ANNUAL PROGRESS REPORT

2021-22

Department of Plant Pathology

College of Agriculture

CSK Himachal Pradesh KrishiVishvavidyalaya

PALAMPUR-176062 (HP)

ANNUAL PROGRESS REPORT

(2021-22)

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Department of Plant Pathology

College of Agriculture

Chaudhary Sarwan Kumar
Himachal Pradesh Krishi Vishvavidyalaya
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ACKNOWLEDGEMENT

The 36th Annual Progress Report of the department has been brought out with the co-operation of the whole faculty deployed in the department, different Research Centers, Research Sub-stations and Krishi Vigyan Kendras of the university located at different regions of the state. I express my appreciation to all of them. I am especially thankful to the committee comprising of Dr Amar Singh, Dr. Pardeep Kumar and Dr Deepika Sud for compilation and editing of the report.

I express my deep sense of gratitude to the honorable Vice-Chancellor for the motivation and encouragement rendered to the 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 sinsere help and scientific co-operation whenever required. My thanks are also due for the staff of the department for their co-operation in printing/ photo copying and binding of the report.

Date: 01.11.2022 *Head of the Department*

CONTENTS

1. INTRODUCTION

The Department of Plant Pathology has the mandate of teaching, research and extension education pertaining to different streams of plant patholozy viz., Mycology, Virology, Bacteriology, Epidemiology, Plant Disease Management and Mushrooms. Scientists conduct research on different areas of specialization under different projects and the students admitted to M.Sc and Ph.D programmes are assigned research problems on different aspects of diseases of cereals, pulses, oilseeds, vegetable crops and mushrooms.

The research work on various ad-hoc projects & AICRPs is being carried out in the main department at Palampur, Hill Agriculture Research & Extension Centres (Bajaura, Dhaulakuan and Kukumseri), Shivalik Agriculture Research & Extension Centre (Kangra), Rice & Wheat Research Centre (Malan) and Research Stations (Berthin and Akrot). Research on wheat diseases is mainly carried out at Malan, Dhaulakuan and Bajaura, on rice diseases exclusively at Malan and on maize diseases at Bajaura and Dhaulakuan, whereas, the research on diseases of pulses is carried out at Palampur, Berthin and Dhaulakuan and on oilseed crops at Kangra and Palampur. Among diseases blast, yellow rust, banded leaf & sheath blight, bacterial stalk rot, anthracnose, powdery mildews, downy mildews, bacterial wilt and canker, late blight, fusarial wilt, white rot, root rot /wilt complex, fruit rots and viral diseases receive special attention.

The department is also conducting research on different aspects of cultivation of mushrooms including their diseases. 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 various seminars/ symposia/ conferences organized by different scientific societies and workshops held by AICRPs and University from time to time.

Several *ad-hoc* research projects are being carried out in the department with financial support from different agencies *viz.*, Government of Himachal Pradesh, RKVY, ICAR, DST and fungicide companies.

The department is engaged in various extension education activities such as advisory service to farmers for diagnosis and management of diseases, conducting on farm trials & field demonstrations, participation in district/ state level workshops/ seminars/ field days/ kisan melas and on & off campus trainings etc. The scientists of the department are also actively involved in training and disseminating mushroom cultivation technology to the mushroom growers.

2. STAFF POSITION

a. Faculty

The faculty strength of the discipline/ department borne on teaching, research and extension schemes has been given in the following Table.

Name	Position/ Designation	E-mail
Dr D K Banyal	Professor & Head	dkbanyal@gmail.com
Dr S K Rana	Principal Scientist cum Librarian and SWO	skrana62@gmail.com
Dr Arun Sud,	Principal Extension Specialist & Programme Director CMRT	arunsud7217@gmail.com
Dr Amar Singh	Principal Scientist	singhamar008@gmail.com
Dr Deepika Sud	Assistant Extension Specialist/ Subject Matter Specialist	deepika_agri@rediffmail.com
Dr. Shikha Sharma	Assistant Professor	shi.bha.80@gmail.com
Hill Agricultural Research & Extension Centre, Bajaura – 175125		
Dr R K Devlash Vacant	Principal Scientist Senior Scientist	devlashbajaura@rediffmail.com -
Hill Agricultural Research & Extension Centre, Dhaulakuan – 173031		
Hill Agricultural Research & Extension Centre, Kukumseri - 175142		
Vacant	Scientist	-
Mountain Agricultural Research & Extension Centre, Sangla – 172106		
Vacant	Scientist	
Shivalik Agricultural Research & Extension Centre, Kangra – 176001		
Vacant	Scientist	
Rice & Wheat Research Station, Malan – 176047		
Dr Sachin Upmanyu Vacant	Scientist Scientist	sachinupmanyu_mpp@rediffmail.com -
Research Sub-Station, Akrot – 177211		
Dr B K Sharma	Principal Scientist & Scientist Incharge	sharmabk63@yahoo.com
Research Sub-Station, Sunder Nagar - 175019		
Vacant	Scientist	-
Directorate of Extension Education, Palampur - 176062		
Dr Arun Sud,	Principal Extension Specialist	arunsud7217@gmail.com
Krishi Vigyan Kendra, Dhaulakuan - 173031		
Dr Shiwali Dhiman	Assistant Extension Specialist	shiwalidhiman7@gmail.com
Krishi Vigyan Kendra, Kukumseri – 175142		
Dr. Shabnam Katoch	Subject Matter Specialist	skatoch6292@gmail.com
Krishi Vigyan Kendra, Bara - 177044		
Dr Pardeep Kumar	Subject Matter Specialist/Programme Coordinator	pkdogra2007@rediffmail.com
Krishi Vigyan Kendra, Kangra - 176001		
Dr. Deepika Sud	Subject Matter Specialist	skatoch6292@gmail.com
Krishi Vigyan Kendra, Berthin - 174029		
Dr Suman Kumar	Subject Matter Specialist/ & Programme Coordinator	sumanhpkv@gmail.com
Krishi Vigyan Kendra, Una - 174303		
Vacant	Subject Matter Specialist	-
HAREC, Lari (Lahaul and Spiti)- 172113		
Dr. Joginder Pal	Assistant Professor	jpal5889@gmail.com

(b) Staff

The department is having a total strength of 6 staff members borne on various teaching and research schemes as given below.

Staff	Name & Designation
Ministerial Staff	
1	Sh Ravi Kumar, Senior Assistant
Technical Staff	
1	Sh Naresh Kumar, Field Assistant G-I)
2	Sh Himat Ram, Junior Technician
3	Sh Balwant Singh (Tech Asstt Gr-II) (deputed at Salooni from 19.06.18)
4	Sh Subhash Chand Lab Attendent
Supporting Staff	
1	Sh Desh Raj, Beldar

3. FINANCIAL OUTLAY AND STAFF POSITION IN DIFFERENT SCHEMES

The receipt of funds under plan and non plan schemes for 2021-22 is as given under:

Name of the Scheme	Expdt (Lac Rs.)	Staff
Creation of facilities for Postgraduate Studies in the Department (APL-001-17)	22.78	Sh Harbans Lal, Sr Asstt (Biotech) Sh Shakti Chand, Jr Technician (COBS) Sh. Subhash Chand, Beldar w.e.f. 01.09.2022
Facilities for teaching in the Department/ College of Agriculture (APL-010-17)	78.18	Dr S K Rana, Professor & Head Dr A K Sud, Principal Extension Specialist Sh Ravi Kumar, Senior Assistant Sh Vijay Kumar (Security Cell) Sh Balwant Singh, Tech Asstt G-II (RRS Salooni)
Strengthening of facilities for research in the Department (APL-021-17)	10.63	Sh Ramesh Kumar, Beldar (Seed Tech) Sh Desh Raj, Beldar
All India Coordinated Research Project on Seed Technology Research under NSP (ICAR-017-17 Pt-II)	9.78	Sh. Himat Ram, Jr. Tech.
All India Coordinated Mushroom Improvement Project (ICAR-056-17)	10.91	-
Molecular mapping of anthracnose resistance gene in common bean land race KRC8 and identification of adult plant resistance components (DST- GOI-5042-17)	10.63	Dr. Anila Badiyal, Research Associate upto Feb. 2022
Fungicide testing (Ad Misc 626-17)	4.35	-
Protected Agriculture and Natural Farming (PANF) under NAHEP-CAAST Programme (NAHEP-ICAR-231-17)	5.49	Ms. Diksa Sinha, JRF
Assessment, Validation and refinement of disease management technology for vegetable crops	10.99	Mr. Vakul Sood, JRF
Self Finance Scheme (SFS-001-17)	2.31	-
Revolving Fund (RF-A-46-036-17)	3.28	-
Revolving Fund Scheme under SFS (Experiential Learning) (RF-B-61-142-17)	0.45	-
Central Assistance Development (CDA-010-17)	0.89	-
Central Assistance Development (CDA-011-17)	0.50	
Total	**171.17**	

4. TEACHING

a. Courses offered/ taught:

(i) UG courses			
Course No.	**Course Title**	**Cr Hr**	**Teacher(s)**
Pl Path 352	Principles of Integrated Disease Management	2+1	Dr Amar Singh/ Dr. Sachin Upmanyu
Pl Path 353	Diseases of Field & Horticultural Crops and their Management-I	2+1	Dr. Deepika Sud/Dr A K Sud
Pl Path 121	Fundamentals of Plant Pathology	2+1	Dr Amar Singh/ Dr. Sachin Upmanyu
Pl Path 364	Diseases of Field & Horticultural Crops and their Management-II	2+1	Dr Deepika Sud/ Sachin Upmanyu
Pl.Path. 475	Mushroom Cultivation (Semester-I) Exp Learning	0+10	Dr A K Sud/ Dr Deepika Sud
Pl.Path. 475	Mushroom Cultivation (Semester-II) Exp Learning	0+10	Dr A K Sud/Dr Deepika Sud Dr. Pardeep Kumar
(UG courses offered by other Departments)			
Agron 3613	Agrochemicals	2+1	Dr D K Banyal
Soils 354	Biopesticides & Biofertilizers	2+1	Dr Amar Singh

(ii) PG courses			
Pl Path 501	Mycology	2+1	Dr Deepika Sood
Pl Path 502	Plant Virology	2+1	Dr S Upmanyu/ Dr. Shikha Sharma
Pl Path 503	Plant Bacteriology	2+1	Dr S K Rana Dr Shabnam
Pl Path 504	Principles of Plant Pathology	2+1	Dr Amar Singh/ Dr. Joginder Pal
Pl Path 505	Detection and Diagnosis of Plant Diseases	0+2	Dr S K Rana/ Dr D K Banyal Dr Amar Singh/ Dr. Shikha Sharma
Pl Path 506	Principles of Plant Disease Management	2+1	Dr Amar Singh/
Pl Path 510	Seed Health Technology	2+1	Dr S K Rana
Pl Path 511	Chemicals in Plant Disease Management	2+1	Dr D K Banyal
Pl Path 513	Disease Resistance in Plants	2+0	Dr. SK Rana
Pl Path 518	Epidemiology and Forecasting of Plant Diseases	2+1	Dr D K Banyal/ Dr Joginder Pal
Pl Path 591	Master's Seminar -I/II	1+0	Dr Deepika Sud
Pl Path 599	Master's Research	1-18	Major Advisors
Pl Path 601	Advanced Mycology	2+1	Dr Deepika Sud
Pl Path 602	Advanced Virology	2+1	Dr S Upmanyu
Pl Path 603	Advances in Plant Pathogenic Prokaryotes	2+1	Dr S K Rana Dr Pardeep Kumar
Pl Path 604	Molecular Basis of Host Pathogen Interaction	2+1	Dr Amar Singh / Dr. Shikha 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 A. K. Basandhrai/ Dr. Sachin Upmanyu
Pl Path 691/692	Doctoral Seminar-I/ II	1+0	Dr Deepika Sud
Pl Path 699	Doctoral Research	1-18	Major Advisors

b. Students admitted:

S. No.	Name of student	Major advisor	Title of research problem
M Sc Programme			
1	Pragti Shree (A-2021-30-047)	Dr. Sachin Upmanyu	Ecofriendly management of false smut of rice caused by Ustilaginoidea virens (Cke) Tak.
2	Shilpa Sharma (A-2021-30-050)	Dr. Pardeep Kmar	Biological management of bacterial wilt of tomato caused by *Ralstonia solanacearum*
3	Dipanshi Thakur (A-2021-30-068)	Dr. Deepika Sud	Evaluation of organic additives on bio efficacy of Pleurotus ostreatus (Jacq.) P. Kumm.
4	Gaurav Katoch (A-2021-30-069)	Dr. Suman Kumar	Studies on collar rot of elephant foot yam caused by *Sclerotium rolfsii*
5	Shiwali Thakur (A-2021-30-071)	Dr. Amar Singh	Eco-friendly management of collar rot of soybean caused by *Sclerotium rolfsii* Sacc.
6	Tanisha Gupta (A-2021-30-072)	Dr. Rakesh Devlash	Investigations on banded leaf and sheath blight of maize cused by *Rhizoctonia solani* Kuhn
7	Twinkle (A-2021-30-073)	Dr. Amar Singh	Detection and management of seed borne mycoflora of soybean (*Glycine max* (L.) Merrill)
8	Mansi Arora (A-2021-30-0117)	Dr. Shikha Sharma	Characterization of viruses associated with capsicum under protected cultivation I Himachal Pradesh
9	Ms Kavita Kushwaha (A-2021-30-118)	Dr Joginder Pal	Fungal root endophytes mediated management of pea root rot in Himachal Pradesh
Ph. D. Programme			
1	Riya (A-2021-40-052)	Dr. Deepika Sud	Evaluation of germplasm and organic additives for quality production of *Lentinula edodes* (Berk.) Pegler
2	Akshay Pathania (A-2021-40-051)	Dr. Sachn Upmanyu	Virulence diversity of *Pyricularia oryzae* Cavara and identification of resistant sources against rice blast
3	Somya Hallan (A-2021-40-032)	Dr. Suman Kumar	Etiology and management of storage rot of garlic
4	Sonali Parwan (A-2021-40-033)	Dr. D. K. Banyal	Epidemiology, variability and management of purple blotch of garlic cused by *Alternaria porri* (Ellis) Cif.
5	Chetna Mahajan (A2021-40-031)	Dr. Rakesh Devlash	Epidemiology and manament of brown spot of maize (*Zea mays* L.) caused by *Physoderma maydis* (Miyabe) Miayabe

c. Ongoing students:

S No	Name of student	Major advisor	Title of research problem
M Sc Programme			
1	Anshul Kumar Sharma	Dr. Amar Singh	Biology of *Colletotrichum truncatum* causing anthracnose of soybean and identification of resistant sources
2	Nidhi	Dr. Deepika Sud	Fortification of substrates to produce bio-enriched oyster mushrooms
3	Nikhil Rana	Dr. B. K. Sharma	Studies on black point of wheat in Himachal Pradesh
4	Preeti	Dr. Sachin Upmanyau	Management of false smut of rice caused by Ustilaginoidea virens (Cke.) Tak.
5	Parul Upadhyay	Dr. D. K. Banyal	Etiology ad epidemiology of Ascochyta leaf spot of Urdbean
6	Sachin Sharma	Dr. Pradeep Kumar	Eco-friendly management of bacterial wilt of tomato

Ph D Programme			
1	Ms Diksha Sinha (A-2019-40-024)	Dr D K Banyal	Biology and management of early blight of tomato caused by *Alternaria Solani*
2	Ms Khushwinder Kaur (A-2019-40-025)	Dr Amar Singh	Diversity analysis of *Pseudocercospora griseola* populations causing angular leaf spot of common bean and identification of resistant sources
3	Vakul Sood (A-2019-40-026)	Dr A K Sud	Studies on variability in pathogen(s) causing root rot of okra and its integrated disease management
4	Ms Priya Bhargava (A-2017-40-021)	Dr S K Rana	Epidemiology and management of flag smut *(Urocystis agropyri* (Preuss) Schroet) of wheat
5	Ms Abhilasha Sharma (A-2018-40-023)	Dr Amar Singh	Characterization of variability in *Cercospora sojina* Hara causing frogeye leaf spot and identification of resistant sources in soybean
6	Ms Gurpreet Kaur (A-2018-40-024)	Dr S K Rana	Epidemiology and management of Fusarium head blight of wheat

d. Students completed M Sc / Ph D programme:

	Name of student	**Major advisor**	**Title of thesis**
	M Sc programme		
1	Ms Ayushi Sharma (A-2019-30-067)	Dr Amar Singh	Biological control of pea root rot caused by *Fusarium solani* f. sp. *pisi*
2	Ms Kajal (A-2019-30-068)	Dr Rakesh Devlash	Epidemiology of Turcicum leaf blight in maize and identification of resistance sources
3	Ms Monika Rathi (A-2019-30-069)	Dr Sachin Upmanyu	Virulence analysis of *Rhizoctonia Solani* Kuhn and evaluation of resistance in rice
4	Ms Ridhima Gupta (A-2019-30-070)	Dr S K Rana	Biology of *Xanthomonas axonopodis* pv *glycines* causing bacterial pustule of soybean and identification of resistance sources
5	Ms Sakshi Sharma (A-2019-30-071)	Dr B K Sharma	Studies on epidemiodogy of lentil wilt and host resistance
6	Ms Tarushi (A-2019-30-072)	Dr Deepika Sud	Studies on synthetic log cultivation of Shiitake mushroom *Lentinula edodes*
	Ph D programme		
1	Ms Ashima Thakur (A-2017-40-019)	Dr D K Banyal	Epidemiology and management of Stemphylium blight of onion

e. Students' placement

Name of Student & Admission No.	**Name of Major Advisor**	**Nature of Placement along with Details**
Mr. Anudeep B M (A-2016-40-017)	Dr D. K. Banyal	Plant Protection officer, Govt of India
Ms Shabnam Katoch A-2015-40-020	Dr S K Rana	Subject Matter Specialist, KVK, Kukumseri
Ms Shiwali Dhiman A-2015-40-021	Dr P N Sharma	Subject Matter Specialist, KVK, Dhaulakuan

f. Salient Achievements of Students' Research.

M. Sc.

1 **Monika Rathi (**A-2019-30-069), Advsor: Dr. Sachin Upmanyu

Thesis title: Virulence analysis of *Rhizoctonia solani* Kuhn and evaluation of resistance in rice

Significant findings:

- Twenty isolates of *Rhizoctonia solani* were studied and colony colour varied from cream to dark brown while hyphal cell size ranged from 102.90 x 4.20 µm to 220.50 x 5.95 µm.
- Studies on pathogenic variability among *R. solani* isolates carried out on seven different rice cultivars showed that the relative lesion height (RLH) caused by the isolates varied from 15.38 to 55.71per cent on different different cultivars.
- On the basis of RLH induced on different cultivars, ten *R. solani* isolates were classified as highly virulent (>45 % RLH), seven as moderately virulent (35-45% RLH) and three as less virulent (<35% RLH).
- Out of sixty seven genotypes, seven genotypes showed resistant, reaction on the basis of disease severity while, no genotype was found immune.

2 **Ms Ridhima Gupta** (A-2019-30-070) Advisor: Dr. S K Rana

Title of thesis: Biology of *Xanthomonas axonopodis* pv. *glycines* causing bacterial pustule of soybean and identification of resistance sources

Significant findings:

- The bacterial leaf pustule of soybean was recorded from four locations viz. Utrala, Mahakal, Nagri and Palampur of district Kangra on Hara Soya variety with per cent disease index of 11.11 per cent.
- The nutrient agar medium was found to be the best for pathogen growth. The optimum temperature and pH for the growth of pathogen were 30ºC and 7.0, respectively.
- Out of fifty germplasm lines, six genotypes *viz.* Him Soya, EC 7048, MAUS 732, RSC 11-22, DSb 37 and MAUS 1566 were found to resistant and two [EC 250591 and VLS 59] were moderately resistant against pathogen.

3 **Ayushi Sharma** (A-2019-30-067), Advisor: Dr. Amar Singh

Title of thesis: Biological control of pea root rot caused by *Fusarium solani* f.sp. *pisi*

- **Significant findings:** Out of twenty one fungal isolates and six bacterial isolates evaluated for their antagonistic activity *in vitro* against *F. solani* f.sp. *pisi*, *Trichoderma* sp. (I-12) proved to be the most effective strain that inhibited 67.74 per cent mycelial growth followed by *Trichoderma koningii* (67.32%), *Trichoderma* sp.-I-7 (66.54%) and *Trichoderma* sp.-I-6 (65.52%).
- Among the eight different solid media evaluated for the mycelial growth and spore production of potential bioagents *Trichoderma* sp.(I-12) showed maximum mycelial growth in both sorghum and maize seeds (172.50 mm).
- Agro-by products *viz.*, paddy straw, cow dung and FYM supplemented with different carbohydrates *viz.*, glucose, sucrose and jaggery (at the rate 1.0% and 5.0%) enhanced the growth of bioagents.
- *Trichoderma* sp. (I-7) was found to be the best in managing the root rot disease when it was applied as soil application and seed treatment.

4 **Tarushi** (A-30-072), Advisor: Dr. Deepika Sud

Title of thesis: Studies on synthetic log cultivation of Shiitake mushroom, *Lentinula edodes* (Berk.)

Significant findings:

- Among five sawdust substrates viz., eucalyptus, mango, mulberry, poplar and tooni, maximum mycelial growth (10.75 cm) and highest MRR (3 mm/day) was recorded on eucalyptus substrate.
- Grain substrates were suitable for master spawn production of shiitake and sawdust substrates could be used for commercial spawn production as it is more compact and easier to handle while using automatic inoculating machines. Minimum and maximum days to complete the incubation process were required by Ecalyptus+ poplar synthetic logs (66 days) and M+P combination (88 days). Most healthy basidiocarps with maximum diameter of pileus and stalk (9.9 cm & 1.1 cm), maximum stalk length (7.5 cm) was recorded from Mango + Poplar sawdust substrate.

5 **Kajal** (A-2019-30-068), Major Advisor: Dr.Rakesh Devlash

Title of thesis: Epidemiology of turcicum leaf blight in maize and identification of resistance sources

Significant findings:

- Oat Meal Agar was found best medium for *Exserohilum turcicum* able to infect all age stages of maize, but severity differed significantly with the age of plant as higher turcicum leaf blight infection was recorded on plant age group of 60 days.
- Maximum disease progression rate was observed during 35th MSW in Early Composite (20.5) and Dhari Local (20.4), whereas it was 10.7 in Bajaura Makka during 31st MSW.
- Fourteen medium maturity, fourteen early maturity and seven QPM inbreds were found resistant to TLB.
- *In vitro* evaluation of bioagent revealed that maximum mycelial inhibition (78.8 %) recorded in *Trichoderma koningii* (JMA-11).
- Dhari Local recorded maximum yield loss (27.2%) followed by Early Composite (25.3%).

6 **Sakshi Sharma** (A-2019-30-071), Advisor: Dr. B.K. Sharma

Title of thesis: Studies on epidemiology of lentil wilt and host resistance

Significant findings:

- Lentil wilt incidence (*Fusarium oxysporum* f.sp. *lentis*) was increased with decrease in soil moisture and vice versa. The disease incidence was maximum (10.74 per cent) in early sown crop as compared to the late sown crop, however the yield was observed maximum at the second date of sowing i.e. 15th November.
- Temperature was positively correlated; Relative humidity was negatively correlated and with the disease incidence. Coefficient of determination revealed that the temperature, relative humidity and rainfall contributed 96.7, 94.4, 96.0 and 98.0 per cent towards the disease incidence of wilt on crop sown at 15th October, 30th October, 15th November and 30th November respectively.
- Genotypes EC-223235, IC-212688, IC-231785 and IC-240910 were found highly resistant whereas, genotypes IPL 316, IPL 526, IC-241260, LL 1641 and 1698 were resistant under field conditions.

Ph.D

1 Ms. Ashima Thakur (Admission No. A-2017-40-019) Major Advisor: Dr. D. K. Banyal

Title of thesis: "Epidemiology and management of Stemphylium blight of onion

Significant findings:

- Stemphylium blight of garlic caused by *Stemphylium vesicarium* was prevalent in all the onion growing districts of Himachal Pradesh. The maximum disease severity was observed in district Una (45.4%) followed by Bilaspur (42.5%), Mandi (37.5%) and Kangra (36.9%) whereas, minimum disease severity (35.2%) was observed in district Hamirpur.
- The 32 isolates of *S. vesicarium* studied on the basis of virulence, morphological characters, physiological and molecular characterization, were grouped into six groups. Among different media, Potato dextrose agar was observed as best medium while 250C temp. was found best for the mycelial growth, whereas maximum sporulation occurred at 15-20^{0}C.
- The pathogen perpetuated on debris for 8 months as compared to perpetuation in soil and seeds.
- Among the eight fungicides, propiconazole 25 EC (250 ppm), difenoconazole 25 EC (500 ppm) and trifloxystrobin 25% + tebuconazole 50% WG (1500 ppm) were found most effective which gave complete mycelial inhibition at 250, 500 and 1500 ppm, respectively.
- Late sown crop at wider spacing resulted into less disease severity with higher bulb yield.
- *In vitro* evaluation of plant extracts (aqueous & alcoholic) of *Melia azedarach, Lantana camera, Eupatorium adenophorum* and *Eucalyptus camaldulensis* showed that aqueous extract of Eucalyptus gave maximum mycelial inhibition of 53.30 per cent (@ 50%) whereas, alcoholic extracts of all botanicals at 50 per cent concentration except Lantana provided complete mycelial inhibition.
- *In vitro* evaluation of bio agents i.e., *Trichoderma viride, T. harzianum* (JMA-4 and SMA-5), *T. koningii* (DMA-8 and JMA-11)) and *Pseudomonas fluoroscens* gave mycelial inhibition 10.40 to 35.65 per cent.
- The organic inputs viz; Tamarlassi, Bijamrit, Biosol, Vermiwash, Jeevamrit and Eucalyptus ark evaluated under *in vitro*, revealed that Eupatorium ark was most effective with complete mycelium inhibition at 10 per cent concentration being followed by Jeevamrit (88.78%) at 25 per cent concentration.
- Under field conditions (KVK Berthin & RSS Akrot), individually among chemicals three sprays of propiconazole 25EC and among non-chemical three sprays of Eupatorium ark were found most effective with 63.96 and 28.03 per cent disease control, respectively.

5. RESEARCH

A. Survey and surveillance

I. Rice:

Survey in major rice growing areas of district Kangra and a few locations of tehsil Sandhol of district Mandi was conducted during *kharif* 2021.

Kangra: Sixteen locations from five blocks of district Kangra were covered under production-oriented survey during *kharif* 2021 at different crop stages. However, information in respect of rice cultivation was collected from the farmers from Nagrota Bagwan, Bhawarna, Dharamshala and Rait blocks. Diseases such as leaf blast, neck blast, false smut, sheath rot and grain discolouration were observed as moderate whereas brown spot, sheath blight and narrow brown leaf spot were recorded as low to moderate. Leaf blast severity was quite higher on susceptible varieties like Pusa 1121 including local cultivars in some parts of Rait, Nagrota Bagwan and Bhawarna blocks. Some farmers used Bavistin 50 WP as foliar application (1g/ L) against blast.

Mandi: During *kharif* 2021, survey in district Mandi was conducted in Sandhol tehsil of Dharampur block only during booting to maturity stage of the rice crop. Among diseases like sheath rot, brown spot and grain discolouration appeared as low to moderate while leaf blast, neck blast, false smut, sheath blight and brown spot appeared as low. However, severe outbreak of narrow brown leaf spot was observed in Gowarla area of Sandhol tehsil.

II. Maize:

In Kangra district the **brown spot** disease was in sever form and ranged from 50-75% and incidence of **BLSB** varied from 10-40%, incidence of **Maydis leaf blight** ranged from 25-75% while incidence of turcicum leaf blight was 5-25%. In Kullu district, the occurrence of Turcicum leaf blight, Maydis leaf blight, Banded leaf & sheath blight disease was modrate in different surved locations such as Nahalach, Pirdi, Khokhan, Garsa, Mohan, Dhaman, Shalouri, Ratwa, Targali, Banjar, Panarsa, Nagwain, Jia.

III. Wheat and barley:

Stripe Rust: During *Rabi* 2021-22, high yellow rust intensity was observed on variety, HD 2967 (40S) in Chalwara area of Nagrota Surian block, HPW 368 (40S) in Palli area of Fatehpur block and on UP 2380 and HD 3086 in Saleti and Drakata areas of Pragpur and Dehra blocks, respectively exhibiting up to 80 per cent (80S) severity.

Powdery Mildew: Sporadic appearance of powdery mildew was observed in locations surveyed.

In Kullu district, the occurrence of yellow rust severity was modrate while losesmut and hill bunt was low in surveyed locations such as Bhekhali, Nahalach, Pirdi, Khokhan, Garsa, Mohan of Kullu Block, Dhaman, Shalouri, Ratwa, Targali, Sai Ropa, Banjar of Banjar block. In case of barley main disease was stripe rust with modrate severity while coverd smut and brown stripe were in low intensity in surveyed locations.

IV. Vegetables and pulses

a) Survey and Surveillance of diseases (Bajaura)

Systematic surveys were conducted in the command area of Hill Agricultural Research and Extension Centre Bajaura. The diseases observed in different crops are given in Table 1. Incidence of various diseases varies from locality to locality.

b) Survey and surveillance of pea root rot

Surveys in major pea growing areas of district Kangra, Mandi, Hamirpur, Kinnaur and Lahaul Spiti were conducted during the year 2022 to record data on the occurrence of root rot of pea (Table 2). In each district, three localities were surveyed. The maximum disease incidence of 51.67 per cent was observed in Kuther area of Mandi district, however, least incidence (9.33%) was recorded in Gue area of Lahaul Spiti district. Overall, the incidence of pea root rot was found ranged between 9.33 to 51.67 per cent.

Table 1: Survey and Surveillance

Crop	Disease	Disease Intensity	Area Surveyed
Tomato	Early Blight and Alternaria fruit Rot,	Moderate	Kelhali, Garsa, Jia, Ruaru, Bhuntar, Nagwain, Panarsa, Aut, Haat, Jhiri, Jwalapur, Manikaran, Katrain, Seobagh
	Late Blight and fruit Rot, Buck Eye Rot	Moderate - High	
	Septoria Blight, Bacterial Spots, Bacterial wilt,	Low - Moderate	
	Virus diseases and Disorders.	Low	
Capsicum	Blight and Fruit Rot, Anthracnose	Moderate	Kelhali, Garsa, Jia, Ruaru, Bhuntar, Nagwain, Panarsa, Aut, Haat, Jhiri, Jwalapur, Manikaran, Katrain, Seobagh
	Bacterial wilt and virus diseases	Moderate	
Cabbage and Cauliflower	Black rot	High	Do
	Alternaria leaf spot	Low - Moderate	
French Bean	Angular leaf spot	Low - Moderate	Do
Peas	Wilt & root rot, Powdery Mildew,	Low- Moderate	Do
	Bacterial blight	Moderate	
Cucumber	Powdery mildew, Downey mildew.	Moderate- High	Kelhali, Garsa, Jia, Ruaru, Nagwain, Panarsa, Aut, Haat, Piridi, Mohal, Khokhan
Garlic	Stemphylium blight & purple blotch in garlic.	Moderate	Nahalach, Pirdi, Khokhan, Chheol, Garsa, Mohan, Dhaman, Shalouri, Ratwa, Targali, Sai Ropa, Banjar
	Rust	Low	
	Bulb rot	Low	
Onion	Purple blotch, downy Mildew.	Moderate	-
	Bulb rot	Low	
Urd Bean	Cercospora leaf spot,	Low - Moderate	-
	Leaf crinkle virus	Low	
Maize	Turcicum leaf blight, Maydis leaf blight, Banded leaf & sheath blight	Moderate	Nahalach, Pirdi, Khokhan, Garsa, Mohan, Dhaman, Shalouri, Ratwa, Targali, Banjar, Panarsa, Nagwain, Jia,
Wheat	Yellow rust	Moderate	Bhekhali, Nahalach, Pirdi, Khokhan, Garsa, Mohan of Kullu Block, Dhaman, Shalouri, Ratwa, Targali, Sai Ropa, Banjar of Banjar block.
	Loose smut, Hill Bunt	Low	
Barley	Stripe rust	Moderate	Bhekhali, Nahalach, Pirdi, Khokhan, Garsa, Mohan of Kullu Block, Dhaman, Shalouri, Ratwa, Targali, Sai Ropa, Banjar
	Covered Smut, Barley stripe	Low	

Table 2: Survey of pea root rot in major pea growing districts of Himachal Pradesh during 2022

District	Location	Incidence (%)
Kangra	Palampur	12.30
	Nagrota	15.27
	Zamanaabad	45.67
Mandi	Behna	18.30
	Kuther	51.67
	Dari	22.00
Hamirpur	Lambloo	15.00
	Nadaun	21.33
	Bara	18.67
Kinnaur	Sangla	42.00
	Kalpa	12.50
	Leo	19.33
Lahaul & Spiti	Lari	11.00
	Chango	13.80
	Gue	9.33

On garlic the incidence of Stemphylium blight and purple blotch diseases was recorded 60-80% in all the garlic growing areas of the district sirmour along with the garlic bulb rot complex with 40-60% incidence. Out break of garlic rust was observed in garlic growing areas of the district Sirmour.

In capsicum the powdery mildew severity varied from 20-50% and Phytophthora blight severity ranged from 10-40%. In tomato mderate severity of leaf blight (50-70%) was recorded in a polyhouse at Palampur. In Mash the anthracnose severity was very high at Palampur and ranged from 50-75% whereas, the Cercospora leaf spot severity varied from 25-50%.

V. Oilseeds/ Soybean

a) Survey and surveillance of the diseases of crops in the area

Surveys were conducted in main soybean growing areas of Himachal Pradesh during September 2021 to record data on the occurrence of different diseases. Mainly four diseases *viz*., frog eye leaf spot (*Cercospora sojina*), pod blight (*Colletotrichum truncatum*), bacterial pustule (*Xanthomonas campestris* pv. *glycines*) and yellow mosaic virus (YMV) were found to occur in areas surveyed in Kangra and Mandi districts. Diseases were scored on 0-9 scale. Location wise per cent disease index (PDI) is presented in table 3.

Table 3: Occurrence of soybean diseases in major soybean areas in Himachal Pradesh

District/village	**Variety grown**	**Percent disease index**			
		Frogeye leaf spot (*Cercospora sojina*)	Pod blight (*Colletotrichum truncatum*)	YMV	Bacterial pustule (*Xanthomonas campestris* pv. *glycines*)
Kangra district					
Sagoor	Hara Soya	33.33	11.11	0.0	0.0
Sulha	Palam Soya	33.33	11.11	0.0	0.0
Baijnath	Palam Soya	55.55	33.33	0.0	11.11
Sadarpur Tanda	Himsoya	11.11	11.11	11.11	0.0
Matour	Hara Soya	33.33	33.33	0.0	0.0
	Him Soya	33.33	11.11	11.11	0.0
Jhehol	Him Soya	77.77	55.55	0.00	0.0
Bagli	Him Soya	33.33	33.33	0.00	
Nagri	Hara Soya	55.55	33.33	0.0	
Kangra	Hara Soya	33.33	11.11	33.33	0.0
	Shivalik	77.77	33.33	00	0.0
Palampur	Hara Soya	33.33	33.33	0.0	11.11
	Bragg	55.55	55.55	0.0	0.0
	Shivalik	77.77	11.11	0.0	0.0
	Him Soya	77.77	33.33	0.0	0.0
Mandi district					
Guma	Hara Soya	11.11	11.11	0.0	0.0
	Palam Soya	33.33	33.33	0.0	0.0
Ahju	Hara Soya	55.55	11.1	0.0	0.0

Frog eye leaf spot (*Cercospora sojina*) and pod blight (*Colletotrichum truncatum*) were mainly observed on Hara Soya, Him Soya, Palam Soya and Bragg varieties of soybean and bacterial pustule (*Xanthomonas campestris* pv. *glycines*) was observed on Hara Soya in Himachal Pradesh. Low incidence of collar rot caused by *Sclerotium rolfsii* was also observed at seedling stage. Incidence of YMV disease was also prevalent at low to moderate intensity only in warmer climate around Kangra area.

VI. Fodder crops

Survey and surveillance of Diseases of fodder crops: Survey of diseases of fodder crops: During *Kharif* 2021 wilt/root rot, leaf spot and blights of cowpea, blight and BLSB of maize, zonate leaf spot sorghum and blast of bajra were observed the main diseases. In the *Rabi* 2021-22 season oat powdery mildew and leaf blights of oats, root rot and powdery mildew of clovers was observed the important diseases (Table 4).

Table 4. Diseases and Insect-pests of different *Kharif* & *Rabi* fodder crops

Crop	Diseases and insect pest	Incidence/ Severity (%)
***Kharif* 2021**		
Cowpea	Wilt/root rot (*Fusarium, Rhizoctonia*)	75
	Leaf spot and blight (*Phytophthora Ascochyta, Phyllostricta*)	37
Maize	Blight (*Helminthosprium maydis* and *H. Tercecium*)	20
	Banded leaf & sheath blight (*Rhizoctonia*)	5
Sorghum	Zonate leaf spot (*Gloeocercospora sorghi)*	60
Bajra	leaf blight *(Helminthosporium*)	20
	Blast (*Pyricularia grisea*)	30
***Rabi* 2021-22**		
Oats	Powdery mildew	45
	Leaf blights	18
Berseem	Root rot	5
	Leaf spot	12
Lucerne	Leaf spot	12

VII. Protected cultivation

Status of diseases under protected condition

Capsicum: Powdery mildew is the most prevalent disease occurring with average disease severity ranging from 10 to 50% followed by root rot i.e. up to 5-25%. Third important disease was Cercospora leaf spot (5-74 % incidence and average disease severity ranged from 10 to 25 per cent). Bacterial wilt was also observed 10-25% in Kangra district (Table 5).

Tomato: Complex leaf spotting was observed due to target spot, early blight and gray leaf spot diseases as major problem while powdery mildew was observed second important disease. Incidence of Fruit rot and Fusarium wilt was sporadic with low intensity. A new mold disease is also emerged under protected condition.

Cucumber: Powdery mildew was the most prevalent disease with disease severity of 20-30% while downy mildew was also found at with moderate intensity with disease severity of 10-50% particularly after rainy season (Oct.-Nov.) crop. A new disease sowing target spot symptom was also emerging as new threat to the cucumber cultivation in the polyhouses.

Table 5: Prevalence of diseases under protected cultivation

Crop	Disease(s)	Disease Severity (%)
Tomato	Blights (Early, gray and target spots)	10-25
	Fruit rots (target, gray mould and sunscald)	5-10
	Powdery mildew	20-30
	Fusarium wilt	5-10
	Bacterial wilt	10-40
Capsicum	Root/collar rot	5-25
	Bacterial wilt	5-15
	Blights (Cercospora leaf spot)	20-50
	Viruses	5-25
	Powdery mildew	10-50
Cucumber	Powdery mildew	20-30
	Downy mildew (August-November)	10-50
	Target leaf spot	5-75

B. Cereals

I. Rice

i. Screening for leaf and neck blast resistance:

Rice germplasm consisting of 1449 entries from various screening nurseries viz. National Screening Nursery-1 (NSN-1=303), National Screening Nursery-2 (NSN-2=625), National Screening Nursery-Hills (NSN-H=118), National Hybrid Screening Nursery (NHSN=112) and Donor Screening Nursery (DSN=291) were screened under natural epiphytotic conditions at RWRC, Malan for leaf blast resistance under Uniform Blast Nursery Pattern and for neck blast resistance under transplanted conditions. Out of these nurseries, 75 entries from NSN-1, 143 entries from NSN-2, 18 from NSN-H, 38 from NHSN and 51 entries from DSN were found promising against leaf blast. However, out of these 37 entries from NSN-H and 12 from NHSN were found promising against neck blast.

ii. Monitoring of field virulences in *Pyricularia oryzae*:

To characterize the virulence spectrum in the population of *Pyricularia oryzae* in different rice ecosystems, a set of 35 differentials consisting of international differentials, donors and commercial cultivars was planted across 29 locations across the country adopting UBN pattern including Malan. Among these, C101 A51, C104 PKT, RIL 29, A-57, C101 PKT, Raminad -STR -3, Tetep, RP Patho-1, RP Patho-2, RP Patho-7 and RP Patho-8 showed susceptible reaction while rest of the differentials were found resistant to leaf blast. The reaction pattern of genotypes at all the locations was grouped into eight major groups at 65 percent similarity coefficient. The reaction pattern at IIRR, Pattambi, Jagdalpur, Khudwani, Hazaribag, Ranchi, Mugad, Upper Shillong, Gerua, Wangbal, Coimbatore, Rajendranagar, New Delhi, Nawagam, Karjat, Nellore, Jagtial, Pantnagar and Ponnampet fall in Group1, Gaghraghat in 2, Gangavathi in 3, Mandya in 4, Malan, Almora and Lonavala in 5, Gudalur in 6, Cuttack in 7 Navsari and Ponnampet in 8 group.

iii. Disease Observation Nursery:

To observe the time of occurrence and intensity of leaf blast a trial was conducted during *kharif* 2021 at RWRC, Malan. Variety HPU 2216 was used as the susceptible variety against Leaf blast and the crop was sown in i.e. 21.05.2021 (early), 05.06.2021 (normal) and 20.06.2021 (late). Highest disease intensity (PDI) was observed in late sown crop (3.2 to 28.7). The early sown crop was found to be disease free (Table 6) when compared to the normal (3.7 to 17.8% % PDI). Excess moisture during the early stages of the crops under the late sown conditions led to the more incidence of the disease, when compared to the relatively dry season during early sown conditions and as a result the initial stage of the crop was relatively dry and hence incidence was low.

Table 6. Occurrence of leaf blast of rice in disease observation nursery at Malan during *kharif*-2021

DAT*	Per cent Disease (Leaf blast) Severity		
	Early	Normal	Late
30 DAT	0.0	0.0	0.0
40 DAT	0.0	0.0	3.2
50 DAT	0.0	0.0	11.3
60 DAT	0.0	3.7	20.2
70 DAT	0.0	12.0	28.7
80 DAT	0.0	17.8	-

DAT = Days after transplanting

iv. Disease Management:

i) Evaluation of new fungicides against location specific diseases:

A field trial was conducted during *kharif* 2021 in randomized block design to evaluate the efficacy of difenconazole 25% EC, isoprothiolane 40% EC, kasugamycin 3% SL, kitazin 48% EC, propineb 70% WP, tebuconazole 25.9% EC, thifluzamide 24% SC including some new fungicide

formulations against blast using a susceptible variety 'HPU 2216'. Two sprays were applied first on September 10, 2021 and second spray was applied on September 25, 2021 at the time of booting and flowering stages, respectively. Data on neck blast incidence were recorded a week before harvest by counting the infected over total panicles following 0-9. The grain yield was recorded on plot basis and was converted to q/ha.

A perusal of the data (Table 7) revealed that all the fungicides significantly reduced the neck blast incidence as compared to control. Application of difenoconazole and isoprothiolane proved to be highly effective in reducing neck blast incidence to 6.1 per cent as compared to 31.2 per cent in untreated control (> 80% reduction in neck blast incidence) which were statistically at par with kasugamycin and kitazin (7.3%) resulting in 76 per cent reduction in neck blast incidence over control each. Tebuconazole was next best fungicide in order of efficacy resulting in 74 per cent (8.2% neck blast incidence) reduction in neck blast incidence over control being at par with the former ones.

All the fungicides significantly enhanced the grain yield over control but highest mean grain yield was obtained from plots where difenoconazole was sprayed resulting in >65 per cent increase in grain yield (36.1 q/ha) over control (21.9 q/ha) closely followed by isoprothiolane, kasugamycin and thifluzamide which were statistically at par with each other as well as difenoconazole resulting in >50 per cent increase in grain yield over control.

Table 7. Evaluation of new fungicides for the management of rice blast during *kharif* 2021

Fungicide	Dose / L	Neck blast incidence (%)	Per cent reduction in neck blast	Grain yield (q/ ha)	Per cent increase over control
T1- Difenconazole 25% EC	0.5 ml	6.1 (14.2)	80.4	36.1	65.1
T2- Isoprothiolane 40% EC	1.5 ml	6.1 (14.2)	80.4	34.7	58.8
T3- Kasugamycin 3% SL	2.0 ml	7.3 (15.6)	76.6	33.0	50.8
T4- Kitazin 48% EC	1.0 ml	7.3 (15.7)	76.6	31.6	44.4
T5- Propineb 70% WP	3.0 g	12.3 (20.5)	60.6	28.1	28.6
T6- Tebuconazole 25.9% EC	1.5 ml	8.2 (16.6)	73.7	30.9	41.3
T7- Thifluzamide 24% SC	0.8 g	9.9 (18.3)	68.3	33.0	50.8
T8- Control	-	31.2 (33.9)	-	21.9	-
CD (*P = 0.05*)	-	2.8		3.6	

Figures in parentheses are arcsine transformed values

ii) Integrated disease management:

To test the effect of Integrated Disease Management practices against major diseases like blast, a trial was laid out in RBD design with three replications during *kharif* 2021. A highly susceptible variety, HPU 2216 with 6 treatments of IDM was planted. Treatment-wise sprays were applied, first of bioagent (*Trichoderma viride*) between 15-20 DAT on August 16, 2021 and second spray of fungicides was applied on September 14, 2021 at the time of booting stage of the crop.

Observations on leaf blast severity were recorded from 10 hills/ plot following 0-9 scale at flowering and that on neck blast incidence were recorded a week before harvest by counting the infected over total panicles. The grain yield was recorded on plot basis and was converted to q/ha.

The perusal of data (Table 8.) revealed that among different treatments, T5 i.e. treatment combination of seed treatment with carbendazim (2 g/kg) + one blanket application of combination fungicide Nativo 75 WG (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage proved to be highly effective and reduced neck blast incidence to 23.2 as compared to control (55.2%) resulting in about 58 per cent reduction in neck blast incidence and increased the grain yield by about 80 per cent over control followed by treatment T4 i.e. combination of Seed treatment with bio-control agent + one application of bio-control agent at 15-20 DAT (10 g/litre) + One blanket application of propiconazole (1 g/litre) at booting stage registering an increase of about 51 per cent in grain yield.

Table 8. Integrated management of neck blast of rice during *kharif*-2021

Treatment	Neck blast incidence (%)	Reduction in disease incidence (%)	Grain yield (q/ ha)	Per cent increase over control
T1 = ST with Bio-control agent @ (10 g/kg)	45.1 (31.61)	18.3	18.9	24.3
T2 = T1 + bio control agent at 15-20 DAT	40.7 (29.70)	26.3	19.5	28.3
T3 = T1 + one spray of propiconazole at booting stage	34.8 (27.09)	37.0	22.2	46.1
T4 = T2 + one spray of propiconazole at booting stage	34.7 (27.07)	37.1	22.9	50.7
T5 = ST with carbendazim (2 g/kg) + spray of Nativo 75 WG @ 0.4 g/l at booting stage	23.2 (21.60)	58.0	27.3	79.6
T6 = Control	55.2 (35.96)	-	15.2	-
CD (*P = 0.05*)	5.14	-	3.7	-

Figures in parentheses are arcsine transformed values

iii). Special trial on yield loss assessment due to rice blast:

A special trial on yield loss assessment due to leaf blast was laid out during *kharif* 2021 in a randomized block design with five replications and four treatments, viz., Inoculum sprayed thrice at an interval of 2 days (T1); Inoculum sprayed twice at an interval of 2 days (T2); Inoculum sprayed once (T3) and uninoculated/ fungicide treated plot served as control (T4). Leaf blast susceptible variety HPU 2216 was used for yield loss assessment. The pathogen was artificially inoculated by spraying conidial suspension or supplementing with spreading of diseased leaves and disease was recorded as percent disease index (PDI). The inoculation was done on 18.08.2021, 20.08.2021 and 22.08.2021. The grain yield was recorded on plot basis and was converted to q/ha.

The perusal of data (Table 9) revealed that the highest disease severity (84.38%) was observed where the plots received pathogen inoculum thrice as compared to plots with two times (67.12%) and one time inoculated (49.36%). The highest yield was recorded in control plot (30.70 q/ha) and lowest in plot with more disease severity (T1- 11.30 q/ha). The grain yield was decreased by 63.2%, 51.5% and 35.8%, respectively in T1, T2 and T3 over control plot.

Table 9. Leaf blast disease severity on rice grain yield during *kharif*-2021

Treatment	Leaf blast severity (%)	Grain yield (q/ ha)	Per cent increase over control
T1 Inoculum sprayed thrice at an interval of 2 days (Randomly select 5 one sq m area where disease intensity is more than 50%)	84.38 (66.85)	11.30	63.19
T2 Inoculum sprayed twice at an interval of 2 days (Randomly select 5 one sq m area where disease intensity is 30-50%)	67.12 (55.01)	14.90	51.47
T3 Inoculum sprayed once (Randomly select 5 one sq m area where disease intensity is below 30%)	49.36 (44.61)	19.70	35.83
T4 Un-inoculated + fungicide/antibiotic treated control plot	19.66 (26.27)	30.70	
CD (*P = 0.05*)	2.60	1.84	-

Figures in parentheses are arcsine transformed values

II. Maize

i. Evaluation of Maize Germplasm

A total of 79 normal maize (medium maturity, early maturity and OPV) and 61 specialty corn (QPM, Pop Corn, Sweet Corn and Baby Corn) genotypes were screened artificially against Turcicum leaf blight (TLB) during *kharif*, 2021. The details of promising genotypes under various maturity groups and speciality corn are as under:

- **Medium maturity**

  A total of 15 genotypes showed resistant/ moderately resistant reaction to turcicum leaf blight out of 25 genotypes screened. Promising genotypes having resistance against TLB were JH 17026, PHM 114, DKC 9224, DKC 8221, PHM 113, JH 19099, JKMH 4646, DH 347, JKMH 4505, KDMH 126, LMH 10921 (NIVT), DKC 8211 (IU8229), JKMH 4546, HM 20105 (AVTI) and DKC 8209 (IT 8192) (AVT II).

- **Early maturity**

  A total of 12 genotypes showed resistant/ moderately resistant reaction to turcicum leaf blight out of 23 genotypes screened. Promising genotypes having resistance against TLB were LMH 21147, LMH 2174, AH-4657, KDMH-130, CP 111, AH-4654, SMH-4555, KDMH-129, CP 999, DH 348 (NIVT), DKC 7211 (IU7514) (AVTI) and KMH 18-15 (AVT II).

- **QPM I-II-III:** A total of 10 genotypes viz. IQPMH 2102, FQH 160, IQPMH 2103 (NIVT), HQPM 29, HQPM30, IQPMH 2012, IQPMH 2001(AVT L) and FLPH 19, FQH 165, SMH-4555 AVT II) were found resistant/moderately resistant against TLB out of 18 genotypes evaluated.
- **Sweet Corn :** Genotypes FSCH 131, CP SWEET -2, CPSC-301, CSCH 16034, FSCH 144 and FSCH 196 were found resistant/moderately resistant to TLB.
- **Pop Corn :** Genotypes IMHSB 21KP 1, LPCH 219 and MZM 23 were found resistant/ moderately resistant to TLB.
- **Baby Corn :** Genotypes MBC-20-5, DBCH 331, DBCH 350, IMHSB-19KB- 2, IMHSB-20KB- 3 and JH 32434 were found resistant/ moderately resistant against TLB.
- **OPV(Open pollinated variety):** Seven genotypes viz. L316, MZM 20, MZM 8, ADC-2, DOP-339, ADC-3 and MZM 16 showed resistant/ moderately resistant reaction against TLB out of fourteen genotypes screened.

ii. Maize Disease trap nursery

Maize disease trap nursery consisting of 10 lines was planted to determine the prevalence of different diseases of maize. Highest TLB score was observed in CM600 and Early Composite (7.0) whereas it was recorded 2.0 in CM 500 and IIMR SBT POOL.

iii. Screening of maize hybrids of public and private sector

Twenty three maize hybrids of public and private sectors along with three checks (Bio 605, Palam sankar Makka 2 and Bio 9544) were screened against Turcicum leaf blight (TLB) and Maydis leaf blight (MLB) under artificial epiphytotic conditions during *kharif* 2021. All the maize hybrids were found resistant/ moderately resistant against both the diseases. Maize hybrids DKC-8209, P-3378, MM-9366, Nutra Early, DKC-7204 , K-25 Super, C.P. 555 , Bioseed 9784, C.P. 333 , Bioseed 9220 and MM-9344 were found promising.

III. Wheat

i. Screening of wheat germplasm against Stripe Rust

A total of 433 Wheat lines/ genotypes received from ICAR-IIWBR under PPSN AVT and PPSN NIVT/ Special Trials were screened against yellow rust during Rabi 2021-22. A total of 300 genotypes were found free from Stripe rust.

ii. Screening of wheat germplasm against Hill Bunt

Thirty four wheat genotypes were screened against Hill bunt under artificially inoculated conditions during Rabi 2021-22. One genotype was found free from hill bunt infection and seven genotypes showed less than 5% infection.

iii. Wheat Disease Trap Plot Nursery

Trap nursery comprising of 20 lines of wheat and one line of barley was received from Regional Station, Directorate of Wheat Research (ICAR), Flowerdale, Shimla to monitor the appearance and progress of yellow rust during *Rabi* 2021-22. Yellow rust appeared in 11 lines of wheat. Disease samples were sent to Flowerdale, Shimla as soon as the disease appeared for pathotype analysis.

iv. Evaluation of advanced breeding material against yellow rust and powdery mildew At Malan

In all, 1947 wheat entries comprising Initial Plant Pathological Screening Nursery (IPPSN = 1215), Plant Pathological Screening Nursery (AVT = 153; NIVT = 280), Elite Plant Pathological Screening Nursery (EPPSN = 68) and Multiple Disease Screening Nursery (MDSN = 31) were evaluated against yellow rust at Malan under natural epiphytotic conditions with disease augmentation by following artificial inoculation procedure. Entries from Powdery mildew Screening Nursery (PMSN = 200) were screened against powdery mildew separately while MDSN entries were screened against both yellow rust as well as powdery mildew. Besides this, Loose Smut Screening Nursery (LSSN = 200) was also planted this season from which the inoculated panicles were harvested and will be evaluated against the disease during *Rabi* 2022-23.

It was observed that out of 1947 entries from various screening nurseries, 58 entries from EPPSN, 106 from AVT, 150 from NIVT, 22 from MDSN and 959 from IPPSN were highly promising (0-5S) against yellow rust infection. However, 22 entries from PMSN were found were found promising against powdery mildew (Table 11). Out of 34 entries from HBSN only 3 entries were found promising exhibiting hill bunt incidence ≤ 5. The information is given below:

Table 10: Stripe rust resistant entries in stable wheat breeding material received from IIW&BR, Karnal under AICRP on wheat.

Nursery	No. of entries	Resistant entries with reaction to yellow rust		
		Free	Severity≤ 5	Promising entries
EPPSN	68	30	9	58
IPPSN	1215	704	124	959
PPSN (NIVT)	280	136	16	150
AVT	153	104	13	106
MDSN	31	26	2	22
Total	1747	1000	164	1295
PMSN	200	-	-	22*
HBSN	34	-	-	3**

*Promising against powdery mildew **Promising against hill bunt

iv. Disease Managemant

i). Evaluation of GLOIT 30% w/v EC [Propiconazole 13.9 (15% w/v) + Difenoconazole 13.9 % w/w (15% w/v) EC] against stripe rust of wheat

A new fungicide GLOIT 30% w/v EC [Propiconazole 13.9 (15% w/v) + Difenoconazole 13.9 % w/w (15% w/v) EC] was tested for its bioefficacy for the control of stripe rust of wheat. Fungicide was tested by laying out trial in RBD with three replications with susceptible wheat variety PBW343 during *Rabi* 2021-22. The test fungicide was found very effective for the management of yellow rust at all the doses. The test fungicide provided 92.9 - 93.1 per cent control of yellow rust with 71.5 – 89.2 percent increase in yield at doses 350 ml/ha and 500 ml/ha, respectively. 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 0, 1, 3, 5 , 7 & 10 days after spray at all doses of test fungicide (Table 10).

Table 11: Evaluation of GLOIT 30% w/v EC [Propiconazole 13.9 (15% w/v) + Difenoconazole 13.9 % w/w (15% w/v) EC] against stripe rust of wheat

Treatment Details	Dosage (ml/ ha)	Yellow rust Severity (%)			Control (%)	Yield (q/ha)	Yield increase (%)
		Before Spray*	10 days After Ist Spray	10 days After 2nd Spray			
Propiconazole 13.9% + Difernconazole 13.9% w/w (15% w/v) EC)	250	Traces	5.0 (12.9)	7.0 (15.3)	91.4	26.5	42.5
Propiconazole 13.9% + Difernconazole 13.9% w/w (15% w/v) EC)	350	Traces	4.2(11.8)	5.7 (13.7)	92.9	31.9	71.5
Propiconazole 13.9% + Difernconazole 13.9% w/w (15% w/v) EC)	500	Traces	4.0 (11.5)	5.7 (13.7)	93.1	35.2	89.2
Propiconazole 13.9% + Difernconazole 13.9% w/w (15% w/v) EC)	625	Traces	5.2 (13.1)	7.2 (15.5)	91.2	26.2	40.9
Propiconazole 13.9% + Difernconazole 13.9% w/w (15% w/v) EC)	1000	Traces	5.5 (13.5)	7.3 (15.7)	91.0	22.7	22.0
Propiconazole 25 EC	500	Traces	4.0 (11.5)	6.0 (14.1)	92.5	28.2	51.6
Difenconazole 25 EC	500	Traces	9.0 (17.4)	13.0 (21.1)	84.5	20.4	9.7
Tebuconazole 50%+Trifloxystrobim 25%WG	300	Traces	4.7 (12.5)	8.0 (16.4)	90.2	22.7	22.0
Picoxystrobin 7.05%+Propiconazole 11.7%	1000	Traces	5.5 (13.5)	9.5 (17.9)	88.5	23.4	25.8
Control	-	-	39.5 (38.9)	83.3 (65.9)	-	18.6	-
CD (0.05)	-	-	0.9	0.8	-	0.8	-

*****Disease start appearing in infector row planted in the periphery.

**Angular transformed values in the parentheses.

ii). Evaluation of fungicides for the management of wheat powdery mildew At Malan:

A field trial was conducted during *Rabi* 2021-22 in randomized block design to evaluate the efficacy of some new fungicide formulations against powdery mildew of wheat using a susceptible variety 'HPW 155'. Fungicides namely, azoxystrobin 18.2% w/w + cyproconazole 7.3% w/w SC, azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC, tebuconazole 50% + trifloxystrobin 25% WG, propiconazole and tebuconazole including untreated control were evaluated for their efficacy against powdery mildew. Two sprays were applied first on the initiation of disease on March 13, 2022 and second spray was applied 15 days after 1st spray on 28th March, 2022. Observations on powdery mildew were recorded following 0-9 scale (Leath and Heun, 1990). The grain yield was recorded on plot basis and was converted to q/ha.

A perusal of the data (Table 12) revealed that all the fungicides significantly reduced the powdery mildew severity as compared to control during 2021-22 season. Application of azoxystrobin 18.2% w/w + cyproconazole 7.3% w/w SC proved to be highly effective in reducing powdery mildew to 25.9 per cent as compared to 45.6 per cent in untreated control and was statistically at par with tebuconazole 50% + trifloxystrobin 25% WG (Nativo 75 WG) and azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC reducing powdery mildew severity to 26.8 and 27.2 per cent with more than 40 per cent reduction over control, respectively.

Application of all the fungicides significantly enhanced the grain yield resulting in 37-42 per cent increase over control. Azoxystrobin 18.2% w/w + cyproconazole 7.3% w/w SC though proved to

be highly effective in enhancing the grain yield significantly over control resulting in about 42 per cent (22.5 q/ ha grain yield) increase in grain yield but was at par with rest of the fungicides.

Table 12. Evaluation of fungicides for the management of wheat powdery mildew at Malan

Fungicide	Dose	Disease Severity (%)	Disease reduction (%)	Yield (q/ ha)	Per cent increase
T1=Azoxystrobin 18.2% w/w + Cyproconazole 7.3% w/w SC	0.1%	25.9 (30.6)	43.2	22.5	42.4
T2=Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC	0.1%	27.2 (31.4)	40.4	21.7	37.3
T3=Tebuconazole 50% + Trifloxystrobin 25% WG	0.06%	26.8 (31.1)	41.2	22.5	42.4
T4=Propiconazole	0.1%	30.2 (33.3)	33.8	21.7	37.3
T5=Tebuconazole	0.1%	30.7 (33.6)	32.7	21.7	37.3
T6=Control	-	45.6 (42.5)	-	15.8	-
CD (*P = 0.05*)	-	2.5		3.2	

Figures in parentheses are arcsine transformed values

iii). Evaluation of fungicides for the management of wheat powdery mildew At Dhaulakuan

Fungicides namely, azoxystrobin 18.2% w/w + cyproconazole 7.3% w/w SC, azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC, tebuconazole 50% + trifloxystrobin 25% WG, propiconezole and tebuconazole including untreated control were evaluated for their efficacy against powdery mildew using a susceptible variety 'PBW 343'. In all, two sprays were applied at 15 days interval and observations on powdery mildew were recorded. A perusal of the data (Table 13) revealed that all the fungicides significantly reduced the powdery mildew severity as compared to control during 2021-22 season. Application of azoxystrobin 18.2% w/w + cyproconazole 7.3% w/w SC proved to be highly effective in reducing powdery mildew to 79.79 per cent followed by azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC with 73.88 per cent. Tebuconazole 50% + trifloxystrobin 25% WG (Nativo 75 WG) reduced powdery mildew 64.53 per cent whereas propiconazole and tebuconazole were the next in order of efficacy resulting in about 45.00 per cent reduction in powdery mildew severity over control. Application of all the fungicides significantly enhanced the grain yield resulting in 28-36 per cent increase over control.

Table 13. Evaluation of fungicides against Wheat Powdery Mildew at Dhaulakuan

Fungicide	Dose	Disease Severity (%)	Reduction in disease(%)	Yield (q/ ha)	Per cent increase
T1=Azoxystrobin 18.2% w/w + Cyproconazole 7.3% w/w SC	0.1%	13.67(21.52)	79.79	55.72	36.46
T2=Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC	0.1%	17.67(24.84)	73.88	54.16	32.64
T3=Tebuconazole 50% + Trifloxystrobin 25% WG	0.06%	24(29.25)	64.53	51.57	26.30
T4=Propiconazole	0.1%	37(37.44)	45.32	50.11	22.27
T5=Tebuconazole	0.1%	36.67(37.24)	45.81	52.49	28.55
T6=Control	-	67.67(55.33)	-	40.83	-
CD (*P = 0.05*)	-	3.85		0.13	

Figures in parentheses are arcsine transformed values

IV Barley

i. Screening of Barley Germplasm against Stripe Rust

A total of 558 barley lines/ genotypes received from ICAR-IIWBR under IBDSN, NBDSN and EBDSN were screened against yellow rust during *rabi* 2021-22. A total of 301 genotypes were found resistant to Stripe rust.

C. Pulses and Oilseeds

I. Soybean

i. Performance of the previous year's resistant entries (Frogeye leaf spot and Pod blight (Ct): Twenty nine lines found resistant in IVT, AVT, AVT-II, PP4 trial and germplasm evaluation during 2020, *kharif* season either against frogeye leaf spot (*Cercospora sojina*) and pod blight (*Colletotrichum truncatum*) were sown along with two susceptible checks (JS 335 and Shivalik) in two replication on 28.06.2021. Three rows of 3.5m were kept in each line. Data on disease severity was recorded on 0-9 scale for Frogeye leaf spot (FLS) and anthracnose (pod blight) and each entry was categorised into different disease reaction as presented in table 14. Twenty seven lines maintained their high resistance status against frogeye leaf spot (*Cercospora sojina*). Twenty lines maintained their high resistance status against pod blight (*Colletotrichum truncatum*). Eighteen lines have shown highly resistance against both the diseases.

Table 14: Disease reaction of previous resistant entries against various diseases

S no	Variety	Year of testing	Frogeye leaf spot (*Cercospora sojina*)		Pod blight(*Colletotrichum truncatum*)	
			Score	Reaction	Score	Reaction
1	VLS 99	1st year	1	R	1	R
2	UPSL 77	1st year	3	MR	1	R
3	PK 25	1st year	1	HR	0	HR
4	EC 241780	1st year	0	HR	0	HR
5	EC 141117	1st year	0	HR	0	HR
6	UGM 77	1st year	1	HR	0	HR
7	EC 391181	1st year	1	R	0	HR
8	DSb 21	1st year	1	R	3	MR
9	DSb 33	1st year	5	MS	3	MR
10	DSb 37	1st year	1	R	1	R
11	Harder	1st year	0	HR	0	HR
12	ASb 50	2ndt Year	1	R	1	R
13	ASb 51	2nd year	1	R	1	R
14	AUKS 218	2nd year	0	HR	3	MS
15	DSb 37	2nd year	1	R	3	MR
16	TS 46	2nd year	1	R	3	MR
17	EC 241778	2nd year	0	HR	0	HR
18	Cat 195 c (BR4)	2nd year	0	HR	5	S
19	Cat 411A	2nd year	1	R	1	R
20	SKF 6029	2nd Year	1	R	1	R
21	NRC 154	2nd year	1	R	3	MR
22	EC 1619	2nd Year	1	R	1	HR
23	MACS 1566	2nd year	0	HR	3	MR
24	AMS MB 5-18	3nd year	1	R	1	R
25	RSC 10-52	3rd year	1	R	1	R
26	KDS 992	3rd year	1	R	1	R
27	Himso 1685	5th year	0	HR	1	R
28	JS 20-116	5th year	0	HR	3	MR
29	PS 1572	5th year	1	R	1	HR
	JS 335 (Check)		5	MR	7	S
	Shivalik (Check)		9	S	3	MR

HR= Highly resistant, R= Resistant, MR= Moderately Resistant, MS= Moderately susceptible, S= Susceptible, HS= Highly susceptible

ii. Evaluation of breeding materials for resistant donor(s) IVT Early trail: Twenty-five entries including checks in Initial Varietal Trial (IVT-E) 2021 received from ICAR IISR, Indore werer evaluatted against disease resistance under natural hot spot conditions. The disease incidence was recorded when the diseases were at terminal condition. The data were recorded based on 0-9 scale. The lines were categorized into different resistance categories. The entry MAUS 819, KDS 1169, KDS 1194, and AMS 77-3-6 were found resistant to highly resistant against FLS (*Cercospora sojina*). The entry PS 1660, PS 1675 and NRC 198 were found resistant to highly resistant against anthracnose (*Colletotrichum truncatum*).

iii. IVT Normal: Fifty seven entries including checks of IVT-Normal trial were evaluated for disease resistance during kharif 2021 in RBD. Each line was sown in two rows of 3.5m each woth two eplications. Two susceptible checks i.e JS 335 and Shivalik were sown after every five entries. Both the replications were kept unprotected. Data were recorded on 0-9 scale and disease reaction. 15. The lines SKAU-WSB-101, PS 1605, KDS 1149 and LOKSOY-1were found resistant to highly resistant against FLS (*Cercospora sojina*). The test entries, AS 40, PS 1689, PS 1682, NRC 195, NRC 193, KDS 1149, TS 21-2, TS 21-1, LOKSOY-1 and KSS 204 were found resistant to highly resistance against anthracnose (*Colletotrichum truncatum*). The entry KDS 1149 and LOKSOY-1were resistant against both FLS and anthracnose diseases.

iv. **Evaluation of germplasm lines for identification of multiple disease resistant sources**

Fifty soybean germplasm lines received from ICAR IISR, Indore were sown on 07.07.2021. Two rows of 3 meter length of each line were sown in augmented design. After every 5 entries two susceptible checks were sown. Data on disease severity was recorded on 0-9 scale for Frogeye leaf spot (FLS), anthracnose (pod blight) and brown spot (BS) and each entry was categorised into different disease reaction as presented in table 5. The germplasm lines; EC 280129, EC 289149, EC 291401, EC 325098, EC 350664, EC 357998, EC 383165, EC 389153 and 390981A were observed having multiple disease resistance against frogeye leaf spot (*Cercospora sojina*), anthracnose (*Colletotrichum truncatum*) and brown spot (*Septoria glycines*).

v. Integrated management of the root rot complex and stem borersof soybean

An experiment comprising twelve seed treatment with chemical fungicides or bioagents alone or integrated with insecticide seed treatment along with one check was conducted with three replications in RBD. Experiment was planted on 24.06.2021. Data on % field stand. % root rot incidence, % girdling incidence, plant growth parameters and yield attributes were recorded and presented in table 15.

vi.Estimation of avoidable losses soybean diseases

The experiment was planted on 24.06.2021 comprising two main treatments i. e. Variety VLS 59 and JS 335 and six sub-treatments in split plot design (Table 18). Different sprays i. e. one, two, three and four sprays were applied on 10.08.21, 25.08.21, 10.09.21 and 25.09. 21 were applied. Data on frogeye leaf spot (FLS) and anthracnose (pod blight) was recorded at 15 days intervals on 0-9 scale on 10 randomly selected plants. Per cent disease index (PDI) was calculated and AUDPC was also calculated. Avoidable yield loss also calculated and presented in table 16. The treatment comprising combine seed treatment of Carboxin +thiram (3g/kg) and Thiomethoxam (2g/kg) followed by two sprays with propiconazole was fond most effective in managing root rot, anthracnose and stem girdling infestation resulting maximum yield of 14.67q/h than control (8.77q/h)

Table 15. Integrated management of the root rot complex and stem borers of soybean

Treatment	% field stand	% root rot incidence	Anthracnose (PDI)	% Girdling	Plant height (cm)	No. of pods/Pt	100g seed wt.(g)	Seed yield (q/ha)
T1= ST with Carboxin +thiram (3g/kg)	90.3	6.67	3.7(10.96)	3.67	53.00	54.3	13.73	11.210
T2= ST with Trifloxystrobin +Penflufen (1ml/kg)	89.2	8.33	4.44(11.89)	4.33	50.33	52.0	13.40	11.480
T3= ST with Thiophanate methyl +Pyraclostrobin)(2ml/kg)	88.3	8.33	5.18(13.08)	3.67	53.33	50.3	13.57	11.653
T4= ST with *Trichoderma harzianum* (10g/kg)	78.2	10.00	5.92(13.88)	5.00	53.33	53.3	13.73	11.900
T5= ST with Thiomethoxam (2g/kg)	82.2	16.67	6.66(14.81)	2.33	57.67	50.3	13.23	13.997
T6= T1 +T5	84.9	4.33	3.7(10.96)	1.33	50.00	46.7	13.37	14.670
T7= T2 +T5	86.5	6.67	5.18(13.08)	1.67	54.67	56.7	13.63	13.800
T8= T3 +T5	91.8	5.00	4.44(11.89)	1.33	56.67	58.7	13.63	14.417
T9=T4 +T5	84.8	6.67	4.44(11.89)	2.33	51.67	51.3	13.77	12.050
T10= ST with biopolymer chitosan based *Trichoderma* formulation (IIOR)@ 4ml/kg	82.7	8.33	19.27(26.01)	5.67	53.00	48.3	14.17	10.790
T11= ST with biopolymer cellulose based Trichoderma formulation (IIOR),@ 10ml/kg	85.1	7.33	30.37(33.37)	5.00	54.33	51.3	14.17	9.877
T12=ST with biopolymer cellulose based *Trichoderma* formulation (IIOR) +Thiomethoxam (@10 + 2g/kg)	83.7	6.33	31.85(34.33)	6.00	52.33	48.3	13.57	10.863
T13= Untreated control	77.7	16.67	58.51(49.89)	6.33	49.00	49.3	12.60	8.767
CD (P= 0.05)	8.143	4.607	3.483	2.197	NS	NS	NS	2.285

ST = Seed treatment
Two sprays with chlorantroniprole @ 0.2ml/L at 15 and 35 DAS in treatment no. T1 to T9
Two sprays with Propiconazole @ 1ml/L at 35 and 45 DAS in treatment no. T1 to T9

Table. 16: Assessment of avoidable losses due to FLS and pod blight

Variety/Treatment	PDI of Frogeye leaf spot					PDI of Pod blight			Yield (q/ha)	Avoidable yield loss (%)
	17th Aug	1st Sept	16th Sept	30th Sept	AUDPC	16th Sept.	30th Sept.	AUDPC		
Variety 1: VLS 59										
Sub T 1= Seed treatment + one spray	5.18	7.77	18.81	34.07(35.65)	694.89	8.14	22.96(28.58)	233.28	14.663	25.75
Sub T 2= Seed treatment + two sprays	5.18	6.29	15.55	29.81(32.98)	540.05	6.66	17.03(24.24)	177.70	15.307	22.49
Sub T 3= Seed treatment + three sprays	4.81	5.55	6.29	18.52(25.44)	452.55	4.07	13.70(21.69)	133.28	17.677	10.53
Sub T 4= Seed treatment + four sprays	4.81	5.55	5.92	9.62(17.99)	283.33	3.70	7.03(15.30)	80.48	19.750	-
Sub T 5= Seed treatment + water spray	4.81	12.59	27.4	40.37(39.43)	938.72	10.00	24.44(29.60)	258.28	13.480	31.74
Sub T 6= No seed treatment and no spray	4.81	13.33	32.59	44.44(41.18)	1058.18	12.59	31.85(34.34)	333.30	13.010	34.13
Variety-2 (JS 335)										
Sub T 1= Seed treatment + one spray	6.29	14.44	31.11	47.03(43.27)	1083.41	22.49	50.15(45.06)	538.83	12.687	29.21
Sub T 2= Seed treatment + two sprays	5.92	7.4	20.74	37.03(37.45)	744.20	15.18	27.40(31.54)	338.83	14.643	18.30
Sub T 3= Seed treatment + three sprays	7.03	7.4	11.48	24.44(29.60)	516.45	11.85	19.63(26.25)	236.08	15.307	14.59
Sub T 4= Seed treatment + four sprays	6.66	7.4	8.88	15.55(23.12)	394.13	7.03	12.59(20.45)	147.15	17.923	-
Sub T 5= Seed treatment + water spray	7.03	26.66	44.81	58.15(49.67)	1560.83	28.89	57.03(49.02	644.38	9.853	45..03
Sub T 6= No seed treatment and no spray	7.773	28.88	49.25	60.37(50.96)	1681.60	34.81	64.07(53.96)	741.58	8.690	51.51
CD (P=0.05)	A=0.88 B=N/A	A=1.27 B=2.21 AxB=3.13	A= 3.02 B= 5.23 AxB= 7.93	A=1.052 B=1.821 A x B= 2.576	A=64.61 B=112.25 AxB= 158.75	A=1.66 B=2.88 AxB= 4.08	A=1.517 B=2.628 A xB=3.717	A=22.15 **B=**38.37 A xB= 54.26	A= 1.03 B= 1.78	-

Figures in parentheses are angular transformation value, A = main factor (variety), B = Sub-factor (Fungicide treatments)
Seed treatment: Thiophanate methyl + Pyraclostrobin @ 2ml/kg of seed
Foliar spray: Tebuconazole @ 625ml/ha

D. Vegetables

Onion/garlic:

Evaluation of Metalaxyl-M 3.3 %+Chlorothalonil 33.1% SC against Onion diseases: The test fungicide Metalaxyl-M 3.3 % + Chlorothalonil 33.1 % SC) was evaluated at different conc. (1g, 2g and 3g/L) against purple blotch *(Alternaria porri)*, downy mildew *(Peronospora destructor) and* Stemphylium Leaf Blight (*Stemphylium vesicarium*) during 2020-21 and 2021-22 cropping season. Two sprays were applied at 15 days interval. Data on disease severity was observed and presented in Table 17. Duirng *Rabi* 2020-21 all the treatments were significantly effective in controlling purple blotch of onion as compared with the untreated check. All the treatments were significantly effective in controlling downy mildew as compared with the untreated check. The test fungicide Metalaxyl-M 3.3 % + Chlorothalonil 33.1 % SC was found very effective in controlling downy mildew of onion. The test chemical provided 86.98 per cent control of downy mildew with 83.11percent increase in yield at dose 2.0 g/L. All the treatments were significantly effective in controlling stemphylium leaf blight as compared with the untreated check. The test fungicide Metalaxyl-M 3.3 % + Chlorothalonil 33.1 % SC was found very effective in controlling stemphylium blight of onion. The test chemical provided86.90 per cent control of stemphylium leaf blight with 83.11percent increase in yield at dose 2.0 g/.

Table 17. Evaluation of Metalaxyl-M 3.3 % + Chlorothalonil 33.1 % SC against diseases of onion during 2021-22 and 2021-22

Treatment	Dose (ml/gm/lt)	Disease Severity (%)						Bulb Yield (q/ha)		% Yield Increase	
		Purple Blotch		Downy mildew		Stemphylium blight					
		2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Untreated Check	-	47.8	32.0	38.0	30.67	38.7	30.0	152	152	-	-
Metalaxyl-M 3.3 % + Chlorothalonil 33.1 % SC	1.0	8.2	5.53	5.2	4.93	5.4	5.33	269	275	76.9	80.92
Metalaxyl-M 3.3 % + Chlorothalonil 33.1 % SC	2.0	6.1	4.73	3.3	3.80	3.5	3.93	283.3	278.33	86.4	83.11
Metalaxyl-M 3.3 % + Chlorothalonil 33.1 % SC	3.0	6.1	5.93	4.5	4.00	4.63	4.13	277.7	276.67	82.7	82.01
Metalaxyl-M 31.8% ES	0.35	9.5	4.87	8.7	8.00	8.9	8.13	258.3	266.67	69.9	75.44
Chlorothalonil 75% WP	2.0	13.2	7	9.4	7.67	9.6	7.8	254.7	255	67.6	67.76
Azoxystrobin 11% +Tebuconazole 18.3%SC	0.94 ml/lt	15.0	6.2	11.1	8.00	11.3	8.13	252	260	65.8	71.05
Boscalid 25.2% +Pyroclostrobin 12.8% WG	1.0g/lt	16.2	9.4	12.0	8.73	12.1	8.9	250	246.67	64.5	62.28
CD (p=0.05)		1.613	1.01	1.54	0.83	1.072	0.323	4.81	7.57		

E Seed Pathology

I. Monitoring and detection of bunt, bacterial leaf blight, false smut, grain discoloration and bakane in paddy

i. Identification and documentation of important seed borne diseases in paddy

During the year under report (*Kharif 2021*), a limited number of locations in districts Kangra, Mandi and Una were assessed for the incidence of diseases in rice varieties and hybrids being grown by farmers due to restricted movements on account of Covid-19. The data on disease incidence and severity given in Table 18 revealed the prevelanece of almost all the important diseases on rice hybrids, improved and local varieties. False smut intensity ranged from 3-5 (0-9 scale) with average incidence of 5-15%. Majority of varieties recorded Neck blast incidence between 1-10% except PB 1509 (20-25%) and Sawa200 (40-50%) which recorded higher incidence. Sheath rot incidence in most of the varieties ranged between 5-10 % with maximum incidence in HPR 2770 (10-15%) in one of the locations in Dharamshala block. The incidence of grain discoloration varied from 1-11% with highest on Sawa 200 (5-11%). Fungi viz. *Sarocladium, Bipolaris, Alternaria, Fusarium and Curvularia* species were found associated with the grain discoloration.

Table 18. Status of seed borne diseases in rice varieties grown by farmers in Himachal Pradesh during *kharif* 2021

Location District/ Blocks	Variety	False Smut Incidence (%)	False Smut Incidence (Scale 0-9)	BLB Severity	Neck Blast Incidence (%)	Sheath Rot Incidence (%)	Grain Discoloration (%)	Brown Spot/ Narrow Brown
Kangra								
Rait	HPR 2720	5-10	3	-	-	5-10	1-3	-
Dharamshala	PB 1509	-	-	-	20-25	-	3-7	-
	HPR 2612	-	-	-	5-10	-	2-4	-
	HPR 2720	5-10	3	-	-	10-15	2-7	-
	Hyb. 1111	10-15	5	-	-	5-10	3-6	-
	Local/ HPR 2612	-	-	-	5-10	-	2-5	-
Nagrota Bagwan	Sawa 200,	Upto 5	3	-	40-50	-	5-11	-
	HPR 2612	-	-	-	5-10	-	1-3	-
	HPR 2656	-	-	-	-	5-10	1-2	-
	MRP 5632 (Suruch	10-15	5	-	-	5-10	3-5	-
Bhawarna	Kali Jhini		3	-	5-10	-	-	-
	HPR 2795	-	-	-	-	5-10	1-2	-
	HPR 2612	-	-	-	5-10	5-10	2-5	5-10
	Hyb. 834	5-10	3	-	-	-	1-2	-
	Hyb. 100	5-10	3	-	-	5-10	2-5	-
Mandi								
Sandhol	HPR 2143	-	-	-	-	5-10	1-3	-
	Local/ Parmal	-	-	-	5-10	5-10	2-5	5-10 (BS)
Chauntra	HPR 2143	-	-	-	-	5-10	1-3	-
	Local/ Parmal	-	-	-	-	10-15	2-6	0-5 (BS)
Una								
Amb	PR 110, 111 & 114	5-10	3	-	1-3	2-5	5-9	-
	Pusa Basmati 1121	Upto 5	3	-	2-5	3-5	2-5	-

ii. Monitoring of emerging diseases of seed borne nature in paddy

Sheath rot has been observed to be the emerging disease in paddy for the last 2-3 decades in Himachal Pradesh infecting almost all the varieties under cultivation and its occurrence is observed regularly in

different rice growing areas of the state. Initial studies conducted by the rice pathoglogist have reavled the association of *Sarocladium oryzae* in most of the disease samples, however, some of the samples also exhibited the presence of *Fusarium* spp. Likewise, BLB has also been observed to be an emerging problem in the state with global warming and introduction of varieties from other states. However, its occurrence depends upon the prevailing climatic conditions during the cropping seasons/ years and it was not recorded on any of the varieties and locations surveyed during *kharif* 2021 probably due to survey/ monitoring of limited locations.

II. Monitoring and detection of Karnal bunt, loose smut, spot blotch and head blight in wheat

i. Identification and documentation of important seed borne diseases

The data on Black Point (BP) was taken by analyzing the samples visually while Karnal Bunt (KB) was recorded by visual and microscopic examinations whenever necessary. In all 79 wheat samples (including 17 from research/ seed multiplication farms and 62 from farmers) from Mandi, Kullu, Una, Hamirpur and Bilaspur districts were analyzed for the incidence of KB and BP. A total of 10 varieties viz., HPW 349, HPW 360, HPW 368, HPW 373, HS 507, HS542, HS 562, PBW 343 Unnat, PBW 550 and PBW 660 were grown at research/ seed multiplication farms of the University. KB and LS was not recorded in any of the varieties however, incidence of BP varied from 1-10% (Tables 19,20 & 21). It was higher (6-10%) in varieties of PBW series cultivated in foot hills of HP (Una). A total of 62 seed samples of wheat belonging to farmers of Kullu, Una, Hamirpur, Kangra, Mandi and Bilaspur districts were analyzed for the incidence of KB, BP and LS. The data presented in Table 22 revealed that no KB was recorded in Kullu district. Moreover, the average incidence of KB was also very less (< 0.02%) in other districts and ranged from 0.0-0.1%. No incidence of loose smut was recorded from these districts. The incidence of BP ranged from 0-7% with average incidence of 0.8 to 2.3%. It was comparatively higher in Una district on variety HD 2687.

ii. Monitoring of emerging diseases of seed borne nature

The Fusarium head blight has been found an emerging problem in the state though its occurrence largely depends upon the prevailing climatic conditions during the crop season. The emerging problems/ diseases of seed borne nature are being monitored in the current *rabi* season (2021-22) and data will be supplied later on.

III. Studies on seed health status of farmers saved seeds

i. Status of loose smut in framers saved seeds: Farmers saved seed samples of wheat pertaining to *Rabi* season 2020-21, procured through the Incharges of Research Stations and KVKs are being tested by GOT for the prevalence of loose smut under field conditions during current *rabi* season.

ii. Status of Karnal bunt in farmers saved seeds:

In all 278 seed samples (stage Certified-I and Foundation-I) of registered farmers of district Sirmour comprising of 13 varieties and 14 samples of six varieties (stage Foundation- I) from four Government farms arranged through the Associate Director, HAREC Dhaulakuan were assessed for the prevalence of Karnal bunt infection (Table 23). Karnal bunt was recorded only in 89 seed samples of registered farmers with an incidence ranging from 0.05 to 0.20% while, it was recorded in 8 samples from Government farms with incidence varying from 0.05 to 0.10% in varieties WH 1184, VL 953, HPW 373, DBW 88 and HS 562 with maximum incidence of 0.1% in variety DBW.

iii. Status of paddy bunt in farmers saved seed: A total of 52 samples of farmers saved seeds from district Kangra and six from district Una were procured through KVK Kangra and RSS Akrot, respectively as well as collected by the Field Assistant of Palampur center. These samples were analyzed by following standard procedure (Na OH test) for recording the incidence of bunt. Bunt was recorded in 26 seed samples of paddy from Kangra district with incidence ranging from 1 to 5% while it was recorded in 4 samples (out of 6) and incidence varied from 2 to 6% in Una district.

Table 19. Incidence of seed borne diseases in wheat samples received from KVK Sundernagar (Research Farm), District Mandi (Rabi 2020-21)

Variety	No. of sample(s)	Incidence of KB (%)	Incidence of BP (%)	Incidence of LS (%)
HS 562	1	0.0	1.0	0.0
HPW 368	1	0.0	2.0	0.0
HPW 349	1	0.0	3.0	0.0
HPW 360	1	0.0	3.0	0.0
HPW 373	1	0.0	2.0	0.0
Total samples: 5; Number of seeds analyzed: 2000 per sample				

Table 20. Incidence of seed borne diseases in wheat samples received from HAREC Bajaura (Research Farm), District Kullu (Rabi 2020-21)

Variety	No. of sample(s)	Incidence of KB (%)	Incidence of BP (%)	Incidence of LS (%)
HPW 368	1	0.0	1.0	0.0
HS 542	1	0.0	2.0	0.0
HPW 349	1	0.0	1.0	0.0
HPW 373	1	0.0	0.0	0.0
HPW 360	1	0.0	2.0	0.0
HS 507	1	0.0	0.0	0.0
HS 562	1	0.0	0.0	0.0
Total samples: 7; Number of seeds analyzed: 2000 per sample				

Table 21. Incidence of seed borne diseases in wheat samples received from RSS Akrot (Research Farm), District Una (Rabi 2020-21)

Variety	No. of sample(s)	Incidence of KB (%)	Incidence of BP (%)	Incidence of LS (%)
HPW 360	1	0.0	2.0	0.0
HPW 368	1	0.0	4.0	0.0
PBW 343 Unnat	1	0.0	9.0	0.0
PBW 550	1	0.0	6.0	0.0
PBW 660	1	0.0	10.0	0.0
Total samples: 5; Number of seeds analyzed: 2000 per sample				

Table 22. Consolidated data on incidence of seed borne diseases in farmers' seed samples

District	No. of samples	KB (%)	BP (%)	LS (%)
Kullu	11	0.00	0.8 (0-3)	0.0
Una	15	0.02 (0.00-0.10)	2.3 (0-7)	0.0
Hamirpur	12	0.008 (0.00-0.05)	1.0 (0-4)	0.0
Kangra	12	0.0125 (0.0-0.1)	0.75 (0-4)	0.0
Mandi	7	0.007 (0.00-0.05)	1.57 (0-4)	0.0
Bilaspur	5	0.01 (0.0-0.05)	1.2 (0-3)	0.0

Table 23. Testing of wheat seed samples of Government farms (Rabi 2020 – 21) for Karnal bunt incidence in respect of district Sirmour (HPSCA Paonta Sahib)

Name of Govt. Farm	Variety	Stage	No. of sample(s)	Incidence of Karnal bunt (%)
SMF Bhagani	WH - 1184	F-1	1 No.	0.05
	HPW - 349	F-1	1 No.	0.0
	VL - 953	F-1	1 No.	0.05
	HPW - 373	F-1	1 No.	0.05
	DBW - 88	F-1	1 No.	0.1
SMF Kheri	WH - 1184	F-1	1 No.	0.0
	HPW - 349	F-1	1 No.	0.0
	DBW - 88	F-1	1 No.	0.0
	HS - 562	F-1	1 No.	0.05
SMF Bubi	WH - 1184	F-1	1 No.	0.05
	HPW - 373	F-1	1 No.	0.0
GDS Harlo	VL - 953	F-1	1 No.	0.0
	WH - 1184	F-1	1 No.	0.05
	HPW - 373	F-1	1 No.	0.05
Total samples: 14; Number of seeds analyzed: 2000 per sample				

F. Fodder crops

i. Evaluation of breeding material: During *Kharif*, 28 entries of maize were evaluated against leaf blight and all the entries found either resistant or moderately resistant. However, in cowpea all the 11 entries of IVTC were found susceptible. During *Rabi,* 68 entries were evaluated and 16 entries were found moderately resistant, under different experiments of oats against powdery mildew. Incidence of root rot of berseem was observed low during the season and all entries were observed as resistant or moderately resistant. In clover all the entries of white and red clover were found susceptible for powdery mildew.

ii. Germplasm evaluation programme against diseases and insect-pests in Rabi forages: During *Rabi* 2021-22, the germplasm of oats having total 122 entries were evaluated against diseases and insect-pests and 27 entries i.e. Oats- 1, 2, 6, 8, 16, 28, 32, 33, 35, 37, 40, 49, 51, 57, 58, 60, 66, 72, 73, 78, 85, 86, 90, 94, 97, 118 and 119 were found moderately resistant against powdery mildew. Rest all entries were recorded as susceptible. The germplasm of berseem having total 72 entries were evaluated. The incidence of root rot of berseem was observed low and all entries were observed as resistant or moderately resistant

iii. Assessment of crop losses due to diseases and insect-pests in forage Cowpea

The experiment was conducted to assess the crop losses due to diseases and insect-pests in forage cowpea with two treatments i.e. protected and unprotected. In the protected treatment the cowpea was protected from all the prevalent diseases and insect pests by 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) for diseases management. For insect management foliar application of *B. bassiana* @ 5g/L ($1x10^7$ cfu/ml) and two sprays of imidacloprid 17.8 SL @ 0.3 ml/lit at 15 days interval followed by two sprays of *Verticillium lecani* @ 5 g/L at 10 days interval were given. In protected treatment 72.37, 62.50, 75.00 and 64.66 per cent control of root rot, foliar diseases, YMV and defoliators, respectively was found with 73.02 percent yield increase over unprotected treatment (Table 24). Hence, by using theses protective measures 73.02 per cent losses of GFY can be avoided in cowpea at Palampur.

Table 24: Assessment of avoidable crop losses due to diseases and insect-pests in forage Cowpea

Treatments	Root rot		Foliar diseases		YMV		Defoliators		Green Fodder yield	
	Incidence (%)*	Control (%)	Severity (%)*	Control (%)	Incidence (%) **	Control (%)	Incidence (%)*	Control (%)	(q/ha)	(%) increase
T_1 =Protected	15.00 (22.75)	72.37	12.86 (20.91)	62.50	1.14 (1.43)	75.00	5.86 (13.96)	64.66	168.57	73.02
T_2 = Unprotected	54.29 (47.45)	-	34.29 (35.79)	-	4.57 (2.36)	-	16.57 (23.98)	-	97.43	-
CD (5%)	1.77		3.61		0.27		2.31		10.69	

*Figures in parentheses are arc sine transformed values**Figures in parentheses are square root transformed values

iv. Management of leaf blast in forage pearl millet

The experiment was conducted with 11 treatments for the management of leaf blast (*Pyricularia grisea*) of forage pearl millet using chemicals & non chemical methods. Among all the treatments the seed treatment with tricyclazole @ 0.6 g/kg seed followed by two sprays of same fungicide @ 0.3g/l was found most effective which gave 79.5 % disease control with 13.2 % increase in the green fodder yield over check. This treatment was followed by seed treatment with tebuconazole + trifloxystrobin @ 1 g/kg seed and two sprays of same fungicide @ 0.4g/l which gave 71.9% disease control with 11.1 % increase in the yield over check. Among the non-chemical methods seed treatment with chitosan @ 0.05% followed by the foliar spray of chitosan @ 0.05% was found effective with 68.5 % disease control with 8.2 % increase in the yield over check (Table 25).

Table 25: Evaluation of IDM components against leaf blast of forage pearl millet

Treatment	Leaf Blast of pearl millet						GFY	
	Leaf Blast		Infection rate (r) (per day)		AUDPC			
	Severity (%)	Control (%)	Rate (r)	Relative rate (%)	AUDPC	Relative AUDPC (%)	(q/h)	Increase over check (%)
T1	33.7 (35.5)^{e}	30.8	0.11^{c}	90.1	484.17^{d}	65.0	329.33^{c}	4.0
T2	33.0 (35.0)^{e}	32.2	0.12^{c}	100.0	466.67^{d}	62.7	329.67^{c}	4.1
T3	38.3 (38.2)^{f}	21.2	0.10^{c}	84.3	579.83^{f}	77.9	324.00^{c}	2.3
T4	41.3 (40.0)^{f}	15.1	0.10^{c}	84.3	647.50^{g}	87.0	323.33^{c}	2.1
T5	34.0 (35.7)^{e}	30.1	0.09^{bc}	75.6	520.33^{e}	69.9	330.00^{c}	4.2
T6	18.7 (25.6)^{c}	61.6	0.07^{b}	57.1	339.50^{b}	45.6	349.00^{b}	10.2
T7	13.7(21.7)^{b}	71.9	0.05^{ab}	42.1	325.50^{b}	43.7	351.67^{ab}	11.1
T8	15.3(23.0)^{bc}	68.5	0.08^{bc}	70.2	397.83^{c}	53.4	342.67^{b}	8.2
T9	29.3(32.8)^{d}	39.7	0.05^{ab}	42.1	456.17^{d}	61.3	325.33^{c}	2.7
T10	10.0(18.4)^{a}	79.5	0.04^{a}	36.7	203.00^{a}	27.3	358.33^{a}	13.2
T11	48.7(44.2)^{g}	-	0.12^{c}	100.0	744.33^{h}	100.0	316.67^{d}	-
CD (5%)	2.38		0.02		38.27		7.36	
CV	4.84		12.24		4.75		1.28	
SE (M)±	0.80		0.02		12.88		2.48	

*Figures in parentheses are arc sine transformed values

Treatments:

T1: Seed treatment with carbendazim @ 2.0g/kg seed
T2: Seed treatment with tebuconazole + trifloxystrobin @ 1 g/kg seed
T3: Seed treatment with chitosan @ 0.05%
T4: Seed treatment with neem seed extract @ 5%
T5: Seed treatment with tricyclazole @ 0.6 g/kg seed
T6: T1+ foliar spray of carbendazim @ 0.5 g/L
T7: T2+ foliar spray of tebuconazole + trifloxystrobin @ 0.4g/L
T8: T3+ foliar spray of chitosan @ 0.05%
T9: T4+ foliar spray of neem seed extract @ 5%
T10: T5+ foliar spray of tricyclazole @ 0.3 g/L
T11: Control

v. Validation of best treatment of trial entitled "Integrated disease management in berseem"

The experiment was conducted to validate the effective treatment on large plots. It was observed that seed treatment with carbendazim @ 0.2 % followed by foliar spray of Chitosan @ 0.05 % was proved best with 87.83and 85.16 per cent control of root rot and leaf blight respectively, with maximum increase (4.65 %) in the GFY over the check (Table 26)

Table 26: Validation of best treatment of trial entitled "Integrated disease management in berseem"

Treatment	Root rot		leaf blight		GFY		B : C
	% incidence	% control	% severity	% control	q/ha	% increase	
T_1= Seed treatment with carbendazim @ 0.2 % + foliar spray of carbendazim @ 0.1 %	1.71	79.13	3.14	75.82	352.71	6.28	1: 3.3
T2 = Seed treatment with carbendazim @ 0.2 % + foliar spray of Chitosan @ 0.05 %	1.00	87.83	1.93	85.16	347.29	4.65	1: 4.6
T3 =Control	8.21	-	13.00	-	331.86	-	
CD (5%)	0.63		0.82		3.17		
CV	14.72		11.57		0.78		
SE (M)±	0.20		0.26		1.02		

vi. Eco friendly management of zonate leaf spot of Sorghum

The experiment was conducted with 9 treatments having 3 replications in RBD at Palampur for the management of zonate leaf spot (*Gloeocercospora sorghi*) of Sorghum using non chemical methods.

Among all the treatments the three foliar spray of propiconazole @ 0.1% (Chemical check) was found most effective which gave 65.04 % disease control with 18.48 % increase in the green fodder yield over check. Among the non-chemical methods three foliar sprays of extract of eupatorium ark @ 10% giving 49.19 % disease control with 12.35 % increase in the yield over check, was found best which is followed with non-significant differences by three foliar spray of Tamarlassi @ 10% with 47.15% disease control with 7.81 % increase in the yield over check. Three foliar spray of Panchgavya @ 10% also found effective with 43.09 % disease control and 15.63% increase in the yield (Table 27). The higher yield in Panchgavya may be due to its nutritional effect on the host. In control the disease severity was observed 82.0 per cent with maximum r (0.11) per day and AUDPC (800.33) and minimum GFY (315.7 q/ha).

Table 27: Eco friendly management of zonate leaf spot of Sorghum

Treatment	Zonate leaf spot of Sorghum						GFY	
	Zonate leaf spot		r (per day)		AUDPC			
	Severity (%)	Control (%)	Rate (r)	Relative infection rate (%)	AUDPC	Relative AUDPC (%)	(q/h)	Increase over check (%)
T1	55.67 (48.24)^{c}	32.11	0.09^{b}	87.50	673.17^{cd}	84.11	331.7^{cd}	5.07
T2	58.33 (49.78)^{c}	28.86	0.09^{b}	87.50	689.50^{d}	86.15	325.3^{d}	3.06
T3	50.00 (44.98)^{bc}	39.02	0.09^{b}	87.50	648.67^{cd}	81.05	349.3^{c}	10.67
T4	43.33 (41.12)^{b}	47.15	0.09^{b}	87.50	572.83^{bc}	71.57	340.3^{d}	7.81
T5	41.67 (40.10)^{b}	49.19	0.09^{b}	84.38	565.83^{b}	70.70	354.7^{c}	12.35
T6	48.33 (44.03)^{bc}	41.06	0.10^{b}	93.75	628.83^{c}	78.57	359.3^{bc}	13.83
T7	46.67 (43.07)^{bc}	43.09	0.10^{b}	93.75	609.00^{b}	76.09	365.0^{b}	15.63
T8	28.67 (32.36)^{a}	65.04	0.07^{a}	62.50	462.00^{a}	57.73	374.0^{a}	18.48
T9	82.00 (64.90)^{d}	-	0.11^{c}	100.00	800.33^{e}	100.00	315.7^{e}	-
CD (5%)	5.47		0.01		60.34		6.69	
CV	6.90		0.02		5.69		1.11	
SE (M)±	1.81		37.84		19.96		2.21	

*Figures in parentheses are arc sine transformed values

Treatments:

T1: Three foliar spray of *Trichoderma viride* @ 0.5%
T2: Three foliar spray of *Psuedomonas flourescens* @ 0.5%
T3: Three foliar spray of Jeevamrit @ 10%
T4: Three foliar spray of Tamarlassi @ 10%
T5: Three foliar spray of extract of eupatorium ark @ 10%
T6: Three foliar spray of Azadirachtin 3000 ppm @ 0.3%
T7: Three foliar spray of Panchgavya @ 10%
T8: Three foliar spray of propiconazole @ 0.1% (Chemical control)
T9: Control

vii: Estimation of yield losses due to foliar diseases (anthracnose, gray leaf spot and zonate leaf spot) in fodder sorghum

The experiment was conducted with 8 treatments for the management of zonate leaf spot (*Gloeocercospora sorghi*) of Sorghum. Among all the treatments the two foliar sprays of propiconazole @ 1ml/l at 20 and 35 DAE was found most effective which gave 46.5 % disease control with 22.14 % increase in the green fodder yield over check. This was followed with non-significant difference by seed treatment with carbendazim (2g/kg) + foliar spray of propiconazole @ 1ml/l at 20 and 35 DAE with 45.4% disease control with 23.47 % increase in the yield over check. In control the disease severity was observed 61.7 per cent with maximum r (0.12) per day and AUDPC (842.33) and minimum GFY (326.67q/ha). The crude protein increased from 3.43 to 20.69 per cent in treatments as compared to control being maximum in T1, T2 and T4. However the ADF and NDF decreased i.e. -0.57 to -4.26 and -1.34 to -4.01 per cent in different treatments as compared to control (Table 28).

Table 28: Estimation of yield losses due to foliar diseases (anthracnose, gray leaf spot and zonate leaf spot) in fodder sorghum

Treatment	Zonate leaf spot of Sorghum						Quality Characters						GFY	
	Zonate leaf spot		r (per day)		AUDPC		Crude protein		ADF		NDF			
	Severity (%)	Control (%)	Rate (r)	Relative infection rate (%)	AUDPC	Relative AUDPC (%)	Crude protein (%)	% increase	ADF (%	% decrease	NDF (%)	% decrease	(q/h)	Increase over check (%)
T1	33.67 (35.45)[a]	58.78	0.05[a]	39.76	537.50[a]	45.08	10.21[a]	20.69	67.40	-4.26	58.20	-2.68	403.33[a]	23.47
T2	36.00 (36.85)[ab]	55.92	0.09[b]	72.49	543.33[ab]	45.57	10.21[a]	20.69	68.20	-3.13	57.40	-4.01	381.00[b]	16.63
T3	39.33 (38.82)[bc]	51.84	0.06[a]	44.92	564.67[b]	47.36	9.62[ab]	13.71	67.80	-3.69	58.60	-2.01	375.67[b]	15.00
T4	33.00 (35.04)[a]	59.59	0.04[a]	30.61	534.33[a]	44.81	10.21[a]	20.69	69.80	-0.85	57.80	-3.34	399.00[a]	22.14
T5	37.00 (37.45)[b]	54.69	0.09[b]	72.49	592.67[c]	49.71	9.33[bc]	10.28	70.20	-0.28	59.00	-1.34	385.33[b]	17.96
T6	40.67 (39.60)[c]	50.20	0.12[c]	94.23	672.00[d]	56.36	9.04[bcd]	6.86	68.40	-2.84	57.40	-4.01	377.33[b]	15.51
T7	43.00 (40.96)[c]	47.35	0.11[b]	82.35	616.00[c]	51.66	8.75[cd]	3.43	70.00	-0.57	58.60	-2.01	331.33[c]	1.43
T8	81.67 (64.67)[d]	-	0.13[c]	100.00	1192.33[e]	100.00	8.46[d]	0.00	69.40	0.00	59.80	0.00	326.67[c]	-
CD (5%)	1.88		0.02		29.44		0.77						13.86	
CV	2.59		15.06		2.75		4.57						2.11	
SE (M)±	0.62		0.01		9.61		0.25						4.53	

*Figures in parentheses are arc sine transformed values

T1: Seed treatment with carbendazim (2g/kg) + foliar spray of propiconazole @ 1ml/l at 20 and 35 days after emergence (DAE)

T2: Seed treatment with carbendazim (2g/kg) + foliar spray of propiconazole @ 1ml/l at 20 DAE

T3: Seed treatment with carbendazim (2g/kg) + foliar spray of propiconazole @ 1ml/l at 35 DAE

T4: Foliar spray of propiconazole @ 1ml/l at 20 and 35 DAE

T5: Foliar spray of propiconazole @ 1ml/l at 20 DAE

T6: Foliar spray of propiconazole @ 1ml/l at 35 DAE

T7: Seed treatment with carbendazim (2g/kg)

T8: Control

G. Protected Cultivation

I.Identification of biological control agents (BCAs) against plant pathogens under protected cultivation: Among ten bacterial isolates tested against the pathogen *R. solanacearum*, bacterial isolate 5 gave the maximum inhibition zone of 9.91 per cent followed by bacterial isolate seven with the 7.39 per cent inhibition zone. Ten bacterial isolates were evaluated in Hoagland solution against the *Ralstonia solanacearum* wilt pathogen and found that bacterial isolate 5 did not cause any wilt symptom while bacterial isolate 2,4,7 and 8 resulted in partial wilt symptom on tomato (Table 29).

Table 29: *In vivo* evaluation of bacterial bioagents against *Ralstonia solanacearum* on tomato

Sr. No.	Bacterial isolates	Response
1	Bacteria 1	CW
2	Bacteria 2	PW
3	Bacteria 3	CW
4	Bacteria 4	PW
5	Bacteria 5	NW
6	Bacteria 6	CW
7	Bacteria 7	PW
8	Bacteria 8	PW
9	Bacteria 9	CW
10	Bacteria 10	CW
11	Control	CW

* CW= Complete wilt, PW= Partial wilt, NW= No wilt

Among the tested twenty two bioagents isolates, the *Trichoderma* isolate TI-14 was found to be most effective against *Fusarium oxysporum* resulting in 72.60 per cent mycelial inhibition followed by TI-7 with the 60.71 per cent inhibition (Table 30).Among the twenty three bioagents tested against *R. solani*. The *Trichoderma* isolate TI-6 was found to be most effective and gave 86.88 per cent mycelial inhibition followed by TI-7 with the 77.23 per cent inhibition (Table 30).

Table 30: *In vitro* evaluation of bioagents against *Fusarium oxysporum*

Sr. No.	Bioagents	*Fusarium oxysporum*		*Rhizoctonia solani*	
		Mycelial growth (mm)	% Mycelial inhibition	Mycelial growth (mm)	% Mycelial inhibition
1	DMA-8	12.89	53.96	35.44	41.90
2	JMA-11	15.00	46.42	35.56	41.70
3	TH-4	13.67	51.17	38.11	37.52
4	TH-5	12.00	57.14	33.56	44.98
5	TH-11	11.56	58.71	28.78	52.82
6	SMA-5	11.74	58.07	32.67	46.44
7	TV -1	19.67	29.75	36.00	40.98
8	TI-1	12.56	55.14	28.78	52.82
9	TI-2	13.00	53.57	39.56	31.07
10	TI-3	12.00	57.14	43.00	29.50
11	TI-4	10.67	61.89	35.55	48.48
12	TI-5	12.44	53.96	32.56	46.62
13	TI-6	12.89	53.96	8.33	86.88
14	TI-7	11.00	60.71		
15	TI-8	12.55	55.17		
16	TI-9	13.00	53.57		
17	TI-10	11.33	59.53		
18	TI-11	12.56	55.14		
19	TI-12	12.45	55.53		
20	TI-13	13.22	52.78		
21	TI-14	7.67	72.60		
22	TI-15	11.67	58.32		
23	Control	28.00			
	CD (0.05)	2.24			

H. Molecular Plant pathology

I. Mapping of anthracnose resistance gene(s) in land race KRC-8 using molecular markers

i. Bulked Segregant Analysis (BSA) and segregation in the population using parental polymorphic markers:IAC 238, BM146, IAC235 and IAC259 were found to be polymorphic on bulks. These were further used for screening of the $F_{2:9}$ RIL mapping population. The marker IAC-238 resulted in identical amplification in bulks to that of parents and similar amplification pattern was also observed in the individuals of susceptible and resistant bulks. The Co-dominant nature of this marker resulted in the amplicon of ~240 bp size in susceptible parent (Jawala), bulk as well as individuals, whereas in case of resistant parent (KRC-8), bulk and individuals, it yielded the amplicon of ~220 bp. It revealed one heterozygous individual (JB 184) in the population. Similarly, BM146 resulted in amplification of ~270 bp band in the susceptible parent Jawala, susceptible bulk as well as individuals. On the other hand the same marker showed amplification of ~290 bp band in the resistant parent KRC-8, resistant bulk and individuals (Fig. 7.2a & b). BM146 revealed three heterozygous individuals (JB 75, JB 177 and JB 180) among the whole population screened. IAC 235 resulted in an amplicon of ~270 bp in the susceptible parent, bulk and individuals while ~290 bp in resistant parent KRC-8, resistant bulk and individuals (Fig. 7.3a & b). IAC259 segregated among the population showing an amplification of ~210-215 bp in the susceptible parent Jawala and susceptible RILs whereas it showed an amplicon of ~200 bp in the resistant parent KRC-8 and resistant RILs.

ii. Construction of linkage map: The genotypic and phenotypic data in $F_{2:9}$ were analyzed using Join Map 3.0 software to construct the linkage map of the candidate resistance gene with markers IAC-238, IAC 235, IAC 259 and BM 146 (Fig 1). The linkage analysis revealed the presence of R-gene on chromosome 1, which is known to harbor many resistance genes *i.e*. *Co-1* including their alleles (*Co-1*^{2}, *Co-1*^{3}, *Co-1*^{4},*Co-1*^{5}, *Co-1*^{HY}, *Co-1*^{x}), *Co-x*, *Co-w*, *Co-Pa*, *Co-Ac* and *Co-CDRK*. However, the physical position of the resistant loci is distinct from the earlier known genes mapped on the chromosome 1. Further, linkage of three markers to the R-gene was observed at 11cM (IAC 259), 18 cM (BM 146) and 25 cM (IAC 235) while IAC 238 was observed to be on the gene.

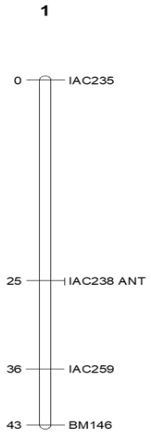

Fig. 1 Linkage map of chromosome 1 harboring R-gene (ANT represents the R- gene)

To determine the physical position of resistance locus identified in landrace KRC-8, the sequence of linked marker (IAC-238) F- GAGATAGATCATAGACCCCAA, R- CTTTCAATTTTAACTCATCCTC was subjected to blast analysis on Phytozome database. The blast analysis on the Phytozyme database showed 6 hits on different chromosomes with best match on chromosome 1 with blast score of 41 and E value of 7.5E-4. The identified marker showed the best hit on chromosome 1 at position **44472100 – 44472139** (41b), with the transcript - **Phuvl. 001G186600.1** coding for **K141510- Serine / Theronine- protein kinase CTR1**. Therefore, the marker IAC-238 appears to be positioned on the gene **Phuvl. 001G186600.1** which may be involved in the plant defence mechanism.

I. Mushrooms

i. Evaluation of selected white accessions of *Agaricus bisporus* Advance Varietal trial -1 for yeild
Cultures of six strains i.e.AVTB-21-101-106 of white button mushroom were evaluated for yield potential. It was observed from the data that Maximum yield was recorded in AVTB-21-106 (21.4 kg) followed by AVTB-21-105 (21.0) and 104 (20.0 Kg) and minimum yield was recorded in AVTB-21-102 (17.9 kg) Time taken for first harvest (post casing) was between 19-22 days and average fruit body weight ranged between 9.1-13.5 gms. Maximum fruit body weight was observed in AVTB -21-101 (13.5gms and lowest in AVTB -21-102.

Table 31 : Evaluation of selected white accessions of *Agaricus bisporus* (AVTB) for yeild

Strains	Yield kg/100kg compost	Time takes for first harvest (post casing) (Days)	Average fruit body weight (g)
AVTB-21-101	19.0	19	13..5
AVTB-21-102	17.9	20	9.1
AVTB-21-103	18.5	22	9.5
AVTB-21-104	20.0	20	10.3
AVTB-21-105	21.0	19	11.1
AVTB-21-106	21.4	21	12.0
CD	0.77		0.91

ii. Evaluation of selected white accessions of *Agaricus bisporus* of Initial Varietal trial for yield
Ten strains of IVT trail were evaluated for yield parameters. It was observed that maximum yield was recorded in IVTB-21-01 (21.4 Kg) followed by IVTB-21-02 (19.0 Kg) and minimum yield was recorded in IVTB-21-10 (15 Kg). Time taken for first harvest (post casing) was between 20-23 days and average fruit body weight ranged between 8.3 – 10.5 gms.

Table 32: Evaluation of selected white accessions of *Agaricus bisporus* of IVTB for yield

Strains	Yield kg/100kg compost	Time taken for first harvest (post casing) (days)	Average fruit body weight (g)
IVTB-21-01	21.4	20.0	9.0
IVTB-21-02	19.0	20.0	9.1
IVTB-21-03	17.9	23.0	8.3
IVTB-21-04	16.0	20.0	8.7
IVTB-21-05	17.9	21.0	8.9
IVTB-21-06	18.0	22.0	9.4
IVTB-21-07	16.8	20.0	10.5
IVTB-21-08	16.0	22.0	10.1
IVTB-21-09	17.3	20.0	10.2
IVTB-21-10	15.0	21.0	10.0
CD	0.67		0.51

iii: Evaluation of high yielding varieties/strains of Oyster Mushroom (*Pleurotus pulmonarius*) Initial Varietal trial of on wheat straw
The experiment was conducted with ten strains of PL-21-01 to Pl-21-10 of *Pleurotus pulmonarius* having 5 replications of 1.5 kg dry wheat straw in each replication. It was observed that PL-21-07 gave the highest yield of 112.3 kg with average fruit body weight of 15.0 gm followed by PL-21-06

(108.5 kg) with average fruit body weight of 14.0 gm. Lowest yield was recorded in PL-21-08 (35.5kg) with average fruit body weight of 9.5 gm. Average fruit body weight ranged between 9.5 - 15.0 gm and time taken for first harvest ranged between 30-38 days because harsh winter season this time.

Table 33: Evaluation of high yielding varieties/strains of Oyster Mushroom (*Pleurotus pulmonarius*) IVT on wheat straw

Strains	Yield kg/100kg dry straw/saw dust	Time take for first harvest	Average fruit body weight (g)
PL-21-01	86.6	35	12.5
PL-21-02	60.7	30	12.0
PL-21-03	83.0	32	10.0
PL-21-04	50.9	32	14.5
PL-21-05	90.0	35	10.0
PL-21-06	108.5	38	14.0
PL-21-07	112.3	36	15.0
PL-21-08	35.5	32	9.5
PL-21-09	90.0	36	12.0
PL-21-10	99.0	36	13.0
CD	0.90		

iv.: Evaluation of Shiitake mushroom strains of Initial varietal trial on saw dust

The experiment was conducted with ten strains of IVTL-21-01 - IVTL-21-10 of Shiitake mushroom having 3 replications of 600 gm dry Poplar sawdust used in each replication. IVTL-21-10 gave the highest yield of 390.4 g with average fruit body weight of 35.2 gm followed by IVTL-21-09 (380.5 g) with average fruit body weight of 23.1 g. Lowest yield was recorded in IVTL-21-06 (65.0 g) with average fruit body weight of 31.2 g. Average fruit body weight ranged between 35.2- 16.5 gm and time taken for first harvest ranged between 41-48 days .

Table 34: Evaluation of Shiitake mushroom strains of IVT on poplar saw dust

Strains	Yield g/600g dry saw dust	Time taken for first harvest (days)	Average fruit body weight (g)
IVTL-21-01	280.5	48	19.6
IVTL-21-02	240.4	47	17.2
IVTL-21-03	290.6	45	15.2
IVTL-21-04	210.5	40	19.3
IVTL-21-05	322.7	40	17.2
IVTL-21-06	65.0	42	31.2
IVTL-21-07	295.4	40	24.2
IVTL-21-08	200.5	41	16.5
IVTL-21-09	380.5	42	23.1
IVTL-21-10	390.4	42	35.2
CD	1.34		0.62

Photographs

High and low yieiding strains of Button , Oyster and Shiitake mushrooms

6. EXTENSION EDUCATION

The faculty of Plant Pathology posted at head quarter, research stations and KVKs undertook/ participated in different extension activities as given below:

Advisory	Advisory and consultancy services to farmers and visitors regarding diagnostic and management of diseases of cereals, pulses, oilseeds, vegetable & horticultural crops and mushroom cultivation was provided to more than **3025 farmers**
Advisory through news papers	**16**
Liaison/ collaboration with National/ International bodies/ agencies	Liaison was established with various agencies like ICARDA, AVRDC, ICRISAT, NBPGR, MYMV, RKVY, ATMA, JICA etc.
Trainings conducted	130 **training programmes** on different topics were conducted at head quarter (DEE) and out stations/ KVKs and more than **3250 farmers** were trained
Participation in Extension Training Programmes	**252 numbers of lectures** were delivered to farmers in various training programmes conducted at head quarter and out stations/ KVKs / other agencies
Front Line Demonstrations	**47 numbers** of Demonstrations were conducted (KVKs)
On farm trials	**36 numbers** of on farm trials were conducted
Field demonstrations	**Demonstration:** 60 demonstrations on Setaria (20) NXB hhybrid (20), Oat (20) and Rye grass (10). Establishment of New Demonstration unit on **IFS -1 no**
Adaptive trials	**2 numbers** of adaptive trials were conducted
Kisan melas/ divas/field days/Special Celebrations	**32 numbers** of kisanmelas/ divas were organized (KVKs)
Workshops organized/ attended	Faculty participated in 57 **numbers of workshops**
Radio & TV talks	The faculty delivered **7 radio/ TV talks**
Mushroom cultivation	Produced and Sold spawn of 1. *Agaricus* and *Pleurotus* mushroom: **2021.94 kg worth Rs 2,22.413.40 /-** 2. Compost of button mushroom: **6356 kg worth Rs 95350/-** 3. Fresh mushroom :**273.33kg worth Rs. 41,050.0/-** **Total economic activity- 3,58,813.40/-**
Disease samples analyzed	**316 numbers**
Diagnostic visits	**66**
Telephonic Consultation	**112**
Monitoring and joint visits with other departments	**52**

7. MISCELLANEOUS ACTIVITIES

i) Honour & Awards:

- Certificate of Reviewing 2021 by Indian Phytopathological Society (Dr. D.K. Banyal)
- Fellow Indian Society of Plant Pathologist 2021to Dr. D.K. Banyal
- Best Research Paper Award in National Symposium on "Novel strategies in plant stress diagnosis and management" organised by Himalayan Phytopathological Society at UHF Solan on May 6-7, 2022 to Ms Diksha and Dr D K Banyal

ii) Participation in Workshops/ Conferences/ Symposia/ Seminars/ Trainings/ Meetings

The faculty of Plant Pathology participated in 25 Workshops/ Conferences/ Symposia/ Trainings etc. during 2021-22 as enlisted below:

Sr. No.	Date	Details of programme	Name of participants
1.	15-17/4/21 (online)	National Web Conference on Mushroom - 2021 "Mushroom Biology: Opportunities and Challenges"from	Dr Deepika Sud
2.	2/7/21 (online)	Group Meet/ Workshop of AICRP on NSP – STR	Dr S.K.Rana
3.	18-20/7/21	Attended Annual Zonal workshop of KVKS of Zone-I KVK Bilaspur Online	Dr Suman kumar
4.	18-20 / 7/21	Zonal workshop of KVKs (Zone-1) through virtual mode and made the presentation of KVK- Hamirpur.	Dr Pardeep Kumar
5.	27/7/21	Attended felicitation function w.r.t Best KVK award at CSK HPKV Palampur	Dr Suman kumar
6.	5 /8/21	State level interface meeting on state specific issues pertaining to agriculture and allied sectors for the state of Himachal Pradesh organized by CPRI, Shimla.	Dr Pardeep Kumar
7.	5/8/21	Participated in Crop Protection – Work Plan Meeting 2021-22 for the discussion and finalization of crop protection work plan 2021-22 held organized by ICAR-IIWBR, Karnal.	Dr Sachin Upmanyu
8.	9-11 /8/21	Training programme on "Road Map for KVKs to Enhance Mushroom Production and Consumption" organized by ICAR-IIHR, Hasarghatta (Banglore) w.e.f.	Dr Pardeep Kumar
9.	24-26 /8/21	Training programme on "Organic and Natural Farming" organized by DEE, CSKHPKV, Palampur .	Dr Pardeep Kumar
10.	6-7 /8/ 21 (Online)	XXIII Annual Virtual Workshop of AICRP-Mushroom	Dr Deepika Sud
11.	10/ 8/ 21 (Online)	Participated in 1st Interactive meeting of all AICRIP centers 2021 (Zone 1: Hills) with Director, ICAR-IIRR for discussions as well as presentation of All India Coordinated Rice Trails of different disciplines conducted during *kharif* – 2021 through virtual mode on August.	Dr Sachin Upmanyu
12.	11/8/21	Attended meeting w.r.t Governing board of ATMA and activities undertaken in Bilaspur	Dr Suman kumar
13.	23-24/8/21	Participated in 60th AICRP Wheat and Barley Research Worker's Virtual Meet (2021) held during August organized by ICAR-IIWBR, Karnal.	Dr Sachin Upmanyu
14.	18.09.2021.	Participated in awareness camp cum field day on 'Basmati Rice Cultivation' at Sandhol in collaboration with KVK, Mandi at Sundernagar sponsored by BEDF, APEDA, Modipuram	Dr Sachin Upmanyu
15.	20/9/21	Annual group meeting – *Rabi 2021* of All India Co-ordinated Research Project on Forage online	Dr D K Banyal
16.	24 / 9/21	One day workshop on bamboo cultivation under National Bamboo Mission sponsored by Department of Agriculture, Hamirpur and organized by KVK Hamirpur at Bara.	Dr Pardeep Kumar
17.	25 /9/21.	One day workshop on bamboo cultivation under National	Dr Pardeep Kumar

		Bamboo Mission sponsored by Department of Agriculture, Hamirpur and organized by KVK Hamirpur at Bara.	
18.	10 /9/ 21 (Online)	24Th National Mushroom mela at DMR Solan	Dr Deepika Sud
19.	15/9/ 21 (Online)	AICRP-Mushroom Review Meeting	Dr Deepika Sud
20.	21/9/21 (Online)	Inaugural session of start - ups under Him Palam RABI	Dr Deepika Sud
21.	24/9/21	Brainstorming meeting on sustenance of pulses, chaired by Honble VC, CSK HPKV, Palampur	Dr Suman kumar
22.	22-24/9/21 Online	Webinar-cum-Workshop on Seed Quality Enhancement for Northern Zone organized by ICAR-IARI, New Delhi & CCSHAU, Hissar (Haryana) India	Dr Suman kumar
23.	24/9/21 Online	Bio control- A global sustainable approach for Eco-friendly agriculture by NIPHM	Dr Suman kumar
24.	28/9/21 Online	PM Live telecast at KVK Campus	Dr Suman kumar
25.	01/10/21 Online	Introduction to GIS Mapping and spatial analysis using ArcGIS by SKILL LYNC	Dr Suman kumar
26.	22 /10/21	DFAC meeting at DDA, office Hamirpur.	Dr Pardeep Kumar
27.	22 /10/21	Awareness programme cum workshop on safe use of pesticides and adoption of good agricultural practices for production on Basmati Rice at Dhanotu	Dr D K Banyal
28.	22 /10/21	Participated in an awareness camp cum workshop on 'Basmati Rice Cultivation' at Dhanotu (Rait) organized by KVK, Kangra sponsored by BEDF, APEDA, Modipuram	Dr Sachin Upmanyu
29.	25-27/10/21	Training cum webinar on "On farm and mass production protocols of bioagents and microbial agents for fall armyworm management" organized by FAO India, DPPQ & S and ICAR-IIMR	Dr R.K Devlash
30.	12/11/21 (online)	Annual Meeting of AICRP on NSP-STR for monitoring the progress made by Northern Zone centers	Dr S.K. Rana
31.	8-12 /11/21 (Online Training)	On farm production of biocontrol agents and microbial biopesticides" by NIPHM Hyderabad	Dr Amar Singh
32.	16 /11/21	Launch ceremony of H.P. Crop Diversification Promotion Project (Phase –II) and interaction workshop	Dr Deepika Sud
33.	30/11/21 Online	Workshop on "Natural Farming organized by NITI Aayog, Govt of India at KVK Campus	Dr Suman kumar
34.	6-7/12/21	National Symposium on Strategic Plant Disease Management for Food security organised by INSOPP at CPRI Shimla	Dr D K Banyal, Dr S.K Rana A Thakur, Diksha Shina and A. Singh
35.	07/12/21 Online	Workshop on Mobile Apps for farmers jointly organized by ICAR-IASRI, New Delhi and ATARI, Zone-1, Ludhiana at KVK Campus	Dr Suman kumar
36.	16/12/21 Online	Natural Farming "Pre-Vibrant Gujarat Summit at KVK Campus	Dr Suman Kumar
37.	28 / 12/21	Agriculture Officer's workshop – cum – farmer Scientist Interface – 2021	Dr D K Banyal, Dr Amar Singh, Dr Deepika Sud and Dr Shikha Sharma Dr Joginder Pal
38.	22/1/22 Online	Production and productivity of grain legumes for food security: Prospects, Problems and need for future research at KVK Campus.	Dr Suman kumar
39.	24 /1/22 (Online)	ICAR-IIMR lecture series #11 Azadi ka Amrit Mahotsav on National Girl Child Day	Dr R.K Devlash
40.	3-4/2/22	1st conference on "Intellectual Property Rights 2022 Stepping Stone Towards Astmanirbhar Bharat" organized by Institute of Positivity and CSK Himachal Pradesh	Dr. Joginder Pal

		Krishi Vishvavidyalaya, Palampur	
41.	11/2/22; 23/2/22 Online	ICT based platform-KISAN SARTHI jointly organized by Indian Council of Agricultural Research and Digital India Corporation at KVK Campus	Dr Suman kumar
42.	25 – 26 /2/22 4-5/3/22	National training cum webinar on "Diagnosis and Management of Diseases and Insects, Mite and Nematode Pests of Vegetables Crops in Protected Agriculture and Natural Farming"	Dr. Joginder Pal
43.	25-26/2/22 and 4-5 /3/22	National Training cum Webinar on "Diagnosis and management of diseases, insects, mites and nematodes pests of vegetables crops under protected Agriculture and natural farming" on Feb March 2022 organised by CAAST, CSKHPKV Palampur. Acted as Chairman in technical Session on 26th Feb and 4th March 2022.	Dr D K Banyal
44.	19/03/22 21/03/22	SAC meetings of KVK Mandi at Charkhari on and KVK Kangra at Jamanabad	Dr D K Banyal
45.	22-24 /2/22 (Online)	National Workshop on Shiitake Mushroom: As Nutraceutical and Next Generation Functional Food (Hybrid Mode)	Dr Deepika Sud
46.	21 -22 /2/22 (Online)	National Symposium on "Recent Trends in Phytopathology to address Emerging Challenges for Achieving Food Security"	Dr Shikha Sharma
47.	28/02/22	Participated in the 9th Hill Rice Research Group Meeting (2022) through virtual mode on organized by ICAR-IIRR, Hyderabad.	Dr Sachin Upmanyu
48.	10-11 /3/ 22 (Online)	Two days Workshop on taxonomy of wild edible mushrooms for AICRP scientists on	Dr Deepika Sud
49.	24-26/ 3/22 (Online)	National Seminar on "Fruit production in Eastern Tropical Region of India: Challenges and Opportunity,	Dr Shikha Sharma
50.	28/3/22 Online	Improved cultivation practices of oilseed crops ATARI-Ludhiana	Dr Suman kumar
51.	19 – 21/4/22	Annual Maize Workshop (AICRP, Maize) held at CCS HAU, Hisar	Dr R.K Devlash
52.	18/04/22	Participated in the 57th Annual Rice Research Group Meeting cum Pre-workshop (Plant Pathology) through virtual mode on organized by ICAR-IIRR, Hyderabad	Dr Sachin Upmanyu
53.	22/ 4/22 (Online)	pre-workshop of AICRP on NSP-STR	Dr S.K.Rana
54.	25-27/4/ 2022 (Online)	Participated in the 57th Annual Rice Research Group Meeting cum Workshop (2022) through virtual mode during organized by ICAR-IIRR, Hyderabad.	Dr Sachin Upmanyu
55.	6-7 /5/22	Novel strategies in plant stress diagnosis and management" by Himalayan Phytopathological Society at UHF Solan	Dr D K Banyal, Dr Deepika Sud, Dr Sachin Upmanyu and Dr Shikha Sharma
56.	10-11 /5/22 (Online)	Attended inaugural and plenary sessions of Annual Group Meet of AICRP on MULLARP	Dr S.K. Rana
57.	13-14 / 6/ 22	Annual group meeting – *Kharif 2022* of All India Co-ordinated Research Project on Forage at SAKUAST –K (J&K)	Dr D K Banyal
58.	1-2/6/22	XII Biennial National Conference of KVKs 2022 at Dr. Y.S. Parmar, UHF, Nauni, Solan	Dr Suman kumar
59.	4/6/22	Garib Kalyan Sammelan organized by DC Bilaspur in collaboration with KVK Bilaspur at KVK Campus	Dr Suman Kumar
60.	17-18 /5/22	52nd Annual Group Meeting of AICRP on Soybean on at Indore MP	Dr Amar Singh
61.	28-30 /6/22	In New CONNECTIONS: plant pathology, entomology and the road ahead, Organized by *University of Bristol, UK*	Dr Shikha Sharma

8. PUBLICATIONS

a) Research papers with NAAS ratings

1. Arora, A., Sood, V. K., Chaudhary, H. K., Banyal, D K., Kumar, S., Rajni D., Kumari, R., Khushbu, A., Priyanka and Yograj, S. 2021. Genetic diversity analysis of oat (*Avena sativa* L.) germplasm revealed by agro-morphological and SSR markers. ***Range Management. & Agroforestry*** 42 (1): 38-48. (NAAS rating 6.37)
2. Atri, A., Banyal, D. K, Bhardwaj, N. S and Roy A. K 2021. Exploring the integrated use of fungicides, bio-control agent and biopesticide for management of foliar diseases (anthracnose, grey leaf spot and zonate leaf spot) of sorghum. **International Journal of Pest Management**: https://doi.org/10.1080/09670874.2022.2039799. (NAAS rating 7.91)
3. Banyal, D.K., Bhargava, P and Sharma, B.K**.** 2021. Bioefficacy of fungicides against Karnal bunt and flag smut of wheat in Himachal Pradesh. ***Plant Disease Research***. 36(1): 85-89. (NAAS rating 4.76)
4. Basandrai, A. K., Basanrai,D., Amritpal, A., Sharma,B.K. and Singh, H.P. 2021. Multiple resistance sources to yellow rust and powdery mildew in some exotic wheats. ***Plant Disease Research***. 36(1): 52-57. (NAAS rating 4.76)
5. Bhandhari, D., Singh Amar, Patel J.V. and Banyal D.K. 2021. Biological Management of Colocasia Blight Incited by *Phytophthora colocasiae* using Native Strains of Antagonists in North Western Himalayas. ***Indian Journal of Agricultural Research***. DOI: 10.18805/IJARe.A-5880 (NAAS Score: 5.2)
6. Bhardwaj, N.R., Atri, A., Banyal D K., Dhal A. and Roy A K. 2022. Multi-location evaluation of fungicides for managing blast (*Magnaporthe grisea*) disease of forage pearl millet in India. ***Crop Protection***. 159: 106019 https://doi.org/10.1016/j.cropro.2022.106019. (NAAS rating 8.57)
7. Bhardwaj, NR., Atri, A., Rani, U., Banyal D K, and Roy A K.2021. Weather-based models for predicting risk of zonate leaf spot disease in Sorghum. ***Tropical Plant Pathology***. (2021). https://doi.org/10.1007/s40858-021-00461-1 (NAAS 7.34)
8. Bhardwaj, NR., Banyal, D. K. and Roy A K. 2022.Integrated management of crown rot and powdery mildew diseases affecting red clover (*Trifolium pratense* L.) ***Crop Protection*** DOI: https://doi.org/10.1016/j.cropro.2022.105943. (NAAS rating 8.57)
9. Bhargava, P., Rana, S, K, and Upmanyu, S. (2022). Impact of different inoculation techniques and levels of inoculum load of *Urocystis agropyri* (Preuss) A A Fisch. Waldh. on wheat. ***The Pharma Innovation Journal***, New Delhi 11(5): 669-672. (NAAS rating 5.23)
10. Choudhary, A. K., Yadavm D.S., Sood P., Dua, V.K., Singh Amar and Rahi S. 2021. Influence of integrated crop management technology on potato productivity, profitability, energy dynamics and carbon footprints in North-Western Himalayas. ***Potato J*ournal** 48 (2): 148-160.
11. Devi, M., Banyal, D.K., Anudeep B.M. and Sinha, D. 2021 Management of gray leaf spot of tomato caused by Stemphylium lycopersici under protected cultivation. ***Plant Disease Research***. 36 (2): 154-160 DOI No. 10.5958/2249-8788.2021.00025. (NAAS rating 4.76)
12. Dhiman, S., Badiyal, A., Katoch, S., Pathania, A., Singh, A., Rathour, R., Padder,B.A., Sharma, P.N. 2022**.** Insights on atypical adult plant resistance phenomenon in Andean bean cultivar Baspa (KRC-8) to *Colletotrichum lindemuthianum*, the bean anthracnose pathogen. ***Euphytica*** 218:17. (NAAS rating 7.90)
13. Dhiman, S**.,** Kumari, N., Badiyal, A., Sharma, V. and Sharma, P.N. 2022. Developement and validation of a direct PCR based assay for the detection of Colletotrichum species on chili seeds. ***Seed Science and Technology*.** 50 (1), 149-161. (NAAS rating 6.91)
14. Jain, J., Sohal, M.K., Lore, J.S., Jain, S., Sidhu, N. and **Upmanyu, S**. 2021. Identification and quantification of slow blasting resistance in basmati/aromatic germplasm against neck blast (*Pyricularia oryzae* Cavara). ***Indian Journal of Genetics and Plant Breeding*** 81(4): 505-512. (NAAS rating 6.51)
15. Karn, M., Sharma, S.K., Pal, J., Devi, S., Sharma, A. and Sharma, N. 2022. Efficacy of induced resistance chemicals in triggering defense mechanism of pomegranate plants against the pathogenic bacterium *Xanthomonas axonopodis* pv. *punicae*. ***The Pharma Innovation Journal***.11: 1656-1664. (NAAS rating 5.23)
16. Kumar, B., Choudhary, M., Kumar, P., Kumar, K., Kumar, S., Singh, Kumar, B., Lahkar, C., Meenakshi, Kumar, P., Dar, Z. A., **Devlash, R.**, Singh, H.K., Guleria, S.K. and Rakshit, S.

2022. Population Structure Analysis and Association Mapping for Turcicum Leaf Blight Resistance in Tropical Maize Using SSR Markers. ***Genes***, 13: 618. https://doi.org/10.3390/genes13040618 1-14. (NAAS rating 10.10)

17. Kumari, S., Sharma, N., Rana, D. and **Singh, A**. 2020. (Published in 2021) Evaluation of bioagents and chemicals for the management of root rot disease of bell pepper. ***Plant Disease Research*** 35 (2): 103-110 (NAAS Score: 4.76)
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30. Tarushi, Sud, D. and Sud, A. 2021. Evaluation of different sawdust substrates for spawn production of shiitake mushroom [Lentinula edodes (Berk.)]" published online in the issue 29(2).http://epubs.icar.org.in/ejournal/ index.php/MR/article/view/116258 (NASS Rating 4.3)
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b) Book/ Book Chapters

1. Banyal. D. K., Thakur, N. and Sinha. D. 2022. Analysis of diversity at er loci for identification of diverse sources of pea powdery mildew resistance. Pages 288-300. Editors; H R Gautum, Narender Bharat, Anil Handa and S K Sharma. Novel strategies in plant stress diagnosis and management Neoti Book Agency Private Limited, New Delhi pp 1-444. ISBN 978-81-952185-5-4.

2. Sharma, S.K., Pal, J. and Sharma, A. 2021. Seb ke Safed Jarh Saran Rog Ka Ekikrit Prabandhan. Department of Plant Pathology, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) pp. 1-28.
3. वर्ष भर ऋतु आधारित खुम्ब की खेती से सुनिश्चित आमदनी" Submitted for a book published under NHEP CAST Project

c) Papers in Proceedings/ presented in different conferences/ symposia

1. Banyal, D. K. and Mallannavara, A.B. 2021. Oat powdery mildew caused by Blumeria graminis and its management. In the National Symposium on Strategic Plant Disease Management for Food security organised by INSOPP at CPRI Shimla on 6-7th December, 2021.
2. Banyal, D. K., Thakur, N. and Sinha, D. 2022. Analysis of diversity at *er* loci for identification of diverse sources of pea powdery mildew resistance in National Symposium on "Novel strategies in plant stress diagnosis and management" at UHF Solan on May 6-7, 2022. Page 16
3. Basandrai,D;Sharma,B.K.;JyotiKumari;Sharma,Naiya;Barpa,V.;Sharma,Sakshi;Kaur,Harpreet and A.K.Basandrai..2021 Identification of diverse sources of wheat with resistance to yellow rust (Puc cinia striiformis) and powdery mildew (Blueria graminis tritici). Paper presented in National Symposium on "Strategic Plant Disease Management foe Food Security" held at ICAR-Central Potato Research Institute,Shimla from December 6th -7th ,2021
4. Chauhan, Ankita, Kumar, Pardeep and Sud, A. 2022. Prevalence of bacterial wilt (*Ralstonia solanacearum*) of soalanceous vegetables in Himachal Pradesh. National Symposium on "Novel strategies in plant diagnosis and management" w.e.f May 6-7, 2022 held at Dr YS Parmat University of Horticulture and Forestry Nauni (Solan). Abstract: 50-51p.
5. Dhiman **S**, Singh A, Banyal, D.K., Sharmam S., Badiyal, A and Sinha, D. 2022. Efficacy of fungal and bacterial bioagents against bacterial wilt of tomato caused by *Ralstonia solanacearum*. National symposium on Novel strategies in Plant Stress Diagnosis and Management May 6-7, 2022 pp.77
4. Katoch, S., Arora, A., Hunjan, M. S., Sharma, S. and Ingle, Y.V. 2022. Molecular detection and identification of Candidatus liberibacter asiaticus associated with citrus huanglongbing disease. In National Seminar on "Fruit production in Eastern Tropical Region of India: Challenges and Opportunity, 24-26th March.
6. Kaur, G., Rana, S.K. and Singh, A. 2021. Efficacy of new fungicides against Fusarium head blight of wheat in Himachal Pradesh. Plant Disease Research 36 (2): 231 (Abstract). Paper presented in the National Symposium on "Strategic Plant Disease management for Food Security" held at ICAR, CPRI, Shimla from 6-7th December, 2021.
7. Lahkar, C., Kumar, K., Jha, A. Kumar., Singh, B. K., Nagar, S., Devlash, R, Dar, Z. A., Harlapur, S. I, Mallikarjuna. N, Hooda. K. S., Rakshit, S., Kumar, B. 2022. Genome-wide association mapping for turcicum leaf blight resistance in tropical maize. Paper presented in National Conference on "Maize for Resource Sustainability, Industrial Growth and Farmers' Prosperity" organized by Maize Technologists Association of India at Udaipur February 23-25, 2022.
8. Monika, R., Upmanyu, S. and Rana, S.K. 2022. Morpho-cultural and pathogenic variability in Rhizoctonia solani Kuhn causing sheath blight of rice. Paper presented in National Symposium on "Novel Strategies in Plant Stress Diagnosis and Management" at UHF, Nauni, Solan during May 6-7, 2022.
9. Pawar, T., Sharma, S. and Arora R. K.2022. Characterization of of cotton leaf curl associated begomoviruses in The South Western region of Punjab. In National Symposium on "Recent Trends in Phytopathology to address Emerging Challenges for Achieving Food Security" from 21st to 22nd February.
10. Rana, S.K. and Kaur. Gurpreet. 2021. Status of diseases and their management in different crops under natural farming. Plant Disease Research 36 (2): 221 (Abstract). Paper presented in the National Symposium on "Strategic Plant Disease management for Food Security" held at ICAR, CPRI, Shimla from 6-7th December, 2021.
11. Sharma, A., Sharma, B. K. and R.K.Devlash.2021. Bioefficacy of new fungicides against yellow rust disease of wheat in Himachal Pradesh. Paper presented in National Symposium on "Strategic Plant Disease Management foe Food Security" held at ICAR-Central Potato Research Institute,Shimla from December 6th -7th ,2021

5. Sharma, S. and Sharma, A. 2022. Generational vegetative transmission of Potato virus Y and effect on yield attributes Theory vs Experiment. In New Connections: Plant pathology, entomology and the road ahead 28th -30th June, Organized by *University of Bristol, UK*
12. Sharma, S. and Sharma, B. K. 2022. Biopesticides: A good approach towards sustainable agriculture .Paper presented in 10th National Seminar on "Agriculture and More Beyond 4.0" May 26-28,2022,organized by Society for Community Mobilization for Sustainable Development in collaboration with SKUAST-Kashmir and SKUAST Jammu
13. Shina, D. and Banyal, D. K. 2022. Profiling of *Alternaria solani* isolates with respect to aggressiveness on tomato in National Symposium on "Novel strategies in plant stress diagnosis and management" by Himalayan Phytopathological Society at UHF Solan on May 6-7, 2022. **(Won the First best research paper Award)**
14. Sinha, D., Banyal, D. K. and Singhm A. 2021 Evaluation of new chemical molecules for the management of powdery mildew of wheat. in the National Symposium on Strategic Plant Disease Management for Food security organised by INSOPP at CPRI Shimla on 6-7th December, 2021.
15. Tarushi and Sud, D. 2022. Evaluation of different sawdust substrates for quality production of shiitake mushroom 2022. in Symposium on "*Crop Protection through bio-rational approaches - current trends and future perspective*" in hybrid mode at CCS HAU Hisar on March 10, 2022.organised by Indian Phytopathological Society (NZ).
16. Thakur, A. and Banyal, D. K. 2021. Studies on morpho-cultural variability in *Stemphylium vesicarium* causing Stemphylium blight of onion. In the National Symposium on Strategic Plant Disease Management for Food security organised by INSOPP at CPRI Shimla on 6-7th December, 2021.
17. Thakur, A., Uttam, Firoz, H., Vignesh. M., Singh, B., Chand, G., Devlash, R., Guleria, S. K. 2022. Biochemical and molecular characterization of locally adapted maize inbreds for kernel provitamin- A and α-tocopherol. Paper presented in National Conference on "Maize for Resource Sustainability, Industrial Growth and Farmers' Prosperity" organized by Maize Technologists Association of India at Udaipur February 23-25, 2022.
18. Thakur, S., Guleria, .SK, Devlash, R. 2022. Screening for maydis leaf blight under artificial epiphytotic conditions in maize (Zea. Mays L.). Paper presented in National Conference on "Maize for Resource Sustainability, Industrial Growth and Farmers' Prosperity" organized by Maize Technologists Association of India at Udaipur February 23-25, 2022.
19. Upadhyay, P., Banyal, D.K., Singh, Amar. 2022. Efficacy of *Trichoderma* spp. in ecofriendly management of stem rot of berseem caused by *Sclerotinia sclerotiorum* (Lib.) de bary_in National Symposium on "Novel strategies in plant stress diagnosis and management" at UHF Solan on May 6-7, 2022.

d) Popular articles

1. Suman Kumar & Manpreet Kaur. Gobhi vargiye sabjion main samekit Keet wah rog parbandhan. Giriraj DEE, CSKHPKV, Palampur (HP): (06-12, Oct 2021),9-11pp
2. Suman Kumar & Manpreet Kaur. Adhunik padhti apnakar safal krishi udhami bane Bharat Bhushan. Giriraj DEE, CSKHPKV, Palampur (HP): (09-15, Feb, 2022),9-11pp
3. Suman Kumar & Seema Shah. Adhunik Krishi main Mahilon ki Bhagidari. Parvatia Khetibadi. DEE, CSKHPKV, Palampur (HP): (April-June 2021),9-11pp
4. Girish Mahajan, Pardeep Kumar, Chaman Lal, Anjana and Dhanbir. 2020. Krishi vikas mei sahkarita ka mahtav- Bhag- (क), Girija Saptahika14 October, 2020, 43 (2): 5
5. Girish Mahajan, Pardeep Kumar, Chaman Lal, Anjana Thakur and Dhanbir Singh. 2020. Krishi vikas mei sahkarita ka mahtav- Bhag- (क), Girija Saptahika 21 October, 2020, 43 (3): 5
6. Sud Deepika and Nidhi 202**1.** Dhingri mushroomkisano ki aaye ka behtereen vikalp. Giriraj sapthahik**. 43(48) 5**

e) Pamphlets

1. Pardeep Kumar, Sanjay Sharma, Deep Kumar, Neetu Sharma and Rakesh Thakur. 2020. Dhan ke pramukh rog avam prabandhan. 82: 2020.

f). Lead Lectures

1. Banyal D K, Thakur Nisha and Sinha Diksha.2022. Analysis of diversity at *er* loci for identification of diverse sources of pea powdery mildew resistance in **National Symposium** on "Novel strategies in plant stress diagnosis and management" **at UHF Solan on May 6-7, 2022. Page 16**

g) Radio talk

SrNo.	Topic	Date	Telecast Date	Speaker
1.	Mushroom cultivation in Hamirpur district	06.7.2021	Live Phone In Kisan Bani programme at 6.30 – 7.0PM From AIR Hamirpur	**Dr. Pardeep Kumar**
2.	Mushroom diseases and their management	01.02.2022	Live Phone In Kisan Bani Programme at 6.30 – 7.0PM from AIR Hamirpur	**Dr. Pardeep Kumar**
3.	Recording on Shiitake Cultivation and Training Centre on by	10.6.22	Fasal Kranti and casted on Y-Tube by the link - **https://youtu.be/--pc9s_XDMw**	Dr. Deepika Sud
4.	Wheat diseases and their management	16.2.2021	Live Phone In Kisan Bani Programme at 6.30 – 7.0PM from AIR Hamirpur	**Dr. Pardeep Kumar**

h). Recommendation Accepted:

- **Integrated disease management in berseem (submitted in AICRP forage crops):** Seed treatment with carbendazim @ 0.2 % followed by foliar spray of Chitosan @ 0.05 % was proved best with 87.83and 85.16 per cent control of root rot and leaf blight respectively, with maximum increase (4.65 %) in the GFY over the check.
- **Compounding of tall fescue grass with white clover" for adoption in Package of Practices for *rabi* crops (CSKHPKV):** In wet-temperate climatic conditions, planting of tall fescue grass seedlings (rootslips) at 30 cm x 30 cm spacing and over sown with white clover @ 2 kg seed/ha (160 g per *bigha*) through broadcast sowing in pastures or horti-pastoral systems is recommended as a perennial grass + legume mixture to get higher fodder yield, crude protein yield and economic returns.
- **White Clover** Him Palam White Clover-1 (PWC-25) approved in the 87th meeting of central Sub-committee on on Crop Standards, notification and release of varieties for horticultural crops **held on 22nd september, 21 and 18th October,21** under the Chairmanship of Dr. T R Sharma, DDG, ICAR New Delhi .
- Him Palam Matar-1 and Him Palam Matar-2 **approved in the** 29th meeting of Central Sub-committee on Crop Standards, notification and release of varieties for horticultural crops **held on 23rd March 2022 circulated vide proceeding no. 1149123/2022/Hort. Sci.-I** under the Chairmanship of Dr. A. K. Singh, DDG (Hort.), ICAR New Delhi.
- Snow Pea Him Palam Meethi Phali-2 **approved in the** 29th meeting of Central Sub-committee on Crop Standards, notification and release of varieties for horticultural crops **held on 23rd March 2022 circulated vide proceeding no. 1149123/2022/Hort. Sci.-I** under the Chairmanship of Dr. A. K. Singh, DDG (Hort.), ICAR New Delhi.
- Garden pea genotype **''DPPMR-09-1 (INGR21221)'** developed by has been registered by **Plant Germplasm Registration Committee** (PGRC) of Indian Council of Agricultural Research on December 24, 2021.

i) Success stories

1. Sharma Sanjay, **B.K. Sharma**; B.N.Sinha and Yogita Sharma (2021). Eco-safe and Farmer Friendly PALAM TRAP Technology for the Management of Fruit Fly Menace in RainySseason Cucurbits. In: Dynamic Agricultural Scenario in Himachal Pradesh: Stories of promising Rural Agri-preneurs. Lav Bhushan;Deepika Sud;D.R.Chaudhary and Y.P.Thakur (Eds.).Directorate of Extension Education,CSK HP Krishi Vishavavidyalaya,Palampur 94p (35-39 pp)
2. Sharma,Yogita;**B.K.Sharma** and S.K.Sharma (2021).Value Addition: Changes Fortune of Women Farmers of Una District. In::Dynamic Agricultural Scenario in Himachal Pradesh: Stories of promising Rural Agri-preneurs. Lav Bhushan;DeepikaSud;D.R.Chaudhary and Y.P.Thakur. (Eds).Directorate of Extension Education, CSK HP Krishi Vishavavidyalaya,Palampur 94p (68-71 pp)
3. Sinha,B.N, B.K. Sharma , Sharma Sanjay and Yogita Sharma (2021.Diversification from Traditional Farming to Successful Vegetable Growing. In: Dynamic Agricultural Scenario in Himachal Pradesh: Stories of promising Rural Agri-preneurs. Lav Bhushan;Deepika Sud;,D.R.Chaudhary and Y.P.Thakur.(Eds.).Directorate of Extension Education,CSK HP Krishi Vishavavidyalaya,Palampur 94p (80-81 pp)

9. SALIENT FINDINGS

a) Cereals

- A total of 65 normal maize and 75 specialty corn (QPM, Pop Corn, Sweet Corn and Baby Corn) genotypes in different trials comprising of various maturity groups were screened artificially against Turcicum leaf blight (TLB) during *kharif*, 2020.
- New maize composite L316 were found promising in AICRP testing and identified for release through Central Variety Release Committee during AICRP maize workshop, 2022.
- No new disease threat was observed in maize as revealed from the Trap plot nursery.
- A total of 433 wheat genotypes were screened artificially for resistance to stripe rust of wheat.
- A total of 34 wheat genotypes were screened artificially for resistance against hill bunt.
- New fungicide Propiconazole 13.9% + Difenconazole 13.9% w/w (15% w/v) EC) were found effective for the control of yellow rust of wheat.
- A total of 558 Barley genotypes were screened artificially for resistance to stripe rust of Barley.
- Increased incidence of Bacterial spots and bacterial canker of tomato was observed in farmers' field as compared to previous years.
- Involved in breeder seed production of Maize (Palam Sankar Makka 2, Bajaura Makka, Girija, Bajaura Pop Corn and Bajaura Sweet corn), Okra (Palam Komal), Chilli (Surajmukhi), Garlic (GHC1), Onion (Palam Lohit), Radish (Japanese white), Palak (Pusa Harit), Common methi (Palam Saumya), Kasuri methi (Pusa Kasuri) and Peas (Punjab 89).
- Rice germplasm consisting of 1449 entries from various screening nurseries viz. National Screening Nursery-1 (NSN-1=303), National Screening Nursery-2 (NSN-2=625), National Screening Nursery-Hills (NSN-H=118), National Hybrid Screening Nursery (NHSN=112) and Donor Screening Nursery (DSN=291) were screened under natural epiphytotic conditions at RWRC, Malan for leaf blast resistance under Uniform Blast Nursery Pattern and for neck blast resistance under transplanted conditions.
- Out of these nurseries, 75 entries from NSN-1, 143 entries from NSN-2, 18 from NSN-H, 38 from NHSN and 51 entries from DSN were found promising against leaf blast. However, out of these 37 entries from NSN-H and 12 from NHSN were found promising against neck blast.
- Among 35 differentials screened against leaf blast to monitor virulence pattern in the population of *Pyricularia grisea* across 23 centres, C101 A51, C104 PKT, RIL 29, A-57, C101 PKT, Raminad -STR -3, Tetep, RP Patho-1, RP Patho-2, RP Patho-7 and RP Patho-8 showed susceptible reaction while rest of the differentials were found resistant to leaf blast. Early planting resulted in low leaf blast severity while normal and late planting increased the disease intensity.
- Of all the fungicides tested, fungicides namely, difenoconazole and isoprothiolane followed by kasugamycin and thifluzamide were found promising in reducing neck blast incidence by 80 and 76 per cent, respectively and enhancing the grain yield by more than 50 per cent over control.
- Treatment combination of Seed treatment with carbendazim (2 g/kg) + one blanket application of combination fungicide Nativo 75 WG (trifloxystrobin 25% + tebuconazole 50%) @ 0.4 g/l at booting stage proved to be highly promising resulting in more than 50% reduction in neck blast incidence and increased the grain yield by 80% over control followed by treatment combination of Seed treatment with bio-control agent + one application of bio-control agent at 15-20 DAT (10 g/litre) + One blanket application of propiconazole (1 g/litre) at booting stage.
- In yield loss assessment trial, Block (B1) inoculated thrice with blast inoculum resulted in considerable increase in neck blast incidence (84.4%) along with 63% reduction in grain yield over un-inoculated, fungicide treated block (B4) followed by B2 (inoculated twice) and B3 (inoculated once) resulting in 51 and 36 per cent reduction in grain yield, respectively.
- Production oriented surveys conducted in the rice growing areas of Kangra and Mandi districts during *kharif* 2021 revealed that severity of prevailing rice diseases varied between low and low to moderate while Leaf and neck blast, false smut, grain discolouration and

sheath rot incidence remained moderate in some pockets of district Kangra whereas incidence of narrow brown leaf spot was severe on some cultivars in Sandhol area of Mandi district.

- It was observed that out of 1947 entries from various screening nurseries which were evaluated against yellow rust at Malan under natural epiphytotic conditions with disease augmentation by following artificial inoculation procedure, 58 entries from EPPSN, 106 from AVT, 150 from NIVT, 22 from MDSN and 959 from IPPSN were highly promising (0-5S) against yellow rust infection. However, 22 entries from PMSN were found were found promising against powdery mildew. Out of 34 entries from HBSN only 3 entries were found promising exhibiting hill bunt incidence ≤ 5.
- In chemical control trial, azoxystrobin 18.2% w/w + cyproconazole 7.3% w/w SC, tebuconazole 50% + trifloxystrobin 25% WG (Nativo 75 WG) and azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC proved to be highly effective in reducing powdery mildew severity with more than 40 per cent reduction over control while all the fungicides enhanced the grain yield by 37-42 per cent over control.
- Status of yellow rust was observed bur periodical survey and surveillance of the yellow rust hotspots of district Kangra during 2021-2022. The varieties grown by the farmers included UP 2380, S-308, DPW 621-50, HD 3086, HD 2967, WH 1080, HPW 349, HPW 360, HPW 368, Unnat PBW 343 besides varietal mixture. During the surveys, high yellow rust intensity was observed on variety, HD 2967 (40S) in Chalwara area of Nagrota Surian block, HPW 368 (40S) in Palli area of Fatehpur block. Severe yellow rust intensity was also observed on varieties, UP 2380 and HD 3086 in Saleti and Drakata areas of Pragpur and Dehra blocks, respectively exhibiting up to 80 per cent (80S) severity. However, no or very low traces of powdery mildew were observed during the surveys.
- Sheath rot of rice caused by *Sarocladiumoryzae*has was found to be an emerging disease in Himachal Pradesh and its incidence in most of the varieties ranged between 5-10 %
- In farmers saved seed samples of *rabi* 2020-21, Karnal bunt was recorded in samples from Una, Hamirpur, Kangra, Mandi and Bilaspur districts with the average incidence ramging from from 0.0-0.1%
- The incidence of KB varied from 0.05 to 0.10% in seed samples (*Rabi* 2020-21) of WH 1184, VL 953, HPW 373, DBW 88, HS 562 and DBW (0.1%) from Government Farms
- *Fusarium graminearum, F. compactum* and *F. avenaceum* were found associated with head blight/ scab but *F. graminearum* was more prevalent in wheat growing districts of Himachal Pradesh.
- Seed treatment with carbendazim 50 WP followed by its two foliar sprays gave maximum reduction in the incidence and severity of head scab under field conditions.
- The integrated treatment viz., seed treatment with carbendazim 50 WP followed by three foliar sprays each of Jeevamrit, *Acorus calamus* extract and carbendazim 50 WP was found most effective in managing head scab of wheat.
- Tebuconazole 060 FS @ 1, 2 and 3 ml/ kg seed, carboxin 37.5% + thiram 37.5% DS, carbendazim 50 WP and carboxin 75 WP all @ 3 g/ kg seed as seed dressing fungicides gave complete control of flag smut of wheat.
- Morphological and molecular variations showed higher genetic diversity among the isolates of *U. agropyri* in Himachal Pradesh.

b) Vegetables

- Incidence of rust and bulb rot in garlic was observed in the farmers' field
- For the management of purple blotch and Stemphylium blight of onion, maximum disease control (80.7 and 83.0 %) was recorded with two foliar applications of Folio Gold 440 SC (Metalaxyl-M 3.3 % + Chlorothalonil 33.1 % SC) @ 2.0 ml/ l, and 2.5ml/ l at fortnightly interval with highest yield (262.6q/ha)

c) Pulses

The adult plant resistance against anthracnose in common bean landrace KRC-8 seems due to the presence of a novel recessive resistance gene located on linkage group Pv01.

d) Oil seeds

- In field screening of soybean IVT (Early) entries, the coded entries were categorized into different resistance categories. The entry MAUS 819, KDS 1169, KDS 1194, and AMS 77-3-6 were found resistant to highly resistant against FLS (*Cercospora sojina*). The entry PS 1660, PS 1675, and NRC 198 were found resistant to highly resistant against anthracnose (*Colletotrichum truncatum*).
- In IVT normal, The lines SKAU-WSB-101, PS 1605, KDS 1149 and LOKSOY-1were found resistant to highly resistant against FLS (*Cercospora sojina*). The test entries, AS 40, PS 1689, PS 1682, NRC 195, NRC 193, KDS 1149, TS 21-2, TS 21-1, LOKSOY-1 and KSS 204 were found resistant to highly resistance against anthracnose (*Colletotrichum truncatum*). The entry KDS 1149 and LOKSOY-1were resistant against both FLS and anthracnose diseases.
- Out of 29 soybean lines showing resistance in previous years, twenty seven lines maintained their high resistance status against frogeye leaf spot (*Cercospora sojina*). Twenty lines maintained their high resistance status against pod blight (*Colletotrichum truncatum*). Eighteen lines have shown highly resistance against both the diseases.
- Out of 50 germplasm line screened for having multiple disease resistance, the germplasm lines; EC 280129, EC 289149, EC 291401, EC 325098, EC 350664, EC 357998, EC 383165, EC 389153 and 390981A were observed having multiple disease resistance against frogeye leaf spot (*Cercospora sojina*), anthracnose (*Colletotrichum truncatum*) and brown spot (*Septoria glycines*).

e) Organic and Natural Farming

- Among the tested ten bacterial isolates against the pathogen *R. solanacearum*, bacterial isolate 5 showed maximum inhibition zone of 9.91 mm followed by bacterial isolate 7 with the 7.39 mm inhibition zone (Table 2 & Fig. 3).
- Twenty two *Trichoderma* isolates (bioagent) were evaluated against the pathogen *Fusarium oxysporum* and among all the tested bioagents TI-4 isolate was found to be most effective resulting in 72.60 per cent mycelial inhibition of *Fusarium oxysporum*) followed by TI-7 isolate (60.71 per cent).
- Twenty three bio-agents isolates (22 *Trichoderma* spp & 1 bacterium) were evaluated against *Rhizoctonia solani* and *Trichoderma* isolate **TI-6** was found to be most effective with **86.88** per cent mycelial inhibition followed by **TI-7** with the **77.23** per cent inhibition.

f) Fodder

- **Survey of diseases of fodder crops:** During *Kharif* 2021 wilt/root rot, leaf spot and blights of cowpea, blight and BLSB of maize, zonate leaf spot sorghum and blast of bajra were observed the main diseases. In the *Rabi* 2021-22 season oat powdery mildew and leaf blights of oats, root rot and powdery mildew of clovers was observed the important diseases
- **Evaluation of breeding material:** During *Kharif*, 28 entries of maize were evaluated against leaf blight and all the entries found either resistant or moderately resistant. However in cowpea all the 11 entries of IVTC were found susceptible. During *Rabi*, 68 entries were evaluated and 16 entries were found moderately resistant, under different experiments of oats against powdery mildew. Incidence of root rot of berseem was observed low during the season and all entries were observed as resistant or moderately resistant. In clover all the entries of white and red clover were found susceptible for powdery mildew
- **Management of leaf blast in forage pearl millet:** Seed treatment with tebuconazole + trifloxystrobin @ 1 g/kg seed followed by two sprays of same fungicide @ 0.4g/l was found most effective which gave 79.5 % disease control with 13.2 increase in the green fodder yield over check. Among the non-chemical methods seed treatment with chitosan @ 0.05% followed by the foliar spray of chitosan @ 0.05% was found effective with with 68.5 % disease control with 8.2 % increase in the yield over check.

- **Assessment of avoidable crop losses due to diseases and insect-pests in forage Cowpea**: The experiment was conducted to assess the crop losses due to diseases and insect-pests in forage cowpea with two treatments i.e. protected and unprotected. In protected treatment 72.37, 62.50, 75.00 and 64.66 per cent control of root rot, foliar diseases, YMV and defoliators respectively, was found with 73.02 per cent increase over unprotected treatment.
- **Eco friendly management of zonate leaf spot of Sorghum:** Three foliar spray of propiconazole @ 0.1% (Chemical check) was found most effective which gave 65.04 % disease control with 18.48 %increase in the green fodder yield over check. Among the non-chemical methods three foliar spray of Tamarlassi @ 10% disease giving 47.15% disease control with 7.81 % increase in the yield over check.
- **Estimation of yield losses due to foliar diseases (anthracnose, gray leaf spot and zonate leaf spot) in fodder sorghum:** The experiment was conducted to assess the crop losses due to diseases and insect-pests in fodder sorghum and two foliar sprays of propiconazole @ 1ml/l at 20 and 35 DAE was found most effective which gave 46.5 % disease control with 22.14 % increase in the green fodder yield over check
- **Validation of best treatment of trial entitled "Integrated disease management in berseem:** Seed treatment with carbendazim @ 0.2 % followed by foliar spray of Chitosan @ 0.05 % was proved best with 87.83and 85.16 per cent control of root rot and leaf blight respectively, with maximum increase (4.65 %) in the GFY over the check

10. Photos Gallery

Management of *Stemphyllium* blight and Lentil wilt at Akrot

ELP Students performing various operations in mushroom cultivation













Trainings of Farmer groups on Mushroom Cultivation