36. There was no staghead formation in any of the entry.

Twenty eight entries of rapeseed-mustard were screened against Alternaria blight and white rust diseases in National Disease Nursery trial. None of the entry was found resistant to Alternaria blight. Lowest disease severity on leaves (29.2%) was observed in NDN-06-44, whereas lowest disease on pods (16.7%) was recorded on NDN-06-42. The severity of white rust ranged from 0-22.5%. The entries like NDN-06-44, 46, 50, 52, 56, 63 and 64 remained free from white rust infection. The disease pressure of white rust was low. There was no staghead formation in any of the entry.

Evaluation of single low /double low *Brassica juncea* germplasm against major diseases

Fifteen entries of rapeseed-mustard were screened against Alternaria blight and white rust diseases in this trial. The severity of Alternaria blight on leaves ranged from 26.7 in RMQ-06-9 to 45.9% in RMQ-06-11. The highest severity of disease on pods (31.7%) was recorded in RMQ-06-8, whereas minimum disease on pods (18.4%) was recorded in RMQ-06-5. The overall disease pressure of white rust was low. Maximum disease severity was recorded in RMQ-06-4(20.9%). The entries RMQ-06-8 , 9 and 10 remained free from white rust disease. There was no staghead formation due to white rust in any of the entry.

Linseed

Germplasm evaluation

Two hundred entries of linseed were screened against rust and *Alternaria* bud blight disease under natural conditions at Kangra. Entries observed resistant/moderately resistant to rust and bud blight is given below:

A. Rust

Resistant: RLC-48, RLC-89,LCK-9313, S-91-7, S-91-15, S-91-28,S-91-29,S-91-34, Surkhi Sagar, Sydnog,UP-6, Jeewan, DPL-17, DPL-19, DPL-27, KL-1, KL-77, KL-178, KL-188, LC-2014, LC-2021, LC-2023, LC-2032, LC-2057, LCK-89512, LCK-9011,LCK-9213, LCK-9216, LCK-9303, LCK-9313, LCK-9319, LCK-9320 and LCK-9324.

B. Alternaria bud blight

Moderately resistant: RLC-49, RLC-55, S-91-38, JLT-43, JLT-90, LC-2002

Seventy entries were screened under uniform disease nursery trial against prevailing diseases like rust and Alternaria bud blight under natural field conditions. Entries like RLC-112, JLS-9, Padmini, Parvati and Sheela were found to be highly resistant to rust and moderately resistant to bud blight.

Thirty six entries of linseed under uniform disease nursery under artificial conditions (UDNAI) observed to be resistant to rust under natural conditions were screened against rust under artificial field conditions. Entries KL-221, LC-2063, LMS-153-03, NDL-2004-05, RL-25127, Padmini, Parvati and Surbhi were highly resistant and KL-226, LMS-2279-4, LCK-4036, LCK-5021, LMS-95-4, RLC-92, SLS-66, J-23, JLS-9, LC-54 and Meera were resistant.

Thirty nine promising entries/elite materials of linseed were screened against rust under high inoculum pressure at Kangra. Entries Ayogi, BAU-9906, BAU-2K-20, ES-44, JRF-3, H-40, NP-55, NPRR-436, NPRR-453, NPRR-485, PKDL-42, POLf-5, POlf-31and RLC-3 were highly resistant and DPL-21, JLT-118, KL-221, OR-1-4, OR-8-44, Polf-14, Polf-19, R-966-5, R-1017, RH-4-LK-4, Rl-29-8, Rl-50-2, Rl-2206, RR-204x4x4/29, RLC-29, RLC-44 and RLC-102 were resistant.

Disease management

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

Three sprays of each fungicide were applied on 60, 80 and 100 days after sowing. Data on severity of diseases, yield, 1000 seed weight and oil content were recorded (Table 30). The severity of Alternaria blight on leaves as well as pods was lowest (2.7, 3.8%) in case of Score (0.05%). Lowest severity of white rust on leaves (1.5%) was observed in case of Ridomil MZ (0.25%). Highest yield (2867kg/ha) was obtained in case of Score. 1000 seed weight and oil contents were also highest in this treatment (3.95g, 42.5%).

Table 30. Chemical control of *Alternaria* blight and white rust of mustard

Treatment	Disease severity (%)			Yield (kg/ha)	Oil content (%)
	Alternaria blight (leaves)	*Alternaria* blight (pods)	White rust		
Tilt (0.1%)	7.1(15.4)	6.2(14.4)	30.0(33.2)	2178	41.0
Indofil M-45 (0.25%)	22.9(28.6)	14.4(22.3)	11.3(19.6)	2167	40.5
Companion (0.2%)	35.8(36.7)	18.0(25.1)	9.8(18.2)	2167	40.5
Ridomil MZ 72 WP (0.25%)	34.2(35.8)	17.5(24.7)	1.5(7.1)	2200	41.5
Score (0.05%)	2.7(9.3)	3.8(11.2)	14.2(22.2)	2867	42.5
Contaf (0.1%)	14.9(22.7)	11.3(19.6)	26.4(30.9)	2344	42.5
Blitox-50(0.25%)	23.1(28.7)	14.2(22.1)	11.6(19.9)	2094	41.9
Antracol (0.2%)	27.1(31.3)	17.1(24.4)	11.8(20.1)	2122	40.5
Indofil Z-78(0.25%)	36.2(37.0)	19.3(26.1)	13.1(21.2)	1978	40.5
Unsprayed	44.9(42.0)	21.8(27.8)	26.9(31.2)	1739	40.2
CD(P=0.05)	2.5	1.7	1.6	201	0.5

Figs. in parentheses are arc sine transformed values

Management of white rust of mustard

Three different components of integrated disease management namely date of sowings (Oct.25, Nov.15) varieties (RCC-4, Varuna) and fungicidal treatments (P1:seed treatment with Apron 35 SD 6g/kg seed, P2:Seed Treatment with Apron 35 SD 6g/kg seed + one spray of Indofil M-45 (0.2%), P3:Seed Treatment with Apron 35 SD 6g/kg seed + Two sprays of Indofil M-45 (0.2%), P0:Untreated control) were evaluated against white rust disease of mustard in a field trial conducted during 2006-2007 (Table 31). Severity of white rust on leaves and staghead formation was significantly low (12.7 and 0.17%) in crop sown on Oct.25 in comparison to Nov.15 sown crop (22.9 and 1.35%). No significant difference in severity of white rust on leaves and staghead infection was observed between two varieties. Lowest severity of white rust on leaves (5.3%) and stagheads (0.13 %) was observed in case of P3 (seed treatment with Apron 35 SD + 2 sprays of Indofil M-45).

Yield was significantly higher in Oct.25 sown crop (1861kg/ha) as compared to Nov. 15 sown crop (1452 kg/ ha). No significant difference was observed between the yields of two varieties. Seed yield, 1000 seed weight and oil contents were highest (1906 kg/ha , 3.21g, 41.9%) in case of P3 (seed treatment with Apron 35 SD + 2 sprays of Indofil M-45).

Table 31: Effect of date of sowing, varieties and fungicidal treatments on white rust of mustard

Treatment	Diseases severity (%)		Yield (kg/ha)	Oil content (%)
	White rust	Stagheads		
A. Date of sowing				
D1(Oct.25)	12.7(19.8)	0.17(1.63)	1861	41.6
D2(Nov.15)	22.9(27.6)	1.35(5.90)	1452	41.0
CD(P=0.05)	(1.0)	(0.52)	43	0.3
B. Variety				
V1(RCC4)	18.0(23.8)	0.70(3.63	1673	41.5
V2(Varuna)	17.7(23.6)	0.82(3.90)	1640	41.1
CD(P=0.05)	NS	NS	NS	0.3
C. Fungicidal treatment				
P1(seed treatment with Apron 35 SD 6g/kg seed)	26.0(30.4)	1.28(5.86)	1483	40.9
P2 (seed treatment with Apron 35 SD 6g/kg seed+ one spray of Indofil M-45(0.2%)	10.7(18.6)	0.21(1.67)	1841	41.7
P3 (seed treatment with Apron 35 SD 6g/kg seed+ two sprays of Indofil M-45(0.2%)	5.3(13.1)	0.13(1.29)	1906	41.9
P0(Untreated control)	29.4(32.6)	1.43(6.25)	1398	40.7
CD (P=0.05)	(1.10)	(0.74)	61	0.4

Figs in parentheses are arc sine transformed values

Evaluation of plant extracts against the foliar diseases of rapeseed-mustard

Fresh extract (1%) from leaves of *Eucalyptus, Datura*, *Azadirachta*, *Agave americana* and *Ipomea cornea* and bulbs of garlic and onion were evaluated along with the recommended fungicide Indofil M-45 against Alternaria blight and white rust diseases of mustard. There was a significant reduction in the severity of Alternaria blight and white rust as a result of sprays (Table 32). Severity of Alternaria blight on leaves as well as pods (26.9%, 15.8%) and white rust (4.9%) was lowest in case of Indofil M-45. Alternaria blight on leaves as well as pods (30.0%, 16.7%) and white rust (7.8%) was recorded in case of leaf extract of *Agave americana* . The yield of 1346 kg/ha in case of *Agave americana*, however was statistically at par with Indofil M-45(1333 kg/ha) and Eucalyptus(1324 kg/ha.

Table 32: Role of plant extracts in management of foliar diseases of mustard

Treatments	Disease severity (%)			Yield (kg/ha)	Oil content (%)
	AB (leaves)	AB (pods)	White rust		
Eucalyptus	36.7(37.3)	17.6(24.8)	11.9(20.2)	1324	42.4
Onion	38.9(38.5)	20.7(27.0)	14.9(22.7)	1191	42.3
Datura	36.7(37.2)	20.7(27.0)	15.8(23.4)	1250	42.4
Azadirachta	38.2(38.2)	19.8(26.4)	13.3(21.4)	1228	42.6
Garlic	41.3(40.0)	20.2(26.7)	14.2(22.6)	1145	42.6
Agave	30.0(33.2)	16.7(24.1)	7.8(16.2)	1346	43.4
Ipomea	33.5(35.4)	18.7(25.6)	18.2(25.2)	1225	42.3
Indofil M-45(0.25%)	26.9(31.2)	15.8(23.4)	4.9(12.8)	1333	43.4
Control	43.3(41.1)	25.1(30.0)	21.2(27.4)	957	41.3
CD(P=0.05)	2.1	1.4	1.9	161	0.9

Figs in parenthesis are arc sine transformed values

Chemical control of major diseases of linseed

A field experiment was conducted to evaluate seven different fungicides (Table 33) against rust and Alternaria bud blight in linseed using susceptible variety Chambal. Minimum disease severity of rust and bud blight (7.2 and 7.1%) and maximum yield (1144 kg/ha) was recorded in case of Propiconazole (0.1%).

Table 33: Chemical control of linseed rust

Treatment	Disease severity (%)		Yield (kg/ha)
	Rust	Bud blight	
Propiconazole (0.1%)	7.2(15.5)	7.1(15.4)	1144
Hexaconazole (0.1%)	13.1(21.1)	9.4(17.8)	1133
Difenconazole (0.05%)	21.1(27.3)	8.7(17.2)	967
Chlorothalonil (0.2%)	45.6(42.5)	14.6(22.4)	598
Companion (0.1%)	44.8(42.0)	12.2(20.5)	666
Dithane M-45 (0.25%)	40.8(39.7)	10.7(19.1)	691
Dithane Z-78 (0.25%)	48.3(44.0)	15.0(22.7)	497
Control	75.3(60.3)	20.1(26.6)	195
CD (P=0.05%)	(3.8)	(1.4)	(108)

Figs in parenthesis are arc sine transformed values

Assessment of yield losses due to linseed rust: Repeated sprays of Propiconazole (Tilt, 0.1%) were applied in the protected plots for the control of rust. The yield losses due to rust were highest (73.5%) in case of variety R-552 and minimum (8.3%) in variety Nagarkot. Minimum disease severity was also recorded in variety Nagarkot under protected as well as unprotected conditions. Variety Nagarkot gave the highest yields of 409 kg/ha and 375 kg/ha under protected and unprotected conditions, respectively (Table 34).

Table 34: Assessment of avoidable yield losses due to rust in linseed

Treatment	Disease severity (%)	Yield (kg/ha)	Yield Loss (%)
J-23(UP)	27.0 (31.3)	292	23.9
J-23(P)	3.2 (10.2)	384	--
Kiran(UP)	46.0 (42.7)	192	48.8
Kiran(P)	5.6 (13.6)	375	
R-552(UP)	68.8 (56.1)	42	73.5
R-552(P)	17.2 (24.5)	159	--
T-397(UP)	72.4 (58.3)	75	71.0
T-397(P)	15.8 (23.4)	259	--
Nagarkot(UP)	7.6 (16.0)	375	8.3
Nagarkot(P)	0(0)	409	--
Chambal(UP)	48.6 (44.2)	200	49.0
Chambal(P)	7.2 (15.5)	392	--
Kangra local(UP)	42.0 (40.3)	75	59.0
Kangra local(P)	3.6 (10.9)	183	--
CD (P=0.05%)	4.8	50	

Figs in parenthesis are arc sine transformed values

Soybean

Germplasm evaluation

Fifty five soybean entries comprising IVT, AVTI, AVT II were evaluated for resistance to two diseases i.e., target leaf spot and anthracnose /pod blight. The entries comprising each of four rows of 4m lengths were sown in the fields where soybean had been grown for quite many years and where these diseases have been appearing regularly.

Entries VLS 63 and VLS 47 were found moderately resistant to TLS and highly resistant to pod blight in AVT I trial. In AVT II, MACS 985, JS 335, SL682, JS (SH) 91 14, VLS 47 and MACS 5923 were highly resistant to resistant while MACS 985, SL 679, VLS 61, VLS 47 and MACS 5923 were resistant to pod bight /anthracnose.

In IVT, entries 01, 04 to 06, 16, 18, 19, 23 and 30 were resistant to TLS while 04 to 07, 09, 10 to 12, 14 to19, 24, 25, 29, 33 and 34 were resistant to pod blight /anthracnose.

Effect of weather parameters on disease development

To study the effect of weather parameters, three soybean varieties were sown on three different dates viz., 17th June, 24th June and Ist July, 06 to study the effect of different environmental factors on the pod blight development. The pod blight appeared around the beginning of 3rd week of September, 06. The data were recorded on five different dates at weekly intervals with effect from 20th Sept., 06 onwards.

All the three varieties showed that when sown in first week of July, the disease incidence was comparatively low as compared to other dates. In fact, when sown in mid June, the disease incidence was highest followed by last week of June and it was least when sown in first week of July in all varieties. Among varieties, Shivalik had the least incidence of pod blight when sown in the first week of July.

As the disease progressed during first and second week of October, 06, the temperature ranged between 25-26^{o}C, the relative humidity also ranged between 83-85%. However, the number of rainy days increased while rainfall decreased. That means the disease was favored by optimum RH (85%) and 25^{o} C temperature.

IV. Vegetables

Pea

Germplasm evaluation

Five hundred seventy five pea lines were screened against powdery mildew. Only 40 lines were found resistant against powdery mildew. Three hundred and fifty seven pea germplasm lines procured from different sources were also evaluated for resistance under laboratory conditions to two major pathogens *Ascochyta pisi* and *A. pinodes* with three isolates from each species. Germplasm was evaluated using detached leaf/ intact plant method. All the lines were found susceptible to both the species.

Collection and maintenance of *Erysiphe pisi* isolates

Eight isolates of *E. pisi* were collected from different locations of the state and maintained at Palampur for further resistance studies.

Disease management

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

Data (Table 35) revealed that seed treatment with biocontrol agents resulted significant reduction in root rot incidence over check. However, local isolates of *T. harzianum* and *T. viride* gave maximum reduction of root rot complex. *Trichoderma harzianum* seed treatment followed by one spray of Bavistin gave maximum reduction of white rot, Ascochyta blight and powdery mildew. *T. 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 35. Relative efficacy of biocontrol agents and fungicides against soil borne and foliar diseases of pea

Treatment	Disease severity (%)					Yield/plot (g)*
	RR	WR	AB	Rust	PM	
T. harzianum ST @ 5g/kg + Bavistin spary @ 0.1%	3.33 (2.08)	0.00 (1.00)	2.66 (1.91)	12.66 3.69)	0.00 (1.00)	350.00
T.viride ST @ 5g/kg + Bavistin spary @ 0.1%	3.66 (2.15)	0.50 (1.22)	3.33 (2.08)	12.00 (3.60)	1.66 (1.63)	333.33
Ecoderma @5g/kg ST+Tilt spary @ 0.1%	5.66 (2.58)	2.66 (1.91)	10.56 (3.40)	6.33 2.70)	6.66 2.76)	308.33
Sanjeevani @5g/kg ST+ Folicur spary @ 0.1%	10.33 (3.66)	5.00 (2.46)	9.66 (3.26)	0.00 (1.00)	7.00 (2.82)	391.16
Kali Sena @5g/kg ST + Blitox-50 spary @ 0.3%	5.66 (2.58)	8.66 (3.10)	3.66 (2.15)	7.00 (2.82)	6.66 (2.76)	283.33
Thiram ST @ 3g/kg seed + Contaf spary @ 0.1%	4.33 (2.30)	7.33 (2.88)	4.00 (2.33)	8.66 (3.10)	0.00 (1.00)	266.66
Bavistin ST @1g/kg seed +Contaf spary @ 0.1%	4.00 (2.33)	0.50 (1.22)	6.00 (2.64)	8.00 (3.00)	0.00 (1.00)	286.33
Check (No treatment)	20.33 (4.61)	12.33 (3.69)	10.33 (3.36)	15.66 (4.04)	7.66 (2.99)	250.00
CD (P=0.05)	2.06	1.08	3.61	5.16	2.14	

RR=root rot, WR=white rot, AB=Ascochyta blight, PM=powdery mildew, ST=seed treatment
Figure in parentheses are angular transformed values * dry grain weight , Plot size= 4x3 m

Efficacy of Panchgavya (PG) against pea root rot wilt complex

Field evaluation of Panchgavya against root rot wilt complex of pea along with check-I (seed treatment with 0.2% carbendazim) and check-II (untreated seeds) in RBD with 14 treatments and three replications revealed that seed dip in PG for 1 hr before sowing followed by soil drenching with PG on germination resulted in maximum (68.1%) control of disease with 90% survival of plants in comparison to check-II. (Table 36). Rest of the treatments gave disease control in the range of 15.0 to 61.7% with 73.4 to 85.4% survival of seedlings in comparison to check-II. Maximum green pod yield was obtained with treatments T_1 and T_{13} followed by T_6 and T_9. Row drenching at initiation of flowering & thereafter were comparatively less effective in controlling the disease.

Table 35: Field efficacy of Panchgavya against pea root rot wilt complex

Treatment	Disease severity (%)	Disease control (%) (over check-1)	Plant survival (%)	Green pod yield (kg/Plot)*
T_1, seed dip in PG for 1 hr	14.7	53.0	85.3	2.2
T_2, seed dip in PG for 2 hr	14.6	53.4	85.4	1.6
T_3, row drenching with PG before sowing +T_{14}	12.0	61.7	88.0	1.8
T4, row drenching with PG before sowing +T_1	16.0	48.9	84.0	1.8
T5, row drenching with PG before sowing +T_2	23.3	25.6	76.7	1.6
T6, row drenching with PG at germination	16.7	46.6	83.3	2.0
T_7,T1+row drenching with PG at germination	10.0	68.1	90.0	1.8
T_8, T_2+row drenching with PG at germination	24.7	21.1	75.3	1.8
T_9,T_{14}+T_6+thrice row drenching at weekly intervals	15.3	51.1	84.7	2.0
T_{10}, T_{14}+T_6+thrice row drenching at fortnightly intervals	D20.6	34.2	79.4	1.6
T_{11}, + row drenching at initiation of flowering and thereafter twice at weekly intervals	22.0	29.7	78.0	1.8
T_{12}, T_{14}+ row drenching with PG at initiation of flowering & then after twice at fortnightly intervals	26.6	15.0	73.4	1.2
T_{13}, seed treatment with carbendazim @ 0.2% (Check-I)	15.5	50.5	84.5	2.2
T_{14}, untreated seeds (Check-II)	31.3	-	68.7	1.6
CD (P=0.05)	3.6		NS	NS

Plot size: 2x2m

Efficacies of PG against root rot of pea

Results (Table 37) revealed that majority of treatments supported good seed germination except treatments T_5 to T_9 , T_{11} to T_{13} where there was less germination of seeds in comparison to check. Although there was 93.33 per cent germination with untreated seed but it showed maximum root rot incidence whereas T_5 though supported comparatively less germination of seeds gave complete control of root rot of pea. Similarly T_{10} which supported 100 per cent seed germination gave 77.61 per cent control of disease. In other treatments, seed germination ranged between 73.33 to 90 per cent with 18.55 to 88.71 per cent control of root rot. No relation was established between seed germination and root rot of pea.

Statistically treatments T_3, T_7 and T_{11}; T_2 and T_9, and T_4 and T_{10} were at par in their effect on root rot of pea. Untreated seeds sown in sick soil (T_1) and drenched with PG 48 hr before sowing resulted in 80.10 per cent control of disease, whereas, T_1 + soil drench with Bavistin 48 hr before sowing gave 88.71 per cent control of root rot of pea. However, T_1 +

soil drench with Bavistin and PG one week after germination showed 18.55 and 53.41 per cent control of disease.

Table 37: Effectiveness of PG against root rot of Pea caused by *Fusarium solani* f.sp. *pisi*

	Germination (%)	Disease incidence (%)	Disease control over check (%)
T_1, untreated seeds	93.33(77.67)	37.20(37.56)	-
T_2, seed treatment with Bavistin @ 2.5 g / kg seed	96.66(83.32)	20.13(26.64)	45.89
T_3, T_1 + soil drench with PG 24 hr before sowing	93.33(77.67)	17.5(24.69)	52.96
T_4, T_1 + soil drench with PG 48 hr before sowing	100(89.96)	7.40(15.73)	80.10
T_5, T_1 + soil drench with Bavistin (0.1 %) 24 hr before sowing	83.33(66.11)	0.00(0.80)	100
T_6, T_1 + soil drench with Bavistin (0.1 %) 48 hr before sowing	90.00(71.53)	4.20(11.81)	88.71
T_7, T_1 + seedling drench with PG, 1 week after germination	83.33(66.11)	17.33(24.56)	53.41
T_8, T_1 + seedling drench with Bavistin (0.1 %), 1 week after germination	73.33(58.98)	30.30(33.38)	18.55
T_9, soil drenching with PG 24 hr before sowing + T_2	90.00(74.96)	20.30(26.76)	45.43
T_{10}, soil drenching with PG 48 hr before sowing + T_2	100(89.96)	8.33(16.70)	77.61
T_{11}, seed dip in PG for half hr before sowing	73.33(58.98)	15.80(23.38)	57.53
T_{12}, seed dip in PG for one hr before sowing	83.33(66.11)	25.40(30.25)	31.72
T_{13}, seed dip in PG for two hr before sowing	83.33(66.11)	13.26(21.33)	64.35
CD(p=0.05)	(11.78)	(1.93)	

Arc sine transformed values in parentheses

Integrated management of root rot/wilt complex disease of pea

The on farm trials were conducted in agro-ecological situation IV and V at four locations comprising five treatments (Table 38). Integration of chemical and bio-agent i.e. seed treatment with fungicides (Bavistin + Thiram 3g/kg of seed, 1:2) and soil application of bio-agent (2.5 kg/62kg FYM/ha) proved most effective in managing the root rot/wilt complex disease of pea. This treatment also resulted in higher green pod yield.

Table 38: Integrated management of root rot/wilt complex disease of pea*

Treatment	% disease severity	Yield q/ha
T_1 seed treatment with bio-agent (4g/kg of seed)	32.5	43.6
T_2 soil application of bio-agent (2.5 kg/62kg FYM/ha)	30.0	50.5
T_3 seed treatment with Bavistin + Thiram (3g/kg of seed, 1:2)	23.8	58.6

T_4 = T2 +T3	22.3	61.5
T_5 (control)	38.6	41.3

- Average of four replications

Management of root rot/ wilt complex of peas

A field trial on the management of root rot/wilt complex disease was conducted on pea variety Azad P-1 consisting of 13 treatments in RBD with 3 replications. All the fungicides were found effective in controlling the disease as compared to control. Raxil @ 2 gm followed by carbendazim 2.5 gm and F-100 @ 3.5 gm reduced the wilt incidence and improved the yield (Table 39). Interestingly a reduction in number of nodules per plant was observed in all the treatments except in treatments F-100 (@ 3.5 gm), carbendazim (@ 2.5 gm), Thiram (@ 2.5 gm), and Ridomil (@ 2.5gm). How ever this needs further investigations.

Table 39: Management of root rot/ wilt complex of peas through fungicides

Fungicides	Rate (gm/ kg seed)	Wilt incidence (%)	No. of nodules/ plant *	No. of pods/ plant #	Yield (q/ ha)
F-100 WS	2.5	15.90 (23.47)	17.66	19.73	13.07
F-100 WS	3.0	13.50 (21.52)	16.67	19.73	15.92
F-100 WS	3.5	11.02 (19.39)	25.33	20.80	17.77
Carbendazim	2.5	10.36 (18.74)	21.66	19.47	19,76
Mancozeb	2.5	22.02 (27.94)	19.67	21.36	9.77
Carboxin	2.5	15.28 (22.95)	19.00	19.53	15.10
Thiram	2.5	22.33 (28.17)	21.00	19.67	11.29
Vitavax Power	2.5	14.84 (22.59)	13.00	20.47	15.70
Companion	2.5	24.55 (29.68)	12.00	20.10	12.04
Raxil	1.0	12.25 (20.43)	10.66	19.00	15.51
Raxil	2.0	10.22 (18.60)	11.67	21.20	18.15
Ridomil	2.5	16.85 (24.18)	29.33	19.27	14.26
Control		33.14 (35.15)	21.33	19.80	7.77
CD (0.05)		2.27	1.98	Ns	3.17
CV (%)		5.64	6.43		13.22

Angular transformed values in the parentheses.

* Nodules/ plant = Average of nodules of 5 plants/ treatment/ replication.

Pods/ plant = Average of pods of 5 plants/ treatment/ replication.

Potato

Disease management

Evaluation of biocontrol agents and fungicides against black scurf and foliar diseases of potato

Potato tuber treatment with Ecoderma (*T. viride*) and Kalisena (*Aspergillus* spp.) resulted in maximum reduction of black scurf intensity and significant increase in tuber yield (Table 40).This treatment was at par with Emisan and Boric acid in reducing black scurf severity. Foliar sprays of Antracol and Ridomil resulted in minimum intensity of early and late blight and gave significant increase in tuber yield.

Table 40: Relative efficacy of bio-control agents and fungicides against black scurf and foliar diseases of potato

Treatment	Disease severity (%)			Yield/ plot (kg)
	Black scurf	Early blight	Late blight	
T. harzianum tuber treatment @ 5g/litre +Indofil spray @ 0.25%	9.56 (3.24)	15.66 (4.08)	10.00 (3.31)	3.500
T. viride tuber treatment @ 5g/litre+Blitox-50 spary @0.3%	7.46 (2.90)	12.00 (3.60)	9.33 (2.00)	3.033
Ecoderma (*T. viride*) tuber treatment @ 5g/litre + Ridomil MZ 72 WP spary @ 0.25%	3.58 (3.58)	10.66 (3.41)	2.00 (1.73)	5.130
Sanjeevani (*T. viride*) tuber treatment @ 5g/kg + Copper oxychloride spray @ 0.3%	15.00 (4.00)	11.66 (3.55)	8.66 (3.10)	3.030
Kalisena (*Aspergillus* spp.) @ 5g/kg + Melody Duo 66WP spary@ 0.2%	4.33 (2.94)	9.33 (3.21)	3.66 2.15)	4.833
Emisan tuber treatment @ 2.5g/litre + Antracol 75 WP spary@ 0.25%	3.67 (2.16)	6.66 (2.76)	15.33 (4.04)	4.166
Boric acid tuber treatment @ 3g/litre + Kavach 75 WP spary@ 0.25%	4.00 (2.23)	10.00 (3.31)	20.00(4.58)	3.030
Check (No treatment)	15.28 (4.03)	23.33(4.93)	25.00 (5.00)	2.100
CD (P=0.05)	2.01	3.29	4.01	0.302

Figure in parenthesis are square root transformed values Plot size= 4 x 3 m

Evaluation of fungicides for the management of late blight of potato

Performance of non systemic fungicides along with Ridomil MZ 72 WP as check was tested at Malan against late blight (Table 41). Kavach was found most effective which gave 55.1 % disease control followed by Propineb (50.0%) and Indofil M-45 (48.0%). Kavach also increased the yield significantly.

In other trial seven non systemic (Dithane Z-78, Flowin HT, Mancozeb WDG Kavach, Propineb, Copper oxychloride and Indofil M-45) and 3 coordinated mixture fungicides (Ridomil, Matco and Curzate) were evaluated against late blight of potato (Table-42). The coordinated mixture fungicides were more effective than non systemic fungicides. Ridomil provided 87.0% disease control, followed by and Matco (85.7%) with non-significant differences with 41.2 and 39.9% increase in the yield. The non systemic fungicide Kavach resulted 74.6% disease control followed by Flowin HT (70.4%) and propineb (68.0%) over check.

Table 41: Efficacy of different fungicides against late blight of potato during 2007

Treatment (3 sprays of each fungicide)	Conc. (%)	Disease severity (%)	Disease control (%)	Yield (q/ha)	Yield increase (%)
Propineb	0.25	28.3 (32.1)	50.0	285.9	12.6
Indofil M-45	0.25	29.0 (32.4)	48.0	276.7	5.4
Kavach	0.25	25.3 (30.1)	55.1	290.0	14.2
Ridomil MZ	0.25	16.0 (23.5)	71.6	316.0	24.4
Control	-	56.3 (48.6)	-	254.0	-
CD (P=0.05)		6.4		17.8	

Table 42: Efficacy of different fungicides against late blight of potato during 2007

Treatments (3 sprays of each fungicide)	Conc. (%)	Disease severity (%)	Disease control (%)	Yield (q/ha)	Yield increase (%)
Ridomil MZ	0.25	7.0 (15.3)	87.0	388.3	41.2
Matco	0.25	7.7 (16.0)	85.7	384.7	39.9
Curzate	0.25	12.3 (20.5)	77.2	313.7	14.1
Kavach	0.25	13.7 (21.7)	74.6	332.0	20.7
Propineb	0.25	17.3 (24.5)	68.0	320.3	16.5
Indofil M-45	0.25	22.7 (28.4)	58.0	309.7	12.6
Flowin HT	0.40	16.0 (23.5)	70.4	308.3	12.1
Mancozeb WDG	0.25	21.7 (27.7)	59.8	293.3	6.7
Dithane Z-78	0.25	19.0 (25.8)	64.8	291.7	6.1
Copper oxychloride	0.30	23.7 (29.0)	56.1	299.0	8.7
Control	-	54.0 (47.3)	-	275.0	-
CD (P=0.05)		2.9		15.6	

Evaluation of spray schedule for the management of late blight of potato

Twenty one fungicides were evaluated for their effectiveness against late blight of potato (Table 43). Among all the treatments, three foliar sprays of Ridomil MZ were found most effective to contain the late blight severity (5.7%) and provided 90.1 % disease control. Spray schedules of Ridomil–Ridomil-Flowin HT, Ridomil + Kavach + Propineb, Ridomil–Kavach –Kavach and Ridomil–Ridomil–Mancozeb WDG were next in order of efficacy providing 87.3, 82.7, 82.7 and 82.1 % disease control, respectively.

Three sprays of Ridomil also enhanced the yield to 382.3 q/ha with maximum increase of 36.0 % over control. This was followed by spray treatments of Ridomil–Ridomil-Flowin HT, and Ridomil–Ridomil– Mancozeb WDG registering 34.2, and 33.5% yield increase over control.

Table 43: Efficacy of different fungicides schedules against late blight of potato

Treatments	Disease severity (%)	Disease control (%)	Yield (q/ha)	Yield increase (%)
Ridomil + Indofil M-45 + Indofil M-45	17.3 (24.5)	70.0	363.0	29.2
Ridomil + Indofil M-45 + Kavach	14.7 (22.4)	74.5	366.3	30.4
Ridomil + Propineb + Propineb	12.0 (20.2)	79.2	370.7	31.9
Ridomil + Kavach + Kavach	10.0 (18.4)	82.7	360.0	28.1
Ridomil + Indofil M-45 + Propineb	10.7 (19.0)	81.4	345.0	22.8
Ridomil + Kavach + Propineb	10.0 (18.4)	82.7	354.3	26.1
Ridomil + Ridomil + Flowin HT	7.3 (15.7)	87.3	377.0	34.2
Ridomil + Ridomil + Mancozeb WDG	10.3 (18.7)	82.1	375.0	33.5
Ridomil + Ridomil + Ridomil	5.7 (13.7)	90.1	382.3	36.0
Kavach + Kavach + Kavach	24.7 (29.7)	57.2	291.7	3.8
Kavach + Ridomil + Ridomil	17.0 (24.3)	70.5	316.0	12.5
Propineb + Propineb + Propineb	20.3 (26.8)	64.8	291.7	3.8
Propineb + Ridomil + Ridomil	18.7 (25.6)	67.6	323.0	14.9
Indofil M-45 + Ridomil+ Indofil M-45	27.7 (31.7)	52.0	302. 0	7.5
Indofil M-45 + Indofil M-45 + Indofil M-45	33.0 (35.0)	42.8	299.7	6.7
Ridomil + Flowin HT+ Flowin HT	20.7 (27.0)	64.1	303.3	7.9
Flowin HT + Flowin HT+ Flowin HT	30.7 (33.6)	46.8	300.0	6.8
Ridomil + Mancozeb WDG+ Mancozeb WDG	22.3 (28.1)	61.3	318.3	13.3
Mancozeb WDG + Mancozeb WDG + Mancozeb WDG	36.7 (37.2)	36.4	305.0	8.5
Flowin HT+ Ridomil + Ridomil	24.3 (29.6)	57.9	333.3	18.6
Mancozeb WDG + Ridomil + Ridomil	28.7 (32.3)	50.2	354.3	26.1
Control	57.7 (49.4)	-	281.0	-
CD (P=0.05)	2.5		19.4	

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

To study the effectiveness of carbendazim 25 % + mancozeb 50% (75 WS) as tuber treatment against black scurf and late blight of potato, trials were conducted at Una and Palampur. The test fungicide was evaluated at four different concentrations along with carbendazim (Benfil), mancozeb (Indofil M-45) and Emissan-6. The tubers were treated for 30 min before sowing. The data presented in Table 44 revealed that test fungicide @3 g/l and Emissan-6 were most effective and provided 78.5 & 77.1% disease control with 41.1 & 44.1% increase in yield, respectively with non-significant differences.

The data (Table 45) showed that appearance of late blight of potato was delayed for l4 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. 69.3% & 63.1% disease control with

36.8 and 37.5% 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 44: Effect of Carbendazim 25% + Mancozeb 50% (75 WS) on black scurf of potato

Fungicide	Conc. (g/l)	Disease severity (%)	Disease control (%)	Yield	
				Q/ha	Increase (%)
Carbendazim + mancozeb 75 WS	2.0	8.5	61.8	140.9	25.5
Carbendazim + mancozeb 75 WS	2.5	7.2	67.7	139.6	24.4
Carbendazim + mancozeb 75 WS	3.0	5.3	76.2	153.8	37.0
Carbendazim + mancozeb 75 WS	3.5	4.8	78.5	158.4	41.1
Carbendazim 50 WP	2.0	6.9	69.0	146.9	30.8
Mancozeb 75 WP	2.5	9.8	56.0	144.9	29.1
Emisan-6	3.0	5.1	77.1	161.7	44.1
Check	-	22.3	-	112.2	-
CD (P=0.05)		0.77	-	7.6	-

Table 45: Effect of Carbendazim 25 % + Mancozeb 50 % (75 WS) on late blight of potato

Fungicide	Conc. (g/l)	Disease severity (%)	Disease control (%)	Days after disease appearance over check	Yield	
					Q/ha	Increase (%)
Carbendazim + mancozeb 75 WS	2.0	9.3	42.9	12	278.3	28.0
Carbendazim + mancozeb 75 WS	2.5	8.0	50.9	12	275.0	26.5
Carbendazim + mancozeb 75 WS	3.0	5.0	69.3	14	297.3	36.8
Carbendazim + mancozeb 75 WS	3.5	6.0	63.1	14	299.0	37.5
Carbendazim	2.0	8.3	49.0	9	234.7	8.0
Dithane M-45	2.5	10.3	36.8	7	230.0	5.8
Emisan-6	3.0	12.0	26.3	7	223.3	2.8
Check	-	16.3	-	-	217.3	-
CD (P=0.05)		2.50	-	-	16.7	-

Tomato

Chemical control of collar rot under protected cultivation

A trial on the efficacy of seedling dip for 1hr in fungicides/Panchgavya before transplanting followed by soil drenching at transplanting and twice at fortnightly intervals was conducted under protected cultivation against collar rot of tomato with “7711” hybrid. Results (Table 46) revealed that fungicide; tebuconazole 2 DS and Captan 50 WP @ 0.05 and 0.2% provided more than 95 percent control of disease. Vitavax power and HZ resulted in 77 and 75 percent control of disease. The effectiveness of Panchgavya was comparable with tebuconazole 2 DS and Captan.

Table 47: Chemical control of collar rot of tomato under protected cultivation

Treatment	Dose/ l	Disease incidence (%)	Disease control (%)
Tebuconazole 2 DS	0.50 g	0.93	96.20
Carboxin 37.5%+thiram 37.5%	2.5 g	5.56	77.31
Panchgavya	100 ml/Plant	0.93	96.20
Propiconazole 25 EC	0.50 ml	19.44	20.65
Tebuconazole 250 EW	0.50 ml	19.44	20.65
Hexaconazole+zineb	2.5 g	6.06	75.27
Tricyclazole+mancozeb	2.5 g	16.66	32.00
Captan	2.5 g	0.93	96.20
Check (none)	-	24.50	-

Data, average of 2 sets of experiment with three replications/treatment

Effect of PG on collar rot of tomato

Data (Table 48) revealed that all the treatments were significantly superior to check in controlling the collar rot of tomato, the most effective being T_5 followed by T_{17}. Seedling dip in Captan (0.25%) for half and one hr before transplanting provided 54 to 62 per cent control of disease. Soil drenching after 24 hr of transplanting provided 61.56 per cent control of collar rot which decreased to 49 per cent when drenched 48 hr after transplanting. Untreated seedlings sown in sick soil and drenched with Captan and Raxil 24 and 48 hr after transplanting gave 71.77 to 72.28 per cent control of collar rot of tomato whereas seedlings drenched one week after transplanting with Captan and Raxil failed to provide adequate protection to tomato seedlings from collar rot. Thus, untreated tomato seedlings sown in sick soil and drenched with PG 24 hr, 7 and 14 days after transplanting provided 94.8 per cent protection to tomato seedlings against collar rot disease.

Table 48; Effect of PG against collar rot of tomato caused by *Sclerotium rolfsii*

Treatment	Disease incidence (%)	Disease control over check (%)
T_1, untreated seedlings	66.60(54.31)	-
T_2, seedling dip in 0.25 % Captan for half hr before transplanting	30.57(33.53)	54.09
T_3, seedling dip in 0.25 % Captan for one hr before transplanting	25.10(30.05)	62.31
T_4, seedling dip in 0.05 % Raxil for half hr before transplanting	28.08(32.44)	57.84
T_5, seedling dip in 0.05 % Raxil for one hr before transplanting	3.20(10.21)	95.19
T_6, seedling dip in PG for half hr before transplanting	40.50(39.50)	39.19
T_7,seedling dip in PG for one hr before transplanting	18.60(25.52)	72.07
T_8, T_1+ soil drench with PG, 24 hr after transplanting	25.60(30.38)	61.56
T_9, T_1+ soil drench with PG, 48hr after transplanting	33.77(35.51)	49.29
T_{10}, T_1+ soil drench with PG, 1 week after transplanting	40.40(39.44)	39.34
T_{11}, T_1+ soil drench with 0.25 % Captan,24 hr after transplanting	18.80(25.67)	71.77
T_{12}, T_1+ soil drench with 0.25 % Captan, 48 hr after transplanting	18.46(25.43)	72.28
T_{13}, T_1+ soil drench with 0.05 % Raxil, 24 hr after transplanting	18.66(25.57)	71.98

T_{14}, T_1+ soil drench with 0.05 % Raxil, 48 hr after transplanting	18.46(25.43)	72.28
T_{15}, T_1+ soil drench with 0.25 % Captan, 1 week after transplanting	29.53(32.90)	55.66
T_{16}, T_1+ soil drench with 0.05 % Raxil, one week after transplanting	37.23(37.58)	44.09
T_{17}, T_8 + soil drench with PG, 7 and 14 days after transplanting	3.46(10.70)	94.80
CD(p=0.05)	(1.48)	

Arc sine transformed values in parentheses

Management of collar rot of bell pepper

A trial with fifteen treatments including check (Table 49) on the management of collar rot of bell pepper under protected cultivation was conducted with 'Indira' hybrid in RBD. Soil along with seedlings were drenched with chemicals, botanicals and Panchgavya a week after transplanting and thereafter twice at 10-days interval. Vitavax power gave complete control of collar rot followed by tebuconazole 25 EC. Standard Panchgavya was superior to its 1:1 dilution in controlling the disease. Hot water extract of rhizomes of *Acorus calamus* was superior over its cold one and its 1:1 dilution with water was less effective in controlling the disease.

Table 49: Management of collar rot of bell pepper under protected cultivation

Treatment(*Soil drenching with)	Disease incidence (%)	Disease control (%)
T_1, Raxil 2 DS @ 0.1%	36.1	60.0
T_2, Vitavax power @ 0.2%	0.0	100.0
T_3, Panchgavya @ 100 ml/plant	27.8	69.2
T_4, Dhan (propiconazole) @ 0.05%	27.8	69.2
T_5, Tebuconazole @ 0.05% 25 EC	11.2	87.6
T_6, **HZ @ 0.2%	25.0	72.3
T_7, Tricyclazole + mancozeb @ 0.2%	27.6	69.2
T_8, Captan @ 0.2%	36.1	60.0
T_9, Sitara 25 EC @ 0.05%	27.8	69.2
T_{10}, Standard cold extract of rhizomes of *Acorus calamus* @ 100 ml/plant	50.0	44.6
T_{11}, T_{10} (1:1 dilution)	52.8	41.5
T_{12}, Standard Hot water extract of rhizomes of *A. calamus* @ 100 ml/plant	39.4	56.3
T_{13}, T_{12} (1:1 dilution)	69.5	22.9
T_{14}, Panchgavya(1:1 dilution)	66.8	25.9
T_{15}, Check (none)	90.2	-
CD (P=0.05)	2.5	-

*Soil drenching at one week after transplanting and thereafter twice at fortnight intervals. **hexaconazole + mancozeb.

Pot culture studies

Efficacy of PG against damping-off of okra

The disease control over check was maximum (91.16 per cent) in T_{10} treatment where Bavistin treated seeds were sown in infested soil, drenched with PG 48 hr before sowing, followed by T_2 treatment i.e. Bavistin treated seeds (Table 50). All the treatments were superior to check in their effect on seed germination and gave 86 to 95 per cent germination of okra seeds except T_4 (untreated seeds sown in infested soil drenched with

PG 48 hr before sowing) which resulted in comparatively less germination than check. Although T_{13} (seed dip in PG for two hr before sowing) supported the maximum germination of seeds but the maximum control of damping-off was achieved with T_{10} (soil drenching with PG 48 hr before sowing + T_2). Similarly, though T_3 (T_1 + soil drench with PG 24 hr before sowing) resulted in better germination of seeds but showed 18.57 per cent control of disease whereas, T_4 (T_1 + soil drench with PG 48 hr before sowing) with minimum germination gave 79.9 per cent control of disease. Thus, no relation could be established between seed germination and damping-off among the treatments.

Table 50: Effectiveness of PG against damping-off of okra caused by *Rhizoctonia solani*

Treatment	Germination (%)	Disease incidence (%)	Disease control over check (%)
T_1, untreated seeds	84.30(67.14)	28.97 (32.51)	-
T_2, seed treatment with Bavistin @ 2.5 g / kg seed	86.53(68.84)	2.78 (6.13)	90.40
T_3, T_1+ soil drench with PG 24 hr before sowing	88.73(73.88)	23.59(16.82)	18.57
T_4, T_1+soil drench with PG 48 hr before sowing	81.06(61.46)	5 .81 (11.71)	79.94
T_5, T_1+ soil drench with Bavistin (0.1 %) 24 hr before sowing	86.53(68.84)	8.33(10.54)	71.25
T_6, T_1+soil drench with Bavistin (0.1 %) 48 hr before sowing	92.96(76.93)	17.94 (24.38)	38.07
T_7, T_1+ seedling drench with PG, 1 week after germination	93.33(79.90)	6.67 (12.39)	76.98
T_8, T_1+ seedling drench with Bavistin (0.1 %) ,1 week after germination	95.30(79.13)	11.90 (16.20)	58.92
T_9, soil drenching with PG 24 hr before sowing + T_2	90.86(72.58)	14.46(22.36)	50.09
T_{10}, soil drenching with PG 48 hr before sowing + T_2	86.53(68.84)	2.56(5.90)	91.16
T_{11}, seed dip in PG for half hr before sowing	88.89(70.54)	4.94(10.80)	82.95
T_{12}, seed dip in PG for one hr before sowing	88.89(71.54)	7.51 (13.13)	74.08
T_{13}, seed dip in PG for two hr before sowing	95.55(79.80)	4.44(7.68)	84.67
CD(p=0.05)	(NS)	(2.5)	_

Arc sine transformed values in parentheses

V. Miscellaneous crops

Tea

Germplasm evaluation

Out of nine recommended tea cultivars (Table 51), P312, Kangra Asha and Kangra Jawala were found moderately resistant to blister blight.

Table 51: Varietal reactions of tea cultivars against blister blight

Cultivar	*Exobasidium vexans*	
	Incidence (%)	Severity (%)
Kangra Local	21.12	6.92
Kangra Asha	12.73	4.85
Kangra Jwala	14.37	5.32
P-312	9.02	2.41
T-253	16.67	5.93
TV-8	24.17	9.34
TV-9	22.69	8.33
TV-23	26.17	10.59
TV-1	23.46	9.66
TV-18	29.14	12.35

Management

Efficacy of Antracol (Propineb 70 WP) against blister blight

Antracol was tested at three concentrations (Table 52) along with Blitox 50WP and Zn SO_4 against blister blight of tea**.** Antracol at 0.5 and 0.63 % concentrations was found significantly at par with Blitox with approximately 50 % reduction in disease incidence, whereas, ZnSO4 was found ineffective against the disease.

Table 52: Efficacy of Antracol (Propineb 70WP) against blister blight

Treatment	Concentration (%)	Disease incidence (%)	Per cent Disease control over check	Severity (%)	Per cent control over check
Antracol	0.375	15.87 (23.47)	24.90	5.02 (12.95)	27.50
Antracol	0.5	10.59 (18.98)	49.90	3.65 (11.00)	47.30
Antracol	0.63	11.36 (19.69)	46.20	4.07 (11.64)	41.20
Blitox(COC 50WP)	0.3	11.27 (19.61)	46.60	3.77 (11.19)	45.50
Blitox + $ZnSo_4$	0.3+0.5	11.72 (20.01)	44.50	3.73 (11.13)	46.10
$ZnSo_4$	0.5	19.41 (26.13)	8.00	6.38 (14.62)	7.80
$ZnSo_4$	0.3	19.23 (20.00)	8.90	6.93 (15.26)	0.00
Control	--	21.12 (27.35)	-	6.92 (15.25)	-
CD $_{(0.05)}$		(0.367)		(0.165)	

The values in the parentheses are angular transformed

***In vitro* evaluation of Boon and Antracol against blister blight of tea**

A systemic triazole fungicide Boon (Myclobutanil WP) and a broad spectrum contact fungicide Antracol (Propineb 70 WP) were evaluated at different concentrations under *in-vitro* conditions (Table 53). Boon was found effective at 0.2 percent concentration with more than 70 per cent inhibition of basidiospore germination whereas, Antracol was found effective with cent per cent inhibition of basidiospore germination at 0.03 % concentration and more than 70 per cent inhibition even at 0.003% concentration

Table 53: *In vitro* **e**valuation of Boon and Antracol against basidiospore germination

Boon			Antracol		
Concentration (%)	Germination (%)	Inhibition (%)	Concentration (%)	Germination (%)	Inhibition (%)
0.02	49.74 (44.83)	27.85	.0005	54.97 (47.84)	25.12
0.04	56.20 (48.58)	18.48	.001	40.49 (39.48)	44.84
0.06	45.26 (42.26)	34.35	.002	49.35 (44.61)	32.78
0.08	38.27 (38.27)	44.49	.003	21.29 (27.46)	71.00
0.10	21.81 (27.79)	68.36	.004	14.17 (20.02)	80.70
0.20	17.98 (25.06)	73.92	.005	9.84 (18.25)	86.60
0.30	15.45 (23.08)	77.59	.01	4.44 (12.08)	93.95
0.40	18.33 (25.28)	73.41	.02	1.81 (7.62)	97.53
0.50	16.86 (24.18)	75.54	.03	0.00	100
Control	68.94 (56.13)	-	Control (distilled H_2O)	73.41 (59.05)	-
CD (p=0.5)	(3.73)		CD (p=0.5)	(2.9)	

The values in the parentheses are angular transformed

In-vitro evaluation of botanicals/Neem based fungicides against blister blight of tea

Six botanicals/ neem based fungicides viz; Wanis, Spictaf, Achook, Tricure, Neemgold and Neemazal were evaluated at different concentrations (Table 54) for per cent inhibition of basidiospore germination under *in-vitro* conditions. Wanis was found effective even at low concentrations i.e. more than 70 per cent inhibition of basidiospore germination at 0.003 % concentration and total inhibition at 0.15% concentration. Spictaf was also found effective at 0.2 % concentration with more than 70 per cent inhibition. Rests of the neem based fungicides were found ineffective

Table 54: *In-vitro* testing of botanicals/neem based fungicides against blister blight

Wanis		Spictaf		Achook	Tricure	Neemgold	Neemazal
Conc. (%)	Inhibition (%)	Conc. (%)	Inhibition (%)	Inhibition (%)	Inhibition (%)	Inhibition (%)	Inhibition (%)
.0005	29.26	.025	7.71	7.37	-	10.04	3.80
.001	68.48	.05	15.31	4.48	6.15	6.73	2.35
.002	69.50	.10	7.83	6.48	3.44	10.29	1.36
.003	76.18	.15	46.98	21.34	0.57	11.38	1.95
.005	71.81	.20	72.37	4.32	3.01	6.51	2.21
.01	78.12	.30	78.48	23.88	9.97	4.03	4.53
.02	84.58	.40	95.82	5.55	8.87	12.59	12.75
.025	95.14	.50	95.65	2.52	-	12.12	18.66
.05	96.27	Control	-	-	-	-	-
.10	97.98				-	-	-
.15	100						

Ginger

Germplasm evaluation

Initial evaluation trial

Twenty four promising clones were selected from the micro trial 2005-06 for this experiment. The trial was conducted in 2m long two row plots with row to row distance of 30 cm in two replications. It was observed that clone GIET 17 was free from rhizome rot whereas, incidence of rhizome rot in clones GIET 9, 10, 12, 21 and 22 was less than 10%. The yield level of the clones varied from 70.8 – 158.3q/ha. The highest yield of 158.3 q/ha was recorded in clones GIET 16 (183.3 q/ha) followed by GIET 22 (158.3q/ha).

Micro evaluation trial

Forty clones collected during 2005-06 were selected for this experiment. The trial was conducted in 2m long single row plots with row to row distance of 30 cm in two replications. It was observed that none of the clones were free from rhizome rot whereas, incidence of rhizome rot in clones GMT 10, 11, 17, 18, and 22, was less than 15% (Table 55). The yield level of the clones varied from 9.2 – 146.7 q/ha. The highest yield of 146.7 q/ha was recorded in clones GMT 9.

Table 55: Yield and disease reaction of promising ginger clones from Sirmour, Solan and Shimla in micro trial (MT)

	Rhizome rot incidence		Yield (q/ha)	
Genotype	Percent	Arc sine value	Fresh rhizome	Old rhizome
GMT 1	10.0	(18.34)	91.7	17.5
GMT 2	16.7	(24.05)	37.1	12.9
GMT 3	66.7	(54.73)	60.4	25.0
GMT 4	30.0	(32.89)	105.4	12.1
GMT 5	40.0	(39.22)	100.0	20.8
GMT 6	29.8	(33.04)	62.5	11.7
GMT 7	16.7	(23.97)	72.9	25.8
GMT 8	61.7	(51.78)	62.9	27.9
GMT 9	42.8	(40.81)	146.7	9.2
GMT 10	12.5	(20.60)	107.9	20.0
GMT 11	14.3	(22.18)	102.1	37.5
GMT 12	25.0	(29.88)	49.6	36.7
GMT 13	50.0	(44.98)	86.3	10.8
GMT 14	40.0	(39.19)	82.1	32.1
GMT 15	16.2	(23.54)	70.8	17.9
GMT 16	37.5	(37.66)	112.9	35.4
GMT 17	13.9	(21.78)	118.3	29.2
GMT 18	15.0	(22.49)	127.9	17.5
GMT 19	45.2	(42.15)	138.3	25.8
GMT 20	36.7	(37.22)	62.1	30.8
GMT 21	59.0	(50.30)	40.8	37.5
GMT 22	12.5	(19.74)	60.4	22.5
GMT 23	83.4	(72.35)	9.2	2.3
GMT 24	20.6	(26.51)	42.9	20.0
GMT 25	66.7	(55.42)	56.3	14.6
GMT 26	31.0	(33.77)	68.3	20.8
GMT 27	60.7	(51.31)	87.9	24.2
GMT 28	52.1	(46.19)	60.4	40.8
GMT 29	85.7	(73.81)	10.8	1.3
GMT 30	52.5	(46.42)	58.8	16.7
GMT 31	47.9	(43.77)	89.6	16.3
GMT 32	62.5	(52.48)	50.4	18.0
GMT 33	50.0	(44.98)	55.0	18.8
GMT 34	41.3	(39.81)	127.9	30.0
GMT 35	25.0	(29.67)	68.8	18.8
GMT 36	23.9	(29.10)	127.1	8.3
GMT 37	24.3	(29.44)	72.9	19.2
GMT 38	29.6	(32.94)	86.3	50.8
GMT 39	34.8	(36.12)	118.3	29.2
GMT 40	27.5	(31.59)	91.7	17.5
CD (0.05)		(16.1)	28.1	16.7
CV (%)		21	17.5	23.7

Disease management

Nine chemicals and three biochemical agents were evaluated individually and in combinations for the management of rhizome rot.

The *Pythium* spp was found to be associated with the rhizome rot. It was observed that all the treatments resulted in significantly less rhizome rot incidence as compared with the no treatment check (Table 56). All the treatments resulted in significantly less disease as compared to check (54.44q/ha). Rhizome treatment for 1 h dip in solution of mancozeb+ carbendazim @ 0.25 + 0.1% resulted the least rhizome rot incidence(18.59%) followed by dipping rhizomes in solution of mancozeb+ carbendazim @ 0.25+0.1% and drenching with bleaching powder @ 20kg/ha. All the treatments resulted in significantly more yield as compared to check (54.44q/ha). The highest yield was recorded in plots with rhizome dipping in Ridomil + Bayleton (0.4+0.1%) followed by recommended practice and curzate +Bavistin. Yield in all these treatments were statistically a par. The biocontrol agent Niprot resulted in yield of 82.2 q/ha.

Table 56. Management of ginger rhizome rot through chemicals and biocontrol agents

Fungicide (dose)	Rhizome rot incidence (%)	Yield (q/ha)	
		Fresh rhizome	Old rhizome
Indofil M 45+ Bavastin (0.25+0.1%) +Streptocycline 500ppm	14.63 (22.44)	59.0	18.3
Ridomil + Bavastin (0.4+0.1)	12.76 (20.84)	72.7	19.6
Antracol + Bavastin (0.4+0.1)	21.5 (27.56)	69.4	17.6
Ridomil + Bayleton (0.4+0.1)	25.26 (29.86)	96.44	12.8
Control (No chemical)	30.83 (33.71)	54.44	10.6
Recommended +Bleaching powder (Drenching @ 20kg/ha)	14.00 (21.91)	63.7	11.7
Niprot (8gm/kg) slurry	19.13 (25.78)	82.3	19.4
Groderma ((8gm/kg) slurry	18.16 (25.19)	69.44	18.9
Tricholex (8gm/kg) slurry	18.56 (25.47)	75.5	25.0
Recommended	10.23 (18.59)	91.1	18.9
Curzate	14.83 (22.63)	83.33	19.4
Curzate+ bavastin	13.83 (21.68)	84.11	7.6
CD (0.05)	(5.29)	14.3	17.5
CV (%)	12.65	11.24	

Figures in parentheses are arcsine transformed values

Management of Phyllosticta leaf spot

Systemic fungicide Score was highly effective for the management of Phyllosticta leaf spot of ginger. Spray schedule was worked out as 2 and 3 foliar sprays (0.05 and 0.1%) at 15 days interval. The first spray was given with the initiation of the disease. Cholorothalonil @ 0.25% and Folicur @ 0.1% were also included as 3 sprays.

The disease severity was significantly less in all the treatments as compared to the check (41.15%).It was least (6.4%) in plots with three sprays of Score 25EC (9.72%) followed by three sprays of Folicur @ 0.1% (11.47%) (Table 57). The yield was statistically at par in all the treatments, however, it was the highest in plots with three sprays of score @ 0.1% (126.1 q/ha) followed by contaf 5EC (111.1 q/ha).

Table 57: Spray schedule for management of Phyllosticta leaf spot of ginger

Fungicide (conc. %) [no. of sprays]	Phyllosticta leaf spot severity (%)	Rhizome yield (q/ha)	
		Fresh	Old
Score (0.05) [2]	20.0 (26.44)	66.7	21.1
Score (0.1) [2]	10.0 (18.04)	97.2	15.3
Score (0.05) [3]	6.3 (14.50)	87.2	13.3
Score (0.1) [3]	3.0 (9.72)	126.1	26.1
Contaf (0.1) [3]	25.0 (29.91)	111.7	21.1
Folicur (0.1) [3]	4.0 (11.47)	78.9	17.7
Copper oxychloride (0.3) [3]	31.7 (34.13)	97.2	22.8
Indofil M 45+ carbendazim (0.1) [3]	28.3 (32.05)	90.6	24.4
Kavach (0.25) [3]	7.3 (1 5.56)	76.1	18.9
Antracol (0.3) [3]	8.33(16.73)	63.9	10.6
Control (No spray)	43.33 (41.15)	44.4	8.33
CD (0.05)	5.7	22.2	4.38
CV (%)	14.65	15.76	14.19

Forage crops

Germplasm evaluation

During *Kharif* the maize and cowpea germplasm were evaluated against different diseases and three entries of maize were observed moderate resistant to leaf blights and no entry of cowpea and cluster bean was observed resistant to root rot. During *Rabi* the material of oats and berseem were evaluated and 21 entries of oats were found resistant to moderately resistant against powdery mildew.

Non– chemical management of pests of cowpea and maize

Maize blight and cowpea diseases i.e. wilt/root rot, Phytophthora blight and anthracnose were significantly reduced by most of the treatments. The seed treatment with *Trichoderma viride* @ 5g/kg + FYM @ 4t/ha or *Paecilomyces lilacinus* 5 g/kg + FYM 4t/ha or neem seed powder @ 50g/kg followed by Spray of cattle urine + cow dung extract in 30 and 45 days crop give best control of all the maize and cowpea diseases with maximum yield of maize (349.3, 352.3 and 349.0 q/ha) and cowpea (64.7,63.0 and 65.0q/ha) as compared to control i.e.271.7 and 54.7 q/ha, respectively.

Integrated disease management of fodder maize

Integrated management of brown spot, leaf blights and BLSB fodder maize with ten treatments and three replications was conducted. It was observed (Table 58) that seed treatment with Vitavax power @ 2 g/kg seed + three sprays of Indofil M-45 @ 0.25% gave minimum disease incidence i.e.2.3, 10.1 and 3.3 percent of brown spot, leaf blights and BLSB respectively, with maximum yield (341.7q/ha) . Soaking of seeds in PGPR (*Pseudomonas fluorescens*) suspension followed by three sprays of *P. fluorescens* also found effective for the management of maize diseases.

Table 58. Integrated disease management of fodder maize

Sr. No.	Treatment	Disease severity / incidence (%)*			Green fodder yield (q/ha)
		Brown spot	Leaf blights	Banded leaf & sheath blight	
1.	Seed treatment with Vitavax power @ 2 g/kg seed	3.2	14.5	4.1	329.3
2.	Seed treatment with *Trichoderma viride* @ 5 g/kg seed	4.4	15.8	6.3	321.7
3.	Soaking of seeds in PGPR (*Pseudomonas fluorescens*) suspension @ 10^9 cfu/ml for 1 hour	4.3	15.6	7.6	320.3
4.	T1+ 3 spray of Indofil M-45 @ 0.25%	2.3	10.1	3.3	341.7
5.	T2 + 3 spray of Indofil M-45 @ 0.25%	3.5	11.6	5.7	319.3
6.	T3 + 3 spray of Indofil M-45 @ 0.25%	3.7	10.4	7.0	321.3
7.	T1 + 3 spray of *P. fluorescens* @ 10^7 cfu/ml	2.8	9.8	3.9	315.0
8.	T2 + 3 spray of *P. fluorescens* @ 10^7 cfu/ml	3.6	11.2	4.6	310.0
9.	T3 + 3 spray of *P. fluorescens* @ 10^7 cfu/ml	4.3	13.7	6.6	324.7
10.	Control	5.1	18.4	11.2	298.3
CD (P=0.05)		0.6	2.2	1.0	1.0

Root rot and stem rot disease management of berseem

An experiment was conducted with 6 treatments with 3 replications and data showed minimum disease incidence of stem rot and root rot i. e. 2.5 and 1.8 %, respectively, when seed was treated with Thiram 0.25% + carbendazim 0.2% as compared to control i.e. 7.1 and 6.9 %, respectively (Table 59). This was followed by seed soaking in salicylic acid (0.02%) + spray of salicylic acid (0.02%) after 1st & 2nd cut.

Table 59: Root rot and stem rot disease management of berseem

Treatment	% Disease incidence		Yield q/ha
	Stem rot	Root rot	
Seed treatment with *Trichoderma harzianum* @ 5 g/kg seed + soil application of *T.harzianum* @ 4kg/ha along with FYM @ 60 kg/ha.	5.3	5.5	166.0
Seed treatment with neem seed powder@50g/kg seed	4.3	5.4	171.7
Biopriming of seed with *Trichoderma*+ neem cake 400 kg/ha	4.5	4.1	195.3
Seed soaking in salicylic acid (0.02%) + spray of salicylic acid (0.02%)after 1st & 2nd cut	3.1	2.9	207.7
Seed treatment with thiram 0.25%+carbendazim 0.2%	2.5	1.8	221.0
Control	7.1	6.9	152.3
CD (P=0.05)	0.2	0.7	13.1

VI. Seed pathology

Monitoring and detection of rice bunt, false smut and bacterial leaf blight diseases

Thirty three rice samples from farmers' fields and seven from Govt. multiplication farms were analysed for the presence of rice bunt. No sample was found infected with rice bunt. The incidence of false smut in farmers' fields was in traces.

Seed health status of farmers' own saved seed as compared to certified seed

Wheat

During period under report 10 certified wheat seed samples were collected from GSM Farms and 10 from farmers' own saved seed. The loose smut incidence (0.88 & 0.19%) was detected from two samples of GSM Farm Pekhubela and Bhangrotoo on variety Raj -3777, whereas, from four wheat samples from farmers' own saved seeds which ranged from 0.20 to 0.65 per cent (Table 60). Similar trend was found in embryo count method though the incidence was slightly high in this method.

Table 60 : Status of loose smut in certified and farmers' saved wheat samples collected from different locations

Location	Variety	Germination (%)	Loose smut incidence (%)	
			in field	Embryo count
GSMF Pekhubela	HS-295	100	0	0.20
GSMF Pekhubela	PBW -343	94	0	0
GSMF Pekhubela	PBW-343	4	0	0
GSMF Pekhubela	Raj -3777	90	0.88	0.96
GSMF Auhar	HPW 42	100	0	0
GSMF Auhar	HS-295	98	0	0
GSMF Paprola	HS-295	100	0	0
GSMF J. nagar	HPW 42	100	0	0
GSMF Bhangrotoo	HS-295	100	0	0
GSMF Bhangrotoo	Raj -3777	98	0.19	0.30
Mehrya	Local	94	0	0
Chowkikhalate	-do-	100	0	0
Banuri	-do-	98	0.20	0.19
Rajpur	-do-	94	0	0
Mandi	-do-	100	0.65	0.81
Tanda	-do-	96	0	0
Bharmat	-do-	98	0	0.01
Lohna	-do-	92	0.20	0.32
Lohna	-do-	100	0.33	0.42
Ghuggar	-do-	100	0	0

Detection of BCMV from Local germplasm of common bean using grow-on test and DAS-ELISA

Thirty six land races of common bean collected from different bean growing areas of Himachal Pradesh were screened for the seed borne infection of BCMV under glass house condition through grow-on –test (Table 61). Out of these 36 lines 29 showed the seed borne infection ranging from 0.00 to 100 per cent and only three lines were completely free from the disease. Seedlings of local land races exhibiting mosaic symptoms under glass house conditions reacted positively with the BCMV antiserum in DAS- ELISA test except Pandar and Dheedag sample.

Table 61: Detection of BCMV in local land races of common bean through grow-on test

District	Location	Seed borne infection(%)	District	Location	Seed borne infection(%)
Kullu	Karan-I	28.57	Mandi	Pandar	0.00
	Karan-II	20		Kanda Jhach	100
	Diyar-2	30		Sheel (Jinjaili)	NG
	Shaundadhar-I	33.33		Barkhan	28.57
	Shaundadhar-II	NG*		Tikkan	36.36
	Khun	66.66		Barot	37.50
	Ghiyagi	9.09		Barot	33.33
	Shaundadhar	50.00	**Shimla**		
	Diyar	41.67		Jarol (kotkhai)1	100
	Karan-II (Lag valley)	25.00		Kotidhar 2 (Thanedarr)	100
	Kuhn-I	33.33		Kheni (Rohru)3	50
				Gasta 4 (Kotkhai)	100
Chamba	Garon C1	100		Dodrakawar 5	50
	Deol C2	50		Dodrakawar 6	25
	Bhuntu	75	**Sirmour**		
Mandi				Palu (Rajgarh)	NG
	Okli (Rohanda)	NG		Dheedag (Nauradhar)	0.00
	Neulidhar	100		Gaonta-I	NG
	Aaon (Bagsyar)	100		Sangrah	100
	Skaus (Jingaili)	42.86		Gandoari	0.00

*NG: No seed germination

Table 62: DAS-ELISA of local land races of common bean collected from different districts of Himachal Pradesh.

Coating Antiserum Polyclonal BCMV Conc. 1:200 Time: 3h Temp: 37°C
Antigen BCMV isolates Conc 1:20 Time: Overnight Temp: 6°C
Conc. Antiserum Conc 1:200 Time: 2-3 h Temp: 30°C
Substrate pnPP Conc. 1mg/ml Time 1-2h Temp.: RT

Plate Setup

	1	2	3	4	5	6	7	8	9	10	11	12
A												
B		K-1		C-2		Sh-2			J-P isolate		-ve control	
C		K-4		M-2		Sh-3			Pandar			
D		K-5		M-3		Sh-4			G2333		+ve control	
E		K-7		M-4		Sh-5			Dheedag			
F		K-8		M-6		Barot			-ve Control			
G		C-1		Sh-1		Sh-6						
H												

C: Chamba; K: Kullu; M: Mandi; Sh: Shimla

Results

	1	2	3	4	5	6	7	8	9	10	11	12
A												
B		0.152		0.120		0.078			0.151		0.003	
C		0.100		0.080		0.120			0.00			
D		0.183		0.161		0.190			0.321		0.345	
E		0.250		0.200		0.185			0.00			
F		0.092		0.321		0.110			0.002			
G		0.125		0.170		0.140						
H												

VII. Molecular plant pathology

DNA fingerprinting of Ascochyta blight isolates

The RAPD profiles generated by different primers were compared to determine relationship among 40 isolates collected from pea growing areas of Himachal Pradesh.

Initially 150 primers were used for PCR amplification of DNA of two fungal isolates. Of these, nine viz., OPA-02, OPA-13, OPA-09, OPC 8, OAS-13, OPQ-13, OPD-11, OPQ-18, and S-1466 giving consistent banding pattern were selected for RAPD analysis of 40 isolates of *Ascochyta* species. Based on RAPD data isolates were categorized in to two major clusters accommodating 18 and 19 isolates respectively. There was no correlation between the geographic distribution and phenogram as the isolates were grouped regardless of their geographic collection.

Out of 11 ISSR primers screened for polymorphism 4 were selected and all the 40 isolates were fingerprinted using BA1, BA2, BA4 and BA9 primers.

Rep PCR analysis of 40 isolates was also carried out using ERIC and BOX-AIR primers. Ribosomal DNA of 20 isolates was restricted with 4 restriction enzymes (*Alu* I, *Hinf* I, *EcoR* I and *Taq* I)

Three *Ascochyta* populations collected from three different agro-climatic regions of Himachal Pradesh comprising 37 isolates causing pea blight were studied to know the genetic diversity and probable rate of spread of pathotypes. The genetic diversity existing amongst the pathogenic populations was calculated on the basis of allele frequencies of 13 random amplified polymorphic DNA markers using Nei's genetic diversity formulae. Isolates of *Ascochyta* spp. were scored for variation at 13 putative random amplified polymorphic DNA (RAPD) loci. Allele frequency at single locus varied from 0.00 to 1.00. Diversity within each population (H_S) was high with values ranging from 0.36 to 0.40. Significant genetic differentiation was detected among all three subpopulations indicating less distance gene flow. Haplotype diversity in three populations was 0.57 (Sangla), 0.53 (Janjhali) and 0.54 (Chamba). Phenogram developed revealed three distinct clusters of pathogen isolates within each subpopulation. Genetic distance between the populations was very low in case of Chamba and Sangla populations (0.09), thereby indicating high variation between the two populations. Based on NTSYS pc 2.0, the 37 isolates were categorized into two major clusters accommodating 18 and 19 pathogen isolates. There was no correlation between the geographic distribution and phenogram.

Molecular characterization of BCMV strains

Coat protein gene of two most prevalent strains of BCMV infecting common bean in Himachal Pradesh was ligated in pGEM-T Easy Vector system, cloned in *E. coli* strain 410 and nucleotide sequencing was done by using custom services. Blasted nucleotide sequence revealed the presence of partial NIb (1-610 bp) and cp (611-973bp) of the test BCMV NL-1 strain and partial NIb (1-551 bp) and cp (552-883bp) of the test BCMV NL-1n strain .The results of multiple sequence alignment indicated that the per cent identities of the partial NIb and cp sequence among the test BCMV NL-1 strain, BCMV NL-1n strain and other potyviruses ranged between 85 to 99 per cent (Table 63). However, maximum genetic homology of these test strains was between each other (99 %) followed by AY112735 (97 %), DQ054366 (97 %) and BCU55319 (97 %). The variation in the 3' terminal region of coat protein by five nucleotide bases differentiated the two strains (NL-1 and NL-1n) at molecular level, which were earlier differentiated pathologically and through the coat protein profiles.

Table 63: Per cent dissimilarity between the coat protein peptide profiles of the strains of BCMV

	Dissimilarity (%)			
Stain groups	Ia	Ib	IIa	IIb
1a	-			
1b	100	-		
IIa	100	91.67	-	
IIb	91.67	100	91.67	-

Studies on inheritance of resistance in common bean against BCMV

Genetic studies on inheritance of resistance against BCMV were conducted with four resistant cultivars viz., Hans, Contender, KRC4 and KRC 22 and susceptible cultivar. The perusal of the data (Table 64) revealed a good fit in the ratio of 3 resistant to 1 susceptible in F_2 generation of cross Jawala x Hans and Jawala x Contender indicating the presence of single dominant gene for resistance in Hans and Contender against bean common mosaic virus. In cross Jawala x KRC-22, a good fit of a segregation ratio of 1 resistant to 3 susceptible in F_2 generation was observed, which indicated that the resistance in KRC-22 against BCMV is governed by the presence of single recessive gene. However, in cross Jawala x KRC-4, the F_2 ratio of 1 resistant to 3 susceptible did not fit well which indicates that linked genes might be involved in resistant mechanism of KRC-4 against BCMV.

Table 64: Inheritance of resistance in common bean cultivars against BCMV strain NL- In

Parents/Crosses		No. of seedlings				
		Resistant	Susceptible	Expected ratio	Chi-square	P
Cross I						
Jawala	P1	-	All	-	-	-
Hans	P2	All	-	-	-	-
Jawala X Hans	F_2	74	25	3:1	0.003^{NS}	0.95 -0.98
Cross II						
Jawala	P1	-	All	-	-	-
Contender	P2	All	-	-	-	-
Jawala X Contender	F_2	57	24	3:1	0.926^{NS}	0.30-0.50
Cross III						
Jawala	P1	-	All	-	-	-
KRC-22	P2	All	-	-	-	-
Jawala X KRC-22	F_2	24	74	1:3	0.014^{NS}	0.90-0.95
Cross IV						
Jawala	P1	-	All	-	-	-
KRC-4	P2	All	-	-	-	-
Jawala X KRC-4	F_2	28	48	1:3	5.684^{*}	0.01-0.05

P1= Parent 1; P2 = Parent 2 * significant at 5% level; NS= non-significant at 5% level

VIII. Mushrooms

Evaluation of yield potential of selected strains on different agricultural wastes

Wheat, paddy, maize, soybean, mash, Lantana and Eupatorium and maize cobs were evaluated for cultivation of two promising strains of *Pleurotus ostreatus*. The chopped straw substrates were soaked and hot water treatment was given. Spawning was done with grain based spawn @ 4 % w/w basis of straw. Spawned substrate 2-2.5 kg/bag (dry straw) was filled in perforated polypropylene bags and bags were sewed with nylon rope. The bags were kept in cropping room and after complete colonization of straw with mycelium polybags were removed. Both *Pleurotus* strains preferred all the substrates but strain 3 x 6 showed maximum yield on soybean and paddy straw which were statistically at par with each other followed by wheat and mash straw (Table 65).

Table 65: Evaluation of various straw substrates for the growth of improved *Pleurotus* sp

Substrate	Spawn run#(days)		Pin head stage#		Yield# (g/kg substrate)		Biological efficiency #(%)	
	3x6*	3x8	3x6	3x8	3x6	3x8	3x6	3x8
Mash straw	13	15	19	17	895	900	89.5	90.0
Maize straw	14	16	20	18	770	775	77.0	77.5
Maize cobs	12	14	20	19	600	450	60.0	45.0
Paddy straw	10	12	17	18	990	885	99.0	88.5
Soybean straw	11	13	18	16	1100	999	110.0	99.9
Wheat straw	12	14	19	18	980	900	98.0	90.0
Lantana	14	16	22	20	720	775	72.0	77.5
Eupatorium	12	14	20	18	450	350	45.0	35.0
CD (P=0.05)	1.73	1.61	1.36	1.53	129.37	125.10	12.93	12.51

Average of three replications*the strain found promising and recommended for cultivation

Nutrient analysis of a wild strain of *Pleurotus ostreatus* cultivated on various substrates

Nutrient analysis of fruit bodies of *Pleurotus ostreatus* grown on different substrates was attempted. Maximum protein content (39.16 %) was recorded on the fruit bodies grown on soybean and maize cobs followed by those grown on lantana. However, maximum fat (20 %) contents were observed on the fruit bodies grown on maize straw followed by maize cobs and mash straw. Highest fiber and ash contents were registered by the fruit bodies grown on soybean and maize cobs (Table 66). Results reveal high nutrient status and biological efficiency of soybean straw.

Table 66: Nutrient analysis of a wild strain of *Pleurotus ostreatus* cultivated on various substrates

Substrates	Nutrients (%)			
	Proteins	Fats	Ash	Fiber
Wheat	24.91 (2.99)	0.11 (0.01)	4.10 (0.50)	0.78 (0.10)
Paddy	26.18 (3.14)	0.11 (0.01)	5.56 (0.67)	0.78 (0.10)
Maize	30.40 (3.65)	0.20 (0.24)	8.45 (1.01)	0.65 (0.10)
Maize cobs	39.16 (4.70)	0.15 (0.02)	9.52 (1.14)	0.73 (0.10)
Mash	29.87 (3.58)	0.15 (0.02)	5.51 (0.66)	0.76 (0.10)
Soybean	39.16 (4.70)	0.09 (0.01)	6.26 (0.75)	0.86 (0.10)
Lantana	35.97 (4.32)	0.13 (0.02)	7.96 (1.14)	0.76 (0.10)
Eupatorium	29.95 (3.59)	0.10 (0.01)	7.79 (0.93)	0.65 (0.10)
Pine needles				

Figures in parentheses represent fresh weight values

Nutrient analysis of spent mushroom substrate before and after vermicomposting

Samples of spent mushroom substrate (SMS) were analysed for major plant nutrients. Spent mushroom substrate was used for preparing vermicompost using *Eudrilus eugeniae* species of worms procured using surface bed method. Vermicompost was also analysed for major plant nutrients like nitrogen, phosphorous and potassium. Results revealed that NPK in the spent mushroom compost increased after vermicomposting (67).

Table 67: Nutrient analysis of spent mushroom substrate before and after Vermicomposting

Substrates	Nutrients (%)		
	Nitrogen	Phosphorous	Potassium
Wheat	0.44 (1.68)	0.10 (0.58)	0.78 (1.05)
Paddy	0.32 (1.16)	0.12 (0.53)	0.83 (1.13)
Maize	0.28 (1.12)	0.15 (0.32)	0.47 (0.57)
Maize cobs	0.33 (1.33)	0.10 (0.50)	0.43 (0.48)
Mash	0.78 (1.18)	0.10 (0.36)	0.45 (0.49)
Soybean	0.84 (1.28)	0.10 (0.35)	0.49 (0.59)
Lantana	2.08 (2.63)	0.18 (0.67)	0.61 (0.65)
Eupatorium	1.97 (2.33)	0.15 (0.71)	0.56 (0.62)

Figures in parentheses represent values of SMS after vermicomposting

Evaluation of substrates

Straw of rice, wheat, soybean, mash, maize, crushed maize cobs, pine needles and weeds like lantana, and Eupatorium were evaluated for yield of *Pleurotus* species. Rice-bran and straw of broad leaved trees was used as a substrate for the cultivation of *Flammulina velutipes.* Wheat grains were used for preparing spawn using standard procedure. Amongst different substrates, yield potential of different *Pleurotus* spp. on soybean, and mash straw were statistically at par with each other followed by paddy straw giving more than 100% biological efficiency irrespective of the *Pleurotus* species. Out of two weeds, yield performance of all the species of Oyster mushroom was better in Lantana as compared to Eupatorium (Table 68). There was no fruiting on pine needles.

Table 68: Evaluation of different agricultural wastes for yield performance of different *Pleurotus* species

Substrates	Yield(g/kg)				
	Pleurotus florida	*Pleurotus sapidus*	*Pleurotus ostreatus*	*Pleurotus sajor caju*	*Pleurotus flabellatus*
Wheat straw	500	450	366	*366*	*400*
Rice straw	600	596	350	376	483
Maize straw	550	626	300	290	350
Maize cobs	350	495	260	283	1087
Soybean straw	1060	1010	1000	100	1030
Mash straw	1080	1050	1010	973	400
Lantana	488	433	413	320	393
Eupatorium	413	323	356	400	248
CD (p= 0.05%)	49.05	47.50	51.43	95.58	70.33

Analysis of polysaccharides

Analysis of polysaccharides using TLC detection 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°C for 10 minutes were done before observing under UV light. TLC results of polysaccharide analyses revealed that *P. sajor caju, P. florida* and P. *flabellatus* contain polysaccharides in form of their monomers (glucose, galactose, xylose and mannose) whereas, these polysaccharides were absent in *P. sapidus* (Table 69).

Table 69: TLC patterns of monomers of polysaccharides of *Pleurotus spp* run on benzene glacial acetic acid: methanol (20:20:60)

No. of spots	Rf values and colours after spraying with naptharesorcinol		
	P. ostreatus	*P. sajorcaju*	*P. flabellatus*
1	0.33 glucose (brown)	0.33 glucose (brown)	0.33 glucose (brown)
2	0.33 galactose (light brown)	0.33 galactose (light brown)	0.33galactose (light brown)
3	0.42 mannose (red)	0.42 mannose (red)	0.42 mannose (red)
4	0.44 xylose (red)	0.44 xylose (red)	0.44 xylose (red)
5	0.46 raffinose (red)	-	-
6	0.28 ribose (blue)	-	-

Analysis of amino acids

The same principle as used for detecting polysaccharides was used for detecting polysaccharides except for the developing solvent (ethanol: water 70.30) and reagent (1% ninhydrin in acetone) at 100°C for 5 minutes were applied before observing under UV light. TLC results of amino acid analyses showed the presence of alanine, glutamine, aspargine, lysine and proline in all the tested species of *Pleurotus* (Table 70).

Table 70: TLC pattern of amino acids of *Pleurotus* spp run on ethanol: water (70:30**)**

No. of spots	Rf values and colours after spraying with ninhydrin		
	P ostreatus	*P sajor caju*	*P flabellatus*
1	Alanine 0.22 Purple	Alanine 0.22 Purple	Alanine 0.22 Purple
2	Glutamine 0.58 Bluish	Glutamine 0.58 Bluish	Glutamine 0.58 Bluish
3	Glutamic acid 0.30 Blue	Glutamic acid 0.30 Blue	Glutamic acid 0.30 Blue
4	Proline 0.35 Pink	-	Proline 0.35 Pink
5	-	Lysine 0.47 Red	-
6	Aspargine 0.56 Purple	-	-

Collection, identification and culturing of fleshy fungi of Western Himalayan region for bioactive molecules

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 550 collections of the fleshy fungi belonging to nearly 240 species of more than 60 genera were made from various localities after thorough exploration during the period under report. They were identified and cultured.

As many as 530 collections were attempted for culturing of which, 205 isolates were obtained in pure culture from fresh specimens. The success rate was low because of mycorrhizal nature of most of the fleshy fungi growing in the forests. Thus out of total of 550 collections made, only 205 isolates could be brought in culture and were successfully maintained and processed. Majority of the cultures grew optimally between pH 6.5 to 7.5 at 24±1°C 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.

Culture extracts of 184 isolates have already been deposited with the specified laboratories for further evaluation of bioactivity. Five culture extracts viz. F HKV-IHB 631 MB, F HKV-IHB 644 MB, F HKV-IHB 645 MB, F HKV-IHB 646 MB and F HKV-IHB 657 MB have been found to possess anti-dementia activity. Culture no. F HKV-IHB 652 MB has been found to be active for the anti-dementia and anti-parkinsonian activity whereas culture no. F HKV-IHB 658 MB has been found to possess activity against dementia, depression and anxiety in *in vitro* screening at ITRC, Lucknow.

Cultivation of new edible mushrooms

Among the wild collections of mushrooms made from various localities of Himachal Pradesh, a wild strain of *Pleurotus eryngii* was cultivated on paddy straw, soybean straw and mash straw following standard technique under mushroom house conditions with temperature ranging 20-25$^0{}_C$. Biological efficiency was maximum on soybean straw (60 %) followed by mash straw (55%).

3. Extension Education

The extension activities of the teachers/scientists and extension specialists of the department at the main campus, research stations and Krishi Vigyan Kendras during 2006-2007 are described under the following heads.

On farm trials: Forty eight 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 related activities were conducted and monitored by the scientists/extension specialists. During 2006-07, about 639 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 217 off-campus, 32 on-campus, 3 in service and 22 vocational trainings in which about 6560 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 trainees by delivering specialized lectures organized by other agencies.

Scientists of the department also imparted 55 trainings on mushroom cultivation and benefited the farmers by demonstrating practical mushroom cultivation. They also conducted 10 demonstrations at different locations of Himachal Pradesh on the mushroom cultivation methodology.

Spawn production: Quality spawns of white button mushroom and dhingri worth Rs. 2, 36, 836/- was produced during the year under report.

Kisan Melas/Kisan Divas/Field Days: The scientists/extension specialists of the discipline participated in the State Level Kisan Divas/ Field Days/ Kisan Melas etc. They organized 23 Field days/Divas in which 3200 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 of the university. 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 of mushroom houses smoothly.

Lectures: The teachers/scientists/extension specialists delivered about 87 lectures to the different beneficiaries in different trainings and workshops etc.

TV Talks

Dr. Amar Singh delivered talk "Integrated Pest & Disease management in Cucurbits" on13.07.06

Dr. A.K. Basandrai delivered talk on "Storage of ginger" on 29-12-06

Dr Suman Kumar delivered following 5 TV talks

1. On 14.08.06 "Diseases and insect pests of Kharif crops"
2. On 3.1.2007 "Cultivation of off- season vegetables under protected environment"
3. On 5.2.2007 "Diseases and Insect pests of Rabi crops"
4. On 8.3.2007 "Diseases and Insect pests of potato"
5. On 9.5.2007 "Diseases and Insect pests of tomato"

Popular articles

Kalia , V. , Basandrai, A K. Jarial , R.S. and Thakur, S K. 2006. Stalk rot of maize: A major constraint in Shivalik Hills of Himachal Pradesh. AGROBIOS February 2006, pp 49-50.

Katoch, S and Sud, D. 2006. New substrate preparation techniques for oyster mushroom cultivation. *Kheti Duniya* 11p.

Katoch, S and Sud, D. 2006. Spent mushroom substrate recycling for beneficial purposes. *Kheti Duniya.3*1p.

Kumar, A., Dev, J., Thakur, K.S., Kumar, A. and Srivastava, A. 2006. Makka aur urad sath sath. Kheti 59: 27-29.

Kumar, Pardeep; Rana, R.K; Sharma, P.K. and Patiyal, A. 2007. Alu ka murjhan rog: karan avam prabandhan. *Kheti Duniya* 3-7p

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Rana, S., Srivastava, A., Sharma, S., Sood, G. K. and Pawan Kumar, 2006. Gehun ke rog va keet tatha unaka niyantran. *Giriraj Saptahik*

Srivastava, A., Rana, S., Bhateria, S., Sood, G.K.and Singh, D. 2006. Alu ke pramukh rog va keet tatha unka uchit niyantran. *Giriraj Saptahik*, 8-14 November, 2006 (5).

Sud, D. 2006. Systems approach for technological empowerment in mountains. *Kheti Duniya* 12p.

Sud , D., Sharma, B.M. and Katoch, S. 2006. Sanitation, hygiene and post harvest handling of mushrooms. *Agribios Newsletter* 6 11-12.

Sud, D. and Sehgal, S. 2006. Role of hill farm women in mushroom cultivation. *Agribios Newsletter* 5: 9-10.

Singh, A. and Singh, Dhanbir.2006. Makki ko Parmukh Rogo se Bachayein. Kisan Bharti . September 2006, Page 15-17.

Singh, Dhanbir. 2006. Makki ke Rog Avum Nidan. Krishi Samridhi. July- August 2006, Page 17-18.

Singh, Dhanbir.2006. Kese Karein Gaehun mein rogo ki roktham. *Giri Raj* 29 (11)5.

Symposium/ Meetings: Scientists attended research workshops /meetings of their respective AICRPs.

Recommendations accepted for package and practices during 2006-07:

A new recommendation for the management of Karnal bunt (two sprays of Tilt @ 0.1%) has been given.

Research Papers

Published

Ahmad , A.U., Pande , S., Basandrai , A. K., Kishore , G.K. and Rao J.N. (2006). Variation in Botrytis cinerea causing grey mould in chickpea. Bangladesh Journal of Agriculture Science. 32: 135-143.

Banyal, D.K. Sugha S. K. and Rana ,S.K. 2006. Management of powdery mildew of bell pepper caused by *Leveillula taurica* with fungicides *Pestology*.30: 17-19

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SUMMARY

The department is actively engaged in teaching, research and extension activities pertaining to plant diseases and mushrooms. The significant findings of the department for the year 2006-07 are summarized below:

Teaching

The department offered 7 undergraduate, 16 postgraduate courses including minor courses. Three students for M.Sc. and one for Ph.D. programmes were admitted during the period. Three M. Sc. and one Ph.D. student successfully completed their theses and degrees, during the year.

Research

Cereals

- Incidence of rice diseases ranged from low to medium except false smut and bacterial leaf blight incidence which were generally found low. However, in Paonta Valley incidence of brown spot was high (80 %) on variety PR116. In maize leaf blights were predominant. Incidence of banded leaf and sheath blight was very high in some areas. However, incidence of Erwinia stalk rot was low (traces – 5%). In wheat yellow and brown rusts were the main diseases. Karnal bunt incidence ranged fro 0.68 to 1.32 percent whereas, Loose smut ranged from 2-5 percent. Incidence of flag smut was also reported from Mandi and Una districts. High incidence of root rot and seedling blight of barley was found in Spiti Valley.
- A large number of germplasm of rice, wheat, and maize were found resistant to their major diseases. Five wheat varieties viz. WL1562, HD 2204, C-306, WH 542 and WH 896 remained free from YR. The pathotypes analysis revealed the presence of races ; 21 R 55 (104-2) of LR and 46 S 119 and 78 S 84 of YR. Five entries namely; HPW 233, DDK 1025, TL 2942, TL 2949 and LOK 54 were found resistant to Karnal bunt
- Entries SKAU-292; UPR-2674-23-1-1; HPR-2001 GHS & VL-306878 were resistant to leaf blast and VL 30278; HPR-2001; GHS; HPR-701; HPR 704; and VL Dhan 61 were resistant to neck blast. Variety RP -2421 a resistant variety against rice blast has become susceptible during 2006-07. Out of 13 improved rice varieties; Himalaya 741, Himalaya 2216, RP 2421, Palam Dhan 957, HPR 1068 and HPR 1156 were found to be resistant to bacterial leaf blight a future threat to rice cultivation in H.P whereas 3 aromatic / basmati lines viz. T 23, Hassan Serai and Kasturi and newly released variety HPR 2143 were susceptible
- Two sprays of biocontrol agent resulted in 88.95 percent disease control. However, one spray of *T. viride* (Ecoderma @ 5g/litre) at flag leaf stage followed by another spray of Tilt at 50% emergence of ear gave complete control of Karnal bunt. Seed treatment with Bavistin/Raxil/ Vitavax alone was not effective in controlling Karnal bunt however; seed treatment and foliar spray of Tilt gave effective control of disease.
- Amongst the five new fungicides evaluated, three sprays of Fillia 52.5 SE (@ 2.5 ml/litre of water, and Gain 75WP@ 0.6g /litre were found equally effective in controlling leaf and neck blast as compared to check. Native 75 WG (Trifloxystrobin 25% + Tebuconazole 50%), a new fungicide at all the concentrations tested (25 + 50, 37.5 + 75 and 50 + 100 g.a.i./l) was found best in controlling both leaf and neck blast, and grain infection and improved the grain yield . 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. Two sprays of Tilt @ 0.1 % after 45 and 60 days of transplanting resulted maximum reduction of brown leaf spot.

Pulses

- In mash incidence of Cercospora leaf spots ranged from medium to high , Web blight and Leaf crinkle virus diseases ranged from low to high whereas in rajmash Anthracnose ranged from medium to high. In chickpea stem rot was the predominant disease followed by collar rot.
- A good number of germplasm of mash, lentil, and chickpea were found resistant to their major diseases. Seed soaking in Panchgavya @ 10% for 1hr + foliar spray of neem seed kernel extract @3% resulted minimum incidence (31.2%) collar/ root rot of cowpea.
- Three foliar sprays of fungicides Tilt 25 EC, Bayleton 25 EC @ 0.1%, Contaf 5 EC and Score 25 EC @ 0.05 and 0.1%, Indofil M 45 (0.25) and Indofil Z -78 (0.25) resulted in significantly lower lentil rust disease severity.

- The least incidence of chickpea wilt/root rot was recorded when seed was treated with Captan (3g/kg) followed by Companion (3g/ha).

Oilseeds

- Alternaria blight, white rust and stem rot were the main diseases of rape seed mustard. In linseed, bud blight (20-30%) and powdery mildew (10-50%) were the predominant diseases. In Sesame Phytopthora blight (10-25%) and Cercospora leaf spot (51-75%) were the main diseases.
- Rape seed mustard entries; SBG-06-2 and SBG-06-11 showed lowest severity of Alternaria blight. The entries SBG-06-34 to 38 and SBG-06-41 remained free from white rust disease. A good number of linseed germplasm were found resistant ot rust and alternaria bud blight. Soybean entries VLS 63 and VLS 47 were found moderately resistant to target leaf spot highly resistant to pod blight.
- Fungicide Score (0.05%) showed lowest severity of Alternaria blight in mustard whereas Ridomil MZ (0.25%) resulted lowest severity of white rust. Leaf extract of *Agave americana* was most effective among the plant extracts in controlling Alternaria blight. Propiconazole (0.1%) was most effective in managing linseed rust and bud blight.
- The yield losses due to rust were highest (73.5%) in case of susceptible variety R-552 and minimum (8.3%) in resistant variety Nagarkot.
- The pod blight incidence was comparatively low on all the three varieties Soybean as compared to other dates.

Vegetables

- Potato late blight incidence ranged from 10-50 percent in some pockets of Kangra district it reached to 100 percent. In peas root rot/ wilt complex disease was the most widely spread disease especially in Zone II and IV of H.P. Ascochyta blight incidence was also found very high in Zone III .In tomato , Capsicum and brinjal , bacterial wilt was the predominant disease. In Chillies Anthracnose and Fusarium rot were the main diseases.
- Forty lines of pea were found resistant to powdery mildew.
- Local isolates of *T. harzianum* and *T. viride* gave maximum reduction of root rot /wilt complex. *T. harzianum* seed treatment followed by one spray of Bavistin gave maximum reduction of white rot, Ascochyta blight and powdery mildew. Seed dip in PG for 1 hr before sowing followed by soil drenching with PG on germination resulted in maximum (68.1%) control of root rot wilt complex disease.
- Integration of chemical and bio-agent i.e. seed treatment with fungicides (Bavistin + Thiram 3g/kg of seed, 1:2) and soil application of bio-agent (2.5 kg/62kg FYM/ha) proved most effective in managing the root rot/wilt complex disease of pea.
- Potato tuber treatment with Ecoderma (*T. viride*) and Kalisena (*Aspergillus* spp.) resulted in maximum reduction of black scurf intensity and significant increased tuber yield. Kavach was found most effective which gave 55.1 % disease control followed by Propineb (50.0%) and Indofil M-45 (48.0%). Spray schedules of Ridomil–Ridomil-Flowin HT, Ridomil + Kavach + Propineb, Ridomil–Kavach –Kavach and Ridomil–Ridomil–Mancozeb WDG were next in order of efficacy providing 87.3, 82.7, 82.7 and 82.1 % disease control, respectively.
- Fungicide; tebuconazole 2 DS and Captan 50 WP @ 0.05 and 0.2% gave more than 95 percent control of collar rot of tomato under protective cultivation. Soil drenching with PG, 24 hr after transplanting gave 61.56 percent collar rot control.
- Vitavax power gave complete control of collar rot of bell pepper followed by tebuconazole 25 EC. Standard Panchgavya was also effective in controlling the disease.

Miscellaneous crops

- Tea cultivars P312, Kangra Asha and Kangra Jawala were found moderately resistant to blister blight. Antracol at 0.5 and 0.63 % significantly controlled blister blight of tea.
- Ginger clone GIET 17 was free from rhizome rot whereas, incidence of rhizome rot in clones GIET 9, 10, 12, 21 and 22 was less than 10%.
- Rhizome treatment for 1 h dip in solution of mancozeb+ carbendazim @ 0.25 + 0.1% resulted the least rhizome rot incidence(18.59%). Three sprays of Score 25EC at the interval of 15 days significantly reduced the Phyllosticta leaf spot of ginger.
- Soaking of seeds in PGPR (*Pseudomonas fluorescens*) suspension followed by three sprays of *P. fluorescens was* found effective for the management of forage maize diseases.

Seed Pathology

- No rice bunt was detected from 33 rice samples collected from farmers and Govt. Seed Multiplication Farms. The incidence of false smut in farmers' fields was found in traces.
- The loose smut incidence (0.88 & 0.19%) was detected from two samples of GSM Farm Pekhubela and Bhangrotoo on variety Raj -3777, whereas, from four wheat samples from farmers' own saved seeds which ranged from 0.20 to 0.65 per cent.
- Out of these 36 lines of common bean collected from different bean growing areas of Himachal Pradesh screened for the seed borne infection of BCMV, 29 showed the seed borne infection ranging from 0.00 to 100 per cent

Molecular plant pathology

- Based on NTSYS pc 2.0, the 37 isolates of *Ascochyta* of pea were categorized into two major clusters accommodating 18 and 19 pathogen isolates.
- Blasted nucleotide sequence revealed the presence of partial NIb (1-610 bp) and cp (611-973bp) of the test BCMV NL-1 strain and partial NIb (1-551 bp) and cp (552-883bp) of the test BCMV NL-1n strain.
- Resistance in Hans and Contender against bean common mosaic virus is found to be controlled by single dominant gene whereas in KRC-22 it is governed by a single recessive gene.

Mushrooms

- Two *Pleurotus* strains preferred all the substrates but strain 3 x 6 showed maximum yield on soybean and paddy. Maximum protein content (39.16 %) was recorded on the fruit bodies grown on soybean and maize cobs followed by those grown on lantana. However, maximum fat (20 %) contents were observed on the fruit bodies grown on maize straw.
- NPK in the spent mushroom compost increased after vermicomposting
- Five culture extracts of mushroom viz. F HKV-IHB 631 MB, F HKV-IHB 644 MB, F HKV-IHB 645 MB, F HKV-IHB 646 MB and F HKV-IHB 657 MB have been found to possess anti-dementia activity. Culture no. F HKV-IHB 652 MB has been found to be active for the anti-dementia and anti-parkinsonian activity whereas culture no. F HKV-IHB 658 MB has been found to possess activity against dementia, depression and anxiety in *in vitro* screening.

Extension

- Forty eight on farm trials on the management of important diseases, pulses and vegetables were conducted during the year.
- During 2006-07, about 639 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
- Scientists also attended numerous training programmes, on-campus and off-campus covering various aspects of plant diseases organized by Directorate of Extension Education, Krishi Vigyan Kendras and Research Stations.
- Scientists/extension specialists organized 217 off- campus, 32 on-campus, 3 in service and 22 vocational trainings in which about 6560 participants received training.
- The teachers/scientists/extension specialists of the discipline participated in the State level Kisan melas, Kisan divas, Field days, *Rabi* and *Kharif* workshops etc.
- A large number of disease samples of various crops received from farmers, extension personnel from Department of agriculture and from the various disciplines of the University were diagnosed and suitable remedial measures were suggested. Mushroom growers were also advised in making there own compost, setting up and running of mushroom houses smoothly.
- In all 7 TV talks on different aspects of plant disease management were delivered, 14 popular articles were published during the period under report.
- Quality spawns of white button mushroom and dhingri worth Rs. 2, 36, 836/- was produced during the year under report

Research Publications

- Teachers/scientists published 29 research publications, besides 11 research papers were accepted for publication and 10 research papers were presented in different workshops/symposia/annual conferences.