ANNUAL PROGRESS REPORT

(2013-2014)

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Department of Plant Pathology
College of Agriculture
CSK, HIMACHAL PRADESH KRISHI VISHVAVIDYALAYA
PALAMPUR-176062 (H. P.)

ACKNOWLEDGEMENT

The 28th Annual Progress Report of the department has been brought out with the co-operation of the scientists of the department as well as from different Research and Extension centers, Research-substations and KVKs of the university located at different regions of the state. To all of them I express my appreciation.

I am thankful to Dr. B. R. Thakur, Dr.Amar Singh and Dr Suman Kumar for compilation and editing of the report.

I express my deep sense of gratitude to the Hon'ble Vice-Chancellor for the motivation and encouragement rendered to scientists of the department. The sincere advice and guidance provided by Director of Research, Dean, Post Graduate Studies, Dean, College of Agriculture, and Director of Extension Education in the spheres of research, teaching and extension education is duly acknowledged.

I am grateful to the faculty members of the department for their necessary help and scientific co-operation whenever required. My thanks are also due for staff of the department for their co-operation for printing and Photostat of the report.

Head of the Department

CONTENTS

INTRODUCTION

The Department of Plant Pathology has the mandate for teaching, research and extension education pertaining to plant diseases and mushrooms. Scientists work in different areas of specialization and 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 Centers (Bajaura, Dhaulakuan and Kukumseri), Mountain Agriculture Research and Extension Centre (Sangla), Shivalik Agriculture Research and Extension Centre (Kangra), Rice Wheat Research Station (Malan) and Research Stations (Berthin and Akhrot). Research on wheat diseases is being carried out at Malan, Dhaulakuan and Bajaura, on rice diseases exclusively at Malan and that on maize diseases at Bajaura and Dhaulakuan, whereas the research on diseases of pulses is being carried out at Palampur, Sangla, Berthin and Dhaulakuan and on oilseed crops at Kangra. Among the diseases of vegetable crops, bacterial wilt and fruit rots of solanaceous crops; powdery mildew, white rot and root rot/wilt complex disease of peas; fungal, bacterial and viral diseases of French bean and Phomopsis leaf blight and fruit rot of brinjal receive special attention.

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

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

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

STAFF POSITION	
TEACHING	-
RESEARCH	
Palampur Campus	
Staff Position	
Professor & Head	Dr. Dr. P. N. Sharma
Professor/Principal Pathologist	Dr. Y. S. Paul
	Dr. S. Dhancholia
	Dr. B. R. Thakur
	Dr. D. K. Banyal
Assistant Scientist	Dr. Amar Singh
	Dr. Suman Kumar
Hill Agricultural Research & Extension Centre, Bajaura	
Sr. Scientist	Vacant
Assistant Scientist	Dr. R .K Devlash
Hill Agricultural Research & Extension Centre, Dhaulakuan	
Principal Pathologist	Dr. Dhanbir Singh, Associate Director, HAREC, **Dhaulakuan**
	Dr. .A. K. Basandrai
Hill and Agricultural Research & Extension Centre, Kukumseri	
Sr. Plant Pathologist	Vacant
Assistant Scientist	Vacant
Shivalik Agricultural Research & Extension Centre, Kangra	
Principal Scientist	Dr. Ashok Kumar
Rice and Wheat Research Station, Malan	
Wheat Pathologist (Principal. Scientist)	Dr. S. K. Rana
Rice Pathologist (Assistant Scientist)	Dr. Sachin Upmanyu
Mountain Agricultural Research & Extension Centre, Sangla (Kinnaur)	
Assistant Scientist	Dr. S. K. Sharma
Research Sub-Station, Berthin	
Principal. Scientist	Dr. Akhilesh Singh
Research Sub-Station, Salooni (Chamba)	
Assistant Scientist	Vacant
Research Sub-Station, Lari (Spiti)	
Assistant Scientist	Vacant
EXTENSION EDUCATION	
Principal. Extension Specialist	Dr. K. S. Rana (DEE)
	Dr. A. Singh (KVK, Bara)
	Dr. B. K. .Sharma (KVK, Una)
	Dr. A. K. Sud (DEE)
Asst Ext. Specialist	Dr. Pardeep Kumar, (SMS-KVK, Kukumseri)
	Dr. Deepika Sood (KVK, Kangra)

FINANCIAL OUTLAY AND STAFF POSITION IN DIFFERENT SCHEMES OF THE DEPARTMENT 01.07.12 TO 30.06.2013

Name of the Scheme	Budget allocation (Lac Rs.)	Expenditure (Lac Rs.)	Staff
APL-001-17 "Creation of facilities for PG studies in the Department of Plant Pathology", CSKHPKV, Palampur	55.20	67.41	Dr.Y.S.Paul Sh. Madan Singh upto Sept. 2013 Sh. Kehar Singh, Clerk Sh. Prem Chand, Sr. Technical Asstt.II Sh. KIshori Lal, Lab Asstt. Sh. Vikram Singh (Horticulture) upto 31.5.2014
APL-010-17 "Facilities for Teaching in the College of Agriculture and creation of facilities for Postgraduate Studies" in the Plant -Pathology, CSK HPKV, Palampur	30.05	35.82	Dr. S. Dhancholia Sh. Vijay Kumar Dixit Sh. Sh. Swami Ram, Tech. Asstt. Gr.II(CPDU) Sh. Vijay Kumar Chowkidar (Security Cell)
APL-21-17 "Strengthening of facilities for research of Plant Pathology" CSKHPKV, Palampur	18.50	22.32	Dr. Suman Kumar, Asstt.Scientist(upto 22.8.2013) Sh. Ramesh Kumar, Beldar Sh. Dalip Kumar, Beldar Sh. Hans Raj, Beldar Sh. Desh Raj, Beldar Sh. Madho Ram, Beldar (upto 28.2.2014) Sh. Rattan Chand, Beldar
APL-59-17 "Facilities for research in the department of Plant Pathology" CSKHPKV, Palampur	17.00	18.69	Sh. Subhash Chand, Beldar
ICAR-017-17 Pt.-II" All India Coordinated Research Project on Seed Technology Research" under NSP	16.05	18.54	Dr.P.N. Sharma, Propf.&Head Sh. Amar Nath Walia, Sr. Tech. Asstt. Gr.I Sh. Himat Ram, Lab. Asstt.
APL-076-17 Department of Plant Pathology	-	2.65	-

FINANCIAL OUTLAY OF AD HOC PROJECTS FOR THE YEAR 2012-2013

Scheme No.	Name of the scheme	Allocation	Expenditure	Staff
CSIR-MISC 700-17	Molecular mapping of BCMV Recessive resistance gene in KRS22 landrace of common bean	386667	350546	Dr. P.N. Sharma, PI, Ms. Ruby Nag, SRF
GOI-478-17	Identification and molecular characterization of Bean Common Mosaic Virus strains prevalent in North Western region of India	1185840	978790	Sh.Kapil Patial SRF Ms.Anuradha RA
State Adhoc 2110-17	Development and refinement of IDM technologies for the management of diseases under protected cultivation	419100	321026	Dr. D.K.Banyal PI Sh. Raj kumar, Sh. Ranjit Singh Project staff FH
Misc.626-17	Fungicide testing	4070313	827228	Dr. P.N. Sharma
Adhoc 2122-17(1)	Technological intervention for Protected cultivation of Vegetable Science in Himachal Pradesh.	612800	516884	Dr. D.K. Banyal, PI, Sh. Parveen Kumar Field Asstt. Ms. Jaya Chaudhary, SRF
Adhoc 2122-17(II)	Technological intervention for Protected cultivation of Vegetable Science in Himachal Pradesh.	612800	-	Dr. P. N. Sharma, PI Ms. Deepika Rana,SRF Anup Kumar Field Asstt.
Adhoc -5002-17	Understanding the complexity of Biocontrol mechanic & metabolic level.	7,00,000	523698	Dr. Vivek Kumar, PI,
Adhoc-5003-17	Diversity, cultivation, Nutritional & Nertraceutical aspect of genus cordyceps fr. From North West India.	7,00,000	506906	Dr. Sapan Kumar, PI,
Adhoc-491-17	FIST Programme	9024461	792274	Dr. P. N. Sharma, PI,

TEACHING

The following courses were taught during the year under report:

Course No.	Course title	Cr Hr	Name of Instructor
FIRST SEMESTER			
Pl. Path. 111	Plant Pathogens & Principles of Plant Pathology	3+1	Dr Amar Singh
Pl. Path. 233	Diseases of field crops & their management	2+1	Dr. B. R. Thakur
Ento. 474	Management of post harvest insect pest and diseases	1+2	Dr. Amar Singh
VSF.. 474	Protected cultivation of horticultural crops and seed production of vegetables and flowers	1+3	Dr. Suman Kumar
Pl. Path. 475	IPM and IDM	2+2	Dr. Suman
Pl. Path. 476	Mushroom cultivation	0+2	Dr. S. Dhancholia
Pl. Path. 477	Biocontrol agents and biopesticides	1+2	Dr. B. R. Thakur/ Dr. Ajay Srivastava
Ento.. 477	Pesticides and Plant Protection Equipment	1+2	Dr. D. K. Banyal
Pl. Path. 501	Mycology	2+1	Dr. S. Dhancholia
Pl. Path. 502	Plant Virology	2+1	Dr. P.N. Sharma
Pl. Path. 503	Plant Bacteriology	2+1	Dr. Suman Kumar
Pl. Path. 504	Principles of Plant Pathology	3+0	Dr. .K. .S, .Rana
Pl. Path. 505	Detection and Diagnosis of Plant Diseases	0+2	Dr. Y. S. Paul / Dr. B. R. Thakur / Dr. Suman Kumar/ Dr. P.N. Sharma
Pl. Path. 518	Epidemiology and Forecasting of Plant Diseases	2+1	Dr. .D. K. .Banyal
Pl. Path. 591	Master`s Seminar	1+0	Dr. P. N. Sharma
Pl. Path. 599	Masters Research	1+0	Major advisor
Pl. Path. 604	Molecular basis of Host-Pathogen Interaction	2+1	Dr. P. N. Sharma
Pl. Path. 605	Principles and Procedures of Certification	1+0	Dr. .D. K. Banyal
Pl. Path. 606	Plant Bio-security and Bio-safety	2+0	Dr. B. R. Thakur
Pl. Path. 691/692	Doctoral Seminar`s I and II	1+0	Dr. P. N. Sharma
Pl. Path. 699	Doctoral Research	1+0	Major advisor
SECOND SEMESTER			
Pl. Path 241	Crop Protection-I	0+1	Dr. D. K. Banyal
Pl.Path. 364	Diseases of Horticulture Crops and their Management	2+1	Dr. Amar Singh
RAWE	RAWE Programme	0+2	Dr. B. R. Thakur /Dr. S. Dhancholia
Pl.Path.506	Principles of Plant Disease Management	2+1	Dr. B. R. Thakur
Pl. Path 510/SST512	Seed health technology	2+1	Dr.P. N. Sharma
Pl. Path.511	Chemicals in plant disease management	2+1	Dr. D. K. Banyal
Pl. Path 513	Disease resistance in Plants	2+0	Dr. B. R. Thakur/ Dr.P. N. Sharma
Pl. Path 591	Master`s Seminar	1+0	Dr.P. N. Sharma
Pl. Path 600/Pl Path 599	Master`s /Doctoral Research	-	Major advisor
Pl. Path 601	Advanced Mycology	2+1	Dr. S. Dhancholia
Pl.Path.602	Advanced Virology	2+1	Dr.P. N. Sharma
Pl. Path. 603	Advanced bacteriology	2+1	Dr. Suman Kumar
Pl. Path.691	Ph.D. Seminar/Doctoral Seminar-I	1+0	Dr.P. N. Sharma
Pl.Path.692	Ph.D. Seminar/Doctoral Seminar-II	1+0	Dr.P. N. Sharma
Pl.Path.700/ Pl.Path.699	Ph.D. Research/Doctoral Research		Major advisor

STUDENTS ADMITTED

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

Name of the Student	Admission No.	Major Advisor
M. Sc.		
Ms. Aditi Kumari Mehra	A-2013-30-50	Dr. D. K. Banyal
Ms. Priyanka Dogra	A-2013-30-51	Dr. Amar singh
Ms. Shabnam	A-2013-30-52	Dr. Suman Kumar
Ms. Shiwali Dhiman	A-2013-30-53	Dr. P. N. Sharma
Ph. D.		
Ms. Naiya	A-2013-40-	Dr. P. N. Sharma

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

Name of the Student	Admission No.	Major Advisor
M. Sc.		
Ms. Dimple Rana	A-2011-30-035	Dr. Y. S. Paul
Ms.Naiya Sharma	A-2011-30-036	Dr. Dhancholia
Ms. Sonam Kumari	A-2011-30-037	Dr. Amar Singh
Ph.D		
Ms. Anuradha	A-2010-40-05	Dr. P. N. Sharma

ABSTRACTS

M. Sc.

Name of student: **Ms Sonam Kumari** (A-2011-30-037) Major Advisor: Dr. Amar Singh,
Title: **Etiology and management of root rot of bell pepper under protected cultivation**.

Present investigations on root rot of bell pepper under protected cultivation were undertaken to ascertain the associated pathogen(s), factors affecting the disease development and management of disease through biological and chemical control. Different polyhouses were visited in 5 districts of Himachal Pradesh, namely Kangra, Mandi, Kullu, Hamirpur and Bilaspur. The disease incidence ranged between 5.0 to 52.0 per cent. Maximum disease incidence was found at Bandla (52.0%) in Kangra district followed by at Rajgarh (50.4%) in Mandi district. The disease was caused mainly by *Phytophthora capsici* where as *Fusarium* and *Rhizoctonia* spp. were found associated as secondary invaders. On the basis of various cultural characteristics *viz.*, growth, shape, colour and colony diameter and morphology of sporangia twelve root rot pathogenic isolates of the *Phytophthora* spp. were identified as *P. capsici* (11 isolates) and *P. nicotianae* var. *nicotianae* (1 isolate). The identity of pathogenic species also confirmed through rDNA analysis by targeting ITS1 and 2 region using primer pair ITS 1 & 4 and these DNA probes were proved quick and very effective in pathogen identification. 25-30°C temperature was found to be optimum temperature for the growth of *P. capsici*. Maximum mycelial growth of *P. capsici* was observed on Corn meal agar. Sporangial formation was observed in Corn meal agar, Oat meal agar and Potato dextrose medium. Sporangial induction takes place best at 6.5 pH in 0.01M KNO_3

solution showing 26.3 sporangia/microscopic field (10X) after 120 hours of incubation. Clay loam soil with an intermediate range of soil moisture and neutral pH were the most conducive conditions for the disease development. Disease occurred at any stage of plant age and it was observed that maximum disease development was found at seedling stage. Out of total 6 bioagent tested under *in vitro* condition, *T. harzianum* (SMA-5) and *Trichoderma* sp. (AF2) were observed as potential bioagents which inhibited the mycelial growth upto 84.7 per cent. Studies on different methods of application of bioagent revealed that drenching was effective in controlling disease (61.1%). *In vitro* evaluation of fungicides revealed that out of 7 fungicides tested, Ridomil MZ and Moximate @ 100 µg/ml were highly fungitoxic as compare to other fungicides. Under pot experiments, Ridomil MZ and Moximate @ 0.25 per cent were found highly effective in managing root rot disease upto 64.7 and 59.0 per cent, respectively. Integrated application of *Trichoderma* sp. (AF2) with Ridomil MZ (1.75g/l) was found most effective in the management of Phytophthora root rot of bell pepper under polyhouse conditions.

Ph. D.

Name of students: 1 Anuradha Sharma (A-2010-40-05) Major Advisor: Dr. P. N. Sharma
Title: Molecular characterization of NL-1n strain of BCMV infecting common bean in Himachal Pradesh and development of diagnostic kits

Abstract: Common bean (*Phaseolus vulgaris* L.), locally known as "Rajmash" one of the most widely grown grain legume crop grown around the world is vulnerable to the attack of wide range of plant pathogens. Among these bean mosaic disease caused by *Bean common mosaic virus* (BCMV), a member of family *Potyviridae* is most important to low yield contributing factor because of its regular occurrence and ubiquitous seed borne nature. In India, five strains of BCMV *viz.*, NL-1, NL-1n, NL-4, NL-7 and NL-7n have been reported from north-western Himalayas, of which NL-1n is widely prevalent in the entire region. The present investigations on BCMV- NL-1n strain were undertaken to obtain complete genome sequence, relationship with different strains and to elucidate the presence of R-genes to find out durable sources of resistance. Typical symptoms produced were mosaic, blistering, downward leaf rolling, green vein banding, thickening of leaves, reduction of leaf lamina and leaf deformation which were more severe on seed borne infected plants as compared to sap inoculated. DAS-ELISA test and coat protein gene amplification confirmed the identity of virus as BCMV and reaction pattern on International differential set of bean varieties established the strain identity. This strain was separated from other BCMV strains on the basis of temperature sensitivity assay as it induced temperature insensitive necrosis on cv. Jubila that contains resistance gene (*I, bc-1*), thus differs from all other strains of BCMV and BCMNV. The genome size was 10.081 kb and contains an open reading frame that encoded a single polyprotein of 3222 amino acids which cleaved into ten proteins typical of *Potyvirus*. Sequence homology, multiple alignment and phylogenetic analysis on nucleotide and amino acid sequences showed that BCMV-NL-1n is more closely related to BCMV-NL-1 though clustered along with other strains and isolates of BCMV. HC-Pro region sequences based comparison among BCMV strains showed its potential for the discrimination of different strains, however, it still needs further validation involving more number of isolates. Under artificial inoculation conditions, 130 common bean accessions were found resistant to strain BCMV-NL-1n in a panel of 304 accessions comprising of diverse germplasm. BCMV resistance gene prediction based on marker assisted selection (MAS) approach, using tightly linked SCAR markers showed the presence of three resistance genes *viz., I, bc-1*^{2} and *bc-3* genes in 105, 53 and 22 common bean accessions found resistant in the present study. Five genotypes *viz.,* IC-43567, EC-109731, EC-116178, EC-120636 and Improved Tender Green possessed all the three genes. The resistant sources identified against the prevalent strains can be exploited in resistance breeding programme.

RESEARCH

A) Survey and Surveillance

Wheat

Yellow rust: Survey and surveillance programme was undertaken to record diseases of field crops at farmers' field in Sirmour district. The disease was less in Sirmour as compared to reports from other districts. However, high incidence/severity of yellow rust was recorded on all the varieties in mid and high hills of the state due to prolonged winter season. All the recommended varieties had minimum incidence of karnal bunt and yellow rust. Wheat varieties viz. HPW 89, HPW 147, HPW 236 and HPW 249 which were earlier resistant - moderately resistant to YR recorded severity up to 60S at HAREC Bajaura, RWRC Malan and KVK Sunder Nagar due to prolonged cool and moist weather conditions.

Karnal bunt: Three hundred eighty one wheat grain samples were collected from farmer`s field, grain market and Govt. seed multiplication farms to record the incidence of karnal bunt in Sirmour district. The karnal bunt incidence was recorded 0.1 to 1.8 per cent. Most of the sample of Wheat variety HPW-236 was found free from karnal bunt.

Brown rust: The disease severity of 20-60S was recorded at Una, Nalagarh, Kunihar, Malan, Kangra, Ner chowk. in low and mid hills towards the end of April and start of May on wheat varieties viz. RAJ 3765, HPW 42, HPW 184, HS 295, VL 804, VL 829, VL 616, PBW 343, PBW 550, Sonalika, Kanaku, WH 711, WH 1080, VL 738, RAJ 3777 and Tarmohri.

Powdery mildew: The disease was recorded with high intensity/ severity level of 7 - 8 (on 0-9 scale) on susceptible varieties HS 507, VL 804, VL 907, VL 892, HPW 42, HS 295, HPW 155, HPW 184, PBW 343, PBW 550 and VL 829 at some locations, otherwise, the overall intensity/ severity remained low to moderate (3-5) during current *rabi* season.

Flag smut: The disease incidence was recorded from 3-11% at some locations in foot and mid hill areas.

Loose smut: The disease was recorded at few locations in interiors of district Mandi i. e. Chail chowk, Shianz, Sandhoa (Katola) and Ghatasani with incidence ranging from 0.5 - 2.0%.

Septoria blotch: The disease was recorded at some locations in districts Kangra and Mandi (Mid hills) especially in Kangra valley on wheat variety Sonalika with incidence as high as 70-90% and its intensity on wheat varieties varied from 35-57.

Barley

Yellow rust: The disease was recorded at few locations in Kangra, Mandi and Kullu districts viz. Nagrota Surian, Chail Chowk, Bajaura, Kandi and severity ranged from 10-80S.

Rice

Survey in major rice growing districts of Himachal Pradesh namely, Kangra, Mandi and Chamba was conducted under Production Oriented Survey programme of AICRIP during *Kharif* 2013 (Table 1).

Kangra: Twenty nine villages from eight blocks of district Kangra were covered under the programme. Diseases such as leaf blast, neck blast, false smut, sheath blight, and sheath rot were observed as low to moderate whereas bacterial leaf blight, brown spot, grain

discolouration, leaf scald and narrow brown leaf spot were recorded in traces. Severity of BLB was low (< 5%) on variety TN1 in Ansui and Rehlu areas of Rait block as compared to the previous *kharif* season.

Mandi: Farmers of sixteen villages from six blocks were contacted under the programme during dough to maturity stage of the rice crop. Diseases such as leaf blast, neck blast, brown spot, sheath blight, sheath rot, leaf scald and narrow brown leaf spot appeared in low to moderate forms; bacterial leaf blight, and grain discolouration as low whereas false smut appeared in moderate to severe forms with incidence ranging between 20-50% on hybrids.

Chamba: Eleven villages from one block of district Chamba were covered under the programme at maturity stage. Intensity of leaf and neck blast, and sheath blight was low while false smut was observed in traces.

Table 1. Prevalence of diseases of rice in Himachal Pradesh during *kharif* 2013

District	Diseases									
	LBL	**NBL**	**BS**	**GD**	**FS**	**LS**	**NBLS**	**SHBL**	**SHR**	**BLB**
Kangra	L-M	L-M	L	L	L-M	L	L	L	L-M	L
Mandi	L	L	L-M	L	M-S	L	L	L	L-M	L
Chamba	L	L	-	-	L	-	-	-	L	-

LBL: Leaf blast, NBL: Neck blast, BS: Brown spot, GD: Grain discolouration, FS: False smut, LS: Leaf scald, NBLS: Narrow Brown leaf spot, SHBL: Sheath blight, SH.R: Sheath rot. BLB: Bacterial leaf blight

Disease Intensity, L = 2-5%; L-M = 6-15%; M = 16-25%; M-S = 26-50%; S = 51-100%.

Maize

Maize crop was also monitored for the occurrence of different diseases in parts of districts Kangra and Mandi during *kharif* 2013. It was infected by Maydis Leaf Blight with incidence of 30-100% and severity of 20-80%, Turcicum leaf blight with incidence 10-60% and severity 20-70%, Brown Spot with incidence of 20-100% and severity of 40-90% and Banded Leaf and Sheath Blight with incidence of 20-90% and severity of 10-60%.

Maize Disease trap nursery

Maize disease trap nursery consisting of 12 lines was planted to determine the prevalence of different diseases of maize. Maximum disease incidence of TLB was recorded on LM 5, whereas MLB was showed maximum incidence in CM 130. Incidence of BLSB was observed in CM 119. Curvularia leaf spot was observed on CM 211 and LM 5.

Soybean

Soybean growing areas were surveyed in mid September to record data on incidence of different diseases occurring in Himachal Pradesh. Mainly four diseases *viz*., frog eye leaf spot (*Cercospora sojina*), pod blight (*Colletotrichum truncatum*), bacterial pustule (*Xanthomonas campestris* pv. g*lycines*) and yellow mosaic virus (YMV) were found to occur in areas surveyed in Kangra and Mandi districts. Diseases were scored on 0-9 scale and area wise per cent disease index (PDI) is presented in table 2. In Himachal Pradesh Hara Soya, Palam Soya and Bragg varieties were mostly grown in majority of soybean growing areas. Frog eye leaf spot (*Cercospora sojina*), pod blight (*Colletotrichum truncatum*) and bacterial pustule (*Xanthomonas campestris* pv. *glycines*) were mainly observed. However, yellow mosaic virus was mainly confined to area fall at altitude below 1000m amsl. Brown spot (*Septoria glycines*) and Powdery mildew (*Microsphaera diffusa*) diseases were observed in moderate intensity only at Palampur, from experimental farm.

Table 2. Occurrence of major soybean diseases in Himachal Pradesh

District/Location	Variety grown	Percent disease index			
		Frogeye leaf spot (*Cercospora sojina*)	Pod blight (*Colletotrichum truncatum*)	YMV	Bacterial pustule (*Xanthomonas campestris* pv. *glycines*)
Kangra district					
Kandbari	Hara soya	33.3	11.1	0.0	11.1
Bhadiyarkhar	Hara soya	33.1	11.1	0.0	33.3
	Palam soya	11.1	33.3	0.0	0.0
Kangra	Shivalik	77.7	33.3	0.0	0.0
	Bragg	33.3	55.5	55.5	0.0
Baijnath	Hara soya	55.5	11.1	0.0	33.3
	Palam soya	0.0	33.3	0.0	0.0
Palampur	Hara soya	33.3	11.1	0.0	00.0
Mandi district					
Chauntra	Hara soya	33.3	11.1	0.0	0.0
	Palam soya	11.1	33.3	0.0	0.0
Bajaura	Hara soya	11.1	0.00	0.0	0.0
Sundernagar	Hara soya	11.1	11.1	11.1	11.1

Incidence of Soybean mosaic virus (SMV), Red crown rot (*Calonectria* sp.) and a leaf spot (*Helminthosporium* sp.) were also noticed at low intensity on few entries of different trials.

Rapeseed-Mustard

Alternaria blight, white rust and *Sclerotinia* rot were observed to affect rapeseed-mustard crops in different areas of Himachal Pradesh during the crop season. Severity of these diseases in different locations surveyed and affected varieties is given in table 3.

Table 3: Occurrence of different diseases in rapeseed-mustard during 2013-14

District/Locations	Crop/Variety	Disease severity (%)		
		***Alternaria* blight**	**White rust**	***Sclerotinia* rot**
Kangra				
Kangra	RCC-4(Mustard)	40	30	2.0
Gummer	Neelam (Gobhi sarson)	30	-	10.0
Rait	Brown sarson local	50	20	5.0
Hamirpur				
Nadoun	Gobhi sarson	40	-	5.0
Galore	Brown sarson	60	10	10.0
Chamba				
Sihunta	Brown sarson	20	10	-
Khargat	Brown sarson	10	5	-
Boh-Darini	Brown sarson	10	10	-
Una				
Amb	Mustard	45	25	5.0

Linseed

Rust, wilt and powdery mildew were observed to affect the linseed crop in major linseed growing areas of district Kangra and Mandi during the crop season. Variety Kangra local was infected by rust and wilt at all the locations. Highest severity of rust (60%) and wilt (10%) was observed at Kangra (Table 4). The severity of powdery mildew was comparatively low during the season and ranged from 10-25%.

Table 4: Occurrence of different diseases in linseed during 2013-14

District/Locations	**Variety**	**Disease severity (%)**		
		Rust	**Wilt**	**Powdery mildew**
Kangra				
Rait	Local	25.0	5.0	10
Kangra	Local	60.0	10.0	-
Malan	Local	60.0	5.0	10
Palampur	Local	25.0	5.0	25
Kandbari	Local	10.0	5.0	25
Mandi				
Hara Bag	Local	50.0	5.0	25

Sesame

In sesame, *Phytophthora* blight, *Cercospora* leaf spot and phyllody remained major disease problem at the farmer's fields in districts Kangra. Severity of these diseases in different locations surveyed during *kharif* 2013 and affected varieties are given in Table 5.

Table 5: Occurrence of different diseases in Sesame during Kharif 2013

District /Locations	**Variety**	**Disease severity (%)**		
		***Cercospora* blight**	***Phytophthora* blight**	**Phyllody**
Kangra				
Kangra	Brajeshwari	60	25	5.0
Gahlian	Local	50	-	5.0
Kuthera	Local	40	-	2.0
Gummer	Local	40	25	10.0
Hamirpur				
Nadoun	Local	50	30	5.0

Pea

Periodic survey was done in the farmer's fields to record the occurrence of pea diseases in Lahaul valley (Zone IV) of Himachal Pradesh (Table 6). Five locations from Patan valley, two from Mayar valley, two from Tinnan and five from Tode valley were selected and observations were made on incidence of pea root rots/ wilt complex, white rot and powdery mildew diseases in Azad P-1 variety of green peas.

Maximum disease incidence of root rot/wilt complex and white rot was observed in Gondhla village whereas; maximum incidence of powdery mildew was recorded in Keylong village. White rot was recorded in Karpat and Jispa . The pea powdery mildew severity was found moderate at Sangla & Chitkul, whereas root rot complex ranged between 20-30 percent at sangla & 30-40 per cent in Pooh & surrounding areas(Nako & Chango). In Hangrang valley (Hango & Chulling) high severity of powdery mildew was observed.

Table 6: Per cent incidence of pea diseases in Lahaul Valley

Location	Root rot/wilt complex	White rot	Powdery mildew
Tindi	18.0	6.0	31.0
Madgran	34.0	15.0	32.0
Udaipur	37.0	5.0	38.0
Shansha	35.0	7.0	31.0
Lote	38.0	11.0	45.0
Gondhla	42.0	18.0	48.0
Sisoo	35.0	6.0	42.0
Keyong	28.0	6.0	49.0
Beeling	35.0	6.0	48.0
Kolong	35.0	8.0	46.0
Tino	25.0	9.0	40.0
Jispa	20.0	4.0	42.0
Tingret	34.0	9.0	28.0
Karpat	38.0	4.0	41.0
Average	**32.43**	**8.14**	**40.0**

Rajmash: In Kinnaur, the incidence of root rot of rajmash was found 50 to 60 percent.

Fodder crops

During *kharif* 2013, wilt/root rot, Anthracnose and blights of cowpea, blight of maize, Helminthosporium blight of bajra and sorghum were the main diseases (Table 7). In the *rabi* 2013-14 season oat crop was affected by powdery mildew, whereas berseem with root rot.

Table 7: Diseases of *Kharif* & *Rabi* fodder crops

Crop	Diseases and insect pest	Disease severity /incidence %)
***Kharif* 2013**		
Cowpea	Wilt/root rot (*Fusarium, Rhizoctonia)*	42
	Leaf spot and blight (Ascochyta/ Phyllosticta)	30
	Anthracnose/stem rot	45
	Phytophthora Blight	20
	CMV	5
Maize	Blight (*Helminthosporium maydis, H. tercicum)*	25
	Banded leaf & sheath blight	6
Sorghum	Leaf blight *(Helminthosporium*)	20
	Zonate leaf spot (*Gloeocercospora sorghi)*	35
Bajra	Leaf blight *(Helminthosporium*)	45
***Rabi* 2013-14**		
Oats	Powdery mildew	80
	Leaf blights	15
	Loose smut	3
Berseem	Root rot	5
	Leaf spot	15
Lucerne	Leaf spot	7

Polyhouse diseases

Surveys were conducted during 2013-14 crop season of different polyhouses in district Kangra, Mandi, Hamirpur, Kullu and Bilaspur of Himachal Pradesh. The disease incidence/severity of important diseases recorded during the survey is given in table 8. During survey disease incidence on different crops in polyhouses was observed and major diseases recorded were Stemphylium leaf spot of tomato (10-75%), Powdery mildew of tomato (5-80%), Cercospora leaf spot of capsicum (15-20%), Powdery mildew of capsicum (25-80%) , Bacterial wilt of capsicum (10-25%) and root rot of capsicum(5-20%). Incidence of a new disease confusing with alternaria leaf spot was also observed on tomato in protected cultivation. It was detected as target leaf spot caused by *Corynespora cassiicola* . Capsicum leaves were noticed heavily infected with a new leaf spot in the polyhouses grown at CSK HPKV, Palampur and the disease was identified as gray leaf spot caused by *Stemphylium* sp. During polyhouse survey, major diseases recorded were Powdery mildew, Downy mildew and Collar rot of cucumber. Powdery mildew, Cercospora blight, Stemphylium blight, gray mould and white rot of capsicum while Alternaria blight, Septoria leaf spot, Phytophthora blight, gray leaf spot and target spot were recorded on tomato under protected cultivation.

Table 8: Severity of different diseases in polyhouses in different districts of Himachal Pradesh

Crop	Disease	Per cent incidence/severity/
Tomato	Gray leaf spot	10-75
	Alternaria leaf spot	5-25
	Powdery mildew	5-80
	Target spot	10-50%
	Late blight	5-25%
	Septoria leaf spot	0-25%
Capsicum	Cercospora leaf spot	10-25
	Powdery mildew	25-80
	Bacterial wilt	10-25
	Root /collar rot	5-25
	Stemphylium blight	0-25%
	White rot	0-25%
	Gray mould	0-50%
Cucumber	Downy mildew	5-75%
	Powdery mildew	5-50%
	Alternaria blight	0-10%
	Collar rot	0-10%

Organic farming

The disease scenario during 2013-14 cropping season in different cropping systems viz., CS – 1 (Tomato (kharif) – Cauliflower (Rabi) – French Bean (Summer)), CS-2 (Tomato (Summer) – Cauliflower (Rabi)), CS-3 (Black Gram (Kharif) – Cauliflower (Rabi) – Summer Squash (summer), CS-4 (Lady's Finger (kharif) – Pea (Rabi) was observed in organic farm and presented in Table 9.

Table 9: Disease scenario in different crops in organic farm

Crops	Disease	Incidence
Tomato	Buck Eye rot and other fruit rot diseases	>40 %
	Alternaria Blight	10-15%
	Septoria Leaf spot	5-10%
	Bacterial spots	< 10%
Peas	Root rot	< 5 %
French Bean	Angular leaf spots	20-25%
Cauliflower	Curd Rot	20%
Black Gram	Cercospora leaf spot	5-10%
	Leaf crinkle	< 2%
Lady's Finger	Powdery Mildew	10%

B) Cereals

Wheat

Evaluation of germplasm
All India Coordinated Wheat and Barley Improvement Project (ICAR-22-77)
Under this project, five disease nurseries viz. Initial Plant Pathological Screening Nursery (IPPSN), Plant Pathological Screening Nursery (PPSN), Powdery Mildew Screening Nursery (PMSN), Hill Bunt Screening Nursery (HBSN) and Trap Plot Nursery (TPN) were conducted by this centre.

i) Initial Plant Pathological Screening Nursery (IPPSN): Comprising of 1534 wheat entries from different centres was screened for resistance to YR under artificial epiphytotic conditions at RWRC, Malan. Of these, 205 entries remained free from YR and 388 recorded severity below 20S. However, out of 30 entries pertaining to RWRC Malan, one entry viz. DW 171 remained free from YR and 18 recorded severity below 20S under artificial epiphytotic conditions at RWRC Malan. At all India level under multi locations testing, 4 entries viz. PW 1036, 1039, 1040 and 1046 of Malan centre, 2 entries viz. DW 170 and 171 of Dhaulakuan centre and one entry viz. BW 222 of Bajaura centre showed high level of resistance (ACI < 15.0) to both YR and LR.

ii) Plant Pathological Screening Nursery (PPSN): A total of 552 entries, comprising of 93 AVT-II, 116 AVT-I and 343 NIVT lines were screened for resistance to YR under artificial epiphytotic conditions. Of these, 11 and 23 entries from AVT-II & I respectively and 59 from NIVT remained free from YR whereas, 16, 31 and 100 entries respectively were resistant to YR (recorded less than 20S severity). Among AVTs entries pertaining to Northern Hill Zone which remained free/ resistant to YR are as given under:

Entries free from YR: HS 542, HPW 401 and HS 590.

Entries resistant to YR (scoring less than 20S): HPW 376, VL 967, HPW 349, HS 490, HS 507, VL 829, VL 892, VL 907, HPW 373, HPW 411, HS 547, 562, 577, 592, 593, 594, VL 976, 977, 1003, 1004, 3002 and 3004.

iii) Powdery Mildew Screening Nursery (PMSN): A total of 217 entries were evaluated for resistance against powdery mildew under artificial epiphytotic conditions in the field at Malan. Of these, 19 entries viz. TL 2934, 2942, 2969, 2995, 2996, 2997, 2998, 2999, 3000, HW 1095, DDK 1029(Dic), NIDW 295(D), MACS 5022, SPL-DIC-02, 03, 06, 07, 08 and 10 were found immune scoring 0 whereas, two entries viz. PBW 661 and HD 3043 were resistant scoring up to 3 on 0-9 scale. Twenty one entries were moderately resistant/ susceptible scoring 5 on 0-9 scale. Rest of the entries, were found susceptible scoring above 5 on 0-9 scale.

iv) Hill Bunt Screening Nursery (HBSN): Forty five wheat entries comprising of AVT I & II (NHZ) and VPKAS Almora material, were screened against *Tilletia caries* and *T. foetida* by inoculating the seed of individual entry with teliospores @ 5.0 % (W/W) before sowing. Of these, 5 entries viz. HS 592, VW 0636, VW 0752, VW 0810 and VW 0855 remained free from the disease and 9 entries viz. HPW 251, HS 277, HS 375, VL 829, HS 558, HS 575, VL 3002, VW 0565 and VW 0912 recorded resistant reaction (below 10 %). Rest of the entries, were susceptible to the disease scoring above 10% incidence.

v) Wheat Disease Monitoring Nursery/ Trap Plot Nursery (TPN): Comprising of 20 wheat lines and one barley line was planted at SAREC Kangra, Thana (Farmer's field) in Dehra block, district Kangra and KVK Sunder Nagar. Yellow rust infection under natural conditions was recorded and rusts samples were sent to DWR Regional Station, Flowerdale for identification of races. Leaf rust was recorded only at one location i.e. SunderNagar on a single entry viz. C 306 with severity 20S. However, yellow rust was recorded with high severity, 40S or more, on all the wheat lines at three locations except C 306 which recorded 10S at Sunder Nagar and Kangra and, WL 1562, HW 2021, HD 2204 and WH 147 recorded 10-20S at Kangra in the third week of March. Barley Local remained free from YR at three locations. The pathotypes identified by DWR Regional Station, Flowerdale on the leaf samples sent by this centre for identification of races of YR were 46 S 119 and 78 S 84. Pathotype 46 S 119 was recorded in about 80% leaf samples and 46 S 119 on 19% samples.

Evaluation/ screening of germplasm against yellow rust and powdery mildew:

i) DWR lines: Out of 267 lines/ varieties received from DWR, Karnal and evaluated during *rabi* 2012-13, 75 lines which were found immune/ resistant to yellow rust and powdery mildew were revaluated for resistance to yellow rust during *rabi* 2013-14 at RWRC, Malan. Of these, 49 entries were found immune/ resistant to yellow rust. Some of the most promising and resistant lines were VG 81, 96, 97, 99, 100, 103, 105, 106, 128, 132, 137, 138, 141, 155, 190, 191, 196, 205, 206, 209, 210, 217, 232, 240, 258, 264 and 265.

ii) PAU lines: Out of 264 lines received from PAU, Ludhiana and screened against yellow rust at Malan in *rabi* 2012-13, 60 lines which were found immune/ resistant to YR were revaluated during *rabi* 2013-14 at RWRC, Malan. Some of the promising and immune/ resistant lines to YR were BWL 0770, 1444, 1499, 1831, 1978, 2062, 2334, 2395, 2486, 2748, 2752, 2754, 2791, 1112, 1781, 1927, 1994, 2061, 2243, 2438, 2553, 2735, 2755, 2756, 2786 and 2793.

iii) HPW lines: Seventy seven wheat stocks developed by CSKHPKV were screened against yellow rust and powdery mildew under artificial/ natural epiphytotic conditions at RWRC, Malan during *rabi* 2013-14. Of these, 22 wheat stocks viz. HPW 191, 265, 271, 281, 292, 293, 297, 306, 307, 308, 309, 310, 312, 314, 317, 318, 319, 327, 330, 332, 351 and 387 were most promising showing resistance to both YR and PM and can be used in the breeding programme.

Evaluation of Wheat Germplasm against Powdery Mildew

During *rabi* 2013-14, Wheat lines/ genotypes received from Directorate of Wheat comprising 217 entries were evaluated against Powdery mildew. Fourteen entries viz. VL 892, NIAW 1885, TL 2934 , TL 2942, K1217, TL2996, TL2997, TL2998, TL2999, TL3000, TL2972, TL2969 were found free from powdery mildew infection. Genotypes VL 804,VL 829, WH 1129, DBW 88, PBW 660, WH 1124, DBW 107, K 0307, DBW 110, HW 2044, HD 2864,HD 2932, UAS 347,MP 4010, GW 322, PBW 689, HW5224,VL977, HS591, VL3006, HS594, HPW412, HS562 and HPW401 were found resistant to powdery mildew.

Evaluation of Wheat Germplasm against Hill Bunt

During *Rabi* 2013-14, Wheat genotypes received from Directorate of Wheat comprising 45 entries were evaluated against Hill bunt under artificially inoculated conditions. Seventeen genotypes viz. HPW 251, HS 375, VL 804, HPW 401, HPW 411, HPW 412, HS 547, HS590, VL 977, VL 1003, VL 1004, VL3006, VW 0636, VW 0752, VW 0810, VW 0855 and VW 0912 were found free from hill bunt infection. Whereas two genotypes HS490 andVW0565 showed less than 5% infection.

Wheat Disease Trap Plot Nursery

Trap nursery was received from Regional Station, Directorate of Wheat Research (ICAR), Flowerdale, Shimla to monitor the appearance and progress of yellow rust. A total of 19 lines of wheat and one line of barley were planted in this nursery and yellow rust appeared in 19 lines of wheat, whereas barley line was free from yellow rust infection. Disease samples were sent to Flowerdale, Shimla as soon as the disease appeared for pathotype analysis. Prominent races were 46S119 and 78S84.

Evaluation of Wheat Germplasm against yellow Rust

During *rabi* 2013-14, Wheat lines/ genotypes received from Directorate of Wheat Research under PPSN AVT II, AVT I and PPSN NIVT/ Special Trials comprising 93, 116 and 343 entries, respectively were evaluated against yellow rust. Twenty seven, 55 and 226 genotypes were found free from yellow rust infection in PPSN AVT I, AVT II and PPSN NIVT/ Special Trials, respectively. The promising genotypes with yellow rust resistance in PPSN AVT II and AVT I are HPW 376,VL 967, HD 3086,HPW 349, HS 490, PBW 660, PDW 233, PDW 291, PDW 314, WH 1142, HS 542, HUW 666, PBW 681, WH 1138, WH 1021,WH 1080, WH 1105,WH 1124, DBW 110, HI 8736 (D), HI 8737 (D), HI 8498 (D), HI 8627 (D), AKDW 2997-16(d), HD 3090, KRL 210, HPW 373, HPW 411, HPW 412, HS 547, HS 558, HS 591, HS 592, HS 594, VL 976, VL 1003, VL 1004, VL 3002, VL 3005, VL 3006, DBW 95, DBW 128, DBW, 129, HD 3128, HD 4730, HUW 675, K 1204, MP 1277, PBW 677.PBW 695, PBW 697, PBW 698, PBW 702, PBW 703, TL 2995, WH 1156, WH 1157, WH 1164, HUW 661, WH 1132, HD 4728 (D), HI 8750 (D), HI 8755 (D), K 1215, MACS 3916 (D), MACS 3927 (D), UAS 451 (D), DDW 27 (D), HI 8751 (D), SPL-DIC-01, SPL-DIC-05, TL2996, TL 2997, TL 2998, TL 2999, TL 3000, PBW 722, PBW 723 and FLW 32-

Twenty four wheat varieties were evaluated under natural infection conditions against rusts, powdery mildew and karnal bunt and data are presented (Table 10) indicated that HPW 236, VL 616, RAJ3765, HPW 155, DBW621-50, HPW 89 and HS 490 showed good degree of resistance against yellow and karnal bunt. HPW236 was completely free from karnal bunt. None of the varieties was free from powdery mildew, however, HPW 236, HPW 211 and HPW 89 had less powdery as compared to other varieties. Brown rust did not appear in none of these test varieties.

Pathogenic forms:

Sixty eight yellow rust samples were collected from Sirmour District and had been sent to ICAR Regional Station, Flowerdale , Shimla for pathotype analysis. Two pathotypes namely; 46S-119 and 78S- 84 were prevalent on wheat in Sirmour. However, pathotype 46S-119 was most prevalent.

Management

Management modules against yellow rust of wheat: The data presented (Table11) indicated that all the test modules resulted in significant control of yellow rust over the check. First spray of propiconazole followed by another of tebuconazole @ 0.1% on susceptible variety HS 240 gave least disease development and resulted in maximum grain yield. Similarly, one spray of Nativo 75 WG followed by another spray of propiconazole @ 0.1% on HS240 also gave excellent control of yellow rust and good grain yield. All the test fungicides were evaluated @ 0.1% of commercial formulations and none of the test fungicides showed phytotoxicity.

Table 10: Disease score of yellow rust, brown rust and powdery on different wheat varieties under natural conditions

S. No.	Variety	Yellow rust score	Brown rust score	Powdery mildew score	Karnal bunt incidence (%)
1	HD2967	40S	Did not appear	2	**0.7**
2	VL829	20S	-	4	0.5
3	HPW236	0	-	2	0.0
4	HPW211	60S	-	2	0.3
5	HPW349	10S	-	4	0.2
6	DBW621-50	10S	-	4	0.3
7	RAJ3765	20S	-	3	0.1
8	HPW42	40S	-	2	0.3
9	WH1080	10S	-	4	0.2
10	PBW550	5S	-	5	0.4
11	DBW-17	20S	-	6	0.2
12	HPW251	10S	-	9	0.5
13	RAJ3777	10S	-	6	0.1
14	HS295	10S	-	4	0.8
15	HPW89	0S	-	2	0.6
16	PBW502	40S	-	3	0.3
17	Sonak	60S	-	4	0.5
18	HS420	20S	-	3	0.4
19	HPW184	40S	-	7	0.3
20	HPW42	10S	-	4	0.5
21	UP2338	40S	-	8	0.5
22	VL616	20S	-	3	0.0
23	HPW155	20S	-	4	0.6
24	HS490	20S	-	3	0.8

Table11: Effect of yellow rust management modules on the development of yellow rust of wheat

Treatment	Grain weight (10spikes)	Grain Wt(1000)	Yellow rust score	Yield (q/ha)
T1: Resistant variety (CHECK HPW 236)	18.1	42.2	5.0S	39.3
T2:Moderately resistant variety+ Single spray of Propiconazole (Tilt/Shine) 25 EC	21.6	43.1	6.6S	38.7
T3: Moderately resistant variety+ 1 spray of Tebuconazole (Folicur) 25 EC	21.2	41.0	5.0S	39.1
T4: Moderately resistant variety+ 1 spray of Opera 18.3 SE	18.2	37.5	8.3S	37.3
T5: Moderately resistant variety+ 1 spray of Nativo 75WG	21.2	39.7	6.6S	41.0
T6: Moderately resistant variety (CHECK HPW 249)	22.4	41.1	16.6S	35.0
T7:Susceptible variety+First spray of Opera 18.3 E+Second spray of Propiconazole 25EC	19.7	33.0	20.0S	40.4
T8:Susceptible variety+First spray of Opera 18.3SE+Second spray of Tebuconazole 25EC	17.9	33.8	23.3S	36.3
T9:Susceptible variety+First spray of Nativo 75WG+Second spray of Propiconazole 25EC	21.1	38.5	5.0S	45.3
T10:Susceptible variety+ 1st spray of Nativo 75WG+ 2nd spray of Tebuconazole 25EC	23.4	33.3	6.6S	44.4
T11:Susceptible variety+1st spray of Propiconazole 25EC+ 2nd spray of Tebuconazole 25EC	19.8	42.2	3.3S	49.7
T12:Susceptible variety (CHECK HPW 240	17.2	31.3	53.3S	31.9

Management modules against yellow rust of wheat: A field experiment was conducted during 2013-14 for development of management module against yellow rust in wheat. Nine different modules were evaluated and data on severity of yellow rust, grain weight of ten spikes, 1000 grain weight and yield were recorded (Table 12).

Yellow rust didn't appear in T1 i.e. resistant variety HPW-236. Disease was also checked completely in T6 (Susceptible variety HS240 + first spray of Nativo75%WG fb 2nd spray of Propiconazole (Tilt) 25EC) and T7 (Susceptible variety HS240 + first spray of Nativo75%WG fb 2nd spray of Tebuconazole (Folicur) 25EC (1ml/liter). Severity of yellow rust remained quite low in the other modules except T9 (susceptible variety HS-240 without spray) where 42.5% severity was observed. Lowest yield, 1000 grain weight and yield of 10 spikes was observed in case of T9 (susceptible variety HS-240 without spray). Highest yield of 48.33 q/ha was recorded in case of T6 remaining statistically at par with other modules except T9.

Table 12: Efficacy of different modules against yellow rust of wheat (2013-14)

Treatments	**Disease severity (%)**	**Grain wt. of 10 spikes (g)**	**1000 grain wt.(g)**	**Grain yield (q/ha)**
T1	0(0)	20.2	50.9	47.33
T2	1.9(8.0)	22.0	50.0	46.00
T3	1.8(7.7)	22.2	50.1	46.17
T4	1.9(8.0)	23.4	52.2	46.33
T5	4.6(12.3)	22.4	49.4	45.67
T6	0(0)	19.5	39.0	48.33
T7	0(0)	19.3	39.7	48.00
T8	0.3(1.7)	19.5	39.1	47.67
T9	42.5(40.6)	16.7	35.8	37.50
CD(P=0.05)	1.9	1.3	3.0	5.34

Details of treatments

T1: Resistant variety (HPW236) + no fungicide spray (Check)
T2: Moderately resistant variety (HPW249) + single spray of Propiconazole (Tilt) 25EC (1ml/liter)
T3: Moderately resistant variety+ single spray of Tebuconazole (Folicur) 25EC (1ml/liter)
T4: Moderately resistant variety+ single spray of Nativo75%WG (300g/ha/500 l water)
T5: Moderately resistant variety (HPW249) + no fungicide spray (Check)
T6: Susceptible variety (HS240) + first spray of Nativo75%WG fb 2nd spray of Propiconazole (Tilt) T7: Susceptible variety (HS240) + first spray of Nativo75%WG fb 2nd spray of Tebuconazole (Folicur) 25EC (1ml/liter)
T8: Susceptible variety (HS240) + Propiconazole (Tilt) fb 2nd spray of Tebuconazole (Folicur) 1ml/liter)
T9: Susceptible variety+ no fungicide spray

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

The results revealed that all the treatments were effective over the check in controlling loose smut and hill bunt except Triticonazole 2.5% FS which was statistically at par with the check and least effective in controlling hill bunt. Seed treatment with Triticonazole 4% + Pyraclostrobin 8%FS (Insure Perform 12%FS) @ 1.00 ml per kg seed was most effective for the combined control of loose smut and hill bunt giving 96.7 and 83.9% control respectively and was statistically at par with Mavistin @ 2.5 g per kg seed which gave cent per cent and 66.9% control of loose smut and hill bunt respectively. For loose smut control Mavistin, Exzole, Raxil and Triticonazole gave cent per cent control followed by Insure Perform and Vitavax giving 96.7 and 96.0% control over the check and all the treatments were statistically at par. For hill bunt control Insure Perform was most effective and statistically at par with Mavistin (Table 13). These were followed by Raxil, Vitavax and Exzole which were statistically at par in controlling hill bunt. The increase in yield with the fungicides treatments over the check was non- significant however, maximum yield was obtained with Insure Perform.

Table13: Efficacy of fungicides against loose smut and hill bunt of wheat

Treatment	Dosage (g/ ml per kg seed)	Loose Smut (%)	Hill Bunt (%)	Grain Yield (q/ ha)
Vitavax 75% WP	2.5	0.07 (1.034)	3.29 (2.07)	26.98
Mavistin 50% WP	2.5	0.00 (1.000)	1.81 (1.67)	31.69
Exzole 2% DS	1.0	0.00 (1.000)	3.74 (2.15)	28.26
Raxil 2% DS	1.0	0.00 (1.000)	3.28 (2.04)	27.64
Insure Perform 12% FS	1.0	0.06 (1.027)	0.88 (1.34)	32.90
Triticonazole 2.5%FS	2.0	0.00 (1.000)	4.98 (2.41)	27.35
Control	-	1.80 (1.658)	5.47 (2.50)	23.66
CD (P=0.05)		0.181	0.36	NS

Figures within brackets are square root transformed values

RKVY funded project on "Management strategies for yellow rust of wheat in Himachal Pradesh" Component-II (*Combined report- all the centres*): A trial on the development of yellow rust management module/ schedule was conducted at 9 centers by planting three different varieties viz. HPW 236 representing resistant one, HPW 249 representing moderately resistant/ susceptible and HS 240 representing a susceptible to highly susceptible variety. In case of resistant variety no spray of fungicide(s) was given. In case of moderately resistant variety single sprays of fungicides viz. propiconazole (Tilt) 25 EC (0.1%), tebuconazole (Folicur) 250 EC (0.1%) and Nativo (trifloxystrobin 25% + tebuconazole 50%) 75 WG (0.06%) were given at the appearance of yellow rust whereas, in case of a susceptible variety, two sprays in three different combinations viz. Nativo (0.06%) + Tilt (0.1%), Nativo

(0.06%) + Folicur (0.1%) and Tilt (0.1%) + Folicur (0.1%) were given at the appearance of the disease and 15 days after first spray. Checks (no spray) of all the three varieties were maintained. So, in this way, there were four treatments under moderately susceptible variety and four treatments under susceptible variety and a single treatment of resistant variety. The trial(s) were conducted in RBD design with three replications at all the centres. The consolidated results are as given under:

A single spray of Propiconazole (Tilt) 25 EC (0.1%) was found most effective (Table 14) giving 65% control of yellow rust in moderately resistant variety HPW 249, on average basis (9 locations) and was followed by Nativo 75 WG (0.06%) and tebuconazole (Folicur) 250 EC (0.1%) which were statistically at par(Table 14). Yellow rust management with single sprays of Tilt, Folicur and Nativo resulted in significant increase in yield in moderately resistant variety HPW 249 however, Tilt 25 EC (0.1%) was most effective enhancing the yield by 18% over the check, on average basis (9 locations). In case of a susceptible variety HS 240, two sprays of fungicides, first of Tilt (0 .1%) and second of Folicur (0.1%), were found highly effective in controlling yellow rust (Table 16) giving over 90% control and followed by Nativo (0.06%, 1st spray) + Tilt (0.1%, 2nd spray) and Nativo (0.06%, 1st spray) + Folicur (0.1%, 2nd spray) which were statistically at par, on average basis (9 locations) (Table 15).

Table 14: Effect of fungicides sprays on severity of yellow rust in HPW 249

Treatment	**Disease Severity (%)**									
	Bara	Akrot	Berthin	Dhaulakuan	Bajaura	Kangra	Sundernagar	Una	Malan	**Pooled data**
Tilt (0.1%)	16.67 (4.19)	0.00 (1.00)	18.40 (4.39)	6.67 (2.74)	13.33 (3.77)	1.93 (1.71)	13.10 (3.74)	0.00 (1.00)	2.13 (1.75)	**8.03S (2.07)**
Folicur (0.1%)	25.00 (5.08)	0.00 (1.00)	27.10 (5.28)	5 .00 (2.45)	16.67 (4.19)	1.93 (1.71)	17.50 (4.29)	0.00 (1.00)	2 .00 (1.72)	**10.56S (2.97)**
Nativo (0.06%)	16.67 (4.19)	0.00 (1.00)	24.73 (5.07)	6.67 (2.74)	13.33 (3.77)	1.93 (1.71)	16.80 (4.22)	0.00 (1.00)	1.73 (1.63)	**9.09 S (2.81)**
Check	41.67 (6.51)	11.67 (3.45)	48.33 (6.98)	16.67 (4.16)	23.33 (4.91)	4.75 (2.36)	40.00 (6.34)	8.33 (3.03)	13.17((3.68)	**23.08S (4.60)**
CD (p=0.05)	**0.73**	**1.07**	**1.26**	**1.11**	**0.52**	**1.72**	**1.31**	**0.50**	**0.79**	**0.25**

Figures within brackets are square root transformed values

Table: 15 Effect of fungicides sprays on severity of yellow rust in HS 240

Treatment	**Disease Severity (%)**									
	Bara	Akrot	Berthin	DHK	Bajaura	Kangra	SNR	Una	Malan	**Pooled data**
Nativo (0.06%) + Tilt (0.1%)	20.00 (4.56)	8.33 (3.03)	20.73 (4.63)	5.00 (2.45)	11.67 (3.54)	0.00 (1.00)	8.20 (3.03)	0.00 (1.00)	3.10 (2.01)	**8.56 R (2.81)**
Nativo (0.06%) + Folicur (0.1%)	20.00 (4.56)	14.00 (3.63)	22.53 (4.75)	6.67 (2.74)	8.33 (3.02)	0.00 (1.00)	13.20 (3.77)	6.67 (2.74)	2.67 (1.91)	**10.41R (3.11)**
Tilt (0.1%) + Folicur (0.1%)	15.00 (3.97)	2.00 (1.73)	12.47 (3.58)	3.33 (1.97)	11.67 (3.54)	0.267 (1.11)	8.09 (3.01)	0.00 (1.00)	5.63 (2.57)	**6.39R (2.46)**
Check	66.67 (8.21)	53.33 (7.34)	82.40 (9.13)	53.33 (7.34)	76.67 (8.81)	42.47 (6.59)	75.30 (8.73)	60.0 (7.81)	65.33 (8.15)	**63.97 S (8.01)**
CD (p=0.05)	**1.31**	**2.02**	**1.15**	**1.31**	**0.94**	**0.22**	**0.58**	**0.5**	**0.35**	**0.31**

Figures within brackets are square root transformed values

Two sprays of fungicides at 15 days interval, in three combinations viz. Tilt + Folicur, Nativo + Tilt and Nativo + Folicur (Table 16) resulted in significant increase in yield over the check in HS 240 and were statistically at par. However, first spray of Tilt (0.1%) at the

appearance of YR followed by second spray of Folicur (0.1%) after 15 days, were most effective, enhancing the yield by 34% over the check, on average basis (9 locations).

Table16: Effect of fungicides sprays on the yield of HS 240

Treatment	Yield (Q/Ha)									
	Bara	Akrot	Berthin	DHK	Bajaura	Kangra	SNR	Una	Malan	**Pooled data**
Nativo (0.06%) + Tilt (0.1%)	29.17	60.33	45.51	45.37	33.83	48.33	48.46	33.64	56.54	**44.58**
Nativo (0.06%) + Folicur (0.1%)	20.27	56.67	42.76	44.17	36.27	48.00	48.30	31.73	56.68	**43.87**
Tilt (0.1%) + Folicur (0.1%)	31.39	58.18	47.69	49.75	36.53	47.67	49.62	32.53	54.03	**45.27**
Check	12.50	42.50	29.27	31.67	17.76	37.5	35.97	28.71	31.85	**29.75**
CD (p=0.05)	**6.97**	**7.15**	**10.31**	**1.61**	**5.51**	**NS**	**2.60**	**2.60**	**5.93**	**1.86**

In case of susceptible varieties like HS 240 two sprays of fungicides first at the appearance of YR and second after 15 days interval , in moderately resistant/ susceptible varieties like HPW 249 single spray at the appearance of the disease and in resistant varieties like HPW 236 no spray is required to manage yellow rust(Table 17).

Instead of an overall high severity (64S) HS 240 recorded a yield of 29.3 q/ha, HPW 249 gave 35.8 q/ ha and HPW 236 yielded 44.4 q/ ha (Table 17 and 18) on average basis of 9 locations without any spray. It indicates that the farmers growing susceptible varieties like HS 240, VL 616, Sonalika, PBW 343 etc. keeping in view their desirable characters like chapatti making, straw yield etc. can take bumper crop of these varieties by giving two sprays of fungicides at appropriate stages and doses. If not interested in giving fungicidal sprays they have to grow resistant varieties.

Table 17: Comparative yields of resistant, moderately resistant and susceptible varieties without any control of disease

Variety	Yield (Q/Ha)									
	Bara	Akrot	Berthin	DHK	Bajaura	Kangra	SNR	Una	Malan	**Pooled data**
HPW 236	33.33	59..50	50.66	39.50	32.13	47.33	39.47	44.58	53.04	**44.39**
HPW 249	15.28	51.17	28.29	35.00	27.20	45.67	37.38	33.16	48.73	**35.76**
HS 240	12.50	42.50	25.94	31.67	17.77	37.50	35.98	28.71	30.66	**29.25**
CD (p=0.05)										**2.2**

Table 18: Comparative disease severity on resistant, moderately resistant and susceptible varieties without any control/ spray

Variety	Disease Severity (%)									
	Bara	Akrot	Berthin	DHK	Bajaura	Kangra	SNR	Una	Malan	**Pooled data**
HPW 236	8.33 (4.30)	0.00 (1.00)	16.93 (4.23)	5.00 (2.45)	26.67 (5.24)	0.00 (1.00)	48.40 (7.03)	0.00 (1.00)	1.35 (1.53)	**12.96 S (3.09)**
HPW 249	41.67 (6.51)	11.67 (3.45)	48.33 (6.99)	16.67 (4.16)	23.33 (4.91)	4.57 (2.36)	60.00 (7.78)	8.33 (3.03)	13.19 (3.68)	**25.31 S (4.76)**
HS 240	66.67 (8.21)	53.33 (7.34)	82.40 (9.13)	53.33 (7.34)	76.67 (8.810	42.47 (6.59)	75.30 (8.73)	60.00 (7.81)	65.53 (8.15)	**63.97 S (8.01)**
CD (p=0.05)										**0.29**

Figures within brackets are square root transformed values

Management of yellow rust of wheat

All the treatments were found superior over the control treatment. Two sprays of Tilt @ 0.1% at 15 days interval was found most effective in controlling yellow rust. Similar trends were also observed in yield and thousand grain weight (Table 19).

Table 19: Management of yellow rust of wheat through fungicides.

Treatments	Rust Severity (%)	Yield (q/ha)	Thousand Grain Weight (gm)
Tilt (0.01%) one spray	11. 7 (19.8)	31.5	38.8
Tilt (0.01%) two sprays	6. 7 (14.7)	41.6	45.0
Mancozeb (0.25%) two sprays	56. 7 (48.8)	19.3	20.8
Mancozeb (0.25%) three sprays	53.3 (46.9)	23.5	32.3
Folicur (0.01%) one spray	16. 7 (24.0)	30.7	38.6
Folicur (0.01%)two sprays	13.3 (21.3)	33.9	44.9
Bayletan (0.01%) one spray	18.3 (25.3)	29.9	32.8
Bayletan (0.01%) two sprays	13.3 (21.3)	34.2	43.9
Untreated	83.3 (66.1)	16.5	17. 2
CD (0.05)	5.3	3.7	1.2

* Transformed (arcsine) values in the parentheses

Yellow rust management modules in wheat

Single spray of Folicur (500ml/ha) was found to be most effective in controlling yellow rust and increasing yield in moderately resistant variety (HPW-249) whereas two sprays of Nativo 75 WG (300g/ha) followed by propiconazole (500ml/ha) after 15 days interval were most effective in susceptible variety HS-240 Table 20.

Table 20: Management of yellow rust of wheat through fungicides

Treatment	Yield (Kg/plot)*	1000 grains (gms)	Yellow rust severity
Resistant Variety (HPW-236) + No fungicide spray **(Check)**	5.95	42.66	-
Moderately Resistant Variety (HPW-249)+Single spray of Propiconazole (500ml/ha)	5.90	42.00	-
Moderately Resistant Variety (HPW-249)+Single spray of Folicur (500ml/ha)	6.1	43.96	-
Moderately Resistant Variety (HPW-249)+Single spray of Nativo 75 WG (300g/ha)	5.83	43.00	-
Moderately Resistant Variety (HPW-249)+ No fungicide spray **(Check)**	5.11	40.66	20MS
Susceptible variety (HS-240) + First spray of Nativo 75 WG(300g/ha) +second spray of Propiconazole (500ml/ha)	6.03	39.20	10MR
Susceptible variety (HS-240) + First spray of Nativo 75 WG (300g/ha) +second spray of Tebuconazole (500ml/ha)	5.67	39.60	20MRMS
Susceptible variety (HS-240) + First spray of Propiconazole (500ml/ha)+second spray of Tebuconazole (500ml/ha)	5.82	39.23	TMR
Susceptible variety (HS-240)+ No fungicide spray **(Check)**	4.25	36.83	60S
CD (P=0.05)	1.24	-	-

Plot size 5.0 X 2.0 M = 10 sq.m

Barley

Evaluation of Germplasm for yellow rust

Out of 635 entries of barley in EBDSN, NBDSN and IBDSN nurseries, 397 entries were found resistant to yellow rust under artificial inoculation conditions (Table 21).

Table 21: Number of Barley stocks resistant to yellow rust

Nursery	Entries	Resistant
Elite Barley Disease Screening Nursery(EBDSN)	91	41
National Barley Disease Screening Nursery (NBDSN)	187	124
Initial Barley Disease Screening Nursery (IBDSN)	357	232
Total	635	397

Barley genotypes received from Directorate of Wheat Research under IBDSN, NBDSN, EBDSN, Released variety and BCU comprising 357, 187, 91, 78 and 383 entries, respectively were evaluated against yellow rust under artificial epiphytotic condition. Fourty five, 117, 60, 28 and 204 genotypes were found free from yellow rust infection in IBDSN, NBDSN, EBDSN, Released variety and BCU nurseries, respectively Table 22.

Table 22: Evaluation of Barley germplasm against yellow rust.

Nurseries	**Entries**	**Free**	**Resistant**	**Susceptible**
IBDSN	357	45	103	209
NBDSN	187	117	47	23
EBDSN	91	60	21	10
Released Variety	78	28	30	20
BCU	383	204	133	46
	1096	454	334	308

Management

Yellow rust of barley

A field trial consisting of ten treatments was conducted for the management of yellow rust of barley (var. Jyoti) with fungicides in RBD with 3 replications during *Rabi*, 2013-14. Two sprays of test fungicides were given at 15 days interval started with the appearance of disease. All the treatments were found superior over the control. Two sprays of Tilt @ 0. 1% at 15 days interval was found most effective in controlling yellow rust. Two sprays of Folicur, Bayletan and Raxil @0.01% were statistically at par in controlling yellow rust (Table 23).

Table 23: Chemical control of yellow rust of barley

Treatment	**Yellow rust severity after spray (%)**	**Grain yield (q/ha)**
Tilt (0.01%)	11.7 (19.8)	38.2
Folicur (0.01%)	13.3 (21.3)	36.0
Bayletan (0.01%)	16. 7 (24.0)	36.1
Raxil (0.01%)	18.3 (25.3)	39.4
Tilt (0.05%)	18.3 (25.3)	33.8
Folicur (0.05%)	20.0 (26.5)	35.4
Bayletan (0.05%)	18.3 (25.3)	35.9
Raxil (0.05%)	18.3 (25.3)	36.3
Dithane M45 (0.2%)	56. 7 (48.8)	32.1
Untreated	73.3 (58.9)	19.6
CD (0.05)	4.4	2.3

Transformed (arcsine) values in the parentheses

Rice

Evaluation of Germplasm

Evaluation of long duration varieties of paddy against major diseases: Eighteen genotypes of paddy were evaluated against major diseases and data are recorded on incidence of important diseases. The data presented (Table24) indicated that genotypes Arize 6129, GI 29 Gold, BS 1008 and Arize Swift showed good degree of resistance against brown spot, leaf scald, false smut and blast.

Table 24: Incidence of diseases on different genotypes of paddy

Genotypes	Brown spot (%)	Leaf scald (%)	False smut (%)	Leaf(Neck) Blast severity(%)
IR 64	5	5	0	20 (10)
HPR 2041	10	5	0	20(5)
HPR 2321	10	10	5	10(0)
HPR2313	0	5	0	10(2)
HPR2344	30	0	0	20(5)
HPR2625	5	0	5	20(5)
HPR2612	20	0	1	30(10)
PAU201	5	0	0	30(5)
HKR126	10	0	1	20(5)
Pusa1121	10	1	5	30(2)
Sharbati	20	0	0	20(0)
Basmati	5	0	1	20(1)
Basmati 370	10	10	0	30(1)
Kasturi	20	0	0	30(0)
NPH 909	10	10	1	20(5)
Arize 6129	5	0	1	5(0)
GI 29 Gold	5	0	0	5 (0)
BS 1008	5	0	0	0(0)
Arize Swift	5	5	1	5(0)

Leaf and neck blast resistance: Rice germplasm consisting of 1599 entries from various screening nurseries viz. National Screening Nursery 1 (205), National Screening Nursery 2 (615), National Screening Nursery-Hills (84), National Hybrid Screening Nursery (125), Donor Screening Nursery (159) and germplasm for multiplication evaluation (422) were screened under natural epiphytotic conditions at RWRC, Malan. Out of these nurseries > 40% entries from NSN-H, 30% from NHSN and DSN each, > 25% from NSN-1, > 15% entries from NSN-2 and around 25% entries from rice germplasm were found promising against leaf blast under uniform blast nursery. However, 19 entries from NSN-H (> 30%) were found highly promising against neck blast.

Two entries developed at RWRC, Malan also showed multiple disease resistance across the locations viz., HPR 2706 (moderately resistant against sheath blight and BLB) and HPR 2691 (moderately resistant against leaf and neck blast).

Pathogenic forms:

Field virulences in *Pyricularia grisea*: Twenty Five differentials comprising of International blast differentials, RILs, donors, NILs and commercial cultivars were screened against leaf blast at two dates of sowing at RWRC, Malan to monitor virulence pattern in the population of *Pyricularia grisea*. Among these, Tadukan, Tetep, Raminad STR-3, IR 64, C105 TTP-4-123 and C101 LAC showed resistant reaction while rest of the differentials were found susceptible to leaf blast. Cluster analysis of *P. grisea* reactions in different test locations revealed that all the locations formed five distinct groups where in Malan was included in group one. However, there was a considerable variation in reaction at locations within each group.

Management

Brown leaf spot and false smut: Two seed dressing fungicides and three fungicides as foliar applications were evaluated in various combination against brown leaf spot and false smut of paddy and data are presented **(**Table 25**)** indicated that Tilt seed treatment + two foliar sprays of same fungicides 45 and 65 days after transplanting resulted in least disease development and gave significant increase in grain yield. This treatment was rated at par with no seed treatment + two foliar sprays of Tilt. Seed treatment of Bavistin + Two foliar sprays of Nativo 75WP (trifloxystrobin 25 + tebuconazole 50) @ 0.8g/l were found highly effective against false smut.

Table 25: Management of brown leaf spot of paddy

Treatment	Dose	Brown leaf spot intensity (%)	False smut incidence (%)	Yield q/ha
Bavistin ST + 2 sprays of Tilt	1g/kg seed + 1ml/l	3.33	1.33	54.2
Bavistin ST + 2 sprays of Indofil M-45	1g/kg seed + 2.5g/l	12.33	16.66	44.0
Bavistin ST + 2 sprays Nativo 75WP	1g/kg seed + 0.8g/l	16.33	0.66	50.0
Bavistin ST only	1g/kg seed	33.66	8.66	32.2
Tilt ST + 2 sprays of Tilt	1ml/kg seed + 1ml/l	0.75	0.98	53.1
Tilt ST + 2 sprays of Indofil M-45	1ml/kg + 2.5g/l	12.66	15.66	43.2
Tilt ST + 2 sprays of Nativo 75WP	1ml/kg + 08g/l	14.66	0.75	49.2
No ST+ 2 spray of Tilt	0+ 1m/l	8.33	1.03	52.8
Tilt ST only	1ml/kg	38.33	19.66	30.5
Check(No treatment)	-	40.00	21.33	28.2
CD(0.05 %)		5.43	1.08	4.01

Integrated disease management:

To test the efficacy of disease management practices and host resistance on the rice blast management a trial was laid out in split plot design with three replications during *kharif* 2013. Spray applications of tricyclazole @ 0.06 % was done on 29th August, 9th and 19th September, 2013 after the first appearance of disease symptoms. In the management level, NDM represented by farmers' practice no fungicide spray was done. The perusal of data (Table 26)

revealed that there was no leaf blast incidence on varieties viz., HPR 2612 (moderately resistant) and Arize 6129 (locally released hybrid) with or without disease management practice whereas in susceptible variety, 'Himalaya 2216' the leaf blast severity was 32.7 percent without application of any fungicide spray while it was 23.1 per cent with three sprays of tricyclazole (Beam). In case of neck blast, disease incidence was very low i.e. 6.0 per cent with application of fungicide and resulted in > 90 per cent disease control over farmers' practice i.e. without application of any fungicide. Neck blast incidence was low on moderate resistant variety, 'HPR 2612' in both the conditions while it was nil on Arize 6129. Grain yield data showed non-significant difference among the treatments but it was higher with the application of fungicide.

Table 26: Integrated management of leaf and neck blast of rice

Main plot	**Leaf blast severity (%)**			**Neck blast incidence (%)**			**Grain yield**		
Variety	**DM**	**NDM**	**Mean**	**DM**	**NDM**	**Mean**	**DM**	**NDM**	**Mean**
Himalaya 2216	23.1 (28.7)	32.7 (34.8)	27.9 (31.7)	6.0 (14.1)	69.7 (56.6)	37.8 (35.4)	53.7	41.1	47.4
HPR 2612	0	0	0	5.4 (13.4)	8.5 (16.9)	6.95 (15.1)	54.1	43.7	48.9
Arize 6129	0	0	0	0	0	0	52.2	38.1	45.2
Mean	7.7 (9.56)	10.9 (11.61)		3.8 (9.2)	26.1 (24.5)		53.3	41.0	
CD (5%)	Management Level = 1.76 Varieties = 1.21 Interaction = 1.72			Management Level = 0.15 Varieties = 1.57 Interaction = 2.22			NS	NS	

Figures in parentheses are arcsine transformed values

DM = Disease management; NDM = No disease management

Maize

Evaluation of Germplasm

Turcicum leaf blight: A total of 290 maize and 31 specialty corn (QPM, Pop Corn, Sweet Corn and Baby Corn) genotypes in 9 different trials comprising of various maturity groups were evaluated against Turcicum leaf blight (TLB) during *kharif*, 2013. The screenings of these genotypes were carried out under artificial epiphytotic conditions.

Resistant maize genotypes in IVT late maturity

A total of 57 genotypes out of 68 tested were resistant/ moderately resistant to turcicum leaf blight. Promising genotypes resistant/ moderately resistant against TLB are ASMH-777, TMMH-807, Janahit, Siri 4527, DAS-MH-104, FCH-11270, PRO-392, JH 31623, CMH 11-660, IM8539, IM8562, IM8556, IM8554, II 8017, RMH-972, Super GA-105, HTMH-5202, HTMH-5404, DMH-696, FCH-11273, VNR-31834, VNR-31355, KMH-2811, JKMH-4029, DAS-MH-105, ASMH-333, PRO-391, B-54, Polo, CP-999, GK-3155, GK-3158, Super-6768, Super-1177, NMH-1603, CMH 10-548, CMH 10-550, CMH 11-583, CMH 11-586, CMH 11-591, BH 41036, BH 41642, BH 41151, GH-0945, GH -1102, GH -1001, GH-1043, DKC9133, X35D612, X35D613, X35D601, BB 032, HTMH-5108, REH-2012-3, JH 31638, JH 12003, HKH 421

Resistant maize genotypes in IVT medium maturity

A total of 68 genotypes showed resistant/ moderately resistant reaction to turcicum leaf blight out of 87 genotypes. Promising genotypes resistant to TLB RMH-932, RMH-3591, EHL-3512, SAFAL X-2, KNMH-4304 , KNMH-4305, MAHABEEJ-1202 (Nirdhar), CMH 11-

582, QMH-29134, QMH-2916, EHL-3412, EHL-1111, S-6750, PHM-34(W), LG-3271, LG-3282, FCH-85, FCH-184, FCH-11231, KMH-6, KMH-84, KMH-6681, JKMH-4545, Kuber Shakthi, DAS-MH-304, DAS-MH-305, KH-517 Gold, KH-2248, TH-38, EH-2205, EH-2208, EH-2240, VaMH-08015, PMH-209, PRMH-2177, NMH-1289, HTMH-5402, CMH 10-488, CMH 10-547.

Resistant maize genotypes in IVT early maturity

A total of 17 genotypes showed resistant/ moderately resistant reaction against Turcicum leaf blight out of 30 genotypes. Promising genotypes showing resistance against TLB LG-3181, DMH-63, EH-2233, NMH-1258, CMH 11-626, CMH 11-629, MEH-1-12-13, HKH 341, FH-3669, EH-2214, CMH 11-579, CMH 11-595, CMH 11-611, Bio 9720, GYH-0653, KNMH-4301.

Resistant maize genotypes in IVT extra early maturity

A total of 2 genotypes showed moderately resistant reaction against turcicum leaf blight out of 13 genotypes. Promising genotypes are DH-271, AH-1212.

Resistant maize genotypes in AET (I & II) late maturity

A total of 32 genotypes out of 37 tested were resistant/moderately resistant to Turcicum leaf blight. Promising genotypes with resistance to TLB are FMH-11195, LTH-20, CP-802, CMH 10-477, Orbit, CMH 08-381, CMH 08-381 (G), CMH 09-464, JH 31601, JH 31555, Ryder-M, P3491(X35B391), P3596(X35B396), Geo Premium Dimond, LTH-22, NMH-1265, A 7503, CMH 10-540, X35B390, P3292(X35B392, P3580(X35A180), Laxmi 333, P 4546, PRO 385, MCH-46, S 6668, PFMH-97 I 57(AMAR), CP 333, HTMH 5402, MCH-45, PRO 384, GK 3103.

Resistant maize genotypes in AET (I & II) medium maturity

A total of 17 genotypes showed resistant/ moderately resistant reaction out of 22 genotypes. Promising genotypes with resistance to TLB are IJ8533, EHL-2211, S-6790, EHL-161708, KMH-25K-45, KMH-7148, NMH-1276, X35B403, Bio 719, S-6850, Proline -777, Rasi 3033, CMH 10-473, X35A189, PRO 383, JH 31470, EH-1974.

Resistant maize genotypes in AET early maturity

A total of 13 genotypes showed resistant/moderately resistant reaction out of 22 genotypes. Promising genotypes with resistance to TLB are CMH 10-484, KMH-7021, DAS-MH-501, FH-3609, FH-3626, EH-2212, Bio 6008, FH-3605, CMH 10-531, K 21, EHL 162508, KNMH-4010141 and FH-3548.

Resistant maize genotypes in AET extra early maturity

A total of 3 genotypes showed resistant reaction out of 12 genotypes. Promising genotypes with resistance to TLB are AH-1202, FH-3556 and FH-3555.

Resistant maize genotypes in Speciality corn

A total of 31 genotypes comprising of 10 QPM, 6 Pop Corn, 11 Sweet Corn and 4 Baby corn genotypes were screened againt turcicum leaf blight (TLB) pathogen. Among QPM genotypes VEHQ 11-1, EHQ-63, EHQ-64, JH (QPM)3 and VEHQ -3020 were found resistant to TLB. Pop corn genotypes VL Popcorn 2, Bajaura Popcorn were found resistant to TLB. Among sweet corn genotypes ADVSW-1, KSCH-333, FSCH-18 and Bajaura Sweet Corn were found moderately resistant to TLB. Genotypes CMH 11-658, CMH 11-659 and Vivek Hybrid-27 of Baby corn was found resistant against TLB.

Elite maize lines for diseases resistance

Maize genotypes comprising 112 entries were screened against turcicum leaf blight (TLB) pathogen under artificial epiphytotic conditions during *kharif* 2013. Twenty five genotypes viz. DMRQPM 03-113,Tempx Trop(H0)QPM-B-B-B-57-B-B, HKI164—4(1-3),BML13,HKI2-6-2-4, CLQ-RCYQ40,HKI-2-6-2-4(1-2)-4, G18seqcef74-2-1,CML161, CUBA 377,CM 132, POBLAC61C4, CML 451(P2), CM123, CML 33, CM149, CM145,

CM128, CM105, BML 6, EW-DMR-G-C7-HS-(SIB)-9-B-1-B-B-B, P72c1Xbrasil1177-2, BML 7, HKI163,CM 501 and EI-670-2 were found resistant to Turcicum leaf Blight (TLB), whereas 48 genotypes DMSC16-2, CM130, S99TLWQ-HG-B-B-B-20, HKI 164-D-3-3-2, V336, HKI1352-5-8-9, Pop.31DMR-88-3#-B*13-B-B-1, HKI191-1-2-5, HKI 164-7-6 x 161, HKI-484-5, La Posta Seq C7-F10-3-1-2-3-B-B-B-B-B-B, Tempx Trop(H0)QPM-B-B-B-57, DMSC1, BML15, HKI 1128, KML 3-3, EC 646012, SC7-2-1-2-6-1, V334, La Posta Seq C7-F10-3-1, CM119, P390AM/CMLC4F230-B-2-1, CML287, WS KHOTHAI-1-WAXY-1-1, V345, HKI C 322, S01sIyq-B-B-B-13-B, 42050-1, HYDE05R/204-1, TS2TR1107 and WINPOP2 etc. were found moderately resistant to Turcicum leaf blight.

Maize QPM lines against Major Diseases

Twenty one Quality protein maize genotypes were screened against turcicum leaf blight (TLB) pathogen under artificial epiphytotic conditions during *kharif* 2013. Four genotypes viz. DQL-2015, DQL-2024, DQL-2025, DQL-2048 were found resistant to Turcicum Leaf blight

Maize hybrids of public and private sector

Twenty maize hybrids of public and private sectors were evaluated against TLB and MLB under artificial inoculated conditions. Hybrids NMH589 (Suvarna), IJ7519 and IM8479 were found resistant (≤ 2 disease score) to turcicum leaf blight. Similarly hybrids IM8479, PG2440, PMZ-4©, II-8017, PG-2488, IJ-8533, NMH007 (Bond), VIVEK-21©, P3377 and PG2493 showed resistant reaction against MLB. Hybrids P3303, KH2136, 115-08-1, IM8478 were found resistant to both the diseases.

Evaluation of maize hybrids against major diseases: Twenty hybrids of maize from private sector were screened against banded leaf and sheath blight disease under artificial inoculation conditions at Kangra. Data of brown spot and maydis leaf blight was also recorded under natural conditions. None of the hybrid showed resistance to banded leaf and sheath blight (Table 27).

Table 27: Disease reaction of different maize hybrids to major diseases

Sr. No.	Code	Entry	Disease rating (1-5 scale)			
			BLSB*	Turcicum blight	Brown spot**	Maydis leaf blight**
1	M-1301	NMH589(Suvarna)(DC)	5	3	2	2
2	M-1302	IJ7519(SC)	5	3	2	2
3	M-1303	P3303(SC)	5	3	2	2
4	M-1304	KH2136 (MSC)	4	3	3	2
5	M-1305	IM8479(TWC)	4	3	4	2
6	M-1306	PG2440(SC)	4	3	3	2
7	M-1307	PMZ-4©(MSC)	4	3	2	2
8	M-1308	II-8017(SC)	4	3	3	2
9	M-1309	PG-2488(SC)	5	4	3	2
10	M-1310	IJ-8533(TWC)	4	3	3	2
11	M-1311	115-08-1(SC)	4	3	3	2
12	M-1312	IM8478(TWC)	4	4	3	2
13	M-1313	LG 31.81(SC)	5	3	4	2
14	M-1314	NMH007(Bond)(MSC)	5	3	3	2
15	M-1315	DKC9125(SC)	4	3	2	2
16	M-1316	VIVEK-21©(SC)	5	4	3	2
17	M-1317	PG2419(SC)	5	4	2	2
18	M-1318	IM7501(SC)	3	2	2	2
19	M-1319	P3377(SC)	4	3	3	2
20	M-1320	PG2493(SC)	4	3	3	2

* Artificial inoculation conditions ** Natural conditions

One single cross hybrid viz. IM-7501 was observed as moderately susceptible to BLSB under artificial conditions and moderately resistant under natural conditions. Rest of the hybrids showed moderately susceptible to highly susceptible disease reaction both under natural and artificial conditions. Out of the 20 hybrids, seven hybrids namely NMH-589, IJ-7519, P-3303, PMZ-4, DKC-9125, PG-2419 and IM-7501 were observed moderately resistant to brown spot under natural conditions, whereas all the tested hybrids showed moderately resistant reaction to maydis leaf blight under natural conditions.

Management

Field experiments consisting of four treatments viz. seed treatment with *PALAM TRICHOFORM* @ 10 gm/kg of seed with respect to Trichoderma viride @10 gm/kg of seed and Bavistin @ 2.5 gm/kg of seed was conducted at four locations i. e. Dhaulakuan, Berthin, Bajaura and Kangra for the management of banded leaf and sheath blight of maize (variety Early composite) in RBD with 3 replications during *Kharif*, 2013. All the treatments were found better over the control. Similar trends were also observed in yield (Table 28).

Table 28: Performance of *PALAM TRICHOFORM* with respect to *Trichoderma viride*

Treatments	Dose	BLSB Score (1-5 Scale)	Yield(q/ha)
PALAM TRICHOFORM	10 gm/kg of seed	2.3	66.69
Trichoderma viride	10 gm/kg of seed	2.7	66.1
Bavistin	2.5 gm/ kg of seed	2.3	66.79
Control		3.3	58.59
	CD (0.05)	0.64	4.79

C) Pulses

Urdbean

Evaluation of germplasm

Cercospora leaf spot: During *Kharif* 2012, 28 lines received from IIPR, Kanpur under MULLaRP were evaluated against cercospora leaf spot and genotypes viz. PU-04, PU-08, PU-13, PU-19, PU-24, PU-23, PU-12, PU-07 and PU-03 were found only moderately resistant.

Management

Foliar Diseases of Urdbean: A field trial was conducted for the management of foliar diseases of urdbean by seed treatment and foliar sprays using variety KU-159. All the treatments (Seed treatment + foliar spray) resulted in significantly less disease incidence (Table 30) of Cercospora leaf spot, *Colletotrichum* leaf spot and web blight as compared to check (untreated seed and no spray). Seed treatment with Raxil @ 1.0g/kg seed and foliar spray of propiconazole (0.1%) and seed treatment with Raxil @ 1.0g/kg seed and foliar spray of hexaconazole (0.1%) were highly effective in reducing disease incidence of foliar diseases and increasing yield in mash crop.

Table 29: Management of Foliar Diseases of Urdbean by seed treatment and foliar spray

Treatment	Disease severity (%)*			Yield (q /ha)
	Cercospora sp	*Colletotrichum* sp	Web Blight	
T 1 – Seed treatment with Raxil 1.0 g/kg	20	2 0	2 5	8.3
T 2 – ST + Foliar spray of Propiconazole (1gm+ 0.1%)	5	3	5	11.2
T 3 – ST + Foliar spray of Tebuconazole (1gm+ 0.1%)	5	5	10	10.8
T 4 – ST + Foliar spray of Difenconazole (1gm+ 0.05%)	5	10	5	10.5
T 5 – ST + Foliar spray of Hexaconazole (1gm+ 0.1%)	10	5	5	11.0
T 6 – ST + Foliar spray of Mancozeb (1gm+ 0.25%)	5	5	10	10.4
T 7 – ST + Foliar spray of Mancozeb +Carbendazim (1gm+ 0.25%+0.1%)	10	10	5	11.0
T 8 – Foliar spray of Mancozeb (0.25%)	5	5	10	10.0
T 9- Foliar spray of Carbendazim (0.1%)	10	5	10	10.6
T 10 – Untreated seed & no spray	40	3 0	30	6.2
CD (0.05)	-	-	-	1.2

Moong bean

Evaluation of germplasm

Cercospora leaf spot: Moong bean genotype received from IIPR under MULLaRP were evaluated against cercospora leaf spot the genotypes viz. P-23, P-12, P-24, P-11, P-20, P-17, P-28, P-34, P-33, P-15A, P-19, P-13 and P-25 were found only moderately resistant.

D) Oilseed

Rapeseed-Mustard

Evaluation of germplasm

Screening of *Brassica* germplasm and breeding material: 27 entries of rapeseed-mustard were screened against *Alternaria* blight and white rust diseases under natural conditions. Data on severity of diseases on leaves was recorded on 100 DAS at the time of maximum disease appearance. Severity of Alternaria blight on leaves ranged from 32.4(PRE-2010-15) to 82.2 % (RTM-1351). The severity of *Alternaria* blight on pods varied from 27.4% (MCP-802 and PHR-2) to 49.1% (PT-2006-4).

Highest severity of white rust on leaves (38.3%) was recorded in PBR-422. Few entries like RTM-1355, TMB-29, RTM-1351, DLSC-1 and EC339000 remained free from white rust disease. Similarly severity of white rust was also low (< 10%) in entries like RAUDT-10-33, PRO-5111 and PT-2006-4. Stagheads were not formed in the entries like

RAUDT-10-33, RTM-1355, PT-2006-4, TMB-29, RTM-1351, DRNMR-150-35, DLSC-1, EC-399299, EC-339000 and EC-399301.

Uniform Disease Nursery Trial: 45 entries of rapeseed-mustard were screened against *Alternaria* blight and white rust diseases in this trial under natural conditions. The severity of *Alternaria* blight on leaves on 100 DAS varied from 46.6% in PRL-2010-10 to 85.5% in PT-2006-4. The severity of *Alternaria* blight on pods ranged from 21.6 (DRMR-312) to 60.6% (PYS-2007-10). Entries coded PR-2009-6, RAURD-09-32 and DLSC-1 showed low (< 25%) infection on pods.

The severity of white rust on leaves remained low to moderate and maximum disease severity of 38.3% was observed in PT-2010-11 on 100 DAS. Entries coded DRMRMJA-35, PTC-2009-3, DRRMR-312, RTM-1351, PYS-2008-5, DRMR-316, DRMR-100, PT-2010-10, DLSC-1 and GSL-1 remained free from white rust infection on leaves. Disease severity was also low (< 10%) in the entries like PYS-2010-3, RMT-10-10, PYS-2007-10, RMT-10-7, PT-2006-4, PRE-2011-15, PTC-2011-3, PYS-2011-1, RTM-314, PT-303 and YSB-9. Stagheads were not formed in most the entries.

National Disease Nursery for white rust resistance: Twenty four entries of rapeseed-mustard were screened against white rust under artificial conditions in this trial. *Alternaria* blight severity on leaves and pods was also recorded under natural conditions. None of the entry remained free from white rust disease at leaf stage. White rust severity on leaves ranged from 5.8% (RMT-10-7) to 50.8 % (NDRE-11-2) on 100 DAS. Apart from RMT-10-7, one more entry namely DRMRWR-13-1 showed less than 10% disease severity of white rust on leaves. Stagheads were formed in all the entries except PT-2006-4, RMT-10-10 and RMT-10-7.

Disease severity of *Alternaria* blight on leaves ranged from 20.0 (NDRE-11-2) to 68.2% in PT-2006-4 on 100 DAS, whereas, *Alternaria* pod blight severity varied 30.0% (NPJ-176) to 48.3% (RMT-10-7)

Management

Alternaria blight and white rust: A field experiment was conducted fungicidal management of Alternaria blight and white rust of mustard (Var. Varuna). Data on severity of diseases, yield and 1000 seed weight were recorded (Table 30). Minimum Alternaria blight severity on leaves as well as pods was developed (26.1%) in case of seed treatment with Apron 35 SD (6g/kg seed) combined with two sprays of Score(0.05%) on 80 and 100 DAS. This treatment was statistically at par with two sprays of Score (0.05%) on 80 and 100 DAS. Lowest severity of white rust on leaves (1.1%) and no stagheads were recorded in case seed treatment with Apron 35 SD (6g/kg seed) combined with two sprays of Ridomil MZ (0.25%) on 80 and 100 DAS which is statistically at par with two sprays of Ridomil MZ (0.25%) on 80 and 100 DAS.

Highest seed yield of 1432 kg/ha was recorded in case of Apron ST(6g/kg seed)+ first spray of Ridomil MZ(0.25%) followed by 2nd spray of Score(0.05%). Highest 1000 seed weight (3.10g) was recorded in case of two sprays of Score (0.05%).

Table 30: Chemical control of *Alternaria* blight and white rust of mustard (2013-14)

Treatments	Disease Severity (%)				Yield (kg/ha)	1000 seed wt.(g)
	Alternaria blight (Leaves)	*Alternaria* blight (Pods)	White rust	Stagheads		
Apron ST(6g/kg seed)	59.2(50.3)	36.0(36.9)	27.1(31.3)	6.6(14.8)	1029	2.76
Apron ST(6g/kg seed)+ 2 sprays of Ridomil MZ (0.25%)	55.9(48.4)	32.6(34.8)	1.1(5.0)	0(0)	1251	2.79
Apron ST(6g/kg seed)+ 2 sprays of Score (0.05%)	26.1(30.7)	26.1(30.7)	32.1(34.5)	5.9(14.0)	1276	3.03
Apron ST(6g/kg seed)+ first spray of Ridomil MZ(0.25%) fb 2nd spray of Score(0.05%)	33.2(35.2)	30.4(33.4)	17.8(24.9)	1.5(7.0)	1432	3.02
Ridomil(0.25%) MZ fb 2nd spray of Score(0.05%)	34.9(36.2)	29.4(32.8)	18.9(25.7)	1.7(7.4)	1295	3.01
Two sprays of Ridomil MZ (0.25%)	56.4(48.7)	33.2(35.2)	3.9(11.3)	0.3(2.9)	1187	2.73
Two sprays of Score(0.05%)	28.2(32.1)	27.1(31.4)	31.1(33.9)	6.6(14.8)	1168	3.10
Two sprays of mancozeb(0.25%)	37.2(37.5)	31.1(33.9)	25.5(30.3)	4.1(11.7)	1117	2.96
Unsprayed	60.3(50.9)	38.8(38.5)	35.4(36.5)	9.1(17.5)	921	2.81
CD(P=0.05)	2.2	1.6	3.8	1.3	196	0.20

Figs in parenthesis are arc sine transformed values

Oil Seed

Linseed

Evaluation of germplasm

Screening of linseed germplasm: 200 entries of linseed were screened against rust under natural conditions at Kangra. The disease appeared late in the season and overall disease pressure remained moderate. Following entries scored 0 and 1 on 0-5 scale.

Disease score 0-Jabalpur local, Kangra local, KL-176, KP-1313, Mayurbanj local, LCK-88311, MS-3, NP-115, Polf-5, OP-2-2, Polf-2, Polf-16, Polf-11, KL-1, LC-2014, LC-2021, LC-2127, LCK-9303, LCK-9320, S-91-11, KL-168, LCK-9119, LCK-9312, LCK-9324, LCK-9436, EC-1497, SJKO-10, Nagarkot, EC-384154, H-8, H-43, JRF-1, H-5, H-11, H-12, H-25, Polf-23, KP-8, LCK-87312, LCK-8722, ES-44, LCK-152, LMH-21, No. 41-561, NP-40, NP-71, Rashmi, RLC-45, LC-2002, LC-2023, LC-2057, S-91-26, KL-178, RL-56-6-2, RL-903, KL-217, KL-220 and Kl-221.

Disease score 1: LCK-11, UP-6, LC-2023, LC-2045, KL-134, LC-2057, ES-1476, GS-51, H-15, H-17, JRF-3, KL-168, LCK-87312, LCK-8520, NP-RR-93, LCK-9414, KL-223, KL-227 and KL-229.

Out of the above mentioned entries following entries also showed less than 10 % incidence of wilt. Jabalpur local, NP-115, Polf-5, OP-2-2, Polf-2, Polf-16, Polf-11, KL-1, LC-2014, LC-2021, LC-2127, LCK-9303, LCK-9320, S-91-11, LCK-9119, LCK-9312, LCK-9324, LCK-9436, EC-1497, SJKO-10, Nagarkot, EC-384154, H-5, Polf-23, LCK-8722, LMH-21, No. 41-561, NP-40, NP-71, LC-2002, LC-2023, LC-2057, SJKO-17. KL-178, RL-56-6-2, KL-217, KL-220 and KL-221, LCK-11, LC-2023, LC-2045, KL-134, LC-2057, ES-1476, H-17, KL-168, LCK-8520, NP-RR-93 and LCK-9414,

Uniform Disease Nursery Trial (Natural conditions): 55 entries were screened against prevailing diseases like rust and wilt under natural field conditions at Kangra. The disease appeared late in the season and overall disease pressure was moderate. The entries which showed score of 0 and 0 on 0-5 rating scale are given below.

Disease score 0: UDN 1 to 5, UDN-10, UDN-12, UDN-13, UDN-15, UDN-17, UDN-19, UDN-22-24, UDN-26, UDN-27, UDN-29, UDN-30, UDN-31, UDN-33, UDN-34, UDN-36, UDN-37, UDN-39, UDN-42, UDN-43 and UDN-47 to 53

Disease score 1: UDN-16, UDN-38, UDN-41 and UDN-46.

The entries coded as UDN-1 to 5, UDN-8, UDN-9, UDN-12, UDN-15, UDN-16, UDN-22, UDN-23, UDN-31, UDN-33, UDN-34, UDN-37, UDN-39, UDN-41, UDN-42, UDN-46 and UDN-48 to 53 were found resistant to rust as well as wilt under natural conditions.

Uniform Disease Nursery under Artificial conditions (UDNA): 14 entries of linseed were screened against rust under artificial field conditions at Kangra. Six entries coded UDNA-1, UDNA-4, UDNA-5, UDNA-7, UDNA-12 and UDNA-13 remained free from rust, whereas three entries coded as UDNA-2, UDNA-3 and UDNA-10 scored 1 against rust. Rest of the entries showed moderately resistant to susceptible disease reaction to rust.

Evaluation of promising entries/elite materials: 40 promising entries/elite materials of linseed were screened against rust at Kangra. Disease pressure was low and all the entries showed moderately resistant to highly resistant disease reaction.

Soybean

Evaluation of germplasm

IVT: Forty entries of IVT from DSR Indore were evaluation for disease resistance under natural hot spot conditions. The data were recorded based on 0-9 scale and percent infection index was calculated as per the standard method (Table 31).

The lines were categorized into different resistance categories. The lines KDS 726, PS 1539, RKS 109, DS 3047, MACS 1419, BAUS 27, BAUS 96, NRC 96, NRC 97, NRC 98, NRC 107, JS 20-89, KBS 100-2012, and RSC 10-04 were found highly resistant and KDS 722, PS 1543, Himso 1685, RSC 10-17 and RVS 2002-19 were free from frogeye leaf spot (FLS). The lines, DS 3050, SL 983, Himso 1685, RKS 111, KBS 100-2012, VLS 86 and RSC 10-04 were found highly resistant against anthracnose i.e. Pod blight (Ct) phase.

AVT-I: Twenty entries of AVT-I were sown in four replications along with checks in RBD. Two replications were kept disease protected and two unprotected. Data were recorded on 0-9 scale and infection index (I.I.) was calculated (Table 32). Reaction to disease consortium was calculated on the basis of Maximin-Minimax approach (Odulaja and Nokoe, 1993). Line KDS 708, MACS 1407, MAUS 612, NRC 92, NRC 93, PS 1518 and SL 979 were highly resistant to frog eye leaf spot while KDS 693, MAUS 614 and RKD 113 were free from the disease. Lines Ds 2705, JS 20-69, MACS 1394, MAUS 614 and NRC 93 were highly resistant to pod blight (Ct.) while line MAUS 612, MACS 1416 and NRC 94 were free from pod blight (Table 40). MACS 1407 were found to be resistant high yielding (R-HY). DS 2705, JS 20-71, KDS 693, KDS 705, MACS 1394, MACS 1416, MAUS 614, NRC 93 and RKS 113 were found susceptible high yielding (S-HY) entries.

Table 31: Infection Index of various diseases in IVT

S. No.	Entry	Infection Index (%)					
		FLS	PB(Ct)	BS	PM	BP	SMV
1	KDS 726	11.1	33.3	33.33	0.0	0.0	11.1
2	PS 1539	11.1	44.4	11.11	0.0	0.0	0.0
3	DS 3050	44.4	11.1	33.33	0.0	11.1	33.3
4	SL 983	44.4	11.1	33.33	0.0	11.1	0.0
5	DS 2961	40.8	33.3	33.33	0.0	33.3	0.0
6	RKS 109	11.1	33.3	33.33	33.3	0.0	11.1
7	SL 955	55.6	11.1	33.33	0.0	33.3	0.0
8	DS 3047	11.1	33.3	33.33	33.3	33.3	11.1
9	AMS 1001	25.9	55.6	33.33	0.0	33.3	0.0
10	JS 20-79	62.8	33.3	11.33	0.0	0.0	0.0
11	MACS 1419	5.6	33.3	11.11	33.3	0.0	0.0
12	NRC 98	5.6	33.3	55.55	3.3	33.3	11.1
13	RVS 2002-4	22.2	55.5	55.55	0.0	55.6	0.0
14	KDS 722	0.0	33.3	33.33	0.0	33.3	0.0
15	MAUS 609	40.7	33.3	11.11	0.0	11.1	0.0
16	NRC 107	5.8	88.9	33.33	77.8	33.3	0.0
17	MACS 1410	48.3	66.7	11.11	0.0	33.3	0.0
18	JS 20-53	22.2	55.5	55.55	0.0	33.3	0.0
19	PS 1543	0.0	33.3	33.33	0.0	11.1	0.0
20	Himso 1685	0.0	5.6	11.11	0.0	0.0	0.0
21	RVS 2002-22	33.3	33.3	55.55	33.3	33.3	0.0
22	RKS 111	7.3	11.1	55.55	0.0	11.1	0.0
23	BAUS 27	11.1	70.3	55.55	0.0	33.3	0.0
24	DSb 25	75.1	22.2	33.33	33.3	11.1	33.33
25	RSC 10-17	0.0	33.3	33.33	0.0	0.0	11.1
26	NRC 96	11.1	44.4	33.33	55.6	33.3	0.0
27	RVS 2002-19	0.0	37.8	88.88	0.0	11.1	11.1
28	MAUS 613	22.2	77.8	33.33	0.0	0.0	0.0
29	NRC 97	11.1	55.5	55.55	77.8	11.1	0.0
30	DSb 23-2	5.6	44.4	55.55	0.0	11.1	0.0
31	JS 20-89	11.1	33.3	11.11	11.1	33.3	0.0
32	KBS 100-2012	11.1	11.1	11.11	22.2	11.1	0.0
33	VLS 87	44.4	55.5	33.33	55.5	11.1	0.0
34	KDS 743	40.7	44.4	33.33	33.3	11.1	0.0
35	BAUS 96	11.1	44.4	33.33	33.3	55.5	0.0
36	NRC 95	33.3	33.3	33.33	0.0	11.1	0.0
37	MACS 1370	40.7	70.3	33.33	88.9	11.1	0.0
38	VLS 86	55.5	11.1	11.11	0.0	11.1	0.0
39	PS 1540	50.0	22.2	11.11	0.0	0.0	0.0
40	RSC 10-04	11.1	5.6	33.33	55.6	11.1	0.0
41	JS 335 (Check)	11.1	77.8	33.33	0.0	33.3	0.0
42	Shivalik (Check)	73.3	25.9	33.33	0.0	55.6	0.0
43	VLS 59 Check	11.1	18.9	55.55	0.0	33.3	0.0
44	VLS 63 Check	33.3	33.3	33.33	0.0	0.0	0.0

FLS= Frogeye leaf spot (*Cercospora sojina*), PB= Pod blight (*Colletotrichum truncatum*), BS= Brown spot (*Septoria glycines*), PM= Powdery mildew (*Microsphaera diffusa*)

AVT-II: Four replications of 10 entries of AVT-II 2013 were sown in RBD as in case of AVT I. The line DSb 19 was free from frog eye leaf spot while DSb 21, JS 20-41, KDS 378 and KDS 699 were highly resistant. DS 2708, JS 20-41, KDS 378 and SL 958 were found highly resistant to pod blight (Ct.). Only line DS 2706 was found resistant high yielding (R-HY) (Table 33).

Table 32: Infection Index of various diseases in AVT-I

S. No.	Entry	Yield (kg/ha)		Infection Index (%)		Reaction to disease consortium
		Unprotected	Protected	FLS	PB(Ct)	
1	CSB 904	1648.9	1808.5	33.33	22.22	RLY
2	DS 2705	2393.7	2925.55	86.66	5.55	SHY
3	JS 20-69	1595.8	1808.5	55.55	11.11	RLY
4	JS 20-71	2127.7	2659.55	55.55	22.22	SHY
5	KBS 22-2009	1489.4	1702.1	33.33	33.33	RLY
6	KDS 693	1808.6	2446.8	0.0	66.66	SHY
7	KDS 705	1436.2	1702.1	0.0	70.33	SHY
8	KDS 708	1383.0	1808.1	11.11	55.55	SLY
9	MACS 1394	1861.7	2340.4	55.55	5.55	SHY
10	MACS 1407	2340.5	2712.8	11.11	22.22	RHY
11	MACS 1416	1914.9	2446.8	33.33	0.0	SHY
12	MAUS 612	1595.8	2127.7	11.11	0.0	SLY
13	MAUS 614	1648.9	3085.1	0.0	11.11	SHY
14	NRC 92	1383.0	1383.0	11.11	55.55	RLY
15	NRC 93	1063.8	2393.7	11.11	11.11	SHY
16	NRC 94	1320.3	1648.9	77.77	0.0	SLY
17	PS 1518	1648.9	2127.7	11.11	29.55	SLY
18	RKS 113	2127.7	2978.7	0.0	24.66	SHY
19	SL 979	1276.6	1489.4	11.11	33.33	SLY
20	SL 982	1383.0	1489.4	77.77	22.22	RLY
21	Bragg	1170.2	1542.7	33.33	33.33	SLY
22	JS 335	1383.0	1914.5	22.22	88.88	SLY
23	Shivalik	1648.9	2659.6	77.77	44.44	SHY
24	VLS 59	2127.7	2340.5	11.11	11.11	RHY
25	VLS 63	3031.9	3404.3	11.11	22.22	RHY
	CD (5%)	434.26	370.877	-	-	-
	CV	12.29	8.18	-	-	-

Table 33: Infection Index of various diseases in AVT-II

S. No.	Entry	Average yield (Kg/ha)		Infection Index (%)		Reaction to disease consortium
		Unprotected	Protected	FLS	PB (Ct)	
1	DS 2706	3191.5	3510.7	77.77	29.88	RHY
2	DS 2708	2978.7	3510.7	77.77	11.11	SHY
3	DSb 19	2021.3	2127.6	0.0	33.33	RLY
4	DSb 21	1382.9	1648.9	11.11	22.22	SLY
5	JS 20-41	1914.9	1914.9	11.11	11.11	RLY
6	KDS 378	1702.1	1808.5	11.11	11.11	RLY
7	KDS 699	1755.3	1755.3	11.11	33.33	RLY
8	MACS 1340	1542.6	1808.6	33.33	33.33	SLY
9	RVS 2001-18	1170.2	1542.6	33.33	55.55	SLY
10	SL 958	2127.7	2340.5	33.33	11.11	RLY
11	Bragg	1170.2	1542.6	33.33	33.33	SLY
12	JS 335	1383.0	1914.5	22.22	88.88	SLY
13	Shivalik	1648.9	2659.6	77.77	44.44	SHY
14	VLS 59	2127.7	2340.5	11.11	11.11	RLY
15	VLS 63	3031.9	3404.3	11.11	22.22	SHY
	CD (5%)	612.24	497.87	-	-	

Multiple disease resistant sources: Fifty soybean germplasm lines were screened under field conditions. Data on disease severity was recorded on 0-9 scale for Frogeye leaf spot (FLS), anthracnose (pod blight) and brown spot (BS). The lines Bhatt, CAT 147, CAT 7, CAT, 76, CAT 81, JS 20-36, MAUS 113, MAUS 26-1, MAUS 453, MAUS 470, MAUS 704,

and PK 1042 and were found free from FLS and PB. Only one line JS 20-87 was highly resistant to Brown spot (BS) and none of the line was found free. The lines JS 20-65, JS 20-87 and MAUS 26-1 were found having multiple disease resistance against three diseases.

Management (IDM strategies)

An experiment comprising four modules *viz*. bio-intensive (I), chemical (II), adaptive (III) and control (IV) was conducted with five replications in RBD. Experiment was planted on 19.06.2013. Data was recorded on plant growth parameters, disease incidence and yield and presented in table 34.

Table 34: Evaluation of different pest management modules

Module	Parameters				Infection Index		Bean bug incidence #	Yield (q/ha)
	Plant height (cm)*	No. of branches/plant	No. of pods/plant *	100 grains weight (g)*	FLS	PB		
Module I:	73.2	5.0	69.3	16.8	28.88	27.64	42.6	15.08
Module II	69.3	4.7	74.1	16.8	9.55	12.67	11.0	19.01
Module III	73.8	5.0	71.7	17.1	12.18	14.84	39.8	18.25
Module IV	66.3	4.2	56.8	16.1	32.66	13.55	57.4	14.24
CD(5%)	NS	NS	6.72	NS	5.60	3.96	5.627	3.686
CV	-	-	7.17	-	19.53	12.67	10.83	16.06

*Average value; #No. of bugs per meter row length, FLS =Frogeye leaf spot, PB =Pod blight

Module I: ST with *Trichoderma harzanium* @ 6g/kg + Spray cow urine (@ 10%) + neem oil (0.5%), *Nomuraea rileyi* (5g/L) at 45 DAS followed by Cow urine (10%) + neem oil (0.5%) spray at 55 DAS and spray with Cow urine (10%) +neem oil(0.5%) at 65 DAS

Module II: ST with Thiram + carboxin @ 2g/kg + Spray with Lamda-cyhalothrin (@ 0.05%) + spray hexaconazole (0.1%) at 45 DAS followed by second spray at 60 DAS with hexaconazole (0.1%) & Spinosad (0.05%) followed by spray with Carbendazim (0.1%) at 70 DAS and 85 DAS

Module III : ST with *Trichoderma harzianum* @ 6g/kg + *Rhizobium* @ 500g/ha of seeds + Spray neem oil @ 0.1% and *Nomuraea rileyi* @ 5g/L followed by second spray at 60 DAS with hexaconazole @ 0.1% and *Pseudomonas fluorescens* @ 0.5% at 75 DAS

Module IV: ST with *Rhizobium* @ 500g/ha

E) Vegetables

Tomato: Evaluation of germplasm

Twelve varieties/ hybrids of tomato were evaluated during kharif, 2013-14. Field trial was conducted in RBD with 3 replications. Data on fruit rot diseases, foliar blight diseases and fruit borer were taken using standard procedures. Tomato hybrids Best of All, Palam Pink and Manish were found superior with respect to foliar blight incidence. Hybrids Best of All and Marglobe also showed comparatively less incidence of fruit borer (Table 35).

Table 35: Evaluation of tomato varieties suitable for organic farming

Varieties	Fruit Rot Incidence* (%)	Foliar Blight Severity* (%)	Borer Incidence* (%)
Yash	22.5 (27.6)	38.1 (38.0)	3.6 (10.5)
Him Sona	24.4 (28.1)	37.2 (37.5)	8.1 (16.2)
Naveen2000	35.7 (35.6)	44.4 (41.7)	3.5 (10.7)
RK123	32.3 (34.6)	40.6 (39.5)	2.4 (8.7)
Manish	28.5 (32.2)	26.8 (31.1)	2.7 (9.4)
Red Gold	33.5 (35.1)	37.7 (37.6)	3.5 (10.6)
7730	27.2 (31.1)	34.1 (35.7)	3.2 (10.2)
Palam Pink	22.7 (27.8)	20.4 (26.4)	2.4 (8.7)
Sioux	33 (33.8)	47.0 (43.3)	3.3 (10.3)
Best of all	25.3 (29.9)	23.9 (29.2)	0.4 (2.1)
Mar Globe	20.4 (25.3)	36.6 (37.10	1.6 (5.5)
Roma	22.3 (27.4)	30.4 (33.3)	3.9 (11.2)
CD (0.05)	NS	7.7	3.3

*Transformed (arcsine) values in the parentheses.

IDM technologies for protected cultivation

Stemphylium leaf spot of Tomato: Seven fungicides *viz* Tilt (propiconazole), Score (defenoconazole), Contaf (hexaconazole), Folicur (tebuconazole), Cabrio (pyraclostrobin 5% + metiram 55%), Nativo and Meloduo (iprovalicarb 5.5% + propineb 61.25%) were tested for the management of disease(Table 36).

Table 36: Effect of fungicides on Stemphylium leaf spot of tomato under polyhouse

Treatment	Dose	Stemphylium leaf spot of tomato		Yield	
		Disease severity (%)	% Control	g/plant	% increase
Tilt	0.5ml/l	12.7	61.0	320	62
Score	0.4ml/l	11.3	65.0	350	77
Contaf	0.5ml/l	12.3	62.0	305	54
Folicur	0.5ml/l	10.7	66.8	383	93
Cabrio*	2g/l	14.0	56.6	282	42
Nativo	0.4g/l	13.7	57.5	220	11
Meloduo	2g/l	15.0	53.5	245	24
Control	-	32.3	-	198	-
CD @5%	-	2.96	-	36.0	-

*Fungicides registered with CIB

Among these fungicides Folicur, Score and Tilt were found to be most effective against the pathogen giving 66.8%, 65.0% & 61.0% control, respectively with 93, 77 and 62 per cent increase in the yield as compare to control. While Meloduo was found to be least effective giving only 53.5% control.

Capsicum

Management of Phytophthora root rot of capsicum: Six fungicides *viz;* Blitox 50 WP (copper oxychloride), Indofil M-45 (mancozeb 75 WP), Cabrio Top (pyraclostrobin 5% + metiram 55%), Melody Duo (iprovalicarb 5.5% + propineb 61.25%) Moximate (cymoxanil 8% + mancozeb 64% WP) andRidomil-MZ 72WP (metalaxyl 8% + mancozeb 64% WP) were tested against the pathogen *Phytophthora capsici* among which the significant maximum disease control of 64.7 per cent was obtained with Ridomil MZ followed by 59.0 per cent in case of Moximate (59%). Blitox, Melody duo and Indofil M-45 resulted in 31.0, 21.8 and 5.8 per cent disease control. Least disease control was found in Cabrio Top (3.7%). The effect of all the fungicide treatment was found significant in comparison to the control (Table 37).

Table 37: Fungicidal management of root rot of bell pepper caused by *Phytophthora capsici* under protected conditions

Treatment	Dose (g/l)	Disease severity (%)	% Control
Blitox*	2.5	53.1 (46.7)	31.0
Indofil M 45*	2.5	72.4 (58.3)	5.8
Cabrio Top	2.5	74.1 (59.4)	3.7
Melody Duo	2.5	60.1 (50.9)	21.8
Moximate	2.5	31.5 (34.1)	59.0
Ridomil MZ	2.5	27.1 (31.3)	64.7
Control	-	76.9 (61.3)	-
CD @5%	-	2.5	-

*Fungicides registered with CIB

Powdery mildew: The university technology was found at par with CPRI technology and both were superior to Farmer's practices (Table 38).

Table 38: Management of Powdery mildew in Capsicum grown under protected conditions

Technology Assessed	*Source of Technology*	*Production (q/ha)*	*Net Return (Profit) in Rs. / unit*	*BC Ratio*
$T_{1:}$ 5-6 sprays of different available fungicides (FP)	FP	220.0	2,90,000	7.25
$T_{2:}$ Spray of hexaconazol (Sitara @4ml/10 l at the appearance of disease followed by 2-3 sprays of Karathane@1ml/l (RP)	CSKHPKV	330.0	4,55,000	11.30
$T_{3:}$ One Spray of Karathane @1ml/l at the appearance of disease, followed 3-4 alternate sprays Bayleton @ 0.5ml/ l and Contaf @ 0.5ml/ l at 10 days interval	CSKHPKV	345.0	4,77,000	11.90

Potato

Management

IDM for late blight: The university technology was found at par with CPRI technology and both were superior to Farmer's practices (Table 30).

Table 39. Integrated management of late blight of Potato.

Technology Refined	*Source of Technology*	*Production* qt/ha	*Net Return (Profit) in Rs. / unit*	*BC Ratio*
T_1 : One spray of Dithane M 45 after appearance of disease(FP)	FP	190.0	1,50,000	3.75
T_2 : Two sprays of Ridomil MZ 72 (2.5g/l) followed by Two sprays of Dithane M 45 (2.5g/l) + sticker 2ml/l at fortnight interval (RP)	CSKHPKV	225.0	1,85,000	4.60
T_3 : One Prophylactic spray of Ridomil MZ 72 (2.5g/l) at 40-45 days crop followed by Two sprays of Moximate (2.5g/l) at fortnight interval+ sticker 2ml/l . (NP)	CPRI	245.0	2,05,000	5.13

Onion

IDM: Technology assessed by the university was found superior to UHF and Farmer's practices (Table 40).

Table 40: Integrated disease management in onion

Technology Assessed	Source of Technology	Production Kg/ha	Net Return (Profit) in Rs. / unit	BC Ratio
T_1: No spray or one spray of Diathane-M45 (FP)	FP	165.0	**1,30,000**	3.17
T_2: Two sprays of Matco + 2 sprays of Mancozeb @ 2.5g/lt of water	UHF	235.0	**2,00,000**	5.71
T_3: 2 sprays of Moximate + 2 sprays of Mancozeb at fortnight intervals	CSKHPKV	260.0	2,25,000	6.42

F) Forages

Evaluation of breeding material

The reactions of breeding materials of against Leaf blight of maize, Stem and Leaf blight of cowpea, Powdery mildew of oats and root rot of Beseem are presented in the table 41.

Table 41: Field screening of *Kharif* & *Rabi* breeding material

Crop	Name of Trial	Entries	Resistant/ Moderate Resistant
Maize (Leaf blight)	IVTM	8	IVTM-1, 2 & 4
	AVTHM	6	AVTHM- 1, 4, & 5
Cowpea (Stem and Leaf blight)	IVTC	8	Nil
Oats (Powdery mildew)	IVTO (SC)	16	IVTO (SC)-9,10,12 &13
	AVTO (SC-1)	12	AVTO (SC-1)-9
	AVTO(SC-2)	7	AVTO(SC-2)-1&2
	AVTO-2 (SC) Seed	7	AVTO-2(SC)-1&2
	AVTO (SCS-2)	11	AVTO (SCS-2)-1, 6 &15
	AVTO-2 (SC) Seed	11	AVTO-2 (SC)-4, 5 & 8
	IVTO(MC-1)	12	IVTO(MC-1)-2, 7, 8 & 9
	AVTO(MC-1)	9	AVTO(MC-1)-5, 6,7 & 9
	IVTO (Dual)	9	IVTO (D)-5,6,7,8, & 9
Beseem (root rot)	IVT Berseem	7	Very low diseases incidence

Cowpea

IDM for root rot and foliar diseases: The data in table 43 revealed that root rot incidence increase with the delay in sowing of the crop. Minimum incidence (11.4%) was observed in

early sown crop & maximum (41.4%) in late sown crop. However, the disease severity of Anthracnose increases with the delay in the sowing of crop being maximum (26.3%) on 4th June sown crop & minimum (12.5%) in crop sown on 4th July. In case of leaf blight the severity was maximum (25.4%) in the normal sowing date (19 June)& minimum (13.4%) in late sown crop. The nematode population also increases with the delay in sowing.

For the management of diseases & nematode seed treatment with fungicides (tebuconozole 2DS or metalaxyl + mancozeb) and NSKP followed by foliar spray with propiconazole were found effective. Both the treatments i.e. seed treatment with tebuconozole + NSKP followed by sprays of propiconazole (T_3) and seed treatment with metalaxyl + mancozeb + NSKP followed by sprays of propiconazole (T_4) were found very effective & gave maximum control of root rot, anthracnose, leaf blights and nematode in all the three dates of sowing with maximizing the GFY.

Data in table 42 revealed that the appearance of the root rot and leaf blight was delayed with the delay in sowing. The incidence of root rot was maximum (45%) where as disease severity of leaf blight was minimum (25%) in the late sown crop.

Data in table 44 and figure 1 revealed the the simple correlation co-efficient shows that temperature (Max & Min) was negatively correlated with the root rot and leaf blight, indicating that the intensity of root rot and leaf blight increases with the decrease in temperatures. The negative correlation of both the diseases with RH was also observed. The correlation of coefficient of weather variables with these diseases was found highly correlated with the 4th June & 19th June sowing as compare to 4th July date of sowing. This indicates that effect of these weather variables was more evident during early & normal date of sowing as compare to late sown crop. This may be attributed due to commencement of monsoon which leads to high rains during the later part of the season.

Table 42. Integrated management of root rot and foliar diseases of forage cowpea.

Treatment		Severity/ incidence of Diseases and nematodes					Yield (q/ha)	
Main (DOS)	Sub	Root rot	Anthracnose	Leaf blight	Nematodes /g of soil		GFY	DFY
					Before sowing	After harvest		
04.06.13	T_1	11.4	26.3	18.1	125.0	273.3	42.6	15.2
	T_2	8.4	8.4	5.4	125.0	134.0	49.8	15.5
	T_3	3.5	7.1	4.1	125.0	128.3	54.4	16.4
	T_4	4.1	7.0	3.4	125.0	121.0	54.1	16.4
19.06.13	T_1	19.0	22.7	25.4	150.0	313.3	46.1	14.9
	T_2	16.0	6.6	6.6	150.0	156.7	50.4	15.2
	T_3	8.4	5.1	5.1	150.0	155.7	56.8	16.8
	T_4	8.3	4.9	4.8	150.0	150.0	58.5	16.8
04.07.13	T_1	41.4	12.5	13.4	170.0	410.0	39.4	14.1
	T_2	36.3	3.8	3.2	170.0	188.3	42.8	15.5
	T_3	12.5	3.2	3.2	175.0	200.0	50.3	16.1
	T_4	13.7	2.7	3.1	175.0	193.0	50.2	15.7
CD (P=0.05)								
A (date of Sowing)		1.02	1.06	1.28	0.0003	14.06	1.38	0.26
B (Treatments)		1.18	1.23	1.48	0.0003	16.23	1.60	0.30
A x B		2.04	2.17	2.56	0.0005	28.13	NS	0.52

Treatments:

Main plot: 3 (Date of Sowing):T_A = 1st Date of sowing i.e. 15 days before Normal Days of Sowing ;T_B = 2nd Date of sowing i.e. Normal Days of Sowing; T_C = 3rd Date of sowing i.e. 15 days after Normal Days of Sowing

Sub plot: 4 (Treatments): T_1 =No treatment: T_2 =Seed treatment with *Trichoderma viride* + *Paecilomyces lilacinus* @ 5 g/kg seed each followed by foliar sprays of propiconazole @ 1ml/l at 15 days interval.; T_3 =Seed treatment with tebuconazole 2DS @ 1g/kg seed + NSKP(50 g/kg seed) followed by foliar spray of propiconazole @ 1ml/l at 15 days interval.; T_4 =Seed treatment with metalaxyl 8% + Mancozeb 64% @ 2.5g/kg seed + NSKP(50 g/kg seed) followed by foliar spray of propiconazole @ 1ml/l at 15 days interval.

The partial correlation coefficient of maximum temperature (0.777 to 0.959), minimum temperature (0.814 to 920) and RH (0.860) with root rot incidence indicates significant effect of weather variables on the disease development (Table 43 and 44). Partial correlation coefficient of RH with root rot was observed only in the normal date of sowing which shows that RH does not have impact on the root rot development. The partial coefficient values ranged between 0.777 to 0.828 for maximum temperature, 0.520 to 0.817 for minimum temperature and 0.814 to 0.0851 for RH with Leaf blight severity, which indicates these factors have significant impact on the development of leaf blight.
The coefficient of multiple determination (R^2) shows that maximum temperature, minimum temperature and RH resulted in 92.2, 91.2 and 32.4 % of root rot and 94.4, 98.8 and 98.6% leaf blight development in early, normal and late sown crop, respectively.

So, it is concluded that for the management of root rot, crop should be sown earlier as high temperature & RH was observed unfavourable for the disease development. However, for the management of leaf blight normal or late sowing of crop is recommended, because in early sown crop the infection stage of the crop appears early & remains for longer period, which leads to more disease severity as compare to late sown crop.

Table 43: Relation of root rot and leaf blight of cowpea with environmental factors

Date/Week	Disease incidence/severity (%)						Weather Variable		
	1st date of sowing (04.06.2013)		2nd date of sowing (19.06.2013)		3rd date of sowing (04.07.2013)		Maximum Temp. (^{0}C)	Minimum Temp. (^{0}C)	Maximum RH (%)
	Root Rot	Leaf blight	Root Rot	Leaf blight	Root Rot	Leaf blight			
17.06.2013	5	-	-	-	-	-	35.1	24.6	69.6
24.06.2013	8	-	-	-		-	35.0	24.0	68.7
01.07.2013	10	-	10	-	-	-	34.8	24.0	75.6
08.07.2013	12	10	15	8	-	-	34.5	23.9	74.1
15.07.2013	-	15	20	15	10	7	33.5	23.5	78.0
22.07.2013	-	18	-	22	25	15	33.8	23.6	76.6
29.07.2013	-	25	-	27	45	20	33.3	23.4	75.9
05.08.2013	-	40	-	39	-	22	31.2	23.3	70.7
12.08.2013	-	-	-	41	-	24	32.7	23.2	75.4
18.08.2013	-	-	-	-	-	25	32.7	22.9	77.0

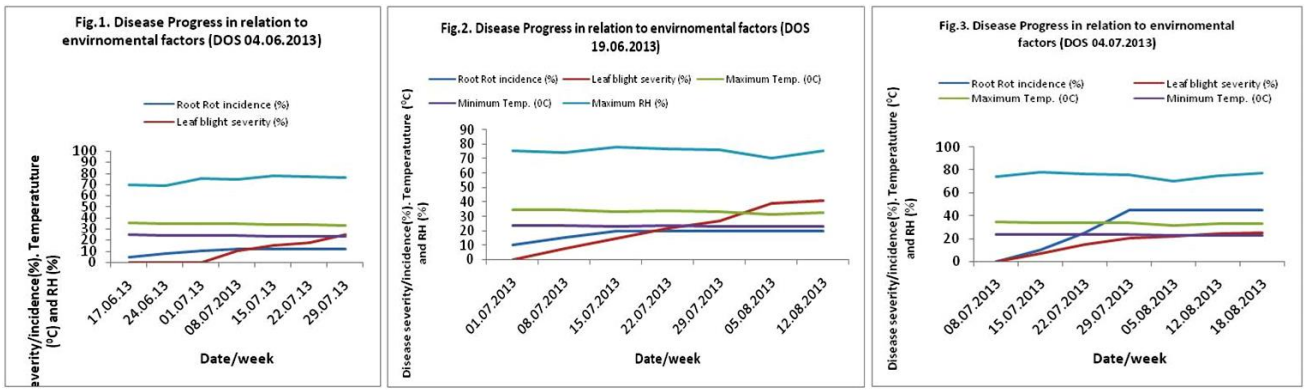


Figure 1: Relation of root rot and leaf blight of cowpea with environmental factors

Table 44: Correlation and regression equations between disease severity/incidence and weather variables in cowpea

Date of sowing	Combinations	Simple correlation	Partial correlation	Multiple correlation		Regression equation
				(R)	R^2	
04.06.2013	RR x Max. T	-0.949	0.959	0.996	0.922	$Y=355-7.10x_1-4.10x_2$
	RR x Min. T	-0.898	0.920			
	RR x RH	0.756	-			
	LB x Max. T	-0.967	0.777	0.994	0.989	$Y=1162+1.44\ x_1-42.32\ x_2-2.5\ x_3$
	LB x Min. T	-0.842	0.814			
	LB x RH	-0.697	0.817			
19.06.2013	RR x Max. T	-0.953	0.979	0.955	0.912	$Y=492-10.75\ x_1-1.42\ x_2$
	RR x Min. T	-0.950	-			
	RR x RH	-0.619	0.860			
	LB x Max. T	-0.848	0.828	0.988	0.976	$Y=23-0.012\ x_1+0.122\ x_2-0.0494\ x_3$
	LB x Min. T	-0.917	0.711			
	LB x RH	-0.436	0.851			
04.07.2013	RR x Max. T	-0.471	-	0.569	0.324	$Y=2376-100.0\ x_1$
	RR x Min. T	-0.569	-			
	RR x RH	-0.963	-			
	LB x Max. T	-0.563	0.795	0.986	0.973	$Y=162-0.213\ x_1-1.60\ x_2-1.07\ x_3$
	LB x Min. T	0.178	0.520			
	LB x RH	-0.457	0.814			

Sorghum

Management of zonate leaf spot of forage sorghum: Data reveal that the seed treatment with carbendazim @ 2 g/kg and *two foliar sprays of propiconazole @ 1ml/l* provided best management of zonate leaf spot with 12.8 % disease severity with maximum green fodder yield (304.9 q/ha) as compared to control i.e. 74.4 per cent disease severity with 234.4/ha green fodder yield (Table-45).

Table 45: Management of foliar diseases of forage sorghum

Treatment		Zonate leaf spot and sheath blight severity (%)	Green Fodder yield (q/ha)
T_1 =	Seed treatment with carbendazim @ 2 g/kg seed	28.7	281.3
T_2 =	Seed treatment with *T. viride* @ 5g/k	33.5	273.6
T_3 =	Two foliar sprays of *T. viride* @ 0.5%	34.3	256.0
T_4 =	Two foliar sprays of propiconazole @ 0.1%	19.0	296.6
T_5 =	Two foliar sprays of copper oxychloride @ 0.3%	64.5	247.1
T_6=	T_1 + Two foliar sprays of propiconazole @ 0.1%	12.8	304.9
T_7=	T_2 + Two foliar sprays of propiconazole @ 0.1%	16.3	293.8
T_8=	T_1 + Two foliar sprays of copper oxychloride @ 0.3%	61.4	251.7
T_9 =	T_2 + Two foliar sprays of copper oxychloride @ 0.3%	55.5	254.0
T_{10} =	Control	74.4	234.4
CD (P=0.05)		**2.96**	**10.15**

Oat

Pathogenic variability

Blumeria graminis* f. sp. *avenae: Seven isolates of oat powdery mildew were collected and are maintained in the controlled conditions (Green house) for the development of differential set to study the pathogenic variability. The reaction of the three isolates was recorded on detached leaf method under *in vitro* as infection types *i.e.* 0-4 under stereo zoom microscope on seventy line of oat. These 70 lines evaluated with 7 isolates to be during 2013 and 2014 and preliminary differential set of 10 line was developed. The pathogenic variability was studied on differential set. The infection types were employed for studying the pathogenic variability. In designating the pathotypes, only two disease reaction categories were used viz; resistant (R) 0,1 and 2 infection types, and susceptible (S) 3 and 4 infection types(Table 46).

The virulence pattern of the 7 isolates of *Blumeria graminis* f. sp. *avenae* on differential set (10 lines) is given in table 46. On the basis of reaction of 10 differentials, the 7isolates were grouped into 5 different pathotypes (Table 47). Of the 7 isolates 1 isolate were placed in pathotypes PMO-1, two in pathotypes PMO-2, one in pathotypes PMO-3, two in pathotypes PMO-4 and one in pathotype PMO-5 (Table 47).

Table 46: Disease reaction of powdery mildew isolates on oat differential lines

S. No.	Isolates	Reaction type of isolates on Differential Lines									
		OL-160	OAT- H 38	IG-03-248 R1	UPO-119	OAT-TRS-RKC	IG-03-251	EC-6058	OAT902-2011-12-R-11	HFO-114	OAT-OS-121
1	Agronomy	0	1	1	0	0	0	0	1	0	0
2	Tanda	2	4	2	2	2	2	2	2	3	1
3	Nagrota	1	1	1	2	1	1	2	1	1	1
4	Rajpur	0	0	0	4	1	1	4	0	4	3
5	Plant Pathology	2	1	2	2	2	2	1	4	2	3
6	Kangra	4	2	4	2	4	4	3	3	0	2
7	Fodder Farm	2	4	1	1	1	1	0	1	3	4

Table 47: Virulence pattern of isolates of *Blumeria graminis* f. sp. *avenae* causing powdery mildew of oats on differential set

S. No	Isolate	Infection Types on Differential lines										Pathotypes	Virulence Frequency (R:S)
		OL-160	OAT-H 38	IG-03-248 R1	UPO-119	OAT-TRS-RKC	IG-03-251	EC-6058	OAT902-2011-12-R-11	HFO-114	OAT-OS-121		
1	Agronomy	R	R	R	R	R	R	R	R	R	R	PMO-1	10:0
2	Tanda, Kangra	S	S	S	S	S	S	S	S	S	R	PMO-2	1:9
3	Nagrota	R	R	R	S	R	R	S	R	R	R	PMO-3	8:2
4	Rajpur, Fodder Farm	R	R	R	S	R	R	S	R	S	S	PMO-4	6:4
5	Plant Pathology Farm	S	R	S	S	S	S	R	S	S	S	PMO-5	2:8

White clover

IDM in seed crop: Data reveal that integrated management i.e. Seed treatment with carbendazim @ 2 g/kg and *Trichoderma viride* @ 5g/kg seed followed by alternate sprays of carbendazim and Contaf provided best management of powdery mildew severity (2.9%) and clover rot incidence (1.1%) with maximum seed yield (2.3 q/ha) as compared to control i.e. 59.3 % powdery mildew 8.1 % clover rot 1.6 q/ha seed yield (Table 48).

Table 48: Integrated disease management in white clover against powdery mildew and root rot

TREATMENT	Disease Severity (%)		Yield (q/ha)
	Powdery mildew	Clover rot	
T_1 - Seed treatment with Bavistin @ 2 g /kg seed	38.8(38.53)	1.6	1.7
T_2 - Seed treatment with *Trichoderma viride* @ 5g/kg seed	44.8(42.02)	5.5	1.8
T_3 - T_1 + Foliar spray of Bavistin (0.5%)	19.7(26.34)	1.3	1.7
T_4 – T_2+ Foliar spray of Bavistin (0.5%)	31.8(34.31)	5.3	2.2
T_5 - T_1+ Foliar spray of Contaf (0.04 %)	4.8(12.69)	1.2	2.3
T_6 - T_2 + Foliar spray of Contaf (0.04 %)	4.3(11.91)	5.8	1.9
T_7 - T_1 + Foliar spray of Bavistin followed by Contaf	3.0(10.02)	1.5	2.0
T_8 – T_2+ Foliar spray of Bavistin followed by Contaf	4.5(12.24)	5.3	2.2
T_9 - T_1+ T_2 + Foliar spray of Bavistin followed by Contaf	2.9(9.80)	1.1	2.3
T_{10} - Untreated control	59.3(50.34)	8.1	1.6
CD (5%)	1.20	0.76	0.10

G) Seed Pathology

Rice

Management

False smut in seed crops: Management trial on false smut of rice was conducted at two locations, Sundernagar (District Mandi) and Malan (District Kangra) in Himachal Pradesh, hot spots for false smut during 2013 kharif season using cv. HPR 1068 (Table 49). . Overall disease incidence was quite low. The data recorded on per cent spike lets infected/panicle and per square meter percentage of infected panicles was quite less in the sprayed plots as compared to control.

Emerging new seed borne diseases

In order to study the status of seed borne diseases in Hybrid rice varieties cultivated by farmers in Himachal Pradesh, survey was conducted in different locations/ districts of Himachal Pradesh and found that overall false smut incidence was low in almost all the hybrid growing locations of the state and its severity varied between 0 to 3 per cent with maximum incidence in. Mandi, on hybrid US312 PAC 807 and PA6129 (Table 50). BLB was absent in all the locations. Neck blast incidence was ranged from 5 to 15 per cent, with

maximum at Surajpur (var. PA 6444) area of. Sirmour. Incidence of Sheath blight was maximum in Indora location of. Kangra.

Table 49: Evaluation of fungicides for the management of false smut in rice seed crop at Sundernagar

Treatments	Dose (g or ml/l)	Stage of spraying	% Infected spikelets/ panicle
Seed treatment with Raxil	1g/kg seed	Before sowing	
Seed treatment with *Trichoderma viridae/harzianum*	5g/kg seed	Before sowing	
Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG)	0.4 g	Two sprays: 1st at 50% PE and 2nd after 12-15 days	4.50
Propiconazole 25 EC (Tilt or Result)		Booting	2.52
Raxil ST + Nativo (75 WG) spray	0.4 g	Two sprays: 1st at 50% PE and 2nd after 12-15 days	
Raxil ST + Propiconazole 25 EC (Tilt)	1.0 g	Two sprays: 1st at 50% PE and 2nd after 12-15 days	
Seed treatment with *Trichoderma viridae/harzianum* + Nativo (75 WG) spray	0.4g	Two sprays: 1st at 50% PE and 2nd after 12-15 days	
Seed treatment with *Trichoderma viridae/harzianum* + Propiconazole 25 EC (Tilt)	1.0g	Two sprays: 1st at 50% PE and 2nd after 12-15 days	
Untreated control			10.38

Table 50: Status of seed borne diseases in Hybrid Rice Varieties cultivated by farmers in Himachal Pradesh during *kharif* 2013

District /Location	Variety	False Smut Incidence (%)	False Smut (0-9 scale)	BLB Severity (%)	Neck Blast	Sheath Rot	Sheath Blight Incidence (%)	Brown Spot
Kangra								
Indora	Hybrid	-	-	-	-	-	27.50	-
Rehlu	Hybrid	10		-	-	-	-	-
Malan	PAC 807	5-10	3	-	-	10-15	-	-
Mandi								
Jogindernagar	Hybrid	<5	1	-	-	-	-	-
Balh Valley (Nalsar, Bheora, Chatraur etc.)	PAC 807	20-25	3	-	-	20	7.50	-
	PA6129	20-25	3	-	-	20-25	7.50	-
	US312	25-30	3	-	-	20-25	15.00	-
Naag Chala	US312	25-30	3	-	-	15-20	3.5	-
	PA 6129	15-20	3	-	-	15-20	7.5	-
Sarkaghat	Hybrid	8.5	3	-	-	-	-	-
Una	PAC 807	6.5	3	-	-	-	-	-
	PA 6129	3.0	1	-	-	-	-	-

Wheat

Studies on seed health status of farm- saved seed.

1. Loose smut in framers wheat samples

The incidence of loose smut in farmers' saved seed revealed that the overall incidence ranged between 0.00 to 0.4 per cent. Maximum incidence of 0.4 per cent was in the sample collected from Khera (var. Local) of Solan district followed by 0.3 per cent from Dhaulakuan of Sirmour district (var. Local). Germination percentage varied from 50.00 to 63.7 per cent, maximum in sample collected from Sarkaghat (var. Local) and Ghano (var. Local) of district Mandi and Hamirpur. The overall per cent germination was low in all the samples.

2. **District wise and variety wise status of karnal bunt in unprocessed farmers wheat seed sample and seed production plots in Himachal Pradesh**

Karnal bunt incidence in different seed samples collected from 241 locations of six districts of Himachal Pradesh ranged between 0.00 to 13.00 per cent. Maximum incidence of 13.00 per cent was recorded in sample collected from Bangran area (var. Local) of Solan districts. Out of 241 seed samples, 94 samples showed more than 0.20 per cent seedborne infection which is above the seed certification level. 119 samples from different districts were free from karnal bunt infection.

H) Molecular Plant Pathology

Molecular characterization of Bean common mosaic virus strains prevalent in north western region of India

Survey of different common bean growing areas of HP, Uttrakhand and J&K states conducted during the year 2013-14, revealed wide prevalence of the BCMV disease. Samples collected from 102 locations showed 2.00 to 50.00 per cent disease incidence. The disease incidence varied from 5.00 to 40.00 per cent was recorded from 19 of three districts of HP viz., Kullu, Kangra, Mandi with maximum incidence from Bulash area of district Mandi and minimum from Madhed (Kangra). In J&K, disease incidence ranged between 5.00 to 35.00 per cent in 46 locations of six districts viz., Kulgam, Anantnag, Badgaon, Baramulla, Ganderbal and Srinagar. The maximum disease incidence was recorded from Gartung-I of Badgaon district and minimum from Arbalshalimar area of district Srinagar. In Uttrakhand, disease incidence was in the range of 2.00 to 50.00 per cent, maximum incidence was in Raitukibeli area.

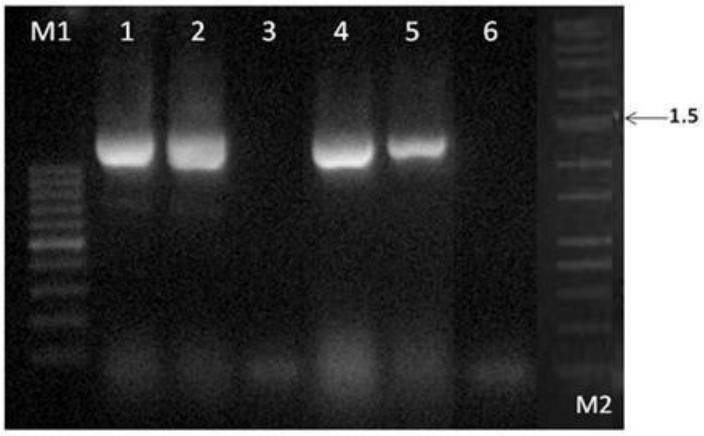


Fig. 1. Detection of BCMV through RT-PCR in different common bean cultivars using coat protein gene specific primers; M1 represents 100 bp DNA ladder and M2- 1 kb plus DNA ladder

The identity of the virus as BCMV was established by DAS-ELISA test using virus specific antiserum and amplification of genomic RNA by RT-PCR using coat protein gene specific primers. Out of 102 isolates collected during survey, 90 reacted positively with BCMV polyclonal antiserum, thus confirmed the identity of these isolates as BCMV. The OD value of positive samples ranged between 1.0078 to 4.3071 compared to 0.3695 in control was recorded. Similarly, RT-PCR

using cp gene specific primers, amplified an amplicon of ~1200 bp in 90 test isolates reacted positively in DAS-ELISA, whereas no amplification was observed in healthy common bean plant and out-group samples (BYMV infected leaves), thus further establishing the virus identity as BCMV (Figure 1).

Identification of BCMVstrains on differential cultivars

Virus isolates were inoculated on CIAT differential set having different genes for resistance to determine strain identity, as per the procedure by Drijfhout (1978). The reaction pattern of 90 isolates determined on the basis of reaction on differential bean varieties categorized them into four strains. NL-1 strain was found to be present in 72 isolates, NL-1n in 15 and NL-7n in 2 isolate whereas NL-4 was present in only one isolate. NL-1 and NL-1n strain were most prevalen Table 51.

Table 51: Strain characterization of BCMV isolates based on differential responses

Isolates	**Differential sets of common Bean**									**Strain identity**
BCMV-203,206,210,217,220,225,228,235,240,245,246,248,255,256,303	I +	II -	III -	IV -	V -	VI +	VII -	VIII -	IX -	NL-1n
BCMV-204,205,207,208,211,212,213,214,215,218,219,221,222,223,224,226,229,230,231,232,233,234,236,237,238,239,241,242,243,244,247,249,250,251,252,253,254,257,258,259,261,262, 263,264,266,267,268,269,270,271,272, 275, 278,279,280,281,282,283,284,285,286,288,289, 290,291, 292,295,296,297, 298, 299, 304	+	-	-	-	-	-	-	-	-	NL-1
BCMV-210,216	+	+	-	-	-	+	-	-	-	NL-7n
BCMV-278	+	-	+	+	-	-	-	-	-	NL-4

+: Susceptible; -: Resistant

I: Double witte, II: Redland's Greenleaf 'C', III: Redland's Greenleaf 'B', IV: Michelite '62', V: Monroe,VI: Jubila, VII: Top crop, VIII: Black turtle soup, IX: Amanda

Full genome sequencing of BCMV NL-1n strain

Full genome of BCMV-NL-1n strain was amplified by using gene specific primers and RACE PCR primers. The PCR products were cloned in pGMET-Easy vector, plasmid isolated from positive clones and submitted for custom sequencing. The genome sequences were assembled manually as well as using DNAstar package (DNASTAR® Inc., USA). Sequence analysis revealed that NL-1n strain genome consists of 10081 nucleotides (nt) comprising of 5'-UTR (134 nt), P1 (1329 nt), HC-Pro (1371 nt), P3 (1041 nt), 6K1 (156 nt), CI (1902 nt), 6K2 (159 nt), NIa-Vpg (570 nt), NIa-Pro (729 nt), NIb (1548 nt), CP (861 nt),

3'-UTR (254 nt) and Poly A tail (24 nt) regions. The genome sequence was deposited in the Genbank vide accession number KF114860.

Phylogenetic tree was constructed by neighbor joining method using MEGA5 software to confirm the identity of the test virus strain as BCMV. The nucleotide sequences were translated using Expasy Translator Tool (www.expasy.org/tools/dna.html). Phylogenetic tree derived from amino acid sequence data grouped BCMV-NL-1n with other BCMV strains. Further within BCMV group, BCMV-NL-1n strain was clustered with BCMV-NL-1n and BCMV-MS-1 showed maximum identity with BCMV- NL-1 followed by BCMV-MS1 (Fig. 2). Lowest per cent similarity with the strains of BCMNV and maximum with other strains of BCMV separated BCMV-NL-1n from necrotic strains of BCMNV and established that strain belongs to BCMV species of the genus *Potyvirus.*

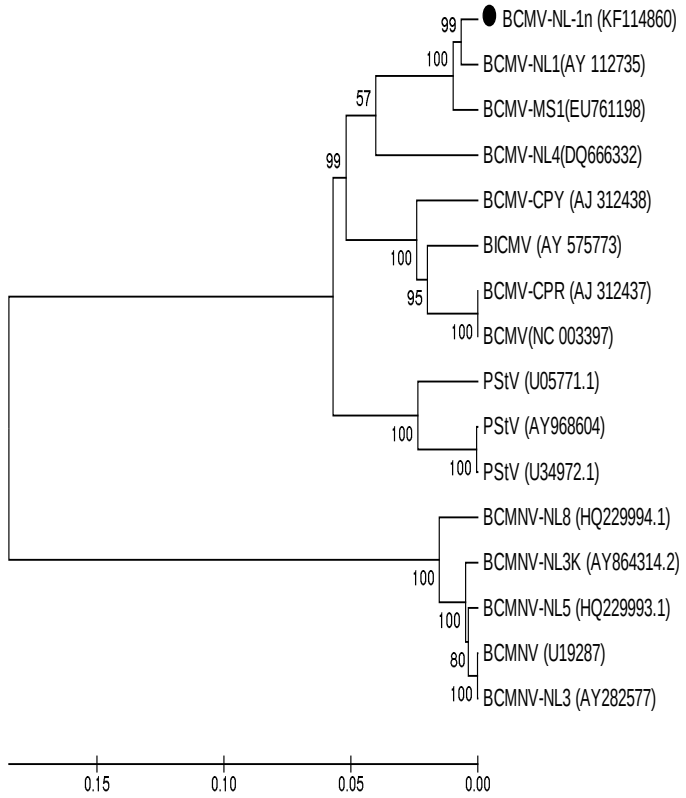


Figure 2. Phylogenetic tree showing relationship between BCMV-NL-1n and related strains/ isolates of BCMV based on complete genome deduced amino acid sequence using MEGA5 software

Evaluation of common bean germplasm

In an attempt to identify durable sources of resistance, 424 accessions comprising local landraces, recommended cultivars, indigenous and exotic accessions were evaluated under glasshouse conditions against BCMV strain NL-1 and NL-1n. Resistance in the plants showing no disease symptoms was confirmed by back inoculation on healthy plants of susceptible cv. Jawala for symptomless carriers. None of plants produced symptoms and plants were graded as resistant. The resistance was then further confirmed by performing ELISA test and RT-PCR using BCMV specific antiserum and cp gene specific primers by taking leaves from the resistant plants. The DAS-ELISA test using BCMV polyclonal antiserum showed negative result and no amplification was observed in RT-PCR. Out of 424

accessions, 60 accessions showed resistance whereas all other genotypes were susceptible to BCMV-NL-1n. The resistant accessions included Indigenous (14), Exotic (30), snapbeans (16) (Table 52).

Table 52: Comparative sources of resistance in different common bean germplasm against BCMV- NL-1n strain

S.No.	Bean accessions	Resistant genotype
2.	**Snap Beans**	IVFB-2, Surya, MFB-3, Falguni, HAFB-1, HAFB-2, MFB-2, VLF-2003, HAFB-4, DPDFB-1(M), Arka Anoop, Aparna, B-Sel, DWDFB-57, Contender, Kentuky wonder
3.	**Indigenous collections**	IC-37144, IC-37165, IC-37168, IC-39051, IC-39067, IC-43567, IC-328655, IC-415517, IC-445656, IC-313627, Hans, KRC-22, HPR-215, KRC-18
4.	**Exotic collections**	EC-18714, EC-21750, EC-21751, EC-24944, EC-24951, EC-24956, EC-24957, EC-25501, EC-25504, EC-103346, EC-109731, EC-115962, EC-120636, EC-127581, EC-500709, EC-500807, EC-500298, EC-675652, Black Turtle Soup, Improved Tender Green 40031, Great Northern UI-123, Sanilac, Monroe, Bat-332, Amanda, Streengless Green Refuge, Cornell 49-242, To, Montecalm, Don timoteo

Molecular mapping of BCMV resistance gene in KRC22 landrace of common bean

1. **Advancement of mapping population (F2 & RILs)**

The work on generation advancement has been affected badly due to failure of crop at MAREC, Sangla because of flash floods in Kinnaur during 2013. Hence, the required generations from F7 to F8 will be raised during 2014 *kharif* season. The F6 generation was advanced to F7 during 2013 *kharif* season under green house condition of CSK HPKV, Palampur. DNA of individual RIL plant was extracted following standard protocol.

2. Maintenance virus culture

Virus culture of BCMV-NL-1n is being maintained and multiplied on healthy seedling of the susceptible cv. Jawala under insect proof conditions.

Phenotyping of F_2 and F_7 population with NL-1n strain of BCMV under greenhouse conditions.

The F_2 individuals were inoculated by sap inoculation with BCMV-NL-1n strain. The symptoms appeared on first trifoliate leaves after about 8 to 10 days of inoculation followed by the development of well-defined dark and light green areas on leaf lamina, downward rolling along the main vein of each leaflet. In the later stages, the infected leaves showed green vein banding and blistering symptom along with leaf and foliage distortion. Infected plants were stunted, possessed flowers and few deformed pods. However, resistant plants did not show any symptom even upto one month of inoculation. The RT-PCR with BCMV specific primers also showed absence of the virus in the resistant parent.

Out of 150 F_2 plants, 39 plants showed resistance and 111 were found susceptible to BCMV-NL-1n . The chi-square analysis suggests that the data fits well in segregation ratio 1:1 for resistant and susceptible plants (Table 53).

Table 53: Inheritance of resistance in common bean landrace KRC 22 against Bean common mosaic virus strain NL-1n

		Number of seedlings				
Parents/ Crosses	**Generation**	**Resistant**	**Susceptible**	**Expected ratio**	χ^2 cal	**P≤ 0.05**
Jawala	P 1	-	111	112.5	-	-
KRC-22	P 2	39	-	37.5	-	-
Jawala x KRC-22	F1	-	11	-	-	-
Jawala x KRC-22	F_2	39	111	1:3	0.19	**0.8-0.9**

Bulk segregating analysis

Out of 215 RAPD primers used in polymorphic survey of parents, 29 primers viz., OPA-1, OPA-2, OPA-19, OPY-7, OPF-10, OPG-5, OPAI-18, OPQ-6, OPO-10, OPAM-7, OPE-2, OPW-13, OPW-6, OPR-12, OPV-20, OPT-8, OPG-6, OPS-8, OPF-4, OPP-7, OPAH-18, OPI-18, OPL-2, OPL-4, OPL-5, OPK-3, OPV-16, OPV-17, OPV-18, showed polymorphism. Whereas out of 145 SSRs primers, only 14 viz., Bm140, Bm210, Bm175, Pvctt-01, GATS-91, BM-114, BM-172, BM-205, BM-202, BMB-506, BMB-64, BMB-256, BMB-473 & BMD-2 differentiated resistance and susceptible parents. The primers differentiating resistance and susceptible parents were used to amplify the R & S bulk to identify the polymorphic primers separating the bulks.

For bulk preparation, initially 10 resistant and 10 susceptible F_2 plant's DNA was bulked after checking the virus infection through RT-PCR using BCMV cp gene specific primers. PCR amplification was carried out in 25µl reaction volume containing 2.5µl of 10x Taq buffer, 1.5µl of 25mM $MgCl_2$, 0.2µM of dNTP each, 1µl of 10nM random primer, 20ng template DNA, 0.2µl of 5U/µl Taq polymerase (Merck Genei) and final volume was adjusted with nuclease free water. PCR amplification was carried out in a thermocycler using the following temperature profile: initial denaturation at 92°C for 5 min, followed by 30 cycles of 92°C for 1 min, annealing for 1 min (temperature as per the primer requirement), extension at 72°C for 2 min and final extension at 72°C for five minutes for SSR primers and for RAPD primers initial denaturation at 94°C for 5 minutes followed by 40 cycles of 94°C for one minute, annealing for 37°C for one minute, extension/ synthesis at 72°C for two minutes and final extension at 72°C for five minutes. Ten µl of each PCR product was analyzed in agarose gels 1.4% agarose for RAPDs and 3% for SSRs prepared in 0.5 X Tris Acetic Acid-EDTA (TAE) buffers and visualized by ethidium bromide (0.5µg/ml) staining.

Only 8 primers viz., OPG5, OPAW-15, OPH-12, OPF-4 (RAPD) and Bm140, Bm210, Bm175, Pvctt-01 (SSRs) were able to differentiate the resistance and susceptible bulks and are being used for bulk segregant analysis (BSA) (Fig 3). The segregation pattern of the SSR markers is in progress. RAPD primer OPG5 that differentiated resistant and susceptible parents and bulks was used to amplify F_2 R and S individuals. OPG5 produced clear polymorphic band (~450bp) between R-and S- bulk DNA. The RAPD band of ~450 bp was amplified from 36 resistant plants out of 39 and was present in 40 susceptible plants out of

111 thus showing linkage with the resistance gene in *cis* phase (Fig. 4). Chi square test for independent segregation of marker with trait of interest showed deviation from independent segregation, thereby indicating association of marker with disease resistance gene in land race KRC-22 (Table 54). In order to get the precise linkage between marker and the disease resistance gene, further analysis of RIL population of the same cross is in progress.

Table 54: Segregation pattern of OPG5 marker in common bean landrace KRC22 F2 population.

		Number of resistant plants showing presence/ absence of marker			
OPG5	**Classes**	**Observed**	**Expected ratio**	χ^2 cal	**P≤ 0.05***
Presence	3	36	29.25	1.56	0.010<P<0.025
Absence	1	3	9.75	4.67	
				6.23	
		Number of susceptible plants showing presence/ absence of marker			
OPG5	**Classes**	**Observed**	**Expected ratio**	χ^2 cal	
Presence	1	40	27.75	1.80	0.010< P< 0.005
Absence	3	71	83.25	5.40	
				7.20	

*Calculated chi square value in both the cases is more than tabulated value at 5% level, hence this reject the null hypothesis that marker is independent of the disease resistance gene.

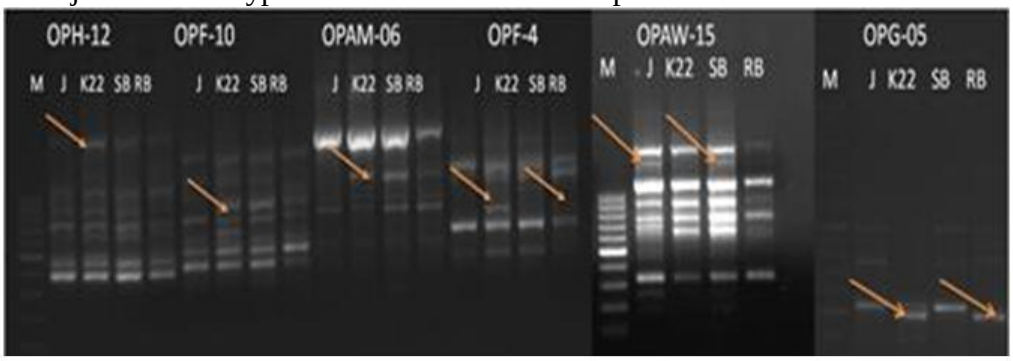


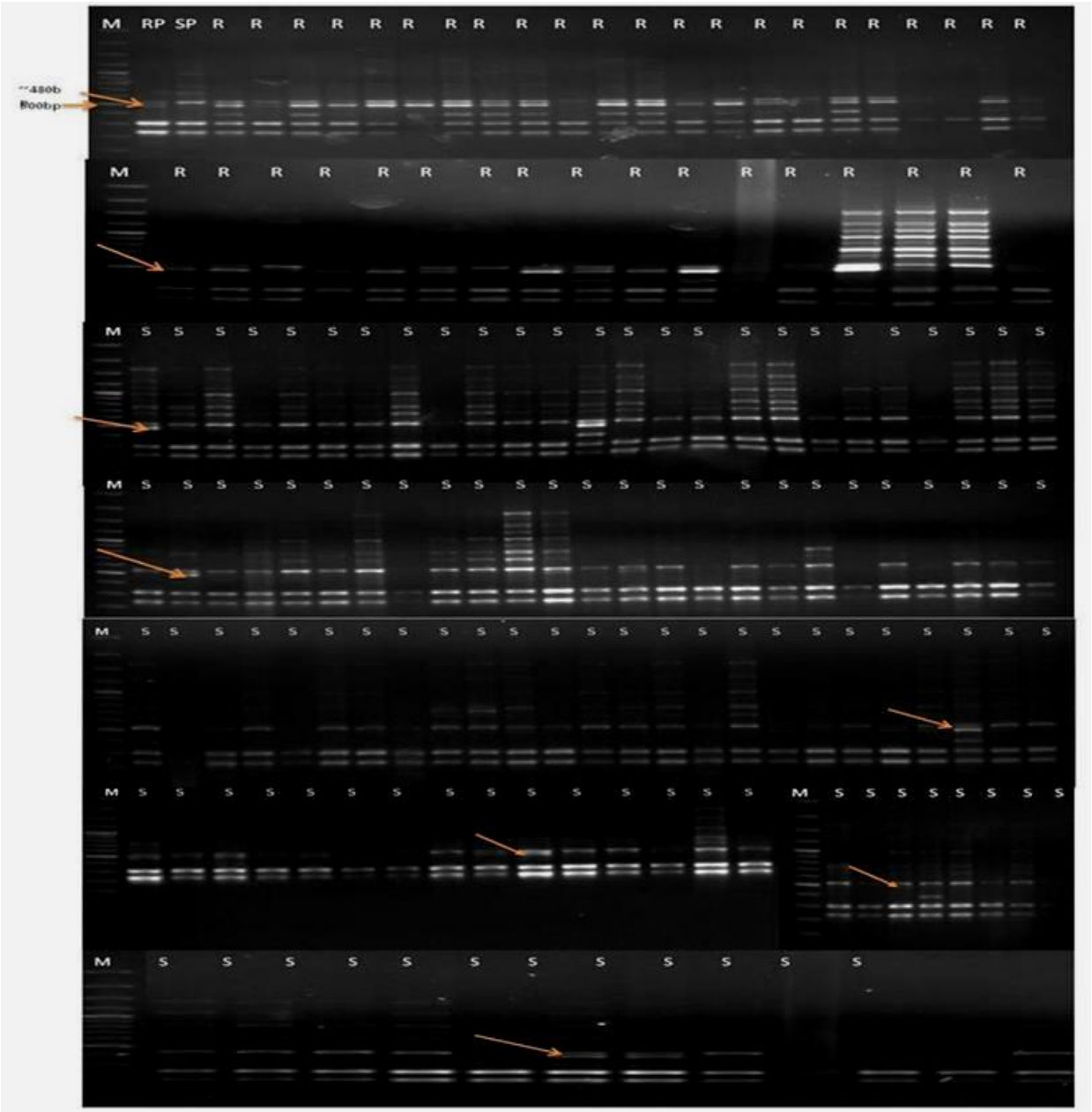
Fig. 3. Bulk segregation analysis using RAPD marker

I) Fungicide testing

Seed dressing fungicides against loose smut of wheat: The data presented in table 55 revealed that Raxil 2DS and Exzole (tebuconazole 2% DS) resulted in cent percent control of loose smut and gave significant increase in grain yield. No treatment was phytotoxic.

Table 55: Efficacy of seed dressing fungicides against Loose smut of wheat

Treatment	**Dose (g/kg)**	**Germination (%)**	**Av. No. of tillers infected**	**Average grain yield (q/ha)**
Power	2.5	90.3	41.3	34.6
Bavistin	2.5	88.6	1.6	36.0
Raxil 2DS	1.0	90.0	33.6	37.3
Vitavax	2.5	88.5	7.0	36.6
Exzole	1.0	87.0	0.0	38.3
Raxil new	1.0	90.6	0.0	39.6
Check	-	85.0	157.3	31.2
CD(0.5%)		NS		2.3



M= Marker, RP=Resistant parent (KRC-22), SP = Susceptible parent (Jawala); R= resistant F2 individuals and S=susceptible F2 individuals

Fig. 4. Polymorphism survey of resistant susceptible parents, their bulks and population (F_2)using OPG-5 RAPD marker.

Seed dressing fungicides against karnal bunt and flag smut of wheat: The data presented in table **56** revealed that Raxil 2DS @1g/kg seed resulted in least karnal bunt development followed by Vitavax and Bavistin @2g/kg seed and rated at par in their efficacy with each other. Flag smut did not appear due to regular rains received during entire crop season .None of the treatments showed phytotoxicity.

Table 56: Efficacy of Tebuconazole 060 FS (Raxil 060 FS) against Karnal bunt and Flag smut of wheat

Treatment	Forml.Dose (g/kg)	Germination (%)	Karnal bunt incidence (%)	Average grain yield (q/ha)
Untreated (check)	-	90.0	3.5	36.6
Tebuconazole 060 FS (Raxil 060 FS)	0.167	90.5	3.5	36.8
Tebuconazole 060 FS (Raxil 060 FS)	0.250	90.5	3.0	37.6
Tebuconazole 060 FS (Raxil 060 FS)	0.333	91.0	2.9	38.3
Tebuconazole 2% DS (Raxil 2 DS)	1.0	90.0	2.1	37.2
Carboxin75 WP(Vitavax)	2.0	90.0	2.6	37.0
Carbendazim50 WP(Bavistin)	2.0	90.0	2.8	36.0
CD(0.5%)		NS	0.9	2.8

Evaluation of phytotoxicity of Tebuconazole 060 FS (W/V) (Raxil 060 FS) in wheat: The data presented in table 57 indicated that the test fungicide did not show any phytotoxicity symptoms at any test concentration. No significant difference in karnal bunt incidence and grain yield was recorded

Table 57: Evaluation of efficacy and phytotoxicity of tebuconazole 060 FS (W/V) (Raxil 060FS) against karnal bunt in wheat

Treatment	Dosage/10 kg seed	Germination(%)	Phytotoxicity	Karnal bunt incidence(%)	Yield(q/ha)
Untreated control	-	90.0		3.5	38.5
Tebuconazole 060 FS(Raxil 060 FS)	3.33	95.5	Nil	3.5	38.0
Tebuconazole 060 FS(Raxil 060 FS)	6.66	95.0	Nil	3.0	38.5
Tebuconazole 060 FS(Raxil 060 FS	13.32	96.5	Nil	2.5	39.5
CD(0.5%)		NS		NS	NS

Evaluation of new fungicides at location specific diseases:

Fungicides namely, trifloxystrobin 25% + tebuconazole 50% (Nativo 75 WG), kresoxim methyl (Ergon 44.3 SC), azoxystrobin 25 SC (Amistar), tricyclazole 75 WP (Beam), carbendazim 50 WP (Bavistin) and propiconazole 25 EC (Tilt) including untreated check were evaluated for their efficacy against location specific diseases. Observations on leaf blast severity were recorded till flowering and that on neck blast incidence were recorded a week before harvest (Table 58).

A perusal of the data revealed that all the fungicides significantly reduced the disease as compared to control during *kharif* 2013 (Table 35.). Of these, tricyclazole 75 WP (Beam) resulted in maximum (75.5 %) reduction in leaf blast severity which was at par with kresoxim methyl (Ergon) resulting in 74.0 per cent reduction in leaf blast severity followed by trifloxystrobin 25% + tebuconazole 50% (Nativo 75 WG) and azoxystrobin (Amistar) with 69.4 and 64.1 per cent reduction, respectively. Tricyclazole 75 WP (Beam) again resulted in the maximum reduction of 75.7 per cent in neck blast incidence followed by trifloxystrobin 25% + tebuconazole 50% (Nativo 75 WG), azoxystrobin (Amistar) and kresoxim methyl while carbendazim and propiconazole were the least effective. Three sprays of tricyclazole also resulted in the maximum grain yield of 43.7 q/ha which was at par with azoxystrobin (Amistar), trifloxystrobin 25% + tebuconazole 50% (Nativo 75 WG) and kresoxim methyl (Ergon) with 43.4, 40.6 and 39.2 q/ha grain yield, respectively.

Table 58: Evaluation of fungicides for the management of leaf and neck blast of rice

Fungicide	Dose / L	Leaf Blast Severity (%)	% reduction in leaf blast Severity	Neck blast Incidence (%)	% reduction in incidence	Grain Yield (q/ha)
Trifloxystrobin 25% + tebuconazole 50% (Nativo 75 WG)	0.4 g/L	16.1 (23.6)	69.4	29.0 (32.5)	67.5	40.6
Kresoxim methyl (Ergon 44.3 SC)	1 ml/L	13.7 (21.7)	74.0	39.1 (38.6)	56.2	39.2
Azoxystrobin 25 SC (Amistar)	1 ml/ L	18.9 (25.7)	64.1	36.6 (37.2)	59.0	43.4
Tricyclazole 75 WP (Beam)	0.6 g/ L	12.9 (21.0)	75.5	21.7 (27.7)	75.7	43.7
Carbendazim 50 WP (Bavistin)	1 g/ L	22.4 (28.2)	57.5	64.3 (53.3)	27.9	36.4
Propiconazole 25 EC (Tilt)	1 ml/ L	22.9 (28.5)	56.5	81.2 (64.3)	8.97	28.8
Check	-	52.7 (46.5)	-	89.2 (70.8)	-	17.4
CD (*P = 0.05*)		2.21	-	3.73	-	5.12

Figures in parentheses are arcsine transformed values

Evaluation of Azoxystrobin 23% SC against late blight of potato: The test fungicide was found very effective for the management of late blight at 500 ml/ha giving 80.0 per cent control with 38.4 per cent increase in yield as compared to control. The market sample of Azoxystrobin gave slightly less control and increase in the yield as compared with test fungicide. The test fungicide proved effective even at 400ml/ha over Metalaxyl 8% + Mancozeb 64% WP and Mancozeb 75% WP (Table 59).

Table 59: Evaluation of Azoxystrobin 23% SC against late blight of potato during 2013-14

Treatments	Dosage (ml/ha)	Late Blight		Grain Yield	
		Severity (%)	Control (%)	Yield (q/ha)	Increase over control (%)
Azoxystrobin 23% SC	400	19.3 (26.1)	74.3	384.0	27.2
Azoxystrobin 23% SC	500	15.0 (22.8)	80.0	418.0	38.4
Azoxystrobin 23% SC (Market sample)	500	18.7 (25.5)	75.1	404.0	33.8
Mancozeb 75% WP	2000	30.0 (33.2)	60.0	339.0	12.3
Metalaxyl 8% + Mancozeb 64% WP	2500	23.7 (29.1)	68.4	389.0	28.8
Untreated control	-	75.0 (60.1)	-	302.0	-
CD (P=0.05)		3.16		12.7	

Evaluation of Azoxystrobin 11% +Tebuconazole 18.3% SC against yellow rust ofwheat: A new fungicide Azoxystrobin 11% +Tebuconazole 18.3% SC was tested for its efficacy for the control of yellow rust of wheat. Fungicide was tested by laying out trial in RBD with three replications with susceptible wheat variety HS240 during *Rabi* 2013-14. Three doses of viz. 1.0 ml/l, 1.5 ml/l and 2.0 ml/l were evaluated along with Azoxystrobin, Tebuconazole and Propiconazol (1.0 ml/l). Two sprays of test fungicides were given at 15 days interval started with the appearance of yellow rust. Unsprayed plots were treated as control. Two

sprays of Azoxystrobin 11% +Tebuconazole 18.3% SC at all doses were found highly effective for the control of yellow rust of wheat (Table 60).

To evaluate phyto-toxicity of Azoxystrobin 11% +Tebuconazole 18.3% SC on Wheat, one spray at 50 days old crop was given. Phyto-toxicity at three doses viz. 1.5 ml/l, 2.0 ml/l and 3.0 ml/l of test fungicide was observed. No phyto-toxic symptoms could be observed on different parameters viz. leaf chlorosis, leaf tip burning, leaf necrosis, leaf epinasty, Leaf hyponasty, vein clearing, wilting & rosetting on 1, 3, 7 , 10 & 15 days after spray.

Table 60: Evaluation of Azoxystrobin 11% +Tebuconazole 18.3% SC against yellow rust of wheat.

Treatments	Severity (%)	Yield (q/ha)
Azoxystrobin 11% +Tebuconazole 18.3% SC (1ml/l)	3.3 (8.6)	35.2
Azoxystrobin 11% +Tebuconazole 18.3% SC (1.5 ml/l)	1. 7 (4.3)	40.32
Azoxystrobin 11% +Tebuconazole 18.3% SC (2 ml/l)	0 (0.0)	42.5
Azoxystrobin 23 SC (1 ml/l)	6. 7 (14.7)	41.2
Tebuconazole 25.9% EC (1 ml/l)	11. 7 (19.8)	38.1
Propiconazole 25% EC (1 ml/l)	8.3 (16.5)	39.4
Control	76. 7 (61.2)	15.5
CD (0.05)	2.6	3.3

QGU42 10OD against Phytophthora blight in bell pepper: All the treatments were significantly effective in controlling Phytophthora blight caused by *Phytophthora capsici* in bell pepper over the check. QGU 42 (400 ml/ha) was most effective against Phytophthora blight caused by *Phytophthora capsici* in bell pepper giving 88.83% control. QGU 42 (400 ml/ha) and 300 ml/ha) and Ridomil (1500 ml/ha) were statistically at par in controlling the disease. Mancozeb 75 WP was least effective in controlling Phytophthora blight of bell pepper. All the treatments significantly increased the yield over check. QGU 42 (400 ml/ha) gave maximum yield of 111.6 q/ha and was statistically at par with QGU 42 (300 ml /ha) and Ridomil(table 61).

Table 61: Evaluation of QGU42 10OD against Phytophthora blight caused by Phytophthora *capsici* in bell pepper -2012-13

Treatments	**Dosage**		**Phytophthora blight**		**Fruit Yield**	
	g a.i. / ha	**ml or g/ha**	**Severity (%)**	**Control (%)**	**Yield (q/ha)**	**Increase (%)**
Control	-	-	36.7 (37.27)		76.4	-
QGU42 10OD	20	200	13.2 (21.28)	64.03	92.9	17.8
QGU42 10OD	30	300	6.5 (14.74)	82.29	109.5	30.2
QGU42 10OD	40	400	4.1 (11.64)	88.83	111.6	31.5
Mancozeb 75 WP	1125	1500	18.3 (25.31)	50.14	90.7	15.7
Ridomil	1125	1500	4.0 (11.48)	89.10	109.3	30.1
CD (P=0.05)			2.09			3.14

I) **Mushrooms**

One hundred eighty one species of mushrooms are being reported for the first time from Lahoul valley of Himachal Pradesh. These 181 species belong to 58 genera and 32 families of the class Aagaricomycetes and the subphylum Agaricomycotina. Two new genera viz. *Baespora* and *Ricknella* have been recorded for the first time from India. One new species, of the highly delicious and most popular edible mushroom in Lahoul valley, was proposed i.e., *Pleurotus himalayaensis* Dhancholia sp. nov. (Dhancholia, 2013). Glucose peptone found to be the best liquid media and Malt extract as a solid media for the mycelial growth. This species exhibited maximum mycelial growth at temperature 28˚C and preferred acidic pH 6.0 for its growth and primordial initiation. Wheat grains were found to be the best basal medium for spawn production. Glucose peptone found to be the best liquid media and Malt extract as a solid media for the mycelial growth. Maximum fruiting occurs during humidity levels between 80 to 90%. The sporocarps could be developed at 10-12 C with humidity of 85% in the growing room at Palampur taking a total duration of 180 days. It was interesting to note that this mushroom grows in association with the threatened plant *Ferula jaeschkeana*. This mushroom is highly priced in the valley due to its thick flesh, long shelf life and its highly delicious nature hence conservation of this mushroom as well as host plant is highly essential on priority basis before their complete extinction.

J. Miscellaneous Crops

Seabuckthorn

Management

Fusarium wilt of seabuckthorn: The perusal of the data in the table 62 showed that the combined use of bioagents i. e. T1+T2 was found to be very effective followed by T1.

Table 62: Management of Fusarium (*Fusarium* sp.) wilt of seabuckthorn with organic fungicides

Treatment	**Dose g/L**	**Incidence (%)**	**Disease control (%)**
T1= Bio Sanjivani *Trichoderma viride* 1.0% w/w	5.0	20.33(26.76)	46.96
T2= Bio Sanjivani *Pseudomonas fluorescens* 0.5%w/w	5.0	22.33(28.12)	41.74
T3= SUDOCEL (*Pseudomonas fluorescens)*	5.0	24.66(29.75)	35.66
T4= NIPROT 0.50%WP (*Trichoderma viride)*	5.0	21.33(27.46)	44.35
T5= BIOSHIELD *(Pseudomonas fluorescens)*	5.0	23.33(28.84)	39.13
T6= T1+T2	5.0+5.0	18.36(25.31)	52.10
T7= Control		38.33(38.22)	-
CD (0.05%)		**3.70**	**-**

The figures in parenthesis are arc sine transformed values

Powdery mildew of seabuckthorn: The perusal of the data in the table 63.showed that the combined use of bioagents i. e. T1+T2 was found to be very effective followed by T1.

Table 63: Management of Powdery mildew (*Phyllactinia hippophaes*) of seabuckthorn with organic fungicides

Treatment	Dose g/L	Severity (%)	Disease control (%)
T1= Bio Sanjivani *Trichoderma viride* 1.0% w/w	5.0	30.33(33.38)	45.23
T2= Bio Sanjivani *Pseudomonas fluorescens* 0.5%w/w	5.0	33.33(35.23)	39.81
T3= SUDOCEL (*Pseudomonas fluorescens)*	5.0	35.66(36.64)	35.60
T4= NIPROT 0.50%WP (*Trichoderma viride)*	5.0	36.33(37.03)	34.39
T5= BIOSHIELD *(Pseudomonas fluorescens)*	5.0	38.33(38.22)	30.78
T6= T1+T2	5.0+5.0	27.33(31.49)	50.65
T7= Control		55.38(48.07)	-
CD (0.05%)		3.40	-

The figures in parenthesis are arc sine transformed values

Fruit rot (*Monilia* sp.) of seabuckthorn:. The perusal of the data in the table 64.showed that the combined use of bioagents i. e. T1+T2 was found to be very effective followed by T1.

Table 64: Management of fruit rot (*Monilia* sp.) of seabuckthorn with organic fungicides

Treatment	Dose g/L	Incidence (%)	Disease control (%)
T1= Bio Sanjivani *Trichoderma viride* 1.0% w/w	5.0	12.43(20.58)	49.14
T2= Bio Sanjivani *Pseudomonas fluorescens* 0.5%w/w	5.0	14.32(22.21)	41.40
T3= SUDOCEL (*Pseudomonas fluorescens)*	5.0	13.68(21.66)	44.02
T4= NIPROT 0.50%WP (*Trichoderma viride)*	5.0	12.73(20.85)	47.91
T5= BIOSHIELD *(Pseudomonas fluorescens)*	5.0	14.33(22.21)	41.36
T6= T1+T2	5.0+5.0	10.72(19.05)	56.13
T7= Control	-	24.44(29.60)	-
CD (0.05%)		**3.05**	**-**

The figures in parenthesis are arc sine transformed values

Cytospora canker of seabuckthorn The perusal of the data in the table 65 showed that the combined use of bioagents i. e. T1+T2 was found to be very effective followed by T3.

Table 65: Management of Cytospora canker (*Cytospora* sp.) of seabuckthorn with organic fungicides

Treatment	Dose g/L	Severity (%)	Disease control (%)
T1= Bio Sanjivani *Trichoderma viride* 1.0% w/w	5.0	20.44(26.85)	42.14
T2= Bio Sanjivani *Pseudomonas fluorescens* o.5%w/w	5.0	18.23(25.23)	48.40
T3= SUDOCEL (*Pseudomonas fluorescens)*	5.0	17.33(24.55)	50.54
T4= NIPROT 0.50%WP (*Trichoderma viride)*	5.0	20.66(27.01)	41.52
T5= BIOSHIELD *(Pseudomonas fluorescens)*	5.0	16.43(23.87)	53.49
T6= T1+T2	5.0+5.0	14.38(22.25)	59.30
T7= Control		35.33(36.44)	-
CD (0.05%)		**1.90**	**-**

The figures in parenthesis are arc sine transformed values

Rust of Seabuckthorn: The perusal of the data in the table 66 showed that the combined use of bioagents i. e. T1+T2 was found to be very effective followed by T4.

Table 66: Management of Rust of Seabuckthorn with organic fungicides

Treatment	Dose g/L	Severity (%)	Disease control (%)
T1= Bio Sanjivani *Trichoderma viride* 1.0% w/w	5.0	17.43(24.64)	38.75
T2= Bio Sanjivani *Pseudomonas fluorescens* o.5%w/w	5.0	19.33(26.01)	32.08
T3= SUDOCEL (*Pseudomonas fluorescens)*	5.0	20.52(26.90)	27.89
T4= NIPROT 0.50%WP (*Trichoderma viride)*	5.0	16.33(23.80)	42.62
T5= BIOSHIELD *(Pseudomonas fluorescens)*	5.0	20.12(26.67)	29.30
T6= T1+T2	5.0+5.0	14.24(22.12)	49.96
T7= Control		28.46(32.21)	-
CD (0.05%)		**2.07**	**-**

The figures in parenthesis are arc sine transformed values

Alternaria leaf spot of Seabuckthorn: The perusal of the data in the table 67 showed that the combined use of bioagents i. e. T1+T2 was found to be very effective followed by T1.

Table 67: Management of Alternaria leaf spot (*Alternaria* sp.) of Seabuckthorn with organic fungicides

Treatment	Dose g/L	Severity (%)	Disease control (%)
T1= Bio Sanjivani *Trichoderma viride* 1.0% w/w	5.0	12.34(20.51)	53.13
T2= Bio Sanjivani *Pseudomonas fluorescens* o.5%w/w	5.0	16.33(23.79)	37.97
T3= SUDOCEL (*Pseudomonas fluorescens)*	5.0	18.56(25.48)	29.51
T4= NIPROT 0.50%WP (*Trichoderma viride)*	5.0	13.53(21.52)	48.61
T5= BIOSHIELD *(Pseudomonas fluorescens)*	5.0	15.75(23.65)	40.18
T6= T1+T2	5.0+5.0	9.33(17.75)	64.56
T7= Control		26.33(30.84)	-
CD (0.05%)		**2.90**	**-**

The figures in parenthesis are arc sine transformed values

K. Organic Farming

Gram

Management Root rot/wilt: The perusal of data in the table 68 showed that t maximum disease control was obtained by *Trichoderma* (53.8%) followed by , NSKE (43.1%) , *Trichoderma* + Beejamrit (41.9 %), Beejamrit (33.9%) and Panchgavya (31.9%).

Table 68: Effect of different organic products against root rot / wilt disease of gram at Model Organic Farm

Treatments	Concentration @	Germination (%)	Mortality (%)		Root rot / wilt complex (%)	Crop stand (%)	Disease control (%)
			Pre-emergence	Post-emergence			
Trichoderma	5g/kg	92.6 (74.2)	15.6 (23.2)	7.3 (15.6)	22.9 (28.5)	77.1	53.8
Beejamrit	5%	72.3 (58.2)	20.6 (26.9)	12.3 (20.5)	32.9 (35.0)	67.1	33.9
Panchgavya	10%	86.6 (68.5)	20.3 (26.7)	13.6 (21.6)	33.9 (35.6)	66.1	31.9
NSKE	5%	78.3 (62.2)	17.3 (24.5)	11.0 (19.3)	28.3 (32.1)	77.1	43.1
Trichoderma + Beejamrit	5g + 5%	81.5 (64.5)	16.6 (24.0)	12.3 (20.5)	28.9 (32.5)	71.1	41.9
Control	-	67.6 (55.3)	25.6 (30.4)	24.3 (29.5)	49.9 (44.9)	50.1	-
CDp=0.05							

The perusal of data obtained from at Holta Organic Farm (Table 69) showed that maximum disease control was obtained by *Trichoderma* (67.0%) followed by Panchgavya (57.7 %) , *Trichoderma* + Panchgavya (57.1%) , *Trichoderma* + NSKE (56.6%, *Trichoderma* + Beejamrit (55.3%) , NSKE (48.4%) and Beejamrit (39.1%).

Table 69: Organic inputs against Gram root rot/wilt disease at Holta Organic Farm

S No.	Treatments	Germination (%)	Mortality (%)		Stem rot/ wilt (%)	Crop Stand (%)	Disease Control (%)
			Pre-emergence (%)	Post-emergence (%)			
1	*Trichoderma*	82.3(65.1)	5.3(13.3)	5.0(12.9)	10.3(18.7)	89.7	67.0
2	Beejamrit	70.6(57.1)	15.3(23.0)	10.0(18.4)	25.3(30.2)	74.7	39.1
3	Panchgavya	71.6(57.8)	10.0(18.4)	5.3(13.3)	15.3(23.0)	84.7	57.7
4	NSKE	73.5(59.0)	13.6(21.6)	7.3(15.7)	20.3(26.7)	79.7	48.4
5	*T.* + Beejamrit	73.1(58.7)	10.0(18.4)	6.6(14.8)	16.6(24.0)	83.4	55.3
6	*T.* + Panchgavya	76.8(61.2)	9.0(17.4)	6.6(14.8)	15.6(23.2)	84.4	57.1
7	*T.* + NSKE	73.6(59.0)	9.6(18.0)	6.3(14.5)	15.9(23.5)	84.1	56.6
8	Control	66.0(54.3)	25.3(30.2)	21.0(27.2)	46.3(42.8)	53.7	-
CDp=0.05		NS	(10.7)	(6.09)	(15.9)	-	-

Pea

Management

Pest and Disease management modules in Cabbage- Pea intercropping system: The following modules were tested against Pea root rot/wilt complex disease and stalk rot of cabbage (Table70).

Table 70: Modules used for the disease management in Cabbage- Pea intercropping system.

Treatments	Seed treatment	Soil treatment	Spray schedule at different intervals						
			7	75	30	45	60	75	90
M_1	Beejamrit+ Panchgavya	Matarhizum	Panchgavya	FBM	Melia extract	Melia extract	Heeng + Panchgavya	Heeng + Panchgavya	Heeng + Panchgavya
M_2	Panchgavya	Beauveria	Neem oil	Neem oil	Neem oil	Neem oil	Panchgavya	Panchgavya	Panchgavya
M_3	Panchgavya	NSKE	Neem oil	Neem oil	Neem oil	Eupatorium extract	Eupatorium extract	Heeng + Panchgavya	Heeng + Panchgavya
M_4	Trichoderma	NSKE	Dashparni	Dashparni	Dashparni	Lantana extract	Lantana extract	Cow milk	Cow milk
M_5	Trichoderma + Panchgavya	Lantana compost	Panchgavya	Panchgavya	Cow milk + FBM	Cow milk + FBM	Heeng + Cow milk	Heeng + Cow milk	Heeng + Cow milk
M_6	Beejamrit	Eupatorium compost	Ghaniri + FBM	Ghaniri + FBM	Ghaniri + FBM	Ghaniri + FBM	Heeng + Panchgavya	Heeng + Panchgavya	Heeng + Panchgavya
M_7	Panchgavya + Beejamrit	Panchgavya compost	Vertcillium	Vertcillium	NSKE	NSKE	NSKE	NSKE	NSKE
M_8	NSKE	Bidens compost	FBM	Agneastra	Agneastra	Akshvan	Akshvan+ Cow milk	Akshvan+ Cow mil	Akshvan+ Cow mil
M_9	Control								

The perusal of data in the table71 reveal that M 4 module and M 1 module were found statistically at par to control the disease above 59.0% followed by M 7 (51.5%), M 2 , M 6 (48.8%) and M 8 (49.4%). For stalk rot of cabbage, M5 module was found most effective to control the disease up to 69.9 % followed by M 2 (47.1%) and M1(45.1%).

Potato

Management

The perusal of data obtained from at Model Organic Farm (Table 71) showed that maximum disease control was obtained by ***Trichoderma* @ 5.0 g/kg of seed and Tamarlassi 5%** (50%) followed by **Panchgavya @ 10%/kg of seed and Orguard 10% (**42.8%)..

Table71. Organic pest and Disease management modules in Cabbage- Pea intercropping system at Model Organic Farm

Treatments	Germination (%)	Mortality (%)		Pea root rot / wilt complex (%)	Crop stand (%)	Disease Control (%)	**Cabbage *(Sclerotinia* rot)**	
		Pre-emergence (%)	Post-emergence (%)				Disease Severity (%)	Disease control %
M_1	86.3 (68.2)	12.3 (20.5)	9.6 (18.0)	21.9 (27.9)	78.1	59.0	24.3 (29.5)	45.1
M_2	80.6 (63.8)	16.3 (23.8)	10.6 (19.0)	26.9 (31.2)	73.1	48.8	23.3 (28.8)	47.4
M_3	84.3 (66.6)	20.6 (26.9)	10.6 (19.0)	31.2 (33.9)	68.8	35.7	31.0 (33.8)	30.0
M_4	74.0 (59.3)	13.0 (21.1)	8.6 (17.0)	21.6 (27.6)	78.4	59.6	30.0 (33.2)	32.2
M_5	78.6 (62.4)	15.3 (23.0)	7.3 (15.6)	22.6 (28.3)	77.4	47.5	13.3 (21.3)	69.9
M_6	79.7 (63.2)	16.3 (23.8)	10.6 (19.0)	26.9 (31.2)	73.1	48.8	38.6 (38.4)	12.8
M_7	70.3 (56.9)	16.6 (24.0)	9.0 (17.4)	25.6 (30.4)	74.4	51.5	36.6 (37.2)	17.3
M_8	71.0 (57.4)	15.6 (23.2)	11.0 (19.3)	26.6 (31.0)	73.4	49.4	32.0 (34.4)	27.7
M_9	64.6 (53.4)	28.3 (32.1)	21.6 (27.6)	50.9 (45.5)	49.1	-	44.3 (417)	-
CDp=0.05								

Table 71: Effect of different organic products against Early blight disease of potato

S No.	Seed Treatments	Spray with organic inputs	Disease Severity %	PEDC %
1	*Trichoderma*	Tamarlassi	22.2(28.1)	50.2
2	Azotobactor + PSV	Panchgavya	28.2(32.0)	36.7
3	Panchgavya	Orguard	25.5(30.2)	42.8
4	Beejamrit	CPP	34.3(35.8)	23.0
5	*Trichoderma* + Azotobactor+Panchgavya	*Trichoderma* + Azotobactor+Panchgavya	28.7(32.4)	35.6
6	*T.* + Panchgavya	*Trichoderma* + CPP	28.5(32.2)	36.0
7	*T.* + Beejamrit	*Trichoderma* + Orguard	28.0(31.9)	37.2
8	*Trich.* + Azoto. + PSV + Panch. + Beej.	*Trichoderma.* + Tamarlassi	27.7(31.7)	37.8
9	Control	Control	44.6(41.9)	-
CDp=0.05				

EXTENSION EDUCATION

The extension activities undertaken by the teachers/scientists and extension specialists of the department at the main campus, research stations and KVKs during 2013-2014 are described under the following heads.

On farm trials: Twenty nine on farm trials for the management of different diseases viz. pea root / wilt complex disease, pea powdery mildew , false smut of paddy , root rot / wilt/ damping off okra , late & early blight of potato and BLSB of maize were conducted during the year.

Field demonstrations: Field demonstrations on management practices of important diseases were conducted and monitored by the scientists/extension specialists. During 2013-14, 237 demonstrations on different cereals, oilseeds and vegetable crops were conducted at different locations.

Training programmes: Scientists/extension specialists organized/ participated in about 79 off-campus, 56 on-campus, 13 in-service and 17 vocational trainings in which more than 7219 participants received training. These trainings were organized for the benefit of farmers, farmwomen, rural youth, unemployed graduates and officers of different departments of H.P. and extension personnel. Scientists imparted specialized training on diagnosis and management of diseases of various crops. They also imparted training to different beneficiaries by participating and delivering specialized lectures organized by other agencies.

Scientists of the department also imparted 12 training programmes on mushroom cultivation and benefited about 1025 farmers. Besides this, 85 quintals. quality spawn of mushrooms was produced in the Spawn Laboratory during the year.

Adaptive research: Scientists conducted 16 adaptive research trials at farmers' fields on the management of different diseases. Trials on new Oyster Mushroom strain were conducted for its successful cultivation at grower's farms in winter.

Kisan Melas/Kisan Divas/Field Days: The teachers/scientists/extension specialists participated in the Kisan melas/ divas, field days etc from time to time whenever they were held during the year. They organized/participated in about 49 Kisan melas/field days/divas in which about 6055 farmers attended and were familiarized with various disease problems and their management. Scientists also participated in different crop seminars in which a large number of farmers participated.

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

Farmer's advisory service: A large number of disease and seed samples of various crops received from farmers, extension personnel from Department of Agriculture and University were diagnosed and suitable remedial measures suggested. During the field visits and survey tours, this service was also extended to the farmers. A large number of trainees were trained in compost making and mushroom growing. A regular advisory service for the dignosis and management of disease problems were extended to the farmers of Himachal Pradesh through ATIC centre in the Directorate of Extension Education by different experts in Plant Pathology.

Lectures: The teachers/scientists/extension specialists delivered about 346 lectures to different beneficiaries in different trainings and workshops etc.

TV/ Radio talks

- Radio talk : 7
- Television talk : 6

ACADEMIC EXCELLENCE

- NET: 4 PG students

PUBLICATIONS

Research

A) Published

Singh, Dhanbir and Sharma, Savita. 2013. Tebuconazole 060 FS(Raxil 060 FS)- A new seed dressing fungicide formulation for the control of flag smut and loose smut of wheat. Pestology 37(5) 34-35.

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Dhancholia, S. 2013. *Pleurotus himalayaensis* Dhancholia sp. nov., a highly delicious edible mushroom from dry temperate cold desert of Lahoul valley in Himachal Pradesh. *American Eurasian Journal of Agricultural and Environmental Sciences* **13** (1):44-49.

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Kumar, Suman and Kumar, Pardeep.(2013). Efficacy of seed treatment , seedling dip and foliar sprays for the management of fruit rots of brinjal (*Solanum melongena*).*J Mycol Pl Pathol, 43 (1) : 99-101*

Kumar, Suman and Kumar, Pardeep.(2013). Mapping of fungi associated with fruit rots of brinjal (*Solanum melongena)* under Himachal Pradesh conditions. *Indian Phytopathology, 66 (2) : 211-212*

Kumari, V., Chaudhary, H. K., Kumar, A., Prasad, R., Jambhulkar, S. and Sharma, S. (2013). Effect of gamma radiations on *in vitro* regeneration in *Brassica carinata* A. Braun. *International Journal of Scientific and Research Publications* **3**(2): ISSN 2250-3153.

Kumari, V., Kumar, A., Chaudhary, H.K., Prasad, R., Jambhulkar, S. and Sharma, S. (2013). Variability in *Alternaria brassicae* and characterization of host response in Ethiopian mustard (*Brassica carinata* A. Braun). *Journal of Oilseed Brassica.* **4**(2): 83-89.

Kumari, V., Kumar, A., Chaudhary, H.K., Prasad, R., Jambhulkar, S. and Sharma, S. (2014). *In vitro* screening method: An efficient tool for screening *Alternaria* blight resistance/tolerance during early generations in Ethiopian mustard (*Brassica carinata* A. Braun). *African Journal of Agricultural Research.* **9**(1): 137-143.

Mankotia, B.S., Thakur, K.S., Chandel, U., Acharya, M. and Kumar, A. (2013). Performance of mustard hybrids (*Brassica juncea* L.) at varying fertility levels in mid hills of Himachal Pradesh. *Himachal Journal of Agricultural Research* **39**(1): 80-82.

Manoj Gupta; V.K.Rathee and P .Mittal **(**2013) Mushroom cultivation :an income genrating venture for farmers of district Sirmour . Paper presented in the National seminar on "Mushrooms for medicinal value and nutritionlsecurity under changing climatic conditions" organized by Indian Mushroom Growers Association and Department of Plant Pathology, Dr. Y.S.ParmarUniversity of Horticulture and forestry ,Nauni, Solan(H.P)-173230,India during December 27-28,2013 at UHF, Solan *pp: 24-25(46).*

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Selvakumar, R., R.P.S.Verma, M.S. Saharan, S. C. Bhardwaj, P.S. Shekhawat, Madhu Meeta, Dhanbir Singh, Rakesh Devlash, S.S. Karwasra, S.K. Jain, and Indu Sharma.(2013). Identification of resistance sources Barley yellow rust (*Puccinia striiformis* fsp. *Hordei* in India. Ind. J.Plant Genet. Resources 26 (2) : 128-131.

Rana, S.K, Rana,Vijay, Srivastava, Ajai, Sharma, B.K., Singh, Amar, Singh, Anand and Sud, Deepika. 2013**.** Status of Yellow rust (*Puccinia stariformis* west end) of wheat in Himachal Pradesh. *Himachal Journal of Agricultural Research*. 39(2): 135-139.

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B) Research paper accepted

Sharma PN, Nag Ruby, and Katoch A. 2014. Evaluation of frenchbean varieties for resistance to *Colletotrichum lindemuthianum* races causing bean anthracnose Himachal J. Agric. Res.(MS 1363-HJ: Accepted).

Kumar, Arun., Katoch, A. and Kuamr, A. (2014). Status and distribution of *Alternaria brassicae* associated with rapeseed-mustard in Himachal Pradesh. *Himachal Journal of Agricultural Research* (Accepted).

C) Presented

Kumar Naveen, Sood VK, Banyal DK and Katoch Rajan. 2013. Forage recourses in the hills of North Westeren Indian Himalaya. Souvenir, AICRP on Forage crops. National group meet (Rabi 2013held at JNKVV Jabalpur from 7-8th Sep.2013 (MP). 68-73p

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Pathania A., **Sharma S.K**, Rana J.C and Kumar Suman. Diversity in agro-morphological traits of amaranth in North-Western Himalayas. Poster Presentation in International Conference on "Crop Productivity and Sustainability -Shaping the future" on 20-21 March 2014 at Baba Farid College, Bhatinda.

Saharan M.S., Bhardwaj S.C., Selvakumar R., Jindal M.M., Rana S.K., Devlash R., Singh D., S.S. Karwasara, R.K. Bansal, D. Shikha, M.K. Pandey, Z.A. Bhat and I. Sharma (2014). Paper presented in BGRI 2014 Technical Workshop w.e.f 22---25 March, 2014 Obregon, Mexico.

Selvakumar R., R.P.S. Verma, M.S. Saharan, S.C. Bharwaj, P.S. Shekhawat, M.M. Jindal, D. Singh, R. Devlash, S.S. Karwasra, S.K. Jain and I. Sharma (2013) Evaluation of barley genotypes for stripe rust resistance in India. Paper presented in BGRI 2013 Technical Workshop w.e.f. 19–22, August 2013 at New Delhi, India.

Sharma Neetu and Sud Deepika. 2013. Women empowerment through self help groups; an impact assessment in District Hamirpur, Himachal Pradesh. International Conference on "Extension Education Strategies for Sustainable Agricultural Development-A Global Perspective" December 5-8, UAS, Banglore. (Abstract, 346 p.)

Singh Amar, Jai Dev, Banyal, D.K. and Kata, G. 2014. Screening of soybean (*Glycine max*) germplasm for multiple disease resistance. Abstract in proceedings of SOYCON-2014 International Soybean Research Conference on "Mitigating Productivity Constraints in Soybean for Sustainable Agriculture" organized by Society for Soybean Research and Development, at DWR, Indore during February 22-24,2014: 254-55

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Thakur, B. R. and Masand, Sachin. 2014. Evaluation of bioformulations of local strains of *Trichoderma* against pea root rot/wilt complex pathogens. *Paper* presented in National Seminar on "Organic Agriculture- Challenges and Prospects" held on 28th and 29th May 2014

Thakur, K.S., Kumar, A., Mankotia, B.S., Kumar, Ashok. and Chandel, U. (2014). Comparative performance of rapeseed-mustard varieties at different dates of sowing under mid-hill conditions of Himachal Pradesh. Paper presented in 2nd National Brassica Conference on Brassicas for addressing edible oil and nutritional security held at PAU, Ludhiana on Feb. 14-16, 2014.

Books/Chapters/Booklets:

Charma (Seabuckthorn) ka vagyanik vidhi se baag lagana. by Pardeep Kumar (2013).

Extension

Popular articles

Banyal, D.K., Singh Amar and Chaudhary Jaya. 2014. Polyhouse main sabjiaon ki bimarian abum roktham (hindi). ***Parvatia Khati Bari*.** 34 (2): 31-32

Rathee, V.K. 2013.Sabjion me ket niyantaran ke sidhant. *Krishi Vigyan Patrika .19(379):5-6*

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Ravinder Singh, Deepika Sud and Reena Kaushal. **2011**. Value added products of elephant foot. **Intensive Agriculture**, Jan-Feb., 57(1)8-10pp.(Published in 2014)

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Singh Akhilesh, Reena Kaushal, Singh Ravinder , Chaubey AK & Kalpna Kashyap (2013).Important diseases of Mentha sp (Mint.) *Indian Farmers Digest*. 46 (7) July 2013 : 9-10.

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Seema Shah, Singh Akhilesh and Kalpna Arya (2013) Mushrum Ka Mulya Samvardhan *Kheti Dunia* 18(51) : 4&7

Ajay Srivastava, Sudheer Kumar Rana and Vijay Rana 2013. Gehun ka Surakshit Bhandaran evam Keet Prabandhan. Giriraj Saptahik , 14 August, 2013 (5).

Thakur, B. R. 2013. Badlate mosam mein ubhartee rogon se asee neptein. *Parvatya Khetibari.* 33 (3):21-22.

Kumar, Suman, 2013. Aloo ka pachate jhulsa rog va uska roktham. Giriraj, 8 May, 2013

Kumar, Suman, 2013Bhindi ke bimariyan va uski roktham. Giriraj, 5th June, 2013

Gehun ki fasal mein rog parbandhan. 2014. Rakesh Devlash, Naval Kishore and Gurudev Singh. Giriraj Saptahik January 26, 2014. *(In Hindi)*

Rabi sabjiyon ki parmukh bimariyan evam niyantran. 2014. Rakesh Devlash and Rajinder Singh Jamwal. Giriraj Saptahik March 26, 2014. *(In Hindi)*

Pamphlets

Virendra Singh; A. R. Khan; L. K. Sharma; R.K. Rana; Bhupinder Singh, Pradeep Kumar; Pankaj kumar; Sunil Kumar and Sonika Chaudhary. 2013. Charma (Seabuckthorn) ka Baag Lagain.

Pamphlet on **"Gehun ka Peela Ratua : Lakshan evam Prabandhan"** depicting the strategies for effective management of yellow rust of wheat was revised and got published in September, 2013. Jointly prepared by CSKHPKV, Palampur and Department of Agriculture, Himachal Pradesh.

Card on **"Gehun ka Peela Ratua evam Prabandhan"** depicting the strategies for effective management of yellow rust of wheat was revised and got published in September,

2013. Jointly prepared by CSKHPKV, Palampur and Department of Agriculture, Himachal Pradesh.

Miscellaneous activities
Member of Editorial Board/ professional societies

1. Dr PN Sharma, Member editorial Board, Inidan Phytopathology, Journal of Mycology and Plant Pathology and Plant Disease research.

Summary/ Salient Achievements

- Two entries of rice developed at RWRC, Malan viz., HPR 2706 and HPR 2691 showed multiple disease resistance against sheath blight and BLB, and leaf and neck blast respectively.
- Tricyclazole (Beam) 75 WP resulted in maximum reduction in leaf blast severity i. e. upto75.5 %.
- Tilt (propiconazole) 25 EC (0.1%) was most effective against yellow rust of wheat enhancing the yield by 18% over the check.
- Seed treatment with Exzole 2 DS @ 0.1% per kg seed has been recommended against loose smut of Wheat.
- Release of variety of Tall Fescue 'Hima-14 'in AICRP workshop at Jabalpur on 7th - 8th September 2013.
- Soybean lines JS 20-65, JS 20-87 and MAUS 26-1 showed multiple disease resistance against three diseases (frogeye leaf spot, pod blight and brown spot).
- *PALAM TRICHOFORM*-a bioformulation developed from resident strains of *Trichoderma* against soil borne pathogens.
- Two new emerging diseases i. e. gray leaf spot of capsicum caused by *Stemphylium* sp. and target leaf spot of tomato by *Corynespora cassiicola* recorded under protected cultivation in Himachal Pradesh for the first time from India.
- *Pleurotus himalayaensis* Dhancholia sp. nov. - highly delicious edible mushroom was reported from Lahaul valley.
- Demonstrations on cultivation of Oyster mushroom for popularization.