

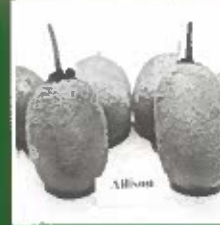
ANNUAL REPORT

2018-19

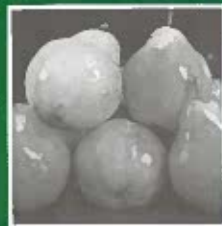
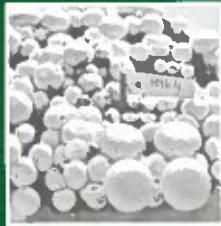
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University of Horticulture & Forestry
Nauni, Solan (Himachal Pradesh) – 173 230



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ANNUAL REPORT 2018-19



Compiled and Edited

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FOREWORD

Horticulture is aptly considered as a growth engine of agriculture, and is presently contributing over 30 per cent to gross domestic product (GDP) from less than 10 per cent land area under this sector in India. Horticulture production has increased by 113 per cent from 145.8 million tonnes in 2001-02 to 311.7 million tonnes in 2017-18 against only 33 per cent increase in the cereal production over the last two decades. Apart from making the food more nutritious, it is now proving to be a major source of income for the farmers, and also for employment generation in the rural and peri-urban areas. One hectare of fruit orchard requires nearly 860 man days as against 143 man days for growing cereal crops on the same area. Agro-climatic conditions, soil and topography in Himachal Pradesh are not as congenial as in the plains for growing cereal crops. However, there is enormous potential for growing speciality fruit crops, off-season vegetables, flowers, spices, and medicinal and aromatic plants. There is a vast scope for exploitation of forest resources and eco-tourism in this state, wherein, more than 60 per cent area should be brought under forests. At the same time, we have an additional potential for generating carbon credits, and save the Indo-Gangetic plains from the vagaries of draughts and floods, which have become quite frequent in the last few decades.

In India, as an emerging economy, a key challenge is to harness the strengths and benefits of advanced technologies developed in Horticulture through capacity building and new training modules for farmers as well as younger entrepreneurs. The YSP University of Horticulture and Forestry is a premier institution conducting basic, strategic, and applied research on various aspects of fruits, vegetables, floriculture, medicinal and aromatic plants, mushrooms, apiculture, agroforestry, and forest products. The University has been established to serve as a knowledge bank and to evolve as an interactive centre of research, development, post-harvest management and value addition of horticultural crops and forestry species.

The YSPUHF has made spectacular progress in human resource development, research, and dissemination of technologies to the farmers in horticulture, forestry and allied sciences in the last year to achieve higher levels of productivity, while safeguarding the environment and natural resources of the State. All the statutory meetings of the University such as Academic, Research, and Extension Councils have been conducted regularly for planning, evaluation and execution of various education, research, and extension activities. The University has bagged 80th position among more than 900 universities evaluated by the National Institutional Ranking Framework (NIRF) of the Ministry of Human Resource Development, Govt. of India. It is the only university in the state in this bracket. It has been ranked 12th amongst 73 Agricultural universities in India by ICAR in 2019, improving its ranking from 51 in 2016/17 to 12th in 2018/19, which is a tremendous achievement for the university and the state.

The University has successfully organised the meetings of its statutory bodies such as Senate, Board of Management, Finance Committee, Academic Council, etc. apart from several academic seminars & symposia, project meetings and workshops in the campus. The university celebrated its Foundation Day on 1st December, 2018 with a great pomp and show. It is a matter of great pride that the Hon'ble President of India, Shri Ram Nath Kovind Ji was our Chief Guest for the 9th Convocation, who awarded 9 gold medals to the meritorious students. Hon'ble Governor of Himachal Pradesh, Acharya Dev Vrat Ji conferred degrees to 467 students during the convocation held on 21st May, 2018. A demonstration unit on Zero Budget Natural Farming (ZBNF) has been further strengthened by allocating additional area for adopting this system on fruit crops in the university campus.

In order to increase the productivity of fruit crops, especially apple, the university is advocating high density plantation on clonal rootstocks in areas suitable for high density planting in Himachal Pradesh. In this pursuit, high density demonstration orchards of apple have been established under the World Bank funded HP-HDP project at the main campus at Nauni, and at the research stations at Kandaghat, Bajaura, Mashobra, Kalpa, and Tabo. Apple plants

on M9 and MM106 rootstocks at Nauni have shown good fruiting in 3rd year of planting, and the demonstration plots was visited by the Hon'ble Horticulture Minister Sh. Mahender Singh Thakur, where an yield of 24-26 tonnes could be harvested.

There has been a considerable increase in flow of funds from the State Government during the current year i.e. 2018-19, and I am highly thankful to the State Government and the Additional Chief Secretary (Finance) for special support in curtailing the budget deficit. Sincere gratitude is also expressed to ICAR, and other funding agencies for their support to the University. The support provided by Board of Management and various executive committees of university is thankfully acknowledged for their cooperation and help in running the university. I would like to congratulate my entire team of statutory officers, scientists, staff and students for carrying out all the teaching, research and extension activities as planned, and contributing to the excellent progress of the University. I appreciate the sincere and concerted efforts of Director Research and Joint Directors Research (Horticulture, Forestry & Planning), and all the faculty members of the University for timely publication of the Annual Report for the year 2018-19.



(Hari Sharma)
Vice Chancellor





PREFACE

Himachal Pradesh is indeed bestowed with unique agro-climatic conditions for growing different horticultural crops. This State has a deeply dissected topography and has emerged as a pioneer of hill development model in the country. It has achieved a massive transformation in horticulture sector during the last fifty years. At present, about 40 per cent of gross cropped area is covered under the horticulture crops. Varied agro-climatic zones ranging from subtropical to high altitude cold deserts of Himachal Pradesh enable the farmers of the state to do successful cultivation of a wide range of horticultural crops viz., fruits, vegetables, flowers, spices, medicinal and aromatic plants. Amongst the fruit crops, perhaps all kinds of fruits grown in the country, except those which are grown in the warm humid coastal regions can be produced in the State. However, apple dominates the fruit industry of the state. Out of total area of 3,30,510 ha under horticultural crops, apple alone occupies about 1,12,630 hectares which constitutes about 48.81 per cent of the total area under fruits in the state. Similarly, apple production is 4,47,570 MT which contributes to 79.16 per cent of total fruit production in the state, whereas, the share of subtropical fruits is 14 per cent only. Apart from above, this state has also got a precious forest wealth and a lot of timber and non timber produce is marketed annually, thereby contributing to the its economy.

Dr YS Parmar University of Horticulture & Forestry, Nauni has been continuing to focus on its mandate to achieve the goals of strategic, need based and farmer oriented development of horticulture and forestry in Himachal Pradesh through excellence in education, research and extension for food and ecological security, improved livelihood opportunities and economic prosperity of hill farming communities of the State. The College of Horticulture and College of Forestry situated at main campus of the university and the College of Horticulture & Forestry, Neri (Hamirpur) are imparting quality education to undergraduate and postgraduate students coming from different states of India. During this year, 565 students have completed their undergraduate, postgraduate and doctorate degrees. The students of university are not only excelling in their studies but they also undergo a rigorous training in RAWE at Regional Stations and Krishi Vigyan Kendra's of the university, industry and State Forest Department under the Student READY programme of ICAR. Our students have also excelled in national examinations and qualified various exams such as Senior and Junior Research Fellowships, National Eligibility Test, Rajeev Gandhi National Fellowship for ST/SC Students, Agricultural Research Services, DST Inspire Fellowship, and NTS Scholarship etc. One of our students of College of Forestry, Ms Jagriti Thakur has been awarded a prestigious IPNI award for pursuing her Ph. D. research by the International Plant Nutrition Institute. The students have also participated in the sports and co-curricular activities at the university and national level.

The Directorate of Research played a pivotal role in planning, implementing, monitoring, evaluating and coordinating research through different departments and research stations in diverse agro-climatic zones of the State. The scientists have prepared more than 100 projects worth Rs. 110 crores, which have been submitted to various funding agencies such as DST, NASF (ICAR), WBF, DBT, Ayush, Central Silk Board, Directorate of Horticulture, SCSTE, NABARD, MOEFCC, MOA, RKVY, MIDH, ATMA, DBT, Biodiversity Board and GBPIHED. In this period, 17 new projects worth Rs. 660 lakhs were sanctioned, and the others are in the pipeline. ICAR-AICRP on fruits has sanctioned a new centre for mango, guava and litchi at COH& F, Neri. Under the changing climate and rising temperature in subtropics, new fruit crops/varieties viz., avocado (TKD-1), coffee (Sln 5B, Sln-9 and Chandragi), custrad apple (Balanagar and ArkaSahan), fig (Poona Fig, Dinkar) and acid lime (Phule Sharbati, Phule Sai), sapota (Kalipatti), ber (seb, sanour, chuhara, umran), dragon fruit (Red flesh and White Flesh), Macademia nut, mangosteen, karonda (Red and Gola) and longan are being continuously introduced at COH&F, Neri (Hamirpur) and RHRTS, Jachh (Kangra) and evaluated. In order to increase the productivity of fruits, the university has advocated high density plantation on

clonal rootstocks in areas suitable for high density plantation of mango, guava, apple etc. in Himachal Pradesh. experimental blocks for high density plantation of apple have been established under the World Bank funded HP-HDP project at the main campus at Nauni and research out-stations. In the third year of plantation, the plants of new varieties viz., Jeromine, Red Cap Valtod, Scarlet Spur II and Redlum Gala raised on MM 106 and MM109 rootstocks at Nauni have shown good fruiting. Tall Spindle system of training of these plants has been found best in comparison to others. A new variety of plum- Black Amber has been established under complete organic production system. Microbial strains of bacteria (*Bacillus cereus*, *B. sonorensis*) synthesizing metal nanoparticles (iron, gold, silver) have been identified which showed antifungal/nematode activities against plant pathogens. Two varieties of vegetable crops viz., cucumber – Solan Srijan and Ginger- Solan Giriganga have been released for cultivation in mid hills of Himachal Pradesh. Technologies for preparation of fruit bar, and extraction of pectin/flour from ripe pumpkin and their utilization in bakery products have been developed. The technologies have been transferred to the entrepreneurs and many memorandums of understanding have already been signed. An important ingredient of Ashtavargai.eJeevak (*Malaxis acuminata*) has been identified and "Solan Selection" was found to have identified having better quality as compared to the existing strains. Plant growth promoting rhizobacteria were isolated and identified for utilization in plant growth promotion in different crops. A new variety of pomegranate 'Kandhari Seedless' selected out of the crosses between Kandhari Kabuli and Bhagwa has been developed which ripens in mid October. The fruits of this variety are saffron coloured with smooth and glossy peel, and arils are attractive cherry red in colour with softer seeds as compared to 'Kandhari Kabuli' and is in much demand among the farmers especially in Kullu valley.

The research outputs of the university were disseminated to the farming community through institutional trainings/exposure visits (117), in which about 2682 farmers have been benefitted. In addition, 178 farmer calls have been attended through Kisan Call Centre, and UHF Farmers Telephone helpline. The scientists of the university have actively participated in the national programme "Mera Gaon Mera Gaurav" and visited various villages adopted by 32 teams of scientists. The University has also supplied more than 1,50,000 quality temperate fruit plants, 2,00,073 subtropical fruit plants, 4q kharif and 2q rabi vegetable crops seed. In addition, 1,00,000 seedlings of different vegetables, 4.5 tonnes mushroom spawn, 7 Kg flower crop seed, 1,30,000 flower plants and 3,19,085 forest and medicinal and aromatic plants were also supplied to the farmers. The university issued regular Agro Advisory to media and newspapers from time to time for the benefit of farmers.

The university developed state of art facilities in the library for the benefit of students and scientists. The CD ROM facility service had been very popular amongst the students and researchers for surfing the latest developments in the field of horticulture, forestry, and allied disciplines. The latest and relevant books have been acquired and I am happy to mention that the library has added 629 new books apart from 78 e books, many periodicals and theses this year. During the year, about 53,253 readers have visited the library who have consulted 13,471 books and 86,028 journal articles.

I take this opportunity to thank Hon'ble Vice Chancellor Dr HC Sharma for the guidance and support rendered during the year under report, and acknowledge the cooperation from all the Statutory Officers, Heads of Departments, Associate Directors (R&E) of Regional Research Stations and Incharges of different Research Stations and KVK's for providing input for compiling this Annual Report. I appreciate the sincere and dedicated efforts of Joint Directors of Research (Horticulture, Forestry & Planning), other staff members of the Directorate of Research and other university scientists associated in bringing out the Annual Report for the year 2018-19.



J.N. Sharma
(Director Research)





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INTRODUCTION

Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan has its origin from Himachal Agriculture College, Solan, established in 1962 with its affiliation to Panjab University, Chandigarh. The College was raised to the status of Post Graduate College, Himachal Pradesh Agriculture College and Research Institute in 1965 with the introduction of M.Sc. (Agriculture) programme. It was affiliated to Himachal Pradesh University, Shimla in 1970 and thereafter it became Agriculture Complex in July 1971. It further became Horticulture Complex of Himachal Pradesh University and Himachal Pradesh Krishi Vishvavidyalaya, Palampur in 1976 and 1978, respectively. Later on, this complex was recognized as Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan on December 1, 1985. The university has now grown into its own kind, not only in India but in entire Asia with new dimensions of education, research and extension in horticulture, forestry and allied areas. The university has three constituent colleges viz., College of Horticulture and College of Forestry located at the main campus, Nauni, having nine and seven departments, respectively besides a College of Horticulture and Forestry at Neri, Hamirpur. In addition, there are five Regional Horticultural Research and Training Stations, one Regional Horticulture & Forestry Research Station, nine Research Sub-Stations and five Krishi Vigyan Kendras (KVKs) situated in different agroclimatic zones of the State.

The University is located at an elevation of about 1270 m above mean sea level. The total farm area of the university is spread over 545 ha at the main campus and 202 ha with the Regional Horticultural Research and Training Stations and the Krishi Vigyan Kendras (KVKs). The university is fully determined to impart quality education to its students and also to disseminate technical know how to end users for overall development of the rural masses with agro based livelihood security. Motivated and enterprising

farming community, committed scientific and extension manpower of the university and appropriate policy planning are providing necessary impetus to achieve the university mission and goals.

Mission

- ❖ Strategic, need based and farmer oriented development of horticulture and forestry in Himachal Pradesh through excellence in education and research for food and ecological security, improved livelihood opportunities and economic prosperity of farming communities.

Goals

- ❖ Human resource development through excellence in education and skill upgradation with intensive practical trainings.
- ❖ Creation of sound scientific base for research and extension education in horticulture, forestry and allied sectors.
- ❖ Dissemination of generated technologies to farming community through region specific transfer of technology modules.
- ❖ Effective management of financial, structural and administrative resources of the University for competitive result oriented initiatives.

Objectives

- ❖ Human resource development in horticulture, forestry and allied sciences.
- ❖ Advancement of basic and applied research pertaining to horticulture, forestry and allied sciences.
- ❖ Extension and dissemination of scientific information among the rural masses of the state.
- ❖ Development of linkages with state, centre, international institutions, NGOs, orchardists, farmers and industrialists for ensuring nutritional, economic and ecological security in the state.





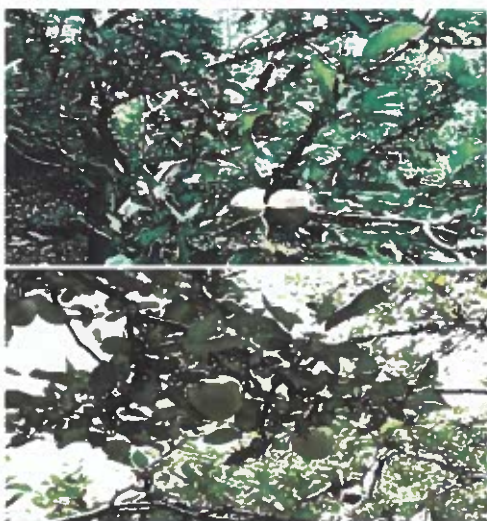
RESEARCH HIGHLIGHTS

Horticulture

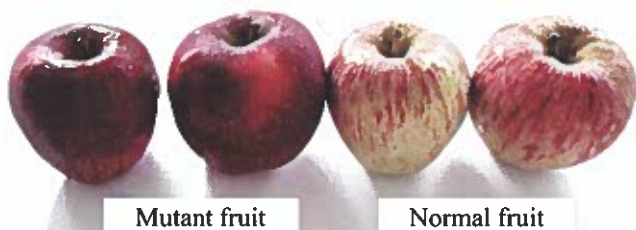
Fruit Crops

Apple

- ❖ Bud mutant of Red Delicious in the orchard of Mr. Joginder Singh, at Village Majholi, PO Kathog, Tehsil Theog, Shimla, HP situated at an altitude of 2193 m amsl, was identified. The fruit samples of normal (non mutated) as well as mutated limbs were collected at full maturity and analysed for fruit quality characteristics (*RHR&TS, Mashobra*).



Initiation of colour on mutant



- ❖ Another bud variants of apple was spotted in lowermost limb of a 32 years old tree of Vance Delicious as a bud sport having earliness w.r.t. colour on fruits at an altitude of 2286 amsl at RHR&TS, Mashobra. The observed bud produced apples are identical to remainder of the tree except to earliness and high intensity of colour, also with the further exception of dark final colour. The stripping was



almost absent and fruits were fully blushed. The fruits started colouring at much earlier date (12.6.2018) and attained full colour (almost 3 weeks earlier) on 9.7.2018 than fruits on rest of the tree (*RHR&TS, Mashobra*).

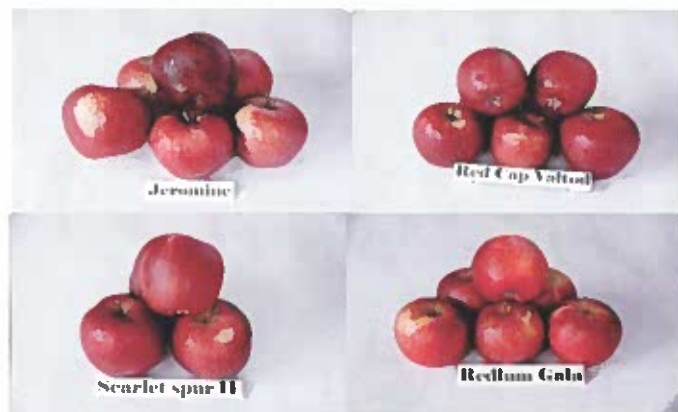


Normal fruits Variant Fruits Normal fruits Variant fruits



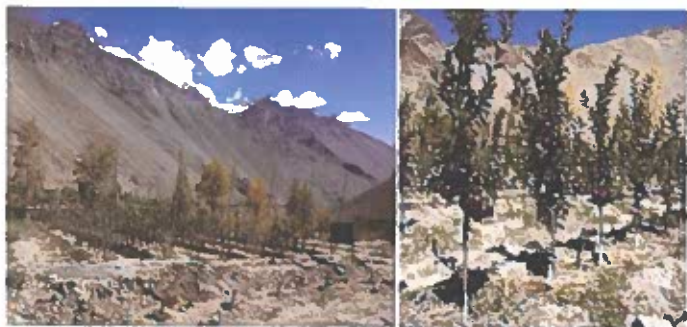
Normal and Variant fruits on Vance Delicious on 9.7.2018 Normal and Variant fruits on Vance Delicious on 1.8.2018

- ❖ Eight varieties viz. Red Cap Valtod, Super Chief, Scarlet Spur II, Jeromine, Redlum Gala, Red Velox, Gale Gala and Auvil Early Fuji, planted in 2016 at a spacing of 2.5 m x 1.0 m were evaluated for their performance in the experimental farm of Department of Fruit Science. The observations on vegetative growth, fruiting and fruit quality parameters were recorded during 2018. Among the different varieties, Jeromine, Red Cap Valtod, Scarlet Spur-II and Redlum Gala performed better in terms of fruit colour, size, yield and fruit quality under lower elevation (*FS, Nauni*).



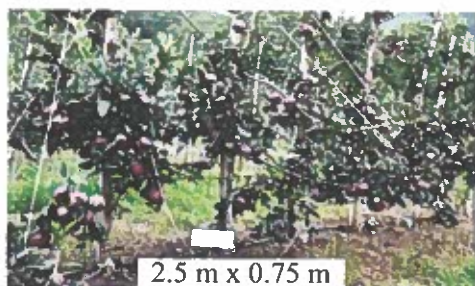
New promising apple varieties for lower elevations

- ❖ The experiments are also under progress at higher altitudes at RHR&TS, Mashobra, Bajaura, Sharbo (Kalpa) and Tabo for evaluation of these varieties w.r.t. to horticultural performance, spacing and training systems. The results at Tabo revealed that, highest plant height was observed in Super Chief/MM 106 cultivar rootstock combinations planted at a density of 2.5 x 1.5m than the remaining cultivars and rootstock combinations. Cultivar Redlum Gala/M9 planted at a density of 2.5 x 1.0 m was most vigorous, followed by the cultivar Jeromine/M9 at same planting density. Maximum fruit yield and fruit quality parameters in terms of TSS and firmness were recorded in cultivar, Jeromine/M9 planted at a density of 2.5 x 0.75 m and Jeromine/M9 planted at a density of 2.5 x 1.0 m, respectively, which were, significantly higher as compared to the remaining cultivars and planting density combinations (*RHRSS & KVK, Tabo*).



High Density Plantation at Tabo

- ❖ For evaluation of planting densities, the standard variety Jeromine raised on M 9 rootstock was planted in 2016 at a spacing of 2.5 m x 0.75 m, 2.5 m x 1.0 m and 2.5 m x 1.5 m. Plant spacing of 2.5 m x 1.0 to 1.5 m with a density of 4000 to 2666 trees/ ha was found better as these resulted in production of better size and quality fruits with highest productivity of 24-28 t/ha after 3 years of planting (*FS, Nauni*).



- ❖ In order to evaluate the different training systems in standard apple plants raised on M 9 rootstock, planted at a spacing of 2.5 m x 1.0 m the trees are trained with Tall Spindle, Slender Spindle and Vertical Axis systems of training. Tall Spindle training system accounted for better yield and quality fruit production in comparison to other training systems. The different training systems viz., Espiller, Vertical Axis, Cordon, Super Spindle etc. in apple under high density planting were also evaluated at HRS, Seobagh. It is noticed that the vegetative growth was highest in Vertical Axis than the other systems of training (*FS, Nauni, RHRSS & KVK, Tabo and RHR&TS, Bajaura*).



Slender Spindle system

Tall Spindle system



Vertical Axis system

- ❖ At Kalpa, the high density apple plantation studies revealed that the maximum plant height (270 cm), plant spread (172.50 cm EW, 185.75 cm NS) and trunk diameter (33.08 mm) was recorded in Red Velox/M9. However, the minimum plant height (164.33 cm) was recorded in Gale Gala/M9, plant spread in east- west direction (84.67 cm) and plant diameter (20.14 mm) was recorded in Auviel Early Fuji / M 9,



whereas; plant spread in north-south direction (77.50 cm) was recorded in Red Cap Valtod / MM 106. The annual shoot extension growth was recorded maximum (9.56 cm) in Redlum Gala / M9 followed by Gale Gala/M9 (6.75 cm) whereas; it was recorded minimum (1.86 cm) in Red Cap Valtod/MM106. Significant differences in fruiting characteristics were observed in the cultivars studied as maximum fruit weight (155 g/fruit) was observed in Auviel Early Fuji/M9 followed by Red Velox/M9, whereas maximum number of fruits/tree (19.50) and yield (2.29 kg/tree) was recorded in Jeromine/M9. However, minimum number of fruits per tree (4.80) were recorded in Redlum Gala/M9; Gale Gala/M9 rootstock, exhibited minimum yield (0.54 kg/tree) and fruit weight (92.29 g/fruit) in comparison to the other cultivars (*RHR&TS and KVK, Sharbo*).

- ❖ At Kalpa, in case of varying plant densities it was observed that shoot growth of different apple cultivars varied significantly and maximum shoot growth (20.31 cm) was recorded in cultivar Jeromine/M9 at plant spacing of 2.5 x 1.5 m, which was followed by the same cultivar planted at 2.5 x 1.0 m. The minimum shoot growth (12.6 cm) was observed in Super Chief/MM 106 planted at 2.5 x 0.75 m. Significantly higher tree height (265.87 cm) was noted in cultivar Super Chief/MM 106 at plan spacing of 2.5 x 1.5 m in comparison to all other cultivars and rootstock combinations. However, the tree height was significantly lower (192.50 cm) in the same cultivar at a density of 2.5 x 0.75 m. The data on plant spread (184.2 cm EW & 210 cm NS) revealed higher values in cultivar Super Chief/MM 106 planted at a density of 2.5 x 1.0 m, followed by the same cultivar at a plan spacing of 2.5 x 1.5 m. The study also revealed maximum number of fruits per tree (32.85 No.) and yield (4.55 kg/tree) in cultivar, Jeromine/M9 planted at 2.5 x 1.0 m, followed by the same cultivars planted at 2.5 x 1.5 m, which were, significantly more as compared to the remaining cultivars and planting density combinations. The number of fruits per tree (11.36 No.) and yield (1.90 kg/tree) and fruit retention per tree was observed minimum in cultivars Super Chief/MM 106 at a plant spacing of 2.5 x 1.5 m. Significantly higher

fruit weight (169.59 g/fruit) per tree was recorded in cultivar Super Chief/MM 106 planted at 2.5X1.5 m, whereas, minimum fruit weight (118 g/ fruit) was observed in Jeromine/M9 in comparison to all other cultivars, rootstocks and planting density combinations (*RHR&TS and KVK, Sharbo*).



Auviel Early Fuji



Redlum Gala



Red Cap Valtod



Red Velox



Jeromine



Gale Gala

- ❖ At Mashobra, maximum plant stock girth (11.73cm) was recorded in Red Velox which was significantly at par with Gale Gala, Super Chief and Red Cap Valtod, whereas, minimum trunk girth (9.07cm) was recorded in Redlum Gala. Scion girth (9.74cm) was recorded maximum in Red Velox which was significantly higher than all other varieties, whereas minimum plant scion girth was 6.78cm. Maximum plant height (243.75cm) was also recorded in Red Velox which was significantly higher than all other varieties. Minimum plant height (136.50cm) was recorded in Super Chief which was significantly lower than all other varieties. Fruit



yield (1423g/tree) was recorded in Red Cap Valtod which was significantly higher than all other varieties. Minimum fruit yield (626.83g/tree) was recorded in Jeromine. Fruit weight (148.06g) was recorded maximum in Red Velox, whereas, minimum fruit weight (116.62g) was recorded in Jeromime. Fruit size in terms of length and breadth was maximum (67.68mm x 75.62mm) in Super Chief whereas minimum fruit size (53.47mm x 62.91mm) was recorded in Redlum Gala (*RHR&TS, Mashobra*).

- ❖ Maximum plant stock and scion girth (11.94cm and 9.76cm) was observed when plants were spaced at 2.5x 1.0 m and was statistically at par with 2.5 x 1.5 m spacing. Minimum plant stock and scion girth (9.48 cm and 7.43 cm) was recorded with plants spaced at 2.5 m x 0.75 m. Maximum plant height (259.54 cm) was observed when plants were spaced 2.5 x 0.75 m which was significantly higher than all other spacings. Minimum plant height (198.86cm) recorded with plants spaced at 2.5 x 1.0 m which was significantly lower than all other spacings. Fruit yield (868.06g/tree) was maximum when plants were spaced at 2.5 x 1.5 m which was significantly higher than all other spacings. Minimum fruit yield (788.24g/tree) was recorded in plants spaced at 2.5 x 0.75 m. Fruit weight and fruit size 136.62 g and fruit size (61.57 x 71.90mm) was also recorded in plants spaced at 2.5 x 1.5 m. Minimum fruit weight (119.50g) and fruit size (59.78 x 69.15 mm) was recorded when plants were planted at closer spacing was recorded (2.5 x 0.75 m) (*RHR&TS, Mashobra*).
- ❖ New varieties of apple viz., Ultima Gala, Gala Venus Fengal, Gala Val on M-9 rootstock and Schelet Spur on MM-111 rootstock were introduced for evaluation and will be used for further multiplication (*RHR&TS, Bajaura*).
- ❖ The initial observations recorded on growth of five low chilling apple cultivars (Anna, Michael, Mollies Delicious, Red Fuji and Scarlet Gala) during the reporting period revealed that cv. Anna and Scarlet Gala surpassed all other cultivars as these had maximum trunk girth (19.2 cm & 18.9 cm), tree height (230.5 cm & 223.6 cm), tree spread in EW (110.7 cm & 106.5 cm) and NS (112.2 cm & 104.8 cm) directions. The initial yield of 10kg/plant was recorded in cultivar Anna

which was observed to be maximum in comparison to other cultivars. Similarly at Nagrota low chilling apple cultivars revealed that cultivar Anna Selection-1 attained maximum tree height (01.95m) followed by Mollis Delicious (01.92m), Harmn-99 (1.88 m), Anna (1.64m) and Dorsett Golden (1.63m). Tree girth was observed to be maximum in Harmn-99 (2.63cm) followed by Anna Selection-1 (2.40 cm), Anna (1.97c m), Dorsett Golden (1.92cm) and Mollis Delicious (1.90cm) (*RHR&TS, Jachh and LMRS, Nagrota*).



- ❖ Investigations were conducted with different levels of nutrients and irrigation schedules in different varieties of apple under high density. Highest flowering intensity (36%), fruit set (51.27 %), fruit drop (7.47%) and fruit weight (172.47g) were observed under treatment combination of drip irrigation at 100% ETC and fertigation at 100% along with maximum fruit yield (25.62 t/ha) while conventional irrigation at 100% ETC along with 100% of AD (NPK) recorded fruit yield of 22.94 t/ha. The study suggests a saving of 78.44 per cent of irrigation water with 11.68 per cent increase in yield under drip as compared to conventional irrigation (*SSWM, Nauni*).
- ❖ The effect of integrated fertilization (100, 80, 60 and 40% of NPK) along with water soluble customized nutrients (WSCN) foliar formulation on fruit russet control was evaluated. Application of 60 per cent of recommended NPK traditional soil fertilization along with foliar application of 75 g WSCN + 25 g urea at 15 days after petal fall +75 g WSCN at 30 and 45 days after petal fall in trees was found to be the most effective combination. Use of customized foliar nutrients fertilization also saved 40 per cent of traditional soil NPK fertilizers with improved fruit yield and quality (*FS, Nauni*).

- ❖ Foliar spray of water soluble NPK fertilizers (19:19:19, 13:0:45, 0:0:50) at 0.25 per cent concentration (500 g in 200 litre of water) at growth stages namely, (i) vegetative (half inch green leaf stage), (ii) flowering (pink bud) (iii) fruit set to fruit development along with 62.5 per cent of RDF of traditional soil fertilization saved 37.5% of traditional soil NPK fertilizers with improved yield and quality in apple (*FS, Nauni*).
- ❖ Comparative efficiency of different nitrogen sources on soil properties and productivity in apple revealed that out of the different sources used, in different cultivars of apple viz. Starking Delicious (Pot culture), Vance Delicious (Seobagh, Kullu, field studies) and Red Chief (Rohru, Shimla field studies), application of calcium nitrate resulted in better fruit growth parameters but the maximum growth and production of quality fruit was obtained with the application of recommended dose of nitrogen (half through calcium nitrate and other half through urea) wherein the residual acidity of urea is neutralized by liming (*SSWM, Nauni*).
- ❖ Experiments on effect of different mulch materials on moisture conservation in apple indicated that grass mulch performed better than the black and grey plastic mulch under flood irrigation. Highest soil temperatures were recorded under the plastic mulches (black and grey- both at par) and highest moisture content was recorded under grass mulch (*RHRSS & KVK, Tabo*).
- ❖ An experiment was conducted to test the effect of Phosphate Rich Organic Manure (PROM) on apple and the result revealed that the PROM has significant effect on the fruit weight (182.6 g/fruit) and yield (35.7 kg/plant). PROM recorded significant effect on yield of apple with highest yield (39.2 kg/tree) recorded in recommended dose of fertilizers-700g N, 350g P₂O₅ and 700g K₂O/ tree through 12:32:16, Urea/Calcium nitrate (CN) and Muriate of potash (MOP) but was statistically at par with 2.5 kg PROM/tree (35.7 kg/tree)] at Katrain, Kullu and 3.0 kg PROM/tree (36.3 kg/tree) at Bari, Kinnaur (*RHR&TS, Bajaura and SSWM, Nauni*).
- ❖ Foliar application of Applin (PGR) @ 2.0 ml/L at walnut stage was found most effective in improving fruit yield and quality of apple. The highest fruit yield 81.1 kg/ tree, fruit weight 165.3g/ fruit, fruit length 6.79 cm and breadth 6.91cm was observed with the spray of Applin @ 2.0 ml/L. No phytotoxicity symptoms were observed on leaves and fruits (*RHR&TS, Bajaura*).
- ❖ Leaf explants of apple 'Red Chief' regenerated best on MS medium containing 5.0mg/l BA and 0.2mg/l NAA which resulted in 88 per cent regeneration with 5-7 shoots per explant. Regenerated shoots were multiplied, rooted and hardened. Effect of antibiotic sensitivity showed 69 per cent shoot induction on above medium with 100mg/l cefotaxime and 21 per cent on 500mg/l. 25-70 per cent regeneration was obtained on 5-8mg/l kanamycin while leave turned yellow on higher concentration. Infection time of 7 min and 2 days co-cultivation duration with *Agrobacterium* strains containing RNAi constructs have been standardized (*BT, Nauni*).
- ❖ For SCAR marker development, five unique and polymorphic bands amplified with OPB-12, 14, OPD-06 and OPA-18 primers at 500bp and 1Kbp in *M. baccata* Shillong, *M. baccata* Khrot, *M. baccata* Kinnaur (Dhack), *M. baccata* Kashmir and *M. baccata* J&K, respectively were purified. After cloning into TA easy cloning vectors, five putative positive clones were obtained on the ampicillin antibiotic selective LB media the plasmids of which were sequenced in an automated DNA sequencer ABI 3500 at CPRI, Shimla. Sequences showed homology with the apple scab and rosy apple aphid resistant genes (*BT, Nauni*).



RAPD profile of crab apple biotype with primer OPB -14 showing unique band in I/4 of approx 1000bp marked with arrow



Putative transformed *E. coli* colonies (encircled) of eluted product on LB plates with ampicillin from sample I/4

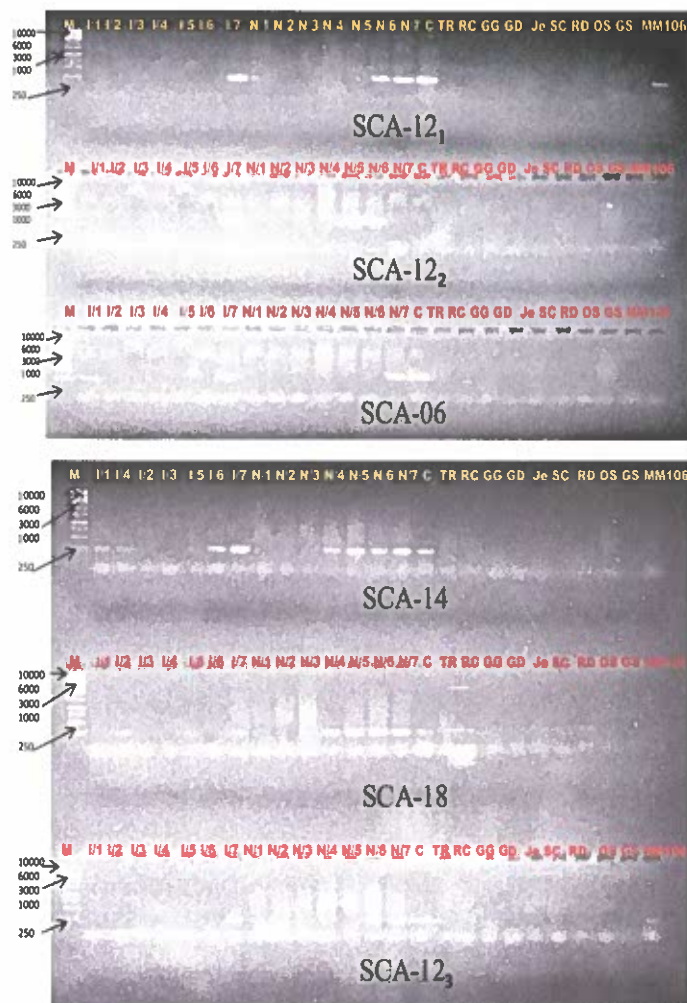
C



Confirmation of presence of approx 1kbp fragment through colony PCR and restriction digestion respectively. 1-4 transformed colonies

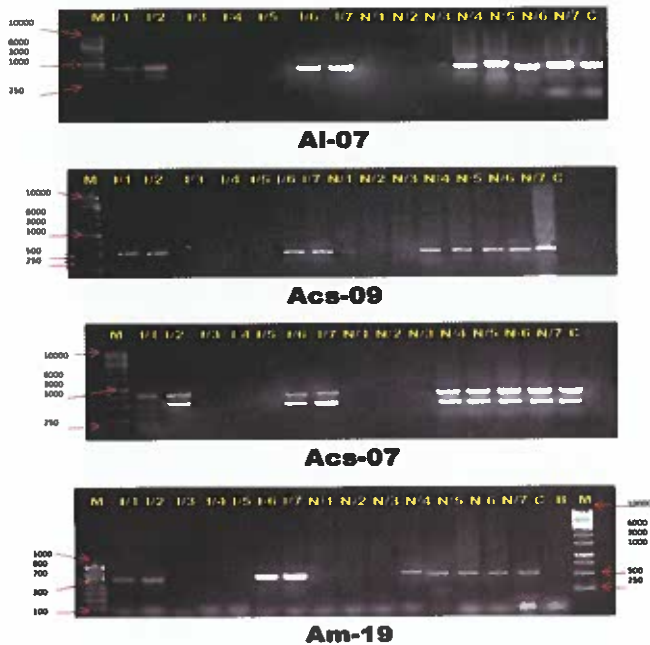
- ❖ Six primer pairs for SCAR markers (SCA06, SCA18, SCA12, SCA14, SCA12₍₂₎ and SCA12₍₃₎) as forward and reverse primers were designed by primer 3 software and validated for screening of crab apple biotypes as well as nine commercial apple cultivars, apple rootstock MM106 and *M. floribunda* of known susceptibility/resistances. All the six SCAR markers were found present in two biotypes *M. baccata* Shillong and *M. baccata* Khrot which are also showing resistance to apple scab and woolly aphid during bioassay studies. However, marker SCA12₂ was absent in *M. baccata* Shillong of NBPGR, RS and *M. baccata* Khrot of IARI, RS. *M. baccata* Kashmir showing moderate resistance to apple scab and susceptibility to woolly aphid during bioassay experiment showed amplification of three SCAR markers for apple scab while no amplification with rosy apple aphid. All the susceptible cultivars did not reveal amplified band with any of the six SCAR markers which is in line with the known susceptibility. Apple rootstock MM106 which is resistant to woolly aphid has shown amplification of SCAR marker SCA12₃ shown homology with resistant gene to rosy apple aphid. Thus these results confirm the efficiency of these SCAR markers for detection of resistance/

susceptibility to apple scab and rosy aphid (*BT, Nauni*).



Confirmation of presence of approx 1kbp fragment through colony PCR and restriction digestion respectively. 1-4 transformed colonies

- ❖ Screening of *M. baccata* biotype collection with earlier developed nine SCAR markers for resistance against apple scab and powdery mildew showed that *M. baccata* Shillong and *M. baccata* Kashmir of both the genebanks showed amplification, however *M. baccata* Kashmir of NBPGR, RS did not amplify SCAR marker for powdery mildew while it was found moderately resistant to this pathogen in bioassay experiments. *M. floribunda* used as control check showed the presence of all the SCAR markers. These SCARs were linked to the identified resistant genes Vbj, Vf, Vrl, P11 and P12 in apple by various workers and it is assumed that some of the biotypes of the indigenous wild apple may possess these genes (*BT, Nauni*).



SCAR marker profiles of wild apple biotypes maintained at two sites and *Malus floribunda* (C) with primers AI-07, Acs-09, Acs-07 and Am-19

Graft-induced variations were studied in different apple stionic combinations using scion (Scarlet Gala and Red Fuji) and rootstocks (MM111, MM106, M7, M9 and M26). Under morphological variations, significant difference were found in all the parameters viz. leaf area, shoot length, internodal length and fruit characters except petiole length and fruit firmness. Likewise, significant difference was also observed in total phenolic contents, total free amino acids and peroxidase enzyme activity. These results were further validated using DNA based molecular markers viz. RAPD, ISSR and SSR. RAPD and ISSR markers revealed very low genetic variability as compared to SSR markers where no polymorphism was observed. Therefore, it was inferred that rootstocks may influence morphological and biochemical parameters of the scion during graft-union but it does not influence genetic constitution of scion at DNA level (BT, Nauni).



Molecular characterization of apple stionic combinations using SSR-CN918509 (SG1-5: Scarlet Gala stionic combinations, RF1-5: Red Fuji stionic combinations)

- ❖ Five varieties of apple namely Gale Gala, Jeromine, Red Velox, Red Cap Valtod and Super Chief were studied to know their flowering phenology and foraging behavior of honey bees. Relative abundance of different insect visitors on different apple varieties revealed that average activity of other insect visitors ($3.46\text{m}^2/\text{min}$) was significantly higher followed by the activity of *A. mellifera* (1.83) and *A. cerana* (1.54). The average activities of different insect visitors were recorded maximum in Red Velox (2.59) which was at par with Gale Gala (2.33), whereas minimum activity was recorded in Red Cap Valtod (2.05). Data on per cent fruit set at different distances showed that maximum fruit set was recorded at 10m (65.44%) followed by 25m (50.11%), 50m (50.15%), 75m (42.67%) and 100m (22.98%) indicating higher fruit set at distance closer to bee colonies following declining pattern with increase in distance from placement of *A. mellifera* colonies. On this basis two strong colonies are sufficient for pollinating about one ha area of apple plantation (Ento, Nauni).
- ❖ Foliar application of Double (Homobrassinoloide 0.04%), provided maximum fruit set (34.45%), fruit yield (41.62kg/tree), fruit weight (167.26g) and fruit firmness ($7.22\text{kg}/\text{cm}^2$) was recorded when trees were sprayed with Double @1.0ml/l at tight cluster and pink bud stage. Maximum TSS content (10.30°B) was recorded when single spray of Double @1.0ml/l was given at pink bud stage. Different treatments of Double did not have any significant effect on L/D ratio of fruit, fruit colour and number of seeds/fruit (RHR&TS, Mashobra).
- ❖ Foliar application of Agro Gain had a significant effect on annual shoot growth, fruit set yield and physical parameters of apple fruit but did not had any significant effect on L/D ratio of fruit. Maximum annual shoot growth (48.49cm) was recorded in trees sprayed with AgroGain @1.0ml/l at pink bud stage. Maximum fruit set (34.69%) was recorded when AgroGain was sprayed @1.0ml/l at pink bud and petal fall stages. Yield (36.25kg/tree and 80.49 t/ha), fruit weight (152.19g), size in terms of length and breadth ($57.43 \times 63.69\text{mm}$) fruit firmness ($7.87\text{kg}/\text{cm}^2$) and TSS (10.77°B) was recorded

maximum in trees treated with AgroGain at pink bud and petal fall stages @1.5ml/l (*RHR&TS, Mashobra*).

- ❖ Surveys were conducted during 2018 to observe disease prevalence in apple orchards in different blocks (Mashobra, Theog, Jubbal & Kotkhai, Rohru, Narkanda, Rampur, and Chopal) of district Shimla. During surveys, incidence and severity of Marssonina blotch, Alternaria leaf spot, root rot, collar rot, cankers, powdery mildew, and virus & viroid diseases were recorded. Maximum incidence (90.0%) of apple scar skin viroid was recorded in orchards at Chiyog, Theog and Lakadhar, Chirgaon during the survey. The symptoms of apple scar skin viroid appeared as round, yellowish green spot 3-4mm in diameter after the appearance of red colour on fruit skin. In most of the cases, these round spots coalesce and large discoloured area developed predominantly at calyx end. On some fruits, russetting in definite streaks appeared on stalk end. In severe cases, cracks on fruits were observed. No apparent symptoms were recorded on the leaves of the infected trees (*RHR&TS, Mashobra*).



- ❖ DA 3176 10% SC was effective on controlling pre-ture leaf face & alternaria leaf spot with 8.60 per cent and 10.34 per cent incidence in apple followed by DA 3176 10% SC @ 1200 g/ha. Dodinofil (0.2%) resulted in minimum disease intensity of 2.27 per cent followed by Dodinofil (0.15%). Ziram (4 kg/ha) resulted in minimum scab intensity of 6.87 % followed by Ziram (2 kg/ha) with scab intensity of 9.64 per cent. Aliette was found much effective against root rot in apple at 8 g/l with 2.86 per cent followed by Aliette (4 g/l) and carbendazim (1 g/l) exhibiting 4.05 per cent and 6.73 per cent incidence, respectively. However, Aliette was also effective against collar rot in apple exhibiting 2.62 per cent minimum incidence at 8 g/l followed by 6 g/l and 4 g/l, respectively. Bipirimate @ 1.75 g/l was highly

effective in controlling powdery mildew in apple resulting 3.03 per cent severity followed by Sulphur (5 g/l) and Bipirimate (1.25 g/l) (*RHR&TS and KVK, Sharbo*).

- ❖ In the ongoing multi-location field evaluation trials of fungicides of 2017 and 2018 crop seasons viz. mefentrifluconazole 20% + pyraclostrobin 20% SC (0.04%), mefentrifluconazole 40% SC (0.03%), fosetyl Al 80% (0.4%), ziram 80% WP (0.3%) Thiophanate methyl (0.05%) showed superior efficacy than standard checks against apple scab. Mefentrifluconazole 20% + pyraclostrobin 20% SC (0.04%), mefentrifluconazole 40% SC (0.03%) were found effective in controlling *Alternaria* leaf spot and powdery mildew of apple. Mefentrifluconazole 20% + pyraclostrobin 20% SC (0.04%), mefentrifluconazole 40% SC (0.03%), fosetyl Al 80% (0.4%), tebuconazole 430SC @0.4% provided superior results in controlling *Marssonina* blotch (*PP, Nauni*).

Combination of difenoconazole (0.30%) and propineb (0.25%) was found to be most effective in managing *Alternaria* blotch of apple with 95.30 per cent disease control (*PP, Nauni*).

- ❖ Biological control of hairy root of apple with with *Agrobacterium radiobacter* starin K-84 and UHFBA-218 has been found most effective. SAR chemical like potassium oxalate and potassium metabisulphite (250 ppm) applied as root dip has also been found effective for the management of hairy root disease in apple and improved growth of the plants (*PP, Nauni*).
- ❖ Combination of calcium cyanamide (100g/m²), PGPR (*Bacillus subtilis* + *Bacillus licheniformis*) 100ml/ m² and AM fungi (*Glomus* sp.+ *Gigaspora* sp.) 100g/m² evaluated under pot conditions resulted in maximum disease control (100%) of white root rot of apple. In virgin and sick nursery fields, this treatment provided 85.26 and 75.97 per cent disease control respectively. Combination of *Trichoderma* formulations with carbendazim/ pyraclostrobin + metiram/ flusilazole + carbendazim and cabbage before plantation of the seedlings were found more effective for the management of white root rot (*PP, Nauni*).

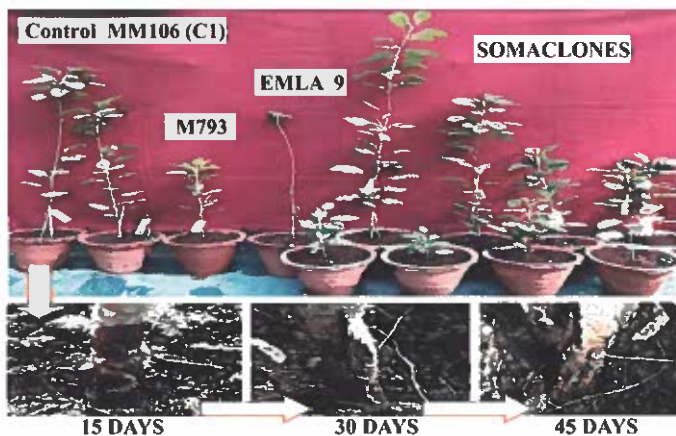


- ❖ *rol B* transgenic lines are being maintained in cultures as well as in pots for further evaluation of shoot growth characters, and *in vivo* rooting characters. In transgenic lines E27(2) and E 16 (2), three plants showed significant reduced height (3-5 cm) compared with the control and other transgenic plants. However, there is no difference in internode length, number of nodes and leaf morphology of transgenic plants as compared to the control (*BT, Nauni*).

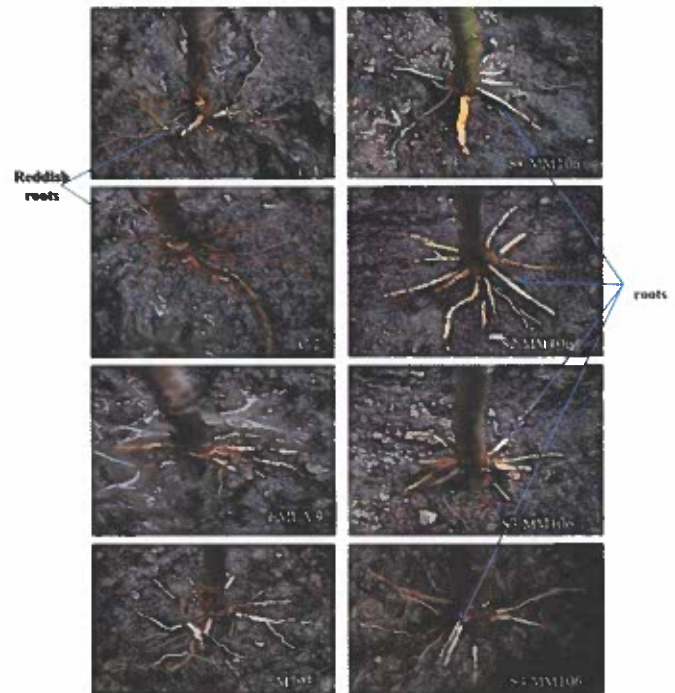


rol B transgenic lines *in vitro* and 14 months old plants in dormancy

- ❖ *In vitro* pathogen cultural filtrate tolerant plants of apple rootstock MM106 were screened for resistance to *Phytophthora cactorum* in inoculated soil. Pathogenicity test showed symptoms on leaves of control plants after 15 days. Primary symptoms like lesions and girdling on the stem below the soil level appeared after one month, while somaclones did not show such type of symptoms. Control plants exhibit symptoms on roots like colour of roots which changed to reddish brown. Whereas in somaclones, some old roots were affected but along with new roots were also produced with good rooting system. Both the control plants showed sign of susceptibility but *in vitro* selected tolerant somaclones showed 100 per cent resistance to collar rot. Brown/reddish colour of roots was an estimate of susceptibility of the control plants (*BT, Nauni*).



Control plants of apple root stock MM106(C1) showing lesion development of collarrot disease after pathogenicity assay



Collar rot symptoms on roots in control plants (C1, C2) of mm106 and new roots in EMLA9, M793, somaclonal variants (S1 - S4 MM106)

- ❖ Fifty decamer RAPD primers were used to evaluate the variations/similarity between axillary bud raised mother plant of MM106, its sixteen collar rot resistant somaclones, rootstocks Merton 793 and EMLA9. Eighteen primers showed the reproducible amplification ability. RAPD analysis showed that somaclones produced almost similar banding pattern with 54 to 93% similarity matrix while 25- 41% between axillary bud raised shoots and somaclones. After screening RAPD profiles, two polymorphic DNA bands with primer TIBMBA 20 were detected in all the somaclones and absent in control plant. These bands were purified and sequenced which showed 77% and 82% homology with leaf rust resistant genes of apple. It can be established that variations/polymorphism in RAPD profiles may have resulted from activation of tolerance/resistance in the somaclones (*BT, Nauni*).
- ❖ Bio efficacy of BAS75101F @ 40ml/100 It was most effective and resulted in 4.27 per cent scab incidence as compared to 23.0 in control followed by tebuconazole and BAS75101F. However, BAS75002F was also found effective against apple scab (6.37%), powdery mildew (11.71%), premature leaf fall (6.25%) and alternaria leaf



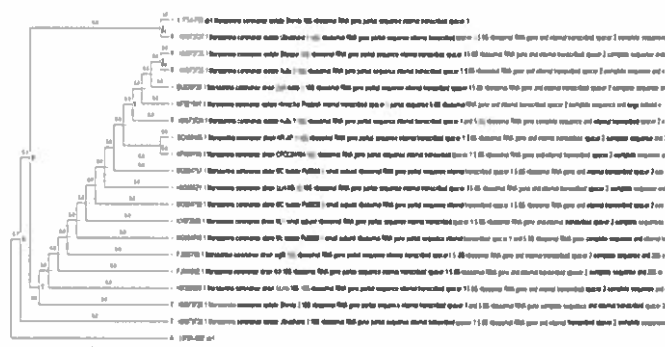
spot (6.51%). Efficacy of 4PF-513 was evaluated under field condition at Sangla valley and it revealed that foliar spray of 4PF-513 @ 0.35% resulted minimum scab intensity of 5.76% followed by 4PF-513 @ 0.3 % and Metiram + Pyraclostrobin @ 0.1%. 4PF-513 (0.35%) resulted in minimum disease severity of 10.82 per cent against Alternaria leaf spot in apple followed by Metiram + Pyraclostrobin (0.1%). Field efficacy of 4PF-209b was evaluated against apple scab and found effective with 4.70 per cent intensity followed by Metiram + Pyraclostrobin (0.1%). Bio efficacy of EPIC 75 per cent WG was evaluated at different concentrations; EPIC 75% WG (0.16 g/l) resulted in minimum scab intensity of 5.33 per cent followed by hexaconazole (0.08 g/l) which was superior to other treatments and statistically at par with each other exhibiting 7.36 per cent scab intensity. However, EPIC 75% WG was less effective in controlling premature leaf fall. Though, EPIC 75% WG was effective in controlling alternaria leaf spot in apple resulting 5.47 per cent followed by EPIC @ 0.08 g/l which was significantly superior to other treatments (RHR&TS and KVK, Sharbo).

❖ DA 3176 10% SC (0.17, 0.026, 0.035 and 0.045%) was evaluated against *Marssonina* blotch (*Marssonina coronaria*) and *Alternaria* leaf spot (*Alternaria* sp.) of apple which recorded highest 61.74 and 79.40 percent disease control at 0.045%, respectively whereas, UPF 513 (0.04%) gave highest disease control i.e. 76.53 and 89.54 per cent against these diseases (RHR&TS, Mashobra).

❖ Persistence of Flint Pro (trifloxystrobin + propineb), fosetyl AI and tebuconazole on apple was studied at two locations of Himachal Pradesh (Matiana and Thanedhar, Distt Shimla) and harvest time residues in fruits and soil were estimated at two locations of HP and J&K. Trifloxystrobin initial residues on apple fruits dissipated to half in 4.07 and 4.49 days, whereas the initial deposits of propineb reduced to half in 1.72 and 2.27 days. Residues of fosetyl AI in apple fruits were estimated below LOQ (0.05 mg/kg) at different days interval after apple tree basin soil was drenched four times with fosetyl AI @ 3.2 and 6.4 g a.i./ L water at 15 days interval. However, due to its foliar application @ 2.4 and

4.8 g a.i./ L water, initial residues of fosetyl AI on fruits dissipated to half in 3.08 and 3.75 days. Harvest time residues of Flint Pro (trifloxystrobin + propineb), fosetyl AI and tebuconazole in apple fruit samples and tree basin soil from two locations of H P and two locations of J & K were below LOQ (0.05 mg/kg) (Ento, Nauni).

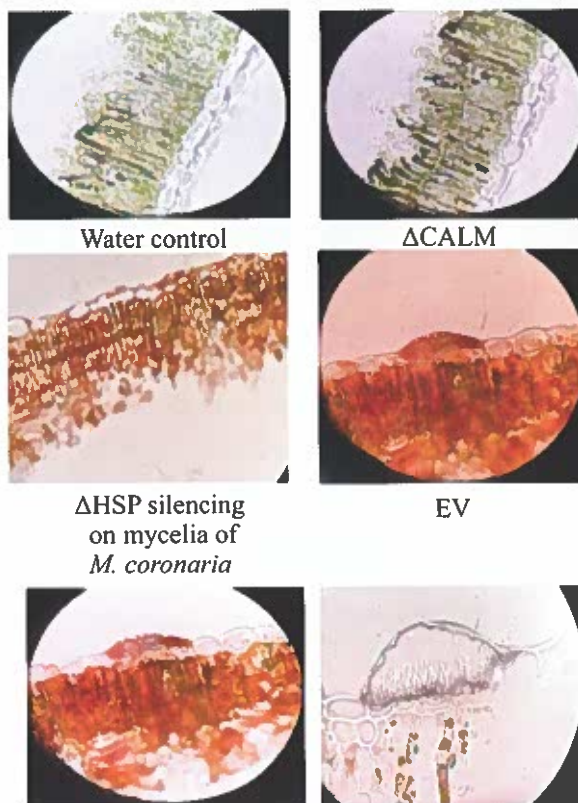
❖ The sexual structures (apothecium, asci and ascospores) were recorded on the fallen leaves infected with *Marssonina coronaria* w.e.f. last week of January to 2nd week of May, 2018. Further, for molecular identification, amplification using universal primer pair ITS1/ITS4 in PCR was done. For phylogenetic analysis, the GenBank accessions for *Marssonina coronaria* sequences from different locations were used: MC984759, KY672995, HM368521, MF521961, EU329733, MC984757, HM368520 etc presented in the figure. The origins of these isolates are shown on the phylogenetic tree. Molecular Evolutionary Genetics Analysis (MEGA) software (<http://www.megasoftware.net/>) was used to construct a phylogenetic tree with the neighbor-joining method. These sequences show 98-99.9% identity with *Marssonina coronaria* (RHR&TS, Mashobra).



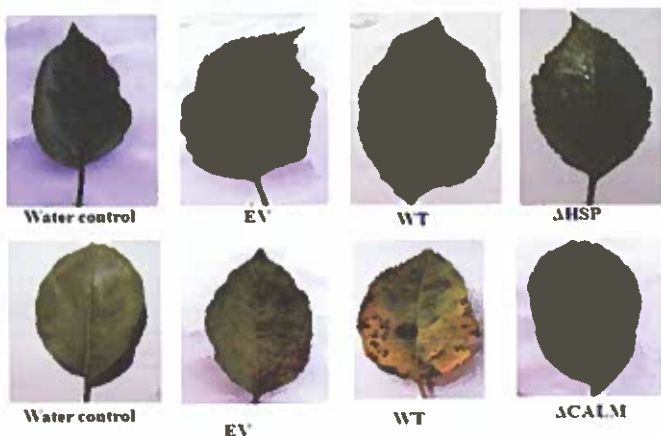
Phylogenetic tree constructed by using neighbour-joining method, showing genetic relationship of *Marssonina coronaria* isolates with other isolates

❖ To study the possible effect of CALM and HSP-90 on *M. coronaria* virulence, infection assays were carried out on leaves of apple cultivars which showed that 'Starking Delicious' leaves did not develop symptoms after inoculation with ΔCALM conidia suspension compared to that of wildtype strain even after 15 dpi. CALM mutants were not able to produce blotch on *in vitro* leaves of 'Red Chief'. Microscopic examination of the

conidia and mycelia of Δ CALM and Δ HSP mutants revealed alteration in the spore morphology and size in all the Δ HSP mutants. The mycelia of the mutants raised by silencing both the genes were defective and abnormal indicating the role of these genes in vegetative growth of *M. coronaria* and role of HSP-90 in cell wall development as well. Examination of the thin section of the infected apple leaves under light microscope revealed that control fungi were able to colonise the leaf tissue and successfully produced the fruiting body, acervuli on the epidermis of the apple leaves. Finally, differentiation of conidiophores and conidia eventually rose the host cuticle upward. However, the CALM mutants altogether failed to infect the tissue as the epidermis layer was intact. But HSP mutants were able to colonise the host tissue as the intracellular hyphae and subcuticular hyphae were observed which resulted in the necrosis and the visible lesions appeared on the leaf surface but these hyphae failed to differentiate into conidiophores and develop the fruiting bodies on the leaf surface of the host (BT, Nauni).



WT
Microscopic examination of the leaves infected by control, Δ CALM and Δ HSP-90 silenced mutants



Effect of Δ CALM and Δ HSP-90 gene silencing on the virulence of *M. coronaria* conidia inoculated on apple leaves



Effect of Δ CALM and Δ HSP-90 gene silencing on conidia of *M. coronaria*

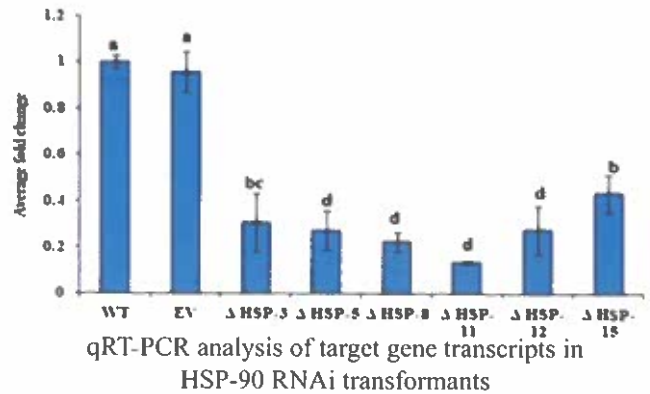
❖ RNAi gene constructs McRNAi-pCAMBIA1300-CALM and McRNAi-pCAMBIA1300-HSP harboring hygromycin marker gene, and sense, intron and antisense fragments under the control of fungal-specific trpC promoter were used for transformation of *Marssonina coronaria* to elucidate their function and role in pathogenesis. PCR reactions with the oligonucleotide pair HPT-F/HPT-R confirmed the presence of the hpt gene, in the genome of all hygromycin resistant putative transformant strains of *M. coronaria* as they revealed the expected amplicon of 500 bp size. All the transformants were stable for transgene integration during sub-cultures (BT, Nauni).



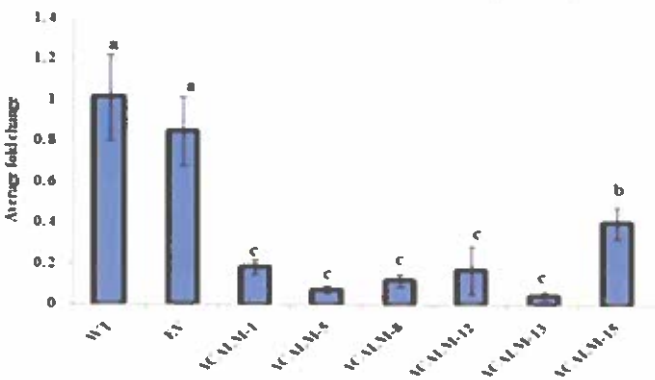
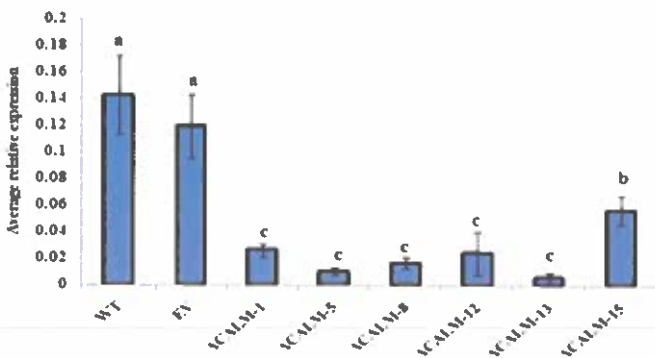
PCR screening of putative RNAi Δ CALM transformants of *M. coronaria*



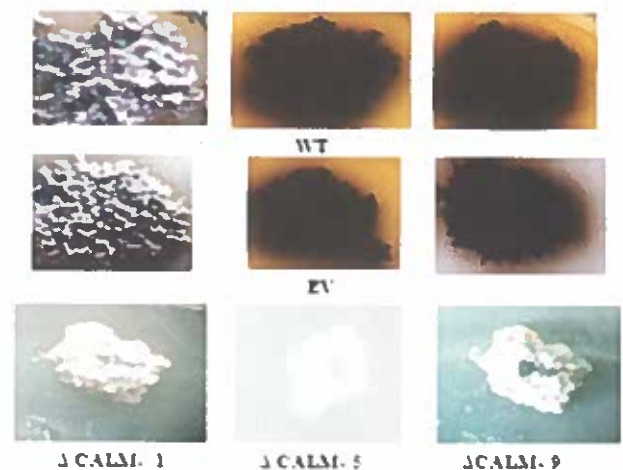
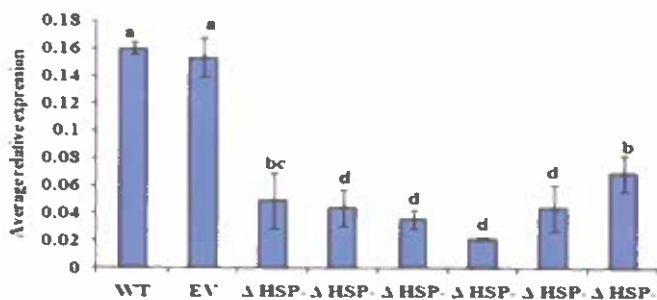
❖ The CALM and HSP-90 transcript levels were significantly dropped in RNAi transformants as compared to untransformed control and empty vector control. Also, level of the gene silencing varied in transformants. CALM transformants Δ CALM-5 and 13 showed more than 10-fold reduction whereas Δ CALM-15 2 fold in the expression of calmodulin gene as compared to the control fungus. Δ HSP-6 showed 10-fold reduction in the expression of the target gene and rest resulted in more than 2-fold. This reduction in the transcripts of the target genes in all the RNAi transformants confirmed that the efficient target genes silencing was triggered with the partial CDS sequences chosen for silencing constructs preparation (*BT, Nauni*).



❖ Δ CALM-5 and 11 transformants exhibited the least colony diameters of 3.67 mm whereas the wild-type strain and empty vector transformant showed 14.00 and 14.67 mm, respectively. The mean colony diameters of all the transformants were significantly different from the controls. Δ HSP-8 transformant revealed the least colony diameter 3.33 mm as compared to the wild type (14.33 mm). There was significant reduction in the mycelia dry weight of the mutants generated with both the genes as compared to controls. It was observed that the conidia production was hampered by silencing the CALM and HSP-90 genes in *M. coronaria*. The wildtype strain can produce large number of conidia after incubation for 15 d but, very less in Δ CALM and Δ HSP mutants. Conidiation is very important for ascomycetous fungi to survive adversity and to propagate. These results gave an insight about the role of calmodulin and HSP-90 genes in the growth and development of fungus. The reduction in pigmentation and conidia due to the silencing of CALM gene revealed the association of melanin and morphogenesis of *M. coronaria* (*BT, Nauni*).

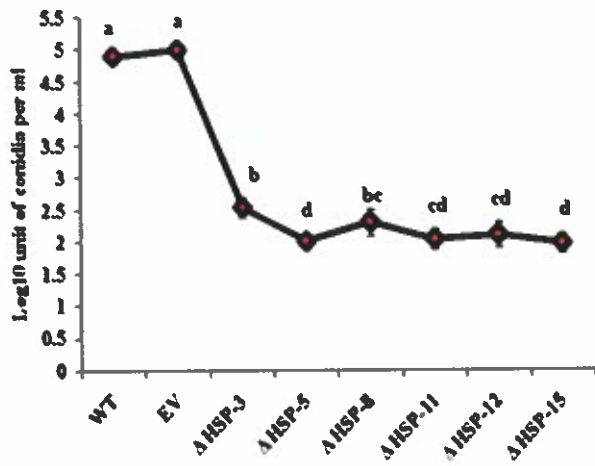
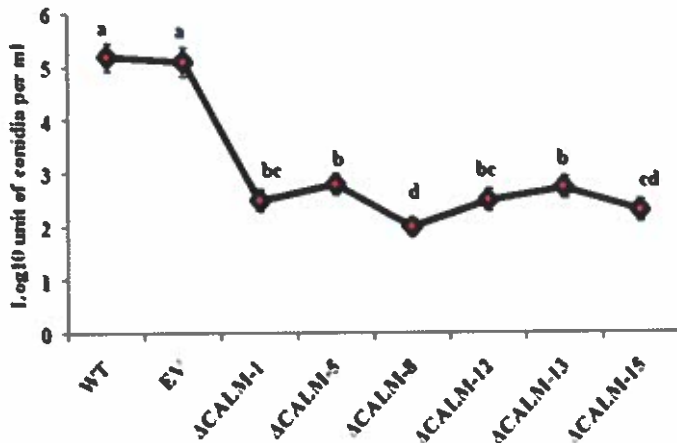


qRT-PCR analysis of target gene transcripts in CALM RNAi transformants





Comparison of colony morphology of *M. coronaria* wild type strain (WT), empty vector (EV) and RNAi fungal transformants



Effect of CALM and HSP90 gene silencing on *Marssonina conidia* production

- ❖ Sequences of ITS 18S and 28S rRNA (MF435986) as well as partial gene sequences of calmodulin from *Marssonina coronaria* isolate HP (accession number -MF460454) have been submitted to GenBank. Isolation, Cloning (pGEM®-T Easy Vector____), sequencing and molecular characterization of the beta tubulin gene from *Marssonina coronaria* have been done, which could be aptly used as a reference gene for the expression analysis of other important genes using qRT PCR studies in this fungus (BT, Nauni).
- ❖ Iron nanoparticles synthesized by *Bacillus cereus* strain MJS3.0 isolated from soil sample of Mandi district and *Pseudomonas putida* strain LUA15.1 isolated from paddy field of Una district Himachal Pradesh. Bioiron nanoparticles shown maximum antimicrobial activity against *Dematophora necatrix* and *Agrobacterium tumefaciens* and also shown nematocidal activity. Both iron nanoparticles and bacterial culture preparations shown maximum decolourization of Brillent green and methylene blue (BT, Nauni).



In vitro antifungal activity of iron nanoparticles synthesized by *Bacillus cereus* strain MJS 3.0 against *Dematophora necatrix*

- ❖ Wooden block attractant- insecticide traps (Methyl Eugenol+Cue lure with malathion) installed at Rewalsar in mango orchard and cucumber fields at Nauni, captured fruit flies namely *Bactrocera dorsalis*, *B. zonata*, *B. cucurbitae*, *B. tau*, *B. nigrofemoralis* and *B. scutellaris*. However, in exclusive methyl eugenol-malathion trap installed at Rewalsar, only *B. dorsalis* and *B. zonata* were trapped, whereas, in exclusive cue-lure-malathion traps only, *B. cucurbitae*, *B. tau*, *B. nigrofemoralis* and *B. scutellaris* were trapped (Ento, Nauni).
- ❖ Infestation of shoot borer, fruit eating beetles (Scarabaeids), shot hole borer and *Helicoverpa armigera* was recorded but the extent of

infestation was quite low except for *H. armigera* where the infestation was around 10-15 per cent (*Ento, Nauni*).



Shoot borer infestation



Fruit eating beetles



Fruit borer infestation

- ❖ During III and IV week of May, severe *Helicoverpa* spp. infestation was observed in high density apple plantation at RHR&TS, Bajaura. On an average 28.33% (0-60%) bored fruits were observed whereas average number of larvae per plant were found to be 1.06 (0-4 larvae/plant) (*RHR&TS, Bajaura*).



- ❖ During the 1st week of August, clearwing moth/dogwood borer infestation (28.57 %) was observed in the burrknots of apple plants (raised on M9 and M7 rootstocks) at HRS, Seobagh. Larvae prefer to feed inside the burr knots and mine beneath the bark. First sign of an infestation is the appearance of reddish brown frass/excrement on the surface. Their feeding inflicts damage to the plant and cause decline (*RHR&TS, Bajaura*).



- ❖ A field trial laid out to test the efficacy of chlorpyrifos (Chlorocil 20EC) against aerial forms of woolly apple aphid, *Eriosoma lanigerum* on apple trees at post harvest stage clearly revealed that Chlorocil @2ml/L of water and Dursban @2.5 ml/L of water provided complete suppression of woolly apple aphid colonies on 14th day of spray while, lower dose of Chlorocil @1ml/L of water exhibited 98.61% control after 21 days of spray (*RHR&TS, Mashobra*).
- ❖ Evaluation of HMOs (1.5% and 2.0%) against winter eggs of European red mite on apple before tight cluster stage proved that Mak All Season @ 2.0% is more effective as compared to other treatments. Bioefficacy of different acaricides and HMOs against two-spotted mite, *Tetranychus urticae* (Koch) infesting *Euonymus* (*Euonymus fortunei*) in polyhouse indicated that after 28 days of spray Oberon and Etoxazole provided complete reduction in population of mites. A mite population was negligible in Omite and Magister treated plants and was at par with Oberon and Etoxazole (*RHR&TS, Mashobra*).
- ❖ A field trial for management of woolly apple aphid population during winter and summer onset in apple by using physical barrier as Yellow Sticky Tape around trunk (5-7 cm above soil) was conducted. After 120 days of applying yellow sticking tape, 59.7 mean numbers of aphids were trapped. The use of these type of physical barrier will be useful in managing the next fruiting season pest population in an environment friendly manner (*RHRSS & KVK, Tabo*).



- ❖ Management of apple root borer, *Dorystenes hugelii* by using *Metarhizium anisopliae* was successfully demonstrated to the farmers of Shimla, Sirmaur and Mandi districts by covering an area of 5ha and 15 orchards (Ento, Nauni).
- ❖ Infestation of *Spodoptera* sp. was observed in the high density apple plantation at Bajaura during the last week of July. The caterpillars skeletonized the leaves. About 5 per cent apple plants were found to be infested (RHR&TS, Bajaura).



- ❖ New miticide Fenazaquin 20SC at 0.25 ml/L of water was found effective against the mixed population of phytophagous mites on apple showing 1.38 mites/leaf as compared with control (32.11 mites/leaf) after 21 days of spray (RHR&TS, Bajaura).
- ❖ New pesticide Goldban^(R) provided effective suppression of apple flower thrips @ 0.02% and 0.04% in comparison with the already recommended Dursban (0.04%) (RHR&TS, Bajaura).
- ❖ A study on “Market Integration and Price Transmission Behaviour in Apple Markets of India” revealed that the growth of productivity of apple in India registered a growth of 0.32 per cent per annum during 1960-61 to 2015-16. The co-integration studies showed that all the selected apple markets viz., Dhalli (Shimla), Chandigarh, Azadpur (Delhi), Bengaluru and Mumbai have long-run price association and are strongly co-integrated in India. Structure, conduct and performance analysis of apple markets namely, Azadpur (Delhi), Chandigarh, Dhalli (Shimla) and Solan revealed that Delhi and Solan are comparatively less competitive having higher Gini Concentration Ratio (GCR), whereas, Chandigarh and Dhalli markets are highly competitive having lower GCR (SS, Nauni).
- ❖ A study on “Economic impact of drip irrigation on apple cultivation in Shimla district of Himachal Pradesh” reported that initial cost has

been found to be Rs. 40,449.44 and Rs. 38,819.30 with drip and without drip irrigation farms respectively in the first year. The maintenance cost was found to be Rs. 29,843.00 and Rs. 27,435.20 in with the drip and without drip irrigation farms, respectively. The total cost of apple cultivation in case of with drip irrigation farms was greater than that of without drip irrigation farms up to non-bearing stage and at the time of bearing stage the cost of apple cultivation with drip irrigation was less than that of without drip irrigation (SS, Nauni).

- ❖ The study was conducted to understand farmers' opinion on various marketing systems used for apple crop and also intend to understand different forces affecting efficiency of apple marketing channels. The study has categorically highlighted various problems and constraints faced by growers while adopting modern marketing systems. It was specifically noted that the private procurement companies are taking over all other marketing channels for selling the apple produce. Private procurement companies are being preferred over Traditional Marketing system (BM, Nauni).

Pear

- ❖ Experiment on varietal evaluation of two pear cultivars i.e. Carmen and Concord grafted on BA 29 in their 3rd year of planting were studied and observed significant differences in the yield parameters. The maximum number of fruits per tree (3.26), yield (702.72 g/tree) and fruit weight (226.59 g/fruit) was recorded in cultivar Concorde/BA29. However, the minimum fruits per tree (4.10), yield (550 g/tree) and fruit weight (141.92 g/fruit) was recorded in cultivar Concorde/BA29 (RHR&TS and KVK, Sharbo).



Carmen

Concord



Apricot

- ❖ Effect of organic manures, PGPRs and mulches on soil properties and growth of apricot cv. New Castle revealed that the treatment consisting of mulch mat + recommended FYM + recommended NPK through vermicompost on N equivalence +PGPR registered maximum soil moisture content and better moderation of soil temperature, improvement in microbial properties, lowest weed growth and significantly higher soil and leaf NPK contents and plant growth characteristics (*SSWM, Nauni*).
- ❖ Economic analysis of apricot cultivation in Solan district of revealed that amortized establishment cost was Rs.12, 829.53, whereas average maintenance cost was Rs. 40,282.96. Net income per year was Rs. 53,112.49. Benefit cost ratio of 2.37 and 2.18. The payback period was found to be 8 years with an internal rate of return (IRR) of 28.40 per cent and also modified internal rate of return (MIRR) was found 16.23. Net present value of Rs. 3,82,228.98 was found which indicated the economic feasibility of apricot cultivation (*SS, Nauni*).

Peach

- ❖ Peach fruits are available in the market early in the season, particularly, from the low chilling cultivars grown in warmer regions of Himachal Pradesh. Although, a number of low chilling cultivars of peach are available but some of them sprout late and thus crop is produced in June-July which get competition from other fruit crops and does not get desired price. In order to identify chemicals, growth regulators and standardize their concentration, stage and time of application so as to induce early dormancy, flowering and fruit maturity in peach an experiment was conducted on cultivars GloHaven and Royal Paradelux. The observations showed that a combination of Urea @ 2% + CuSo₄ 5% + ZnSo₄ 2% induced leaf fall 30 days after application as compared to 57 days in control. Whereas in cultivar Glohaven ZnSo₄ @3% induced the earliest leaf fall (28 days) as compared to 60 days from the date of treatments. Bud break was advanced by the application of GA₃ @100 ppm in cultivar GloHaven and Dormex @1% in cultivar Royal Paradelux (*COH&F, Neri*).



- ❖ Low chill peaches grown in the subtropical area of the country experiences long growing vegetative period after harvesting, which results in crop reduction in the following year. Summer pruning can play important role in affecting the cropping behaviour of low chill peaches. Summer pruning performed during the first fortnight of July reported significant results in both the cultivars viz., Shan-i-Punjab and Florida Prince. However, among different pruning intensities, best quality fruit with higher yields were recorded with 60 per cent summer pruning in Early Grande low chill peaches (*COH&F, Neri*).
- ❖ Single foliar spray of carbendazim (0.1%) at pink bud stage and foliar spray of hexaconazole (0.1%) at green tip stage completely checked the incidence of peach leaf curl to 1.42 per cent (*PP, Nauni*).
- ❖ Serological detection through direct antigen coating (DAC) and double antibody sandwich (DAS) forms of ELISA resulted in the detection of prunus necrotic ringspot virus (PNRSV) in peach cv. July Elberta. Association of PNRSV with viral symptoms in peach was further confirmed by dot immune binding assay (DIBA) and reverse transcriptase- polymerase chain reaction (RT-PCR) assays (*PP, Nauni*).
- ❖ The study was conducted to understand socio-economic status of farmers engaged in production of stone fruits and also intend to understand the existing stone fruits marketing system in respect of marketing channels, marketing costs, margins and producers share. The study has categorically highlighted major problems faced by farmers in production and marketing of stone fruits. It was specifically noted from the results that the major marketing problem faced by the farmers is multiplicity of charges, followed by inadequate market information and high transportation charges that requires an immediate redressed. Major marketing problem faced by the farmers was multiplicity of charges, followed by inadequate market information and high

transportation charges. Delhi is the most preferred markets for peach. Producers share in consumer's rupee was 57 per cent. The growers should opt for new and improved varieties of stone fruits which can cope up with the changing climatic conditions in this area and also which can produce well in this type of climate. For the efficient marketing of fruits, the growers of this area should make their co-operative societies. This will avoid the exploitation by middlemen and also will act as a link between growers and the government (*BM, Nauni*).

Plum

- ❖ An experiment was conducted for evaluating the effects of different weed management practices on the growth, yield and fruit quality in plum cv. Red Beaut. The grass mulching significantly increased fruit yield, size and quality and also controlled the weeds in tree basin. An increase in yield of 24.13 per cent over the unweeded control was recorded under mulch (*FS, Nauni*).



Grass mulching



Control (Unweeded)

Pomegranate

- ❖ A new variety Kandhari Seedless was developed and evaluated which have the moderate characters of its parent's i.e Kandhari Kabuli and Bhagwa. The average fruit weight varies from 350g-400g with TSS 13.8°Brix. It has very good TSS acid blend with average yield 35 kg/plant. The seeds of the developed cultivar are soft (*RHR&TS, Bajaura*).
- ❖ The effect of organic and inorganic mulches on fruit quality, growth and yield of pomegranate cv. Bhagwa was studied. The black polyethylene mulch gave the best results in respect of growth, yield, soil moisture conservation and weed control, followed by silver polyethylene mulch. A yield increase of 36 per cent over control was recorded in black polythene mulch (*FS, Nauni*).

- ❖ The biology studies of pomegranate fruit borer revealed that female laid white creamish circular eggs either singly or in clusters and there were five larval instars in case of pomegranate fruit borer having; first instar mean length 2.63 ± 0.18 mm and mean breadth 0.62 ± 0.05 mm, second instar mean length 5.96 ± 0.38 mm and mean breadth 1.18 ± 0.06 mm, third instar mean length 10.41 ± 0.38 mm and mean breadth 2.33 ± 0.17 mm, fourth instar mean length 13.84 ± 0.23 mm and mean breadth 3.58 ± 0.12 mm and fifth instar mean length 18.27 ± 0.44 mm and mean breadth 3.97 ± 0.15 mm. The bio-efficacy studies revealed that the per cent infestation was lowest in spinosad 45SC @0.004% (15.56%) followed by spinosad 45SC @ 0.002% (16.11%), emamectin benzoate 5%SG @0.004% (17.78%), cypermethrin 25% EC @ 0.02% (18.89), quinalphos 25% EC @0.1% (19.99%), Flubendiamide 20% WG @0.02% (20.56%) and same incase of agni astra @5% (20.56%) were proved effective and avoidable losses value of these tested treatments were 73.03%, 72.52%, 71.63%, 68.27%, 67.60%, 65.56% and 60.20% respectively. The biopesticides namely *Bt* 0.5% WP @0.1% and *Azadirachtin* 0.15% w/w min. @0.02% were found least effective with per cent infestation recorded was 26.10% and 25.56% with avoidable losses 44.57% and 54.27%, respectively (*COH&F, Neri*).

Persimmon

- ❖ Infestation of mealy bugs (unidentified) was observed for the first time in persimmon var. Fuyu at HRS, Seobag during the month of October. The mealy bugs were found concealed/feeding under the calyx of the fruits (*RHR&TS, Bajaura*).

Kiwifruit

- ❖ A study was conducted to investigate the influence of organic manures namely; FYM, vermicompost and poultry manure alone and in combination on the growth, yield and quality parameters of Kiwifruit. The two common treatments i.e application of Jeevamrit and Panchgavya after flower initiation at one month interval and 1 kg neem cake were also given. The results revealed that the vegetative characteristics namely; leaf area, chlorophyll content as well as



fruit size and yield were found better with the application of recommended NPK fertilizers along with 40 kg FYM. However, the treatment comprising of recommended dose of nutrients (RDN) through FYM and vermicompost (50:50) advanced the full bloom date by 11 days during 2018 in comparison to control. This treatment also resulted in maximum improvement of fruit quality and biological properties of the soil (FS, Nauni).

- ❖ A trial was conducted to standardize the fertigation schedule and bio-fertilizers on growth, yield and quality of kiwifruit cv. Allison. Treatment comprising of 80 % recommended dose of NPK through drip and coupled with Arka Microbial Consortium @ 5 ml L⁻¹ applied in the month of February prior to the emergence of new flushes and in the end of July resulted in best performance in terms of growth, yield and quality, which exerted 39 per cent higher yield of better quality fruits over control (FS, Nauni).
- ❖ An experiment was conducted to assess the effect of bee attractants on fruit set, yield and fruit quality of kiwifruit. The results revealed that Bee Scent pheromone (1.25%) and Sugarcane Juice (10%) were found most effective treatments for increasing the fruit set, yield, fruit size and weight. The proportion of A and B grade fruits was also significantly higher under these treatments as compared to control (FS, Nauni).
- ❖ In kiwifruit, fruit fly infestation was recorded during harvest (August-September, 2018) in the Kiwi Block of the Fruit Science Department. The maggots were reared in the laboratory, out of which adults of *Bactrocera dorsalis* emerged. The extent of infestation was around 40 per cent. The variety Allison suffered the most. During inspection of fruit nurseries for nematode infestation, high infestation (20-30 %) of root knot nematode was recorded in nursery plants at Nauni (Ento, Nauni).

Cherry

- ❖ The hybridization programme in cherry was initiated with a view to develop self fruitful cherries with better fruit quality involving different parents/gene sources. All the varieties in

which hybridization was attempted were found to be cross compatible. Maximum fruit set (65.71%) was observed in Deuron Nero-III × Stella and minimum fruit set (32.00%) was recorded in Deuron Nero-III×Lapins cross combination. Maximum fruit retention (52.17 %) was observed in Deuron Nero-III when Stella was used as a pollen parent and minimum fruit retention (41.67 %) was recorded in Deuron Nero-II×Lapins cross (RHR&TS, Mashobra).

- ❖ For the management of cherry stem borer commonly known as leopard moth (*Zeuzera multistrigata*) gum was removed with the help of sharp knife and holes were cleaned up with wire. Thereafter, cotton swabs dipped in chlopyriphos 0.04%, inserted into the holes with the help of wire and treated holes were plugged with mud (RHR&TS, Mashobra).
- ❖ An *in vitro* propagation protocol for Gisela 5 (*Prunus cerasus* × *Prunus canescens*) - clonal cherry rootstock has been developed. Axillary and terminal buds of 'Gisela 5' were collected in the spring season which showed maximum *in vitro* establishment on MS medium fortified with 0.5 mg/l BA and 0.5 mg/l GA₃. Highest multiplication rate of 1:5 was observed on MS medium supplemented with five different combinations of BA, GA₃, IBA and Kin. Shoot multiplication rate and shoot length showed an increase with the increase in number of subculturing passages which increased to a maximal of 1:9 and 6 cm respectively after third and fourth passage. Maximum *in vitro* rooting (100%) was achieved on full strength MS medium fortified with 0.5 mg/l IBA) whereas, very less rooting with IAA and NAA. Rooted plantlets were hardened in sterilized sand where 90 per cent survival was observed after 4 weeks of transfer. One year old hardened plants have been successfully transferred to the field and are not showing any morphological variations. *In vitro* established shoot cultures and hardened plants were indexed for cherry leaf roll virus, apple chlorotic leaf spot virus and prunus necrotic ring spot virus using DAS-ELISA procedure showed negative results for the presence of these viruses, thus ensuring the production of healthy planting material (BT, Nauni).



(A) Multiple shoot culture of Gisela 5 (b) *In vitro* rooting (c) hardened plantlets and (d) one year old Gisela-5 plants growing under field conditions

- ❖ Economics of cherry cultivation in Shimla district revealed that yield of cherry per hundred plants varied from 8.88 quintals to 63.83 quintals in sole as well as mixed orchard. Cherry cultivation was economically feasible during all the stages of production as BC ratio was greater than 1 and varied from 1.44 to 3.72 during early and main bearing stages on overall category (*SS, Nauni*).

Mango

- ❖ Samar Bahist, Baramasi, Totapari, Khas-ul-khas, Bombay green and Fajri were found resistant to floral malformation during this crop season. There were nine moderately susceptible varieties viz., Parry, Alphonso, Dashehari, Pusa Pratibha, Vanraj, Arka Puneet, Arka Arunima, Anmol, and Amarpalli. Three susceptible varieties were Sindhu, Ratna and Pusa Surya (*RHR&TS, Jachh*).



Floral malformation of mango

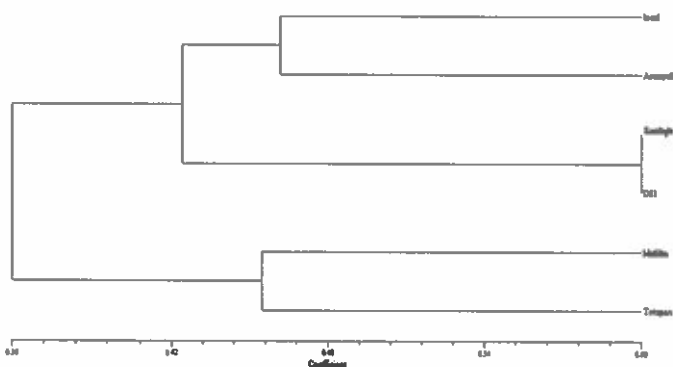
- ❖ Mango bacterial canker disease was observed in all the mango growing areas during this crop season. The maximum disease incidence (80.17%) was encountered at Gangath followed by 78.52 per cent at Ganoh, the minimum disease incidence (58.03%) was observed at Rehan. Maximum disease severity (40.72%) was encountered at Basa Waziran followed by 38.14 per cent at Jachh, minimum disease severity (32.81%) was recorded at Baranda. Fajri was found resistant to bacterial canker disease during this crop season. Samar Bahist, Bombay green, Chausa and Mallika were found moderately resistant. Sindhuri and Parry were found highly susceptible to bacterial canker disease (*RHR&TS, Jachh*).



Mango bacterial canker disease

- ❖ Field experiment were conducted to study the bio-efficacy of different insecticides against *Bacterocera dorsalis* revealed that Lambdacyhalothrin(0.01%) was significantly superior (16.53%) to all other insecticides, followed by 0.005% Chlorantraniliprole (18.93% infestation), 0.002% Cyantraniliprole (20.18% infestation), 0.004% Spinosad (20.42% infestation) and 0.0028% Deltamethrin (21.95% infestation), 0.0075% Cypermethrin (27.94% infestation), 0.1% + 1% sugar Malathion (27.92% infestation) and Neem revealed (27.94, 27.92, 25.68%) infestation. Micronutrient viz 0.4% ZnSO₄ (27.21%), 0.2% Boric Acid (27.08% infestation), 0.4% ZnSO₄ + 0.2% Boric Acid (27.47% infestation) and 0.2% CuSO₄ (27.47% infestation) were also significantly effective in comparison to control. Hence, it is recommended that 2 sprays of Lambdacyhalothrin, Chlorantraniliprole, Cyantraniliprole, Spinosad and Deltamethrin can be applied for the management of fruit fly in mango orchard. (*RHR & TS, Jachh*).

- ❖ Morphological characterization of different varieties of *Mangifera indica* L. using UPOV descriptor was carried out (UPOV-International Union for the Protection of new varieties of Plant). The aqueous extract of leaves of *Mangifera indica* was investigated for the presence of various classes of phytochemicals by performing appropriate tests. Total ten RAPD primers were screened for generation of polymorphic bands among six varieties of mango out of which only four RAPD primers found to be polymorphic viz., OPA-16, OPA-17, OPC6 and OPC-7. The similarity coefficients generated from RAPD data were used to construct dendrogram. The main cluster is divided in to two sub clusters, Sub cluster 1 has four varieties which include Local, Amrapali, Ramkela and D51 whereas sub cluster 2 includes two varieties Mallika and Totapari. The first sub cluster was found to be only 36 % similar to that of second sub-cluster which revealed a high level of polymorphism between the genotypes categorized in these two different sub clusters. However, the varieties Ramkela and D51 further made another sub-sub cluster at 42% Similarity (COH&F, Neri).



Dendrogram showing genetic variation among six varieties of mango

- ❖ Economics of production and marketing of mango in Kangra district revealed that average production varied from 50.96 to 53.00 per 100 plants and net returns varied from Rs. 1,78,365.54 to Rs. 1,85,507.41 in different farm categories. The payback period worked out to be 8th year for all the farm categories. Benefit-cost ratio was 2.02, internal rate of return (IRR) 26.06 per cent and net present value Rs. 5,51,274.37 (SS, Nauni).

Guava

- ❖ Nine budded guava cultivars namely, Lalit, Allahabadi Safeda, DK-Red Flesh, Punjab Hybrid-I, Punjab Hybrid-II, L-49, Shweta (G-4), Hisar Surkha and Hisar Safeda planted at a spacing of 6x6 m which were evaluated for horticultural traits. The cultivar, Lalit recorded the highest fruit yield (40.0 kg tree⁻¹), TSS (16.7°Brix) and fruit length (60.9 mm), breadth (56.3 mm) followed by Allahabadi Safeda with respective values of 36.6 kg tree⁻¹, 16.2°Brix and 60.4 and 52.5 mm (RHR&TS, Dhaulakuan).
- ❖ Foliar applications of nitrogen and potassium showed that the leaf nutrient content, annual shoot growth, fruit set, fruit weight and fruit yield can be enhanced through urea spray @ 1.0 per cent and potassium through potassium nitrate @ 2.0 per cent, twice during September and January (SSWM, Nauni).
- ❖ Foliar application of humic acid was carried out at bud burst to flowering stage in combination with soil supplemented bio-inoculants to the rhizosphere of guava under meadow orcharding. The results inferred that the combination of humic acid at 60 ml/L along with application of PSB and *Azotobacter* at 10 ml/plant supplemented with 80 per cent NPK resulted in higher number of flowers per shoot, fruit set, fruit retention and produced 2 times more yield of better quality fruits than control with yield efficiency of 1.40 kg/cm² TCSA (FS, Nauni).
- ❖ Guava is a potential crop in marginal and rainfed areas in the subtropics. Performance studies conducted in guava germplasm revealed that cv. Allahabadi Safeda excelled over all other cultivars (L-49, Lalit and Arka Amulaya) for fruit size, quality and yield (110.6 kg/tree) (RHR&TS, Jachh).



- ❖ Guava cultivar Lalit was planted in meadow orcharding at a spacing of 2X2m to improve the existing production system besides increasing

productivity. Traditional system of guava cultivation often poses problem in attaining desired levels of productivity. meadow orcharding technique was adopted for enhancement of productivity of quality fruits. Seven year old trees of guava gave fruit yield of 26.5 kg/tree during rainy and winter season (RHR&TS, Jachh).

Litchi

- ❖ Five newly introduced litchi cultivars (China, Shahi, Bedana, Purbi and Dehrrase) from NRC on Litchi Muzzafarpur (Bihar) were evaluated for growth, yield and fruit quality parameters during the reporting period. It revealed that cultivar Shahi was the most vigorous for growth parameter as it had the maximum trunk girth (23.6 cm), tree height (2.67m) and tree spread in EW (2.87m) and NS (2.92m) directions. Sample fruits were harvested and full yield potential is yet to be assessed as these cultivars have not attained full bearing potential (RHR&TS, Jachh).



- ❖ Performance studies on litchi cultivars namely, Dehradun, Calcuttia, Rose Scented, Early Large Red and Seedless Late were carried out at Dhaulakuan during 2018. The cultivar, Early Large Red recorded maximum average plant height (450.7 cm) and canopy spread (460.2 cm). Maximum yield (81.5 kg tree⁻¹) was recorded in Calcuttia, but fruit weight (22.7 g) was maximum in Early Large Red, whereas, Seedless Late obtained maximum aril (87.6%) (RHR&TS, Dhaulakuan).
- ❖ In seedless cultivar of litchi, soil application of Zn @ 100g/plant in the month of January-February in combination with one foliar application of Zn and Boron @ 0.50% and @0.05%, respectively at the time of flowering gave maximum (35.4 kg/plant) fruit yield in comparison to control (5.6 kg/plant). The percentage of shriveled fruits was significantly reduced to 3.5 per cent with same treatment (RHR&TS, Jachh).

Papaya

- ❖ *Alternaria* fruit rot of papaya caused by *Alternaria alternata* was recorded for the first time in the area. The infection in case of ripe fruits resulted in rotting of flesh (RHR&TS, Jachh).



Citrus

- ❖ In sweet orange four cultivars viz. Pineapple, Jaffa, Mosambi and Blood Red were evaluated for maturity and yield potential. In term of maturity, cultivar Pineapple was found to be early maturing (November) followed by Jaffa (December) and Blood Red (January). Pineapple gave maximum yield (32.3 kg/tree) in 7 years old plants in comparison to other three cultivars (RHR&TS, Jachh).



- ❖ Conjoint application of 70 per cent recommended doses of inorganic fertilizers (560gN:350gP:420gK), organic manures (FYM @ 42 kg and vermicopost @ 9kg) and biofertilizers (Azotobacter, VAM and PSB) @ 200g each/tree was found to have significant effect in improving the tree growth, fruit yield, fruit quality of kinnow mandarin and it was also observed to be the most economical (RHR&TS, Jachh).





- ❖ Residues of fluopicolide and its metabolite 2,6-dichlorobenzamide and fosetyl Al on immature citrus fruits with peel, mature whole fruit with peel, mature fruit without peel (edible part) and fruit juice were found below Limit of Quantification at both the doses after last drenching of Profiler @ 4 and 8 ml/tree. Similarly, harvest time residues of fluopicolide and its metabolite and fosetyl Al in citrus tree basin soil were below Limit of Quantification (*Ento, Nauni*).
- ❖ Foliar sprays of silver nano-particles (SNPs) of Tulsi (1000 ppm) and water extract of Tulsi (10%) or Sliver nano-particles (SNPs) of neem (1000 ppm) and water extract of neem (10%) were found effective for the management of green mould disease (*Penicillium digitatum*) of citrus. Similarly, foliar sprays of silver nano particles of *Ocimum americanum* (tulsi) @ 1000ppm and water extract of tulsi @10 per cent completely checked the post-harvest incidence of green and blue mould rot on kinnow fruits in storage (*PP, Nauni*).
- ❖ Integrated management of Fusarium wilt in kagzi lime was practiced under polyhouse conditions. *Fusarium* wilt was not found in Beejamrit (Seed dressing followed by 2 drenchings at fortnight intervals) treated plots during the entire seedling stage. However, plant height was maximum in Blitox + Lime treatment. Consequently, the trial was laid out on 15 Sep.,2018 in the same sick-soiled polyhouse. Mortality of seedlings started from 9 Jan., 2019 and continued till 10 May, 2019. Maximum number of dead seedlings were recorded in a period of 19 Feb., 2019 to 10 May, 2019. After the control, maximum mortality of seedlings was recorded in Beejamrit drenchings (*RHR&TS, Dhaulakuan*).

Pistachionut

- ❖ A study was conducted to mitigate the alternate bearing problem with the application of Boron and NPK fertilizers in pistachio nut cv. Kerman. The application of N:P:K (600:600:800 g tree⁻¹) in the late dormant stage (December-January) along with foliar B (0.5% as boric acid) at four different stages namely, (i) the early bud break-flowering (mid-April), (ii) the leafing out (fourth week of

April), (iii) the full leaf out stage (May) and (iv) the fruit setting stage (last week of May) significantly increased fruit set, reduced buds abscission, blanking as well as non-splits and consequently, increased the nut yield (*FS, Nauni*).

Strawberry

- ❖ In a study on the application of zinc nano-fertilizer on the flowering, yield and runner formation in strawberry, two foliar sprays of ZnO nanoparticles at 200 ppm scheduled at 30 and 60 days after transplanting resulted in early flowering, runner formation, fruit set and cumulative yield. The reduced leaf area of the plantlets were positively correlated with the fruit set (*FS, Nauni*).
- ❖ Foliar sprays of cow urine based botanical (Kadu, Darek, Aloe vera, Banna and Lemon grass) field formulation at 10 days interval starting from first week of July were found effective for management of leaf spot of strawberry (*PP, Nauni*).


Longan fruit

- ❖ Longan can be a valuable fruit for diversification in subtropics of low hills of Himachal Pradesh. Average trunk girth of 18.9 cm, tree height (2.57 m) and tree spread of 1.91 m in EW and 1.98 m in NS direction was recorded in studies undertaken for the evaluation of longan plants for growth parameters. Sample fruits were harvested and full yield potential is yet to be assessed as these cultivars have not attained full bearing potential (*RHR&TS, Jachh*).
- ❖ High density planting of different fruit crops have been established and maintained at experimental farm, Neri. These crop models devised in accordance with the suitability of soil, topography, aspect and agroclimatic situations such as frost prone and non-frost areas on undulated topography of wasteland. The modern technology regarding soil, water and nutrient management has been demonstrated on undulated sloppy land through drip and fertigation system along with black polyethene mulching for orchard floor management. Drip and fertigation system has been laid out in the orchard of different fruit crops on undulated topography to

enhance the productivity and qualitative attributes of different fruit crops besides increasing the water and nutrient efficiency. This technique has proved cost effective by way of automation of water and fertilizer supply to the root zone. To develop crop production mechanisms for adaptation under changing micro agro-climatic situation, different high value low volume new fruit crops/cultivars have been introduced viz., avocado, custard apple, coffee, jackfruit, carambola and macademia nut from different parts of the country (COH&F, Neri).

Vegetable Crops

Tomato

- ❖ Germplasm of tomato consisting of indigenous and exotic genotypes is being maintained. Two genotypes BAJ T-12 and BAJ T-4 developed through crossing, selfing and further selection process have shown better fruit yield per plant and are being evaluated in the farmer's fields for their performance (RHR&TS, Bajaura).
 - ❖ Hybrids are gaining popularity in vegetable crops. For the development of hybrids in tomato, the cross combinations of EC 174913 x FT-5 and EC 191531 x S. Lalima were found most promising and gave higher fruit yield (430.3 and 416.8 q/ha, respectively) under lower hill conditions of the state (RHR&TS, Jachh).
 - ❖ Seven hybrids of tomato were evaluated for yield and other horticultural traits. The results concluded that Red Gold hybrid of tomato showed its superiority for fruit yield/ha (700 q/ha), average fruit weight and number of fruits/plant among all the hybrids under study (HR&TS and KVK, Kandaghat).
 - ❖ For growing tomato crop during off season, experiments were conducted both under poly and net house conditions. Under protected structure (Polyhouse condition) tomato hybrid Himsona gave maximum yield (18.80 kg/m²) and is found to be the most suitable for growing in September-March plantings. Tomato crop planted during the month of March under Net house gave more yield (22.6kg/m²) during summer months (RHR&TS, Jachh).
- 
- ❖ A study was carried out in farmer's field on the effect of jeevamrit application in tomato. 'Jeevamrit' application resulted in increase in the growth and vigour of tomato plants. 'Jeevamrit' treated plants recorded increase in number of flowers and fruits. Low incidence of bacterial leaf spot disease was recorded in jeevamrit treated plants. 'Jeevamrit' application resulted in decrease in the whitefly attack but no effect on tomato fruit borer. Zero budget natural farming is farmer friendly, eco friendly and above all extremely cost effective (RHR&TS, Jachh).
 - ❖ Efficacy of PGPR (*Bacillus subtilis*) strain S₂₁ and chemical fertilizers on growth and yield of tomato was studied which revealed that the application of PGPR at variable doses of chemical fertilizers significantly increased the yield parameters of tomato. Treatment T₃ (*Bacillus subtilis* + 100% NPK) both at Naineti, Sirmaur and UHF-Nauni revealed significantly higher root length (13.71 cm), root dry weight (5.66 g), shoot dry weight (146.09 g) and plant biomass (151.92 g/plant) (SSWM, Nauni).
 - ❖ Effect of mulch on soil properties and yield of tomato was studied. The results revealed that the highest percentage increase in soil moisture content (18.87 to 21.59%) was observed under black polyethylene mulch over unmulched condition. whereas highest increase in minimum soil temperature (2.09 to 2.69°C) and maximum soil temperature (1.55 to 2.71 °C) was recorded under transparent polyethylene mulch. The black polyethylene mulch recorded significantly highest availability of macro nutrients (N, P, K) in soil, highest yield (63.62 q ha⁻¹), highest water use efficiency (1.85 qha⁻¹ cm⁻¹), highest net income (Rs. 7.46 lakhs ha⁻¹), highest B:C ratio (4.58) in comparison to other mulches (SSWM, Nauni).
 - ❖ Isolation of bacterial endophytes from root tissues of *Rosemarinus officinalis* revealed that majority of isolates had triple traits of P-solubilization, siderophore production and

nitrogen fixing ability. Of the total, 77 per cent endophytic bacterial isolates were noted to be positive for P-solubilization, 73 per cent were siderophore producers and IAA production was recorded only in 61 per cent isolates whereas antagonistic traits of HCN, chitinase and protease production was found in 40, 44 and 59 per cent bacterial isolates, respectively (*SSWM, Nauni*).

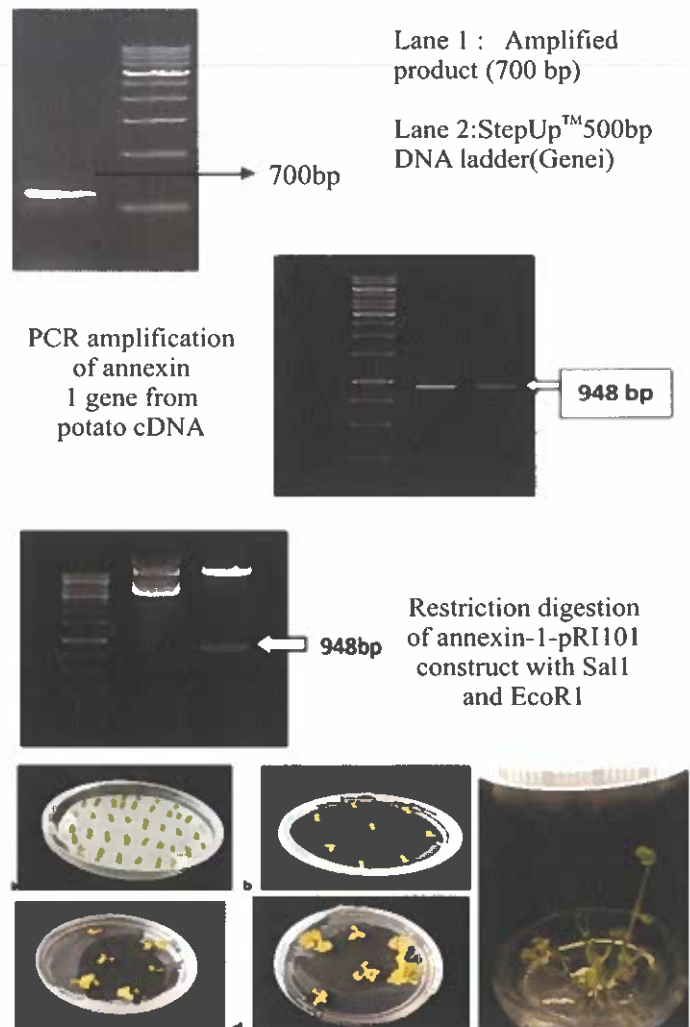
- ❖ Single constructs of AdSGT1 (*Arachisdiogoi*) defense related and TvD1 (*Tephrosia villosa*) defensin genes in binary vector pCAMBIA2300 containing NPT-II selection marker (procured from Prof. P.B. Kirti, University of Hyderabad, Hyderabad, India) are being used for carrying out genetic transformation experiments in tomato var. 'Solan Lalima' for developing resistance against fungus *Phytophthora nicotiana* var. *parasitica* causing Buckeye rot. The kanamycin @ 100 mg/l resulted in 26.66 per cent survival rate of hypocotyl explants, 18.33 per cent shoot regeneration, 1.16 average numbers of shoots per explant and 1.01 cm average shoot length. The explants were pre-incubated for 0 (fresh), 24, 48, 72 and 96 hours and then subsequently co-cultivated with fresh cultures of *Agrobacterium tumefaciens* (@ 10^8 cells/ml). The pre-incubated explants were immersed in bacterial suspension for 15, 30, 45 and 60 seconds for infection and co-cultivated on shoot regeneration medium for different intervals of 24, 48, 72 and 96 h to study the effect of co-cultivation on transformation frequency (*BT, Nauni*).

- ❖ Isolation and identification of causal fungus (*F. oxysporum* f. sp. *lycopersici*) was done from the collar region of tomato showing the Fusarium wilt symptoms on PDA and studied the morphological characters of the fungus. For authentication of the causal organism, genomic DNA was isolated and a region of the nuclear rDNA gene containing ITS region was amplified (700 bp) by PCR using ITS1 and ITS4 primers.

Potato

- ❖ For carrying out *in vitro* cell line selection experiments, calli grown under control experiments was further cultured on selective medium containing defined concentrations of culture filtrate (0-50%, v/v). The observations with respect to per cent survival of callus and

organogenesis etc. are underway. An annexin gene from potato was cloned and a binary vector construct for its overexpression in potato was developed. This construct was used for transformation of potato variety Kufri Chandramukhi. Transformants were screened for the presence of npt II gene by PCR. Five lines out of 71 screened were positive for npt II were further subcultured (*BT, Nauni*).



Agrobacterium mediated transformation of potato: a) Internodes kept on preculture media after cocultivation b) Explants on selective media after 20 days c) Explants after 65 days d) Explants after 90 days e) The regenerated plantlets

- ❖ Forty three isoforms of HSFs in tomato were downloaded from NCBI and out of these 8 gene isoforms (HT2C, HT3A, HT4C, HT6C, HT7C, HT8C, HT9A & HT10A) were partially amplified and are being cloned. For cloning of these genes Linearized pMiniT 2.0 vector and NEB® 10-beta Competent *E. coli* cells provided in



NEB® PCR cloning kit are being used. (*BT, Nauni*).

- ❖ Treatment involving seed priming with Seed Pro @ 4g/ kg of seed followed by soil application of Seed Pro @ 10g/kg of soil while filling of pro trays and soil drenching of Seed Pro @5% after seed germination followed by covering with 50-mesh nylon net of nursery bed supplemented with border row planting (2 rows) of maize at least 15 days before transplanting of seedlings in the main field followed by seedling dip with 0.1% (carbendazim 12% + mancozeb 63% WP) at the time of transplanting and sequential spraying with acephate 75% WP @1.5g/l on 10 DAT, fipronil 5% SC @1.5ml/l on 20 DAT, copper hydroxide 77% WP (2.0g/l) on 25 DAT, imidacloprid 70% WG @2g/15l on 40 DAT, fenamidone 10% + mancozeb 50% WDG (0.25%) two to three times from 45 DAT at 10 days intervals was found cost effective (1:6.16) in the management of economically important fungal, bacterial and viral diseases of tomato and in maximizing the fruit yield (385.2q/ha) (*VS, Nauni*).
- ❖ Seedling dip treatment with potassium chloride at 300 and 200 mM concentration were most effective in managing the bacterial wilt of tomato with minimum disease incidence of 24.44 and 31.11 per cent and maximum disease control of 70.27 and 62.16 per cent, respectively under pot culture conditions. Similarly, two foliar sprays at seven days with potassium chloride at 300 mM was also effective in reducing the disease to 40.54 per cent with 48.88 per cent disease incidence compared to 82.21 per cent disease incidence in control under pot culture conditions (*COH&F, Neri*).
- ❖ Potassium chloride and oxalic acid @ 300 mM and 20mM concentration were most effective in managing bacterial wilt of tomato with maximum disease control of 70.2 and 56.7 per cent, respectively. No disease incidence was recorded when consortium of biocontrol agents namely *Bacillus subtilis*, *Pseudomonas fluorescens* and *Trichoderma viride* was applied (*PP, Nauni*).
- ❖ The initial residues of spirotetramat, a component of Movento Energy, on tomato fruits were 0.462 and 0.903 mg kg⁻¹ whereas, the initial residues of imidacloprid, the second component of Movento Energy, on tomato fruits were 0.513 and 1.00 mg kg⁻¹ at the application rate of 75 g a.i./ha and 150 g a.i./ha, respectively (*Ento, Nauni*).
- ❖ In management of insect-pests of tomato trial, on the basis of three years pooled data, erection of yellow sticky traps (1-2 @ 5 -100 m²+ foliar spray of imidacloprid 200 SL @ 0.5 ml/l at 20 and 30 DAT + spray (mixture of malathion 2 ml and 10 g jaggery or gur in 1 litre after flowering + spray of chlorantraniliprole 18.5 SC/rynaxypyr 20 EC @ 0.5 ml/l at 15 days interval at the initiation of flowering + spray fenazaquin 10 EC @ 2 ml at the appearance of mite was the best amongst all treatments controlling the insect pests and higher production to the tune of 452.99 q/ha vis a vis untreated control (403.33 q/ha) (*VS, Nauni*).
- ❖ Bio-intensive Integrated Pest Management (BIPM) module comprising of pheromone trap (PCI), six releases of *Trichogramma achaeae* @ 50000/ha, two sprays of azadirachtin 1500ppm @ 2ml/L, one spray of *Lecanicillium lecanii* (5g/L of 10³ conidia/g) was developed for the management of *Tuta absoluta* in tomato. The pest incidence was 1.6, 1.8 and 5.2 mines per leaf and 1.12, 1.24 and 4.57 per cent fruit infestation in BIPM, chemical and control plots, respectively (*Ento, Nauni*).
- ❖ The incidence of new invasive insect i.e. tomato pinworm (*Tuta absoluta*) was recorded at different locations in Solan district of Himachal Pradesh. The variation has been observed in its infestation level at different stages and at different places thereby affecting the crop production. At Dharampur, the number of live mines/plant varied between 6.7 to 13.5 and at Solan it was between 1.8 to 10.6 and at Kandaghat it ranged between 1.2 to 7.9. Similarly, the number of shoots damaged and number of fruit damaged per plant varied at these places. Subsequently the crop yield was highest (404.24 q/ha) in Kandaghat and minimum (398.76 q/ha) in Dharampur area due to different infestation level of *Tuta absoluta*. However, the incidence of the insect was prevalent in all the surveyed locations (*SS&T, Nauni*).
- ❖ The initial residues of tebuconazole on tomato fruits were 1.129 and 2.213 mg kg⁻¹ at the application rate of 268.75 g a.i./ha and 537.50 g



- a.i./ha, respectively. Half life values (RL_{50}) were calculated to be 1.3 and 1.4 days, at respective doses (*Ento, Nauni*).
- ❖ Fame Quick (flubendiamide 90 + deltamethrin 60 SC) was applied @ 400 ml/ha and 800 ml/ha on the chilli, okra and tomato crops to study its persistence. Half life values (RL_{50}) for flubendiamide were calculated to be 1.8 and 1.7 days, 3.3 and 3.6 days and 1.9 and 2.3 days in chilli, okra and tomato, respectively. For deltamethrin, half life values were 1.9 and 2.2 days in chilli, 1.8 and 2.3 days in okra and 1.5 and 1.7 days in tomato. Estimation of flubendiamide and deltamethrin residues in chilli, okra and tomato cropped soil at harvest revealed residues below Limit of Quantification (*Ento, Nauni*).
- ❖ Persistence of Flint Pro (trifloxystrobin + propineb) on chilli (trifloxystrobin @ 70 & 140 g a.i./ha and propineb @ 1226 & 2452 g a.i./ha) and tomato (trifloxystrobin @ 61.25 & 122.5 g a.i./ha and propineb @ 1072.75 & 2145.50 g a.i./ha) was studied. The residues of trifloxystrobin and propineb were found below Limit of Quantification (<0.05 mg/kg) at 10 and 15 days after last application of X and 2X dose in both the fruits, respectively. Harvest time residues of trifloxystrobin, its metabolite CGA-321113 and propineb in red chilli fruits, chilli and tomato cropped soil were below the Limit of Quantification (<0.05 mg/kg) (*Ento, Nauni*).
- ❖ GPI 1316 (novaluron + lambda-cyhalothrin) was applied on cabbage and tomato at the application rate of 750 ml ha⁻¹ and 1500 ml ha⁻¹, the initial deposits of novaluron were 1.130 and 2.209 mg kg⁻¹ on cabbage heads & 0.576 and 1.241 mg kg⁻¹ on tomato fruits and of lambda-cyhalothrin were 0.487 and 0.933 mg kg⁻¹ & 0.282 and 0.531 mg kg⁻¹ in cabbage and tomato, respectively (*Ento, Nauni*).
- ❖ All the agroclimatic zones of the state were surveyed for alien invasive pest, *Tuta absoluta*. The pest was recorded in all the tomato growing areas of the state with 38 to 79 per cent infested plants, 0-7 mines/leaf/infested plant and 0-5 per cent fruit damage. During the survey, a mirid predatory bug, *Nesidiocoris tenuis* was recorded preying on eggs and early instars of the leaf miner (*Ento, Nauni*).

- ❖ Farmers attitude towards hybrid seeds of vegetable crops in Bhoranj block of Hamirpur district was studied. It was observed that farmers preferred branded hybrid seeds. Sources of information regarding the use of hybrid seeds were neighbour, other farmers and retailers. Germination, prices, availability and quality of hybrid seeds were the main factors affecting farmers purchasing behaviour. Majority of farmers preferred hybrid seeds and purchased it one week before the sowing period. Majority of farmers were satisfied with the production, quality and availability aspects of hybrid seeds. But the farmers were less satisfied with the prices of hybrid seeds as they were very costly (*BM, Nauni*).

Pea

- ❖ Germplasm of pea consisting of early and mid season pureline varieties have been maintained. Out of the various cross combinations attempted the generation of the cross 'Green Pearl' x 'DPP 9414', which has shown high pod yield as well as field resistance to powdery mildew disease is being standardized for development of pure lines (*RHR&TS, Bajaura*).
- ❖ Effect of different row spacing on green pea production showed that the highest per cent germination in field and maximum number of pods per plant were found in row spacing of 60 cm with seed rate 75 kg/ha. Highest pod yield per block (kg) and pod yield per ha was recorded with row spacing of 22.5 cm with seed rate 150 kg/ha. Same treatment combination recorded the maximum benefit cost ratio of 4.27 (*RHR&TS and KVK, Sharbo*).
- ❖ An experiment was conducted to study the effect of biofertilizers on green pod yield and shelling percentage of pea, which increased with the inoculation of *Pseudomonas* UN7 integrated with different NPK combinations compared to either sole application of Talc, FYM or combinations of both (Talc + FYM). The treatment FYM + NPK₅₀ + *Pseudomonas* UN7 recorded the highest green pod yield, plant height and shelling percentage of (102.16 q/ha), (39.33 q/ha) and (39.50 q/ha) respectively. The lowest green pod yield (30.36 q/ha) was recorded when the plots were supplemented with talc (control). The above

treatments thus resulted in saving of 50 % NPK fertilizers (*RHR&TS and KVK, Sharbo*).

- ❖ The experiment comprised of thirteen seed priming treatments which indicated that priming of sweet pea seeds with GA₃ @ 100 ppm gave significant improvement in comparison to control and other priming treatments w.r.t. various seed yield and quality parameters of sweet pea (*SS&T, Nauni*).
- ❖ Infestation of pea leaf miner (*Chromatomyia horticola*) was observed in the pea crop grown under open field conditions. The two pea cultivars JS-1 and JS-2 were compared against infestation of this pest. JS-1 showed 10-15 per cent infestation whereas, JS-2 showed 15-25% infestation (*RHR&TS, Jachh*).



Leaf miner damage in pea crop

- ❖ The initial deposits of tebuconazole in immature pods with succulent seeds and in succulent seeds (shelled) due to the application of Nativo on pea crop were 0.724 and 0.084 and 1.545 and 0.131 mg kg⁻¹ at the application rate of 175 g ha⁻¹ and 350 g ha⁻¹, respectively. Whereas, the initial deposits of trifloxystrobin, in immature pods with succulent seeds and in succulent seeds (shelled) were 0.527 & 0.053 and 1.044 & 0.086 mg kg⁻¹ at the application rate of 87.5 g a.i. ha⁻¹ and 175 g a.i. ha⁻¹, respectively (*Ento, Nauni*).
- ❖ The residues of Imidacloprid (Gaucho 600 FS) on green pea leaves after 20 days of seed treatment were 0.958 and 2.091 mg kg⁻¹ at the application rate of 1.8g a.i./kg seeds and 3.6 g a.i./kg seeds, respectively. The residues were found below the limit of quantification (<0.05 mg/kg) after 30 days of first sampling (*Ento, Nauni*).

Cauliflower

- ❖ In mid season cauliflower group, the new evolving varieties viz; 2017/CAUMVAR-4 (243.8q/ha), 2018/CAUMVAR-7 (242.6q/ha), and 2016/CAUMVAR-5 (240.3q/ha) and hybrid; 2016/CAUHYB-10 (255.9q/ha) excelled in yield (*VS, Nauni*).

- ❖ The studies on nursery production of various cole crops and solanaceous crops utilizing *jeevamrit* was performed under polyhouse conditions. The seedlings were treated with "Beejamrit" by dipping for half an hour. It was found that there was less incidence of damping-off disease in the nursery. The seedlings sprayed twice with "Jeevamrit" at weekly intervals showed more growth and vigour in comparison to control (*RHR&TS, Jachh*).
- ❖ Rhizospheric soil samples from cauliflower plants collected from different locations in three representative blocks of the Hamirpur district of H. P. were used for obtaining bacterial isolates on nutrient agar by serial dilution agar plating method; 395 bacterial isolates obtained were screened for P-solubilisation on Pikovskaya's medium. Among all, only 65 isolates showed phosphate solubilizing activity at 28 °C after 72 h. The growth of many of these PSB isolates on Jensen's medium reflected their nitrogen fixing ability. Effect of different incubation temperatures viz. 25, 30, 35, 40 and 45 °C on phosphate solubilisation (plate assay) revealed that only one isolate could solubilize P at 40 °C and 45 °C. Some phosphate solubilizing bacterial isolates also showed siderophore production on CAS medium reflecting their additional plant growth promoting traits (*COH&F, Neri*).



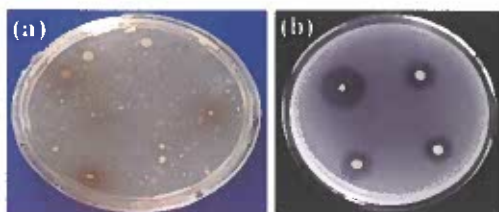
P-solubilisation by different isolates on Pikovskaya's agar



Chrome azurol S (CAS) plate assay for siderophore production

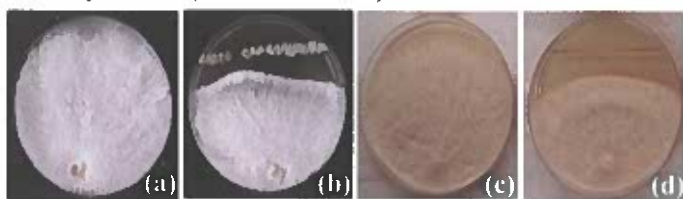
- ❖ Soil samples collected from rhizosphere soils were processed for the isolation of actinobacteria on actinomycetes isolation agar. Before processing, samples were air dried at room temperature for 10 days and then isolated using serial dilution agar plating method. A total of 54 isolates were obtained based on different morphological characters and screened for phosphate solubilization on Pikovskaya's agar by spot inoculation and incubated at 28 °C for 10

days. Among all, only 10 isolates were found positive for phosphate solubilization. The isolates showing highest clearance around the bacterial colonies were selected for further studies (*COH&F, Neri*).



(a) Isolation of actinobacteria on actinomycetes isolation agar; (b) phosphate solubilization shown by different actinobacteria

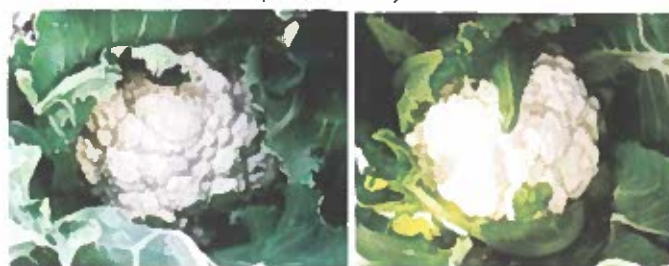
- ❖ The phosphate solubilizing actinobacteria were also studied for antagonistic activity against *Fusarium oxysporum* and *Sclerotinia* sp. All the isolates having phosphate solubilizing ability showed significant inhibition of the mycelial growth by overgrowing the pathogenic mycelium (*COH&F, Neri*).



Growth inhibition of fungal pathogens by different actinobacteria (a-b) *Fusarium oxysporum*; and (c-d) *Sclerotinia* sp

- ❖ Weekly sprays of cow urine based botanical formulation comprising of *Vitex negundo*, *Roylea elegans*, *Aloe vera*, *Melia azedarach* and *Cymbopogon citrates* was found effective for the management of black rot of cauliflower and other foliar diseases with yield of 308 quintals/ha which was more than 16 per cent in comparison to control. (*PP, Nauni*).
- ❖ Twenty-one CMS based cross combinations of late maturity group of cauliflower were evaluated along with national checks; PSB Hybrid-1 and Sweta. The top ranking four hybrids identified in term of heterotic effects (17.7 to 51.3%), curd yield and other marketable quality traits were; UHFCAUH-27 (51.3 t/ha) UHFCAUH-31 (49.2t/ha), UHFCAUH-22 (48.3t/ha) and UHFCAUH-13 (48.1t/ha). Twenty CMS based F₁ hybrids of late maturity group along with two checks (PSB Hybrid-1 and Casper RZ) developed

by IARI RS Katrain (Kullu) were also evaluated. As many as eight hybrids viz; KTCH-17 (51.3t/ha), KTCH-20 (50.7t/ha), KTCH-18 (50.1t/ha), KTCH-2 (49.6 t/ha), KTCH-10 (49.2t/ha), KTCH-13 (48.9t/ha) and KTCH-14 (48.9t/ha) being at par in performance amongst themselves, were most heterotic and promising in term of yield and quality attributes vis-a-vis national checks (*VS, Nauni*).



UHFCAUH-27

(UHF-CAU-CMS-1 × Snowball Super)

UHFCAUH-31

(UHF-CAU-CMS-1 × Early Snowball)



UHFCAUH-13

(UHF-CAU-CMS-1 × Pusa Himjyoti)

UHFCAUH-22

(UHF-CAU-CMS-1 × Olympus)

- ❖ Eight genotypes of cauliflower were evaluated for their performance. Palam Uphar and Megha cultivars were found high yielding and gave higher yield of better quality curds (195.94 and 210.7 q/ha, respectively). Curd compactness as well as the colour of the curd was found optimum in Megha as compared to Palm Uphar (*RHR&TS, Jachh*).



- ❖ Water requirement of cauliflower under drip irrigation system recorded highest yield (261.1 qha⁻¹), water use efficiency (19.9 qha⁻¹ cm⁻¹), net income (Rs. 3.62 lakhs ha⁻¹), B:C ratio (3.28) and least water requirement (13.13 cm) in the treatment with irrigation level @ 0.6 ET_c in conjunction with black plastic mulch. This



treatment also recorded 55 per cent savings in irrigation water under drip irrigation over surface irrigation without plastic mulch (*SSWM, Nauni*).

- ❖ The recommended integrated package of fertilization (FYM 250q + 125kg N, 75 kg P and 65 kg K/ha) with an yield potential of 225.14q/ha when substituted with an absolute organic composition viz; 250q FYM through FYM (50 %) and remaining 50 % FYM through vermicompost on N equivalence basis at time of field preparation + recommended dose of NPK through FYM on N equivalent basis (207.04q/ha), the later (absolute organic module) was found equally effective to the former i.e. recommended integrated practice and therefore, could be suggested for sustainable cultivation of cauliflower in the state (*VS, Nauni*).

Cabbage

- ❖ The variety; 2018/CABVAR-3(459.92q/ha) out-yielded the standard check i.e. KGMR-1 (322.72 q/ha) by registering an increased yield of 42.51 per cent(*VS, Nauni*).
- ❖ Among eighteen genotypes of cabbage evaluated, cv. Harit was found promising for growing in low hill conditions and gave the highest yield (342.59 q/ha) followed by Golden Acre (311.11 q/ha) when seedlings were planted during the first week of October. Head compactness was also found best and there was no incidence of any disease on the crop (*RHR&TS, Jachh*).
- ❖ Among different abiotic resistance-inducers evaluated under pot culture conditions against black rot of cabbage, foliar spray after one week of transplanting with salicylic acid at 20 mM was found most effective in managing the disease and increasing plant height. Three foliar spray of salicylic acid (20 mM) at ten days interval resulted in minimum disease incidence of 10.10 per cent and minimum per cent disease index of 10.01 compared to 44.37 per cent disease incidence and 28.75 per cent disease index in control. This treatment also gave maximum yield of 7.73 kg/plot compared to 5.36 kg/plot in control under field conditions (*COH&F, Neri*).
- ❖ In an experiment on eco-friendly management of insect-pests of cabbage, out of eight different treatments; Difenthiuron 50 WP @ 1g/l found best in controlling the population of aphids/plants infesting cabbage and it decreased significantly ranging from 7.24 to 19.6 per cent in comparison to untreated control (60.24). Resultantly significant higher yield of 233.93 q/ha was also recorded (*VS, Nauni*).
- ❖ The relative toxicity of five insecticides viz. carbaryl, chlorfenapyr, chlorpyrifos, fipronil and novaluron was tested against the 3rd instar larvae of diamond back moth, *Plutella xylostella* collected from five different locations viz. Nauni (1,300m amsl), Keylong (3,080m amsl), Shamshabad (574m amsl), Medak (442m amsl) and Bengaluru (920m amsl). The LC₅₀ values of different insecticides were 128.1785, 7.089, 434.717, 1.214 and 512.939 ppm for Nauni populations, 208.688, 3.168, 485.202, 0.622 and 305.079 ppm for Keylong populations, 378.054, 14.036, 321.823, 0.878 and 437.033 ppm for Shamshabad populations and 97.279, 20.334, 452.667, 2.406 and 354.722 ppm for Medak populations and 197.450, 36.235, 341.507, 1.153 and 515.776 ppm for Bengaluru population, respectively. The results revealed that among five evaluated insecticides, fipronil was found to be the superior most against diamondback moth collected from different locations(*Ento, Nauni*).
- ❖ Six pesticides viz. malathion, *Bacillus thuringiensis* (Bt.), *Beauveria bassiana*, neem seed kernel extract, drake seed extract and jeevamrit were evaluated for their efficacy against the larvae of cabbage butterfly. The order of effectiveness of insecticides based on mortality of the larvae was malathion (0.1%) > malathion (0.05%) > *Bacillus thuringiensis* (0.2%) > *Bacillus thuringiensis* (0.1%) > *Beauveria bassiana* (2.0%) > Neem seed kernel extract (8.0%) > *Beauveria bassiana* (1.0%) > Neem seed kernel extract (4.0%) > Drake seed extract (10%) > Jeevamrit (20%), Drake seed extract (5.0%) > jeevamrit (10%), respectively(*Ento, Nauni*).
- ❖ Tobacco caterpillar (*Spodoptera litura*) was found to be infesting the cabbage crop where infestation to the tune of 10-15 per cent was observed (*RHR&TS, Jachh*).



Tobacco caterpillar (*Spodoptera litura*) on cabbage

Okra

- ❖ The study was carried out on effect of GA₃ foliar spray at 150, 100, 50, 25 ppm at 30, 45 and 60 days after germination. The results revealed that minimum no. of days (38.33) to 50% flowering were taken by the treatment of GA₃ 150 ppm spray at 30 days after germination. The maximum days (52.00) to 50% flowering were taken by control (no spray). Similarly, minimum days to pod maturity (52.22) and maximum fruit length (16.58 cm) were also taken by the treatment of GA₃ 150 ppm at 30 days after germination. In case of fruit yield attributes maximum no. of fruits per plant (14.13) were recorded in the treatment of GA₃ 150 ppm at 45 days after germination spray resulting in maximum fruit yield (71.07 g/plant), (1.28 kg/plot) and (29.63 q/ha). Maximum no. of seeds per fruit (62.34), seed yield g/plant (33.82 g), kg/plot (0.61 kg) and q/ha (14.04 q) was obtained in the treatment GA₃ 150 ppm at 60 days after germination spray (*SS&T, Nauni*).
- ❖ The studies were conducted with okra cv. P-8 to standardize the best hydropriming duration and concentration of the osmopriming material (PEG 6000) for fresh crop production. Based on the observations on per cent increase in weight, germination percentage, seedling length, seedling dry weight and seed vigour index-I and II, hydropriming duration of 24 hours was found the best. In field experiment, osmopriming with PEG 6000 (-0.5 M Pa) for 24 hours was found as the best treatment in reducing the days to 50 per cent emergence (5.00) and first fruit picking (57.53), while increasing total field emergence (86.65%), plant height at 30 days after sowing (49.16 cm) and at final harvest (192.42 cm), harvest duration (48.00 days), number of fruits per plant (19.56) and fruit yield per hectare (148.96 q). The seed storage studies revealed that PEG 6000 (-0.5 M Pa) for 24 hours resulted in significantly higher

speed of germination, germination percentage, seedling length, seedling dry weight, seed vigour index-I and vigour-index-II at 7 days after priming and the corresponding values for all the parameters decreased with every successive period of storage (*SS&T, Nauni*).

- ❖ Out of three cultivars of okra viz. P-8, Arka Anamika and Indranil Improved evaluated for their performance under zero budget natural farming. Indranil Improved gave the highest yield (129.3 q/ha) as compared to P-8 and Arka Anamika. Fruit quality was also found better in all the cultivars when compared with crop grown in general where all inorganic treatments were applied (*RHR&TS, Jachh*).



Brinjal

- ❖ In brinjal, 3 elite purple long fruited entries namely; 2016/BRLVAR-2(184.63q/ha), 2016/BRLVAR-4 (183.65q/ ha) and 2016/BRLVAR-1 (183.64q/ha) had performed exceedingly well as exhibited through their highest yield potential over other tested varieties and standard national check (*VS, Nauni*).
- ❖ Among the various genotypes of brinjal evaluated for their performance under low hill conditions of the state, three genotypes viz. PPR, Rubeena, and PPL were found best for cultivation and gave higher fruit yield 310.00, 296.60 and 270.10 q/ha, respectively, when planted during the second fortnight of March, 2018. Pusa Purple Cluster bear maximum number of fruits (24.3). Incidence of *Phomopsis* blight was also found minimum in these cultivars. Ten hybrids of brinjal were evaluated for different horticultural traits and yield parameters in lower hill conditions. The maximum fruit yield obtained in hybrid Aruna (0.821 kg/plant) followed by Swarna Shree (0.785 kg/plant) in low hill conditions of the state (*RHR&TS, Jachh*).



- ❖ When Nativo (tebuconazole + trifloxystrobin) was sprayed on brinjal @ 175+87.5 g a.i./ha and 350+175 g a.i./ha, the initial deposits of tebuconazole were 0.598 and 1.281 mg kg⁻¹ and 0.537 and 0.918 mg kg⁻¹ of trifloxystrobin on brinjal fruits at respective doses (*Ento, Nauni*).
- ❖ Application of Avancer Glow on tomato fruits at the rate of 1500 g ha⁻¹ and 3000 g ha⁻¹, yields 1.533 and 3.049 mg kg⁻¹ & 1.274 and 2.411 mg kg⁻¹, initial deposits of azoxystrobin and mancozeb, respectively (*Ento, Nauni*).

French bean

- ❖ Conjoint application of 75 % NPK + 25 % N through vermicompost produced significantly highest number of pods per plant (30.23), average pod weight (5.50g) and marketable pod yield (134.81q/ha) in French bean (*VS, Nauni*).
- ❖ Effect of organic nutrient sources on growth, yield and quality of French bean, revealed that the application of 90 per cent of recommended doses of nutrients on the basis of nitrogen equivalence through vermicompost and poultry manure in a 50:50 ratio along with the application of liquid organic formulations i.e., Panchgavya and Jeevamrut @ 5 per cent each, significantly increased the growth, yield and pod quality parameters and available macro and micronutrients, microbial count, microbial biomass and soil enzymes (*SSWM, Nauni*).
- ❖ French bean seed crop cv. Contender was grown under natural farming system. The initial germination and growth was same in comparison to chemical system. The intensity of some diseases like rusts (28.4%) and angular leaf spot (15.8%) was comparatively more as compared to chemical system. In natural system attack of insects like leaf miner (12.3%) was also observed more as compared to chemical farming. The seed yield per plot was observed less (627.5g) in natural farming system as compared to chemical farming system (730g) (*SS&T, Nauni*).
- ❖ The seeds were collected from the French bean plants infected with *Rhizoctonia solani* under six different categories based on their infection level. The results of the experiment revealed significantly higher values w.r.t. normal seedlings (87.75%), seedling establishment

(98.00%), seedling emergence (98.00%) and speed of emergence (2.71) in the plants raised from the seeds taken from infection level of leaves apparently free from spots or very few minute spots less than 5 in number. Further, as the infection level of the plants with *R. solani* increased the seed quality/ and health parameters were reduced significantly. As the infection level of the plants with *R. solani* increased, the seed infection with *R. solani* and other pathogens was also increased (*SS&T, Nauni*).



French bean pods, leaves and seeds showing infection of *Rhizoctonia solani*

- ❖ Five genotypes such as EC -755318, EC-400442, EC-400406, EC-400390 and EC-405210 of French bean showed resistance reaction against bean rust and can be exploited in breeding programme (*PP, Nauni*).
- ❖ Effective management strategy has been developed against bean rust. In screening of the germplasm lines/ cultivars against the disease, 31 were found resistant. Four sprays of azoxystrobin (0.1 %) with plant spacing of 45 × 15 cm were found effective for the management of the disease. In integrated disease management, treatment comprising of seed treatment with azoxystrobin (0.1%) followed by foliar spray with the potassium dihydrogen phosphate (200mM) after 15-20 days of sowing followed by foliar spray with azoxystrobin at disease initiation, followed by alternate foliar spray with Neemajal (2%) and azoxystrobin at 7 days interval was found most effective in reducing the bean rust severity (*PP, Nauni*).
- ❖ Root knot nematode, *Meloidogyne* sp. was found most predominant nematode species on vegetable crops in Hamirpur district with population ranging from 60-840 J2 per 200 cc soil. Whereas, root knot nematode, *Meloidogyne* sp. and spiral nematode, *Helicotylenchus* sp. were recorded



important nematodes on pomegranate in Kullu district. Low populations of *Helicotylenchus*, *Pratylenchus*, *Hoplolaimus* and *Xiphinema* were recorded on fruit crops in Chamba district (*Ento, Nauni*).

Chilli

- ❖ Four local selected strains of chillies (LC-1, LC-2, LC3 and LC-4) were selected from a pool of chilli germplasm and evaluated for different horticultural traits and yield parameters under lower hill conditions. The maximum fruit yield was obtained in LC-1 (135.2 q/ha.) followed by LC-4 (128.3 q/ha.) (*RHR&TS, Jachh*).
- ❖ Two genic male sterile lines of chilli, carrying *msms* gene, named DKC-12 (MS-12) and DKC-2363 along-with four lines of bell-pepper, carrying *Nmsms* gene, are being maintained by practising selfing. The population mean for the trait was 65.76 ± 1.71 ranging from 33.87 to 97.27. Maximum numbers of fruits per plant were recorded in genotype RACH-132 (97.27) which was superior to the check variety by 16.6%. Significant differences were observed among the genotypes which ranged from 1.92g to 4.08 g and the population mean for this trait was 2.78 ± 0.08 g. RACH-132 recorded the highest value of fruit weight at edible maturity (4.08 g) which was 53.9% higher than the check variety (*RHR&TS, Dhaulakuan*).
- ❖ Treatment involving application of neem cake @1.0kg/m² in the seed bed, spraying of Cyzpyr @1.8ml/liter 2-3 days before transplanting, seed treatment with imidacloprid @8g/kg, seedling dip of imidacloprid @0.5ml/L and growing of two rows of maize as border crop in the main field along with sliver agrimulch sheet + rotational spraying of insecticides (acephate @1.5g/L+ neem oil @2.0ml/L) followed by (fipronil @1.0 ml/L+ neem oil @ 2.0ml/L), (imidacloprid @2 g/15L+neem oil @2.0ml/L) and (cyazypyr @1.8ml/L) at 7 days interval till fruit formation was found cost effective (1:3.42) and significantly reduced chilli leaf curl disease, white fly and thrips populations beside increasing the fruit yield (123.82q/ha) (*VS, Nauni*).

- ❖ Analysis of green chilli fruits after drenching of soil with Lesenta @ 500 g and 1000g formulation/ha, revealed that residues of imidacloprid, fipronil and its metabolites (fipronil desulfinyl, fipronil sulfide and fipronil sulfone) were not detected in 0 and 1 day sampled chilli fruits but detected in 3rd day sampled fruits (*Ento, Nauni*).

Ginger

- ❖ A study on effect of maturity i. e. days to harvesting after planting on yield and quality of ginger variety Solan Giriganga concluded that quality characters like essential oil and oleoresin content increased with maturity up to 180 DAP with slight to significant decrease afterwards suggesting thereby to harvest ginger 180 days after planting for maximum availability of these quality attributes in ginger rhizomes (*VS, Nauni*).
- ❖ Use of PGPR formulation viz; combined treatments of talc formulation of *Trichoderma* and talc formulation of GRB 35 talc formulation on three genotypes of ginger i.e. Himgiri, LC-1 and LC-2 resulted in increased growth and yield (93.08 q/ha) along with reduced incidence of rhizome rot (13.87 %) vis a vis corresponding values of 78.80 q/ha and 19.50 per cent, respectively observed in untreated control (*VS, Nauni*).
- ❖ An experiment was conducted under solarized and non-solarized conditions followed by application of calcium chloride, copper oxychloride and a biocontrol agent. In solarized conditions, application of calcium chloride was found most effective in term of fresh rhizome yield and dry rhizome yield along with other quality attributes and reduced incidence of disease followed by copper oxychloride, while, biocontrol agent influenced these horticultural attributes and incidence of bacterial wilt in ginger (*VS, Nauni*).
- ❖ Crop residues of mustard and cabbage incorporated in soil and rhizome treatment with metalaxyl + mancozeb 1.25 g/litre of water for 15-20 minutes resulted in reduction of incidence of rhizome rot of ginger by 50-75 per cent (*VS, Nauni*).

- ❖ Ginger variety Solan Giriganga recommended at national level, developed through clonal selection method from local germplasm of trans-Giri area of Sirmour which has plumpy and bold attractive rhizomes having high quality attributes, average yield 18-19 t/ha, variety is quite suitable for cultivation in mid and foot hills of Western and Eastern Himalayan Regions and Lower Gangetic Plain Region of India (*VS, Nauni*).



Ginger cv. Solan Giriganga

- ❖ In total, 282 bacterial isolates were isolated from rhizosphere and endosphere of ginger from different sites of Solan and Sirmour distt. and screened for plant growth promoting activities. Out of total, 11 potential bacterial isolates viz. CR-9, CR-20, ER-5, FS-23, GS-15, GS-16, HER-9, HER-11, HER-20, IS-2 and IS-19 were selected for evaluation of plant growth promoting activity on ginger under glass house conditions followed by field trials. Phenotypic, biochemical and genotypic characterization of the selected bacterial isolates was also done (*BS, Nauni*).
- ❖ Ginger cultivar 'Himgiri' was propagated *in vitro* by culturing the bud sprouts from rhizome on MS culture medium fortified with growth regulators. Maximum establishment of 80.19 per cent was obtained in medium fortified with 1.0 mg/l BA and 0.1 mg/l NAA, whereas the buds failed to respond on MS basal medium. Vegetative buds sprouted to form shoots after 3 weeks of inoculation and proliferated into multiple shoots after 5 weeks on the same medium. The highest *in vitro* shoot multiplication of 5.2 shoots per explant was obtained on MS medium fortified with 0.5 mg/l BA, 0.1 mg/l NAA. Shoot multiplication rate showed an increase with the

increase in number of subculturings which increased to a maximal of 1:15 after eighth passage. The effect of subculturing was also observed on per cent rooting. It was observed that per cent rooting showed an increasing trend from 0 to 100 per cent in first and sixth subculturing. Biochemical analysis of rhizomes was conducted to compare it with conventionally propagated rhizomes. The essential oil content was similar in both the rhizomes whereas, the content of oleoresin was more in tissue culture propagated rhizomes. Apart from it, tissue culture raised ginger had lower crude fibre as compared to control which is a desirable feature (*BT, Nauni*).



In vitro bud establishment (a) hardening (b), one year old hardened plants (c) and harvested rhizomes (d) of Ginger var. Himgiri

Garlic

- ❖ Strains of garlic were collected from different places in Kullu valley and evaluated alongwith the existing variety Agrifound Parvati and one strain collected from village Hurla which gave high bulb yield as well as bigger clove size under multi-location trials in Kullu valley (*RHR&TS, Bajaura*).
- ❖ Application of 50 % recommended FYM (125 q/ha) + remaining 50 % FYM through vermi compost on N equivalence basis at the time of field preparation + 50% RDF (NPK) and application of Jeevamrit (fortnight application) produced garlic bulbs @ 235 q/ha and return @1:1.62 vis-a-vis recommended package of fertilization (159q/ha and 1:0.98)(*VS, Nauni*).

- ❖ Three foliar sprays of Folicur (tebuconazole) @ 0.1 per cent at ten days interval started with the initiation of disease, effectively controlled *Stemphylium* blight of garlic (71.5%) and enhanced the bulb yield (145.7q/ha) with incremental cost benefit ratio of 1:19.1 (PP, Nauni).

Onion

- ❖ The study on effect of different size of setts on yield and quality of onion was conducted during kharif season 2018. The setts were categorized into four grades viz. 1-1.5cm, 1.5-2.0cm, 2.0-2.5cm, and > 2.5cm on the basis of size. Results from this experiment revealed that setts of the size 1.5-2.0 cm showed higher yield, medium bulb size, less bolting and doubling. The setts below 1.5 cm were slower in germination and produced smaller sized bulbs, whereas the bulbs of more than 2 cm diameter produced big bulbs with high neck thickness. These large sized bulbs were found prone to splitting, doubles, triplets and early bolting which are undesirable traits (COH&F, Neri).



- ❖ The kharif onion cultivar N-53 gave increased production of green onion during off-season in the month of November and December. An yield of 185.8 q/ha was recorded during the month of

November when sets were planted during the first week of September under sub-tropical conditions (RHR&TS, Jachh).

- ❖ Downy mildew of onion is a serious disease in low lying areas. The congenial temperature for the disease was found to be 15°C accompanied with relative humidity of more than 95 per cent for its development. Three protective sprays of Chitosan, a SAR chemical (at 3-4 leaf stage followed by two sprays after disease appearance), Ridomil Gold and Cabrio Top at 15 days interval starting with onset of the disease were effective to manage the downy mildew disease of onion (PP, Nauni).
- ❖ Four foliar sprays of Cabrio Top (metiram + pyraclostrobin) @ 0.2 per cent at ten days interval started with the initiation of disease, effectively controlled purple blotch of onion and enhanced the bulb yield (PP, Nauni).
- ❖ Solomon (beta cyfluthrin + imidacloprid) was applied @ 500 ml/ha and 1000 ml/ha on the onion crop and yields 0.848 and 1.725 mg kg⁻¹ initial residues of beta-cyfluthrin. The initial residues of imidacloprid on whole onion plant were 0.726 and 1.507 mg kg⁻¹ (Ento, Nauni).

Cucumber

- ❖ The hybrids viz. 2016/CUCUHYB-5 (309.06q/ha), 2015/CUCUHYB-3 (302.42q/ha) and 2017/CUCUHYB-2 (292.21q/ha) ranked top with their respective yield potential vis a vis other entries and standard national checks, it was elite breeding line; 2016/BOGVAR-3 which exhibited significantly highest marketable yield potential of 394.04q/ha in bottle gourd (VS, Nauni).
- ❖ In a hybrid development programme in cucumber, cross combinations viz. P₁₂ × L₃, P₁₃ × L₃, P₁₁ × L₃, P₁₁ × L₁ and P₈ × L₃ developed through triple test cross analysis were field evaluated for yield and component traits. The cross combinations viz; P₁₃ × L₃ (451.84q/ha) and P₁₁ × L₁ (408.32 q/ha) beside high heterotic effects, also depicted high mean values for fruit yield and other marketable quality trait under study and registered 44.08 and 30.26 per cent increase in yield, respectively over national check Pusa Sanyog (313.60 q/ha) (VS, Nauni).



P₁₃ x L₃
(451.84q/ha)

P₁₁ x L₁
(408.32q/ha)

Pusa sanyog
(313.60q/ha)

- ❖ Cucumber cv. Solan Srijan has been developed which is a prolific fruit bearer, which matures in 55-60 days after sowing. Fruits are cylindrical, crispy, green in colour having 18-22 cm length with average fruit weight of 255-265g. It bears around 10-15 fruits per plants and having harvest duration of about 25-28 days. Average marketable fruit yield per hectare is 200-225q/ha (About 12.5-18.5 % higher than K-75). This cultivar is also found resistant to attack of fruit fly (*VS, Nauni*).



Cucumber cv. Solan Srijan

- ❖ Amistar Top @ 0.1% evaluated against downy mildew of cucumber was found to be the most efficacious fungicide with minimum average disease severity of 10.33 per cent followed by Nativo @ 0.1% exhibiting disease severity of 14.00 per cent. Curzate 0.25% and Cabrio Top 0.15% were next in efficacy exhibiting 16.67 and 18.67 per cent av. disease severity, respectively. Maximum average fruit yield (2.58 kg/plant) was achieved in Amistar Top followed by Nativo (2.48 kg/plant) (*HR&TS and KVK, Kandaghat*).
- ❖ Under evaluation of different pest management modules in cucurbits trial, after three years of experimentation, it was observed that module; Seed treatment with thiamethoxam 70 WS 5-10 g/kg seed, removal of cotyledonary leaves 7 days

after germination, spraying emamectin benzoate 25 WG @ 0.4g/L, spraying neem oil 3000 ppm @ 5 ml/L, installation of cue lure traps @ 15/acre, spraying spinosad 45SC @ 0.3ml/L was found most effective in reducing the number of red pumpkin beetles or whiteflies. Similarly, highest yield of 170.39 q/ha was also obtained in the same treatment when compared with other and untreated control (141.01q/ha) (*VS, Nauni*).

- ❖ Application of Belt Expert @ of 60 g a.i. ha⁻¹ and 120 g a.i. ha⁻¹ on cucumber generates initial deposits 0.812 & 0.324 mg kg⁻¹ of flubendiamide and 1.214 and 0.609 mg kg⁻¹ of thiacloprid (*Ento, Nauni*).
- ❖ In ongoing fungicide testing trials on field evaluation, Bio-Dewcon @ 5000g/ha was found most effective against powdery mildew of cucumber and also improved fruit quality (*PP, Nauni*).
- ❖ Application of GPF 215 (azoxystrobin + tebuconazole + mancozeb) @ 2000g ha⁻¹ and 4000g ha⁻¹ on cucumber yields the initial deposits of 0.792 and 1.486 mg kg⁻¹ for azoxystrobin, 1.047 and 1.995 mg kg⁻¹ for tebuconazole and 1.575 and 3.231 mg kg⁻¹ for mancozeb (expressed in terms of CS₂) (*Ento, Nauni*).

Capsicum

- ❖ The, elite breeding line; 2015/CAPVAR-2 (252.58q/ha) and a hybrid; 2015/CAPHYB-3 (272.58q/ha) were adjudged most promising vis-a-vis their standard national check. Similarly, in chilli, hybrids 2017/CHIHBYB-2 (137.15q/ha) and 2016/CHIHBYB-3 (125.29q/ha) were rated best in class (*VS, Nauni*).
- ❖ For developing new open-pollinated varieties and hybrids in Red and Yellow sweet pepper and also standardizing their seed production technology for growing under protected conditions in case of Red sweet pepper six parents and their fifteen crosses (which were developed by crossing these six diverse red sweet pepper lines in diallel design) were evaluated for different horticultural and seed yield and quality traits. The analysis of variance indicated highly significant differences among the genotypes for all the traits studied. Experimental results revealed that two lines viz.,



RSPUHF-7 and RSPUHF-2 were found to be superior for earliness. Whereas, the parents RSPUHF-4 and RSPUHF-2 were superior on the basis of mean performance and general combining ability studies for fruit yield and seed component traits. Crosses RSPUHF-7 x RSPUHF-2 and RSPUHF-7 x RSPUHF-1 were found to be best for earliness. Three cross combinations viz., RSPUHF-3 x RSPUHF-2, RSPUHF-4 x RSPUHF-2 and RSPUHF-5 x RSPUHF-2 were found best on the basis of mean performance, heterosis studies and specific combining ability effects for fruit and seed yield traits (*SS&T, Nauni*).

- ❖ Bell pepper seed crop cv. Solan Bharpur was grown during 2018 following natural farming module. The plant growth was initially almost same under natural farming as well as chemical system but later in the month of July-August the crop grown under natural farming system was affected by fruit borer. The per cent infestation of fruit borer in natural farming system was 20 per cent as compared to 5 per cent in chemical system. The number of fruits harvested per plot (172.75) and seed yield per plot (142g) under natural farming system were also found lower as compared to chemical farming system i.e. 244.25 and 198g, respectively (*SS&T, Nauni*).
- ❖ The experiment was carried out to standardize the suitable time of pollination after emasculation to increase the hybrid seed yield and reduce the cost of production in capsicum. Two commercial varieties of bell pepper i.e. Solan Bharpur and California Wonder (CW) were crossed to identify the most efficient time of pollinating the stigma of the female parent for hybrid seed production. Pollination after 24 hours of emasculation in California Wonder x Solan Bharpur resulted in minimum number of days to fruit set after pollination (3.600), minimum number of days to ripe maturity after fruit set (50.667), maximum ripe fruit weight (26.140 g), maximum number of seeds per crossed fruit (353.49), maximum seed yield per plant (15.77 g) and maximum seed yield per hectare (1401.57 kg). Solan Bharpur x California Wonder took maximum days to fruit set when pollinated after 18 hours of emasculation (6.13). Ripe fruit weight is minimum for Solan Bharpur x California Wonder when pollinated immediately after emasculation in evening (16.68). Solan Bharpur X California Wonder when emasculated in the morning followed by immediate pollination took maximum number of days to ripe maturity after fruit set (69.00), had minimum number of seeds per crossed fruit (270.44), minimum seed yield per plant (7.16g) and minimum seed yield per hectare (636.44 kg). Both the hybrids i.e. California Wonder X Solan Bharpur and Solan Bharpur X California Wonder showed significant difference with respect to days to fruit set after pollination, days to ripe maturity after fruit set, ripe fruit weight, number of seeds per crossed fruit, seed yield per plant and seed yield per hectare. Therefore, it is concluded that California Wonder X Solan Bharpur showed better results than Solan Bharpur X California Wonder and most efficient time of pollination was after 24 hours of emasculation (*SS&T, Nauni*).
- ❖ The effect of bell pepper seed pelleting cv. Solan Bharpur with different nutrient elements was assessed on germination and vigour index. Seeds were pelleted with 14 different combinations of nutrient elements. The pelleted seeds were assessed for their quality. Seed germination and vigour was significantly affected by seed pelleting treatments and seeds pelleted with zinc sulphate @ 300 mg/kg seed gave best results as compared to all other treatments and control under laboratory and nursery conditions. Seed pelleting with zinc sulphate+ integrated nutrient management using *Azotobacter* (2.5 kg/ha) + PSB (2.5 kg/ha) +KSB (2.5 kg/ha) as seedling dip and soil application + 80 % recommended dose of NPK (P₁N₄) found superior in fresh market fruit yield and seed yield in bell pepper (*SS&T, Nauni*).
- ❖ In bell pepper seed treatment with PGPR, (10⁸ cfu/ml) for 4 hours before sowing in nursery and soil application of talc formulation of *Trichoderma harzianum* (10⁶cfu/g) mixed with FYM @ 2% w/w in nursery enhanced seedling emergence and vigour in bell pepper cv. Solan Bharpur. Similarly, maximum plant height (70.42 cm), number of fruits per plant (9.50), fruit weight (44.01g) and fruit yield (403.17 q/ha) were recorded in PGPR (seed treatment) + *T. harzianum* (soil application) followed by PGPR (soil application) + *T. harzianum* (seed



treatment). The incidence of common diseases like, cercospora leaf spot (5.10 %) and anthracnose (1.70%) was observed very low (*SS&T, Nauni*).

- ❖ Cow urine based bioformulation was found effective against *Phytophthora* leaf blight and fruit rot of capsicum with 70.5 per cent reduction in disease index of leaf blight, 81.9 per cent reduction in the incidence of fruit rot along with 3.58 times increase in marketable fruit yield (*PP, Nauni*).
- ❖ The effect of hot water seed treatment with a temperature range of 50-52°C for 30 min was observed on disease incidence in bell pepper cv. Solan Bharpur under nursery conditions. The seeds treated with hot water showed significant decrease in incidence of important diseases of bell pepper nursery like damping off of seedling and virus infection. The nursery raised from hot water treated seed showed 3.02 per cent incidence of damping off as compared to 13.34 per cent in untreated seeds. Similarly, the nursery raised from the hot water treated seed showed 0.56 per cent incidence of viruses as compared to 4.23 per cent in untreated seeds (*SS&T, Nauni*).
- ❖ The treatment combination consisting of the use of Seed Pro @ 10g/kg seed for seed treatment and soil solarization followed by incorporation of 5kg FYM fortified with 500g neem cake and 50g *Trichoderma* sp+ 50g *Paecilomyces lilacinus* at the time of soil preparation when combined with periodic spray and drenching of Bordeaux mixture @ 0.8% three times at 15 days interval beginning from 30 days after transplanting proved most cost effective in limiting all diseases like collar rot/root rot (3.60%), powdery mildew (15.10%), YLCV (14.60%) and in maximizing the fruit yield (647.60q/ha) (*VS, Nauni*).
- ❖ Among biocontrol agents, *Chrysoperla zastrowi sillemi* (4 larvae/ plant) (78.1% reduction), *Lecanicillium lecanii* (68.9%) and azadirachtin (66.5%) were the effective treatments for the control of *Myzus persicae* in capsicum. However, all these biopesticides were significantly less effective than imidacloprid which resulted in 98.8 to 100 per cent pest reduction (*Ento, Nauni*).
- ❖ Economics of production and marketing of capsicum in Solan district revealed that the per

hectare cost of capsicum cultivation at an overall level was found to be Rs. 1,34,896. The cost of capsicum cultivation for marginal, small, semi-medium and medium farmers was estimated to be Rs. 1,37,509, Rs. 1,32,979, Rs. 1,30,987 and Rs. 1,36,859, respectively. The per hectare cost of capsicum production was estimated to be highest for marginal farm category followed by medium, small and semi-medium farm category (*SS, Nauni*).

- ❖ The study on farmers' awareness about various modern farm management practices being adopted in vegetable farming and to understand the farmers' attitude towards adopting modern farm management practices in vegetable farm with reference to demographic variables. It was specifically noted that the Training, Knowledge and proper budget planning were mainly considered by the farmers' attitude study while adopting the modern farm management practices. Study further revealed that lack of quality raw material, pest and disease control and ineffective market condition were the key problems faced while adopting modern farm management Practices in Vegetable Farm Business. Challenges like hygiene storage facility for the harvested vegetable, pest and disease control and ineffective market condition were the key areas, where farmers' are expecting the government intervention and playing a supportive role (*BM, Nauni*).

Spinach

- ❖ Studies were conducted on standardization of production technology of spinach under hydroponics in which spinach plants were grown in Nutrient Film Technique (NFT) using water soluble fertilizers (WSF) and compared with soilless media (coco-peat) in grow bags. The plants under NFT matured in 28 days and recorded higher average number of leaves (20.8) and plant yield (368.5 g) compared to plants in growbags which matured in 44 days with 14.3 average number of leaves and plant yield of 251.9g. Overall, plants under NFT recorded 46.28% higher yield over plants under soilless media in growbags (*SSWM, Nauni*).
- ❖ An experiment was conducted in spinach var. Pusa Harit to study the effect of different seed

treatments on the seed yield of spinach. The results concluded that seeds treated with Beejamrit produced highest seed yield/plot (i.e. 3.8 kg/plot) as compared to all the treatments under study (*HR&TS and KVK, Kandaghat*).



Spinach under NFT in hydroponics and grow bags

Asparagus bean

- ❖ Asparagus bean is an important crop grown for its pods during summer months. Cultivar Asparagus Red planted during the mid of April came to flowering in 28 days after seed sowing. The crop has been introduced for the first time for growing during summer season in lower hill conditions of the state. An yield of 138.9q/ha was found in Red Asparagus bean (*RHR&TS, Jachh*).



Root Vegetables

- ❖ Conjoint application of vermicompost 5t/ha + Jeevamrit – drenching @ 5 % (20, 40, 60 days after sowing) + Panchgavya – spray @ 3 % (30, 50, 70 days after sowing) registered maximum yield (180.80q/ha) of carrot cv. Early Nantes (*VS, Nauni*).
- ❖ Polymer seed coating @ 10 ml + carbendazim @ 2g/kg seed + imidacloprid @ 3ml/ kg seed have been found to be the best management practice for storing the seeds of radish for longer durations, with minimum loss of seed viability and vigour. Similarly, another management module comprising of polymer seed coating @10 ml + NPK (19:19:19) @ 5g + carbendazim @ 2g + imidacloprid @ 3ml/kg seed was found to boost growth and yield characteristics in radish (*VS, Nauni*).

Turmeric

- ❖ A new weed management module in turmeric cv. Palam Lalima comprising of pre-emergence weedicide; Metribuzin (0.7 kg/ha) followed by mulch (10 t/ha) and one hand weeding (75 DAP) gave maximum weed control efficiency (95.92 %) and thereby produced better quality fresh rhizome yield of 251.42 q/ha, with net returns of Rs.5,18,480 and B:C ratio of 2.20 (*VS, Nauni*).
- ❖ Of the nine different genotypes of turmeric evaluated for disease reaction, minimum leaf spot disease severity (8.75 %) was observed in CL-54 followed by TCP161 (11.67 %). As far leaf blotch severity, it was minimum in TCP 129 (7.25 %) followed by CL-52 (7.50 %). Yield was maximum in CL-54 (215.25 q/ha) (*VS, Nauni*).
- ❖ Use of PGPR formulation i.e. formulation of *Trichoderma* and GRB 35 on three genotypes of turmeric i.e. Palam Lalima, Palam Pitamber and Local Collection resulted in increased growth and yield (223.65 q/ha) along with reduced leaf blotch incidence (16.52%) (*VS, Nauni*).

Mustard

- ❖ In a leafy crucifer - Mustard green, the genotypes; 2018/MGVAR-6 (292.59q/ha), 2018/MGVAR-5 (288.89q/ha) and 2018/MGVAR-3 (287.04q/ha) were promising ones in term of yield and quality of green leaves (*VS, Nauni*).

Flower Crops

Introduction of Germplasm

- ❖ In the existing germplasm of ornamental bulbs 30 spp/ cvs are being maintained and multiplied for further research work and production of plants and bulbs for sale. During the year; *Crinum*, *Haemanthus* spp., Spider lily, calla lily (Yellow), *Eucharis* lily, Day lily, Australian lily, *Curcuma* spp, *Nerine* spp, *Hedychium*, Calla lily (Red), *Gloriosa*, *Gloxinia* spp etc. were added to the existing germplasm. In the existing germplasm pot plants like pot hibiscus (*Hibiscus rosa-sinensis*), begonias, fuchsia, different varieties of *Syngonium* and *Philodendron* were introduced. Different winter and summer hybrid seed of annuals were introduced like different colours of *Dahlia*, red *Gomphrena*, white *Zinnia*, white marigold, celosia, nasturtium, double

portulaca, Verbena, annual carnation, Osteospermum, Gazania etc. The liliium germplasm collection consists of 27 cultivars. 10 new cultivars namely, 'Armandale', 'Cesare', 'Rialto', 'Lexus', 'Saloniki', 'Arletta', 'Largo', 'Ravenna', 'Tourego' and 'Signum' were introduced, whereas in alstroemeria "Golden Eye" was also added to existing germplasm. Five species of ornamental Asparagus and three cultivars of *Nephrolepis* (Bosten fern) were collected. Solan Centre is harbouring about 34 native ornamental plant species in its native plant collection block. In the year 2018-19, *Deutzia staminea*, *Desmodium oojainense*, *Indigofera pulchella*, *Jasminum pubescens*, *Woodfordia fruticosa*, *Sempervivum sedoides* were collected (FLA, Nauni).

Rose

- ❖ The planting material of rose cultivars 'Arka Sukanya', 'Arka Savi', 'Arka Swadesh', 'Arka Ivory' and 'Arka Pride' were received on 27.07.2018. Out of these, vars 'Arka Sukanya' and 'Arka Savi' have been planted in open for loose flower production. 'Arka Swadesh', 'Arka Ivory' and 'Arka Pride' have been planted under polyhouse conditions for recording various cut flower characters (FLA, Nauni).



Plant tissue culture studies in rose (*Rosa indica*)

- ❖ Rose varieties namely Anabel, Sunset Celebration, Home Garden, Jagan, Lasting Piece, Ashlesh, Mauve were found resistant against the black spot pathogen (*Diplocarpon roase*). The prevalence of powdery mildew was observed in almost all the rose growing districts viz., Bilaspur, Kangra, Mandi, Shimla, Sirmour and Solan of Himachal Pradesh. The disease incidence ranged from 48.57 to 67.38 per cent while per cent disease index ranged between 48.43 to 65.75% (PP, Nauni).

Gladiolus

- ❖ Two newly developed hybrids of gladiolus of Solan Centre viz 'UHFS Gla Hb 4-17' and 'UHF Gla Hb 15-4' were planted along with newly developed cv. 'Solan Mangla' and commercial varieties 'Nova Lux' and 'Jester' in March, 2019 (FLA, Nauni).

Gerbera

- ❖ The planting material of two newly and open evolved cultivars of gerbera namely 'Arka Nesara' and 'Arka Ashwa' was collected from IIHR and tested for their suitability for growing as cut flower crop. Number of leaves per plant was more in genotype 'Arka Ashwa' (7.00) as compared to 'Arka Nesara' (4.80). Leaf length and leaf breadth (20.40 cm & 6.66 cm, respectively) observed more in 'Arka Ashwa' as compared to 'Arka Nesara' 15.60 cm and 6.60 cm, respectively. Parameters such as flower diameter (8.86 cm), disc diameter (3.28 cm), flower stalk length (29.67 cm) and flower stalk diameter (3.40 cm) reported more in 'Arka Ashwa' as compared to 'Arka Nesara' (8.30 cm, 2.34 cm, 28.40 cm and 2.38 cm, respectively). With regards to vase life, 'Arka Nesara' exhibited more vase life (17.45 days) as compared to 'Arka Ashwa' (16.54 days). Less number of days for bud burst and first flower opening (76.70 days and 93.50 days, respectively) were recorded in 'Arka Nesara' while more in 'Arka Ashwa' (77.50 days and 95.50 days, respectively). More number of suckers/plant and flowers/plant were recorded in 'Arka Nesara' (4.50 and 19.50 days) (FLA, Nauni).
- ❖ For testing under open conditions, genotypes 'RCGH-12', 'RCGH-22', 'RCGH-114', 'RCGH-117', 'Arka Krishika' and 'Local Collection' were planted in a randomized block design. The plants of cultivar 'Local Collection' attained maximum height (45.95 cm). On the other hand, plants with minimum height (33.50 cm) were recorded in cultivar 'RCGH-22'. Plants with maximum number of leaves were found in cultivar 'Arka Krishika' (26.67). Maximum leaf length (17.44 cm) was observed in cultivars 'RCGH-117' and 'RCGH-114'. Leaves with maximum width were found in cultivar 'Arka Krishika' (6.50 cm). Maximum flower size (9.70 cm) was observed in



cultivar 'RCGH-22'. Plants with maximum spread were found in cultivar 'RCGH-12 (Magenta)' (26.33 cm). Number of suckers per plant were observed to be maximum in cultivar 'RCGH-117' (4.67). Minimum days to bud burst was recorded in cultivar 'RCGH-12' (78.33). Maximum days to bud burst was observed in cultivar 'RCGH-114' (78.83). The earliest flowering was observed in cultivar 'Arka Krishika' (91.67). Maximum days to flowering were recorded in cultivar 'RCGH-114' (96.33). Maximum disc diameter was found in cultivar 'RCGH-117' (3.77 cm). Maximum flower stalk length was observed in cultivar 'RCGH-12' (40.27 cm). Maximum stalk diameter was recorded in cultivar 'RCGH-114' (0.62 cm), whereas, minimum stalk diameter was found in cultivar 'RCGH-117' (0.41 cm). Number of flowers per plant was found to be maximum in cultivar 'Arka Krishika' (117.00). Maximum vase life was recorded in cultivar 'RCGH-12' (17.53) (*FLA, Nauni*).

- ❖ Effect of jeevamrit and different growing media on growth and flowering of gerbera revealed that the growth and flowering parameters were significantly improved by all the growing media as compared to control [soil + FYM + sand (1:1:1)]. Minimum days for first bud initiation and for first flower harvesting along with maximum plant height, plant spread, number of leaves per plant, number of flowers per pot, flower stalk length, flower diameter, flower stalk girth, length of ray florets, number of ray floret per flower, number of suckers per plant, weight of cut stem and vase life was recorded under cocopeat + vermicompost (1:1) along with application of jeevamrit at 20 days interval. Hence, use of cocopeat and vermicompost (1:1) along with application of jeevamrit at 20 days interval is the best combination for better growth, flowering and yield parameters in gerbera (*FLA, Nauni*).

African marigold

- ❖ The "influence of integrated nutrient management on flower and seed yield of African marigold (*Tagetes erecta* L.) cv. 'Pusa Narangi Gainda' during different seasons of year was studied. During the studies on INM and season it was observed that Azotobacter + PSB + 70% RDF

improved most of the economical parameters viz. plant height (72.10 cm), plant spread (41.44 cm), leaf area (76.34 cm²); earliest bud formation (53.11 days); first flower opening (65.79 days), number of flowers per plant (39.85), flower yield per plant (210.29 g), flower yield per plot (1834.09 g), flowering duration (47.57 days); seed yield per plant (10.86 g) and seed yield per plot (97.70 g) in African marigold. Flower diameter (5.75 cm), individual flower weight (6.11 g), number of seeds per head (186.54), weight of seeds per head (0.53 g) and 1000 seed weight (3.37 g) were best with T₃ (Azotobacter + PSB + 80% RDF). Maximum plant height (71.53 cm) spread (42.94 cm), leaf area (80.12 cm²), number of flowers per plant (39.15), flower yield per plant (187.15 g), flower yield per plot (1684.50 g) and flowering duration (45.97 days) were observed in summer season planting, however, earlier days for bud formation (52.17 days); first flower opening (66.12 days), flower diameter (5.30 cm), individual flower weight (5.40 g), number of seeds per head (229.57) seed yield per plant (12.71 g), seed yield per plot (114.27 g), weight of seeds per head (0.63 g) and 1000 seed weight (3.06 g) were recorded to be maximum during rainy season planting (*FLA, Nauni*).

- ❖ The jeevamrit was applied once as drench method after one month of pinching in all the marigold cultivars. The results showed that there was increased plant height, flower size and number of flowers in all the marigold cultivars with the treatment of Jeevamrit. Maximum plant height was recorded in cv. Pusa Basanti (56.7 cm), largest flower size in cv. Pusa Narangi (7.5 cm), Maximum number of flowers in cv. 'Red Brocade' (65) (*RHR&TS, Dhaulakuan*).

Lilium

- ❖ The different cultivars of lilium were evaluated for their performance during the year. The minimum number of days for bud formation (72.43 days) and first flower (86.83 days) was recorded in cv. 'Blackout'. On the other hand, maximum days for bud formation (92.03 days) and days taken to opening of first flower (144.47 days) was observed in cv. 'Crystal Blanca'. Maximum plant height (108.93 cm) and stem length (88.93 cm) were recorded in cv. 'Crystal

Blanca'. Cultivar 'Blackout' recorded maximum number of leaves/plant (101.88) while minimum was recorded in cv. 'Justina' (26.75). Maximum number of flowers/stem i.e. 4.60 was recorded in cv. 'Blackout'. As regard flower size, maximum flower diameter was recorded in Cultivar 'Signum' (24.22 cm). In general, Oriental hybrids produced considerably larger flower diameter than Asiatic and LA hybrids. Maximum tepal length and width was recorded in cv. 'Signum' (14.57 cm) and (5.29 cm), respectively while minimum tepal length was observed in cv. 'Navona' (8.22 cm) which was at par with cvs 'Blackout' (8.34 cm) and 'Tresor' (8.46 cm). However, cv. 'Tresor' recorded minimum tepal width (2.71 cm) and was found to be at par with 'Navona' (2.86 cm) and 'Blackout' (2.86 cm). Oriental hybrid 'Signum' recorded maximum duration of flowering i. e. 23.80 days. The maximum bulb diameter (4.89 cm) and bulb weight (49.90 g) was noted in cv. 'Blackout'. Asiatic cultivar 'Blackout' recorded maximum number of bulblets per stem (5.07). On the other hand, 'Sorbonne' recorded maximum size of bulblet (2.58 cm) and was at par with 'Nashville' (2.22 cm). Maximum weight of bulblet was recorded in cv. 'Acapulco' (3.87 g) whereas; minimum weight of bulblet was recorded in cv. 'Nashville' (1.76 g) (FLA, Nauni).

- ❖ Effect of plant spacing on growth, flowering and bulb multiplication in LA hybrid lilies was studied using four cultivars i.e. 'Cilesta', 'Eyeliner', 'Pavia' and 'Salmon Classic' The observations were recorded on various growth, flowering and bulb parameters. For growth parameters, per cent sprouting (99.98 %), number of leaves per plant (44.40) was found best in cultivar 'Cilesta' with 42 bulbs/m² planting density, and plant height in cv. 'Salmon Classic' (82.23 cm) with 24 bulbs/m². For flowering parameters minimum days taken for visible bud formation (118.80 days) was noted in cv. 'Cilesta' with 54 bulbs/m², days taken for cut stem harvesting (142.21 days) in cv. 'Salmon Classic' with 54 bulbs/m², maximum inflorescence length (17.45 cm), stem diameter (1.16 cm), bud length (11.00 cm) in cv. 'Eyeliner' with 36 bulbs/m², flower size (17.19 cm) and duration of flowering (13.27 days) in Pavia with 36 bulbs/m², vase life (9.60 days) and weight of bulb per plant (27.81 g)

in cv. 'Cilesta' with 42 bulbs/m² and 24 bulbs/m², respectively, number of bulblets (4.53) per plant in cv. 'Eyeliner' with 42 bulbs/m² and weight of bulblets (1.94 g) in cv. 'Salmon Classic' with 30 bulbs/m². Based on the overall performance it can be concluded that 42 bulbs/m² and 54 bulbs/m² could be recommended for optimum flower and bulb production in LA hybrid lilies depending upon the cultivars (FLA, Nauni).

- ❖ About 500 seedlings have been produced from the seeds collected after cross pollination of amaryllis flowers. The bulbs produced from previous crossings produced flowers. Interesting flower patterns were recorded in different plants. Different lines have been identified on the basis of flower colour, flower size, number of flowers per plant and plant height and planted for further studies (RHR&TS, Bajaura).



- ❖ The effect of flower bud removal was studied on the growth and development of bulbs of *Lilium* cv. Sylvia. The flower buds were removed as they appear on the plant, when buds were of 1-1.5 cm size, when buds were 3-4 cm of size and compared with no bud removal. Early removal of flower buds as and when they appeared on the plant resulted in biggest (18.58 cm, circumference) and heaviest bulbs (84.90 g) as compared to other treatments where as the smallest bulbs with lowest bulb weight were produced when no flower buds were removed



from the plant. The number of bulblets produced per plant also increased with early flower bud removal (4.65) and lowest (2.45) when no flower buds were removed from the plant (*RHR&TS, Bajaura*).

Native ornamentals of Western Himalayas

❖ *Barleria cristata* L. 'Alba' is a native, white flowering perennial shrub used as a hedge and specimen plant in landscaping and has potential of being grown as a pot plant too. The study was conducted on this plant to ascertain the effect of benzyl adenine, paclobutrazol with pinching (shoot decapitation) for making it a presentable pot plant. The rooted plants were vegetatively propagated from mother plants and then planted in pots for providing different treatments. The results revealed that the double pinched plants coupled with the application of benzyl adenine @ 200 ppm and paclobutrazol @ 200 ppm had recorded maximum values for number of side shoots per plant (25.00), number of leaves per plant (110.80), number of flower clusters per plant (28.87), number of flowers per cluster (11.07), number of flowers per plant opened at a time (28.93) and duration of flowering (36.33). However, maximum pot presentability score (88.00) was found in those plants which exhibited optimum plant height (28.39 cm) and plant spread (30.81) along with other pot presentability attributes with the application of double pinching, paclobutrazol and benzyl adenine @ 100 ppm each (*RHR&TS, Dhaulakuan*).



Multiplication of *Barleria cristata* L. 'Alba'



Rooted plants of *Barleria cristata* L. 'Alba'

❖ The extensive surveys were conducted to find out the native habitat of the selected spp. Plant propagules which included seeds, herbaceous cuttings, clumps etc. of different spp were collected from Shimla, Kangra, Kinnaur, Bilaspur, Solan and Sirmaur districts of Himachal Pradesh. Presently, out of 15 ornamental native

plants selected under the project, collection of propagules of *Pyracantha crenulata*, *Buxus wallichiana*, *Osbeckia stellata*, *Rhynchosstylis retusa*, *Polystichum squarrosus*, *Bergenia stacheyi*, *Oroxylum indicum* and *Gloriosa superba* has been done (*FLA, Nauni*):

- ❖ *Pyracantha crenulata* :Semi- hardwood cuttings treated with IBA 3000 ppm planted in cocopeat and maintained at 80% RH was found to be the most suitable vegetative method resulting in 90% rooting. Seeds treatment for 20 minutes in boiling water and planted in cocopeat resulted in 82.55% germination (*FLA, Nauni*).
- ❖ *Osbeckia stellate* :Herbaceous cuttings treated with NAA 500 ppm planted in cocopeat and maintained at 80% RH was found to be the most suitable vegetative method resulting in 95% rooting in 30days (*FLA, Nauni*).
- ❖ *Bergenia ciliate* :Division of rhizomes and treatment with BA 100 ppm followed by planting in cocopeat is found to be the most suitable vegetative method resulting in 82.55% of survival percentage and sprouting in about 45 days (*FLA, Nauni*).

Carnation

❖ An experiment was conducted to evaluate the economics and profitability of carnation production influenced by planting dates and cultivars. The cultivar 'Dumas' was found to be most profitable over 'Kiro' and 'Master' with maximum plant height (83.18 cm), stem length (78.70 cm), bud length (34.93 mm), bud width (21.55 mm), maximum flower diameter (8.29 cm), number of cut flower stems per plant (7.04) and cut flower stems per meter square (175.87). April 2015 planting showed maximum plant height (88.57 cm), stem length (84.00 cm), bud length (42.05 mm), number of cut flower stems per plant (7.19), cut flower stems per meter square (179.74) and duration 34.52 days). Highest gross returns were obtained from cultivar 'Dumas' (Rs. 210856.70/500m²) when planted in the month of April 2015 followed by March 2015 (Rs. 206801.50/500m²) planting of the same cultivar. The cultivar 'Dumas' resulted in maximum benefit cost ratio of 4.05:1 and 4.16:1 respectively. The March 2015 planting was



identified as the best planting time over other plantings with highest cumulative returns to produce desired quantity and quality flowers to meet the growing domestic as well as international demand (*FLA, Nauni*).

- ❖ Carnation mutants responded similarly for most of the propagation parameters noted during experimentation, however 'UHFS Car-4' exhibited best propagation potential. Calcium Hypochlorite (5%) treatment for 20 min. is suggested for surface sterilization of explants as it gave 100 per cent uncontaminated growing cultures. Shoot tips were found better than nodal segment explants for multiplication of carnation. High quality shoots along with best multiplication rate could be obtained in medium containing MS + 3.0 mg l⁻¹ BA + 0.1 mg l⁻¹ NAA. Half strength MS medium containing 2.0 mg l⁻¹ NAA and 0.1% activated charcoal was found to be the best for *in vitro* rooting of multiplied shoots. A medium containing sand, cocopeat and vermicompost (1:1:1, v/v) was found best for hardening of *in vitro* regenerated shoots resulting in 79.16% survival and maximum growth under field conditions (*FLA, Nauni*).
- ❖ Carnation genotypes were characterised using Random Amplified Polymorphic DNA (RAPD), Simple Sequence Repeats (ISSR) and Simple Sequence Repeats (SSR) DNA markers. Out of 10 primers used for each marker, 8 RAPD, 7 ISSR and 7 SSR amplified genomic DNA. Out of 71 RAPD markers obtained, 67 were polymorphic. Ninety six ISSR markers were polymorphic out of 99. Bands amplified by SSR primers were 41, out of which 39 were polymorphic. Unique RAPD, ISSR and SSR markers obtained were 20, 25 and 8, respectively. Percentage of polymorphism ranged from 70.00 to 94.74 for RAPD primers, 83.33 to 94.44 for ISSR primers and 83.33 to 92.85 for SSR primers. Polymorphic information content (PIC) value for RAPD primers ranged from 0.39-0.49 and resolving power (Rp) ranged from 24-62. PIC value for ISSR primers ranged from 0.27-0.49 and Rp ranged from 32-70. For SSR primers, PIC value ranged from 0.00-0.79 and Rp ranged from 10-66. Jaccard's similarity matrix was developed and dendrograms were generated using NTSYSpc version 2.20. Similarity index was computed

based on Jaccard's coefficient and used for cluster analysis based on UPGMA (*BT, Nauni*).

Chrysanthemum

- ❖ Evaluation of cultivars for pot culture of chrysanthemum cvs. 'Pusa Guldasta', 'Pusa Sona', 'DFR-C-2' and DFR-C-3 has been done for pot culture. Similarly, experiment was laid down for evaluation of cultivars for loose flower production viz. 'Pusa Shwet', 'Punjab Shringar', 'DFR-C-1', 'DFR-C-2', 'DFR-C-3', 'UHFS Chry-117', 'UHFS Chry-122', 'UHFS Chry-125' and 'UHFS Chry-132' (*FLA, Nauni*).
- ❖ In chrysanthemum, results revealed that maximum plant height (95.31 cm), plant spread (45.19 cm), minimum number of days taken for visible flower bud formation (71.37 days), first flower opening (95.01 days), maximum number of flowers per plant (170.50), individual flower weight (2.30 g), flower yield per plant (490.80 g), flower yield per plot (4418.18 g), number of pickings (5.00) and duration of flowering (54.97 days) were recorded in the plants receiving the treatment consisting of *Azotobacter* + Phosphate Solubilizing Bacteria (PSB) 75% recommended dose of fertilizers (43.47 g Urea and 62.5 g SSP/m²). Regarding flower size at the time of peak flowering, it was found maximum (5.91 cm) in the plants supplied with *Azotobacter* + PSB + 50% RDF. The observed cost benefit ratio in both the strains ranged from 1.92 (white coloured strain) to 2.00 (yellow coloured strain) (*FLA, Nauni*).
- ❖ Combination of *Trichoderma viride* formulation and growing of green gram in soil solarised with transparent polyethylene mulch for 5 weeks was found effective for the management of *Rhizoctonia* stem rot of chrysanthemum (*PP, Nauni*).

Iris

- ❖ It was observed that pulsing of cut spikes of iris with solution comprising of Sucrose (10%) + 8-HQC (400 ppm) for 16 hours resulted in best treatment for most of the postharvest parameters such as amount of pulsing solution consumed (14.13 ml), amount of vase solution consumed (91.90 ml), appearance of cut bloom (4.75), days

taken for opening of floret (2.73), floret diameter (14.29 cm), vase life (11.07 days) and minimum per cent weight change/loss (15.66 %) of the cut spikes with 100 % bud opening. Holding cut spikes in solution comprising of Sucrose (3 %) + 8-HQC (300 ppm) + BA (150 ppm) resulted in best treatment for most of the postharvest parameters such as amount of solution consumed (116.58 ml), appearance of cut bloom (4.62), days taken for opening of floret (2.40), floret diameter (14.94 cm), vase life (15.87 days) and minimum per cent weight change/loss (23.13 %) of the cut spikes with 100 % bud opening (*FLA, Nauni*).

- ❖ Effect of different nitrogen levels and spacing on growth and flowering of iris (*Iris orientalis* Mill.) cv. 'Frigia' and observations were recorded on various growth and flowering parameters. Among different treatment combinations plants supplied with 30 g N/m² in a spacing of 20×30 cm recorded maximum values for number of leaves per plant (10.07), plant height (96.90 cm), spike length (68.36 cm), plant spread (18.33 cm), number of florets per spike (4.53), floret size (14.12 cm), stem diameter (7.3 mm), fresh weight of cut stems (45.41 g), vase life (11.47 days) and duration of flowering (10.33 days). Therefore, 30 g N/m² with plants spaced at 20×30 cm recorded maximum values in terms of most of the growth and flowering parameters in *Iris orientalis* Mill. cv. 'Frigia' (*FLA, Nauni*).

Dahlia

- ❖ To evaluate dahlia cultivars on the basis of growth, flowering parameters and genetic variability experiment was conducted. About 50 cultivars of dahlia under different group have been collected and evaluated for growth and flowering characteristics i.e. Decorative group (45 No.) Cactus type (03), Single Type (02). Cultivars with upright plant growth habit were Bada Kachari, Sohini, Shaniti, Pink Kelvin, Red Army; semi-upright were Giani Zail Singh, Piyushuna, Jishu, Hiranmoyee, Gilody, Tenzin. Stem anthocyanin (Brown or reddish tinged stems) was present in all the cultivars except Matungini, Sohini, Kenya Yellow, Maa Sharda, Lokeshwar and Priyadarshini which were having green coloured stems. Internodal length was found >12 cm in Arthur Humbley, Bharti, Bada

Kachari, Bhova Pagla, Chitchor, Gilody, Kelvin, Kelvin RO, Krishna Kali, Maa Sharda, Mother Teresa, Red Army, Suryadev, Sohini, Tenzin. Dark greenish black coloured leaves were of Black eternity, Nearest Blue and Tenzin whereas light green in Kenya Yellow Orange, Lokeshwar, Matungini, Maa Sharda, Mother Teresa, Priyadarshini, Shanti (*RHR&TS, Dhaulakuan*).



- ❖ The findings revealed that on the basis of yield and other qualitative traits 'S P Kamla' was found superior to the other cultivars, cultivar 'Bada Kachari' can be grown for early crop, whereas cultivar 'Red Army' was found suitable for longer flower duration, cultivar 'Kenya Orange' had the maximum flower size, cultivars 'Lokeshwar' and 'S P Kamla' had maximum number of side shoots and cultivar 'Anadinath' had maximum stem girth. High heritability coupled with high genetic gain was found for characters like leaf area, intermodal length and plant height, moderate estimate of genetic gain was recorded for number of leaves, vase life and flowering duration. Number of flowers was found positively and significantly correlated with plant height, flower stalk length, number of side shoots, plant spread and number of leaves. The path coefficient analysis revealed that flower stalk length, days taken to bud formation, flowering duration, number of leaves, plant spread showed positive direct effect on the number of flowers (R.H. & T.S, Dhaulakuan).

Sweet William

- ❖ The influence of various levels of N and K fertilization on seed yield and quality parameters of Sweet William revealed that the application of N:K @ 40:30 g/m² along with a constant dose of phosphorous @ 20 g /m² and FYM @ 5 kg/m² improved various growth, flowering, seed yield and quality of sweet William (SS&T, Nauni).

Mushroom

- ❖ Antimicrobial activities of fruit body and mycelial extracts of three species of *Pleurotus* viz., *P florida*, *P otreatus* and *P sajor-caju* was studied against different human pathogenic bacteria viz., *Escherichia coli*, *Streptococcus* sp., *Pseudomonas* sp., *Bacillus* sp. and *Proteus* sp. These extracts were not found to be very effective against any of the test pathogens. However, very small inhibition zones were recorded in case of *P. floridas* and *P. sajor-caju* against *Bacillus* sp. (COH&F, Neri).
- ❖ Antimicrobial activities of fruit body and mycelial extracts of four different strains of *Volverella volvacea* were studied against different human pathogenic bacteria viz., *Escherichia coli*, *Streptococcus* sp.,

Pseudomonas sp., *Bacillus* sp. and *Proteus* sp. The extracts of none of the four stains were found to be effective against any of the test pathogens (COH&F, Neri).

- ❖ The study revealed that mushroom fly *Bradysia asiatica* is infesting white button mushroom *Agaricus bisporus* in low hills of H.P. Adult flies both male and female were collected from mushroom bags in March 2019. Larvae- thrive in the mycelium as well as fruiting body of mushroom. The young larvae with distinct shining black head is dirty white, transparent, with visible alimentary canal (COH&F, Neri).

Eggs of *B. asiatica*Larva of *B. asiatica*Pupa of *B. asiatica*Adult of *B. asiatica*

- ❖ The newly formed pupa is dirty white and at maturity it becomes dark grey to black with distinct compound eyes and appendages. Adults of *Bradysia asiatica* are small, grayish black flies that prefer shady places. They have long thread like antennae with 14 annuli in the flagellum. Abdomen of male fly terminates into claspers. In the female abdomen is swollen with pointed ovipositor. During spawn run the larvae fed on thickened mycelium. When casing was done, larvae moved to casing and pupated there. The newly emerging pinheads turned brown and leathery, making them spongy and hollow. Tunneling in the stipe of matured sporophore occurred due to movement of larvae (COH&F, Neri).



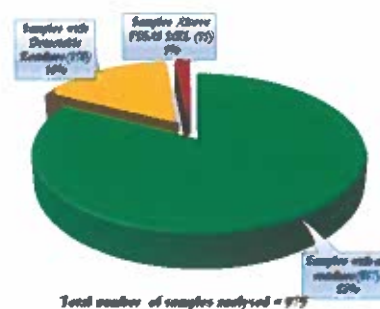
Damage by larvae



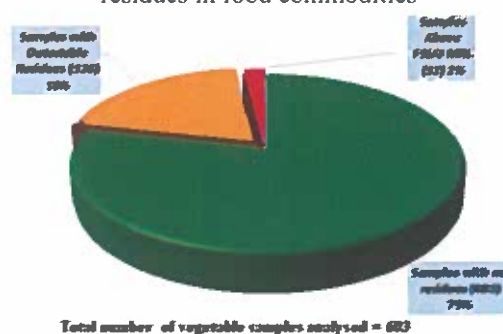
- ❖ Shiitake (*Lentinula edodes*) is one of the priced mushrooms and production technology is standardized for the same. Among different strains of shiitake mushroom strain OE-388 was found to be the best with biological efficiency of 35 per cent on saw dust substrate (PP, Nauni).
- ❖ Among different substrates evaluated for cultivation of Shiitake, willow saw dust gave highest mushroom yield per bag and highest biological efficiency (58.83%) followed by poplar, ban oak and toona saw dust (PP, Nauni).
- ❖ Four potential species of *Ganoderma* viz. DMRO-44, DMRO-45, DMRO-90 and DMRO-207 were identified at the genomic level by ITS gene sequencing technique and their genome sequences have been submitted to NCBI. Antioxidant assay of *Ganoderma* sp. was determined by using DPPH and ABTS method (PP, Nauni).

Pesticide Reduces in fruits & Vegetables

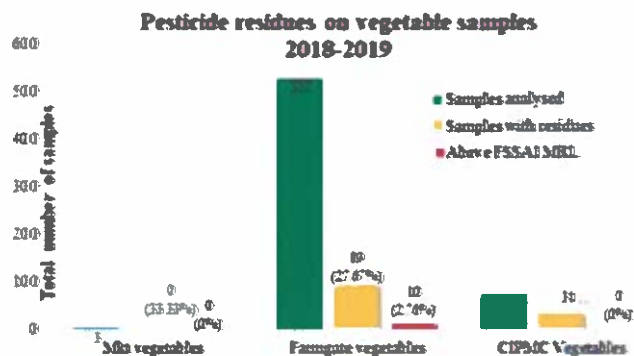
- ❖ In the year 2018-19, 975 marketable vegetables, fruits and other edible commodity beside farmgate, organic vegetable samples and farmgate samples of IPM/Non IPM vegetable samples (73) supplied by CIPMC Chambaghat were analysed. Out of these 975 samples, 603 samples were of vegetables, 216 of fruits, 60 of tea, 36 each of milk and red chilli powder and 24 of water. Out of total 603 vegetable samples analysed, 120 (19.90%) samples were found contaminated and 12 (1.99%) were above FSSAI MRL. Seventeen (17) samples of fruits, 11 of red chilli powder and 10 samples of tea were contaminated. The most commonly encountered pesticides in vegetables and fruits were chlorpyrifos, malathion, profenofos, cypermethrin, quinalfos, ethion, fenvalerate, deltamethrin and dichlorvos. Dicofol and cypermethrin were encountered in tea; ethion, profenofos, chlorpyrifos and triazofos in red chilli powder. Amongst vegetables, maximum samples containing residues were of tomato followed by cauliflower, okra, capsicum, French bean, cabbage, brinjal, cucumber, bitter gourd and pea whereas amongst fruits, maximum samples containing residues were of apple followed by mango, grapes, guava and pomegranate (Ento, Nauni).



Overall result of monitoring of pesticide residues in food commodities



Result of monitoring of pesticide residues in vegetable samples



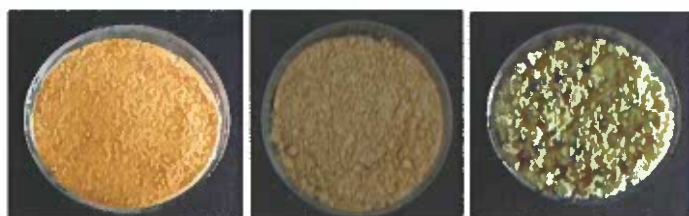
Result of monitoring of pesticide residues in Market, Farm gate and CIPMC vegetable samples

Value Addition

- ❖ Technology for the preparation of pumpkin flours has been developed. The pre-treatment standardized for preparation of pumpkin flesh, seed and seed kernel flour was, steam blanching for 5 min + 750 ppm KMS dip for 10 min, germination with plumule length of 3 cm and roasting for 1 minute, respectively. The production cost of pumpkin flesh flour, seed flour and seed kernel flour found to range from Rs 497.00 to 1008.00 per kg when unpacked while



Rs 60.00 to 115.00 per 100 g, Rs 75.00 to 132.00 per 100 g and Rs 58.00 to 115.00 per 100 g, respectively when packed in LDPE pouch, PET jar and ALP pouches (*FST, Nauni*).

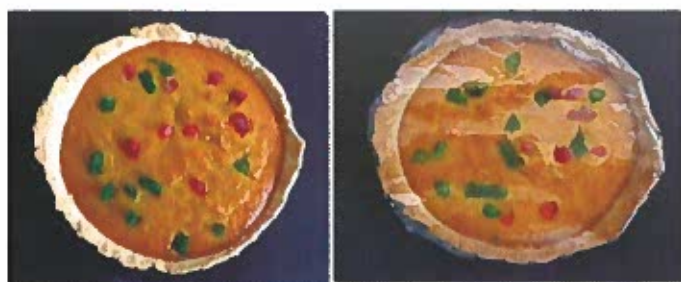


Pumpkin flesh flour

Pumpkin seed flour

Pumpkin seed kernel flour

- ❖ Technology for preparation of pie and puff pastry supplemented with pumpkin flours has been standardized. Among pies supplemented with pumpkin flesh, seed and seed kernel flours, the pumpkin seed flour combination (70:30) contained the maximum value for fat (13.85 %), protein (14.87 %), carbohydrate (34.28 %), fibre (4.69 %), ascorbic acid (9.15 mg/100 g), β -carotene (3.21 mg/100 g) and ash (1.78 %) and also obtained highest overall acceptability score (8.55) followed by seed kernel flour and pumpkin flesh flour supplemented pies. The cost of pie with refined wheat flour without supplementation, supplemented with pumpkin flesh, seed, seed kernel flour was Rs 50.00, 58.00, 76.00 and 70.00 per 100 g of flour, respectively (*FST, Nauni*).



Pumpkin supplemented pie

- ❖ The puff pastry supplemented with seed kernel flour (80:20) was comparatively found to possess higher nutritional properties in comparison to pumpkin seed flour and flesh flour. On the basis of sensory characteristics, puff pastry supplemented with pumpkin seed flour (85:15) got highest scores for colour (8.13), texture (8.35), flavour (8.51) and overall acceptability (8.33) followed by puff pastry supplemented with seed kernel flour and pumpkin flesh flour. The cost of puff pastry with refined wheat flour

without supplementation, supplemented with pumpkin flesh, seed and seed kernel flour was Rs.45.00, 50.00, 58.00 and 65.00 per 100 g of flour respectively (*FST, Nauni*).



Pumpkin supplemented puff pastry

- ❖ Technology for the preparation of ripe persimmon pulp has been developed. The persimmon pulp extracted by hot pulping method showed the maximum pulp recovery of 88.30 per cent with the use of fruits with peel which was awarded highest score for aroma (8.36), consistency (7.86) and overall acceptability (8.48). The chemical analysis showed that the pulp possessed 0.61 mg/ 100 g β -carotene, 8.71 mg/100 g ascorbic acid, 2.91 per cent crude fibre, 6.41 mg/ 100 g total phenols and 62.35 per cent antioxidant activity (*FST, Nauni*).
- ❖ Technology for *Burfi* (fudge) incorporated with ripe persimmon pulp has been standardized. The base recipe standardized for preparation of *burfi* included the ingredients *khoa* (concentrated milk solids) @ 100 per cent and sugar @ 30 per cent. The *khoa* was substituted with persimmon pulp at a level of 5, 10, 15, 20, 25 and 30 per cent for the preparation of *burfi* incorporated with ripe persimmon pulp. The *burfi* of 70:30 substitute exhibited highest value for crude fibre (1.30%), carbohydrates (44.51 %), ascorbic acid (6.05 mg/100 g), β -carotene (0.068 mg/ 100 g), total phenols (1.92 mg/100 g) and antioxidant activity (16.02%). The sensory evaluation of *burfi* showed maximum score for colour (7.55), texture (8.68), flavour (7.78), and overall acceptability (7.71). The *burfi* packed in PET boxes can be stored safely under ambient and refrigerated conditions up to a period of 14 days with minimal changes in chemical and sensory attributes (*FST, Nauni*).



Persimmon supplemented barfi

- ❖ Various ingredients used for the preparation of ice cream were cream, condensed milk (300 ml) and standardized milk. For the preparation of ice cream incorporated with persimmon pulp the cream was replaced with persimmon pulp @ 0, 30, 40 and 50 per cent. Out of four different combinations of cream and persimmon pulp used for preparation of ice cream, 50:50 ratio showed higher values for crude fibre (1.46%), carbohydrates (37.61%), ascorbic acid (6.29 mg/100 g), β -carotene (0.39 mg/100 g), total phenols (3.65 mg/100 g) and antioxidant activity (37.51%) while lower value for protein (5.25%) and fat (15.65%). The sensory evaluation of persimmon ice cream revealed that the highest score for colour (8.32), texture (8.32), flavour (8.72), and overall acceptability (8.55) was awarded to 60:40 ratio followed by 50:50 (*FST, Nauni*).



Ice cream (60% Cream + 40% ripe persimmon pulp)



Ice cream (100% cream)

- ❖ Pilot plant for extraction of pectin from apple pomace has been developed. The pectin plant designed and fabricated by AICRP on PHET, Solan Centre is a completely automatic plant for extraction of pectin from apple pomace. The plant is provided with hopper, automatic pH controller/sensor, grinder (0.1 mm screen), mixing chamber, boiler, autoclaving chamber, cooling chamber, and water chiller with shakers

and the collection chamber and capacity 10Kg dried apple pomace/cycle (12 hrs) with an efficiency of 1.4 kg pectin/10kg (*FST, Nauni*).



Pilot plant for pectin extraction

- ❖ For the development of fibre enriched cake (muffin), the ratio of apple pomace powder as source of dietary fibre was optimized on the basis of sensory quality of product (muffin) prepared from different proportion of refined wheat flour and apple pomace powder. Sensory evaluation of cake (muffin) for the optimization of supplementation concentration revealed that 33 per cent supplemented cake pre-mix was highly accepted by the panellists (*FST, Nauni*).
- ❖ The apple pomace was utilized as fat replacer in baked products such as muffins and cookies. Pectin enriched material (PEM) was prepared using standardized ecofriendly method by autoclaving pomace (121°C for 15 mins.) using citric acid as extractant. The equivalent weight of PEM was recorded as 750.21 while the pectin precipitated from pomace showed higher equivalent weight of 844.94. Degree of esterification recorded for PEM was 53.31 per cent while higher degree of esterification was recorded in pectin as 62.35 per cent. Both PEM and pectin had an acidic pH (2.5). The PEM has been used in muffins and cookies. The sensory quality of muffins showed that although the scores for overall acceptability of the product reduced with increased level of replacement, the panelists found that the fat replaced muffins from 10% fat replacement upto 80% fat replacement had good sensory properties. Therefore 80 per cent fat replacement was optimized on the basis of sensory characteristics of muffins (*FST, Nauni*).



- ❖ The fat replaced muffins had significantly higher moisture content of 25.95 per cent higher ash content (1.47%) and crude fibre (1.49%) as compared to without fat replaced muffins. The energy values recorded were, 472.87 kcal/100g and 307.35 kcal/100g for without fat replaced and fat replaced muffins respectively (*FST, Nauni*).



0% fat replacement in muffins



80% fat replacement in muffins

- ❖ The PEM was utilized as a fat replacer by replacing the shortening on per cent basis at different levels. The sensory evaluation of cookies showed that crust colour was light creamish brown from a darker brown crust colour with fat replacement with crumb colour scores also in decreasing manner with the increase in per cent of replacement. The texture was more compact and harder due to less incorporation of air in the cells. The flavor and taste scores also reduced on higher replacements. The overall acceptability scores were also reduced, however cookies upto 30 per cent fat replacement were liked by the panelists while they did not like the cookies after 30 per cent fat replacement. It was observed that there was increase in the hardness of cookies with increase in fat replacement. The cookies where fat was not replaced exhibited the lowest hardness. Therefore, on the basis of sensory and textural properties the 24 per cent fat replacement was optimized in cookies (*FST, Nauni*).
- ❖ The ginger supplemented confectionery products were developed. The ginger supplemented

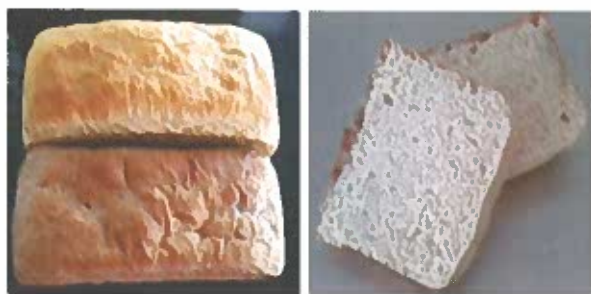
lollipops were prepared by incorporating ginger powder, juice or oleoresin. The standardization of formulation for the preparation of ginger powder supplemented lollipops showed that among the different formulations of lollipops, ginger powder @ 4%, oleoresin @0.1% and in combination in the with recipe was standardized while 25% ginger juice in recipe was optimized on the basis of sensory evaluation (*FST, Nauni*).

- ❖ For the recipe standardization of ginger supplemented jelly candies, varying proportions of ginger powder, oleoresin and juice was incorporated in the recipe and the treatment combination with ginger powder (3%), oleoresin (0.1%) and juice (25%) received highest sensory scores (*FST, Nauni*).
- ❖ The studies were conducted for optimization of proportion of underutilized grains flour for development of composite flour. Coarse grains viz. wheat, kodomillet, red rice, rice bean, buckwheat and amaranth were procured from local market of Kullu, Kangra, Shimla and Sirmour district of Himachal Pradesh and were sorted, washed thoroughly using warm ($65 \pm 2^\circ\text{C}$) water and oven-dried at $70 \pm 2^\circ\text{C}$ for 5 hours. The proximate composition of flours of wheat and underutilized grains flour showed that the moisture content of wheat flour and underutilized grains flour were found in the range 9.60 to 12.40 per cent with rice bean having maximum protein content (24.40%) among all the grains flour. After the nutritional profiling of wheat and underutilized grains, the proportions of pseudocereals flour for development of composite flour was optimized. On the basis of process parameters such as leavening activity and sensory evaluations for baked and extruded products the 10 per cent proportions of underutilized grains (pseudocereals) flour viz kodomillet, red rice, buckwheat and rice bean was optimized whereas 20 percent of amaranths flour was optimized for development of composite flour. Further, 60 per cent underutilized grains flour and 80 per cent wheat flour was optimized as the maximum proportion for the development of composite flour (*FST, Nauni*).
- ❖ The functional properties of composite flour compared with wheat flour revealed that bulk density (g/ml) was higher (0.86) in composite



flour and 0.72 g/ml was recorded in wheat flour. The water absorption capacity and oil absorption capacity of composite flour was higher as compared to wheat flour. The dispersibility (%) which is an index of the ease of reconstitution of flour in water was higher in composite flour (75%). Nutritional quality of composite flour and wheat flour shows that total protein content and total amino acids content of composite flour was 15.90g/100g and 90.91g/100g, higher than the wheat flour (*FST, Nauni*).

- ❖ The pseudo cereals flours were blended with wheat flour (WF) at 70:30 levels of substitution for bread production. The bread recipe consisted of 200 g of composite flour, 6.2 g sugar, 1.7 g salt, 3.9 g fat, 3.3 g yeast, 60 ml of luke warm water. The dry ingredients were thoroughly mixed and the fat was then added in it. The yeast was dissolved in some of the water and added to the flour. The mixture was kneaded into smooth pliable elastic-like dough, covered and allowed to ferment (20 min). It was then knocked back and cut into size and transferred to a lightly greased pan and allowed to proof (15 min), baked at 200 °C for 20 min. The baked product was cooled and packaged in polythene bags (*FST, Nauni*).



Flour based bread

- ❖ Shortening (50g) and powdered sugar (35) were creamed and mixed with dry ingredients like composite flour (100g), sodium bicarbonate (1.50g) and ammonium bicarbonate (1.50g) for preparation of biscuits. The dry mix and homogenous paste of sugar and shortening were mixed thoroughly and kneaded manually by adding required amount of water. The prepared dough was rolled in a uniform shape and cut into round shape with the help of cutter. These biscuits were baked at 175±2 °C for 20 minutes in oven (*FST, Nauni*).



Flour based cookies

- ❖ The hot extraction of Rhododendron flower extract (6-minute cooking with 15 % water) followed by treatment with enzyme Pectinase (0.08% concentration and 60 min.) at 50 °C gave economically higher (79.50%) extract yield and lower (3.55 min.) apparent viscosity and higher sensory quality of extract which was selected for further development of beverages. The extract extracted by combination of hot extraction and enzyme treatment had TSS content as 7.70 °B and reducing and total sugars contents as 2.98 and 6.01 per cent, respectively. Rhododendron extract also contained acidity as 1.11 per cent and pH as 3.01. However, the ascorbic acid, anthocyanins total phenols content and antioxidant activity of the same were found to be as 18.96 mg/100 mL, 73.12 mg/100 mL, 114.52 mg/100 mL and 70.15 per cent, respectively and pectin content of extract was recorded as 0.03 per cent (*FST, Nauni*).



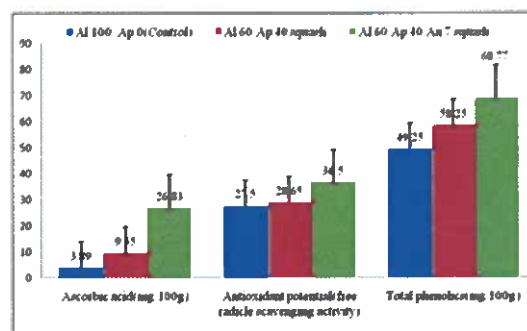
Rhododendron drink Rhododendron squash

- ❖ The maturity indices for the preparation of *anardana* from wild pomegranate were standardized. *Anardana* prepared from the fruits harvested at each harvesting date was analysed for various physico-chemical and sensory characteristics. The results obtained on physico-chemical and sensory characteristics it can be concluded that best quality *anardana* can be prepared from wild pomegranate fruits harvested after 134-137, 136-140, 134-136 and 137-139 days after full bloom in Narag, Karsog, Basantpur and Darlaghat locations, respectively (*FST, Nauni*).



- ❖ Papaya cereal flakes in combination with maida and corn (70:30) was found best on the basis of its sensory attributes. These flakes were packed in laminated pouches and storage study was conducted. The selected product was evaluated for various physico-chemical parameters on initial day and during storage at different intervals. The papaya cereal flakes contained 2.5 per cent moisture, 59.8 °B TSS, 0.96 per cent acidity, 24.30% reducing sugar, 37.76 per cent total sugars, 2.0 mg/100g carotenoid and 37.80 mg/100g Vit C content when evaluated on the preparation day. There was increase in reducing sugar (25.70%), acidity (0.98%) total sugars (38.14%) while decrease in carotenoids (1.96 mg/100g) and vitamin C contents (30.10 mg/100g) was observed during 3 months of storage. It has also been observed that in papaya cereal flakes there was increase in TSS (61.90%), increase in reducing sugar (26.10%), acidity (1.10%), total sugars (39.00 %) while decrease in carotenoid (1.87 mg/100g) and vitamin C contents (27.5 mg/100g during 6 months of storage. Slight decrease in carotenoid content and vitamin C was found during 3 and 6 months storages. The colour, flavour, taste, texture and over all acceptability rating was 8.26, 7.85, 7.90 7.85 and 7.74 during 3 months of storage. After 6 months of storage colour, flavour, taste, texture and over all acceptability rating were 8.0, 7.76, 7.87, 7.70 and 7.65, respectively (FST, Nauni).
- ❖ Technology for the development of *Aloe vera*-apricot blended functional squash has been standardized. Different combinations of *Aloe vera* and apricot pulp with varying levels of fruit part and total soluble solids (TSS) were tried for optimization of a suitable combination for the preparation of palatable *Aloe vera*-apricot blended squash. Out of different combinations, the combination consisting of 60% *Aloe vera* pulp + 40 % apricot pulp with 25 per cent fruit part and 40°B TSS was adjudged the best by the panelists in terms of higher score for flavour, bitterness acceptability and overall acceptability and hence was optimized compared to that of *Aloe vera* squash (FST, Nauni).
- ❖ The addition of apricot pulp had improved the nutritional quality of beverage as evident from its higher total phenolic content (58.56 mg/100g),

ascorbic acid content (9.35 mg/100g) and antioxidant potential (28.65 % free radical scavenging activity) compared to standard squash (49.25 mg/100g, 3.89 mg/100g and 27.50 % free radical scavenging activity), respectively. The fortification of *Aloe vera*-apricot functional squash with aonla juice further improved the nutritional quality of the prepared beverage which is evident from its higher phenolic content (68.77 mg/100g), ascorbic acid content (26.83 mg/100g) and antioxidant potential (36.50%). Further, blending has also exerted positive effect on sensory attributes of the beverages as the blended squash had recorded higher score for flavour (7.90) and overall acceptability (7.92) compared to *Aloe vera* squash (FST, Nauni).



Nutritive and antioxidant potential of *Aloe vera* squash, *Aloe vera*-apricot squash and aonla fortified *Aloe vera*-apricot squash

- ❖ The suitability of preparing low-calorie aonla fortified *Aloe vera*-apricot functional squash was evaluated by replacing sucrose with equivalent level of sweetness of stevioside. The addition of stevioside to replace sucrose in aonla fortified *Aloe vera*-apricot squash brought significant changes on sensory attributes of resultant squash. The overall acceptability score of the prepared squash exhibited a gradual increase with substitution of sucrose with stevioside up to 50 per cent. The treatments obtained superior rating score (8.06) for overall acceptability, while 100 per cent stevioside had lowest score on 9-point Hedonic scale (7.76). Conclusively, it emerged that the *Aloe vera*-apricot squash prepared by replacing 50 per cent sucrose with equivalent proportion of stevioside sweetness was significantly superior to those prepared with more than 50 per cent level of stevioside sweetness, hence was optimized (FST, Nauni).



- ❖ The method for preparation of instant mango powder from different varieties of mangoes viz; Dasherri, Amrapali, Mallika and seedling mangoes by using foam mat drying technique was standardized. Fruit pulp was turned into a stable foam by using carboxy methyl cellulose (CMC) as foaming agent (0-2%) followed by drying in tray drier for preparation of instant mango powder. The pulp after foaming was dried in dehydrator at temperature of 60 ± 5 °C to a moisture content of about 5%. Out of different combinations, use of 2% carboxy methyl cellulose in each variety was found the most appropriate for foaming of mango pulp on the basis of foaming properties. The drying time required for foamed mango pulp was recorded lower than non foamed pulp. Chemically, mango powder from cv Mallika contained 3.50% acidity, 14mg/100gm ascorbic acid and 50g/100g sugar content, Amrapali variety powder contained 3.30% acidity, 13.8 mg/100gm ascorbic acid and 53 g/100g sugar content, Dasherri variety powder exhibited 3.60 % acidity, 14 mg/100gm ascorbic acid and 50 g/100g sugar content while mango powder from In situ /seedling mango contained 4.2% acidity, 17mg/100gm ascorbic acid and 48 g/100g sugar content. Thus, fruit pulp from cultivars Dasherri, Amrapali, Mallika and In-situ mango can be turned into foam by adding 2% carboxy methyl cellulose and drying the foam in tray drier followed by grinding and sieving to prepare instant mango powder suitable for preparation of instant ready to serve beverages (COH&F, Neri).
- ❖ The colour from plant parts of flowers like Rose, Achania, Balsam, Cosmos, Marigold leaves of Jacaranda, rhizomes of curcuma, seeds of Bixa was extracted with acetone or ether. Apart from this, colour of different types of soils was also extracted with water and used for colouring dry flowers. The inflorescence of *Lagurus ovatus* (Rabbit tail grass) was taken as a test sample for checking the efficacy of colour. It was found that the colours extracted from *Bixa orellana*, *Curcuma longa*, *Achania malvaviscus*, *Rosa hybrida* among plants and geru 1 and geru 2 among soil samples were found good for dyeing *Lagurus*. The value - added products like flower sticks, dolls, rakhis and flower arrangements were prepared from dried flowers coloured with biocolours and the products were kept for evaluating their shelf life (FLA, Nauni).
- ❖ The studies were conducted on eight winter annuals namely; *Rhodanthe chlorocephala* (Everlasting flower), *Briza maxima* (Quaking grass), *Bromus rubens* (Broom grass), *Helichrysum bracteatum* (Paper flower), *Lagurus ovatus* (Bunny tail grass), *Limonium sinuatum* (Statice), *Moluccella laevis* (Bells of Ireland), *Xerochrysum viscosum* (Golden everlasting). Maximum cost benefit ratio as dry flower was obtained in *Helichrysum bracteatum* (1.11) followed by *Limonium sinuatum* (1.06), *Lagurus ovatus* (1.03) and *Briza maxima* (1.00) whereas maximum cost benefit ratio when the crops are used for dry flower purposes and seed is also harvested simultaneously; was found in *Bromus rubens* (1.41), *Briza maxima* (1.34), *Lagurus ovatus* (1.29) and *Helichrysum bracteatum* (1.24). Based on the yield parameters, shelf life, overall acceptability and cost benefit ratio seasonal annuals viz. *Lagurus ovatus* (Bunny tail grass), *Helichrysum bracteatum* (Paper flower), *Briza maxima* (Quaking grass), *Bromus rubens* (Broom grass), *Limonium sinuatum* (Statice) and *Moluccella laevis* (Bells of Ireland) can be recommended to be used as dry flowers (FLA, Nauni).
- ❖ Drying of native and naturalized flowers and plant parts was done with the help of resins. Assorted value added items with dry flowers were created being transparent or coloured with epoxy resin. For making such value added products like pendants, ear rings, key chain rings, table top covers etc, the first step was to press dry foliage and flowers of native and naturalized plants parts namely, *Helichrysum bracteatum*, *Ixora coccinea*, *Ornithogalum thyrsoides*, *Limonium sinuatum* etc, foliage of *Adiantum capillus veneris*, *Thuja* sp etc, in between blotting paper sheets whereas naturally dried fruits and seeds of *Abrus precatorius*, *Acer oblongum*, etc. many more with several designs were used as such in this technique. Differently shaped moulds are available to make variety of products (RHR&TS, Dhaulakuan).



Epoxy resin encapsulated keyring products

Resin treated *Helichrysum brateatum* in different moulds for centre table decorationsResin treated *Helichrysum brateatum*, *Ornithogalum thyrsoides*, *Limonium sinuatum* in different coasters

- ❖ Studies on immobilization of bacterial amylase for juice processing were carried out. For this purpose water samples were collected from hot water spring of Manikaran in Kullu district of Himachal Pradesh. The pH and temperature of the hot water spring ranged from 4.3-6.1 and 70-105°C, respectively. A total of 27 bacterial isolates were isolated from hot spring water, out of which 8 isolates namely, MW1, MW2, MW5, MW6, MW7, MW10, MW13 and MW26 exhibited amylase producing activity. On the basis of qualitative screening of 8 isolates, MW2 isolate recorded highest zone size of 8.43 mm with enzyme index of 27.45 which was followed by MW6 with 7.23 mm zone of hydrolysis and 24.62 enzyme index. The isolates MW2 also exhibited higher amylase activity 93.80 IU followed by MW6 with 73.75 IU activity. The

two isolates MW2 and MW6 from hot water spring of Manikaran were identified as *Bacillus cereus* and *Bacillus* sp., respectively. For partial purification with ammonium sulphate fractionation (20-80%) the amylase activity was 235.69 IU for MW2 with 1.85 fold purification. Three matrix were used for immobilization i.e. sodium alginate (3%), chitosan (0.25%) and agar (3%). Among them, sodium alginate was found best matrix for immobilization (BS, Nauni).

Honey Bees/ Bumble Bees

- ❖ Thiamethoxam sprayed at 10 per cent bloom of mustard crop had adverse impact on foraging activity of *Apis mellifera*, which is evident from significant reduction in quantum of bee activity upto 8th day (SFC) and 13th day (FC). However, thiamethoxam spray at pre bloom and imidacloprid seed treatment showed no impact on bee activity and was comparable to control. Under semi field conditions significant decrease in brood area (7th to 28th day), nectar stores (7th to 28th day), pollen stores (7th to 28th day) and bee strength (7th to 28th day) in comparison to thiamethoxam sprayed at pre bloom, imidacloprid as seed treatment and control was recorded. The mortality of *A. mellifera* in dead bee trap was maximum in thiamethoxam sprayed at 10 per cent (Ento, Nauni).
- ❖ Thiamethoxam and imidacloprid sprayed at 10 per cent citrus bloom showed adverse effect on foraging activity of *A. mellifera* as is evident from significant reduction in quantum of bee activity up to 8th day in thiamethoxam and 4th day in imidacloprid (SFC) and 12th day for both molecules (FC). However, thiamethoxam spray at pre bloom showed less impact on bee activity. Further, significant reduction in brood area, nectar stores, pollen stores and bee strength up to 28th day after thiamethoxam and imidacloprid spray (SFC) was recorded (Ento, Nauni).





Evaluating impact of Neonicotinoids on pollinators on mustard and citrus crops

- ❖ Significant variations in *A. mellifera* stock have been found in various colony parameters like colony strength (4.54 to 10.43 bee frames), brood area (1579.49 to 5086.25 cm²), prolificness (271.52 to 874.35 eggs laid / day), pollen stores (81.38 to 401.84 cm²) and honey stores (550 to 2162.5g). The maximum acceptance (100.00%) and emergence (87.50%) were recorded by using royal jelly among seven different priming media viz. diluted royal jelly, coconut water, honey solution, apple nectar, sugar solution and distilled water in old comb wax cups. The *A. mellifera* queens takes 3 days for egg hatching, 5-6 days for capping of the cell and 12-13 days for emergence after one day old larvae has been grafted into a cell. The royal jelly and old comb wax cups were found to be the best priming media and cup material for larval grafting for mass queen rearing in *A. mellifera* as the maximum acceptance of larvae and emergence of queens was obtained in this treatment (*Ento, Nauni*).
- ❖ The analysis of physico-chemical parameters of squeezed honey of *Apis mellifera*, *A. cerana*, *A. dorsata* and *A. florea*, indicated that the pollen density (92000), sucrose (8.9%), Ca (61.2 mg/kg), Mg (17.6 mg/kg), P (63.1 mg/kg) and Na (89.33 mg/kg) content was more for *A. cerana*, whereas pH (6.25), moisture (17.2 %), F:G (1.98), diastase (20.24) and K (287.6 mg/kg) content was more for *A. dorsata*. Whereas, EC (0.61 mS/cm) and vit. C (25.56 mg/100g) were more for *A. mellifera* honey and acidity (83.56 meq/kg), amino acids (76.05 mg/100g) and phenol (86.37 mg/100g) content high for *A. florea* honey (*Ento, Nauni*).
- ❖ Thirty six extracted honey samples of *A. mellifera* obtained from beekeepers of different agroclimatic zones of HP. The honey samples from Zone 1 contained statistically highest EC

(0.24 mS/cm), moisture (16.5%), Mg (34.09 mg/kg), P (62.93 mg/kg), whereas, honey samples from Zone 2 contained statistically highest pollen density (76666), pH (5.94), sucrose (6.94%), proline (103.83 mg/100g), Ca (81.04 mg/kg), phenol (77.39 mg/100g), honey samples from Zone 3 had statistically high content of Na (216.74 mg/kg) and honey from Zone 4 showed statistically high absorbance (0.622), F:G (1.55), acidity (46.07 meq/kg), vit. C (25.04 mg/100g), diastase (19.22). All the samples analyzed were safe and fit according to International Standard of Codex Alimentarius of Honey (pH), Codex Standard for Honey (acidity, diastase activity, EC) and FSSAI Advisory on Standards for Honey (moisture, sucrose, F:G, Fiehe's test) except acidity of squeezed honey of *A. florea* sample from Nalagarh (*Ento, Nauni*).



Honey of *Apis mellifera* from beekeepers of different agroclimatic



Honey of different honey bee species

- ❖ The foraging behavior of the honey bees was observed on the citrus plant during flowering period. The observations were taken at three different timings of the day for different species of honey bees visiting the citrus flowers (*RHR&TS, Jachh*).



Apis mellifera colonies in citrus orchard

- ❖ The Queen and workers of *Bombus haemorrhoidalis* collected at UHF Nauni had black pigmented body with yellow band on dorsal side of abdomen of queen which is bigger in size than worker. Drone bears yellow or white pubescence on its vertex. Bee specimen collected from Keylong have black pigmented body with reddish orange abdomen whereas thorax bears white band. Drones bear pinkish white pubescence on their head (vertex) sometimes white only. The specimen collected from Nauhradhar had black pigmented body with orange band on dorsal side of abdomen as well as on thorax in both queen and foragers. Data on morphometric studies of bumble bee revealed that all the three species having worker bee bigger in size (body length) than drone bee (*Ento, Nauni*).



Keylong
bumble bee

Naunibumble
bee

Nauhradhar bumble
bee

- ❖ The success in field establishment of colonies was moderate (41.4%) from bumble bee queens collected in April, 2018. Bumble bee pollination proved superior in bell pepper grown under caged

condition. Significantly higher 1000 seed weight (6.72g) was recorded in bumble bee pollinated plants as compared to open pollinated (5.90g). Higher fruit yield/m² (2.90 Kg) was found in bumble bee pollinated bell pepper plants as compared to open pollinated plants (1.34 Kg). The bumble bee pollination showed positive impact on different fruit quality parameters viz., increase in fruit weight (24.71%), fruit length (19.61%), fruit breadth (8.74%), seed number (33.14%) and 1000 seed weight (13.99%) over open pollinated (*Ento, Nauni*).



Bumble bee pollination in bell pepper under caged conditions

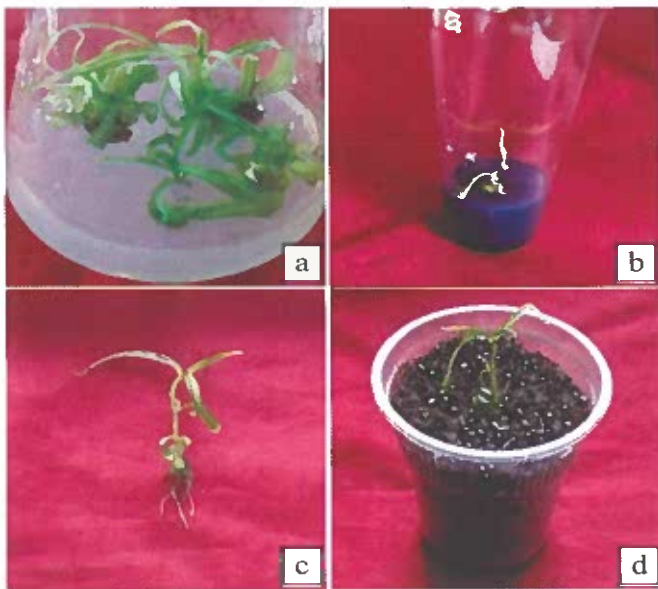
- ❖ Economic analysis of migratory beekeeping in Himachal Pradesh revealed that average cost per colony varied between Rs 257.64 to Rs 489.50 with an average of Rs 411.50. The net returns from 100 colonies varied from Rs 1,66,997 to Rs 2,75,351 on the different groups with an average of Rs 1,88,285. The payback period was found to be 5 years at overall level which means that the beekeepers would get back the initial investment made during the establishment period at 5 year of the beekeeping and also internal rate of return from beekeeping was found to be 35.67 per cent which was higher than the opportunity cost of capital. Thus, study revealed that the investment in beekeeping was highly remunerative and a profitable economic activity (*SS, Nauni*).



FORESTRY

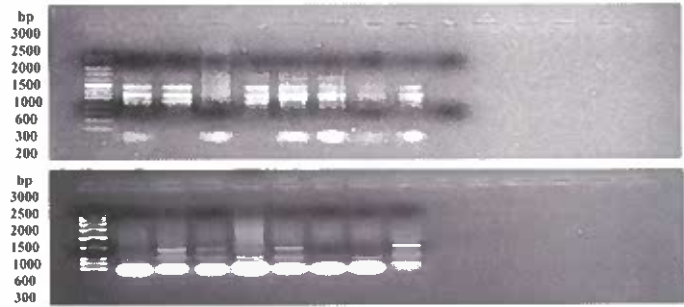
Willows (*Salix* species L.)

- ❖ *In vitro* selection and regeneration of *Salix* species against canker disease was carried out to find out best explants for *in vitro* regeneration of plantlets from leaf and inter nodal segment as explants through indirect regeneration pathway. Healthy fully expanded young leaves and inter nodal segments harvested from newly emerging shoots of *Salix* species clone 799 were used as source of explants (*TIGR, Nauni*).



In vitro shoot multiplication (a), *in vitro* rooting of microshoots on half strength MS basal medium containing 500 mg/l activated charcoal (b,c) and hardening (d) of *Salix* sp.

- ❖ Molecular characterization of *Salix* species putatively tolerant calli with a total of 20 RAPD and 20 ISSR markers were used for genetic variation studies of mother plant, control calli, six 30 per cent FCF selected variant calli out of which only 12 RAPD and 17 ISSR markers were able to amplify the DNA (*TIGR, Nauni*).
- ❖ Performance of Jivaamrit on *Salix* nursery was undertaken on different treatment viz., Jivaamrit, FMS and FMS+NPK. Studies concluded with Jivaamrit treatment mean maximum height (288.85 cm), diameter (1.35 cm) and volume (548.21 cm³) whereas, treatment FMS+NPK gave maximum height (277.58 cm), diameter (1.30 cm) and volume (499.65 cm³) on quantitative characters of *Salix* (*TIGR, Nauni*).



DNA banding profiles of mother plant, control plant and *in vitro* selected variants of *Salix* sp. against 30 per cent FCF of *Cytosporachrysosperma* obtained using RAPD primers a) OPA 01 and b) OPV 14

- ❖ Morphological data recorded for developing brief descriptors of willow clones for further genetic stability. Plant height data was recorded after a period of three years growth and two year growth in the field /farm ranging from 295 cm to 415 cm in different clones. Maximum height observed in UHF-10 Clone i.e. NZ-1140 of *S. matsudanax S. alba* (UK) and minimum height in UHF-7 clone i.e. *S. alba* (Kashmiri willow) of *S. alba* cv. *caerulea* (UK) under the laid out experimental field trail at Trehta Forest Range under Divisional Forest Officer Bharmour, District Chamba (H.P) and locational trial at Chamenji of *Salix* clone J-799 (*TIGR, Nauni*).



- ❖ Height and diameter of sixteen willow clones were recorded at the age of five year of growth. It was deduced from the studies that minimum (7.35 m) plant height was observed with clone V-99 whereas, clone Austree exhibited minimum diameter (2.94 cm). Clone J-799 exhibited maximum plant height (11.05 m) as well as maximum diameter (10.95 cm) amongst all the clones under study (*RHR&TS, Bajaura*).



Evaluation of Willow Clone

Poplars (*Populus deltoides* Marsh.)

- Hybrids developed by crossing different genotypes of *Populus deltoides* were planted in the nursery along with known clones to evaluate their performance. A total of 22 clones were planted in the randomized block design with three replications. Among all the growth characters, phenotypic coefficient of variation (PCV) was found to be maximum for volume (54.89%) followed by diameter (20.66%) and height (19.64%). The PCV values were found higher than GCV which indicates that growth characteristics were greatly influenced by the environment. Genotypic coefficient of variation (GCV) was maximum for volume (34.26%) followed by diameter (14.27%) and height (12%). Heritability was highest for diameter (47.75%) followed by volume (38.95%) which showed that these traits were under very strong genetic control (TIGR, Nauni).

Beul (*Grewia optiva* Drummond)

- Seedling Seed Orchard of *Grewia optiva* Drummond (Beul) established at UHF farm has been evaluated for morphometric and fodder quality parameters at the age of 16 years. Forty (40) families with 3 genotypes each were taken for morphometric and fodder quality parameters studies. On the basis of scoring index on useful morphological and fodder quality parameters, 10 families were found best performers over the other families. The maximum mean performance values were recorded for different morphometric parameters, viz., height (9.20 m), diameter (16.19 cm), leaf area (77.22 cm²), estimated numbers of leaves (3634.3), fresh weight of 100 leaves (87.00 g), dry weight of 100 leaves (50.33 g), leaf dry matter content (55.56%), total fresh leaf biomass (3024.94 g) and fodder yield (13.81 kg) among 40 families (TIGR, Nauni).

Seedling Seed Orchard of *Grewiaoptiva* (Beul) established during 2000 at the age of 16 years at UHF Campus under study

- On the basis of useful morphometric and fodder quality parameters, 10 best families were studied for molecular characterization using 15 RAPD and 20 ISSR primers and 9 RAPD and 12 ISSR primers show amplification respectively. Family SH-7 (Taradevi-Shimla) came as outliner as revealed by both RAPD and ISSR study (TIGR, Nauni).



Primer OPC-11 (AAA GCT GCG G) Primer OPC-13 (AAGCCTCGTC) Primer OPF-08 (GGGATATCGG)

RAPD fingerprints of 10 Families generated by OPC-11, OPC-13 and OPF-08

- Study was also conducted to access the amenability to vegetative propagation through cuttings from the best performing 10 families as treated with different auxins (IBA and NAA) concentration and raised in three different seasons (Spring, Monsoon and Winter). Spring season (S.) during March (First week) was found to be effective among other different seasons for raising cuttings of *Grewia optiva* as quality planting stock Family SH-7 was found to be a best source for raising cuttings of *Grewia optiva* Drummond. IBA 500 mg/lit auxin concentration was found best suitable treatment for raising true to type through cuttings of *Grewia optiva* (TIGR, Nauni).
- Clonal Seed Orchard of *Grewia optiva* (Beul) established at experimental farm of the university at the age of 6 years was evaluated for growth performance traits. Maximum mean height (5.96 m) was recorded in family code no. HA-2 (Patta Balakhar). Maximum mean dbh recorded (11.10 cm) for family CH-5 (Rajpura), Maximum leaf area recorded (56.20 cm²) for the family SO-6 (Badhlech), Fresh weight of 100 leaves (g)

recorded 62.54 for the family SI-7 (Nandel) and Dry weight of 100 leaves (g) recorded 30.69 for the family KA-3 (Varal) (*TIGR, Nauni*).



Beuli (*Grewia laevigata*)

- ❖ Salga population of *Grewia laevigata* showed quite encouraging performance under glass house conditions, over other populations namely, Rajari, Tikkari and Chawaha Mean maximum height (253cm) was observed in Salga population followed by 210 cm in Rajri population and 180 cm in Tikkari population at the age of 3 years of its sowing in polythene bags. This species will be useful for planting population in grassland specific situation in shiwalik region (*TIGR, Nauni*).



Kachnar (*Bauhinia variegata* L.)

- ❖ The studies on combining ability, gene action and heterosis in *Bauhinia variegata* (kachnar) were carried out. Plant material of 10 genotypes involving 6 female ($P_3, P_8, P_{16}, P_{24}, P_{27}$ and P_{32}) and 4 male (P_{12}, P_{13}, P_{14} and P_{17}) were taken from the already raised progeny trial of the species and control crossed using Line x Tester (6 x 4 factorial) mating design. Seedlings of control crosses were raised in the nursery in RBD and were evaluated for morphological and growth characters. Per cent successful cross was highest in $P_{32} \times P_{17}$ (62.50%) and minimum in $P_8 \times P_{13}$ (13.33%). Maximum number of seeds per pod (9.97) was recorded in cross $P_{16} \times P_{12}$. Maximum germination percentage (94.12) in cross $P_3 \times P_{12}$ and survival percentage (96.30) in $P_{16} \times P_{13}$ was recorded. Line x tester analysis for combining ability revealed that line P_{16} followed by P_{32}, P_{27} and P_3 and tester P_{17} followed by P_{14} were found to be good general combiners. On the basis of heterosis

over better parent, mean performance and significant desirable SCA effects for morphological and growth characters, the combinations $P_{16} \times P_{14}, P_{32} \times P_{17}$ and $P_3 \times P_{17}$ were found to be the most promising families. The estimates of SCA variance (σ^2_{SCA}) were more than the GCA variance (σ^2_{GCA}) for most of the characters except for collar diameter and number of branches. The gene action study revealed the importance of both additive as well as non-additive gene effects in the inheritance with preponderance of non-additive gene action. The proportional contribution of lines was higher than individual contribution of testers or line x tester interaction except for plant height, leaf area, intermodal length, root fresh weight and root dry weight. Out of 25 RAPD primers five primers were successful in verifying hybridity (*TIGR, Nauni*).

Seabuckthorn (*Hippophaerhamnoides* L.)

- ❖ Eleven qualitative characteristics, twenty two quantitative characteristics recorded at the vegetative and reproductive stages for the preparation of morphological descriptors in seabuckthorn (*Hippophaerhamnoides*) and four Pseudo-qualitative characteristic were recorded and studied at different stages of active growth (*TIGR, Nauni*).
- ❖ The extensive periodical field surveys for Seabuckthorn studies in Spiti valley revealed the occurrence of ten distinct populations at ten different geographical locations. The variation occurs in their leaves, thorns, flowers, fruits and seeds (*TIGR, Nauni*).
- ❖ Ten Gene pools of seabuckthorn GPA1, GPA2, GPA3, GPA4, GPA5, GPA6, GPA7, GPA8, GPA9, GPA10) are studied for DUS characterization (*TIGR, Nauni*).



Establishment of Gene bank of SBT at Tabo Farm at Spiti Valley

- ❖ Evaluation of different species of Seabuckthorn revealed that the highest fruit berry size was found in *Hippophae salicifolia* (0.8 cm) and the



maximum fruit yield was found in *Hippophaerhamnoides* (7.2 t/ha) (RHRSS & KVK, Tabo).



Bamboos (*Dendrocalamus strictus* Roxb.)

- ❖ Twenty five key morphological characters (15 culm and 10 culm-sheath) were studied alongwith detailed inflorescence and floral characters. Culm character, both qualitative and quantitative characteristic were recorded at experimental site among 23 genotypes. Incidence of sporadic flowering were recorded. The description of culm, culm sheath, inflorescence and floral morphology are in agreement with the prior taxonomic description. All 23 populations planted at our trail does not result in seed production. Namhol population planted at farm showing good growth (TIGR, Nauni).
- ❖ Chinese bamboo (*Phyllostachysreticulata*) has been planted at Shilly nursery through rhizomes during July-August, 2018 and showed excellent performance. This species is recommended for vegetating nullahs (TIGR, Nauni).
- ❖ Rhizome cutting with four buds planted just below soil surface gave more than 80 per cent success and rainy season was found to be the best season for vegetative propagation in Chinese bamboo (TIGR, Nauni).



Chinese bamboo growth in field condition
(1 year growth)

Chil/Chir (*Pinus roxburghii*)

- ❖ Twenty families of the *Pinus roxburghii* (Chil) trail, established at UHF campus, has been evaluated for different traits i.e. Bole biomass, Branch biomass, Twig biomass and Foliage biomass. Maximum mean value bole biomass (151.31 t ha⁻¹) in family code 10, maximum branch biomass (23.34 t ha⁻¹) in family code 17, twig biomass (7.50 t ha⁻¹) in family code 5 and foliage biomass (7.33 t ha⁻¹) was observed in family code 7. Overall family code 17 (Rakni P2) found best performing family on the basis of biomass and productivity traits (TIGR, Nauni).



- ❖ The experiment conducted at Nauni on standardization of borehole height and drilling month revealed that the highest oleoresin yield at a height of 150 cm with yield of 4537.33 g/season was obtained from the borehole drilled in the month of April (FPU, Nauni).



Boreholes at different heights viz., 50 cm, 100 cm and 150 cm

- ❖ Experiment conducted on the evaluation of half sib progenies for oleoresin yield revealed that amongst the 22 progenies selected for oleoresin tapping at Nauni Campus, maximum oleoresin yield (625.00 g/season) was recorded in 23 Kaldoo P-3 (FPU, Nauni).



Progeny Experiment at Nauni (Main Campus),
UHF, Solan

- ❖ Studies conducted on the evaluation of high oleoresin yielders for rosin and turpentine content marked at different sites, viz., Nauni campus, Bhota (Hamirpur), Arki and Piplughat revealed that the maximum percentage of turpentine (21.54%) was recorded at Arki, whereas, the highest (80.11%) rosin per cent was found at Piplughat (Solan) (FPU, Nauni).

Deodar (*Cedrus deodara*)

- ❖ Seeds of *Cedrus deodara* were collected from the three identified sources i.e. P₅ (Bharmour), P₁₄ (Narkanda) and P₁₀ (Nauradhar) on the basis of morphological parameters and sown in polythene bags in 3 replications recorded 91.10 per cent germination with good growth under open conditions at Shilly Nursery farm (TIGR, Nauni).



Soapnut (*Sapindus mukorossi*)

- ❖ Morphological observations recorded on *Sapindus mukorossi* (Soapnut) trial established at Shilly farm, Solan revealed maximum height (272 cm) in Banjar Seed Source followed by 135 cm in Grasa seed source under field condition at the age of three years. Maximum height of seedlings (69 cm) was recorded in Nagrota Bagwan seed source after two year of its sowing (TIGR, Nauni).



- ❖ Soapnut plants raised through tongue grafting (65.50%) and chip budding (48.25%) in the last week of February, gave higher plant survival as compared to last week of March (RHR&TS, Bajaura).



Grafted soapnut in the nursery

- ❖ Direct sowing of soapnut seed in sandy soil in the first week of February gave higher (78.45%) germination success compared to sowing in the last week of March (66.42%) (RHR&TS, Bajaura).
- ❖ For rapid and uniform production of grafted plant of *Sapindus mukorossi*, chip budding/side veneer grafting, capping with poly caps and hardening of grafts in the green house has been done which resulted in 60 to 70 per cent success (RHR&TS, Jachh).

Wild Pomegranate (*Punica granatum*)

- ❖ Progeny analysis in Wild Pomegranate (*Punica granatum*) was conducted to evaluate the selected parent trees, fruits and nursery performance of the half sibs and full progeny. The fruit samples from Tatoon location proclaimed assuring fruit length (56.36 mm) and width (53.30 mm) in tree number 2 with ovate shape which also has a promising average fruit weight of 47.43 g greater than the mean of all the locations with a desirable TSS value of 17.13. Maximum value in fruit traits were obtained from open pollination as compared to controlled cross combination for all the characters except fruit weight and fresh seed weight with aril. The maximum fresh seed weight with aril was recorded from genotypes L, T₂ having ovate fruits (TIGR, Nauni).

Sahtoot (*Morus alba* species)

- ❖ Successful hybridization work on *Morus alba* crosses has been made and the seeds obtained from the crosses have been sown in nursery for further evaluation studies (TIGR, Nauni).

Ulmus villosa (Marinoo)

- ❖ Seeds of *Ulmus villosa* (Marinoo) have been collected from four different seed sources namely, Nauni, Kumi, Jhid (Mandi) and Bandrel (Kullu) and has been sown for nursery performance trials (TIGR, Nauni).

Myrica esculanta (Kaaphal)

- ❖ Seed source variation studies on *Myrica esculanta* has been initiated selecting nine sites from three districts of Himachal Pradesh viz., Solan, Shimla and Sirmour to identify the best seed source on the basis of nursery performance characteristics being undertaken in field (TIGR, Nauni).
- ❖ *Ginkgobiloba* plants were successfully raised from the seeds collected from identified source, however, only 10 per cent germination recorded was only 10 per cent (TIGR, Nauni).



Robinia

- ❖ Presence of stipules on robinia branches make it difficult for lopping and also restrict its palatability to greater extent. To overcome these problems a trial was laid to produce thornless plants through grafting and budding techniques. Out of the two grafting methods employed, tongue method revealed higher (87.15%) survival as compared to cleft method (78.45%). Third week of March was observed the best time for grafting under Bajaura conditions (RHR&TS, Bajaura).



Nursery for raising Thornless robinia Thornless robinia in the nursery

Anola (*Embllica officinalis*)

- ❖ Seven anola cultivars (Kanchan, Krishna, Neelam, Agra Bold, Chakaiya, Francis, Banarasi) were evaluated for maturity period, fruit quality and yield. Kanchan cultivar of anola was observed to be the highest yielder (137.9 kg/plant). However, in term of fruit size and fruit weight cultivar Banarasi was found to be superior over other cultivars under study. With respect to maturity periods Banarasi, Krishna and Agra Bold were earliest to mature (mid Oct-mid Nov.) and the cultivar Chakaiya was found to be late maturing (mid Dec-mid. Jan.) under subtropical conditions of Jachh (RHR&TS, Jachh).



Lasura (*Cordia myxa*)

- ❖ Crop productivity of *Cordia myxa* can be enhanced by applying grafting techniques. viz. side veneer grafting, cleft grafting and chip budding. These techniques result in the quality improvement of the fruits and early production. Side veneer grafting success is usually up to 70 per cent but it can be enhanced up to 90 per cent if the polythene caps are put on the graft just after grafting the stock under shade house. Dehra collection recorded 100 percent success followed by Darang (83.33%) Balugoan, whereas, Nagrota Bagwan, Bijari and Gangath collection recorded maximum survival of 83.33 percent each (RHR&TS, Jachh).
- ❖ Survey of Kangra district has been conducted to locate the promising strains of *Cordia myxa* an endangered lesser known fruit species. Some of the strains of *Cordia myxa* from Gangath, Dehra,



DolaLapiana, Suliali, Raja-ka-Talab and Shahpur area have been identified and are being propagated by vegetative means for further evaluation (RHR&TS, Jachh).



A new strain of lasura which also bear fruits in winter

- ❖ Trials to evaluate the improved stock of *Cordia myxa* under different climatic conditions have been laid out at Dehra, Una, Hamirpur, NagrotaBagwan and Chamba for further testing of stability of characters and performance (RHR&TS, Jachh)
- ❖ Data on three selections of *Cordia myxa* (Lasura) selections planted at Jachh are being recorded. During first year, Dehra selection showed 100 per cent survival followed by Thana Selection (75%) and DolaLapiana (50%)(LMRS, Nagrota).

Neem

- ❖ On-farm trial of 17 improved genotypes of *Melia dubia* procured from Division of Genetics and Tree propagation, Forest research Institute, Dehradun was established under Randomized Block Design (RBD) at Khaggal farm of College of Horticulture and Forestry, Neri and on-farm trial under agroforestry was also established at village Lethwin, Tehsil Ghumarwin, District Bilaspur, Himachal Pradesh falling under low hills conditions of the state. Data on growth parameters, viz., height and diameter were recorded after one year of plantation and genetic parameters, viz., phenotypic variance, genotypic variance, heritability, genetic gain and genetic advance were worked out using standard procedures. Significant variation for diameter, height and genetic parameters was found among the evaluated genotypes. Genetic parameters recorded high values for heritability and genetic advance for diameter as well as height growth in all evaluated genotypes indicating scope of early

selection for these traits. The maximum values for height as well as diameter growth were recorded for genotypes 241 and 231 at both the trial locations, which indicated their suitability for the cultivation in the area under study and further scope in site specific multilocal growth performance evaluation under varied agro-climatic conditions of the state (COH&F, Neri).



(a.) On-farm trial showing one year growth of *Meliadubia* plants under Silvipastoral agroforestry system at forestry farm, Khaggal, College of Horticulture and Forestry, neri, Hamirpur, H.P.

(b) On farm trial showing one year growth of *Melia dubia* plants under wheat/maize based agroforestry system at Village, lethwin, Tehsil Ghumarawin, Distt. Bilaspur, H.P.

Harar

- ❖ Screening of newly developed high yielding strains of climate resilient crop i.e. Harar (*Terminilia chebula*) is in progress since July 2006. During the year under report, Kallar strain has registered the highest fruit yield followed by Tumber, Paluri, Kothi and seedling origin plant. Newly developed strains produced bigger sized fruits which fetch premium price in Amritsar, Hoshiarpur and Delhimarkets. These strains are least affected by stray and wild animals particularly monkeys besides, climate vagaries like frost and hence, can be a good alternative for farmers in monkey affected and frost prone areas (COH&F, Neri).
- ❖ Bio-efficacy of different insecticides and bio-pesticide was evaluated against harar fruit borer (*Dichocrocisspp.*). Among the tested treatments, per cent infestation was lowest in chlorantraniliprole (7.77%) followed by cyantraniliprole (10.00) and fenvelrate (14.44%). The bio-pesticides agniastra @ 2.5 per cent and synthetic insecticide monocrotophos were found least effective with percent

infestation of 42.22 per cent and 24.44 per cent. Peak infestation of the pest was recorded in the month of July (77.5%) (COH&F, Neri).

Agroforestry

- ❖ An experiment was carried out to study the effect of FYM doses and distance from fruit tree trunk of Peach cultivar nectarine on the growth and yield behaviour of Potato (*Solanum tuberosum*). Distance from trunk of Peach tree significantly influenced the number of leaves and yield of the potato crop. Maximum number of leaves (42.11 per plant⁻¹) and potato yield (12.74 t ha⁻¹) was recorded at 2m and 3 m distance, respectively. Maximum plant height (42.37 cm) branches (2.25 per plant⁻¹) were recorded when plants were supplied with FYD manure @ 75 qha⁻¹ and 25 qha⁻¹, respectively. Maximum number of leaves (41.80 per plant⁻¹), stem diameter (18.12 mm), yield (14.73 t ha⁻¹) was recorded when the potato plants were supplied with FYM @ 75 q ha⁻¹. However, net returns (Rs. 2, 15,048 ha⁻¹) and B: C ratio (2.28) was highest when the potato plants were treated with FYM@ 25 qha⁻¹ (SAF, Nauni).
- ❖ Irrespective of lopping intensity maximum plant height (38.74 cm), number of leaves (2.78) of *Allium cepa* (onion) were found in the plant supplied with the farm yard manure (FYM) on N equivalent ratio of recommended doses of fertilizers. The leaf length (35.16 cm) and the yield (27.90g) was maximum in the plants treated with vermicompost @ on N equivalent ratio of recommended doses of fertilisers. However, maximum bulb weight (27.90 g) in the plots treated with Jeevamrut. Leaf length (34.48 cm) was maximum at (75%) lopping intensity. Weight per bulb (28.05 g) and total yield (10.80 t ha⁻¹) were maximum at 50 per cent lopping intensity (SAF, Nauni).

Grasses

- ❖ In grasslands, 86 plant genera and 97 plant species were recorded of which 30 genera and 32 species were shrubs 20 genera and 25 species grasses 29 genera and 30 species forbs 4 genera and 6 species sedges and, 3 genera and 4 species were herbaceous legumes (SAF, Nauni).

- ❖ *Setaria anceps* (vars. Kajungula, Nandi, Narok), *Panicum maximum* (vars. patris green and green panic), *Chloris gayana*, and Hybrid Napier are potentially good species for improvement of sub-tropical grasslands of Himachal Pradesh (SAF, Nauni).

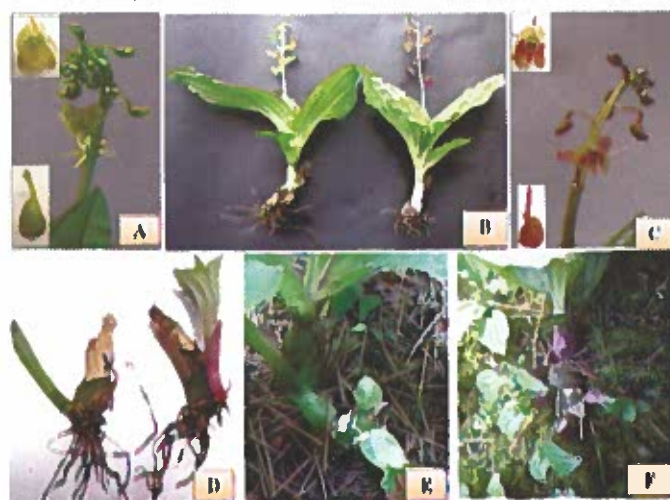
Others

- ❖ Feeding of polyherbal supplement to milking cows resulted in 2.9 per cent higher milk protein as compared to control. Milk acidity and specific gravity was not affected significantly by supplementation of polyherbal mixture (SAF, Nauni).

Medicinal Plants

Jeevak (*Malaxis acuminata*)

- ❖ In Jeevak (*Malaxis acuminata*)- a unique, distinct and stable morphotype SOLAN SELECTION having distinct colour of floral buds (yellowish green), flowers (yellow flowers without any purple tinge), green coloured sheath on base of shoot (rhizome) and pseudobulbs have been developed and registered with National Bureau of Plant Genetic Resources, New Delhi and allotted national identity no. INGR- 18043 (FPU, Nauni).



A – F. *Malaxis acuminata*; A-Yellowish green floral buds & flowers of INGR 18043; B- Wild type (right) & INGR 18043 plant (left); C- floral buds & flowers of wild plants; D- Wild (right)& INGR 18043 plant(left)at sprouting stage; E- green coloured sheath covering pseudobulbs of INGR 18043 plants; F- purple coloured sheath covering pseudobulbs of wild plants.

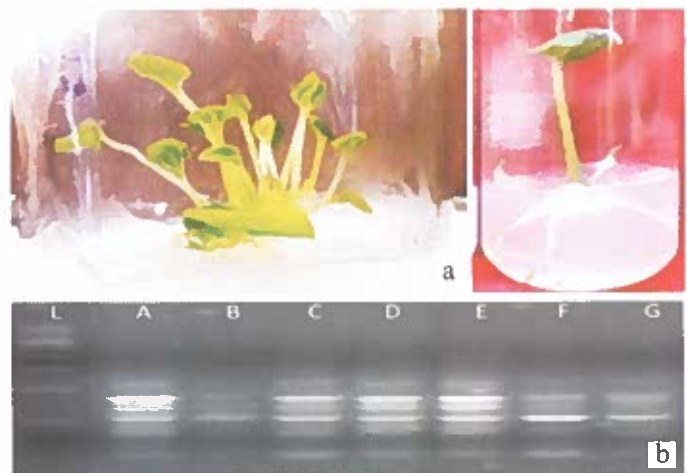
- ❖ The promising germplasm/populations of *Malaxis acuminata* were evaluated for growth and yield parameters at Shilly Farm, Solan and results revealed that Solan Selection (INGR 18043) performed much better as compared to others with economic yield of 13.443g/plant (Fresh yield of rhizome+ pseudobulbs) (FPU, Nauni).
- ❖ Phyto-chemical evaluation of different morphotypes of Indian Valerian through HPLC revealed wide variation in individual valepotriates, viz., Valtrate, Ace-Valtrate, Didro-Valtrate & IVHD-Valtrate in rhizomes and roots of different morphotypes. In rhizomes, the Valtrate content varied from 0.319-3.081 per cent, Ace-valtrate content from 0.023-0.361 per cent, Didro-Valtrate content from 0.098-2.009 per cent and IVHD-Valtrate content from 0.136-1.438 per cent. In roots, the Valtrate content varied from 0.394-3.780 per cent, Ace-valtrate content from 0.020-0.877 per cent, Didro-Valtrate content from 0.098-2.009 per cent and IVHD-Valtrate content from 0.136-1.438 per cent. On the basis of chemical content, the chemotypes with distinct morphological features and with higher concentration of different constituents have been identified (FPU, Nauni).
- ❖ Study conducted on enhancing seed yield of Glory Lily (*Gloriosa superba*) by pollination management revealed that out of seven pollination methods, assisted pollination (APU) performed much better in terms of fruit set (100%), number of seeds per pod (57.10), Pod length (6.69cm), pod diameter (17.377cm) and 100 dry seed weight (2.617g) than other methods (FPU, Nauni).



- ❖ The comparative efficacy of different organic manures and fertilizers on growth and yield of *Matricaria chamomilla* revealed that all the growth and yield parameters were observed to be highest at FYM (10 t/ha) + NPK (60:40:30 kg/ha). The gross income of Rs.78989.60/ha with BC

Ratio (1.92) was observed with the application of same doze while, the maximum B:C ratio was found in Jivamarutha Desi Cow (3.82) (FPU, Nauni).

- ❖ The comparative efficacy of different organic manures and fertilizers on growth and yield of *Ocimum sanctum* revealed that among different organic manures and fertilizers, all the growth and yield parameters of *Ocimum sanctum* (Green type & Purple type) were found maximum at FYM+NPK (10 t/ha+ 120:60:30 kg/ha) (FPU, Nauni).
- ❖ The comparative efficacy of different organic manures and fertilizers on growth and yield of *Lepidium sativum* revealed that among different organic manures and fertilizers, all the growth and yield parameters were observed to be highest at FYM (10 t/ha) + NPK (60:40:30 kg/ha) (FPU, Nauni).
- ❖ Studies on cost effective micropropagation and assessment of genetic stability in *Saussurea costus* (Kuth)-an endangered medicinal herb of North-Western Himalayan region, four different types of explants viz. cotyledon, hypocotyls, leaf and shoot tip were attempted to *in vitro* regeneration. Shoot tip explant was found to be good and induced highest direct shoot regeneration (68.46%) on MS medium supplemented with 0.25 mg/l TDZ and 0.50 mg/l NAA. Cost effective medium containing 45 g/l table sugar, 50 g/l starch and aquaguard water was found to be the best for shoot multiplication and rooting (BT, Nauni).



a) Multiplication & rooting on cost
b) Genetic stability analysis effective medium



- ❖ Effect of plant spacing on herb yield of *Viola odorata* at three different spacing viz. 15x15 cm, 30x30cm and 30x45 cm spacing recorded maximum fresh weight of flower (0.40 gm) at 30x45 cm spacing and minimum (0.25 gm) at 15x15 cm spacing. Fresh weight of five leaves was observed maximum (4.70 gm) at 30x30 cm spacing, whereas, number of flowers per plant showed maximum (8.02) at 30x30 cm spacing followed by 30x45cm spacing (6.45) and minimum (5.64) at 15x15 cm spacing (*RHR&TS, Bajaaura*).

Herbal Garden and Herbarium

- ❖ RET species, viz., *Angelica glauca* Edgew., *Saussurea costus* (Falc.) Lipsch. *Colchicum luteum* Baker, *Curculigoorchoides* Gaertn., *Ginkgo biloba* L., *Zanthoxylum alatum* DC and *Berberis aristata* DC were collected from different locations, multiplied and are being conserved in the Botanic Garden (*FPU, Nauni*).
- ❖ New cactus species, viz., *Hylocereus undatus* (Haworth) Britton & Rose, *Epiphyllum oxypetalum* (DC.) Haworth, some of the other economically important species i.e. *Moringa oleifera* Lam., *Spondias pinnata* (L.f.) Kurz, *Oroxylum indicum* (L.) Benth, ex Kurz and *Myricanagi* Thunb. Few orchids i.e. *Cymbidium hybrid* and *Habenaria edgeworthii* Hook. F. ex. Collett and some of the ferns viz. *Dryopteris marginata* (L.) A. Gray, *Polystichum squarosum* (D. Don), *Diplazium esculentum* (Retz.) Sw. and *Pteris vittata* L. have been introduced and propagated in the Botanic Garden (*FPU, Nauni*).



Angelica glauca Edgew.



Berberis aristata DC.



Moringa oleifera Lam.



Hylocereus undatus (Haworth)



Britton & Rose
Habenaria edgeworthii Hook.f.
ex Collett



Cymbidium hybrid

- ❖ A total of 47 plant samples submitted by different researchers from various Colleges /Institutes /Universities were identified and authenticated. Besides, 669 visitors from different institutions, organizations departments visited the herbarium (*FPU, Nauni*).

Wood Science and Technology

- ❖ Studies on variation in colour, texture and odour of Shisham (*Dalbergia sissoo*) wood procured from different market locations of Himachal Pradesh revealed colour variations along with texture variations.
- ❖ Studies conducted on variation in anatomical properties of Shisham (*Dalbergia sissoo*) wood collected from different market locations of Himachal Pradesh revealed longest fibre length from the samples collected from Ghumarwin site (1.660 mm), while the shortest fibre length (0.495 mm) was noticed in samples collected from Chowkiwalasite. The maximum vessel diameter (0.126 mm) was recorded in wood samples collected from Ghumarwin site where as the lowest vessel diameter was noticed in the wood samples collected from sites Barohand Sundernagar (0.119 mm) (*FPU, Nauni*).



Staining and dehydration series



Transverse section



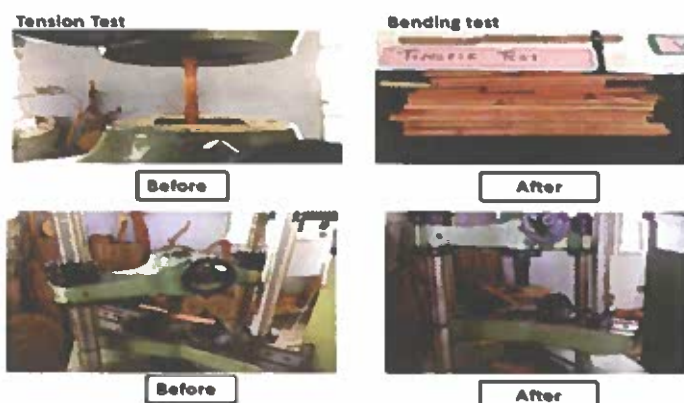
Radial section



Tangential section

Anatomical studies of *Dalbergia sissoo*

- ❖ Studies on variation in mechanical properties of Toon (*Toona ciliata*) wood procured from different market locations of Himachal Pradesh revealed the maximum tensile strength in wood samples collected from Galore (0.120 kN/mm^2) and the minimum in Kheri (0.065 kN/mm^2) (FPU, Nauni).



Breaking pattern of tension and bending test of Toon wood



Breaking pattern of Compression perpendicular to the grain of Toon wood

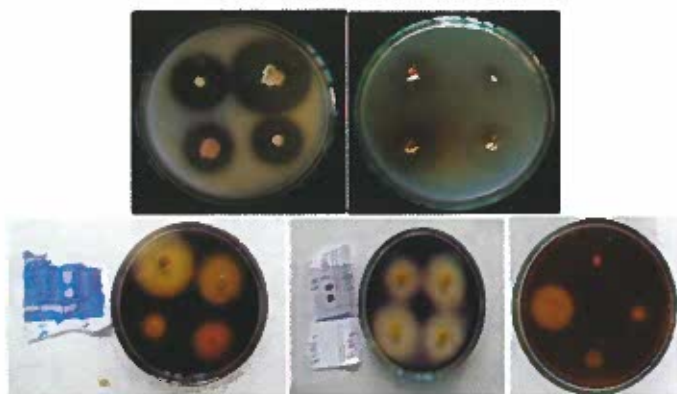
- ❖ Studies conducted on variation in anatomical properties of Ban Oak (*Quercus leucotrichophora* A. Camus) provenances from different sites of Himachal Pradesh revealed that the longest fibre (0.820 mm) was recorded in Sarahan provenance, whereas, the shortest (0.608 mm) was observed in Nao provenance. Fibre width was found to be maximum (0.016 mm) in Nao provenance whereas, the minimum fibre width (0.009 mm) was observed in Kuhasari (FPU, Nauni).
- ❖ Screening of isolates from root nodules of *Dalbergia sissoo* and *Acacia catechu* selected from different locations of Himachal Pradesh and Uttarakhand for different plant growth promoting activities was done *in-vitro* conditions. Among all the isolate AUB5 from nodules of Una (HP) seed source of *Acacia catechu* showed maximum P solubilization ($175.0 \mu\text{g/ml}$), (65.23%) siderophore production efficiency and higher amount of IAA ($76 \mu\text{g/ml}$). However, isolate

DBD1 isolated from *Dalbergia sissoo* nodules from Bilaspur (HP) seed source showed maximum P solubilization ($210.0 \mu\text{g/ml}$), (47.43%) siderophore production efficiency and higher amount of IAA ($39 \mu\text{g/ml}$). Both the selected isolates were characterized. The molecular characterization (16S rDNA) of selected rhizobial isolate AUB5 (Accession no.: MK248593) and the isolate DBD1 (Accession no.: MK248594) were identified as rhizobia and belongs to *Paraburkholderia* (BS, Nauni).

- ❖ The conjoint application of chemical fertilizers with selected rhizobial isolates significantly increased the growth parameters of *A. catechu* over uninoculated control. The maximum shoot length (44.72 cm), number of leaves (16.34), leaf area (27.54 cm^2), collar diameter (2.39 mm) and shoot dry weight (1.43 g) were recorded with (PGPR1 + 40% N) which was significantly superior over all other treatments (BS, Nauni).
- ❖ Application of selected isolates, AUB5 + 40 per cent nitrogen or consortium of two isolates namely AUB5+AUP2 can be exploited as a biofertilizer for enhanced productivity of *Acacia catechu* (BS, Nauni).
- ❖ The conjoint application of chemical fertilizers with selected rhizobial isolates significantly increased the growth parameters of *Dalbergia sissoo* over uninoculated control. The maximum shoot length (49.3 cm), number of leaves (88), leaf area (21.3 cm^2), collar diameter (4.2 mm) and shoot dry weight (5.27 g) were recorded with PGPR1 + PGPR2 which was significantly superior (BS, Nauni).
- ❖ Based on keratinolytic activity, five potential bacterial strains were identified using 16S rRNA gene sequencing technique as *Bacillus cereus* N14 (MF355368), *Bacillus cereus* N27 (MF355367), *Bacillus megaterium* N35 (MF193346), *Bacillus halotolerans* DPE11 (MF193347) and *Bacillus halotolerans* L2EN1 (MF355366). These potential isolates were deposited in a National Culture Collection Centre, NCMR, Pune, Maharashtra (India) and were assigned with accession numbers MCC 3776 (N35), MCC 3711 (L2EN1), MCC 3712 (N27), MCC 3710 (DPE11) and MCC 3709 (N14) (BS, Nauni).



- ❖ A total of 34 actinomycetes isolates obtained from the rhizospheric soil samples of *Arnebia euchroma* (Ratanjot) were screened for lytic enzymes production. Out of 34, fourteen isolates were found to be positive for pectinase, seven for protease, twenty seven for cellulase, ten for amylase and twenty two for lipase activities (BS, Nauni).



Lytic enzymes production (a) Pectinase (b) Protease and (c) Amylase (d) Lipase (e) Cellulase

- ❖ Effect of different leaf extracts, viz., Dharek (*Melia azedarach*), Parthenium (*Parthenium hysterophorus*), Chinese chaste tree (*Vitex negundo*), Eucalyptus (*Eucalyptus globulus*), Harar (*Terminalia chebula*), Eupatorium (*Eupatorium perfoliatum*) was studied on juvenile mortality of root knot nematode. Chinese chaste tree leaf extract and aqueous dharek leaf extract at 10 per cent concentration were found effective (COH&F, Neri).

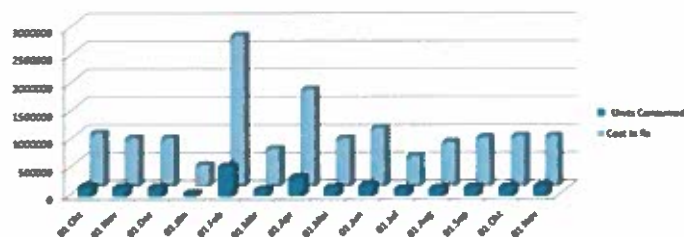
Impact Studies

- ❖ Impact Assessment of Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) on the Rural Livelihoods of Sirmaur district in Himachal Pradesh revealed that young and low and middle income groups households were participating enthusiastically and hopefully in MGNREGA works. Hence, MGNREGA should be implemented affluently in all rural parts of Himachal Pradesh for empowerment of rural People (COH&F, Neri).
- ❖ Impact of MGNREGA on beneficiaries' income, consumption expenditure and employment showed a positive trend. However, labour supply in agriculture sector and out-migration level showed a negative trend. Hence, the work under

MGNREGA should be allotted to the beneficiaries during lean/off seasons so that sufficient numbers of labourers are available during agricultural season for farmers to carry out timely operations. Major constraints faced by the respondents were basic facilities in work site like availability of drinking water, first aid, crèche/care taker and time limit for issue of job card (COH&F, Neri).

Environmental Studies

- ❖ An energy audit indicated total energy load of the university campus 1.5 MW. The global solar radiation received in the campus is estimated as 5.24 kWh/m²/d which can be utilized to meet out the energy demand of the campus. In the campus a total of 200 kg/day kitchen waste is generated which can be used for producing compost. Replacement of CFL/ FI tube light with LED can save 0.24 million kWh of electricity annually. Solar cooking system for 500 students in boys and girls hostel can save 0.18 million kWh of energy annually (ES, Nauni).

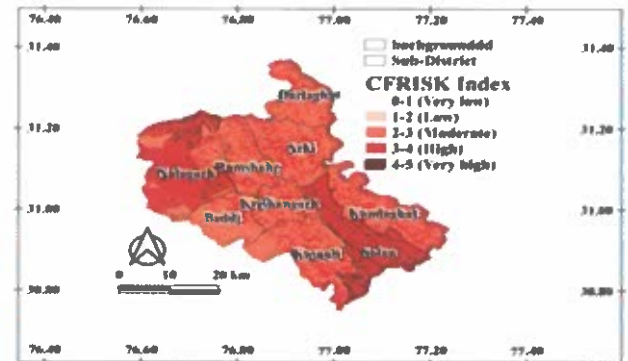




- ❖ The genus *Raoutella* was identified as the main fecal indicator organism from contaminated samples. The deterioration of water quality was more in the monsoon season and in the regions having the presence of industries. The positive correlation of contaminated water with diarrhoea during monsoon ($r = 0.88$) and post monsoon season ($r = 0.74$) indicated towards unsafe environmental conditions (*ES, Nauni*).
- ❖ Impact Assessment of National Highway Expansion on Environmental Quality in the state revealed that expansion activities decreased soil organic carbon by 30 per cent in the soils disturbed by expansion activities as compared to control site which resulted in a carbon loss of 1058.82 Mg C ha⁻¹ from the soil. The highly disturbed soil of 0-5 m registered Cd, Pb, Fe of 0.023 mg kg⁻¹, 0.335 mg kg⁻¹, 24.32 mg kg⁻¹, respectively and were above prescribed permissible limits. The soil heavy metal accumulation decreased with increased in horizontal distance from point of expansion activity (*ES, Nauni*).
- ❖ Environmental Impact Assessment of ecotourism activities in the mid hills of Himachal Pradesh revealed a carrying of 116-204 visitors per day. The study indicated that, with the current rate of tourists and the carrying capacity of the ecotourism sites is projected to exhaust in the next 12-15 years because of limitations of water availability, increasing visitor frequency, energy consumption and infrastructure which is incompatible with the ecosystem. In order to increase the sustainability of ecotourism sites, the stakeholders should manage their activity by focusing on indicators like water, energy, waste and community involvement (*ES, Nauni*).
- ❖ Predictions on forest fire incidences in mid hill of Himachal Pradesh based on Fuzzy Analytic Hierarchy Process (FAHP) technique revealed that in mid hills the highest weight for fuel type (0.3109) followed by aspect (0.2487), agricultural workers (0.1341), nutritional density (0.1244), population density (0.0622), slope (0.0524), elevation (0.0311), literacy rate (0.0207) and distance from road (0.0155), respectively were the factors responsible for fire initiation in the forests. Out of total geographical

area, 4.15 per cent was classified under very high risk, while 40.63 per cent and 54.00 per cent area was under high and moderate risk, whereas area under low risk (0.84%) and very low risk (0.37%) were extremely less (*ES, Nauni*).

FOREST FIRE PRONE AREAS IN SOLAN DISTRICT OF HP



- ❖ Greenhouse gas emission through waste management to quantify, characterize, bio-recycling and energy potential of urban solid waste (USW) of different towns of Himachal Pradesh along with its potential for greenhouse gas emissions revealed that Shimla, Dharamshala and Solan town generated 13.20, 61.5 and 11.4 tonnes of urban solid waste per day. The methane emission potential from urban solid waste of Dharamshala and Solan towns was 2556 and 1700.5 Gg CO₂ equivalent 53676 and 35710.5 per annum. The total per capita methane (CH₄) emission from Shimla town was 39196 Gg CO₂ equivalent 823116 per annum. The energy content of USW generated in Dharamshala town found that 56.36 per cent food, 18.89 per cent paper/ cardboard, 9.9 per cent plastic 2.59 per cent leather having average gross heating value of 16,191.71 KJ/kg. Similarly, the energy content of USW generated in Shimla town was found that 51.00 per cent food, 17.00 per cent paper/cardboard, 8.6 per cent plastic 3.50 per cent leather having average gross heating value of 17,199.9 KJ/kg (*ES, Nauni*).
- ❖ Energy Consumption Pattern in different agro-climatic zones in rural habitations of Western Himalayan Region revealed that 90-100 per cent households in the study area used fuelwood as primary energy source followed by LPG and agricultural waste. Electricity was also being used as a source of energy but mainly for lighting. It was found that with the increase in the altitude the per capita per day energy consumption increased in case of fuelwood but the trend was reverse in case of electricity. The fuel consumption varied with the family size, income and land holdings (*ES, Nauni*).

Externally Funded Research Projects Sanctioned (01.04.2018 – 31.03.2019)

Horticulture

1. Biotechnological interventions for developing resistance in tomato against Fusarium wilt- a prevalent disease in Himachal Pradesh [Dr Rajnish] - Deptt Environment, Science & Technology, Paryavaran Bhawan, Shimla
2. Development of disease resistant somaclonal variants in apple using *in vitro selection technique* [Dr Manju Modgil] - Deptt Environment, Science & Technology, Paryavaran Bhawan, Shimla
3. Popularization of Modern Bee Keeping Technology and Introduction of Mud Hive Technology in Chamba [Dr Anurag Sharma] – NABARD
4. Validation of DUS descriptors for the Dahlia (Dahlia sp) [Dr Priyanka Thakur] - PPB&FRA
5. Development of a Model Demonstration Unit on Zero Budget Natural Farming System for its Refinement Adoption and Expansion in Himachal Pradesh [Dr Rajeshwar S Chandel] – RKVY
6. Diversification of fruit farming through cultivation of potential underutilized fruits in low and foothills of Himachal Pradesh [Dr Vishal S Rana] – DST
7. Genomics-led improvement of biotic and abiotic stress tolerance in mustard rape for economic and environmental sustainability [Dr Anil Handa] – DBT
8. Development of a Model demonstration cum Training Unit on ZBNF systems for its refinement, validation & adoption in Disst. Solan of HP [Dr Rajeswar Sing Chandel] – ATMA

9. Development of Subhash Palekar Natural Farming (SPNF) model in apple [Dr Pankaj Gupta] - Director of Agriculture
10. Skill Development for sustainable livelihood of farmers through processing and value addition of horticultural and minor forest produce [Dr Rakesh Sharma] - HP Forest Department (Wild life Division)
11. In Vivo evaluation of Fusarium wilt resistant/tolerant ginger (*Zingiber officinale* (Rosc.) produced through biotechnological interventions [Dr Manisha Thakur] - Dept. of EN.Sci.& Tech.Shimla
12. Dissemination of dry flower technology to Vigyan Grams of H.P. [Dr Bharti Kashyap] - HIMCOSTE

Forestry

1. Biological Screening, Conservation and Establishment of Gene Bank of Drummond (Beul) [Dr HP Sankhyan] - GBPNIHESD, Kosi-Katarmal Almora
2. Enhancing Farm Income through Climate Resilient Subhash Palekar Natural Farming Systems in Horticulture Ecosystem [Dr Rajesh Kaushal] - Director of Agriculture
3. Biodegradation of low and high-density Polyethylene by Noval Bacterial Consortia for waste management in Himachal Pradesh [Dr Neerja Rana] – HIMCOSTE
4. Establishment of small nurseries (two No.) of Medicinal Plants. [Dr Yash Pal Sharma] – State Medicinal Plant Board, Shimla





EXTENSION ACTIVITIES

(a) Directorate of Extension Education

S. No.	Name of the Extension Activity	No. of participants			
		Farmers		Ext. Workers	Total
		Male	Female		
1.	Institutional Trainings (61 Nos.)	1282	200	-	1482
2.	Off- Campus Trainings/Farmer'- Scientists Interaction/Workshops (2 Nos.)	157	70	-	227
3.	Guided /Exposure Visits (56)	1400	330	-	1730
4.	Van Mahotsav and Birth Anniversary of Late Dr. YS Parmar (10 July., 2018)	-	-	-	Enmasse
5.	Nutrition Week	180	20	2	202
6.	Education Day	46	20	-	66
7.	Crop Seminar (1 No.)	-	-	-	116
8.	One day Workshop-cum- Farmers -Scientist Interaction (1 No.)	327	36	15	378
9.	Coordinated RAWE Training of Eternal University, Barusahib (Sirmaur)	-	25	-	25
10.	Farmer Advisory Services				
	a) Farmers' calls through Kisan Call Centre	-	-	-	178
	b) Courier services	-	-	-	7
	c) Agro-Advisory Services	-	-	-	Enmasse
	d) TV/Radio Talks	-	-	-	6
11.	Installation of University Exhibitions (2)	-	-	-	Enmasse
12.	Other Extension education activities	-	-	-	51

Publications of the Directorate

S.No.	Topics	No. of Copies
1.	Practical Manuals	2700
2.	Office Stationery (Tickets, Gate Entry Tickets, DO Pads, No Dues Certificates, ECR Register, Cash Books, TA Bill Form, Audit Report, Writing Pad cover, TA form, Cash Receipt Registers, Pension Check Register, Writing Pad for trainings etc.	36,160
3.	Answer Sheets, Registration Cards, B.Sc. Entrance Exam Test, Grade Report Card, Forest Guards Question Papers, Programme of study for PG students, etc.	80,050
	कृषि बाणी रोहडू, फल उत्पादन, सब्जी उत्पादन, फलों से पेय पदार्थ, फूलों की व्यवसायिक खेती, जंगली अनार से अनारदाना, बागबानी के लिए केंचुआ खाद का उत्पादन एवं महत्व, शीतोष्ण फल वृक्षों की सिंघाई एवं काट - छाँट, सेब से सिरका बनाने की प्रौद्योगिकी तकनीकी पुस्तिका, औषधीय पौधों शस्य क्रियाएँ, गुण व उपयोग, एशियन गाजर से विभिन्न इंस्टेंट पदार्थ बनाने की प्रौद्योगिक विधी, किन्नर कृषि, तापमान नियंत्रण परोक्ष सोलर ड्रायर	17,570
4.	Identification of insects and mite booklets, two spotted spider mite and its management booklet, and its management under polyhouse condition, technology of development of instant product from Asiatic carrot etc.	2500



Scientist explaining about vegetable cultivation to the farmers



Scientists explaining about Natural farming



Explaining the programmes undertaken by the University to the Chief Guest Dr Rajiv Bindal Hon'ble Speaker Vidhan Sabha, HP during Exhibition in the Shoolini Fair, Solan on 22nd June, 2018



Hon'ble Chief Minister, Himachal Pradesh Sh Jai Ram Thakur, other cabinet ministers planting trees during Van Mahotsav on 10th July, 2018



Scientist explaining about production technology of Fruit crops to the trainees



Scientists explaining about spawning and kiwi production technology



Scientists explaining about Medicinal plants and Budding and Grafting to the farmers of Thunag, Mandi



Chief Guest & MP, Lok Sabha Shimla constituency Prof. Virender Kashyap addressing farmers on the occasion of Inauguration of Pradhan Mantri Kisan Samman Nidhi Yojna on 24th February, 2019 and gathering on this occasion



(b) College of Horticulture

Activity	Food Science & Technology	Business Management	Vegetable Science	Floriculture & Landscaping Architecture	Biotechnology	Seed Science & Technology	Fruit Science	Plant Pathology	Entomology
Lectures delivered (on campus)	41	4		41		23		57	
Lectures delivered (off campus)	4	2				2			
Radio/TV talks				1			4	3	1
Workshops/ Seminars/ Symposia/ Trainings organized		1	26	2		2		2	4
Kisan Mela (organized)	1		1						
Participation in Conferences, Workshops/Seminars/ Symposia/Trainings etc.	12	5	3	7	6	13	4	7	12
VIP Visits	3			1			1		
Books/Manuals/ Compendia	2	1	4					2	2
Book chapters	3		2		2			8	3
Review articles			1						
Popular articles	5		3					2	7
Brochures/Booklets/CDs	3		1			1			

(c) College of Forestry

Activity	Environmental Science	Silviculture and Agroforestry	Social Sciences	Tree Improvement & Genetic Resources	Soil Science & Water Management	Basic Sciences	Forest Products
Lectures delivered (on campus)	6	39		1			
Lectures delivered (off campus)	4	2		1			
Radio/TV talks			1	2	1		
Meetings organized	2						
Workshops/ Seminars/ Symposia/ Trainings organized	8		4		1		
World Forestry Day	1						
Swachh Bharat Abhiyan-cum-Parthenium Eradication Day	1						



Participation in Conferences, Workshops/ Seminars/ Symposia/ Trainings etc.	6	2	3	5	7	11	22
Books/ Manuals/ Compendia	1					2	1
Book chapters	1						2
Brochures/ Booklets/ CDs/Bulletin	4						10

(d) College of Horticulture and Forestry, Neri, Hamirpur

Activity	No. of Programmes
Training Programmes Coordinated	14
Training organized	5
Trainings attended	20
Demonstrations	5
Exhibitions	2
Lectures delivered	83
Diagnostic visits	8
Radio/TV talks	20
Book Chapters	13
Popular Articles	6
Editor/Reviewers of Research Journals	12
External Examiner/ Paper Setter/ Evaluator	28
Study tour conducted	17

(e) Horticultural Research and Training Stations

Activity	Jachh (Kangra)	Bajaura (Kullu)	Dhaulakuan (Sirmour)	Mashobra (Shimla)	Tabo (Lahaul & Spiti)	Kandaghat (Solan)	Rohru (Shimla)	Chamba	Sharbo (Kinnaur)
Lectures delivered		89	34	124			242		
Radio/TV Talk			1	2		1			1
Meetings organized					1		1		
Trainings organized (on and off campus)	25		9	7	21	36	39	188	52
Workshops/Seminars/Trainings/Meetings attended	1	3	8	16	1		11		12
No. of farmers visited				241			592		
Scientific visit to farmers field							82		
Popular articles/booklets/extension booklets/success story/video filmings			2	7		7	54		
Exposure & guided visits of students			11						



Exposure & guided visits of farmers		5	21	4	14		3	
Farmers/students – Scientists interactions	1	4		1	2		439	
Diagnostic field visits (on and off campus)		46	26	44	16	10	92	
VIP visits		8	7					3
Method demonstration to farmers		3		25		66		10
On farm trial				6		11	9	11
Front line demonstration				6		12	24	13
Telephonic Consultancy		58	>1000					735
Whatsapp Diagnostics		25						
Lectures delivered in trainings		20						
Van Mahotsava	1				1		1	
Week/Day celebrated				2	4	2	10	
Field Day					5	5	6	18
Kisan Mela						1	1	
Soil Sample tested				823				124
Soil health cards issued								123
Film Show Gosthies conducted					1	3	52	

ACADEMIC ACTIVITIES

To pursue human resource development in horticulture, forestry and allied sciences, the University offers following undergraduate and postgraduate programmes through its constituent colleges/institute viz. (i) College of Horticulture, Nauni (Solan), (ii) College of Forestry, Nauni (Solan) and (iii) College of Horticulture & Forestry, Neri (Hamirpur).

College of Horticulture

Undergraduate Programme

- ❖ **B.Sc. (Hons) Horticulture- Four Year Programme**

Postgraduate Programme

- ❖ **M.Sc.in Entomology, Floriculture & Landscape Architecture, Food Technology, Fruit Science,**

Molecular Biology & Biotechnology, Plant Pathology, Seed Science & Technology, Spices, Plantation and Medicinal & Aromatic Plants, Vegetable Science

- ❖ **Master of Business Administration (Agribusiness) and Master of Business Administration**
- ❖ **Ph. D. in Entomology, Floriculture & Landscape Architecture, Food Technology, Fruit Science, Molecular Biology & Biotechnology, Nematology, Plant Pathology, Seed Science & Technology, Vegetable Science and Agribusiness Management**



College of Forestry

Undergraduate Programme

❖ B.Sc. (Hons.) Forestry- Four Year Programme

Postgraduate Programme

❖ M.Sc.in Agroforestry, Environmental Management, Forest Genetic Resources, Medicinal & Aromatic Plants, Silviculture, Wood Science & Technology, Agricultural Economics, Soil Science, Environmental Science, Microbiology, Statistics

❖ Ph. D. Agricultural Economics, Agroforestry, Forest Genetic Resources, Medicinal & Aromatic Plants, Wood Science & Technology, Silviculture,

Environmental Science, Microbiology, Soil Science and Statistics

College of Horticulture & Forestry, Neri (Hamirpur):

Undergraduate Programme

❖ B.Sc. (Hons.) Horticulture- Four Year Programme

❖ B.Sc. (Hons.) Forestry- Four Year Programme

❖ B.Tech. Biotechnology

Postgraduate Programme

❖ M.Sc. in Fruit Science, Vegetable Science, Agroforestry, Entomology, Plant Pathology, Soil Science, Food Technology, Molecular Biology and Biotechnology

Programme-wise Total Enrolment till 2018-19

Sr. No.	Programme-wise Admissions	No. of Students
College of Horticulture		
1.	B.Sc. (Hons.) Horticulture	389
2.	M.Sc./MBA	325
3.	Ph.D.	113
College of Forestry		
1.	B.Sc. (Hons.) Forestry	414
2.	M.Sc.	151
3.	Ph.D.	70
College of Horticulture & Forestry, Neri (Hamirpur)		
1.	B.Sc. (Hons) Horticulture, Forestry, B. Tech. Biotechnology	511
2.	M.Sc.	89
	Total students enrolled	2062

Programme-wise students admitted during 2018-2019

College of Horticulture, Naini (Solan)		
1.	B.Sc. (Hons.) Horticulture	125
2.	M.Sc./MBA	182
3.	Ph.D.	32
College of Forestry, Naini (Solan)		
1.	B.Sc. (Hons.) Forestry	132
2.	M.Sc.	79
3.	Ph.D.	44
College of Horticulture & Forestry, Neri (Hamirpur)		
1.	B.Sc. (Hons) Horticulture	74
2.	B.Sc. (Hons) Forestry	61
3.	B. Tech. Biotechnology	30
2.	M.Sc.	58
	Total students admitted in University	817



Students Passed out w.e.f. 01/04/2018 to 31/03/2019

College	B.Sc.	M.Sc.	MBA	Ph.D.	Total
College of Horticulture	98	97	44	35	274
College of Forestry	89	57	-	22	168
College of Horticulture & Forestry, Neri (Hamirpur)					
B Sc (Hons) Horticulture	62	-	-	-	62
B Sc (Hons) Forestry	35	-	-	-	35
B Sc (Hons) Biotechnology	26	-	-	-	26
Total students passed out	310	154	44	57	565

99th Meeting of the Academic Council was held on 19th November, 2018.

FINANCE

Source of Funding

State Government

- ❖ Department of Horticulture, Himachal Pradesh, Shimla
- ❖ Department of Forest Farming and Conservation, Himachal Pradesh, Shimla
- ❖ Department of Youth Services and Sports, Himachal Pradesh, Shimla

The University has received Grant-in-Aid from the aforesaid agencies during the financial year 2018-19

(01.04.2018 to 31.03.2019) for carrying out the teaching, research and extension education programmes. The detail of receipts and expenditure is given as under :

Government of India

- ❖ Ministry of Agriculture, Government of India
- ❖ Ministry of Energy and Environment, Government of India
- ❖ Indian Council of Agriculture Research, New Delhi
- ❖ Indian Council of Forest Research & Education, Dehradun

Sr. No.	Main source of funding	Grant-in-aid received	Domestic Income	Total Receipt	Total Expenditure (tentative)
1	Department of Horticulture	10400.00	2850.00	13250.00	11500.00
2	Department of Forest	49.00	0.00	49.00	42.00
	State Government	10449.00	2850.00	13299.00	11542.00
1	ICAR Development Assistance	523.04	0.00	523.04	523.04
2	Krishi Vigyan Kendra	738.11	0.00	738.11	738.11
3	All India Coordinated Research Projects	841.87	0.00	841.87	841.87
4	ICAR Adhoc Projects	261.73	0.00	261.73	261.73
5	NMH	63.66	0.00	63.66	63.66
6	Government of India	245.85	0.00	245.85	245.85
7	Short Term Misc. Projects	263.92	0.00	263.62	263.62
	Central Government	2938.18	2850.00	2938.18	2938.18
	Grand Total	13387.18	2850.00	16237.18	14480.18

- ❖ Apart from this, the University received the funds amounting to Rs.10,44,538/- from the various funding agencies for Vice Chancellors' Conference-cum-9th Brain Storming Session on the theme "Alternative Farming System Involving Horticulture to Increase Crop Productivity and Doubling Farmers Income" held on May 3-4, 2018 against which Rs.9,47,610/- stands utilized for the purpose for which it had been sanctioned during the financial year 2018-19.

Major achievements w.e.f. 01.04.2018 to 31.03.2019

- ❖ 107th and 111th meeting of the Finance Committee held on 13.07.2018 and 28.11.2018 and 106th,

108th, 109th and 110th meetings of the Finance Committee were got conducted by circulation.

- ❖ An additional grant amounting to Rs.2,500 crore was received from the State Govt. to defray the outstanding liabilities/salary/pension of the employees and the pensioners and Rs. 2.00 crore for construction of Boys/Girls and PG block at COH&F, Neri.
- ❖ 17 New Projects with a total outlay of Rs. 660.97 lacs were sanctioned by the Govt. of India/UGC/ICAR during the year, 2017-18

Efforts are afoot to get outstanding audit paras of LAD as well as AGHP settled and the efforts are also being made to get the outstanding advances adjusted.

LIBRARY, COMPUTER AND INSTRUMENTATION CENTRE

The library specializes in Horticulture and Forestry information and serves its users through computerised in house, National and International databases e.g. books, theses and CD-ROM. The main focus during the year was on the strengthening of collection and implementation of latest information and communication technologies to improve its services further. During the reporting year Library got installed latest technology i.e. Radio Frequency Identification (RFID) which facilitates self check in/out and generating confirmation mail to the users in respect of their transactions without human intervention.

The library has adopted KOHA, Library Management Software (Open Source Software) with Cloud Server for easy and fast delivery of information and documents to its users.

The library has digitized all the theses available in the library since its inception and uploaded on Krishikosh Database of ICAR providing free access to the users in full text available on <https://www.krishikosh.ernet.ac.in>. Besides, library also provides the following services to its users:

Online e-Journals Collection: Consortium for e-resources in Agriculture (CeRA) offers access to 4000+ e-journals through <http://www.Jgateplus.com>

on Horticulture, Forestry and other allied subjects for unlimited users.

Online e-Books Collection: The library has enriched its collection of e-books to ensure that the users are satisfied and their immediate needs for research and academic activities are taken care of. There are 248 e-



books available in its collection for full access and download on perpetual access basis.

e-Books Collection : During the year under report 78 e-books were added to the existing e-books.

Institutional Repository: The Library has an Institutional Repository for important and rare books collection of the university with the Open Source Software (DSpace) for internal distribution of information to its users the digitization and uploading of which is in progress.

CD-ROM Services : CD ROM Services are being used by the students and faculty members for their research. During the year 9916 records were generated from CD-ROM.

Newspaper Clippings: As and when university is in print media the clippings are photocopied and sent to the statutory bodies for their ready reference.

Current Periodical Section: During the financial year 2018-19 library did not get any budget for the subscription of periodicals as such library could not subscribe or renew any Journal.



Acquisition Section: 629 new books and 110 bound volumes of journals were added to the collection. In addition to this, library has also acquired 94 books on gratis from the Government, R&D Organizations, students and voluntary agencies. Besides this, 211 M.Sc. and Ph.D. Theses were also added to library collection received from M.Sc. and Ph.D. students. The total number of documents in the collection 74578 volumes.

Circulation Services: The Satyanand Stokes Library has strong base of users and about 53,253 readers visited the library and 13471 books were issued. About 86028 journals were consulted by the users.

Book Bank: The Library has approx. One thousand books in the Book Bank. During the year, 32 books have been issued to the needy students.

Creation of Modular Workstation: The library has created modular workstation with latest ICT facilities including ACs' with financial assistance from ICAR with capacity of 168 students to provide better reading environment to its users.

Library has organised sensitization workshop on Krishikosh repository and plagiarism and Training-cum-sensitization workshop on "krishikosh-Repository: a tool for strengthening agriculture knowledge" in collaboration with ICAR-Division of Agricultural Education, IARI, New Delhi on 30.10.2018.

Computer and Instrumentation Centre

Computer Centre of Dr YS Parmar University of Horticulture and Forestry provides central facility in computer and information technology to all the students, scientists and other staff of the university with more than two hundred regular users on roll. Besides, various softwares such as Pay Roll System, University Accounts Reconciliation System, DA Arrear System, IR Arrears, GPF/CPF accounting System, Students Semester Report System, Entrance Exam Evaluation system, Income and Reconciliation System are being maintained and updated.

- ❖ The Centre is providing E-mail/internet facility through campus wide Local Area Network (LAN) and 1 Gbps Internet Leased Line (under NKN project). Presently about 250 internet/e-mail nodes at users location have been provided.
- ❖ The University Website is being regularly updated by incorporating the latest information

from departments/offices of the university. All tender notices, jobs notice, training notices, university news and university important office orders/notifications were uploaded on the website.

- ❖ Result of Undergraduate and post graduate Entrance Examination (UGEE-2018 and PGET-2018) for admission to undergraduate and post graduate programmes for the year 2018-19 was evaluated and compiled in the Computer Centre.
- ❖ The results of objective type examination for the recruitments to the posts of Programme Assistant (Computer), Junior Scale Stenographer, Drivers and Junior Office Assistant were evaluated.
- ❖ Centre also collected data and uploaded on AISHE portal.

STUDENT'S ACTIVITIES

The Students' Welfare Organization is looking after the welfare of students in respect of their lodging and boarding, sports and games, cultural, health and hygiene, literary, NCC, NSS and other extra-curricular activities. The details of students activities during 2018-19 are as under:

- ❖ A total of 1212 students of which 60 per cent are residing in 16 hostels maintained by the Student Welfare Office.
- ❖ Rs. 29.00 lakhs received from ICAR were spent for the purchase of study chairs, dining chairs, tables, dining tables, sofa sets, beds, wall storage cabinets LED TV, water cooler, small almirahs, office table and chairs, in order to strengthen the infrastructural facilities for our students.
- ❖ Inter College Sports Competitions and Youth Festival 2017-18 was organized from 23-26 April 2018 at the main campus of the university in which three constituent colleges viz., College of Horticulture, Nauni, College of Forestry, Nauni and College of Horticulture & Forestry, Neri, District Hamirpur participated.
- ❖ Mr Tajender Singh, B.Sc. (Forestry) Ist year and Ms Lalrinzuali, B.Sc. Forestry (Forestry) IIIrd year of College of Forestry, Nauni were declared as Best Athlete, Men and Women, respectively.
- ❖ College of Forestry, UHF, Nauni won the "Overall Trophy for Sports" whereas, College of Horticulture "Overall Trophy for Cultural programmes".



- ❖ Indoor facilities for Kabaddi and Badminton sports have been created by installing Kabaddi Mats and Synthetic Badminton Court in the University Gymnasium which was inaugurated by the Hon'ble Vice Chancellor of the University on 22.12.2018.
- ❖ A troop of 45 students participated in the XIX All India Inter Agri. Universities Sports & Games Meet 2018-19 at Punjab Agricultural University, Ludhiana-141 004, Punjab (India) w.e.f. 02.01.2019 to 05.01.2019 representing thereby in the various sports and games like Races, Football, Volleyball, Table Tennis etc.
- ❖ 22 students participated in 19th AGRUNIFEST 2018-19 at Sardarkrushinagar Duntiwada Agricultural University, Gujarat w.e.f. 3.2.2019 to 7.2.2019 in various events like Music & Dance [(Light Vocal (Indian), Patriotic Song(Indian), Group song (Indian), Group Dance(Folk)], Liteary [(Quiz, Elecution, Debate, Extempore)], Theatre [(One Act Play, Skit, Mime, Mono Acting) and Fine Arts [(On the spot painting, Collage, Poster making, Rangoli). Mr Himesh Kapoor (F-2015-32 –BIV), BSc 4th Year student of College of Forestry bagged 4th position in the Debate event.
- ❖ Ms Ibashongdor Zephaniah Synnah and Ms Avani Chauhan, M Sc. 2nd year students of Department of Social Science, College of Forestry, UHF, Nauri participated in Elocution Contest organized by Punjab Agricultural University, Ludhiana on 24.8.2018.
- ❖ Mr Vipul Sharma, M Sc. Student, COF and Ms Gauri Sood, B Sc. 3rd year student, COH participated in the Declamation Contest on the Youth Awareness for Voting conducted by the SDM-cum-Assistant Returning Officer (Election), Solan at ITI, Solan on 18.10.2018 in which students from eleven universities participated. Ms Gauri Sood stood second in the declamation contest and received a cash prize of

Rs. 700/- (Rupees seven hundred) only.

- ❖ Mr Vipul Sharma, M. Sc Forestry, Mr Piyush Dhiman, B. Sc. Forestry 1st Year and Mr Shubham Sharma, B. Sc. Horticulture 3rd year participated in the Declamation Contest organised by the District Election Officer-cum-Deputy Commissioner, Solan on National Voters' Day on 25th January, 2019 at ITI, Solan.
- ❖ Ms Parul Sharma, B. Sc. (Forestry) final year student participated and bagged 2nd position in the state in the Declamation Contest organized by the Himachal Pradesh Council for Science, Technology & Environment (HIMCOSTE), Shimla at Govt. Girls Sr. Sec. School Portmore, Shimla on 27.2.2019 on the occasion of National Science Day-2019 on 28th February, 2019.
- ❖ Fourth International Day of Yoga was celebrated in main campus of the University on 21st June 2018. Brahmamurti Yogtheerath Ji Maharaj of Dhyani Yog Ashram Avam Ayurved Shodh Sansthan, Kathni (Subathu), District Solan, Himachal Pradesh was the special invitee and expert to teach Yoga and Pranayam to the participants. Hon'ble Vice Chancellor, Dr H.C. Sharma, Statutory Officers, Heads of Departments, teaching/ non-teaching staff and their family members, students of university and nearby school participated in this programme.



- ❖ YSPUHF Gymnasium was inaugurated by the Hon'ble Vice Chancellor on 18th July 2018.
- ❖ Nominations for Central Students Association including 20 Class Representative, 6 Academic Representatives, 2 Sports Representatives and 3 Cultural Representatives of both the colleges of main campus were finalized on 11th October, 2018, and following office bearer were nominated for Central Students Association.

1	Mr Anshul Kumar	President
2	Mr Amit Kumar	Vice President
3	Mr Umesh Sharma	General Secretary
4	Mr Abhishek Jhangta	Jt. Secretary-cum Treasure



- ❖ Central Students Association of this University organized a Cultural Night on the occasion of Holi Festival on 21.03.2019.



NSS Special Camp

- ❖ 7 days NSS camp of the B.Sc. 3rd year students was organized from 14-20 June 2018 in Nauni Panchyat, Solan in which 185 students participated in various activities like cleaning, weeding, construction of Check Dam, plantations, beautifying Senior Secondary School and Primary School, Shamror (Nauni) through painting the walls.
- ❖ Four NSS students Mr Tejaswi Vimal, Mr Prince Thakur, Mr Dharuv Verma and Mr Manish Negi of this University attended the NSS Adventure Camp at Pong Dam, Kangra w.e.f. 12.10.2018 to 21.10.2018 being organized by the Regional Director, Ministry of Youth Affairs & Sports, Government of India.



- ❖ Cleanliness Awareness Programme was organized in the university main campus in association with NSS volunteers of this University on 17th and 24th November, 2018. Local residents and vendors were participated in the cleanliness programme.



- ❖ 2 NSS Volunteers Ms Aparna Gautam and Ms Shikha Arora BSc (Forestry) 1st Year of College of Forestry attended National Integration Camp (NIC) at District Institute of Education and Training, Mandi (HP) w.e.f. 12.02.2019 to 18.02.2019.
- ❖ Troops of NCC and NSS participated in the parade on Republic Day Function on 26th January 2019 which was inaugurated by Hon'ble Vice Chancellor of the University.



- ❖ Seven students from both the Colleges of main campus attended Army Attachment Camps at Solan and Dughshai w.e.f. 4.10.2018 to 13.10.2018.
- ❖ 2 Cadets from this University participated in the National Integration Camp on 'Ek Bharat Shreshth Bharat' programme at Jaisalmer (Rajasthan) w.e.f. 12.11.2018 to 23.11.2018 and one Cadet Dheeraj Lubana participated in *Ek Bharat Shreshth Bharat* programme at Roopnagar (Punjab) w.e.f. 09.01.2019 to 20.01.2019.
- ❖ 49 NCC Cadets awarded "C" certificate, whereas 29 Cadets (18 Boys & 11 Girls) from Boys Battalion and 12 Cadets (12 Girls) from Girls Battalion awarded "B" certificate.
- ❖ 43 students from College of Horticulture and College of Forestry, Nauni attended 4th Agrivision-2019 National Convention on "Integrated Agriculture Prosperous Bharat" which was organised by Vidyarthi Kalyan Nyas, Bhopal in collaboration with Ministry of Agriculture & Farmers Welfare, MHRD, Department of Chemicals and Fertilizers, MFPI, ICAR and NABARD at IARI, New Delhi on January 28-29, 2019.

Training/convention, Personality and Placement of Students

- ❖ Personality Development Training Programme for B.Sc. (Final year) students of College of Horticulture and College of Forestry of this



University was organized on 28-29 May, 2018 and 30-31 May, 2018 respectively by this organization in collaboration with Department of Business Management in two batches. 98 students from COH and 80 students from COF participated in the training. Mrs Vibhuti Dubey Negi from Shimla was invited expert in the programme.

- ❖ The placement Cell contacted various government/private agencies for the placement of University students. During the year 64



students were got placement. 3 students were selected in ARS.

- ❖ 31 students qualified for JRF and one SRF during the year. 53 students qualified the NET examination.

INFRASTRUCTURE DEVELOPMENT

- ❖ During 2018-19 a sum of **Rs.1,086.70 Lakhs** only were spent on various works transferred by the Comptroller/deposited by other departments with the Estate Organization as development assistance from various funding agencies viz.

ICAR, ICFRE, Govt. of India, State Horticulture/Forestry grants etc. for buildings, roads, water supply, irrigation and electrification etc. at the main campus Nauni-Solan and various research stations and KVK's.

a). Works Completed

Sr. No.	Name of work	Status	Location
1.	Renovation of Hostel at main campus (SH:- Rewiring of old PG Hostel)	Completed	Nauni
2.	Construction of Girls Hostel-VII	Completed	Nauni
3.	Providing solar fencing FLS	Completed	Nauni
4.	Construction of Polycarbonate house in the Deptt. of Fruit Science	Completed	Nauni
5.	AR and MO various buildings at main campus (SH:- Repair of Lab. blocks / Offices).	Completed	Nauni
6.	AR and MO various buildings at main campus (SH:- Repair of residences allotted or to be allotted).	Completed	Nauni
7.	Providing concrete flooring in solar fencing at Majhgaon and barbed wire fencing near University dairy farm at main campus Nauni, Solan (SH:- Providing concrete flooring in solar fencing at Majhgaon).	Completed	Nauni
8.	Repair of Rooms in Officer Hostel at main campus Nauni, Solan	Completed	Nauni
9.	Construction of Processing and storage infrastructure for the Deptt. of SST at main campus Nauni, Solan (SH:- Additional storage facility at Makroa farm)	Completed	Nauni
10.	Construction of Processing and storage infrastructure for the Deptt. of SST at main campus Nauni, Solan (SH:- Additional storage facility at Manhat farm)	Completed	Nauni
11.	Repairing 17 Nos. Poly-houses and 03 Nos. shade net houses at experimental farm of the Deptt. of FLA at main campus Nauni, Solan. Completed	Completed	Nauni



12.	Setting up of Electrical sub-stations	Completed	Nauni
13.	Providing fire fighting system in University Auditorium	Completed	Nauni
14.	Modification of Herbarium/ Museum for the Deptt. of Forest product	Completed	Nauni
15.	Construction of clear water storage tank and water treatment plant for residential colony	Completed	Nauni
16.	Repairing of boundary ball to protect the garden area for the Deptt. of Forest product	Completed	Nauni
17.	Re-wiring of new UG Hostel and other repair of hostels	Completed	Nauni
18.	Renovation of Lab in the Deptt. of Social Science	Completed	Nauni
19.	Renovation of work station in the classrooms of Deptt. of basic science	Completed	Nauni
20.	Providing chain link fencing in Girls Hostel	Completed	Nauni
21.	Modernization of smart class room in COH	Completed	Nauni
22.	Construction of Farm Road	Completed	Jachh
23.	Construction of U-shape drain	Completed	Jachh
24.	Providing fencing along the road	Completed	Jachh
25.	Construction of store at RHRS Jachh	Completed	Jachh
26.	Up-gradation of training hall	Completed	Jachh
27.	Providing Three phase LT Panel to various buildings	Completed	Neri
28.	Providing moduler research labs in various Departments.	Completed	Neri
29.	Re-surfacing of approach College road	Completed	Neri
30.	Providing paver in front of main building	Completed	Neri
31.	Providing furniture in newly constructed SC Girls hostel	Completed	Neri
32.	Conversion of Seminar Hall into processing hall at COH&F Neri, Hamirpur (HP).	Completed	Neri
33.	Construction of retaining wall along the road to extend the ground in front of main office building at COH&F, Neri, Hamirpur.	Completed	Neri
34.	Re-surfacing of approach road	Completed	Bhota
35.	Construction of Approach road and fencing of Residential quarters Chamba	Completed	Chamba
36.	Construction of Vermi compost unit in Baghot farm	Completed	Chamba
37.	Construction of irrigation tank at Baghot farm	Completed	Chamba
38.	Construction of Shading net house	Completed	Dhaulakuan
39.	Construction of Polyhouse	Completed	Dhaulakuan
40.	Construction of Mist chamber	Completed	Dhaulakuan
41.	Construction of Green house	Completed	Dhaulakuan



b). Works awarded / in progress

Sr. No.	Name of work	Status	Location
1.	Construction of Boys Hostel –VI	In progress	Nauni
2.	Construction of Field lab. In the Deptt. of FLS	In progress	Nauni
3.	Construction of incubation centre under Chief Minister Startup Scheme	In progress	Nauni
4.	Renovation of Existing path for the Deptt. of Forest product	In progress	Nauni
5.	Renovation of existing gate for the Deptt. of Forest Product	In progress	Nauni
6.	Addition / alteration of play ground and pavilion block	In progress	Nauni
7.	Renovation of old UG Hostel	In progress	Nauni
8.	Renovation of International Student Hostel	In progress	Nauni
9.	Renovation of New Girls Hostel (OFH)	In progress	Nauni
10.	Renovation of all boys hostel	In progress	Nauni
11.	Renovation of all girls hostel	In progress	Nauni
12.	Renovation of new UG hostel	In progress	Nauni
13.	Renovation of Electrical supply in boys hostel	In progress	Nauni
14.	Renovation of Library reading room	In progress	Nauni
15.	Conversion of lecture hall into UG / PG lab in COF	In progress	Nauni
16.	Renovation of UG lab in the Deptt. of Entomology	In progress	Nauni
17.	Renovation of UG/ PG Labs in COH	In progress	Nauni
18.	Renovation of Bio-chemistry lab in the Deptt. of Basic Science	In progress	Nauni
19.	Renovation of smart class rooms in the Deptt. of EVS under COF	In progress	Nauni
20.	Renovation of lab in the Deptt. of Forest Product	In progress	Nauni
21.	Renovation of UG Lab in the Deptt. of TIGR	In progress	Nauni
22.	Providing fencing in Samroar area	In progress	Nauni
23.	Providing fencing in Naganji / Nandho area	In progress	Nauni
24.	Up gradation of Guest House	In progress	Nauni
25.	Completion of STF staff Hutt	In progress	Nauni
26.	Providing LED Display Board	In progress	Nauni
27.	Renovation/extension of common room/kitchen in hostel	In progress	Nauni
28.	Special repair of RCC chajja in various residences	In progress	Nauni
29.	Repair of depressed floor of Comptroller Chamber	In progress	Nauni
30.	Construction of Field Lab in Manjhgaon Farm	Work in hand	Nauni
31.	Augmentation of water supply scheme	Work awarded	Nauni
32.	Construction of shade net house Deptt. of FLA	Work in hand	Nauni
33.	Special repair of Shopping Centre	Work in hand	Nauni
34.	Construction of path Deptt. of FLA	Work in hand	Nauni
35.	Repair of Mist chamber	Work in hand	Nauni
36.	Renovation of Glass House in the Deptt. of Vegetable Science	Work in hand	Nauni
37.	Renovation of cow shed under the Deptt. of SAF	Work in hand	Nauni
38.	Construction of two Nos. of waste water tanks under the Deptt. of SAF	Work in hand	Nauni
39.	Providing Solar fencing of SPNF Farm under the Deptt. of SSWM	Work in hand	Nauni
40.	Renovation of Polyhouses	In progress	Kandaghat
41.	Construction of Field Laboratory-cum-Farmer Practical Training Hall	In progress	Kandaghat
42.	Construction of main gate	In progress	Sharboa



43.	Construction of Multipurpose building at COH&F Neri, Distt. Hamirpur (SH:- Site Development, Building portion, W/S and S/I).	In progress	Neri
44.	Construction of control room for drip fertigation in farm area at COH&F Neri, Distt. Hamirpur (SH:- BP, WS and SI).	In Progress	Neri
45.	Construction of irrigation water storage tank at COH&F Neri, Hamirpur.	In Progress	Neri
46.	Construction of boundary wall around the SC student hostel for girls	In progress	Neri
47.	Providing external electrical connections to Control room	In progress	Neri
48.	Construction of Lab cum store	Work in hand	Neri
49.	Providing three phase LT line in compost / mushroom Unit	Work in hand	Neri
50.	Providing stone wall with chain link fencing	In progress	Seo bagh
51.	Providing chain link fencing at Bajoura	In progress	Bajoura
52.	Repairing of retaining wall	In progress	Mashobra

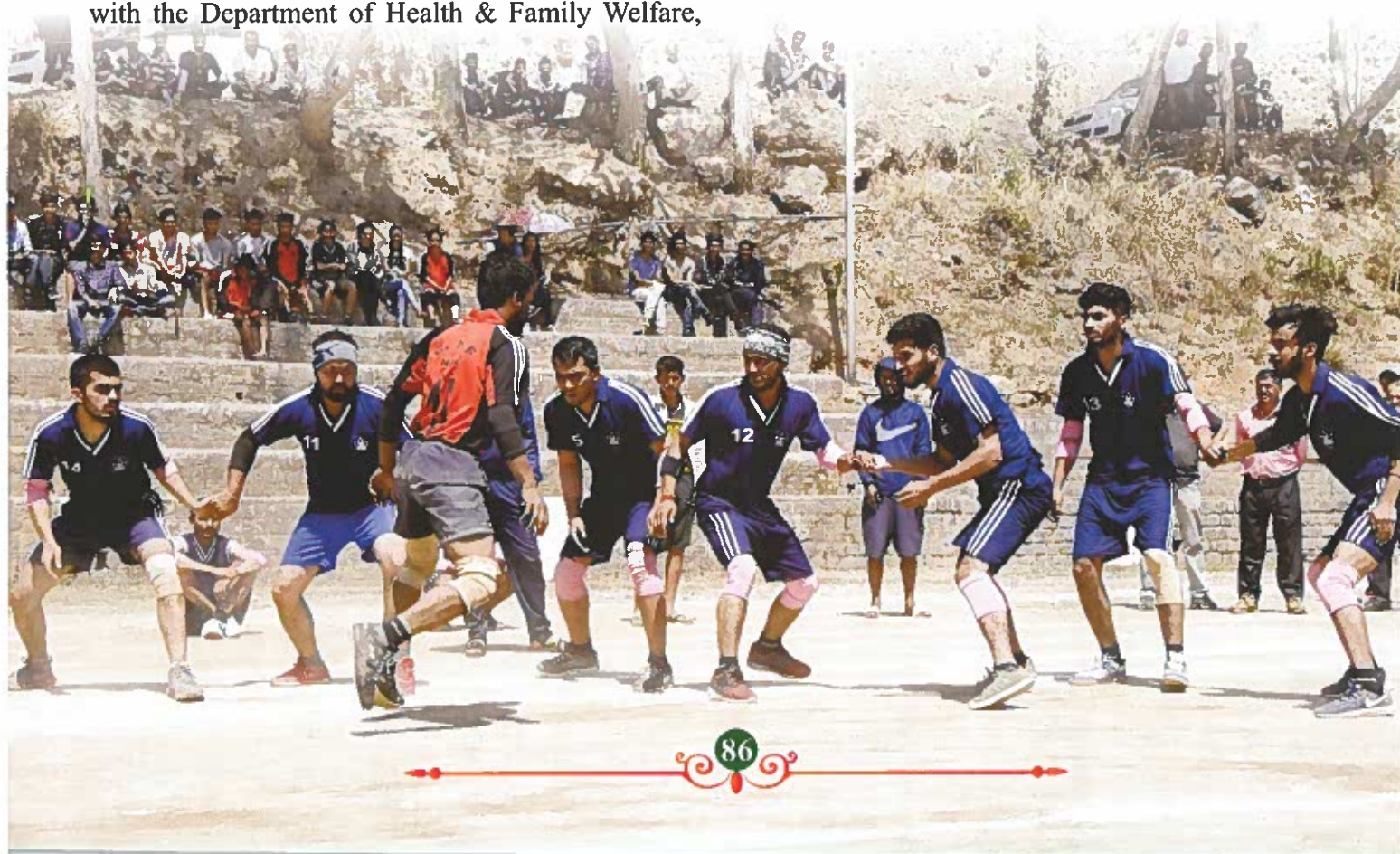
Besides above various other major / small works at Nauri as well as various research stations / KVK's etc. were carried out along with annual maintenance of buildings, water supply sanitary installations,

electrical installations, maintenance of roads, transportation services, repair and maintenance of Guest House, sewerage plant and intercom services etc. during the year.

HEALTH CARE FACILITIES

12511 patients (9808 new and 2703 old) including students, staff and local residents visited the University Health Centre for the treatment. National and other Govt. programmes like Pulse Polio Camps, RNTCP and Immunization/vaccination camps (10th of every month) were also conducted in collaboration with the Department of Health & Family Welfare,

Solan. Basic facilities were provided to the visiting team of Doctors and paramedical staff for Blood Donation Camps being organised by the Central Students Association and NSS contingent in collaboration with Loins Club Solan on 24.11.2018 and 15.02.2019 respectively.





AUTHORITIES OF THE UNIVERSITY (01.04.2018 to 31.03.2019)

The University Authorities comprising of University Senate, Board of Management, Academic Council, Research Council, Extension Council, Finance

Committee and Board of Studies for College of Horticulture, College of Forestry and College of Horticulture and Forestry, Neri.

SENATE

1.	Acharya Devvrat	Chancellor – Chairman
2.	Dr. Hari C. Sharma	Vice Chancellor, UHF, Nauni (Solan)
3.	Secretary (Horticulture)	Government of Himachal Pradesh
4.	Secretary (Forests)	Government of Himachal Pradesh
5.	Director of Agriculture	Government of Himachal Pradesh
6.	Director of Horticulture	Government of Himachal Pradesh
7.	Principal Chief Conservator of Forests	Government of Himachal Pradesh
8.	Dr. Rakesh Gupta	Dean, College of Horticulture
9.	Dr. P K Mahajan	Dean, College of Forestry
10.	Dr. P C Sharma	Dean, College of Horticulture and Forestry Neri, Distt. Hamirpur
11.	Dr. J N Sharma	Director of Research
12.	Dr. Vijay Singh Thakur	Director of Extension Education
13.	Shri Hira Mani Verma	Comptroller
14.	Er. Ajay Gupta	Estate Officer upto 22.05.2018
15.	Er. (Ms.) Aparna Rohela	Estate Officer w.e.f 24.05.2018
16.	Dr. Bhau Singh Thakur	Librarian upto 31.08.2018
17.	Dr. (Mrs.) Anju S. Khanna	Librarian w.e.f 01.09.2018
18.	Dr. S K Gupta	Students' Welfare Officer upto 31.12.2018
19.	Dr. Kulwant Rai Sharma	Students' Welfare Officer w.e.f. 01.01.2019
20.	Shri Balbir Singh Verma	MLA, HP Vidhan Sabha
21.	Shri Suresh Kumar Kashyap	MLA, H.P Vidhan Sabha
22.	Dr. R S Chandel	Joint Director Research, O/o the Directorate of Research, UHF, Nauni (Solan)
23.	Dr. Rohit Bishist	Assistant Professor, Department of Silviculture and Agroforestry, UHF, Nauni (Solan)
24.	Sh. O P Thakur	Superintendent, Department of Environmental Science, College of Forestry, UHF, UHF, Nauni (Solan).
25.	Sh. Rajesh Kumar, HPAS	Registrar, UHF, Nauni (Solan) – Member Secretary



BOARD OF MANAGEMENT

1.	Dr. Hari C. Sharma	Vice Chancellor - Chairman
2.	Prof. Ashok Kumar Sarial	Vice Chancellor, CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur
3.	Secretary (Horticulture)	Government of Himachal Pradesh
4.	Secretary (Finance)	Government of Himachal Pradesh
5.	Secretary (Forests)	Government of Himachal Pradesh
6.	Director of Horticulture	Government of Himachal Pradesh
7.	Principal Chief Conservator of Forests	Government of Himachal Pradesh
8.	Director of Agriculture	Government of Himachal Pradesh
9.	Dr. JN Sharma	Director of Research, UHF, Nauni (Solan) upto 04.12.2018
10.	Dr. Sanjeev K Chauhan	Head, ICAR-CAZRI, RRS, Leh (J&K) upto 04.12.2018
11.	Prof. MS Dahiya	Registrar, HAU, Hissar (Haryana) upto 04.12.2018
12.	Sh. Arun Verma	Village Bhanat, Tehsil Rajgarh, District Sirmaur upto 04.12.2018
13.	Sh. Gopal Mehta	Village Halyana, PO Shamabhalla, Distt. Shimla (HP)-172030 upto 04.12.2018
14.	Shri Dinesh Negi	VPO Yulla, Tehsil Nichar, Distt. Kinnaur (HP)-172104 upto 04.12.2018
15.	Smt. Kiran Kaundal	Jagriti Mahilla Kisan Simniti, Village Paplota, PO Domehar, Tehsil Arki, Distt. Solan (HP)-173221 upto 04.12.2018
16.	Er. Balwant Singh Thakur	Chief Engineer (Retd), House No. 91, Himuda Colony, Opposite DAV School, PO Jhaniyara, Tehsil & District Hamirpur (HP)-177 601 upto 04.12.2018
17.	Dr. G Venkateshwarlu	Additional Director General (EQA&R), ICAR, KAB-II, New Delhi (nominee of ICAR) upto 04.12.2018
18.	Dr. VPTewari	Director, HFRI, Shimla (Nominee of ICFRE) upto 04.12.2018
19.	Sh. Rajesh Kumar, HPAS	Registrar, UHF, Nauni (Solan) – Member Secretary

ACADEMIC COUNCIL

1.	Dr. Hari C. Sharma	Vice-Chancellor
2.	Dr. Rakesh Gupta	Dean, College of Horticulture
3.	Dr. PK Mahajan	Dean, College of Forestry
4.	Dr. PC Sharma	Dean, College of Horticulture and Forestry Neri, Hamirpur
5.	Dr. JN Sharma	Director of Research
6.	Dr. Vijay Singh Thakur	Director of Extension Education
7.	Director, Forestry Education	Forest Research Institute, Dehradun
8.	Dr. Bhau Singh Thakur	Librarian upto 31.08.2018
9.	Dr. (Mrs.) Anju S. Khanna	Librarian w.e.f. 01.09.2018 to 31.03.2019
10.	Dr. S K Gupta	Students' Welfare Officer upto 31.12.2018
11.	Dr. Kulwant Rai Sharma	Students' Welfare Officer w.e.f. 01.01.2019



12.	Dr. Y.C Gupta	Professor and Head, Department of Floriculture and Landscape Architecture, College of Horticulture, UHF, Nauni (Solan)
13.	Dr. G.C Sharma	Principal Scientist, Department of Entomology college of Horticulture, UHF, Nauni (Solan) upto 31.12.2018
14.	Dr. Anju S Thakur	Professor and Head, Department of Basic Sciences, College of Forestry, UHF, Nauni (Solan)
15.	Dr. Ravinder Sharma	Principal Scientist, Department of Social Sciences, College of Forestry, UHF, Nauni (Solan)
16.	Dr. R.S Prashar	Principal Scientist, Deptt of Social Sciences, College of Horticulture and Forestry, Hamirpur at Neri
17.	Dr. Som Dev Sharma	Principal Extension Specialist, Department of Fruit Science, College of Horticulture and Forestry, Hamirpur at Neri
18.	Dr. R.C Sharma	Director of Research (Retd.), Flat No. 6, Mehta Estate, Near BSNL Exchange, P.O Shamti, Distt. Solan
19.	Dr. D.S Ginwal	Dean (Academic), Forest Research Institute, Dehradun, Kaulagarh Road, P.O.E 248195, Uttrakhand.
20.	Sh. Rajesh Kumar, HPAS	Registrar, UHF, Nauni (Solan) – Member Secretary

EXTENSION COUNCIL

1.	Dr. Hari C. Sharma	Vice Chancellor, UHF, Nauni (Solan) – Chairman
2.	Director of Horticulture	Government of Himachal Pradesh
3.	Director of Agriculture	Government of Himachal Pradesh
4.	Principal Chief Conservator of Forests	Government of Himachal Pradesh
5.	Dr. Rakesh Gupta	Dean, College of Horticulture
6.	Dr. PK Mahajan	Dean, College of Forestry
7.	Dr. J.N Sharma	Director of Research
8.	All the Heads of Departments	UHF, Nauni (Solan)
9.	All the Associate Directors (R&E)	UHF, Nauni (Solan)
10.	Director of Extension Education	CSK HPKV, Palampur, District Kangra
11.	Joint Director (Training)	Directorate of Extension Education
12.	Joint Director (Communication)	Directorate of Extension Education
13.	Extension Coordinator	Directorate of Extension Education
14.	Deputy Commissioner	District Solan
15.	Sh. Bihari Lal Sharma	Executive Director, Youth for Sustainable Development, B-2, MC Car Parking, Near HP High Court, Shimla upto 09.01.2019
16.	Smt. Bishma Devi	Village Telangi, PO Reckongpeo, District Kinnaur up to 09.01.2019
17.	Sh. Sudarshan Kumar	Village Ban Kardian, PO Khel, Tehsil Nurpur District Kangra up to 09.01.2019
18.	Sh. Ramesh Kumar	Village Bilkar, PO Bhota, Tehsil Badsar, District Hamirpur up to 09.01.2019



19.	Shri Amar Nath Sharma	Village Baharer, PO Jansooh (Dhaneta), Tehsil Nadaun, District Hamirpur up to 09.01.2019
20.	Shri Rajesh Kumar, HPAS	Registrar, UHF, Nauni (Solan)
21.	Shri Hira Mani Verma	Comptroller
22.	Dr. Vijay Singh Thakur	Director of Extension Education – Member Secretary

RESEARCH COUNCIL

1.	Dr. Hari C. Sharma	Vice Chancellor, UHF, Nauni (Solan) – Chairman
2.	Director of Horticulture	Government of Himachal Pradesh
3.	Director of Agriculture	Government of Himachal Pradesh
4.	Dr. Rakesh Gupta	Dean, College of Horticulture
5.	Dr. P K Mahajan	Dean, College of Forestry
6.	Dr. P C Sharma	Dean, College of Horticulture and Forestry, Neri
7.	Dr. Vijay Singh Thakur	Director of Extension Education
8.	All the Heads of Departments	UHF, Nauni (Solan)
9.	All the Associate Directors (R&E)	UHF, Nauni (Solan)
10.	Director of Research	CSK HPKV, Palampur, District Kangra
11.	Shri MK Badyal	HP Farmer, 1 st Floor, Dogra Bazar, Chamba upto 09.01.2019
12.	Shri Prem Singh Chauhan	Village Jaltahar, Chalnair (Kotkhai), Distt. Shimla upto 09.01.2019
13.	Shri Hariman Sharma	Village Paniyala, PO Kothi, Tehsil Ghumarwin, Distt. Bilaspur (HP) upto 09.01.2019
14.	Shri Nand Kishore Sharma	Village Shanech, PO & Tehsil Kandaghat, Distt. Solan (HP) upto 09.01.2019
15.	Shri Kartar Singh	Village Katoi, PO Chaukath, Tehsil Jawalamukhi, Distt. Kangra (HP) upto 09.01.2019
16.	Shri Rajesh Kumar, HPAS	Registrar, UHF, Nauni (Solan)
17.	Shri Hira Mani Verma	Comptroller, UHF, Nauni (Solan)
18.	Dr. J.N Sharma	Director of Research – Member Secretary

BOARD OF STUDIES (COLLEGE OF HORTICULTURE)

1.	Dr. Rakesh Gupta	Dean, College of Horticulture
2.	All the Heads of Departments	College of Horticulture, UHF, Nauni (Solan)
3.	Head of the Department of Basic Sciences	College of Forestry, UHF, Nauni (Solan)
4.	Head of the Department of Social Sciences	College of Forestry, UHF, Nauni (Solan)
5.	Head of the Department of Soil Science and Water Management	College of Forestry, UHF, Nauni (Solan)
6.	Dr. DP Sharma	Principal Horticulturist, Department of Fruit Science, COH, UHF, Nauni (Solan).
7.	Dr. (Mrs.) Manju Modgil	Professor, Department of Biotechnology, COH, UHF, Nauni (Solan).



8.	Dr. Mohinder Singh	Principal Extension Specialist, Department of Entomology, COH, UHF, Nauni (Solan).
9.	Dr. Sita Ram Dhiman	Principal Extension Specialist, Department of Floriculture and Landscape Architecture, COH, UHF, Nauni (Solan).
10.	Dr. Rakesh Sharma	Assistant Professor, Department of Food Science, COH, UHF, Nauni (Solan).
11.	Dr. (Ms.) Meenu Gupta	Assistant Professor, Department of Vegetable Science, COH, UHF, Nauni (Solan).
12.	Dr. (Ms.) Shalini Verma	Scientist, Department of Plant Pathology, COH, UHF, Nauni (Solan)
13.	Dr. (Ms.) Rashmi Chaudhary	Assistant Professor, Department of Business Management, COH, UHF, Nauni (Solan).
14.	Dr. Krishan Kumar	Professor and Head, Department of Fruit Science, COH, UHF, Nauni (Solan) – Secretary upto 31.08.2018
15.	Dr. Munish Kumar Sharma	Professor and Head, Department of Seed Science & Technology, COH, UHF, Nauni (Solan) w.e.f06.09.2018

BOARD OF STUDIES (COLLEGE OF FORESTRY)

1.	Dr. P K Mahajan	Dean, College of Forestry
2.	All the Heads of Departments, College of Forestry	College of Forestry, UHF, Nauni (Solan)
3.	Head of the Department of Entomology	College of Horticulture, UHF, Nauni (Solan)
4.	Head of the Department of Plant Pathology	College of Horticulture, UHF, Nauni (Solan)
5.	Head of the Department of Biotechnology	College of Horticulture, UHF, Nauni (Solan)
6.	Dr. HP Shankhyan	Principal Extension Specialist, Department of Tree Improvement and Genetic Resources, COF, UHF, Nauni (Solan)
7.	Dr. KS Pant	Principal Scientist, Department of Silviculture and Agroforestry, COF, UHF, Nauni (Solan)
8.	Dr. (Ms.) Ashu Chandel	Associate Professor, Department of Basic Sciences, COF, UHF, Nauni (Solan).
9.	Dr. Sudhir Verma	Assistant Professor, Department of Soil Science and Water Management, COF, UHF, Nauni (Solan).
10.	Sh. Jai Pal Sharma	Assistant Professor, Department of Tree Improvement and Genetic Resources, COF, UHF, Nauni (Solan).
11.	Dr. MK Brahmi	Assistant Professor, Department of Environmental Science, COF, UHF, Nauni (Solan).
12.	Dr. Bhupender Dutt	Professor, Department of Forest Products, COF, UHF, Nauni (Solan) – Secretary.



BOARD OF STUDIES
(COLLEGE OF HORTICULTURE AND FORESTRY, NERI (HAMIRPUR))

1.	Dr. P C Sharma	Dean, College of Horticulture and Forestry, Hamirpur at Neri
2.	Dr. Som Dev Sharma	Principal Extension Specialist, Department of Horticulture, COH&F, Neri, Hamirpur.
3.	Dr. Deepa Sharma	Scientist (Veg.), Department of Horticulture, COH&F, Neri, Hamirpur.
4.	Dr. Kamal Sharma	Principal Scientist, Department of Forestry and Environment, COH&F, Neri, Hamirpur.
5.	Dr. Ravi Bhardwaj	Assistant Professor, Department of Forestry and Environment, COH&F, Neri, Hamirpur.
6.	Dr. Sita Ram Dhiman	Principal Extension Specialist, Department of Floriculture and Landscape Architecture, COH, UHF, Nauni (Solan).
7.	Dr. (Ms.) Sneh Lata Sharma	Assistant Professor, Department of Biotechnology, COH&F, Neri, Hamirpur.
8.	Dr. KD Sharma	Principal Horticultural Technologist (FST), Department of Food Science and Technology, COH&F, Neri, Hamirpur
9.	Dr. Virender Kumar Rana	Principal Extension Specialist, Department of Plant Protection, COH&F, Neri, Hamirpur.
10.	Dr. Ajay Sharma	Assistant Professor, Department of Plant Protection, COH&F, Neri, Hamirpur.
11.	Dr. VK Chaudhary	Principal Scientist, Department of Social and Basic Science, COH&F, Neri, Hamirpur.
12.	Dr. Amit Sharma	Assistant Professor, Department of Social and Basic Science, COH&F, Neri, Hamirpur.
13.	Dr. Vipin Guleria	Senior Extension Specialist, Department of Forestry and Environment, COH&F, Neri, Hamirpur – Secretary upto 04.11.2018.

FINANCE COMMITTEE

1.	Dr. Hari C. Sharma	Vice Chancellor, UHF, Nauni (Solan) – Chairman
2.	Secretary (Finance)	Government of Himachal Pradesh
3.	Secretary (Agriculture)	Government of Himachal Pradesh
4.	Secretary (Horticulture)	Government of Himachal Pradesh
5.	Sh. Rajesh Kumar	Registrar, UHF, Nauni (Solan)
6.	Examiner	Local Audit Department
7.	Director of Horticulture	Government of Himachal Pradesh
8.	Principal Chief Conservator of Forests	Government of Himachal Pradesh
9.	Er. Balwant Singh Thakur	Chief Engineer (Retired), H. No. 91, HIMUDA Colony, Opposite DAV School, PO Jhaniyara, District Hamirpur – 177601 upto 04.12.2018
10.	Shri Hira Mani Verma	Comptroller, UHF, Nauni (Solan) - Member Secretary



OFFICERS OF THE UNIVERSITY (2018-19)

	Officers	Designation/Status
1.	Acharya Devvrat	Chancellor
2.	Dr. Hari C. Sharma	Vice Chancellor
3.	Dr. Vijay Singh Thakur	Director of Extension Education
4.	Dr. J N Sharma	Director of Research
5.	Dr. Rakesh Gupta	Dean, College of Horticulture
6.	Dr. P K Mahajan	Dean, College of Forestry
7.	Dr. P C Sharma	Dean, College of Horticulture and Forestry, Neri, Hamirpur
8.	Dr. Y C Gupta	Dean, College of Horticulture and Centre of Excellence for Horticulture and Extension, Thunag w.e.f. 19.03.2019
9.	Shri Hira Mani Verma	Comptroller
10.	Er. Ajay Gupta	Estate Officer upto 22.05.2018
11.	Er (Ms) Aparna Rohela	Estate Officer w.e.f. 24.05.2018
12.	Dr. Bhau Singh Thakur	Librarian upto 31.08.2018
13.	Dr. (Mrs) Anju S. Khanna	Librarian w.e.f. 01.09.2018 to 31.03.2019
14.	Dr. S K Gupta	Students' Welfare Officer upto 31.12.2018
15.	Dr. Kulwant Rai Sharma	Students' Welfare Officer w.e.f. 01.01.2019
16.	Shri Rajesh Kumar	Registrar upto 31.03.2019
Joint Directors		
17.	Dr. RK Thakur	Joint Director (Communication)
18.	Dr. Mai Chand	Joint Director (Training)
19.	Dr. Ravinder Sharma	Joint Director Research (Forestry) w.e.f. 29.06.2018
20.	Dr. S K Sharma	Joint Director Research (Horticulture)
21.	Dr. Manoj Kumar Vaidya	Joint Director Research (Planning)
22.	Dr. Rajeshwar Singh Chandel	Joint Director Research (Forestry) upto 05/06/2018.
Heads of the Departments		
23.	Dr. Krishan Kumar	Professor & Head, Department of Fruit Science upto 31.08.2018
24.	Dr. JS Chandel	Professor & Head, Department of Fruit Science w.e.f. 01.09.2018
25.	Dr. (Ms) Anju Kumari Dhiman	Professor and Head, Department of Food Science & Technology
26.	Dr. A K Gupta	Professor and Head, Department of Plant Pathology upto 31.07.2018
27.	Dr. H R Gautam	Professor & Head, Department of Plant Pathology w.e.f. 01.08.2018
28.	Dr. (Mrs) Anju S. Khanna	Professor and Head, Department of Entomology upto 31.08.2018
29.	Dr. G C Sharma	Professor & Head, Department of Entomology w.e.f. 01.09.2018 to 31.12.2018
30.	Dr. Divender Gupta	Professor & Head, Department of Entomology w.e.f. 01.01.2019
31.	Dr. HS Kanwar	Professor and Head, Department of Vegetable Science upto 30.06.2018
32.	Dr. A K Sharma	Professor and Head, Department of Vegetable Science w.e.f. 01.07.2018
33.	Dr. YC Gupta	Professor and Head, Department of Floriculture and Landscape Architecture upto 13.03.2019
34.	Dr. H S Baweja	Additional charge of the post of Professor & Head, Department of Floriculture and Landscape Architecture w.e.f. 15.03.2019
35.	Dean, COH	Additional Charge of the post of Professor and Head, Department of Biotechnology
36.	Dr. K K Raina	Professor and Head, Department of Business Management
37.	Dr. P K Mahajan (Dean, COF)	Professor and Head, Department of SAF (additional charge)



38.	Dr. Sanjeev Thakur	Professor and Head, Department of Tree Improvement and Genetic Resources
39.	Dr. Kulwant Rai	Professor and Head, Department of Forest Products upto 31.12.2018
40.	Dr. (Ms) Meenu Gupta	Professor & Head, Department of Forest Product w.e.f. 01.01.2019
41.	Dr. D D Sharma	Professor and Head, Department of Social Science
42.	Dr. J C Sharma	Professor and Head, Department of Soil Science and Water Management
43.	Dr. (Ms) Anju S. Thakur	Professor and Head, Department of Basic Sciences
44.	Dr. Manish Kumar Sharma	Professor and Head, Department of Seed Science and Technology
45.	Dr. Satish Kumar Bhardwaj	Professor and Head, Department of Environmental Sciences
Associate Directors		
46.	Dr. Pankaj Gupta	Associate Director (R&E), Regional Horticultural Research and Training Station, Mashobra (Shimla)
47.	Dr. H S Bhatia	Associate Director (R&E), Regional Horticultural Research and Training Station, Bajaura (Kullu)
48.	Dr. ML Bhardwaj	Associate Director (R&E), Regional Horticultural Research and Training Station, Jachh
49.	Dr. AK Joshi	Associate Director (R&E), Regional Horticultural Research and Training Station, Dhaulakuan (Sirmaur)
50.	Dr. Shashi Kumar Sharma	Associate Director (R&E) and Prog. Coordinator, Regional Horticultural Research and Training Station and Krishi Vigyan Kendra, Sharbo (Kinnaur)
51.	Dr. Hem Raj Sharma	Associate Director (R&E) and Programme Coordinator, Horticultural Research and Training Station and Krishi Vigyan Kendra, Kandaghat (Solan)
52.	Dr. Rajeev Raina	Programme Coordinator, Krishi Vigyan Kendra, Chamba
53.	Dr. NS Kaith	Programme Coordinator, Krishi Vigyan Kendra, Rohru (Shimla)
54.	Dr. Bhupinder Singh Thakur	Scientist-cum-Incharge, Regional Horticultural Research Sub-Station and KVK, Tabo (Lahaul & Spiti) upto 02.07.2018
55.	Dr. Sudhir Verma	Programme Coordinator, Regional Programme Coordinator, Horticultural Research Sub-Station and KVK, Tabo (Lahaul & Spiti) w.e.f. 27.06.2018





Patents

Patent filed entitled Apple Seed Extractor, Inventors Devina Vaidya, Manisha Kaushal, Anil K Verma and Anil Gupta; Patent application filing date: 13th Day of JULY, 2018; Patent filing number: 201811026320; Application Number: TEMP/E-1/28762/2018-DEL

Patent Filed entitled “Instant sweetmeat from carrot pomace biowaste and method thereof” with reference No. 201811039417 dated 17.10.2018 (Applicants: Abrol GS, Verma SK, Thakur NS and Sharma KD)

RECOGNITIONS/HONOURS/AWARDS/APPRECIATIONS

- ❖ Dr Shashi Kumar Sharma honored as Fulbright Fellow for '2018- Fulbright –Nehru International Education Administrators Seminar at the United States from 20.10.2018 to 3.11.2018.
- ❖ Dr Shashi Kumar Sharma received Best Scientist Award -2018 and Certificate of Appreciation from EET-CRS Society, Noida (UP)
- ❖ Prof SK Bhardwaj nominated as a Member of Research Advisory Group (RAG) of HFRI Shimla as nominated by Director General ICFRE Dehradun vide letter no. 301 (30) vol.-XI/2018/413-414 dated 21 August, 2018.
- ❖ Prof SK Bhardwaj nominated as UGC nominee in the advisory committee for ensuring effective implementation and monitoring of the Special Assistance Programme (SAP) in the Department of Environmental Science, University of Jammu, Jammu-180006
- ❖ Dr Meenu Gupta was appointed Zonal Councilor (North Zone) of Indian Phytopathological Society, New Delhi for the year 2018-19.
- ❖ Certificate of Appreciation is awarded to Dr. H.P. Sankhyan, Principal Scientist/ Professor (Forestry) in recognition of outstanding contribution to the University of Horticulture and Forestry, Nauni-Solan (HP). Award has been presented by Acharya Dev Vrat, Hon'ble Governor of Himachal Pradesh and Chancellor of the University on the occasion of 34th Foundation day of Dr. Y.S.P. UHF, Nauni held on dated **01.12.2019**, at UHF, Nauni-Solan (HP). 173 230.
- ❖ Dr DD Sharma got Excellence in Teaching Award in the International Conference held at Jaipur (Rajasthan) w.e.f 28-30 Dec., 2018.
- ❖ Ms. Jagriti Thakur, Ph.D. student of this department has been awarded IPNI-2018, scholar award for her doctoral research. The award ceremony, wherein she was awarded with the “Certificate of Recognition and US\$ 2000” by our chief guest and IPNI official, held on 15-02-2019 at 11:00 AM in the seminar hall of College of Forestry.
- ❖ Dr. Manish Kumar is conferred with Fellowship Award by Hi-Tech Horticultural Society, India for contribution in the field of Vegetable Science in the International Conference and 2nd Global Meet on “Science and Technology for Ensuring Quality Life”(GMST-2018) held at Aston Kuta Hotel and Residence, Kabupaten, Badung- Bali, Indonesia w.e.f. 13-17.11.2018.
- ❖ Dr. Adikshita, Ph.D. scholar of the Department was awarded RL Munjal Memorial Best PhD thesis research award 2018 Presented by Himalayan Phytopathological Society.
- ❖ AICRP on PHET Solan Centre received the Best Centre Award of the Year 2018-2019 at 34th Annual Workshop held at TNAU, Coimbtore, wef 12 March to 15th March 2019.
- ❖ Dr. Sunita Devi awarded with Young Faculty in EET CRS on March 18, 2018 by Education Expo TV Companies Rating System (EETCRS) Hyderabad.
- ❖ Dr PC Sharma Dean received Fellowship of the Horticulture Society of India for recognition of services in the field of Post-Harvest Technology. Fellowship received at IGKV Raipur during Horticulture Congress.
- ❖ Registration of Himachali Chulli Oil under Geographical Indication (GI) Act: Himachali Chulli Oil the product developed by PC Sharma & Anil Gupta in the University has been registered under Geographical Indication (GI) Act, 1999 under registration number 468.
- ❖ AICRP (HB&P) Solan Centre awarded Best Research Centre In National level Biennial Group meeting (2016-17) of All India Coordinated Research Project (AICRP) on Honey bees and Pollinators organized by Indian Council of Agricultural Research (ICAR) at School of Agricultural Sciences and Rural Development Medziphema Nagaland University w.e.f. 7-9 March, 2019
- ❖ Bharat Shiksha Rattan Award was awarded to Dr Divender Gupta by the Global Society for Health and Education Growth New Delhi, in recognition of the work carried out in the field of Agriculture, on April 7, 2018 in a ceremony organized at Vithal Bhai Patel House, New Delhi, in which Sh. Harish Rawat, Ex Chief Minister Uttarakhand, was the Chief Guest.



SELECTED PUBLICATION

Research Publications

- Abrol Diksha, Gupta Divender and Sharma Isha. 2018. Evaluation of insecticides, biopesticides and clay for the management of fruit fly, *Bactrocera* spp. infesting bitter gourd. *Journal of Entomology and Zoology Studies*. 7(1): 311-314.
- Adikshita and Sandeep Kansal. 2018. Studies on the epidemiological parameters of Angular leaf spot (ALS) of French bean caused by *Phaeoisariopsis griseola*. *International Journal of Chemical Studies*. 6(4):2520-2523.
- Adikshita, Sharma IM and Sharma M. 2018. Screening of mango germplasm under natural epiphytotic conditions against anthracnose (*Colletotrichum gloeosporioides*). *Indian Phytopathology*. 71(2):285-289.
- Adikshita, Sharma IM, Sharma M and Sharma K. 2018. Production of cell wall degrading enzymes by *Colletotrichum gloeosporioides* causing mango anthracnose. *Journal of Krishi Vigyan*. 7(1):170-173.
- Adikshita, Sharma IM, Sharma M and Sharma K. 2018. Use of plant water extracts and bio-control agents for post-harvest management of mango anthracnose caused by *Colletotrichum gloeosporioides*. *Journal of Krishi Vigyan*. 7:163-168.
- Aditika, Kanwar HS, Kumar Ramesh, Dogra RK and Sharma Ankita. 2018. Mean performance of parents and hybrids involved in half diallel mating design in bell pepper (*Capsicum annuum* L. var. *grossum*). *Journal of Pharmacology and Phytochemistry*. 7(1):1040-1043.
- Aggarwal RK, Bhardwaj SK, Sharma Rakesh and Sharma P. 2018. Development and evaluation of thermally efficient solar drier with temperature controller system. *International Journal of Chemical Studies*. 6(6):2057-2065.
- Anand Salve, Bhardwaj DR and Thakur CL. 2018. Soil Nutrient study in different agroforestry systems in north western Himalayas. *Bull. Env. Pharmacol. Life Sci*. 7(2):63-72.
- Angmo P, Chandel JS, Katiyar AK, Targais K, Chaurasia OP and Stobdan T. 2018. Zero energy overwinter storage of apple nursery plants in trans-Himalayan Ladakh, India. *Defence Science Journal*. 3(2):95-99.
- Ankush and Sharma DD. 2018. People's attitude towards cashless transaction: an empirical study of Solan town of H.P. *International Journal of Current and Advanced Research*. 7(c):14025-14028.
- Ankush & Sharma DD. 2018. People's Perception and demonetization: a study of Solan town H.P. *International Journal of recent scientific research*. 9(x):27536-27540.
- Ankush, Sharma Rakesh, Aggarwal RK and Bhardwaj SK. 2018. Evaluation of indirect solar dryer for drying of some wild fruits grown in western Himalayan region. *Chem Science Rev. and Letters*. 7(27):824-831.
- Atal H, Thakur KS, Kansal S, Mehta DK, Yousafzai A, Mohammadi MH. 2018. Effect of organic nutrient sources on growth, yield and quality of bell pepper (*Capsicum annuum* L.) under mid hill conditions of Himachal Pradesh. *International Journal of Multidisciplinary Research and Development*. 5(1):135-138.
- Attayee SN, Thakur M, Bhardwaj SK and Verma S. 2017. Biopesticidal properties and composting efficiency of *Parthenium*. *Indian Journal of Weed Science*. 49(2):309-311.
- Attri K, Sharma M and Gupta SK. 2018. Influence of edaphic factors on Fusarium wilt of bell pepper. *International Journal of Bio-resource and Stress Management*. 9(5):606-610.
- Attri S, Dhiman Anju K, Sharma KD, Ramachandranan P and Hamid. 2018. Standardization of pre-drying treatments for the production of papaya fruit powder and its utilization in the development of instant halwa mix. *International Journal of Current Microbiology and Applied Sciences*. 7(10):1879-1887.
- Bajwa J and Sharma N. Evaluation of probiotic properties of yeasts. *International Journal of Current Microbiology and Applied Sciences*. 7 (2): 26432-26439.
- Bala Anu, Sharma Puja, Dhiman SR and Gupta YC. 2018. Effect of calcium nitrate on propagation of LA Hybrid lilies through scaling. *Indian Journal of Horticulture*. 75(4):723-727.
- Bammanahalli S, Pant KS, Khatri P and Sharma R. 2018. Bioeconomic Productivity of Agroforestry systems in sub mountain and low hills, subtropical region of Himachal Pradesh. *Multilogic in Science*. (25):142-144.
- Banshtu Tanuja and Patyal SK. 2018 Effect of processing on reduction of profenofos and chlorpyrifos residues in tomato fruits. *International Journal of Pure & Applied Bioscience*. 6(4):415-422.
- Banshtu Tanuja, Patyal SK and Brar GS. 2018. Decontamination of cypermethrin residues in tomato fruits and cauliflower curds. *International Journal of Farm Sciences*. 8(3):44-50.
- Banshtu Tanuja, Patyal SK and Negi Sarswati. 2018. Effect of processing on profenofos and chlorpyrifos residues in cauliflower curds. *International Journal of Current Microbiology and Applied Sciences*. 7(10):2610-2619.
- Banshtu Tanuja, Patyal SK. 2018. Decontamination processing of chlorpyrifos and cypermethrin residues in cauliflower. *International Journal of Current Microbiology and Applied Sciences*. 7(5):859-868.
- Bhagta Shikha, Sankhyan HP, Sharma Dushyant and Ashine Tesfaye. 2019. Correlation and path coefficient analysis in *Grewia optiva* Drummond. *International Journal of Chemical Studies*. 7(3):746-749.
- Bhagta Shikha, Sankhyan HP, Sharma JP and Kumari Reena. 2019. Assessment of Variability in Half Sib Progenies of *Grewia optiva* Drummond for Various qualitative and Quantitative Traits in North Western Himalayas. *International Journal Current Microbiology Applied Sciences*. 8(4):1661-1669.
- Bhandari DP, Gupta SK, Kumar R and Sharma SK. 2018. Management of Storage Rot of Cole and Root crop in Dry Temperate Region of Kinnaur, Himachal Pradesh. *Journal of Mycology and Plant Pathology*. 48(3):332-337.



- Bhandari DP, Sharma JN, Thakur VS, Sharma SK, Sharma SK, Gupta B and Sharma R. 2018. Prevalence, epidemiology and management of apple scab (*Venturia inaequalis*) in dry temperate region of Kinnaur, Himachal Pradesh. *Journal of Mycology and Plant Pathology*. 48(1):57-64.
- Bhardwaj Sushma and Singh Joginder. 2018. New records of coleopterans on apple in himachal Pradesh. *Indian Journal of Entomology*. 80(2):487-488.
- Bhardwaj S, Kaushal R, Kaushal M and Bhardwaj KK. 2018. Integrated Nutrient Management for Improved Cauliflower Yield and Soil Health. *International Journal of Vegetable Science*. 24:29-42.
- Bharti N, Kapoor B, Shaunak I, Sharma P and Sharma R. 2018. Effect of sterilization treatments on in vitro culture establishment of tomato (*Solanum lycopersicum* L.). *Int. J. Chemical Studies*. 6(5):1165-1168.
- Bhat S Sheeraz, Sankhyan HP and Singh NB. 2018. Estimation of genetic variability, heritability, genetic gain and correlation studies on seed and seedling traits in *Grewia optiva* Drummond. *Range Management and Agroforestry*. 39(1):43:51.
- Bhickta G, Chauhan N and Sharma NC. 2018. Effect of different nitrogen sources and their levels on leaf and soil nutrient status of apple (*Malus × domestica* Borkh.) cv. Starking Delicious. *International Journal of Chemical Studies*. 6(2): 2022-2025.
- Bhutia Karma Gyalpo, Meenu Sood and Bhutia Pempalamu. 2018. The effect of different planting time and harvesting schedule on growth and yield of *Acorus calamus*. *International Journal of Chemical Studies*. 6(6):1606-1614.
- Bijeta, Thakur KS, Kansal S and Sharma AK. 2018. Growth and yield characteristics of capsicum (*Capsicum annum* L.) Cv. Orobelle in response to different growing media and plant spacing under protected conditions. *International Journal of Current Microbiology and Applied Sciences*. 7(5):1096-1103.
- Bishist R, Raina VS, Bhakat M, Mohanty TK, Lone SA, Paray AR, A Rahim A and Sinha R. 2018. Effect of Varying Osmolarity of Tris Extender on Seminal Attributes of Buffalo Bulls during Refrigeration. *International journal of Livestock Research*. 8(11):164-171.
- Brar AS, Sharma HK and Rana Kiran. 2018. Seasonal incidence of wasps in *Apis mellifera* L. colonies at Nauni, Solan (Himachal Pradesh). *Journal of Entomology and Zoology Studies*. 6(2):3177-3178.
- Brar AS, Sharma HK and Rana Kiran. 2018. Survey studies: Integral approach towards the diseases and enemies of *Apis mellifera* L. in upper and lower hills of Himachal Pradesh: Beekeepers prospective. *Journal of Entomology and Zoology Studies*. 6(3): 939-942.
- Brar GPS, Patyal SK, Dubey JK, and Singh GD. 2018. Persistence and efficacy of culinary processes in removing the residues of chlorpyrifos and ethion in brinjal. *Pesticide Research Journal*. 30(2):200-209.
- Brar GPS, Patyal SK, Dubey JK, and Singh GD. 2018. Survey on pesticide use pattern and farmers' perceptions in cauliflower and brinjal growing areas in three districts of Himachal Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*. 7(3):2417-2423.
- Chand Krishan, Sankhyan HP and Chauhan VK. 2018. Studies on growth performance of *Cedrus deodara* (Deodar) populations under field conditions in temperate zone of Himachal Pradesh. *International Journal of Farm Sciences*. 8(1):59-62.
- Chandel JS and Verma P. 2019. Influence of nursery raising techniques on root development and growth of nursery plants of pecan nut (*Carya illinoensis* Koch.) *Progressive Horticulture*. 49(2):113-116.
- Chandel S and Chauhan P. 2018. First report of *Microstroma juglandis* causing downy leaf spot or white mould on *Celtis australis* from Himachal Pradesh, India. *International Journal of Plant Protection*. 11(2):161-163.
- Chandel V, Sharma KD, Gupta A and Verma AK. 2019. Effect of packaging on the storage of oat flour fortified fruit rolls. *International Journal of Chemical Studies*. 7(1):373-378.
- Chandel V, Vaidya Devina, Gupta A, Kaushal Manisha and Verma A. 2019. Effect of enzyme concentration on quality of apple pomace pectin. *International Journal of Current Microbiology and Applied Sciences*. 8(1):2843-2849.
- Chatterjee Subhrajyoti, Mukherjee Debmal, Patil Sumit B, Kansal Sandeep, Kanwar HS, Choudhuri Partha. 2018. Screening of cauliflower genotypes against economically important diseases and disorder in mid hilly regions of Himachal Pradesh. *Int. J. Pure App. Biosci*. 6(1):774-778.
- Chaudhary M, Rana N, and Dipta B. 2018. Optimization of production conditions of amylase producing bacterial strains isolated from hot water springs of Manikaran in Kullu district of Himachal Pradesh. *International Journal of Chemical studies*. 6(5):1200-1205.
- Chaudhary M, Rana N, Ghabru A, Dipta B. 2018. Isolation and optimization of amylase producing bacterial strains (MW6) isolated from hot water springs of Manikaran in Kullu district of Himachal Pradesh. *International Journal of Pharmaceutical Science and Research*. 3(3):13-18.
- Chaudhary M, Rana N, Vaidya D, Ghabru A, Rana K and Dipta B. 2019. Immobilization of amylase by entrapment method in different natural matrix. *International Journal of Current Microbiology and Applied Sciences*. 8(5):1097-1103.
- Chaudhary M, Rana N, Vaidya D, Rana K and Ghabru A. 2019. Partial purification, immobilization and characterization of amylase produced from *Bacillus cereus*. *Annals of phytomedicine*. 8(1):1-7.
- Chaudhary Rashmi, Janjhua Yasmin, Mehta Piyush, Sharma Nikhil and Kumar Krishan. 2018. Factors limiting rural youth participation in agriculture-based livelihood activities in Tehsil Karsog of Himachal Pradesh. *International Journal of Agricultural Science and Research*. 8(3):141-146.
- Chaudhary Rashmi, Janjhua Yasmin, Sharma S and Krishan Kumar. 2018. Assessment of Kisan Credit Card (KCC) scheme: A study among small and marginal farmers in Solan district of Himachal Pradesh. *International Journal of Farm Sciences*. 8(1):21-24.
- Chauhan A, Sharma R and Devi S. 2018. Identification and Characterization of Keratinolytic bacterium Isolated from



- Poultry Waste. *International Journal of Management, Technology and Engineering*. 8(10):2610-2616.
- Chauhan A, Verma SC, Bhardwaj SK, Sharma U, Gupta R and Sharma R. 2018. Impact of cropping systems on physico-chemical characteristics of surface water during different seasons in Shimla region of Himachal Pradesh. *Journal of Applied and Natural Science*. 8:173-178.
- Chauhan Aditi, Mehta Piyush and Raina Krishan Kumar. 2017. Farmers' Appraisal of the Selected Financial Schemes for Rural Development by National Bank for Agriculture and Rural Development (NABARD), Shimla District, Himachal Pradesh. *India. International Journal of Economic Plants*. 4(4):141-147.
- Chauhan Arjun, Sharma JN, Modgil M, Siddappa S. 2018. Comparison of various RNA extraction methods, cDNA preparation and isolation of calmodulin gene from a highly melanized isolate of apple leaf blotch fungus *Marssonina coronaria*. *Journal of Microbiological Methods*. 151:7-15.
- Chauhan Neena, Sharma Naveen and Mankotia M.S. 2018. Hydrogen Cyanide (Dormax) impacts on vegetative bud break, yield and quality of apple cv. Starking Delicious. *International Journal of Chemical Studies*. 6(3):1507-1510.
- Chauhan Neena, Sharma Naveen and Singh Upender. 2018. Effect of Elanta super (n-Acetyl thiiazolidine-4-carboxylic acid) on fruit set, yield and quality of apple cv. Starking Delicious. *Journal of Pharmacognosy and Phytochemistry*. 7(3):1759-1761.
- Chauhan P, Gupta AK, Sharma JN, Sharma M, Chandel JS and Gupta RK. 2018. Cultural Characterization of *Alternaria* spp. associated with *Alternaria* blotch of apple. *International Journal of Current Microbiology and Applied Sciences*. 7(08):1766-1773.
- Chauhan VK and Krishan Chand. 2018. Growth and forage yield evaluation in different cultivars of *Festuca arundinacia* and *Setaria anceps*. *International Journal of Farm Sciences*. 8(1):9-12.
- Devi Diksha, Verma SC, Sharma PL, Sharma HK, Gupta Neha and Thakur Pallavi. 2019. Effect of climate change on insect pests of fruit crops and adaptation and mitigation strategies: A review. *Journal of Entomology and Zoology Studies*. 7(1):507-512.
- Devi Meera, Sharma Uday, Garima and Kumari Yourmila. 2018. Effect of Integrated Nutrient Management on Soil Physico-Chemical Properties and Yield of Capsicum (*Capsicum annum*). *International Journal of Current Microbiology and Applied Sciences*. 7(5):20.
- Devi Meera, Sharma Uday, Kumari Yourmila, Garma and Verma Anjali. 2018. Effect of integrated nutrient management for sustainable production of cauliflower and capsicum. *The Pharma Innovation Journal*. 7(4):713-718.
- Devi Meera, Spehia RS, Mogta Ankush and Verma Anjali. 2018. Influence of integrated nutrient management on growth and yield of cauliflower (*Brassica oleraceae* var. botrytis) and soil nutrient status. *International Journal of Chemical Studies*. 6:2988-2991.
- Devi N and Prasher RS. 2018. Agricultural Diversification in Himachal Pradesh: An economic analysis. *Indian Journal of Economics and Development*. 6(12):1-6.
- Devi N and Prasher RS. 2018. Trends in Growth of Agriculture in Himachal Pradesh. *Journal of Hill Agriculture*. 9(2): 209-216.
- Devi Nisha, Gupta PR, Sharma KC, Sharma PL and Negi BR. 2018. Fertility Table Parameters of Predatory Bug *Orius bifilaris* Ghauri (Hemiptera: Anthocoridae) Preying upon *Thrips palmi* and eggs of *Corcyra cephalonica*. *International Journal of Current Microbiology and Applied Sciences*. 7(3):2574-2586.
- Devi S, Sankhyan HP, Thakur S, Rana N, Chand K, Chauhan V and Sharma SS. 2018. Biological screening of progeny performance traits in *Quercus leucotrichophora* A. Camus (Banoak) populations. *International Journal of Chemical studies*. 6(2):1018-1022.
- Devi S, Sankhyan HP, Thakur S, Sharma SS, Rana N and Chand K. 2018. Variation in seed germination and seedling traits of *Quercus leucotrichophora* A. Camus natural populations in Himachal Pradesh *Journal of Pharmacognosy and Phytochemistry*. 7(2): 749-752.
- Devi Sangeeta, Sankhyan HP, Thakur Sanjeev, Rana Neerja, Chand Krishan, Chauhan Vimal and Sharma SS. 2018. Biological screening of progeny performance traits in *Quercus leucotrichophora* A. Camus (Banoak) populations. *International Journal of Chemical studies*. 6(2):1018-1022.
- Dhiman Anju K, Sharma A, Devi L and Attri Surekha. 2018. *Pyrus serotina*: A Himalayan wild pear fruit utilized for preparation of whole fruit preserve. *International Journal of Agriculture Sciences*. 10(7):5669-5671.
- Dhiman B and Dutt Bhupender. 2018. Evaluation of *Acorus calamus* L. rhizome extract as a bio preservative against wood fungal decay. *Journal of Applied and Natural Science*. 10(1):37-40.
- Dhiman K and Shirkot P. 2018. Bioprospecting and characterization of laccase producing bacteria from paddy fields of Himachal Pradesh. *Indian Journal of Experimental Biology*. 56:334-341.
- Dhiman M, Dhiman VK, Rana N and Dipta B. 2019. Isolation and Characterization of *Rhizobium* Associated with Root Nodules of *Dalbergia sissoo*. *Int. J. Curr. Microbiol. Appl. Sci*. 8(3):1910-1918.
- Dhiman R and Sharma M. 2019. Relation between labor productivity and export competitiveness of Indian textile industry: Cointegration and causality approach. *Vision: The Journal of Business Perspective*. 23(1), 22-30.
- Dhiman R, Chand P and Gupta S 2018. Behavioural aspects influencing decision to purchase apparels amongst young Indian consumers. *FIIIB Business Review*. 7(3):188-200.
- Dhiman S, Dixit SP and Sepehya S. 2018. Pea-okra yield and properties under integrated nutrient management in western Himalayan soils. *International Journal of Agricultural Research*. 10(10):6076-80.
- Dhiman SR, Gupta YC, Thakur Priyanka, Kashyap Bh Sharma, Meenakshi and Sharma, Khushboo. 2018. Effect of different black-out materials on off-season potato



- production of chrysanthemum (*Dendranthema grandiflora*). *Indian Journal of Agricultural Sciences*. 88 (4):601-55.
- Dilta BS, Thapa S, Gupta YC, Sharma BP, Negi N and Kaushal S. 2019. Growth, flowering and presentability of potted azaleas as influenced by pot size and cultivars. *Indian Journal of Agricultural Sciences*. 89(2):199-205.
- Divya, Katna Sapna, Rana BS, Sharma HK and Chauhan Avinash. 2018. Preliminary studies on *Nosema ceranae*: A microsporidian infecting *Apis mellifera* in India. *Journal of Entomology and Zoology Studies*. 6(3):262-265.
- Dogra RK and Kumar Pawan. 2018. Variability and character association studies of yield and its contributing traits in low chilling peach [*Prunus persica* (L.) Batsch]. *International Journal of Farm Sciences*. 8(1):120-126.
- Dogra RK, Sharma Samrita and Sharma DP. 2018. Heritability estimates correlation and path coefficient analysis for fruit yield in walnut (*Juglans regia* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(2):3707-3714.
- Dubey JK, Patyal SK and Sharma A. 2018. Validation of QuEChERS analytical technique for organochlorines and synthetic pyrethroids in fruits and vegetables using GC-ECD. *Environmental Monitoring and Assessment*. 190 (4) 231.
- Gautam B, Sharma P, Gupta YC, Handa A, Thakur M and Shrama P. 2019. Studies on the effect of various sterilization procedures for *in vitro* propagation of carnation (*Dianthus caryophyllus* L.). *International Journal of Current Microbiology and Applied Science*. 8(02): 481-485.
- Gautam HR. 2019. Impact of climate change on disease scenario in crops. *Agriculture Research Journal*. 56 (1): 1-12.
- Gautam N, Kanwar HS, Mehta DK, Kansal S and Kumar S. 2018. Effect of clove weight and plant growth regulators on shelf-life of garlic (*Allium sativum* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(2):1696-1700.
- Gautam Nidhish, Kumar Manish, Vikram Amit, Kumar Sandeep and Sharma Shikha. 2018. Heterosis studies for yield and its components in tomato (*Solanum lycopersicum* L.) under North Western Himalayan Region, India. *International Journal of Current Microbiology and Applied Sciences*. 7(2):1949-1957.
- Gautam Nidish, Kumar Manish, Kumar Dharminder, Kumar Sandeep, Vikram Amit, Dogra Rajesh and Sharma Shikha. 2018. Combining ability and gene action studies for important quality traits in tomato (*Solanum lycopersicum* L.) *International Journal of Chemical Studies*. 6(2):1992-1996.
- Ghabru A and Rana N. 2019. Biological significance of secondary metabolites: A review. *International Journal of Research in Pharmacy and Pharmaceutical Sciences*. 4(2):84-91.
- Ghabru A, Rana N and Meenakshi. 2018. Flavonoids: Phytochemicals of Biological Importance. *Research Trends in Medical Sciences*. 1:33-62.
- Ghabru A, Rana N and Sud RG. 2018. Flavan-3-ols and biological implication of *Camellia sinensis* (L) O Kuntze. *Journal of Pharmacognosy and Phytochemistry*. 7(3):241-248.
- Ghabru A, Rana N, Meenakshi and Sharma M. 2019. Response of rhizobial inoculation to seed germination with respect to various seed sources of *Albizia procera* collected from Uttarakhand. *International Journal of Chemical Studies*. 7(2):1979-1984.
- Gill NS and Verma ML. 2018. Nutrient uptake and yield of cherry tomato under NPK fertilization. *Journal of Pharmacognosy and Phytochemistry*. 7(3):2076-2082.
- Goitom Takele, Sharma K. Rai and Rajneesh Kumar. 2019. Studies on anatomical properties of *Salix* hybrids wood. *International Journal of Chemical Studies*. 7(1):472-476.
- Gularia Chandresh, Vaidya Manoj Kumar, Lal Chaman, Guleria Amit. 2018. Joint Forest Management for Conservation and Auxiliary income in Himachal Pradesh. *Indian Journal of Ecology*. 45(3):494-498.
- Guleria C, Vaidya MK, Negi C and Guleria A. 2018. Joint Forest Management for Conservation and Auxiliary Income in Himachal Pradesh. *Indian Journal of Ecology*. 45(3):494-498.
- Guleria V, Vasishth A and Selvan T. 2018. Studies on CO₂ flux and carbon sequestration in natural grass communities under natural chir-pine forests of Indian North West Himalayas. *International Journal of Advanced Research in Biological Sciences*. 4(10):179-184.
- Gupta B, Sharma U and Verma S. 2018. Refinement of Technology for the management of collar rot in apple. *International Journal of Current Microbiology and Applied Sciences*. 7(6):1551-1556.
- Gupta Bhupesh, Sharma Usha and Verma Shalini. 2018. Refinement of technology for the management of collar rot in apple. *International Journal of Current Microbiology and Applied Sciences*. 7(6):1551-1556.
- Gupta D, Tiwari C, Rajput BS, Kumar S and Sharma D. 2019. Natural regeneration status of Indian Hazelnut (*Corylus jacquemontii* - Decne.) in Western Himalaya of Himachal Pradesh. *Journal of Pharmacognosy and Phytochemistry*. 1(SP1): 327-331.
- Gupta Meenu, Singh Kirtipal and Bhardwaj Kumar Ramesh. 2018. Bio control of lettuce drop caused by *Sclerotinia sclerotiorum* under protected conditions. *The Bioscan*. 13(1):251-254.
- Gupta Neha, Verma SC, Sharma PL, Thakur Meena, Sharma Priyanka and Devi Diksha. 2019. Status of invasive insect pests of India and their natural enemies. *Journal of Entomology and Zoology Studies*. 7(1):482-489.
- Gupta S, Verma S and Thakur R. 2019. Phytosanitary Requirement for Import of Horticulture Crops. *International Journal of Current Microbiology and Applied Sciences*. 8(02):2871-2886.
- Gurung Anamika, Gupta YC, Bhatia Suman, Thakur Priyanka and Yadav Priya. 2018. Effect of Integrated Nutrient Management on Growth and Production of *Hydrangea* (*Hydrangea macrophylla* Thunb.) *International Journal of Current Microbiology and Applied Sciences*: 7(4):2080-2086.
- Hameedi Atal, Thakur KS, Kansal Sandeep, Mehta DK, A Yousafzai, Mohammadi MH. 2018. Effect of organic nutrient sources on growth, yield and quality of bell pepper



- (*Capsicum annuum* L.) under mid hill conditions of Himachal Pradesh. *International Journal of Multidisciplinary Research and Development*. 5(1):135-138.
- Hameedi Atal, Thakur KS, Sharma U, Yousafzai A, Mohammadi MH, Durrani H and Durani A. 2018. Effect of organic nutrient sources on NPK uptake, soil nutrient status and yield of bell pepper (*Capsicum annuum* L.) under mid hill condition of Himachal Pradesh. *International Journal of Chemical Studies*. 6(1):1913-1917.
- Heena, Dutt Bhupender and Sharma KR. 2019. Evaluation of holocellulose and lignin content of wood of banoak provenances from Himachal Pradesh. *International Journal of Chemical Studies*. 7(1):1023-1025.
- Heena, Dutt Bhupender, Sharma KR and Kumar Rajneesh. 2019. Variation in specific gravity of wood of *Quercus leucotrichophora* A. Camus (Banoak) from different provenances in Himachal Pradesh. *International Journal of Chemical Studies*. 7(1):1335-1337.
- Hema and Khanna Anju S. 2018. Effect of pre-sowing nursery treatments on the plant status and nematode population in tomato. *Journal of Pharmacognosy and Phytochemistry*. 7(5):2202-2206.
- Hema and Khanna Anju S. 2018. Yield loss assessment in tomato through *Meloidogyne incognita* (Kofoid and White) Chitwood in Himachal Pradesh, India. *Journal of Entomology and Zoology Studies*. 6(5):448-451.
- Hema, Khanna Anju S, Rachappanavar VK and Pandey Himanshu. 2018. Evaluation of some commercially grown polyhouse cultivars for their susceptibility/resistance against *Meloidogyne incognita*. *Journal of Pharmacognosy and Phytochemistry*. 7(4):3345-3347.
- Himangini and Thakur A. 2018. Effect of seed storage conditions on seed germination and vigour of *Withania somnifera*. *Journal of Pharmacognosy and Phytochemistry*. 7(6):1409-1413.
- Hota D, Sharma DP and Sahoo T. 2018. Effect of Forchlorfenuron and N-acetyl Thiazolidine 4-carboxylic Acid on Chemical parameter of Apricot (*Prunus armeniaca* L.) cv. New Castle. *Current Journal of Applied Science and Technology*. 31(1):1-6.
- Janjhua Yasmin, Chaudhary Rashmi, Deopa V Varnika and Kumar K. 2018. A study on perceived problems and farmers' attitude towards organic farming. *International Journal of Farm Sciences*. 8(2):158-161.
- Janjhua Yasmin, Chaudhary Rashmi, Mehta Piyush, Sharma Nakul and Kumar Krishan. 2018. A study on students' perceptions on online shopping and factors influencing online buying behavior. *Journal of Emerging Technologies and Innovative Research*. 8(5):881-886.
- Jarial RS, Jandaik S, Jarial K and Suman BC. 2018. Evaluation of different locally available materials as substrates for cultivation of *Pleurotus* spp. under subtropical conditions of Himachal Pradesh. *Indian Journal of Mushrooms*. 36(1):25-29.
- Jhiltia P, Rana N, Dipta B, Dhiman M and Meenakshi. 2019. Physiological assessment of *Acacia catechu* seedlings by computing germination parameters and vigour testing. *Int. J. Chem. Stud.* 7(3):1527-1532.
- Jhiltia P, Rana N, Dipta B, Ghabru A. 2018. Studies on the pod, seed and germination traits of *Acacia catechu* from Uttarakhand. *International Journal of Zoology Studies*. 3(4):42-46.
- Joshi AK and Nabi Amreen. 2018. Genetics of inheritance of growth, yield and male sterility in *Capsicum annuum* L. *Journal of Pharmacognosy and Phytochemistry*. 7(1):1682-1688.
- Joshi AK, Brahmi MK, Gupta BK, Kumar P, Thakur P and Chauhan VK. 2019. Apriori to agricultural problems emerged through participatory and rural appraisal in temperate zone of Himalayas. *Indian Journal of Agricultural Sciences*. 89(2):220-230.
- Joshi AK, Brahmi MK, Gupta BK, Kumar Pramod, Thakur P and Chauhan VK. 2019. Apriori to the Problems Emerged Through Participatory Rural Appraisal in Temperate Panchayats of the Himalayas. *Indian Journal of Agricultural Sciences*. 89(2):220-230.
- Joshi VK, Yadav J, Sharma Rakesh and Joshi D. 2018. Preparation and evaluation of seasoned vinegar-optimization of recipe. *Int. J Food Ferment. Technol.* 8(1):63-68.
- Kachwaya Singh Dilip, Chandel JS, Chauhan N, Kuchi Satish Venkata and Singh Chand Mahesh. 2018. Performance of strawberry grown in open field conditions in relation to differential irrigation scheduling. *Journal of Pharmacognosy and Phytochemistry*. 7(2):1977-1980.
- Kakar Ridham, Sharma JC, Sultanpuri Arshi and Sheoran Hardeep Singh. 2018. Effect of mulching on soil microclimate, yield and quality of ginger (*Zingiber officinale* Rose.) under INM. *Journal of Agrometeorology* 20(SPI):343-348.
- Kanwar Pallavi Singh, Khanna Anju S and Hema. 2018. First report and morphological characterization of *Meloidogyne javanica* from Una district of Himachal Pradesh. *Journal of Entomology and Zoology Studies*. 6(2): 2131-2136.
- Kapoor S and Handa A. 2018. ELISA based re-indexing of peach cv. July Elberta: An alternative strategy for producing virus indexed peach plants. *International Journal of Chemical Studies*. 6(4):2231-2233.
- Kapoor S, Sharma A, Handa A and Shylla B. 2018. Ilarvirus and the importance of certified elite planting material in apple production-An overview. *International Journal of Current Microbiology and Applied Sciences*. 7:2444-2462
- Kar S, Chandel A and Pant KS. 2019. Effect of different spacing and combined doses of poultry manure and vermicompost on growth and yield of Bell pepper under Agri-silviculture system *Int. J. Curr. Microbiol. App.* 8(1)2213-2223.
- Kar S, Pant KS, Chandel A and Roshanzada SR. 2019. Trend of soil parameters under different spacing of *Grewia* based agroforestry system in mid hill zone of Himachal Pradesh. 7(1):1904-1907.
- Kashyap Bharati, Dhiman SR, Sharma Puja, Gupta YC and Sharma Meenakshi. 2018. Evaluation of different genotypes



- of Peruvian lily (*Alstroemeria hybrida* L) under Nauni, Solan, Himachal Pradesh conditions. *International Journal of Farm Sciences*. 8(3):17-21.
- Kashyap R, Verma KS, Uniyal SK and Bhardwaj SK. 2018. Geospatial distribution of metal (loid)s and human health risk assessment due to intake of contaminated groundwater around an industrial hub of northern India. *Environment Monitoring Assessment*. 190(3):136.
- Kathuria D, Gautam S and Sharma KD. 2019. Utilization and health benefits of modified starch: A review. *International Journal of Current Agricultural Sciences*. 9(01):347-358.
- Katna S, Dubey JK, Patyal SK, Devi N, Chauhan A and S Ajay. 2018. Residue dynamics and risk assessment of Luna Experience® (fluopyram+ tebuconazole) and chlorpyrifos on French beans (*Phaseolus vulgaris* L.). *Environmental Science and Pollution Research*. 25:27594-27605.
- Kaur Kamal Deep, Verma SC and Sharma PL. 2018. Effect of plant powders on quality characters of treated pea seeds (*Pisum sativum* L.) damaged by *Callosobruchus chinensis* L (Coleoptera: Bruchidae). *Journal of Entomology and Zoology Studies*. 6(4):1682-1686.
- Kaur Kamal Deep, Verma SC and Sharma PL. 2019. Efficacy of plant powders against pulse beetle, *Callosobruchus chinensis*, L. infesting pea seed. *Journal of Entomology and Zoology Studies*. 7(1):737-741.
- Kaur L, Gupta B, Sharma IM and Joshi AK. 2018. Ecofriendly management of powdery mildew of mango through biocontrol agents. *International Journal of Current Microbiology and Applied Sciences*. 7(10):392-39.
- Kaushal M, Vaidya D, Kaushik R, Aarti, Verma A and Gupta, A. 2018. Standardization of formulations for development of ginger supplemented confectionary products. *International Journal of Bio-resource and Stress Management*. 92(2):237-242.
- Kaushal Manisha, Kaushik R, Vaidya Devina, Gupta A and Dhiman S. 2019. Development and characterization of functional ginger powder tablets. *International Journal of Current Microbiology and Applied Sciences*. 8(1):2918-2925.
- Kaushal S, Chandel S, Sharma M and Kashyap P. 2018. Morphological and molecular diversity study among the isolates of *Trichoderma* using RAPD markers. *International Journal of Chemical Studies*. 6(4):1731-1735.
- Kaushal S, Dilta BS, Gupta YC, Kumar P, Spehia RS and Gupta RK. 2018. Studies on drip irrigation levels on growth, flowering and yield of alstroemeria (*Alstroemeria hybrida* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(3):2950-2955.
- Kaushal Sapna, Dilta BS, Gupta YC, Kumar Pradeep, Spehia RS and Gupta RK. 2018. Studies on drip irrigation levels on growth, flowering and yield of alstroemeria (*Alstroemeria hybrida* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(3):2950-2955.
- Khatri Praveen, Sharma Ankita, Kashyap Priyanka, Sharma Neha and Shirkot Poonam. 2018. Biosynthesis, characterization and antibacterial activity of biosilver nanoparticles synthesized by *Bacillus algicola* strain UMP1.1. *International Journal of Chemical Studies*. 6(4):288-300.
- Khosla PK, Kumar K Dutt, N Kathuria, K Mehta, P Farhana M. 2018. "ITKs for land use & water management in cold deserts of Ladakh valley in Jammu & Kashmir" *Journal of Pharmacognosy & Phytochemistry*. 7(6):521-24.
- Kumar A, Jarial RS, Jarial K and Jandaik S. 2018. Effect of Cultural parameters on mycelial growth of *Pleurotus cornucopiae* (Paulet) Rolland. *Indian Journal of Mushrooms*. 36(1):13-19.
- Kumar A, Rana RS, Sharma KC, Chandel VGS Kaur M and Sharma S. 2018. Genetic diversity of diamondback moth, *Pletella xylostella* population from different host plants and across locations in North India. *Journal of Entomology and Zoology Studies*. 6(1):1482-1486.
- Kumar A, Sharma DD, Sharma DP, Shylla B and Sharma S. 2019. Effect of integrated nutrient sources on fruit quality of apricot (*Prunus armeniaca* L.) under mid hill conditions of Himachal Pradesh. *Journal of Pharrmacognosy and Phytochemistry*. 8:1120-1123.
- Kumar Arvind, Rana RS, Sharma KC, Chandel VGS, Kaur Mandeep. 2018. Genetic diversity of diamond back moth, *Plutella xylostella* populations from different host plants and across locations in North India. *Journal of Entomology and Zoology Studies*. 6(1):1482-1486.
- Kumar D, Bhardwaj ML, Kumar S, Kaler R, Kumar R, Verma S and Sharma S. 2018. Comparative performance of Cherry Tomato and Lettuce genotypes under different protected structures in low hills of Himachal Pradesh. *Bull. Env. Pharmacol Life Science*. 7:14-18.
- Kumar K, Dutt N, Kathuria K, Chaudhary R, Janjhua Y, Mehta P, and Bahir M. 2018. Agriculture production systems, farm characteristics & managerial interventions for improved resource use efficiency in dry temperate Lahaul valley of Himachal Pradesh. *Journal of Pharmacognosy & Phytochemistry*. 7(6):1032-36.
- Kumar Krishan, Mohd Bahir, Janjhua Yasmin, Chaudhary Rashmi and Mehta Piyush. 2018. Farm characteristics, microfinance and its use in diversified agriculture by the farming communities of Kandaghat block in Solan district of Himachal Pradesh. *Journal of Pharmacognosy and Phytochemistry*. 7(5):1788-1790.
- Kumar L, Verma SC, Sharma P, Dutt Bhupender and Thakur AK. 2018. Essential oil as grain protectants against pulse beetle *Callosobrunchuschinensis* (L.) infesting pea seeds. *Indian Journal of Entomology*. 80(2):239-243.
- Kumar M, Dilta BS, Sharma BP, Kumar P, Thakur A and Sharma R. 2018. Effect of nitrogen and potassium application on growth and flowering of sweet William (*Dianthus barbatus* L.). *Agric International*. 5(2):6-9.
- Kumar M, Dilta BS, Sharma BP, Kumar P, Thakur A and Sharma R. 2018. Effect of nitrogen and potassium application on yield and quality of sweet William (*Dianthus barbatus* L.) seed. *International Journal of Farm Sciences*. 8(4):150-154.
- Kumar Mukesh, Sharma DD, Singh Niranjana and Shylla Bunty. 2018. Evaluation of newly introduced plum



- (*Prunussalicina* Lindl.) cultivars under mid-hills of Himachal Pradesh. *International Journal of Chemical Studies*. 6: 2925-2930.
- Kumar N, Bhardwaj ML, Kumar S, Sharma A and Kansal S. 2018. Screening of tomato (*Solanum lycopersicum* L.) germplasm for growth and resistance against buckeye rot and alternaria blight severity under mid hills conditions of Himachal. *Journal of Pharmacognosy and Phyto chemistry*. 7(1):2098-2103.
- Kumar Neeraj and Gupta Divender. 2018. Bioefficacy of insecticides and biopesticides against pomegranate fruit borer, *Deudorix epijarbas* (Moore). *Agric International*. 5(1):1-9.
- Kumar Nitish, Bhardwaj ML, Kumari Santosh, Sharma Ankita and Sandeep Kansal. 2018. Screening of tomato (*Solanum lycopersicum* L.) germplasm for growth, yield, resistance against Buckeye rot and Alternaria blight severity under mid-hills conditions of Himachal Pradesh. *Journal of Pharmacognosy and Phytochemistry*. 7(1):2098-2103.
- Kumar P, Sethi S, Sharma RR, Singh S, Saha S, Sharma VK, Verma MK and Sharma SK. 2018. Nutritional characterization of apple as a function of genotype. *Journal of Food Science & Technology*. 55(7):2729-2738.
- Kumar Pramod, Chandel RS, Kumar A, Sharma NC. 2018. Crop load, fruit russeting, vegetative growth traits and leaf nutrient effects as a function of customized foliar nutritive fluids in 'Gala' apple in dry temperate environment. *Indian Journal of Agricultural Sciences*. 88(1):95-106.
- Kumar Pramod, Joshi AK, Chauhan VK. 2018. Stem pruning severities affect growth, physiological and quality consequences in high density planting system of mango in Shiwalik foothills. *Indian Journal of Agricultural Sciences*. 88(2):296-306.
- Kumar Pramod, Sharma SK, Kumar A. 2017. Foliar nutrient feeding affect generative potential of apples: Multilocation DOP indexing and PCA studies under dry temperate agro-climatic conditions of north-west Himalaya. *Scientia Horticulturae*. 218:265-274.
- Kumar R, Kanwar SK and Sharma MK. 2018. Studies on effect of different seed rate and row spacing on green pea production in cold desert region of H.P. *Plant Archives*. 18(2):1895-1898.
- Kumar R, Kumar S, Kumar D and Kansal S. 2018. Heterosis, combining ability and gene action studies for insect-pest and disease resistance in cucumber *Electronic Journal of Plant Breeding*. 9(3):815-828.
- Kumar Ravinder, Thakur Ashok, Vikram Amit, Vaid A, Rane R. 2018. Effect of plasma treatment on seed crop characters of okra (*Abelmoschus esculentus* L.) under field conditions. *International Journal of Current Microbiology and Applied Sciences*. 7:967-976.
- Kumar S and Sharma K. 2019. Cytogenetical Assessment of Apiaceae Lindl. From District Sirmaur, Himachal Pradesh, India. *Journal of Tree Sciences*. 37(2):1-9.
- Kumar S and Verma S. 2019. Variability in plant pathogens and tools for its characterization. *International Journal of Current Microbiology and Applied Sciences*. 8(02):2887-2902.
- Kumar Sandeep, Kumar Ramesh and Dogra Rajesh Kumar. 2018. Heterotic potential, potence ratio, combining ability and genetic control of seed vigour traits for yield improvement in cucumber (*Cucumis sativus*). *Indian Journal of Agricultural Sciences*. 88(5):771-778.
- Kumar Sanjeev, Singh SP, Sharma Ravinder and Sharma Raj Rani. 2018. Resource Use Efficiency of Sustainable Farming Practice: a study of maize and Rajmash intercropping under north-western Himalayan region of J&K. *Int. J. Pure App. Biosci. Spl.* 6(3):798-802.
- Kumar Sumit and Gupta Divender. 2018. Management of pomegranate fruit borer, *Deudorix epijarbas* (Moore) using new group insecticides and some biopesticides. *Journal of Entomology and Zoology Studies*. 6(5):1060-1063.
- Kumar V and Chandel S. 2018. Phylloplane microflora diversity of rose and mycoparasitism over rose powdery mildew (*Podosphaera pannosa* (Wallr.) de B ary). *Journal of Crop and Weed*. 14(1):224-229.
- Kumar V and Chandel S. 2018. Studies on biochemical mechanism of resistance for the management of rose powdery mildew. *Journal of Pharmacognosy and Phytochemistry*. 7(1):1234-1241.
- Kumar V and Chandel S. 2018. Studies on the post symptom anti-sporulant activity of fungicides, bio-control agents, bio-products and botanicals on formation of conidia of *Podosphaera pannosa* on rose. *Journal of Pharmacognosy and Phytochemistry*. 7(3):1284-1288.
- Kumar Vijay and Rana Vishal S. 2019. Seasonal variation in leaf macro nutrient status at various stages of fruit development in nectarine. *Ecology Environment and Conservation*. 25(1):290-294.
- Kumar Lalit, Verma SC, Sharma PL, Dutt Bhupender, Thakur AK. 2018. Essential oils as grain protectants against pulse beetle *Callosobruchus chinensis* (L.) infesting pea seeds. *Indian Journal of Entomology*. 80(2):239-243.
- Kumari A, Bharti, Devi S, Thakur IK, Suman K and Sankhayan N. 2018. Effect of organic formulations on growth of mulberry (*Morus alba* L.) at nursery stage. *International Journal of Chemical Studies*. 6(6):974-978.
- Kumari A, Thakur IK and Devi S. 2018. Carbon Capture and Storage. *Agrobios Newsletter*. 17(3):61-63.
- Kumari Anita, Brahmi MK and Thakur KS. 2019. Factors affecting women participation in joint forest management committees in Punjab. *International Journal of Farm Science*. 9(2):98-102.
- Kumari Anita, Brahmi MK and Thakur KS. 2019. Socio-economic status of forest based rural artisans in mid-hill zone of Himachal Pradesh. *International Journal of Farm Science*. 9(2):103-108.
- Kumari M, Verma SC and Bharat NK. 2018. Effect of elevated CO₂ and temperature on incidence of diseases in bell pepper (*Capsicum annuum* L.) crop. *Journal of Entomology and Zoology Studies*. 6(1):1049-1052.
- Kumari Neena, Raina Ravinder and Sharma Yash Pal. 2018. Interpopulation variations in morphochemical characteristics of *Stevia rebaudiana* Bertoni. *Turkish Journal of Botany*. 42:491-501.



- Kumari Recna, Kumar Ramesh, Mehta DK, Dogra RK and Banyal Vikram. 2019. Heterosis and potence ratio studies for yield and its contributing traits in cucumber (*Cucumis sativus* L.). *Vegetable Science*. 45(2):210-219.
- Kumari S and Bharat NK. 2018. *In vitro* screening and efficacy of plant growth promoting rhizobacteria and biocontrol agents in bell pepper (*Capsicum annuum* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(5):1472-1475.
- Kumari Sangeeta, Dhiman SR, Sharma Puja and Dhiman MR. 2018. Identification of suitable hybrid lily cultivar(s) for commercial cultivation under mid-hills of Himachal Pradesh. *Journal of Ornamental horticulture*. 21(384):109-115.
- Leharwan M, Gupta M and Shukla A. 2018. Effect of temperature and moisture levels on the disease development of stem gall of coriander. *Agricultural Science Digest*. 38(4):307-309.
- Manohar TN, Sharma PL, Verma SC and Chandel RS. 2019. Demographic parameters of the indigenous egg parasitoids, *Trichogramma* spp., parasitizing the invasive tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). *Egyptian Journal of Biological Pest Control*. 29:9.
- Meena Rajesh Kumar, Dutt Bhupender, Kumar Rajneesh and Dobriyal Manmohan J. 2018. Efficient utilization of forest usufructs in composite wood and pulp & paper industry through eco-friendly bio-technological interventions. *International Journal of Forest Usufructs Management*. 19:48-65.
- Meenakshi, Rana N and Ghabru A. 2019. Influence of geographic variation on morphometric traits of seeds, pods and germination behavior of *Albizia procera*. *Int. J. Chem. Stud*. 7(3):1626-1631.
- Mehta Aruna, Rana RC, Sharma YP and Thakur Pancy. 2018. Physico-chemical analysis of some temperate Himalayan *Swertiaspecies*. *Journal of Pharmacognosy and Phytochemistry*. 7(3):156-159.
- Mehta Piyush, Negi Arun, Chaudhary Rashmi, Janjhua Yasmin and Thakur P. 2018. A study on managing crop damage by wild animals in Himachal Pradesh. *International Journal of Agriculture Sciences*. 10(12):6438-6442.
- Mittal S, Dhiman Anju K, Sharma A, Attri S and Kuthuria D. 2019. Standardization of recipe for the preparation of pumpkin (*Cucurbita moschata*) flour and its quality evaluation during storage. *International Journal of Current Microbiology and Applied Sciences*. 8(02):3224-3235.
- Mogta Ankush and Sharma Uday. 2018. Chemical Fractions of Iron and Manganese with Different Physicochemical Properties in Polyhouse Soils of Himachal Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*. 7(4):1903-1911.
- Mogta Ankush and Sharma Uday. 2018. Nutrient status of soils and capsicum foliage under protected cultivation in some vegetable growing areas of Himachal Pradesh. *International Journal of Chemical Studies*. 6(2):3067-3072.
- Nalwa Cherry, Thakur Ashok K. and Vikram Amit. 2018. Effect of plasma treatment on growth parameters and seed quality of bell pepper (*Capsicum annuum* L.) under field conditions. *International Journal of Current Microbiology and Applied Sciences*. 7(9):745-751.
- Navale R Manasi, Bhardwaj DR, Thakur CL and Bishist Rohit. 2018. Seasonal variation in leaf chemical composition of *Ougienia oojeinensis*. *International Journal of Farm Sciences*. 8(2):48-52.
- Negi Pratibha, Chand Subash, Thakur Nirja, Nath Amarjit K. 2018. Biological activity of serine protease inhibitor from seeds of local common bean (*Phaseolus vulgaris* L.) cultivar) *Agricultural Research*. 7:265-270.
- Negi Radhika, Thakur Secma and Sharma Payal. 2018. Advances in breeding of bellpepper- A review. *International Journal of Current Microbiology and Applied Sciences*. 7(4):2272-2281.
- Negi U, Dhiman S and Kumar R. 2018. Effect of *Pseudomonas* sp. based microbial formulation on green pod yield and shelling percentage of *Pisum sativum*. *International Journal of Agriculture Sciences*. 10(15):6784-6787.
- Nitika, Thakur KS and Mehta DK. 2018. Soil nutrient status, NPK uptake and viable bacterial count as influenced by different organic nutrient sources in European carrot. *International Journal of Current Microbiology and Applied Sciences*. 7(8):86-90.
- Pal J and Sharma SK. 2019. Standardization of isolation methodology for early detection and estimation of major hot spots of *Dematophora necatrix*, causing white root rot of apple in Himachal Pradesh. *Int. J. Curr. Microbiol. App. Sci*. 8(1):661-667.
- Panda Lakshmikanta LR, Aggarwal RK, Bhardwaj DR. 2018. A review on Air Pollution Tolerance Index (APTI) and Anticipated Performance Index (API). *Current World Environment*. 13(1):55-65.
- Pangtu S, Sharma BP, Dilta BS and Chaudhary SVS. 2018. Effect of seed priming on growth and flowering of China aster (*Callistephus chinensis* (L) Nees. *Agric International*. 5(1):38-42.
- Pangtu S, Sharma BP, Dilta BS and Chaudhary SVS. 2018. Effect of seed priming on seed parameters of China aster (*Callistephus chinensis* (L) Nees. *Agric International*. 5(1):43-48.
- Parkash P and Pant KS. 2019. Effect of tree spacing, organic manure and PGPR on flowering parameters of *Dianthus barbatus* L. under *Grewia optiva* based agroforestry system. *International Journal of Farm Sciences*. 9(2):31-35.
- Parmar Subhash Chand, Thakur N, Nath AK. 2018. Assessment of genetic diversity among kidney bean (*Phaseolus vulgaris* L.) cultivars using EST-Simple Sequence Repeat (SSR) Markers. *Applied Biological Research*. 201:63-170.
- Pathania S, Sharma N and Handa S. 2018. Utilization of horticultural waste (Apple pomace) for multiple carbohydrates production from *Rhizopus delemar* F2 under solid state fermentation. *Journal of Genetic Engineering and Biotechnology*. 16:181-189.
- Patyal SK, Dubey JK, Katna Sapna, Chauhan Avinash, Devi Nisha and Wani AA. 2018. Residue and Risk Assessment of Spirotetramat in/on Apple. *Pesticide Research Journal*. 30(1):51-58.



- Poonam, Bawa Rajan, Sankhyan HP and Nayak Dileshwar. 2018. Biodiversity loss and conservation of natural resources in cold desert ecosystem of Himachal Pradesh. *Indian Forester*. 144(9):817-824.
- Prakash Chander, Sharma BP, Gupta YC, Thakur KS and Gupta RK. 2018. Influence of different pulsing and durations on post harvest life of China aster (*Callistephus chinensis* (L.) Nees. cv 'Kamini'. *Indian journal of ornamental Horticulture*. 21(1&2):43-50.
- Rai P, Gupta B, Gupta AK, Bhutia PL and Fanai L. 2018. Effect of management regimes and elevational gradient on soil microbial population of *Quercus leucotrichophora* A. Camus forests in north-west Himalayas, India. *International Journal of Current Microbiology and Applied Sciences*. 7(9): 3205-3220.
- Raj T, Bhardwaj ML and Pal S. 2018. Estimation of heterosis for earliness, yield and yield contributing traits in tomato (*Solanum lycopersicum* L.). *Journal of Crop and Weed*. 14(1):64-68.
- Raj T, Bhardwaj ML and Pal S. 2018. Estimation of heterosis for quality traits in tomato (*Solanum lycopersicum* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(1):2401-2404.
- Raj T, Bhardwaj ML and Pal S. 2018. Performance of tomato hybrids for quality traits under mid hill conditions of Himachal Pradesh. *International Journal of Chemical Studies*. 6(4):2565-2568.
- Raj T, Bhardwaj ML, Pal S, Kumar S and Dogra RK. 2018. Performance of Tomato (*Solanum lycopersicum* L.) hybrids for yield and its contributing traits under mid hill conditions of Himachal Pradesh. *International Journal of Bio-resource and Stress Management*. 9(2):282-286.
- Rakesh, Shukla Arti, Sharma H.R. and Thakur Ashok. 2018. Genetic response of tomato germplasm against major diseases and fruit borer. *Journal of Plant Disease Sciences*. 13(2):123-126.
- Rana N and Ghabru A. 2019. Quality attributes in Spices: A perspective. *Research Trends in Food Technology and Nutrition*. (5):1-19.
- Rana N, Ghabru A and Rana K. 2019. Nutritional quality of vegetable as health food. *Kisan World: A Journal of Agricultural and Rural development*. 46(4):15-17.
- Rana N, Ghabru A and Vaidya D. 2019. Defensive function of fruits and vegetables. *Journal of Pharmacognosy and Phytochemistry*. 8(3):1872-1877.
- Rana N, Majneesh and Ghabru A. 2018. Enzyme Immobilization: Techniques, Support Materials and Applications. *Advances in Agricultural Sciences*. (10)1-19.
- Rana N, Vaidya D, Ghabru A and Rana K. 2019. Nutritive value of food. *Research Trends in Food Technology and Nutrition*. (8)89-119.
- Reddy MC and Gupta B. 2018. Soil organic stocks under different forest types of Himalayan moist temperate forests in Shimla district, Himachal Pradesh. *International Journal of Agricultural Science and Research*. 8(4):1-8.
- Rishu S, Dilta BS, Baweja HS, Poonam K and Sahare HA. 2018. Effect of seed priming and planting dates on growth flowering and seed production of pansy (*Viola × wittrockiana* Gams.). *Annals of Biology*. 34(2):176-180.
- Roshanzada SR, Pant KS and Kar S. 2018. Growth and carbon storage potential of important Agroforestry Trees of North-West Himalaya. *Int. J. Curr. Microbiol. App. Sci*. 7(11)1804-1818.
- Saini A and Sharma PL. 2018. Functional Response and Mutual Interference of *Cotesia vestalis* (Hymenoptera: Braconidae) on *Plutella xylostella* (Lepidoptera: Plutellidae). *Journal of Entomological Science*. 53(2):162-170
- Sandeep, Vikram Amit, Dogra Rajesh Kumar and Sharma Shikha. 2018. Combining ability and gene action studies for important quality traits in tomato (*Solanum lycopersicum* L.). *International Journal of Chemical Studies*. 6(2): 1992-1996.
- Sankhyan HP, Kairon K Vinod and Rana Neerja. 2018. Nutritive Value of Deoiled Cake of Seabuckthorn (*Hippophae rhamnoides* L.) Population of Cold Desert Ecosystem of Himachal Pradesh. *Indian Forester*. 144(11):1072-1075.
- Sankhyan HP, Thakur Sanjeev and Sharma SS. 2018. Identification of Discriminating Morphological Descriptors for Characterization of Seabuckthorn (*Hippophae rhamnoides* L.) Germplasm in Himachal Pradesh. *Journal of Non-Timber Forest Product*. 25(1):51-55.
- Saurabh A, Sharma MK. 2018. Standardization of soil nutrient fertigation levels in soil less media to improve the nutrient uptake by *Capsicum annum* grown under protected conditions. *Multilogic in Science*. 8(25):203-205.
- Shalini, Thakur KS, Kumar S and Kumar N. 2018. Effect of active packaging and refrigerated storage on quality attributes of kiwifruits (*Actinidia deliciosa* Chev). *Journal of Pharmacognosy and Phytochemistry*. 7(2):1372-1377.
- Sharma A and Thakur NS. 2018. Wild pomegranate (*Punica granatum* L.): A review on physical and chemical attributes of Himalayan wild pomegranate fruit. *Journal of Pharmacognosy and Phytochemistry*. 7(4):1518-1524.
- Sharma A, Dhiman AK, Mittal S and Attri S. 2019. Carotenoid Pigment: significance as a natural food colourant and factors affecting its isolation. *International Journal of Current Microbiology and Applied Sciences*. 8(2):44-51.
- Sharma A, Dhiman Anju K, Attri Surekha and Thakur RK. 2018. Comparative evaluation of physico-chemical attributes of different portions of *C. moschata* and *C. maxima* species of pumpkin. *International Journal of Chemical Studies*. 6(2):3209-3213.
- Sharma A, Handa A, Kapoor S, Watpade S, Gupta B and Verma P. 2018. Viruses of strawberry and production of virus free planting material- A critical review. *International Journal of Science, Environment and Technology*. 7(2):521-545.
- Sharma A, Handa A, Shylla B and Kapoor S. 2018. First report of Tobacco Streak Iilar virus on strawberry (*Fragaria x ananassa*) in India. *The Pharma Innovation Journal*. 7:976-979.
- Sharma A, Handa A, Shylla B, Pramanick KK and Verma S. 2018. Prevalence of nepoviruses in strawberry and their serological detection. *International Journal of Current Microbiology and Applied Sciences*. 7(3):404-409.



- Sharma A, Kumar M, Dogra RK and Kumar N. 2018. Evaluation of Bell Pepper (*Capsicum annuum* L. var. *grossum*) Genotypes for Yield and Yield Contributing Traits under Mid Hill Conditions of Himachal Pradesh. *Indian Journal of Ecology*. 44(6):736-739.
- Sharma A, Rana VK and Kumar S. 2018. New record of harar (*Terminalia chebula*) fruit borer *Dichocrocis* sp. (Lepidoptera: Crambidae). *Indian Journal of Entomology*. 80(4):1703-1704.
- Sharma A, Thakur N, Jandaik S and Singh R. 2019. Cultivation of wild *Pleurotus* species on agricultural substrates and evaluation of their nutritional properties *Int. J. Adv. Res.* 6(12):1425-1429.
- Sharma A, Vaidya Devina, Gupta A, Kaushal Manisha. 2019. Formulation and evaluation of wild apricot kernel oil based massage cream. *Journal of Pharmagnosy and Phytochemistry*. 8(1):1017-1021.
- Sharma A. 2018. Effects of hosts, temperature and humidity on the biology of *Locastra muscosalis* walker (Lepidoptera: Pyralidae). *Indian Journal of Entomology*. 80(3):567-571.
- Sharma Anju, Mahajan PK, Malhotra R, Belwal OK and Sharma Satish K. 2018. Application of Multivariate Techniques in Horticulture Research-a Case Study of Apple Crop. *International Journal of Bio-resource and Stress Management*. 9(5):556-561.
- Sharma BP and Dilta BS. 2018. Studies on postharvest life of tuberose (*Polianthes tuberosa* L.). *Research and Reviews: Journal of Agricultural Science and Technology*. 4(3):20-24.
- Sharma BP, Choudhry R, Dhiman SR and Dilta BS. 2018. Effect of bulb spacing and size on growth and flowering of chinchinchee (*Ornithogalum thyrsoides* Jacq.). *Research and Reviews: Journal of Crop Science and Technology*. 3(2):1-6.
- Sharma D and Chauhan A. 2019. Effect of plant growth regulators on yield and quality of tomato (*Solanum lycopersicum* L.) under mid hill conditions of Himachal Pradesh. *International Journal of Bio-resource and Stress Management*. 10(3):215-218.
- Sharma D, Kumar A, Thakur S and Sagar N. 2018. Initial growth performance of improved genotypes of *Melia dubia* in low hills of Himachal Pradesh. *International Journal of Chemical Studies*. 6(6):1847-1849.
- Sharma D, Sharma K, Bhardwaj R and Prakash P. 2019. Evaluation of growth performance of improved genotypes of Malabar neem (*Melia dubia*) in low hills of Himachal Pradesh. *Journal of Pharmacognosy and Phytochemistry*. 1(SPI):83-85.
- Sharma DD and Deepika Rathore. 2018. Employees perception on organisation culture and climate in university of Horticulture and Forestry Nauni (Solan) H.P. *International Journal of Recent Scientific Research*. 9(5): 27042-27046.
- Sharma DD, Bala B, Singh N and Sharma DP. 2018. Effect of pruning levels and Benzyl adenine (BA) on bud-wood production in apple (*Malus domestica* Borkh.). *Journal of Pharmacognosy and Phytochemistry*. 7(2):3026-3032.
- Sharma DP and Singh N. 2018. Effect of rejuvenation pruning on the growth, productivity and disease incidence in declining trees of pomegranate (*Punica granatum* L.) cv. Kandhari Kabuli. *Journal of Applied and Natural Science*. 10(1):358-362.
- Sharma HK, Ram Budhi, Rana Kiran and Thakur Meena 2018. Effect of neonicotinoids on *Apis mellifera* under field and semi field conditions. *Journal of Pharmacognosy and Phytochemistry*. 7(6):59-63.
- Sharma HK, Thakur Shabnam, Rana Kiran and Thakur Meena 2018. Small scale rearing of *Bombus haemorrhoidalis* Smith. *The Pharma Innovation Journal*. 7(11):41-45.
- Sharma IM and Bhandari DP. 2018. Effect of climate variation on apple scab occurrence in Himachal Pradesh. *Journal of Agrometeorology*. 20(3):252-252.
- Sharma Isha and Gupta Divender. 2018. Management of fruit flies (*Bactrocera* spp.) in mango (*Mangifera indica*) orchard using biopesticides and clay. *Indian Journal of Entomology*. 80(4):1478-1481.
- Sharma Isha and Gupta Divender. 2018. Morphometry of *Bactrocera dorsalis* and *B. zonata* on mango (*Mangifera indica*), guava (*Psidium guajava*) and peach (*Prunus persica*). *Journal of Entomology and Zoology Studies*. 6(4):395-397.
- Sharma K and Raj H. 2018. Use of local bio-resources for post-harvest management of white rot of apple caused by *Botryosphaeria dothidea*. *Journal of Applied and Natural Science*. 10(1):491-499.
- Sharma K, Sharma N and Sharma R. 2018. A study on optimization of exopolysaccharides from a potential *Lactobacillus casei* KL14 KX774469. *International Journal of Current Microbiology and Applied Sciences*. 7(2):3410-3418.
- Sharma K, Vaidya D and Sharma N. Recent trends of enzymes in food industry: A review. *International Journal of Chemical Studies*. 7(2):1525-1529.
- Sharma KD, Cardona JA, Sibomana MS, Herrera NGS, Nampeera E and Fallik E. 2018. Quality attributes of modified atmosphere packaged bell pepper (*Capsicum annuum* L.) during storage. *Journal of Nutrition, Food Research and Technology*. 1(2):56-62.
- Sharma KD, Chandel V, Gupta A and Verma AK. 2018. Effect of packing and storage behaviour on shelf-stability of functionally enriched fruit rolls. *International Journal of Economic Plants*. 5(1):15-22.
- Sharma KD, Chandel V, Gupta A and Verma AK. 2019. Antioxidant rich mixed fruit rolls and their storage stability. *Journal of Pharmacognosy and Phytochemistry*. (SPI):13-18.
- Sharma Komal, Thakur Meena, Verma Shalini and Bharat Narender. 2018. In vitro studies on uptake of heavy metal by fungi. *Plant Disease Research*. 32(2):262-263.
- Sharma Lokesh, Vaidya Manoj Kumar, Singh Pardeep and Dev Kapil. 2018. Economic Analysis of input use efficiency of garlic in Himachal Pradesh- A case study of Sirmaur District of Himachal Pradesh. *Journal of Agricultural Development and Policy*. 28(2):141-148.
- Sharma M, Sharma RP and Sepehya S. 2018. Effect of a decade long chemical fertilizers and amendments application on



- potassium fractions and yield of maize-wheat in an acid Alfisol. *Communications in Soil Science and Plant Analysis*. 49(15):1869-79
- Sharma M, Shridhar BP and Sharma A. 2018. Efficacy of biocontrol agents against *Phytophthora nicotianae* var. *parasitica*, the causal organism of buckeye rots of tomato. *International Journal of Agriculture Sciences*. 10(10):6109-6110.
- Sharma Monika, Sharma AK and Shilpa. 2018. Integrated Nutrient Management of Pea-Capsicum-Radish Cropping Sequence in Sub-Temperate Climate of North-Western Himalayas. *International Journal of Current Microbiology and Applied Sciences*. 7(3):538-545.
- Sharma N, Sharma S, Gupta SK and Sharma M. 2018. *In vitro* and *In vivo* evaluation of different fungicides against bean rust (*Uromyces appendiculatus*). *Plant Disease Research*. 33(2):174-179.
- Sharma N. 2018. Second Generation Bioethanol Production from Lignocellulosic Waste. *International Journal of Current Microbiology and Applied Sciences*. 7 (5):1285-1290.
- Sharma Neha, Sharma Himani, Khatri Praveen and Shirkot Poonam. 2018. Biosynthesis characterization and antibacterial activity of bioiron nanoparticles synthesized by *Pseudomonas putida* strain LUA 15.1. *International Journal of Chemical Studies*. 6(1):691-699.
- Sharma P and Sharma R. 2018. DNA fingerprinting of peach (*Prunus persica*) germplasm in accessing genetic variation using arbitrary oligonucleotide markers system. *Ind. J. of Biotech*. 17(3):484-491.
- Sharma P, Sharma N and Sharma N. 2019. Optimization of enzymatic hydrolysis conditions for saccharification of carbohydrates in algal biomass: an integral walk for bioethanol production. *The Pharma Innovation International Journal*. 8(1):461-466.
- Sharma P, Sharma N and Sharma N. 2019. Scale up and Optimization of Process Parameters for ethanol fermentation from *Rhizoclonium* sp. of Trans Himalayas. *Journal of Pharmacognosy and Phytochemistry*. 8(1):1386-1398.
- Sharma P, Sharma N and Sharma N. 2019. Screening and Molecular Identification of Microbial Strain *Bacillus axarquiensis* P6 for Production and Optimization of Multiple Enzymes *International Journal of Chemical Studies*. 7(1): 1338-1346.
- Sharma P, Sharma N, Sharma P and Devi S. 2018. The use of response surface methodology as a statistical tool for process parameter optimization in lipase production by *Brevibacterium halotolerans* PS4 isolated from olive orchard soil. *Agricultural Research Journal*. 55(1):92-98.
- Sharma Priyanka, Singh Mohinder, Bhardwaj SK and Gupta Rasna. 2018. Impact of weather parameters on insect pest infestation in cauliflower (*Brassica oleracea* var *botrytis* L.) seed crop in mid hill regions of Himachal Pradesh. *Journal of Entomology and Zoology Studies*. 6(3):156-161.
- Sharma R, Barupal S, Shukla YR, Bharat NK and Dilta BS. 2018. Effect of seed priming on filed performance of okra. *International Journal of Farm Sciences*. 8(2):144-149.
- Sharma R, Sharma RP, Sankhyan NK, Kumar R and Sepehya S. 2018. Effect of a four-decade long application of fertilizers, farmyard manure and lime on forms of soil acidity and their relationship with yield of wheat and maize in an acid Alfisol. *Journal of Plant nutrition*. 41(11):1444-55.
- Sharma R, Thakur A, Kumar R and Shukla YR. 2018. Seed yield and its attributes in carrot as influenced by plant density and fertilizer doses. *Journal of Hill Agriculture*. 9(2):153-157.
- Sharma Rakesh, Sharma R and Thakur A. 2018. Development and evaluation of Vitamin C enriched low calorie Aloe vera-aonla blended functional squash using stevioside. *Indian J Horticulture*. 75(2):289-294.
- Sharma S and Raj H. 2019. *In vitro* evaluation of botanicals and bio-pesticides against the Fusarium wilt of carnation (*Fusarium oxysporum* f. sp. *dianthi*). *Journal of Pharmacognosy and Phytochemistry*. 8(1):1406-1408.
- Sharma S and Raj H. 2019. *In vitro* evaluation of different fungicides against the fusarium wilt of carnation (*Fusarium oxysporum* f.sp. *dianthi*). *International Journal of Chemical Studies*. 7(1):1416-1418.
- Sharma S and Sharma DP. 2018. Effect of orchard floor management treatments on soil hydrothermal regimes under rainfed conditions of Himachal Pradesh in nectarine (*Prunus persica* var. *nucipersica*) cv. Snow Queen. *Indian Journal of Agricultural Science*. 88(7):1115-1122.
- Sharma S and Vaidya D. 2018. Application of kiwifruit protease enzyme for tenderization of spent hen chicken. *Journal of Pharmacognosy and Phytochemistry*. 7(1):581-584.
- Sharma S and Vaidya D. 2018. Kiwifruit enzyme: A new plant coagulant for the development of cottage cheese. *International Journal of Food Science and Nutrition*. 3(1):6-13.
- Sharma S, Dogra RK, Sharma DP and Kalsi K. 2018. Variability studies in walnut (*Juglans regia* L.). *International Journal of Farm Sciences*. 8(4):1-6.
- Sharma S, Negi YS, Sharma R, Mahajan PK and Prasher RS. 2018. Analysis of Production and Marketing problems faced by tree growers of Northern India. *Journal of Tree Sciences*. 37(1):40-46.
- Sharma S, Rana VS, Kumari M and Mishra P. 2018. Biofertilizers: boon for fruit production. *Journal of Pharmacognosy and Phytochemistry*. 7(5):3244-3247.
- Sharma S, Sharma N, Sharma R and Handa S. 2018. Formulation of functional bread and evaluation of their health potential. *International Journal of Current and Applied Microbiology*. 7(7):4120-4126.
- Sharma S, Vaidya D and Chauhan N. 2018. Microbiological analysis and nutritional evaluation of cottage cheese produced with kiwifruit enzyme. *International Journal of Current Microbiology and Applied Sciences*. 7(2):1-7.
- Sharma S, Vaidya D and Rana N. 2018. Extraction, partial purification and characterization of kiwifruit enzyme. *The Pharma Innovation Journal*. 7(1):312-315.
- Sharma Seema and Sharma Yash Pal. 2018. Comparison of different extraction methods and HPLC method development for the quantification of andrographolide from



- Andrographis paniculata* (Burm.f.) Wall. ex Nees. *Annals of Phytomedicine*. 7(1):119-130.
- Sharma Seema, Sharma Yash Pal and Bhardwaj Chitra. 2018. Development and validation of HPLC-UV method for quantification of podophyllotoxin in *Podophyllum hexandrum* Royle. *Journal of Pharmacognosy and Phytochemistry*. 7(2):3748-3752.
- Sharma Seema, Sharma Yash Pal and Bhardwaj Chitra. 2018. Development and Validation of HPLC Method for Analysis of Picroside-I and Picroside-II in *Picrorhiza kurroa*. *International Research Journal of Pure & Applied Chemistry*. 17(4):1-10.
- Sharma Seema, Sharma Yash Pal and Bhardwaj Chitra. 2018. HPLC quantification of andrographolide in different parts of *Andrographis paniculata* (Burm.f.) Wall. ex Nees. *Journal of Pharmacognosy and Phytochemistry*. 7(5):71-74.
- Sharma Seema, Sharma Yash Pal and Bhardwaj Chitra. 2019. Development and Validation of HPLC Method for the Determination and Quantification of Colchicine in *Gloriosa superba*. *International Research Journal of Pure & Applied Chemistry*. 18(1):1-9.
- Sharma Seema, Sharma Yash Pal, Bhardwaj Chitra and Mehta Aruna. 2018. Quantification of Amaroswerin and Amarogentin in different parts of *Swertia chirayita* by chromatographic analysis. *International Research Journal of Pure & Applied Chemistry*. 17(4):1-7.
- Sharma Shilpa, Minakshi, Kaushal Rajesh and Chauhan Anjali. 2018. Characterization of efficient plant growth promoting rhizobacteria associated with *Chrysanthemum (Dendranthema grandiflora Tzvelev)*. *Journal of Pharmacognosy and Phytochemistry*. 7(6):1547-1554.
- Sharma Shweta, Kumar Ramesh, Sharma H.R., Sharma Ajit and Gautam Nidhish. 2018. Divergence studies for different horticultural traits in cucumber (*Cucumis sativus* L.) *International Journal of Current Microbiology and Applied Sciences* 7(2):1733-1741.
- Sharma Shweta, Kumar Ramesh, Subhrajyoti and Sharma Hem Raj. 2018. Correlation and path analysis for yield and its attributes in cucumber (*Cucumis sativus* L.) *International Journal of Chemical Studies*. 6(2): 2045-2048.
- Sharma SK and Pratima P. 2018. Effect of pre-harvest gibberellic acid and calcium application on post-harvest behaviour of subtropical peaches. *Current Agriculture Research Journal*. 6(1):78-84.
- Sharma SK. 2019. Apple high density orcharding – performance reckoning studies in respect of the agro-ecological challenges of Kinnaur. *International Journal of Science Research*. 8(4):636-643.
- Sharma Swati, Verma ML and Kaur Manjeet. 2019. Micronutrients in Mango orchards under Kangra district of Himachal Pradesh. *Agricultural Research Journal*. 56(1):92-96.
- Sharma Usha and Gupta Bhupesh. 2018. First report of *Diplocarpon mali*, the perfect state of apple blotch fungus *Marssonina coronaria* from India. *Journal of Krishi Vigyan* 7(1):239-241.
- Shilpa, Thakur Shivender, Sharma Monika and Sharma AK. 2018. Integrated Nutrient Management of Pea-Capsicum-Radish Cropping Sequence in Sub-Temperate Climate of North-Western Himalayas. *International Journal of Current Microbiology and Applied Sciences*. 7(3):952-961.
- Shreya Handa, Meena Thakur and KS Thakur. 2019. Effect of domestic effluents on tomato crop (*Solanum lycopersicum* L.) production. *Journal of Pharmacognosy and Phytochemistry*. 8(1):01-07.
- Shridhar BP, Sharma M, Sharma SK and Gupta SK. 2018. New generation fungicides for the management of buckeye rot of tomato. *Indian Phytopathology*. 71:621-625.
- Shubhr Jyotsna, Bhardwaj SV and Sharma Usha. 2018. Bio-virus inhibitors with potential for retrieval of virus free plants of *Lilium* spp. *Journal of Pharmacognosy and Phytochemistry*. 7(6):2475-2478.
- Shukla YR, Kaushal M and Bijalwan P. 2018. Studies on the effect of macro and micro nutrients on yield and economics of garlic (*Allium sativum* L.) cultivation. *Journal of Pharmacognosy and Phytochemistry*. 7(5): 2371-2373.
- Shukla YR, Kaushal Manisha and Bijalwan Priyanka. 2018. Studies on the effect of macro and micro nutrients on yield and nutrient uptake in garlic (*Allium sativum* L.). *International Journal of Current Microbiology and Applied Sciences*. 7(10):1201-1204.
- Shukla YR, Kaushal Manisha and Shilpa. 2018. Effect of macro and micro nutrients on quality characters, diseases severity and yield of garlic (*Allium sativum* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(5):2368-2370.
- Shukla YR, Kaushal Manisha and Shilpa. 2018. Studies on the effect of macro and micro nutrients on growth and yield of garlic (*Allium sativum* L.). *International Journal of Current Microbiology and Applied Sciences*. 7(8):4787-4791.
- Shukla YR, Raturi HC and Sharma R. 2019. Effect of seed priming treatments on quality and storage life of cucumber cv. K-75 seeds under temperature-stress conditions. *International Journal of Farm Sciences*. 8(4):137-143.
- Shukla YR, Shilpa, Bijalwan Priyanka and Kaushal Manisha. 2018. Effect of macro and micro nutrients on soil characters and yield of garlic (*Allium sativum* L.). *International Journal of Chemical Studies*. 6(5):2417-2419.
- Singh D, Singh HB, Kumar Pramod, Kumari N and Deepika. 2018. Nitrogen source fertilization for nutrient profiling of Royal Delicious apples in temperate ecosystem. *International Journal of Farm Sciences*. 8(2):169-175.
- Singh D, Kumar K, Chauhan N, Dogra RK and Verma P. 2018. Assessment of genetic variability, its heritable components and character association in yield and yield contributing traits in apricot (*Prunus armeniaca*). *Indian Journal of Agricultural Sciences*. 88(7):1037-1043.
- Singh H, Dutt Bhupender and Sharma KR. 2018. Germplasm Evaluation and interaction studies of *Inula racemosa* Hook.f. little known medicinal and aromatic plant of Himalayan Region. *Int. Jour. of Pure Applied Biosci.(spl.)*. 60:195-205.
- Singh Joginder and Bhardwaj Sushma. 2018. Efficacy of some new insecticides aerial form of the apple woolly aphid,



- Eriosomalnigerum* (Hausmann). *Indian Journal of Entomology*. 80(3):822-824.
- Singh Joginder and Bhardwaj Sushma. 2018. Field efficacy of new insecticides against apple woolly aphid, *Eriosomalnigerum* (Hausmann). *Indian Journal of Entomology*. 80(2):353-355.
- Singh KP, Khanna AS and Kumar S. 2018. Incidence of root-knot nematode (*Meloidogyne* species) on various hosts in different agro-climatic ranges of Himachal Pradesh, India. *Indian Journal of Nematology*. 48(1):96-102.
- Singh Mohan and Aggarwal RK. 2018. Mapping of Agro-Ecological Zones of North-West India in Context to Climate Change using Geographical Information System. *Current World Environment*. 13(1):75-86.
- Singh Mohan, Niwas Ram and Anurag. 2018. Rainfall trend analysis in north-west India. *Journal of Agrometeorology*. 20(3):265-267.
- Singh Mohan, Niwas Ram and Godara AK. 2018. Trend of chilling hours over north-west India. *Journal of Agrometeorology*. 20(3):262-264.
- Singh Mohinder, Sharma PL, Rana VK, Sharma Deeksha and Sharma Priyanka. 2018. Population dynamics of fruit flies, *Bactrocera* spp. infesting vegetable crops in Himachal Pradesh, India. *Indian Journal of Plant Protection*. 45(2):113-119.
- Singh N, Sharma DP and Kumari S. 2018. Nematodes and Biological Activity Status of Declining Apple Orchards in Shimla and Sirmaur Districts of Himachal Pradesh-A Survey. *Indian Journal of Nematology*. 48(1):73-76.
- Singh N, Sharma DP, Kumari S and Kalsi K. 2018. Techniques for crop regulation in guava-a review. *International Journal of Farm Sciences*. 8(2):131-135.
- Singh Paramveer, Thakur Meena, Sharma HK and Sharma KC. 2018. Study of foraging behaviour of syrphids viz. *Episyrphus balteatus* (De Geer) and *Eupeodes frequens* (Matsmura) (Diptera: Syrphidae) on mustard bloom (*Brassica juncea* L.: Cruciferae) under mid hill conditions. *Journal of Entomology and Zoology Studies*. 6(5):1167-1171.
- Singh Pardeep, Vaidya Manoj Kumar and Guleria Amit. 2018. Economic Efficiency of Input Use in Peach Cultivation in North Western Himalayas. *Economic Affairs*. 63(3):01-06.
- Singh R, Bhardwaj DR, Nazir A Pala, Kaushal Rajesh and Singh Bhalendra. 2018. Variation of soil microbial biomass and CO₂ evolution in sub-tropical agro-ecosystems of northwestern Himalaya. *Current Science*. 115(10):1956-1959.
- Singh Thiyam Jeffereson and Gupta Tara. 2019. Development and purity identification of hybrids by using molecular marker in wild pomegranate (*Punica granatum* L.) *Scientia Horticulturae*. 247:436-448.
- Solanki SPS, Sharma NC, Chandel JS and Kumar Pramod. 2019. Effect of conjoint bio-organic and inorganic sources on plant growth, leaf nutrient content and soil properties of peach (*Prunus persica*). *Indian Journal of Agricultural Sciences*. 89(1):16-21.
- Sood G, Kaushal R, Chauhan A and Gupta S. 2018. Indigenous plant growth promoting rhizobacteria and chemical fertilizers: Impact on wheat (*Triticum aestivum*) productivity and soil properties in North Western Himalayan region. *Crop and Pasture Science*. 69:460-468.
- Sood G, Kaushal R, Chauhan A, and Gupta S. 2018. Effect of conjoint application of indigenous PGPR and chemical fertilizers on productivity of maize (*Zea mays* L.) under mid hills of Himachal Pradesh. *Journal of Plant Nutrition*. 41(3):297-303.
- Sood Richa, Pandey Himanshu, Thakur Dinesh, Nath AK. 2018. Molecular characterisation to assess genetic diversity in wild pomegranate of H.P. *International Journal of Chemical Studies*. 6:1102-1107.
- Spehia RS and Verma ML. 2019. Can micro irrigation adoption help in doubling farmers income: A case study of Himachal Pradesh, India. *Journal of Pharmacognosy and Phytochemistry*. 8(3):452-458.
- Spehia RS, Devi Meera, Singh Jaspal, Sharma Shweta, Negi Ajender, Singh Sukhpreet, Chauhan Nirmla, Sharma Deepak and Sharma JC. 2018. Lettuce growth and yield in Hoagland Solution with an organic concoction. *International Journal of Vegetable Science*. 24(6):557-566.
- Sudarshna and Thakur A. 2018. Effects of Brassinosteroids on Growth and Biochemical Responses of Apple Plants to Water Stress. *International Journal of Pure and Applied Bioscience*. 6(6):613-620.
- Sudarshna and Thakur A. 2019. The Effects of Water Stress and Brassinosteroid on Apple Varieties *International Journal of Economic Plants*. 6(1):01-06.
- Sultanpuri A, Dhiman SR, Gupta YC, Kakar R, Thakur Priyanka, Kashyap B and Sharma M. 2018. Effect of number of plants per plant, pot spacing and photoperiod on production of pot mum chrysanthemum. *Journal of Hill Agriculture*. 9(2):149-152.
- Suman Kritika, Thakur IK and Kumari Anita. 2018. Variation in growth characteristics of different clones of *Morus alba*. *Journal of Pharmacognosy and Phytochemistry*. 7(6):1236-1238.
- Suman Kritika, Thakur IK, Kumari Anita and Namdol Stanzin. 2018. Variation studies in leaf fodder qualities in different clones of *Morus alba*. *International Journal of Chemical Studies*. 6(6):2398-2402.
- Tesfaye Ashine and Thakur IK. 2019. Evaluation of combining ability and genetic variance for growth traits in *Bauhinia variegata* L. *International Journal of Chemical Studies*. 7(1):1681-1685.
- Thakur A and Sayal N. 2018. Effect of Dormancy Breaking Treatments on Germination, Vigour and Physio-Biochemical Changes In Seeds of *Rauvolfia serpentina* (L.) Benth. Ex Kurz—Endangered Medicinal Species. *The Journal of the Indian Botanical Society*. 97(3&4):187-193.
- Thakur A and Sayal N. 2018. Effect of Seed Invigoration Treatments on Seed Germination, Seedling Vigour and Physio-biochemical Characteristics of *Angelica glauca* EDGEW—An Endangered Medicinal Herb. *International journal of Bio-resource and Stress Management*. 9(3):353-358.



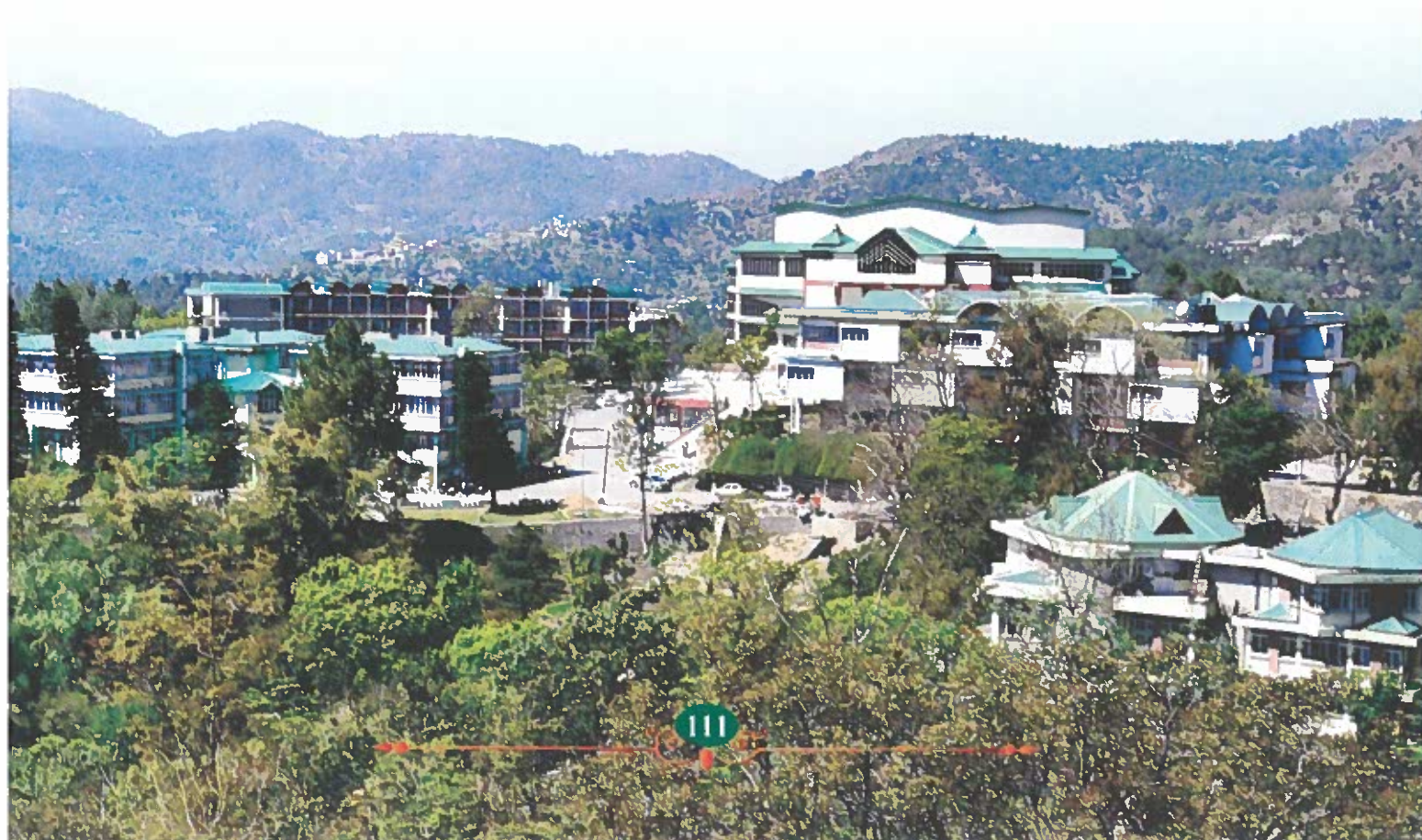
- Thakur A and Thakur CL. 2018. Evaluation of Four medicinal herb species under conditions of water-deficit stress. *Indian Journal of Plant Physiology*. 23(3):459-466.
- Thakur A, Dilta BS, Mehta DK, Sharma BP and Gupta RK. 2018. Effect of plant spacing and GA₃ on growth and flowering of sweet William (*Dianthus barbatus* L.). *International Journal of Farm Sciences*. 8(2):122-125.
- Thakur A, Thakur NS, Hamid and Kumar P. 2018. Studies on physico-chemical and antioxidant properties of wild pomegranate fruits in different locations of Himachal Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*. 7(8):2842-2850.
- Thakur A, Vaidya Devina, Kaushal Manisha, Gupta Anil. 2019. Physico chemical properties, mineral composition, FTIR spectra and scanning electron microscopy of wild apricot kernel press cake. *International Journal of Food Science and Nutrition*. 4(2):140-143.
- Thakur B, Singh K, Kansal S and Sharma AK. 2018. Growth and Yield Characteristics of Capsicum (*Capsicum annum* L.) cv. Orobelle in response to different growing media and plant spacing under protected conditions. *Int. J. Curr. Microbiol. App. Sci.* 7(05):1096-1103.
- Thakur C and Sharma CL. 2018. Effect of plant growth regulators on physico-chemical parameters of pomegranate (*Punica granatum* L.) cv. Kandhari. *International Journal of Chemical Studies*. 6(4):1849-1855.
- Thakur IK. 2018. Estimation of variability, heritability, genetic gain and correlation in clones (grafts) of kachnar (*Bauhinia variegata* L.). *The Indian Forester*. 144(7):666-670.
- Thakur IK. 2018. Variability, heritability, genetic gain and correlation in white mulberry (*Morus alba* L.) clones. *The Indian Forester*. 144(12):1211-1215.
- Thakur KK. and Sharma DP. 2018. Enzyme activities in peach rhizosphere as influenced by various soil management practices under replant situations: A pot culture study. *International Journal of Chemical Studies*. 6(2):2726-2730.
- Thakur M, Soni M, Sharma DP, Manu V, Sharma V. 2018. *In vitro* propagation of Plum (*Prunus salicina*) cv. 'Santa Rosa' and assessment of genetic stability using RAPD markers. *Indian Journal of Plant Physiology*. 23(1):161-168.
- Thakur Mamta and Shylla Bunt. 2018. Effect of Different Soilless Substrates on Flowering, Yield and Fruit Quality of Strawberry (*Fragaria x ananassa* Duch.) cv. Chandler under Protected Conditions *International Journal of Current Microbiology and Applied Sciences*. 7:2830-2836.
- Thakur Mamta and Shylla Bunt. 2018. Influence of different growing media on plant growth and fruit yield of Strawberry (*Fragaria x ananassa* Duch.) cv. Chandler grown under protected conditions. *International Journal of Current Microbiology and Applied Sciences*. 7:2724-2730.
- Thakur Manisha, Kumar Ramesh and Kumar Sandeep 2018. Estimation of heterosis for earliness and yield contributing traits in cucumber (*Cucumis sativus* L.). *The Bioscan*. 13(1):163-168.
- Thakur Nirja, Gupta Rakesh, Chauhan Anjali, Thakur Manisha and Dogra RK. 2019. Physicochemical analysis of soils samples from Shimla and Kinnaur district of Himachal Pradesh. *International Journal of Chemical Studies*. 7(1):41-46
- Thakur Nirja, Nath Amarjit K, Chauhan Anjali, Parmar Subhash Chand, Pandey Himanshu and Thakur Kanika. 2019. Chitinases from microbial sources, their role as biocontrol agents and other potential applications. *Journal of Entomology and Zoology Studies*. 7(1):837-84.
- Thakur NS, Chauhan Monika and Thakur A. 2018. Development of squash from wild prickly pear (*Opuntia dillenii* Haw.) fruit and its quality evaluation during storage. *International Journal of Current Microbiology and Applied Sciences*. 7(7):1942-1954.
- Thakur NS, Dhaygude GS, Hamid Kumar P and Thakur A. 2018. Studies on development and storage quality evaluation of syrup prepared from wild pomegranate (*Punica granatum* L.) fruits. *International Journal of Current Microbiology and Applied Sciences*. 7(2):538-548.
- Thakur NS, Dhaygude GS, Thakur A, Hamid and Kumar P. 2018. Preparation and storage potentiality of chutney from wild pomegranate (*Punica granatum* L.) fruits. *Journal of Pharmacognosy and Phytochemistry*. 7(1):2749-2753.
- Thakur NS, Thakur A, Joshi VK and Sharma SK. 2018. Botrytized Wines: A Review. *Intl. J. Food. Ferment. Technol.* 8(1):01-13.
- Thakur NS, Thakur N, Hamid and Thakur A. 2018. Studies on development and storage quality evaluation of vitamin C rich syrup prepared from wild aonla (*Phyllanthus emblica* L.) fruits. *The Pharma Innovation Journal*. 7(2):167-172.
- Thakur NS, Thakur N, Hamid, Kumar P and Thakur A. 2018. Formulation and optimization of vitamin C rich ready-to-serve juice based beverage from wild aonla fruits and its quality evaluation during storage. *Journal of Pharmacognosy and Phytochemistry*. 7(1):1796-1802.
- Thakur NS, Thakur N, Hamid, Thakur A and Kumar P. 2018. Standardization of method for the preparation of preserve from wild aonla (*Phyllanthus emblica* L.) fruits and its quality evaluation during storage. *International Journal of Chemical Studies*. 6(1):1841-1847.
- Thakur NS, Thakur N, Thakur A, Hamid and Kumar P. 2018. Effect of packaging and storage temperature on storage behaviour of appetizer (Spiced squash) prepared from wild aonla (*Phyllanthus emblica* L.) fruits. *Chemical Science Review and Letters*. 7(25):310-316.
- Thakur NS, Thakur N, Thakur A, Kumar P and Hamid. 2018. Physico-chemical characteristics and standardization of juice extraction method from wild aonla (*Phyllanthus emblica* L.) fruits of Himachal Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*. 7(2):731-737.
- Thakur P, Dilta BS, Gupta YC, Kumar P and Mehta DK. 2019. Effect of planting dates, mulching and application of G_{A3} on growth and flower yield of marigold (*Tagetes erecta* L.) cv. 'Pusa Narangi Gaiinda'. *International Journal of Current Microbiology and Applied Sciences*. 8(4):3028-3039.
- Thakur P, Rana RS, Sharma KC and Sharma N. 2018. Host preference of the fruit borer, *Helicoverpa armigera*



- (Hubner) on tomato varieties in mid hills of Himachal Pradesh. *Journal of Entomology and Zoology Studies*. 6(1):1186-1189.
- Thakur Pancy, Sharma Yash Pal and Bhardwaj Chitra. 2019. Phyto-chemical variation in gynodioecious *Valeriana jatamansi* Jones. *Journal of Pharmacognosy and Phytochemistry*. 8(1):1576-1582.
- Thakur Pancy, Sharma Yash Pal, Mehta Aruna and Bhardwaj Chitra. 2018. Effect of decapitation and spacing on growth and yield of *Swertiachirayita*: A critically endangered medicinal plant. *Medicinal Plants: International Journal of Phytomedicine and Related Industries*. 10(1):10-16.
- Thakur Pancy, Sharma Yashpal and Sharma Jaipal. 2018. Genetic parameters for yield contributing characters in *Valeriana jatamansi* Jones: An endangered medicinal plant *Journal of Pharmacognosy and Phytochemistry*. 7(2):1899-1902.
- Thakur Pancy, Sharma Yashpal, Sharma Seema and Bhardwaj Chitra. 2018. Morphological studies among female and hermaphrodite plants of *Valeriana jatamansi* Jones -An endangered medicinal plant of temperate Himalayas. *Journal of Pharmacognosy and Phytochemistry*. 7(3):116-119.
- Thakur Pancy, Sharma YP, Raina Ravinder and Sharma Seema. 2018. Leaf variation studies in *Valeriana jatamansi* Jones - an endangered medicinal plant of temperate Himalayas. *International Journal of Farm Sciences*. 8(1):74-78.
- Thakur Pankaj, Mehta Piyush and Gupta Nikhil. 2017. *An Impact Study of Food Product Packaging on Consumer Buying Behaviour: A Study Premise to Himachal Pradesh-India*. *International Journal of Bio-resource and Stress Management*. 8(6):882-886.
- Thakur R and Thakur Seema. 2019. Influence of agronomic practices on growth and flowering of Rose cv. First Red under naturally ventilated polyhouses. *International Journal of Agriculture Sciences*. 11(6):8082-8084.
- Thakur R, Gupta RK and Mahajan PK. 2019. Statistical investigation to milk yield data of Jersey and Holesian cross breeds. *International Journal of Current Microbiology and Applied Sciences*. 8. 2056-65.
- Thakur R, Gupta RK and Mahajan PK. 2019. Study on lactation of Jersey cross breed. *International Journal of Current Microbiology and Applied Sciences*. 8:2052-55.
- Thakur Rajni Kant and Shirkot Poonam. 2018. Molecular identification of gold nanoparticles synthesizing bacteria through *in silico* methods. *International Journal of Chemical Studies*. 6(1):218-226.
- Thakur S, Thakur S, Jha SK and Sharma D. 2019. Variability for first year growth in forty nine international clones of *Populous deltoids*. *International Journal of Chemical Studies*. 7(1):980-982.
- Thakur Seema, Negi Radhika and Mehta DK. 2018. Correlation and Path coefficient studies in bell pepper (*Capsicum annum* L. Var. *grossum*) under mid hills conditions of Solan district of Himachal Pradesh. *International Journal of Current Microbiology and Applied Sciences*. 8(1):1788-1796.
- Thakur Seema, Negi Radhika and Sharma Payal. 2018. A review on advances in bell pepper. *International Journal of Agriculture Sciences*. 10(6):5618-5621.
- Thakur Seema, Negi Radhika and Sharma Payal. 2019. Recent Advances in breeding of tomato- A review. *International Journal of Current Microbiology and Applied Sciences*. 8(3):1275-1283.
- Thakur Seema, Negi Radhika and Sharma, Payal. 2019. Genetic Divergence studies in bell pepper under mid hill conditions of Solan District of Himachal Pradesh. *International Journal of Agriculture Sciences*. 11(2):7748-7750.
- Thakur Seema, Thakur Rajesh and Mehta DK. 2018. Effect of biofertilizers on horticultural and yield traits in French bean var. Contender under dry temperate conditions of Kinnaur district of Himachal Pradesh. *Journal of Applied and Natural Science*. 10(1):421-424.
- Thakur Shikha, Thakur Sanjeev and Jha SK. 2019. First year growth variation in some selected clones of *Populus deltoides* in Himachal Pradesh *Journal of Pharmacognosy and Phytochemistry*. 8(1):1040-1042.
- Thakur Shikha, Thakur Sanjeev, Jha SK and Sharma Dushyant. 2019. Variability for first year growth in forty nine international clones of *Populus deltoides*. *International Journal of Chemical Studies*. 7(1):980-982.
- Thokchom R, Sharma DP and Thakur KK. 2018. Effect of rejuvenation pruning and nitrogen levels on leaf nutrients status of old and senile apricot (*Prunus armeniaca* L.) cv. New Castle Trees. *Int. J. Curr. Microbiol. App. Sci*. 7(1):2494-2500.
- Vaidya P and Bhardwaj SK. 2018. Land use changes and their impact on groundwater quality in mid hills of Himachal Pradesh. *International Journal of Ecology and Environmental Sciences*. 44(2):127-34.
- Vaidya P, Bhardwaj SK and Sood S. 2018. Land use and land cover changes in Kullu valley of Himachal Pradesh. *Indian Journal of Agricultural Sciences*. 88(6):902-906.
- Vasishth A and Guleria V. 2018. Potential of *Senegalia Senegal* for Gum Arabic Extraction. *Indian Journal of Ecology*. 44(6):817-819.
- Vasishth A and Guleria V. 2018. Standardized gum tapping techniques to maximize yield from high value Indian tree, *Sterculia urens*. *Journal of Forestry Research*. 28(3):615-619.
- Vedukola PR, Verma S, Sharma Deepika and Thakur Ankita. 2019. Role of resistant-proteins in plant innate immunity- A review. *Agricultural Reviews*. 40(1):12-20.
- Verma Geeta, Mahajan PK and Sharma Anju 2018. Correlation and path analysis between yield and different morphological characters in Kinnow Mandarin (*C. Noballis* × *C. Deliciosa*). *Journal of Applied and Natural Science*. 10(2):759-764.
- Verma Geeta, Sharma Anju and Mahajan PK. 2018. Study on yield and some morphological characters for optimizing kinnow yield through multivariate statistical techniques. *International Journal of Farm Sciences*. 8(2):162-165.
- Verma P and Chandel JS. 2018. Influence of drip irrigation on soil moisture content, water requirement and water use



- efficiency of peach (*Prunus persica* (L.) Batsch.) cv. Redhaven. *Journal of Soil and Water Conservation*. 17(4):350-356.
- Verma S and Khosla K. 2018. Chemical management of marssonina leaf blotch and alternaria leaf spot diseases of apple in Himachal Pradesh. *Int. J. Chem. Stud.* 6(4):3316-3319.
- Verma S, Sharma R and Chauhan A. 2018. Plant growth promoting and antagonistic potential of indigenous PGPR from tomato seedlings grown in mid hills regions of Himachal Pradesh. *Journal of Pharmacognosy and Phytochemistry*. 7(1):968-973.
- Verma SC, Sharma PL, Chandel RS and Negi Saraswati. 2018. Spatial distribution of green peach aphid, *Myzus persicae* Sulzer and its parasitoid, *Aphelinus asychis* Walker in bell pepper under polyhouse conditions. *Journal of Entomology and Zoology Studies*. 6(3):776-780.
- Watpade Santosh, Baswaraj R, Handa Anil, Bhardwaj Pooja, Pramanick KK, Verma Ambika, Kapoor Shelly and Sharma Usha. 2018. RT- LAMP detection of Apple chlorotic leaf spot virus in apple and pear. *Plant Disease Research*. 33(1):94-98.
- Yadav Priya, Kashyap Bharati, Dhiman SR, Chander prakash and Anamaika Gurang. 2018. Effect of glycerine for drying of cut foliage of *Peltophorum ferrugineum*. *Journal of Ornamental Horticulture*. 21(3& 4):70-77.
- Yadav Priya, Kashyap Bharati, Dhiman SR, Gupta YC and Sharma Puja. 2018. Effect of glycerine on drying of cut Foliage of *Buxus sempervirens*. *Journal of Ornamental Horticulture*. 21:17-23.
- Yadav Priya, Kashyap Bharati, Dhiman SR, Sharma Puja, Gupta YC and Sharma, Meenakshi. 2018. Effect of glycerine on drying of cut- foliage of *Polystichum squarrosus* (D Don) Fec. *International Journal of Farm Sciences*. 8(3): 51-57.
- Yadav RP, Gupta B, Bhutia PL, Bisht JK and Pattanayak A. 2019. Biomass and carbon budgeting of land use types along elevation gradient in Central Himalaya. *Journal of Cleaner Production*. 211:1284-1298.
- Yadav RP, Gupta B, Bhutia PL, Bisht JK and Pattanayak A. 2019. Sustainable agroforestry systems and their structural components as livelihood options along the elevation gradient in central Himalaya. *Biological Agriculture and Horticulture*. 35(2):73-95.
- Yankit Panma, Rana Kiran, Sharma HK, Thakur Meena and Thakur RK. 2018. Effect of bumble bee pollination on quality and yield of tomato (*Solanum lycopersicum* Mill.) grown under protected conditions. *International Journal of Current Microbiology and Applied Sciences*. 7(01):257-263.
- Yourmila Kumari, Bhardwaj DR *et.al*. 2018. The biological properties of bamboo growing soils in mid-hills conditions of HP: A comparative study. *Ind. J. Curr. Microbiol. App. Sci.* 7(5):507-512.





Popular Articles

- Bandana and Kaith NS. 2018. Cherry. *Krishi Vani*. Extension publication of KVK, Shimla, HP. 24(2):3-6.
- Bandana and Kaith NS. 2018. Persimmon. *Krishi Vani*. Extension publication of KVK, Shimla, HP. 24(2):1-2.
- Banshtu Tanuja and Kaith NS. 2018. Gobhi vergiya sabgi yoo ke parmokh keet evam unki rookthaam. *Krishi Vani*, Extension publication of KVK, Shimla, HP. 24(02):40-45.
- Banshtu Tanuja and Kaith NS. 2018. Seb me ras chusane wale mukhaye keet evam unki rookthaam. *Krishi Vani*, Extension publication of KVK, Shimla, HP. 24(02):36-39.
- Banshtu Tanuja. 2018. Matar ke parmaokh keet. *Krishi Vani*, Extension publication of KVK, Shimla, HP. 24(01):29-30.
- Banshtu Tanuja. 2018. Mitr keet evam unki pehchaan. *Krishi Vani*, Extension publication of KVK, Shimla, HP, India. 24(01):31-33.
- Bharat NK. 2018. White rot disease: a threat to garlic cultivation in mid Himalayan region. Technology Notes. *Himalayan Phytopathological Society, Department of Plant Pathology, YSPUHF, Nauni 1*: 4-5.
- Chandel S. and Sharma M. 2015. 'Gutali dar phalon ke rogon ka vigayanik prabhandhan'. *Vigayan Garima Shindhu* 95:16-24.
- Gupta Divender and Singh Gagandeep. 2019. "Jaroori hai pesticides ke bare mein janana". *Rajasthan Kheti*: 30.
- Gupta J and Dubey RK. 2019. Ornamental trees for salt affected areas. *Floriculture Today*. 23 (9): 34- 36.
- Gupta Meenu. 2018. Bacterial wilt-an emerging disease in ginger. Technology Notes- *Himalayan Phytopathological Society, Dr Y S Parmar university of Horticulture & Forestry, Nauni, 1(1)*: 7.
- Gupta Meenu. 2018. Pink root of garlic in Himachal Pradesh. *Indian Phytopathological Newsletter* 1(4): 4.
- Jarial Kumud and Jarial RS. 2019. Important diseases of mango and their management. *Technology Notes, Himalayan Phytopathological Society, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan 2* (1):5.
- Jarial Kumud, Jarial RS, Sharma Monica and Kumari Sujata. 2018. Bacterial leaf spot (*Xanthomonas cucurbitae*): an emerging threat for cucurbit cultivation in sub tropical zone of Himachal Pradesh. *Technology Notes, Himalayan Phtopathological Society, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan 1*:5-6.
- Jarial RS and Jarial Kumud. 2018. Occurrence of *Morchella* species in sub tropical zone of Himachal Pradesh. *Technology Notes, Himalayan Phtopathological Society, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan 1*:11.
- Kaith NS, Thakur AK, Banshtu Tanuja, Bandana and Kumari Neelam. 2018. Seb ki achi paidavar keliye paragon labhdayak. *Krishi Vani* 24(02):19-22.
- Kaith NS, Thakur AK, Banshtu Tanuja, Bandana and Kumari Neelam. 2018. Safal Krishi me jaiv urvarko ki upyogita. *Krishi Vani* 24(02):23-26.
- Kaushal Manisha, Vaidya Devina and Gupta Anil. 2019. Novel Technologies in processing of Horticultural Crops. *Smart Post Magazine*. Jan 2019 issue : 25-29.
- Kumar S., Himanshi and Meenakshi. 2019. Sweat button khumb ki makhinyon se rokthaam. *Giriraj Weekly*. 16 Jan. 2019:5.
- Kumari Neelam and Thakur Ashok K. 2018. Kheera jatiya sabjiyon ke pramukh rog or unka niyantaran. *Krishi Vani*. 24(02):31-35.
- Kumari Neelam. 2018. Podhvikas me rhizobacteria (PGPR) ki bhumika. *Krishi Vani*. 24(02):27-30.
- Sharma Harish Kumar, Chandel R.P.S., Thakur Meena and Rana Kiran. 2018: *Apiscerana* Management. Published by Deptt. of Entomology, YSP UHF Nauni, Solan. : 48
- Sharma Usha and Gupta Bhupesh. Success story: Collar rot management in apple. In: *Technology Notes- Himalayan Phytopathological Society, Dr YSP UHF, Nauni, Solan 1*(1) : 9-10
- Sharma Usha, Thakur Neelam, Gupta Bhupesh and Kumar Rakesh. 2019. Management tips for apple diseases. In: *Technology Notes- Himalayan Phytopathological Society, Dr YSP UHF, Nauni, Solan 2*(1):3.
- Sharma Usha. 2018. Apple viroid diseases: the emerging problems for apple plantations. In: *Technology Notes- Himalayan Phytopathological Society, Dr YSP UHF, Nauni, Solan 1*(1):5
- Suman BC., Gupta Dharmesh and Jarial R.S. Shittake Khumb (*Lentinula edodes*) ki Kheti. *Indian Journal of Mushrooms* 36(1):35-38.
- Thakur Ashok K and Kumari Neelam. 2018. Pacheti phoolgobhi ke beej uttpadan ki unnat prodyogiki. *Krishi Vani*. 24(02):12-18.
- Thakur Rajesh and Thakur Seema. 2018. Plug tray nursery production- A modern technique of producing healthy nursery. *Agriculture Today*. 11(5):42-44.
- Thakur Seema and Thakur Rajesh. 2018. Paudh Sarakshan mein prakriti pradat vanspatiyon ka upyog. *Krishak Aradhana* (July 2 to July, 8, 18):4.
- Thakur Seema and Thakur Rajesh. 2018. Gainda ki kheti ki unnat takniq. *Krishak Aradhana*(Nov. 5 to Nov 11, 2018):3.
- Thakur Seema and Thakur Rajesh. 2018. Trichoderma ka upyog, mrida janit bimarion ka jaiv niyantran. *Madhya Krishak Bharti*. 6(4):27.
- Thakur Seema and Thakur Rajesh. 2018. Adhik beej uttpadan ke liye paragon prabhandan. *Krishak Aradhana* (Nov. 26 to Dec 2, 2018):4.
- Thakur Seema and Thakur Rajesh. 2019. Phasl Awshesh ki sahi takniq apnayein. *Madhya Krishak Bharati*. 14(1):11.
- Thakur Seema. 2019. French bean ki vigyanik kheti. *Madhya Krishak Bharati*. 13 (12): 32.



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