Annual Report

2017 – 18

ICAR-Central Institute of Temperate Horticulture
Old Air Field, PO-Rangreth, Srinagar 191132
Jammu and Kashmir, India

Published by:
Dr. Desh Beer Singh
Director

Compiled & Edited by:
Dr Desh Beer Singh
Dr. O.C. Sharma
Dr. Anil Sharma
Dr. J.I. Mir
Dr. Shiv Lal
Dr. Geetika
Dr. K.L. Kumawat
Mr. Sajad Un Nabi
Dr. Waseem H. Raja
Dr. Selvakumar R.

Correct Citation:
CITH - Annual Report 2017-18
ICAR-Central Institute of Temperate Horticulture
Old Air Field, P.O.-Rangreth-191132, Srinagar (J&K)
Phone: 91-194-2305044, 2305045
E-mail: dircithsgr@icar.org.in

Cover Page:
Intensive saffron cultivation, apple HDP, high value vegetables, walnut, espalier system in apple and apple fruits (Front)
Canopy Architecture block & Espalier System (Back)

Design and Printed by:
M/s Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase-I, New Delhi-110028
Mobile: +91 9811622258

CONTENTS

Executive Summary

1

The ICAR-Central Institute of Temperate Horticulture has emerged as a mega hub for generation of farmer friendly technologies during last decade in various temperate horticultural crops. The Institute along with its two Regional Stations is continuously carrying out need based research on temperate horticultural crops to boost the productivity and quality of temperate horticultural crops. The number of technologies generated at ICAR-CITH is increasing year after year. Presently farmers have adopted many technologies to boost the productivity of their farms. To cater the need of farmers associated with temperate horticultural crops, the research work carried out by the Institute and its Regional Stations during 2017-18 are briefly summarized below:

Crop Improvement and Biotechnology

The germplasm is the main wealth of any Institute which can be used to breed the new cultivars or to tackle the problems in future. The collection, evaluation and characterization of germplasm of horticultural crops is one of the major objective of the Institute. The Institute has added 70 new germplasm in its field gene bank and its number has reached to 2610 at main centre Srinagar, J&K while Regional Station Mukteshwar is maintaining more than 300 germplasm lines of various fruit, vegetable and flower crops.

In apple sixty genotypes comprising of commercial and wild cultivars were evaluated for estimating their anti-oxidative and free radical scavenging potential. Significant variability with respect to phenolic compounds was observed across the genotypes. Highest rutin content (483 µg/g) was recorded in cultivar Lal Ambri followed by Well Spur (309 µg/g) and *Malus baccata* (212 µg/g). Highest catechin content (1745 µg/g) was found in cultivar Benoni followed by Lal Ambri (1438 µg/g) and Antonovka (1180 µg/g). Percent inhibition revealed through DPPH assay which varied from 9.01% (*Malus baccata*) to 77.57 % (cv Michal). Maximum anti-oxidative potential was observed in Lal Ambri showing highest FRAP values (2.63µmol Fe^{2+}/g Fw) and highest free radical scavenging potential as revealed through highest percent inhibition through DPPH assays was observed in cultivar Michal, Prima and Jonica with more than 70% inhibition. Flavanol content ranged from 0.021 QE mg/g dry extract (Michal) to 0.315 QE mg/g dry extract (Schlomit). Total phenol content ranged from 85.7 mg GAE/100 mg FW in Star Summer Gold to 455 mg GAE/100 mg FW in Ananas Retrine. Columnar apple cultivars viz. Redlane, Goldlane, Sunlight and Moonlight were evaluated and maximum number of fruits (120) were set in cultivar Redlane followed by Goldlane with 75 fruits. Highest fruit weight (136 g) was observed in Goldlane followed by Sunlight (125 g) and Moonlight (90 g). In addition apple selections representing scab resistant, scab susceptible and selections from *Malus baccata* species were evaluated for different physic-chemical traits wherein maximum fruit weight (260 g) was recorded in apple cultivar CITH-Apple-SR-03 followed by CITH-AAS-GP-BSP-04 with fruit weight of 236 g and highest firmness (85.2 RI) was observed in cultivar CITH-AAS-GP-BSP-11 followed by CITH-AAS-GP-BSP-12 with firmness of 80.11 RI. Variability in fruit quality traits like fruit size, color, firmness and TSS was observed across the indigenous Ambri collections. In pear 32 cultivars were evaluated for different quality related attributes. Among the evaluated European pear cultivars (22) maximum fruit weight (309.37 g), and fruit diameter (81.66 mm), were recorded in cultivar Gent Drouard and maximum fruit length (119.85mm) was recorded in King Pear and minimum fruit weight

(46.87 g), fruit diameter (43.88 mm) was recorded in cultivar Red Anjou. Fruit firmness in pear cultivars ranged from 42.09-69.02 RI. Among the seven Asian pear genotypes Chinese sandy pear showed highest fruit weight (158.42 g), fruit length (68.49 mm) and fruit diameter (66.63 mm) and minimum fruit weight, fruit length and fruit diameter was recorded in cultivar Punjab Beauty. TSS and colour values showed significant variation across the evaluated genotypes of pear. In quince 12 genotypes were evaluated for physico-chemical and yield characteristics where fruit weight ranges from 75.02 to 199.31g with the maximum fruit weight (199.31 g) in CITH-Q-09. Maximum fruit length (72.37 mm) was recorded in CITH-Q-11and fruit diameter (70.54 mm) as recorded in CITH-Q-20, while minimum fruit length (53.45 mm) and fruit diameter (54.50 mm) was recorded in genotype CITH-Q-08. The TSS ranged from 11.4 (CITH-1-16) to 18.6 B° (CITH-Q-12), where maximum TSS has been recorded in genotype CITH-Q-12 (18.6 B°) and minimum (11.4B°) in genotype CITH-Q-16. Acidity ranges from 0.6-1.7%, where maximum acidity was recorded in genotype CITH-Q-14 and minimum in CITH-Q-20.

In plum 20, cultivars (Japanese and European) were evaluated for various physico-chemical and colour parameters. Among the evaluated cultivars the maximum fruit weight (82.81g), length (57.22 mm), diameter (51.19 mm), thickness (48.07 mm) and stone weight (4.07 g) was recorded in Kubio-26, and the minimum fruit weight (16.41 g), length (31.29 mm), diameter (29.70 mm), thickness (28.93 mm) and stone weight (0.52 g) were recorded in Black Beaut. In peach 40 genotypes were evaluated for fruit skin, pulp chromatic, firmness index, physical, chemical and yield parameter. Among fruit chromatic traits, highest fruit skin color "L*" value was recorded in K-209014, "a*" value in Mayfire, "b*" value in Vance Missouri. Highest fruit firmness was observed in Silver King and lowest in Summer Glo. The fruit shape index was found maximum in genotype Stark Early and minimum in genotype South Land Peach-2. Heaviest fruit was observed in Summer Glo and lightest in Mayfire. Among fruit chemical constituents, maximum TSS (°B) was estimated in CITH-P-5. In cherry among 32 evaluated genotypes 53.13% of genotypes showed higher range of TSS (15 to 18 °B) whereas 9.37% genotypes showed lower range of TSS (12 to 13 °B). The yield of fruit ranged from 5.27 to 19.4 kg/tree. CITH-C-04, CITH-C-07, CITH-C-15A, Lapins, and Double (Bigarreau Noir Grossa) recorded more than 15 kg yield/tree. In Apricot 62 germplasm accessions were evaluated for various floral, fruit and yield traits. The heaviest fruit weight was recorded at the tune of 75 g in CITH-AP-1 and minimum fruit weight (19.06g), length (29.64 mm), width (29.72 mm) and thickness (27.58mm) in CITH-AP-30. Variation was also observed for color values (L, a, b). TSS ranged from 8.43 °B (Heartly) to 25.83°B (CITH-AP-35).

In almond 10 cultivars were evaluated for various traits related to flowering, nut, kernel and yield characteristics. The California Paper Shell, Primorskij, and Waris were found promising in respect of physical attributes of nut and kernel. However, highest yield recorded in Pranyaj followed by Waris. Further, highest kernel recovery was obtained from Nonpareil. Highest fruit set recorded in Drake followed by Waris and Makhdoom. Apart from Shalimar (74%) and Waris (84%) more than 90 per cent sound nut were obtained in evaluated cultivars. Double kernel was reported in all cultivars with variable number ranging from 3 to 50 per cent. Except Waris, IXL (3%), Nonpareil and Drake (4%) all other cultivars observed more than 10 per cent double kernel. Twin kernel was not observed in any cultivar. Likewise, empty nut were only found in Pranyaj (2%), Shalimar and IXL (3%). With exception of Shalimar and Drake, 2-13 per cent gummosis infestation was seen in evaluated cultivars. Further, in evaluation of 22 genotypes of almond collected from Kashmir Valley, CITH-Almond-15 and CITH-Almond-19 were found promising in respect of physical attributes of nut and kernel, whereas CITH-Almond-1, CITH-Almond-14 and CITH-Almond-12 were found promising in respect of nut yield. CITH-Almond-10, CITH-Almond-22 and CITH-Almond-23 obtained maximum kernel

recovery among evaluated genotypes. In walnut 208 genotypes were evaluated for qualitative/ quantitative traits and significant variability was noticed for various traits. Based on the nut efficiency of various genotypes, 10 best genotypes are SBB-11, CITH-W-11, ZP-3, CITH-W-26, CITH-W-103, CITH-W-40, CITH-W-104, CITH-W-54 A, LBT-1 and Shalimar-6. Highest nut weight (24.23g) was recorded in CITH-W-7, followed by CITH-W-1(23.2g), YD-1 (23.1g), CITH-W-123(22.83g), CITH-W-6(22.77g),BSP-1(22.27g), CITH-W-117(22.2g), CITH-W-118(22.03g), CITH-W-19(21.27g) & CITH-W-80 (21.23g). Out of 208 genotypes, 20 genotypes produced nuts having weight more than 20g.

In strawberry a total of 102 genotypes were evaluated for maturity, flowering, fruiting and fruit physic-chemical attributes. Genotypes with significantly desirable TSS, acidity, ascorbic acid, fruit size and colour parameters were identified. Biological assays were done to reveal the anti-oxidative and free radical scavenging potential of strawberry genotypes and promising genotypes were identified with significantly higher anti-oxidative and free radical scavenging potential. In olive 18 genotypes and in kiwi fruit 5 genotypes were evaluated for different quality traits and some promising genotypes were identified.

In vegetable crops 53 kale genotypes were evaluated for yield and related parameters. The germplasm expressed marketable leaf yield of 1.00 to 30.78 t/ha. Three genotypes of chilli were evaluated during summer extended rabi 2017-18 at ICAR–CITH Regional Station, Mukteshwar, Nainital (UK) for their growth, yield and quality parameters. Most of lines exhibited significant differences for various growth, yield and quality parameters.

In tulip 22 varieties were evaluated for various growth and floral traits. The plant height varied between 8.66 cm (Candella) to 37.33cm (Ben Van Zaintin) and the spike girth ranged 4.11mm (Candela) to 7.50 mm (Golden Parade).

In development of superior cultivars in apple through conventional and non-conventional breeding methods, thirteen hybrids were evaluated for fruit quality analysis and most of the hybrids showed superior performance with respect to some traits under analysis. Three hybrids viz Prima x Red Delicious, Well spur × *M. floribunda* and American Apirogue × *M.floribunda* showed the presence of resistant gene *Vf Rvi6*. Four hybrids *viz.,* Prima x *Malus floribunda*, American Apirogue x *Malus floribunda*, Prima x Red Delicious and Prima x Ambri were screened for presence of scab resistant genes. In order to identify the self fruitful genotypes in temperate fruits and nuts, experiment was conducted to identify self fruitful genotypes. A mega crossing programme was initiated in March 2018, involving Ambri as one of the parents in apple.

In development of superior varieties and hybrids in solanaceous vegetables, hybridization between slicing tomato (*Solanum lycopersicum* L.) and cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) was done to introgress yellow color from later into former and breed for other characteristics. Ten genotypes of tomato hybrid lines were evaluated under polyhouse at ICAR–CITH Regional Station, Mukteshwar for their growth, yield and quality parameters. Most of lines exhibited significant differences for various growth, yield and quality parameters. In breeding for development of nutra-rich varieties in root crops different crosses of Purple Globe, Purple Round, Pink Top White Globe, Pink Top White Round, Pink Top White Flat, Mustard Yellow, Pink Round, White Round, White Globe, White Flat, Pink Flat, Pink Globe, Golden Ball and Pusa Chandrima were made into turnip hybridization programme and simultaneously got different F_2 programme of turnips whereas in radish (green, white, and pink) were crossed and got F_1 hybrids of radish. The 25 carrot accessions and local temperate types were crossed for improvement of anthocyanin, lycopene and β-carotene content in temperate carrot.

In characterization and diversity analysis for flowering related gene/ genes in almond, floral biology of 32 different cultivars/ genotypes were studied and screened for various flowering phenological stages. Low temperature sensitivity was investigated in almond under *in-vitro* low

temperature treatment (0°C) at popcorn and full bloom phenological stages of flowering. The partial sequence of *PdFLC* was amplified from the genomic DNA of various almond cultivars.

Crop Production

During the year Institute produced about 33544 grafted plants of apple, walnut, cherry, peach and apricot on different rootstocks and 5656 budded plants of almond, apricot, cherry, peach, apple and plum. About 6.0 quintals of quality vegetable seed, strawberry runners (20, 000) and vegetable seedlings (15, 000) were also produced Bud-wood (>50, 000 sticks) of elite varieties of apple, pear, peach, plum, apricot, cherry, walnut, almond and olive were also provided to the stakeholders for popularization of elite varieties.

Apple

For enhancing feathering through plant growth regulators for high quality nursery production in apple, various growth regulator combination were tried and it was found that all treatment of plant growth regulators increased number of feathers, feather length, branching zone and per cent feathered plants compared to control. However, application of BA alone has stronger positive effect on studied parameters than combination with GA_3. Some treatments with BA had a negative influence on the tree height whereas, most treatments increased trunk diameter and crotch angle compared to control. In fertigation, significant impact on apple yield was observed; high yield enhancement along with good nutrient saving was observed on applying 75% of the recommended fertilizer through fertigation in two splits. Hence, 25% of the nutrient from recommended/prevailing practice could be saved along with little but noticeable increase in fruit yield. Effect of rootstock on pre-harvest fruit drop and quality of apple was studied and it was found that highest percentage of pre harvest fruit drop occur on M-9 rootstock and lowest on seedling.

Saffron

Adroit mode of fertilizer application to get optimum quality saffron yield and corm multiplication rate, without polluting the environment was standardized. Midrib fertilizer placement upper to corms in two splits (MRPU-2S) enhanced the quantity and quality of saffron with low nitrate leaching, well below the permissible limit, and low nitrous oxide emissions with least pollution potential and high nutrient use efficiency. In almond based intercropping system, non significant effects were observed for most of growth and floral traits. Significant differences were noticed for flower length, flower diameter, style and stigma length.

Strawberry

Under evaluation of different substrates and systems for soilless strawberry production in naturally ventilated conditions, the effect of different substrates on soilless strawberry production was studied and performance of different strawberry cultivars was evaluated using different media combinations. Coco-peat in combination with vermiculite (25:75) and (50:50) produced maximum growth as well as quality parameters in cv. Chandler and coco-peat in combination with vermiculite (50:50) produced maximum growth as well as fruit quality parameters in cv. Katrian sweet under open ventilated polyhouse condition.

Vegetables

For round the year production of kale, transplanting was done in three different dates, to evaluate 27 promising genotypes and the July & August transplanting dates were found congenial for germination, emergence and growth of all genotypes. However, the September was found to be less favorable for germination and seedling development in most of the genotypes. In apple and vegetable intercropping experiment integrated nutrient management has been standardized. Under crop diversification technology for round the year vegetable production under protected conditions in mid and high hills of Uttarakhand seven genotypes of tomato, eleven genotypes of capsicum, six genotypes of cucumber, lettuce, broccoli and Chinese cabbage were evaluated during summer extended Kharif under polyhouse at one location of ICAR–CITH Regional Station, Mukteshwar and other location at Pokhrad village

of Nainital (UK) for their growth, yield and quality parameters. Most of lines exhibited significant differences for various growth, yield and quality parameters under study.

Crop Protection

Under characterization of pathogens associated with apple canker disease and evaluation of botanicals against most prevalent canker in Kashmir valley, a survey was conducted in different apple growing districts of Kashmir valley during different growing seasons. During the course of survey, two types of canker diseases were observed on different parts of apple trees with varied degrees of incidence and intensity. The cankers observed were smoky and stem bark canker. The smoky canker was more prevalent in all the districts surveyed. For characterization and botanical evaluation against *Stemphylium vesicarium* an incitant of Stemphylium blight (SB) of onion, six botanicals viz., Artichoke, Flex, Oreganum, Geranium, Iris and *R officinalis* were evaluated for its ecofriendly management. Botanical geranium and oreganum used @ 1000 ppm concentration gave highest percent radial growth inhibition among all botanicals evaluated against *Stemphylium vesicarium* under *in vitro* conditions.

In diagnosis and prognosis of apple viruses periodic detection of four apple viruses in different plant parts was done in four seasons, *viz.*, spring, summer, and autumn/fall and winter/dormant. It was observed that all four viruses showed seasonal variation with respect to infectivity in different tested tissues. During spring, maximum infection was detected in leaves followed by buds, flowers, bark and pollen. In spring, flowers and pollen were found infected with the viruses which can be threatening because pollen flow can transfer the viruses to the healthy plants. During fall, ACLSV and ASPV were detectable both in leaves and bark. During winter season, ASPV & ASGV infection was observed in bark. Results obtained through immunological testing were further verified through molecular testing using RT-PCR and Real Time PCR analysis.

For management of chilli wilt different substrates were evaluated for fast multiplication and biomass production of *Trichoderma harzianum*. Vermicompost produced highest biomass of *Trichoderma harzianum* followed by pulses and cereals, after two weeks of inoculation. Conidial quantity assessment revealed that after 15 days, vermicompost followed by moong, produced highest colony forming units (CFU). It was found that *Trichoderma harzianum* grown on "vermicompost + cereals + pulses" reduces chilli wilt incidence significantly as compared to other treatments.

Post Harvest Management

Two drying modes along with 3 cultivars were used for dehydration of plum into prune. Over all study reveals that Italian Plum took less time for dehydration and retained colour and ascorbic acid in addition to relatively higher rehydration ratio. Drying through osmo-dehydration followed by cabinet drying at 60°C took least time (3 hours 10 minutes OD + 8 hours CD) in Italian Plum with maximum retention of colour and ascorbic acid. Cabinet drying at 60°C took minimum dehydration time (10 hours) in Italian plum. After 180 days of storage at low temperature (4° C), maximum colour (L^*, a^* and b^*), ascorbic acid retention was recorded in Italian plum when osmo dehydrated with little loss of some quality attributes. In blending of juices in different ratios, blending of sweet cherry with sour cherry (50% of each) retained maximum desirable colour i.e. brightness, redness, freshness, ascorbic acid, acidity and TSS when compared with other blending combinations. Blending of apricot with plum in the ratio of 25% apricot + 75 % plum retained maximum desirable colour i.e brightness, redness, freshness, ascorbic acid, acidity and TSS when compared with other blending combinations. Both the blends were found to retain their properties upto 8 months. For enhancing storage and retention of quality in walnut different packaging systems were developed. It was found that at 12 month of storage period, vacuum packaging + Oxygen absorber + dark enhanced maximum shelf life and retains the post-harvest quality (fatty acid constituents) of walnut kernel characteristics as compared to traditional air packaging + light. In

chilli, 23 accessions were evaluated antioxidant activities through DPPH and FRAP assays. Highest percentage of scavenging potential of about 15.57% followed by 15.44% was observed in Sel-836-1-2 and Sel-1055/11. FRAP observations ranged from 87.41 µM Fe^{2+}/g FW to 394.294 µM Fe^{2+}/g FW. Positively significant correlation coefficients were observed between Phenol–FRAP, CP– FRAP, DICAP–FRAP, TP–DPPH and DPPH–FRAP.

Extension and other activities

The ICAR-CITH has made an effort for speedy transfer of various technologies to the farmers by various extension modes. The Institute has organized two workshops of two days each, one at Srinagar and another at Leh. One seminar of two days duration was also organized at RS-Mukteshwar. The Institute has organized one crop day (apple), four 2-3 days training programmes for line department and technical staff, one six days training programme for BHT students of KVK, Kargil, 7 student visits/ trainings, 41 one day training/ visits for farmers at Srinagar and 20 training/ demonstration activities at Mukteshwar and one three days training to farmers of Dirang at Regional Station Dirang (Arunachal Pradesh). The technologies were also directly provided to the farmers through demonstrations and trainings under MGMG, TSP, NMSHE, network projects, livelihood and nutritional improvement of tribal farm women through horticulture programme. Besides these, 2 training programmes of 2-3 days for officers of Uttarakhand, 13 one day training programmes to farmers of J&K, H.P, were also organized under various schemes. The scientists delivered 15 radio/ TV talks and displayed 8 exhibitions at various occasions.

Publication and Awards

The scientists of ICAR-CITH published 42 research papers, 4 review articles, 6 books, 14 popular articles and 12 extension bulletin/ folders for the benefit of students, researchers, extension functionaries and farmers. The scientists of ICAR-CITH received 22 awards during the year.

2 Introduction

Fruits and vegetables account for nearly 90% of total horticultural production in the country. India is now the second largest producer of fruits and vegetables (305.4 mt) in the world and is the leader in several horticultural crops, namely mango, banana, papaya, cashew-nuts, areca nut, potato and okra. However, the nature of horticultural crops being such it is not easy to make assessment of their production. Temperate horticulture is a very important component of horticulture as it is only confined to the hilly regions of a country. Temperate fruit crops represent a group, which is physiologically diverse from the sub-tropical and tropical fruit crops grown in other regions. Vegetables and floriculture have immense potential for the keeping the nation well supplied with off-season and exotic vegetables and flowers all the year round. The North Western and Eastern Himalayan states with temperate climate have monopoly in production of temperate fruits, vegetables, ornamentals, medicinal and aromatic plants which have vital role in nutritional and economic security of the region. These crops serve as the backbone of region's economy by supporting about 10-12 million people and generating revenue of about Rs. 12, 000 crores annually. Among temperate fruits and nuts; apple, pear, peach, plum, kiwi fruit, apricot, cherry, almond and walnut are very important with apple and walnut sharing major area while among vegetables, European type of cultivars of cole, bulb and root crops; high value leafy vegetables like lettuce, parsley, celery and Chinese cabbage; asparagus, artichoke, cucumber, capsicum and peas are commercially important. In floriculture; tulip, lilium, alstroemeria, carnation and gerbera and in medicinal and aromatic plants, lavender, lavendine, geranium, dioscoria, podophyllum, pyrethrum, mentha, artemisia *etc*. are becoming increasingly significant in the recent years.

Besides above, very high value and low volume crops like saffron and kalazeera are exclusively grown in this region which has high commercial value. In 1960-61 the area under temperate fruits in the country was just 0.82 lakh hectares which increased to 6.0 lakh hectares and production increased from 3.0 lakh tonnes to 35.0 lakh tones. Among various crops apple and walnut are the major crops of temperate fruits covering about 75% of the total area and accounting for 65% of temperate fruit production, respectively while rest of the production comes from other fruits like peach, plum, almond, apricot, cherry etc. which have significance in regions economy. During 2016-17 apple crop covered an area of 277.16 thousand ha and 2521 thousand MT national production. Walnut being second important crop covering an area of 92 thousand ha with 228 thousand MT production at national level. Other important temperate crops include almond (area = 12,000 ha; production = 8, 000 MT), pear (area = 40, 000 ha; production = 312, 000 MT), peach (area =18, 000 ha; production = 312, 000 MT), plum (area = 22, 000 ha; production = 76, 000 MT) etc. No doubt, there has been manifold increase in area, production and productivity but as compared to average world productivity (8.80 t/ha) our position is far behind (6.00 t/ha). ICAR-central Institute of Temperate Horticulture, Srinagar with its two regional stations at Mukteshwar, (Uttarakhand) and Dirang, (Arunachal Pradesh) is playing a great role in designing and developing research programmes on crop improvement, production, protection and post harvest management for achieving economic and nutritional security in the entire Himalayan region. To overcome the production constraints the research on temperate horticultural crops is being carried out both at main campus Srinagar and at its Regional Stations with the following mandate and objectives:

Mandate

- To act as national repository of germplasm & scientific information on temperate horticultural crops.
- To undertake basic, strategic and applied research on temperate horticultural crops in collaboration with national and international agencies to enhance productivity and quality.
- To serve as centre of training for human resource development & transfer of technology.

Objectives

- Establishment of field gene bank and management of genetic resources and scientific data base of temperate horticultural crops.
- Genetic improvement of temperate horticultural crops for yield, maturity, quality, resistance to biotic and abiotic stresses through conventional breeding methods and biotechnological tools.
- Standardization of nursery management and high tech propagation techniques of temperate horticultural crops.
- To device efficient and cost effective production technologies and cropping systems for increasing productivity and improving quality of temperate horticultural crops.
- To develop eco-friendly integrated diseases/ pest management modules and diagnostics.
- Post harvest value addition, product diversification and waste utilization for increasing availability and returns.
- To work out economics of production and impact assessment of technologies.
- Commercialization and transfer of technologies and skilled manpower development.

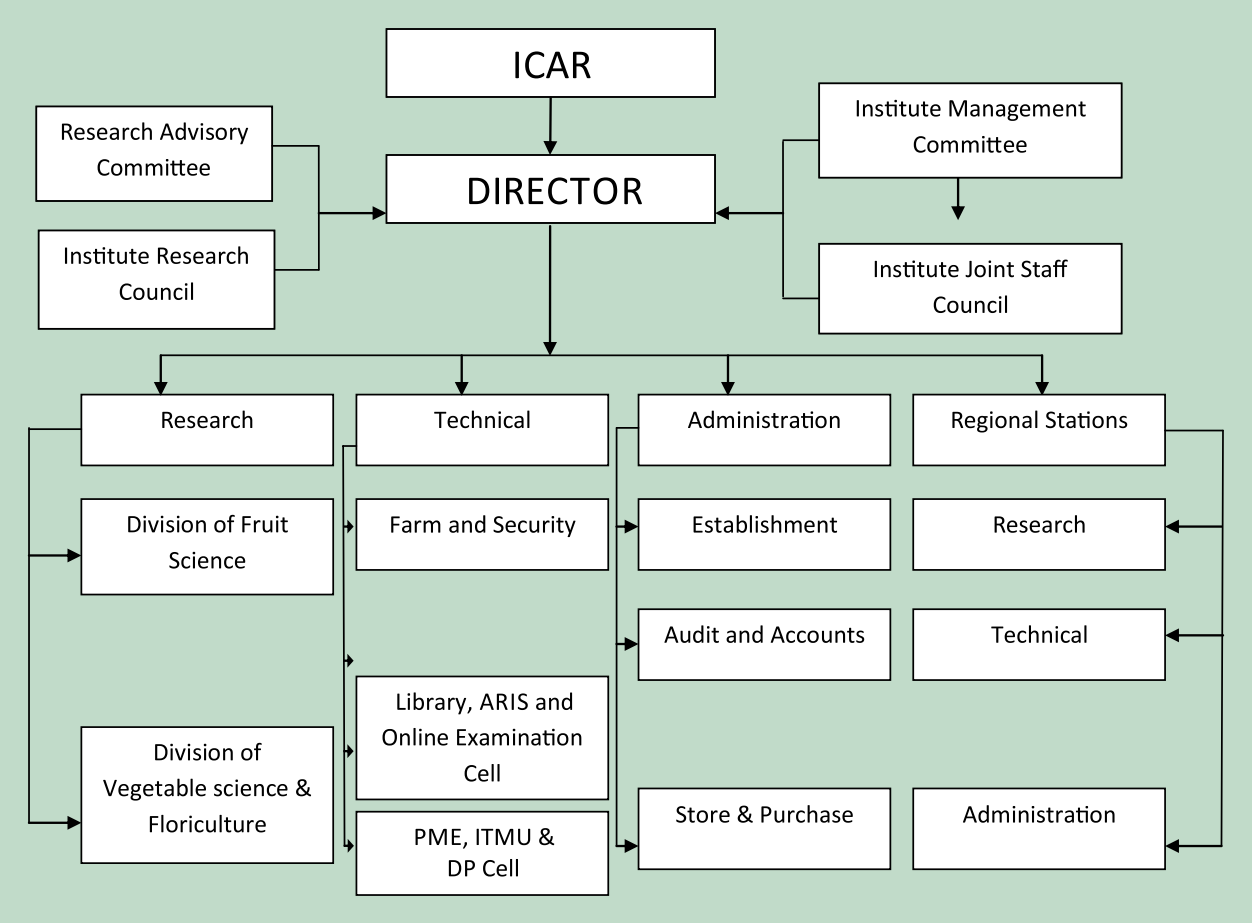
Staff Position (2017-18)

Category	Sanctioned	Filled (as on 31st March, 2018)	Vacant (as on 31st March, 2018)
Scientific	22+1RMP	13+1	9
Administrative	15	14	1
Technical	16	12	4
Supporting	19	11	8
Total	73	51	22

Financial Statement (2017-18)

S. No.	Sub-Head	Expenditure (Rs in Lakhs)
1	Capital	5.98
2	Establishment Charges	451.96
3	T.A.	20.51
4	Research & Operation Expenses	303.96
5	Administrative Expenses	136.05
6	Miscellaneous Expenses	3.13
7	Pension	37.72
8	Loans and Advances	7.00
1	Total	966.31

ORGANOGRAM OF CITH



3 Research Achievements

1. Crop Improvement

The temperate region which extends from North Western Himalayas to North Eastern Himalayas enjoys monopoly in production of temperate fruits, vegetables, ornamentals, medicinal and aromatic plants which have vital role in nutritional and economic security of the region. The horticulture in this Himalayan states, is the backbone of states economy which supports about 10-12 lakh families and provides direct or indirect employment to the tune of about 8-10 million people annually. Among various crops apple, pear and walnut represent major crops of temperate fruits covering about 54, 22 and 6.9% of the total area and accounting for 82.3, 1.1 and 5.6% of temperate fruit production respectively while rest of the production comes from other fruits like peach, plum, almond, apricot, cherries etc. which have significance in regions economy. No doubt, there has been manifold increase in area, production and productivity but as compared to average world productivity (8.80t/ha) and productivity of advanced countries, our position is far behind the advance countries whose productivity has gone up to 40,5 and 2t/ha as against 9.73, 0.70 and 0.31 t/ha in India for apple, almond and walnut respectively. The ICAR-CITH, Srinagar and its regional stations Mukteshwar and Dirang are continuously engaged in identification of superior cultivars/genotypes suitable for commercial production and upliftment of socio-economical life style of hilly farmers through temperate horticulture. The research work carried out by ICAR-CITH and its regional station Mukteshwar on crop improvement during 2017-18 is presented project wise below:

Survey, collection, evaluation, characterization and documentation of temperate horticultural crops

The western Himalaya is abundant source of diversity for temperate horticultural crops. The Institute has made an effort for collection and conservation of germplasm from different region's and sources. The institute is maintaining a good repository of germplasm for evaluation, characterization and future use. During 2017-18 institute has added 70 new genotype in various crops and the total number has reached up to 2610 (Table 1).

Table 1. Germplasm collection and conservation at CITH (2017-18)

S. No	Crop/Group	Germplasm status 2016-17	Added 17-18	2018
1	Fruits:	1129	54	1183
	Pome	372	26	398
	Stone	210	8	218
	Nuts	368	20	388
	Others	179	-	179
2	Vegetables	1059	8	1067
3	Ornamentals	327	-	339
4	Medicinal & aromatic plants	25	8	33
	Total	**2540**	**70**	**2610**

Fruit Crops

Apple

Biochemical characterization of apple genotypes to decipher their anti-oxidative potential

Sixty apple genotypes comprising of commercial and wild cultivars were evaluated for estimating rutin, catechin and quercetin content through RP-HPLC. Significant variability with respect to these bioactive compounds was observed across the genotypes. Highest rutin content (483 µg/g) was recorded in cultivar Lal Ambri followed by Well Spur (309 µg/g) and *Malus baccata* (212 µg/g). Highest catechin content (1745 µg/g) was found in cultivar Benoni followed by Lal Ambri (1438 µg/g) and Antonovka (1180 µg/g). In addition total flavanoids, flavanols and phenolics were estimated between the apple genotypes and variability was observed across the genotypes. Percent inhibition revealed through DPPH assay varied from 9.01% (*Malus baccata*) to 77.57 % (cv Michal). Anti-oxidative and free radical scavenging potential of apple genotypes was compared through DPPH and FRAP assays and maximum anti-oxidative potential was observed in Lal Ambri showing highest FRAP values (2.63µmol Fe2+/g Fw) and highest free radical scavenging potential as revealed through highest percent inhibition through DPPH assays was observed in cultivar Michal, Prima and Jonica with more than 70% inhibition. Flavanoid and flavanol content varied significantly across the apple cultivars with maximum flavanoid content (0.201 QE mg/g dry extract) in Summer Red and Amartara Pride. Flavanol content range from 0.021 QE mg/g dry extract (Michal) to 0.315 QE mg/g dry extract (Schlomit). Total phenol content was estimated in apple cultivars to correlate the phenol content with biological assays. Total phenol content ranged from 85.7 mg GAE/100 mg FW in Star Summer Gold to 455 mg GAE/100 mg FW in Ananas Retrine.

Evaluation of columnar apple cultivars for morphological and biochemical characteristics

Columnar apple cultivars viz. Redlane, Goldlane, Sunlight and Moonlight were evaluated to check their performance in the field conditions at ICAR-CITH, Srinagar. All the four cultivars showed profuse flowering and fruit set. Maximum number of fruits (120) were set in cultivar Redlane followed by Goldlane with 75 fruits. Highest fruit weight (136 g) was observed in Goldlane followed by Sunlight (125 g) and Moonlight (90 g) but Redlane although had highest crop density but have small fruit size (40 g). Columnar apple cultivars showed very good anti-oxidative and free radical scavenging potential as revealed by DPPH assay but these cultivars are acidic in taste (Table 2).

Table 2: Physico-chemical characterization of columnar apple cultivars

Cultivars	Fruit weight (g)	Firmness (RI)	TSS (°B)	Acidity (%)	Ascorbic acid (mg/ 100g)	L	a	b	Total Phenolics (mg GAE/ 100 mg FW)	DPPH (% Inh.)
Goldlane	136	70	14.00	0.76	7.43	70	-8.69	46.11	135.48	57.5
Redlane	40	46	13.50	0.58	6.3	35	23.69	11.01	117.47	42.1
Sunlight	125	65	16.00	0.71	7	58	13.24	27	130.51	51.2
Moonlight	90	58	16.50	0.69	6.73	56	15.77	31	125.47	46.63

Redlane Sunlight

Goldlane Moonlight

Fruit bearing in columnar varieties of apple

Evaluation of apple selections for different fruit quality traits

Apple selections representing scab resistant selections, scab susceptible selections and selections from *Malus baccata* species were evaluated for different physicochemical traits. Maximum fruit weight (260 g) was recorded in apple cultivar CITH-Apple-SR-03 followed by CITH-AAS-GP-BSP-04 with fruit weight of 236 g. Highest firmness (85.2 RI) was observed in cultivar CITH-AAS-GP-BSP-11followed by CITH-AAS-GP-BSP-12 with firmness of 80.11 RI thus can have more shelf life and consumer acceptability. *Malus baccata* selections although were very small in size but are sweet in taste with as high as 28.20 °B TSS (Table 3).

Table 3: Evaluation of apple selections for different fruit quality traits

Selections	Description	Fruit weight (g) Mean ± SE	Firmness (RI) Mean ± SE	TSS (oB) Mean ± SE	Colour parameters		
					L	a	b
CITH-AAS-GP-BSP-04	Scab susceptible selections ((scab incidence under open field conditions >2%)	236 ± 3.23	60.22 ± 1.21	14.65 ± 0.76	65.23± 2.34	12.16 ± 0.44	18.10 ± 0.56
CITH-AAS_GP_BSP-09		70.2 ± 1.32	60.0 ± 1.12	16.88 ± 0.86	62.31± 2.56	11.22 ± 0.23	28.20 ± 0.45
CITH-AAS-GP-BSP-11		132 ± 2.12	85.2 ± 1.42	19.45 ± 0.61	58.96 ± 2.32	-1.11 ± 0.08	27.64 ± 0.43
CITH-AAS-GP-BSP-12		130 ± 2.1	80.11 ± 1.12	15.70 ± 0.86	72.32± 2.12	-6.22 ± 0.18	35.00 ± 0.45
CITH-AAS-GP-BSP-13		160 ± 2.22	60.12 ± 1.12	14.10 ± 0.62	67.54 ± 2.65	-8.63 ± 0.23	32.76 ± 0.45

Selections	Description	Fruit weight (g) Mean ± SE	Firmness (RI) Mean ± SE	TSS (oB) Mean ± SE	Colour parameters		
					L	a	b
CITH-Apple-MS-05	Scab resistant apple selections (scab incidence under open field conditions <2%)	70.2 ± 2.12	60.25 ± 1.22	18.20 ± 0.77	45.32 ± 1.54	18.88 ± 0.78	12.88 ± 0.78
CITH-Apple-MS-11		142 ± 2.12	70.12 ± 1.44	15.00 ± 0.33	46.23 ± 1.24	18.44 ± 0.66	10.87 ± 0.76
CITH-Apple-SR-01		122 ± 1.98	65.12 ± 1.23	19.22 ± 0.33	44.17 ± 1.12	34.44 ± 0.88	18.22 ± 0.64
CITH-Apple-SR-03		260 ± 3.21	70.15 ± 1.22	15.70 ± 0.22	42.45 ± 0.96	22.34 ± 0.76	15.43 ± 0.87
CITH-Apple-MB-01	Malus baccata selections	2.12 ± 0.04	67.32 ± 1.15	28.20 ± 0.88	42.26 ± 0.88	11.34 ± 0.68	28.45 ± 1.23
CITH-Apple-MB-03		1.90 ± 0.02	67.56 ± 1.58	27.10 ± 0.67	24.25 ± 1.00	6.78 ± 0.43	-1.23 ± 0.08
CITH-Apple-MB-05		6.95 ± 0.08	72.45 ± 1.34	25.20 ± 0.62	40.80 ± 1.14	30.89 ± 0.76	16.34 ± 0.98
CITH-Apple-MB-07		6.70 ± 0.09	78.22 ± 1.66	23.70 ± 0.35	65.50 ± 1.32	10.10 ± 0.66	48.56 ± 1.44
CD @ 5%		8.65	4.43	2.45	2.92	4.20	2.98

Genetic variability for horticultural and morphological traits in indigenous Ambri collections at ICAR-CITH, Srinagar.

During the past few years a large number of Ambri variants has been collected from different areas of the Kashmir valley based on superior quality traits and has been established in Ambri block at CITH, Srinagar on MM-106 rootstock at 3.5 x 3.5 M spacing, during the year 2008-09. Most of these Ambri selections are in fruiting. Significant variability has been observed in these selections. During the year 2017 out of total collection 20 Ambri variants has been evaluated for various traits related to fruit quality and yield. Among the genotypes maximum fruit weight (175.89g), fruit length (68.26 mm), and fruit diameter (76.94 mm) was recorded in CITH-A-34 and minimum in fruit weight (70.83g), fruit length (50.36 mm) and fruit diameter (55.17 mm) was recorded in Ambri genotype CITH-A-41. Fruit firmness in 20 Ambri genotypes ranges from 55.8-62.5. The colour characteristics (L*, a* and b*) of Ambri genotypes were determined on sun-exposed side of each fruit with a chromameter, L* values range from 55.88 (CITH-A-44) to 72.59 (CITH-A-23), the a* values range from 4.9 to 20.99 and no negative value was found in any genotype. Values for b* scale range from 17.71 (CITH-A-21) to 42.83 (CITH-A-23) and no accession showed negative b* value. Maximum TSS (15.7 B°) were recorded in genotype CITH-A-22 and minimum TSS in (13.6 B°) in CITH-A-8. Maximum acidity (1.8%) was recorded CITH-A-21 and minimum (0.6%) in CITH-A-3.

Fruits of Ambri selections

Pear

Phenological data related to bud burst, flowering and fruit set has been recorded for 32 pear (Asian and European) cultivars during 2017-18. It was observed that bud burst of cultivars elapsed from third week of March to first week of April. Generally Asian pear cultivars were first to start sprouting and European cultivars mostly sprout in the fourth week of March and first week of April. Asian pear cultivars come into blooming in the fourth week of March and in European cultivars blooming were recorded in first and second week of April. The fruit set was first observed in Asian pear cultivars in the third week of April The information about the flowering pattern in pear cultivars could be very

Punjab Nectar

Punjab Gold

Punjab Beauty

Asian pear cultivars

Starkrimson

Z.H. Copaceae

Hayward

Fertility

Vicar of Winkfield

Donne Burrah

European pear cultivars.

useful for studies related to cross compatibility studies for selecting the effective Pollinizer with synchronization of flowering period and future pear breeding programmes.

During the year 2017-18, 29 European/Asian cultivars of pear have been evaluated for different quality related attributes**.** Among the evaluated European pear cultivars (22) maximum fruit weight (309.37 g), and fruit diameter (81.66 mm), were recorded in cultivar Gent Drouard and maximum fruit length (119.85mm) was recorded in King Pear and minimum fruit weight (46.87g), fruit diameter (43.88 mm) was recorded in cultivar Red Anjou.

Fruit firmness in pear cultivars ranged from 42.09-69.02 RI. The colour Characteristics (L*, a* and b*) of pear were determined on sun-exposed side of each fruit with a chromameter, L* values range from 38.33 in (Starkrimson) to 67.04 in (Doyenne du Comice), negative a* values were recorded in 17 pear genotypes. Values for b* scale range from 11.45 (Starkrimson) to 47.32 (Besri-de-Amanlis) and no accession showed negative b* value indicated that there is no blue coloured variety. Maximum TSS (19.0 B°) were recorded in cultivar Vicar of Winkfield and minimum TSS (11.1 B°) in Max Red Bartlett. Acidity was recorded maximum (1.7%) in Max Red Bartlett and minimum (0.7%) in China pear.

Among the seven Asian pear genotypes Chinese sandy pear showed highest fruit weight (158.42 g), fruit length (68.49 mm) and Fruit diameter (66.63 mm) and minimum fruit weight, fruit length and fruit diameter was recorded in cultivar Punjab Beauty. Maximum TSS and acidity was recorded in cultivars Japanese Pear (14.0 B°) and Chinese sandy pear (0.9 %) respectively. In case of Asian pear cultivars the L* values range from 38.33 (Kashmiri Nakh) to 65.4 (Chinese sandy pear). Values for b* scale range from 32.03 (Punjab Nectar) to 41.58 (Chinese sandy pear) and no accession showed negative b* value indicated that there is no blue coloured variety.

Quince

Twelve quince genotypes were evaluated for physico-chemical and yield characteristics during 2017-18. Fruit weight ranges from 75.02 -199.31g with the maximum fruit weight (199.31 g) in CITH-Q-09. Maximum fruit length (72.37 mm) was recorded in CITH-Q-11and fruit diameter (70.54 mm) as recorded in CITH-Q-20, while minimum fruit length (53.45 mm) and fruit dimeter (54.50 mm) was recorded in genotype CITH-Q-08. The TSS ranges from 11.4-18.6 B°, where maximum TSS has been recorded in genotype CITH-Q-12 (18.6 B°) and minimum (11.4B°) in genotype CITH-Q-16. Acidity ranges from 0.6-1.7%, where maximum acidity was recorded in genotype CITH-Q-14 and minimum in CITH-Q-20. Fruit firmness in genotypes ranges from 73.5-85.3 RI. The colour characteristics (L*, a* and b*) of quince genotypes were determined on sun-exposed side of each fruit with a chromameter Color Flex EZ Hunter lab USA). The values for L* ranges from 58.96-102.25, negative a* value were recorded in 07 genotypes and three genotypes showed negative value for b* which indicates three genotypes have blueness in colour of fruit.

CITH-Q-09

CITH-Q-10

CITH-Q-20

Some promising quince genotype

Plum

During the year 2017-18, 20 Plum cultivars (Japanese and European) were evaluated for various physico-chemical and colour parameters. Among the evaluated cultivars the maximum fruit weight (82.81g), length (57.22 mm), diameter (51.19 mm), thickness (48.07 mm) and stone weight (4.07 g) was recorded in Kubio-26, and the minimum fruit weight (16.41 g), length (31.29 mm), diameter (29.70 mm), thickness (28.93 mm) and stone weight (0.52 g) were recorded in Black Beaut. The pedicle length in these evaluated plum cultivars ranged from 10.02 – 22.88 mm, the maximum pedicle length was recorded in Stanley and the minimum was in Kanto-5. Maximum TSS and acidity were recorded in Au-Rosa (16.2 °B) and Frontier (2.8 %) respectively and the minimum were recorded in Kanto-5 (8.2°B) and Red Plum (0.7 %) respectively. The colour characteristics (L*, a*and b*) were determined on sun-exposed part of each fruits. The L* value ranges from 25.95 in Au-Cherry to 71.31 in Kanto-5 .Values of a* scale ranged from -0.39 in Monarch to 32.39 in Burbank. In case of b* scale the value ranged from 8.2 in Kubio-26 to 56.16 in Kanto-5.

Monarch

Au Cherry

President plum

Some promising plum genotype

Cherry

In cherry, 32 genotypes were evaluated for various traits. Color turning stage in different evaluated genotypes was observed from 1st week of May (CITH-C-08, CITH-C-09) to 1st week of June (CITH-C-02). Different cherry genotypes mature from 3rd week of May to 3rd week of June. Among the evaluated cherry genotype Lambert and Aval Number were earliest matured genotypes whereas cherry genotype CITH-C-01, CITH-C-03, CITH-C-04, CITH-C-08, CITH-C-09, CITH-C-17 matured in third week of June. Evaluated data collected on 32 cherry genotypes indicated the wide variability in fruit weight, length, width, TSS and yield. Among 32 cherry genotypes 53.13% of genotypes showed higher range of TSS (15-18 °B) whereas 9.37% genotypes showed lower range of TSS (12-13 °B). The yield of fruit ranged from 5.27 to 19.4 kg/tree. CITH-C-04, CITH-C-07, CITH-C-15A, Lapins, and Double (Bigarreau Noir) recorded more than 15 kg yield/tree. About 37.5 per cent genotype recorded fruit yield between 10-15 kg/tree.

Fruit of some promising cherry genotypes

Apricot

In apricot, total 62 germplasm accessions were evaluated for various floral, fruit and yield traits. The earliest flowering was recorded in CITH-AP-3 and CITH-AP-4 while latest in CITH-AP-31. The fruit yield per plant varied from 32.39 (Rival) to 13.60 (CITH-AP-32. The top 10 high yielding genotypes based on yield efficiency were CITH-AP-1followed by Erani, Rival, Tilton, Harcot, Turkey, CITH-AP-2, CITH-AP-7, Balcota and Chinese Apricot. The heaviest fruit weight was recorded at the tune of 75 g in CITH-AP-1 and minimum fruit weight (19.06g) , length(29.64 mm), width (29.72 mm) and thickness (27.58mm) in CITH-AP-30. Variation was also observed for color values (L, a, b). TSS ranged from 8.43 °B (Heartly)to 25.83°B (CITH-AP-35) . On the basis of higher TSS genotypes were selected for drying purpose which include Chinese apricot (22.90 °B), CITH-AP-24 (22.20°B), CITH-AP-28 (22.73°B), CITH-AP-32 (23.87°B), CITH-AP-33(22.40°B), CITH-AP-35(25.83°B) and PAS-4 (25.63°B). The stone weight and kernel weight ranged from 1.72 to 4.47 g and 0.62 to 1.30 g respectively. Out of 62 genotypes 47 were having sweet kernels and 14 were having bitter kernels. Besides selecting the genotypes for tables purpose based on yield and fruit size basis, some genotypes can be promoted as multipurpose genotypes having value of table purpose , drying, edible and sweet kernel.

Almond

In almond, 10 cultivars were evaluated for various traits related to flowering, nut, kernel and yield characteristics. The California Paper Shell, Primorskij, and Waris were found promising in respect of physical attributes of nut and kernel. However, highest yield recorded in Pranyaj followed by Waris. Further, highest kernel recovery was obtained from Nonpareil. Highest fruit set recorded in Drake followed by Waris and Makhdoom. Apart from Shalimar (74%) and Waris (84%) more than 90 per cent sound nuts were obtained in evaluated cultivars. Double

kernel was reported in all cultivars with variable number ranging from 3-50 per cent. With the exception of Waris, IXL (3%), Nonpareil and Drake (4%) all other cultivars observed more than 10 per cent double kernel. Twin kernel was not observed in any cultivar. Likewise, empty nut only found in Pranyaj (2%), Shalimar and IXL (3%). With exception of Shalimar and Drake, 2-13 per cent gummosis infestation was seen in evaluated cultivars. In respect of ease to harvesting Waris, Makhdoom and Pranyaj were found easy to harvest whereas, Primorskij and California Paper Shell were found difficult to harvest. As far as kernel shape is concern CPS produced extremely narrow kernel, Primorskij, Nonpareil and Shalimar produced narrow and Makhdoom and Merced produced broad kernel and other evaluated cultivars produced intermediate shape kernel. Further, most of evaluated cultivars produced nut with excellent seal suture of the shell however Shalimar produced nut with about 2 mm open suture, moreover cultivars like Nonpareil and Primorskij show very wide suture opening of shell. In respect of softness of shell, Nonpareil produced nut with paper shell, Waris, Pranyaj and Primorskij produced soft shelled nut, Makhdoom and Merced produced hard shelled nut whereas, all other evaluated cultivar produced nuts with intermediate softness of shell.As far as kernel taste to concern Waris, Makhdoom, Pranyaj, Nonpareil, IXL and Primorskij produced sweet kernel whereas, other evaluated cultivar produced kernel with intermediate taste. As far as Shriveling of kernel to concern Shalimar, Makhdoom and Nonpareil produced slightly wrinkled kernel whereas, other evaluated cultivar produced intermediate kernel. Further, in evaluation of 22 genotypes of almond collected from Kashmir Valley, CITH-Almond-15 and CITH-Almond-19 were found promising in respect of physical attributes of nut and kernel, whereas CITH-Almond-1, CITH-Almond-14 and CITH-Almond-12 were found promising in respect of nut yield. CITH-Almond-10, CITH-Almond-22 and CITH-Almond-23 obtained maximum kernel recovery among evaluated genotypes.

Nut characteristics of some promising almond cultivars

The flowering was observed in three newly introduced late bloomer genotypes *viz.* Ferragnes, Ferralise and Trady Non-Pareil during the period in field gene bank. The significant delay was recorded in all the flowering phenological stages as compared to Non-Pareil and Drake genotypes. These late blooming genotypes will be useful for development of varieties with late blooming trait to escape frost damage in almond.

Ferragnes | Ferralise | Tardy Non-Pareil

Flowering in introduced late bloomers

Walnut

In evaluation of 208 genotypes of walnut during 2017-18, a great extent of variability was noticed for various traits. Based on the nut efficiency of various genotypes, 10 best genotypes are SBB-11, CITH-W-11, ZP-3, CITH-W-26, CITH-W-103, CITH-W-40, CITH-W-104, CITH-W-54 A, LBT-1 and Shalimar-6. On the basis of nut weight, the top ten genotypes are presented in Fig 1. Highest nut weight (24.23g) was recorded in CITH-W-7, followed by CITH-W-1(23.2g), YD-1 (23.1g), CITH-W-123(22.83g), CITH-W-6(22.77g),BSP-1(22.27g), CITH-W-117(22.2g), CITH-W-118(22.03g), CITH-W-19(21.27g) & CITH-W-80 (21.23g). Out of 208 genotypes, 20 genotypes produced nuts having weight more than 20g. The nut efficiency and nut weight of CITH released varieties are presented in the Fig 1.

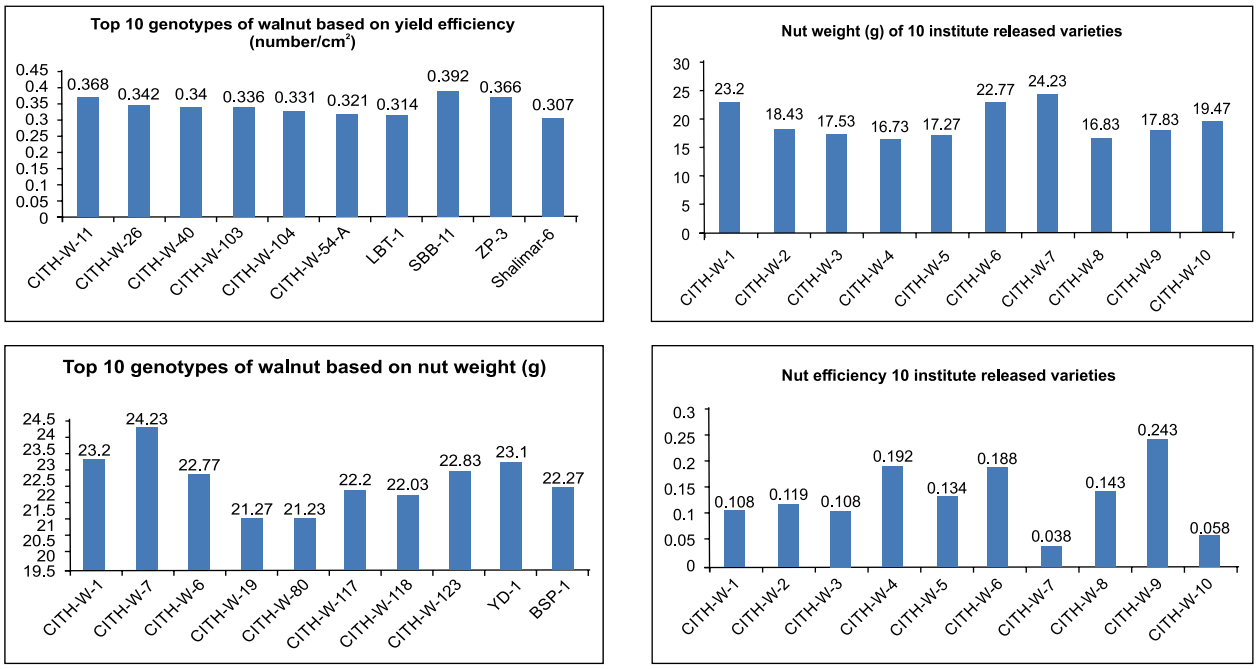


Fig 1: Yield efficiency and nut weight of top ten and Institute released walnut varieties

Peach and Nectarine

Characterization of 40 peach/ nectarine genotypes with respect to fruit skin, pulp chromatic, firmness index, fruit physical, chemical and yield parameter were carried out during 2017-18. Among fruit chromatic traits, highest fruit skin color "L*" value was recorded in K-209014, "a*" value in Mayfire, "b*" value in Vance Missouri however, lowest "L*" value in CITH-P-5, "a*" value CITH-P-3 and "b*" value in Peshawari. The fruit pulp color in terms of "L*" value was recorded maximum in genotype Summer Glo, "a*" value in Shan-e-Punjab and "b*" value for Elberta whereas, minimum "L*" value in CITH-P-7, "a*" value in Silver king and "b*" value in CITH-P-7. Highest fruit firmness was observed in Silver King and lowest in Summer Glo. Maximum fruit length was recorded in CITH-P-8 and minimum in Syria however, maximum fruit width was in Summer Glo and minimum in Mayfire. Higher fruit diameter was estimated in Summer Glo and lowest in Punjab Nectarine. The fruit shape index was found maximum in genotype Stark Early and minimum in genotype South Land Peach-2. Heaviest fruit was observed in Summer Glo and lightest in Mayfire. Among fruit chemical constituents, maximum TSS (°B) was estimated in CITH-P-5 and lowest titratbale acidity in South Land Peach-2 (Table 4). The Sugar acid ratio was measured highest in South Land Peach-2 and lowest in Mayfire genotype however highest fruit yield per plant was recorded in Nimla and lowest in Syria genotype.

Table 4: Variation in fruit physical, chemical and yield among 40 peach/nectarine genotypes

S. No.	Genotypes	Fruit length (mm)	Fruit width (mm)	Fruit diameter (mm)	Fruit shape	Fruit weight (g)	TSS (°B)	Titratable Acidity (%)	TSS/TA	Yield/plant (kg)
1	Mayfire	40.28	31.61	37.66	1.07	27.75	6.70	1.01	6.63	4.06
2.	Early Glo	47.11	47.64	51.18	0.92	66.60	9.20	0.95	9.68	9.68
3	Early Red June	57.08	48.47	51.73	1.10	78.20	11.00	0.81	13.58	16.65
4	Stark Early	56.56	43.88	48.46	1.17	66.64	12.00	0.84	14.29	6.98
5	Fertila	49.62	45.69	48.87	1.02	64.38	11.13	0.79	14.09	8.23
6	Silver King	59.08	47.65	51.03	1.16	75.98	9.47	0.99	9.57	4.36
7	Early Grande	59.81	61.46	63.45	0.94	130.59	10.77	1.02	10.56	6.35
8	Florida Prince	55.16	49.50	52.59	1.05	76.68	16.83	0.87	19.34	6.65
9	Shan-e-Punjab	44.15	39.96	42.85	1.03	40.29	10.57	0.86	12.29	8.34
10	Snow Queen	45.01	41.18	48.06	0.94	54.19	9.17	1.05	8.73	18.32
11	Syria	35.91	34.11	38.73	0.93	28.72	12.40	0.79	15.70	1.89
12	Punjab Nectarine	37.30	31.91	37.21	1.00	28.39	12.37	0.97	12.75	4.35
13	CITH-P-1	53.23	47.13	50.49	1.05	67.67	10.00	0.85	11.76	22.35
14	CITH-P-2	58.88	54.36	55.08	1.07	96.81	11.13	0.78	14.27	19.32
15	CITH-P-3	60.50	56.66	58.64	1.03	103.04	8.50	0.77	11.04	18.9
16	Nimla	68.55	65.42	66.95	1.02	176.07	9.77	0.76	12.86	29.36
17	South Land-P-1	43.12	43.87	43.78	0.98	57.49	14.23	0.71	20.04	3.36

S. No.	Genotypes	Fruit length (mm)	Fruit width (mm)	Fruit diameter (mm)	Fruit shape	Fruit weight (g)	TSS (^{0}B)	Titratable Acidity (%)	TSS/TA	Yield/plant (kg)
18	Peshawari	47.18	45.02	45.55	1.04	59.30	10.53	0.69	15.26	8.65
19	Glo Haven	53.99	51.65	54.50	0.99	99.78	11.27	0.79	14.27	23.36
20	Vance Marble	46.92	38.08	42.75	1.10	51.71	15.95	0.81	19.69	8.56
21	Elberta	44.58	44.51	45.80	0.97	55.18	12.87	0.77	16.71	18.68
22	Red Globe	44.96	42.64	46.43	0.97	53.66	12.07	0.70	17.24	29.56
23	Vance Missouri	60.36	64.28	62.65	0.96	135.72	15.60	0.98	15.92	6.21
24	Summer Glo	68.83	68.62	71.85	0.96	180.20	15.53	1.02	15.23	12.48
25	CITH-P-6	56.98	57.69	57.59	0.99	103.24	14.33	0.86	16.66	15.65
26	July Elberta	61.95	60.53	62.46	0.99	133.88	14.50	0.65	22.31	24.62
27	South Land P-2	42.45	47.77	47.24	0.90	62.20	17.63	0.62	28.44	3.68
28	Sun Haven	49.82	44.58	46.22	1.08	56.32	16.67	0.68	24.51	6.68
29	Snowcrest	59.19	62.82	64.16	0.92	142.11	15.03	0.71	21.17	9.53
30	K-209011	58.47	58.87	59.11	0.99	118.04	15.07	0.80	18.84	8.25
31	Red Heaven	63.73	61.88	60.05	1.06	126.11	15.60	0.72	21.67	3.56
32	Flavorcrest	50.75	49.22	51.07	0.99	76.34	15.53	0.68	22.84	8.8
33	CITH-P-4	59.53	57.82	58.87	1.01	116.90	13.47	0.69	19.52	14.8
34	CITH-P-9	49.27	47.65	48.55	1.01	65.26	14.00	0.71	19.72	16.46
35	CITH-P-5	43.70	45.47	46.35	0.94	56.07	18.43	0.75	24.57	19.69
36	CITH-P-7	50.14	43.94	46.61	1.08	56.53	18.20	0.65	28.00	17.88
37	Crest Haven	53.89	53.70	56.78	0.95	95.28	15.10	0.69	21.88	26.65
38	Fantasia	60.05	53.59	54.31	1.11	103.20	16.10	0.84	19.17	28.35
39	Quetta	40.38	39.39	41.36	0.98	44.35	14.87	0.66	22.53	16.65
40	CITH-P-8	69.19	55.75	59.97	1.15	112.17	11.23	0.68	16.51	12.68
	CD at 5%	*4.53*	*3.24*	*3.22*	*0.42*	*11.92*	*0.750*	0.06	2.23	4.68

Elberta

Gloheaven

Early Grande

Mayfire

Florida Prince

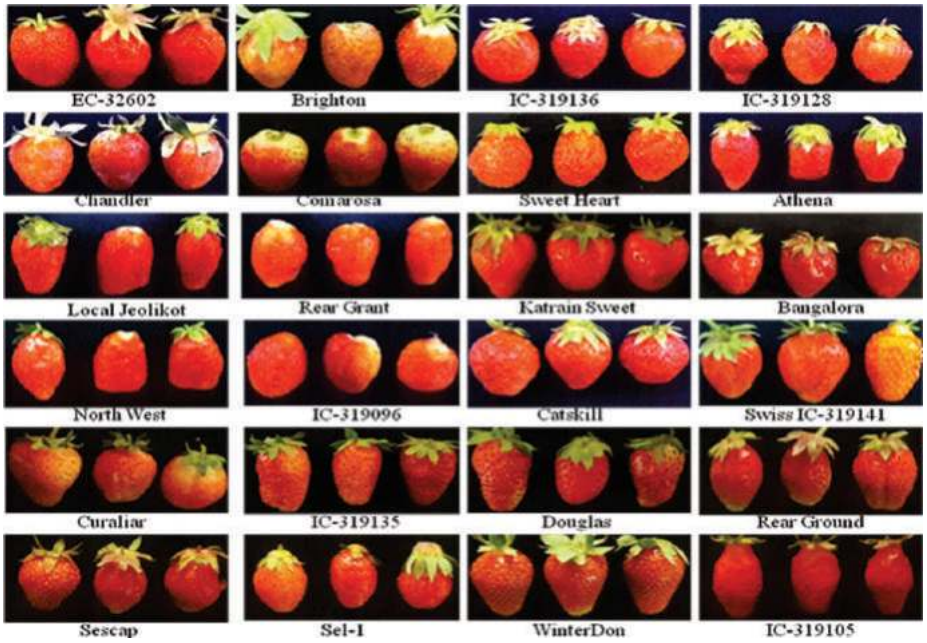
Fantasia

Fruiting in different genotypes of peach/nectarine

Strawberry

A total of 102 strawberry genotypes were evaluated for maturity, flowering, fruiting and fruit physicochemical attributes during the 2017-18. The highest "L*" value for fruit skin was recorded in genotypes Senga Sengana (60.09) followed by Blackmore (47.14) and lowest in IC-319107(26.62) followed by IC-319077 (26.96) likewise "a*" value was found maximum for the genotypes Mastdom (45.98) followed by EC-319127 (43.68) and minimum in IC-319115 (15.92) followed by EC-571812 (16.16). The "b*" value ranged from 40.81 in Mastdom to 7.11 in genotype IC-19077. The number of flowers/plant were recorded highest in EC-32602 (91.66) followed by Sel-1 (84.66) and lowest in genotype EC-362601 (10) followed by EC-319127 (11). Similarly number of fruits/plant was noted higher in genotypes EC-32602 (79.33) followed by Sel-1 (75.00) and lower in genotype EC-362601 (8.33) followed by EC-319127 (9.66). Fruit set (%) was recorded highest in genotypes Chandler (94.34) followed by Mechwary (92.52) and lowest in Tillamook (60.01) followed by Earlydawn (65.31). The genotype Shasta (38.77) produced fruit with highest length and IC-319077 (20.09) with lowest. Likewise maximum fruit diameter (mm) showed by genotype Douglas (30.21) followed by Shasta (29.85) and minimum diameter by IC-319105 (15.25) followed by IC-319115 (15.61) genotypes. Fruit width (mm) was recorded maximum in genotypes Elasta (26.77) followed by Katrain sweet-2 (25.50) and minimum in IC-319105 (13.38) followed by IC-319077 (13.44) genotypes. Heaviest fruit produced by Tillamook, (8.71g) followed by Jutogh Special (8.67g) and lightest in genotypes IC-319105 (3.07g) followed by Sel-1(3.23g). Fruit shape index was ranged from IC-319105 (1.71) to EC-319143 (0.87). Yield per plant were recorded highest in Missionary (512.00) followed by Gorilla (428) and lowest in genotypes EC-319127 (41.00), EC-439580 (44.00). Among fruit bio-chemical attributes, highest TSS (^{O}B) was recorded in Dana (12.97) followed by Bangalora (12.80) and lowest in Brighton (7.26) followed by, IC-319128 (7.38) however higher titrtable acidity (citric acid %) was estimated in Senga Sengana (0.78) followed by Mastodam (0.76) and lowest in CH-111 (0.51) followed by Elasta (0.53). the TSS/acidity ratio was observed maximum in VL-1 (22.14) followed by IC-319107 (22.04) and minimum in Shasta (5.56) followed by Local Jeolikot (5.58). The PH of the juice was highest in Senga Sengana (4.14) followed by Mastodam (4.12) and lowest Elasta (3.10) followed by CH-111 (3.12). Ascorbic acid (mg/100g) content was determined maximum in EC-22355 (78.80) followed by Katrain Sweet (77.80) and minimum in IC-319135 (49.98) followed by Heera (50.80). Maximum reducing sugar (%) was estimated in genotypes Kalimpong Local (2.98) followed by Jutogh Special (2.97) and lowest in Chandler (2.35) followed by Eralydawn (2.36). Highest non-reducing sugar (%) was observed in genotype CH-10 (1.98) followed by Senga Sengana (1.98) and lowest in Kimberly (1.35) followed by IC-319115 (1.35). Total sugar (%) was higher in genotype Senga Sengana (4.89) followed by Pajaro (4.73) and lower in

Eralydawn (3.78) followed by Katrain Sweet-2 (3.87). The Sugar:acid was maximum in Pajaro (9.10) followed by CH-111 (8.75) and minimum in Shasta (5.56) followed by Local Jeolikot (5.58). Among antioxidant constituents genotypes Howard (760) and Rear Ranid (758) were found richest in total phenols (mg gallic acid Eq·100 g–1 fw) contents however, Katrain Sweet (54.62) and Athena (53.21) were in total Flavonoides (mg catechin Eq·100 g–1 fw) contents. Total anthocyanin (mg cyanidin- 3-glucoside Eq·100 g–1 fw) was recorded highest in genotypes EC-362601 (47.76) followed by IC-319129 (45.45), DPPH (mg of ascorbic acid Eq ·100 g–1 fw) contents in genotypes IC-319135 (465) followed by EC-571812 (4.64) and FRAP (mg of ascorbic acid Eq ·100 g–1 fw) contents in genotypes Howard (659.65), followed by Phenomenal (675.25) respectively. The total 102 genotypes were also categorized in to four major group based on time of initiation of flowering, anthesis, full bloom and fruit set. The first group consisted genotypes viz. Katrain Sweet, EC-262589, IC-319140, Local Jeolikot, Athena, IC-319129, Robinson, IC-319128, EC-102642, Comarosa, Northwest, Fair Fox, IC-319153, IC-319077, Chandler, Catskill, Swiss-2, EC-571813, Fiona, Banglora, Seascap, Sweet Heart. The second group consisted early mid viz. Kimberly, Brigton, Missionary, IC-319136, IC-319093, Florida, EC-439591, IC-319096, EC-571812, Tiyoga, Kalimpong Local, IC-319107, Shimla Delicious, Blacknose, VL- 1, Addie, Howard, Nabila, Rear Ground, CITH-B-IC-319130. Third group consisted late mid viz. Perenial, , Tillamook, CH-111, IC-319115, Elasta, IC-319093, Kamila, Pusa Early Dwarf, Senga Sengana, Red Cross, Dilpasand, IC-319141, IC-319132, EC-319141, Larson, Phenomenon, Jutogh Special, Lucundi, EC-22355, Red Coat, IC-319095, IC-319116, NR Ranid, Sweet Messer, Heera, Osograndy , Tanemala, Sel-2, Pajaro and fourth group consisted late viz., IC-319127, Wild pea, EC-439580, CH-111-14, Shasta, Hybrid-12, Mastdom, Mechwary, IC-319133, EC-362601



Fruit morphological variability in strawberry genotypes

Olive

A total of 18 olive exotic genotypes were characterized for important horticultural traits and the highest fruit weight was recorded in genotype Tonda Ibea (3.72g) followed by Coratina (3.70g) and lowest in Pendolino (2.27g) followed by Picholine (2.40g). Fruit shape index was measured highest in genotype Toffohai (9.8) followed by Zaituna (9.56) however, lowest in Cerignola (7.54). Maximun oil content (%) on fresh weight basis was estimated in genotype Messenese (22.68) followed by Leccino (22.50%)

whereas, minimum in Ottobratica (14.2) followed by Morolio (14.60). Highest pulp weight (g) was estimated in genotype Toffohai (3.18) followed by Tonda Ibea (3.07) however, lowest in Picholine. Among stone characteristics maximum stone weight was observed in genotype Picholine and lowest in Ottobratica. Among all the genotypes highest yield per plant (kg) was noted in genotype Picholine (18.11), Zaituna (16.40) and Cipressino (15.84) and lowest in Morolio (1.02).

Coratina

Ceriglola

Zaituna

Frontoio

Belice

Itrana

Fruiting in olive genotypes at ICAR-CITH, Srinagar

Compatibility study in olive

In olive to investigate the fruit set under self pollination, open pollination and various cross combination condition, trial was conducted during the period. Results revealed that highest average fruit set (%) was recorded in Tonda Ibea followed by Coratina and Leccino under self pollination condition however highest average fruit set (%) was recorded in Picholine followed by Etnea and Etrana under open pollination condition. In various cross combinations highest fruit set was Picholine × Leccino followed by Picholine × Coratina and Zaituna × Cornicobra (Table 5 & Table 6).

Table 5: Average fruit set under self and open pollination condition in different olive genotypes

	Self-pollination			Open pollination		
Genotype	**Average no. of flower**	**Average no. of fruit set**	**Average fruit set (%)**	**Average no. of flower**	**Average no. of fruit set**	**Average fruit set (%)**
Cerignola	297	55	18.52	444.00	108	24.32
Frontoio	203	62	30.54	144.00	53	36.81
Morolio	251	85	33.86	268.00	130	48.51
Pendolino	152	80	52.63	205.00	122	59.51
Zaituna	135	58	42.96	65.00	40	61.54

Genotype	Self-pollination			Open pollination		
	Average no. of flower	Average no. of fruit set	Average fruit set (%)	Average no. of flower	Average no. of fruit set	Average fruit set (%)
Biancolilo	104	57	54.81	84.00	43	51.19
Cipressino	171	33	19.30	99.00	15	15.15
Ottobratica	100	37	37.00	95.00	66	69.47
Corniocobra	87	24	27.59	96.00	58	60.42
Messenese	71	41	57.75	66.00	50	75.76
Leccino	101	64	63.37	70.00	54	77.14
Etrana	117	25	21.37	167.00	134	80.24
Belice	54	12	22.22	83.00	61	73.49
Etnea	59	26	44.07	73.00	64	87.67
Tonda Ibea	51	35	68.63	119.00	89	74.79
Coratina	52	34	65.38	95.00	64	67.37
Toffohai	100	51	51.00	150.00	120	80.00
Picholine	234	98	41.88	170.00	155	91.18

Table 6: Average fruit set under various cross combination in different olive genotypes

Cross combination	Cross pollination		
	Average no. of flower	Average no. of fruit set	Average fruit set (%)
Cerignola × Frontoio	90	45	50.00
Frontoio × Cerignola	100	45	45.00
Frontoio × Morolio	150	70	46.67
Zaituna × Pendolino	125	75	60.00
Picholine × Pendolino	150	100	66.67
Zaituna × Coratina	90	50	55.56
Picholine × Coratina	110	100	90.91
Zaituna × Messenese	125	105	84.00
Picholine × Messenese	110	90	81.82
Zaituna × Etrana	290	165	56.90
Picholine × Etrana	130	95	73.08
Zaituna × Leccino	170	140	82.35
Picholine × Leccino	240	220	91.67
Zaituna × Biancolilo	170	145	85.29
Picholine × Biancolilo	255	190	74.51
Zaituna × Corniocobra	375	320	85.33
Picholine × Corniocobra	55	35	63.64
Zaituna × Cipressino	295	115	38.98

Cross combination	Cross pollination		
	Average no. of flower	Average no. of fruit set	Average fruit set (%)
Picholine × Cipressino	420	105	25.00
Zaituna × Tonda Ibea	215	175	81.40
Picholine × Tonda Ibea	150	100	66.67
Zaituna × Etnea	235	160	68.09
Picholine × Etnea	205	145	70.73
Zaituna × Ottobratica	125	60	48.00
Picholine × Ottobratica	110	55	50.00
Picholine × Cerignola	200	145	72.50
Zaituna × Cerignola	150	90	60.00
Picholine × Zaituna	220	120	54.55
Zaituna × Picholine	170	85	50.00

Begging for self pollination and fruit set in cross combination

Kiwifruit

The five genotypes of kiwifruit were evaluated under pergola training system for various horticultural traits. Among fruit attributes highest fruit length, fruit width and fruit diameter was measured in Hayward genotype followed by Monty and lowest in Bruno. No significant differences were observed among all the genotypes for fruit shape index trait and total soluble solids content. Highest titratable acidity was estimated in Allison followed by Abbott and lowest in Bruno which was stastically at par with Monty. Sugar acid ratio was recorded maximum in Bruno followed by Monty, Allison and Hayward and minimum in Abbott. In terms of yield (kg/plant) highest yield was observed in Hayward followed by Abbott, Allison, and Monty and lowest in Bruno (Table 7).

Table 7: Performance of five Kiwi genotypes under pergola training system for various horticultural attributes

Genotypes	Fruit length (mm)	Fruit width (mm)	Fruit Diameter (mm)	FSI	Fruit weight (g)	TSS (°Brix)	Titrable acidity (%)	TSS/ Acidity	Yield (kg)/ plant
Hayward	45.51	35.20	42.42	1.07	49.17	9.45	1.33	7.11	40
Bruno	34.21	25.16	26.98	1.27	18.27	9.17	1.25	7.34	5

Genotypes	Fruit length (mm)	Fruit width (mm)	Fruit Diameter (mm)	FSI	Fruit weight (g)	TSS (°Brix)	Titrable acidity (%)	TSS/ Acidity	Yield (kg)/ plant
Monty	40.10	29.24	33.28	1.33	26.66	9.01	1.26	7.15	10
Allison	38.13	29.33	31.54	1.21	27.63	9.14	1.40	7.14	13
Abbott	37.54	28.93	30.29	1.24	20.24	9.33	1.38	6.66	16
LSD ($p \leq 0.05$)	8.49	3.68	5.12	0.23	9.62	1.32	0.12	0.99	--

Abbott Allison Hayward Month

Variability in fruit characteristics of kiwi cultivars

ICAR – Central Institute of Temperate Horticulture Regional Station, Mukteshwar

Fruit crops

Germplasm of low chill peach (Red June, Red Nectarine, Para Deluxe, Pratap, Florda Prince, Early Grand, Shan-E-Punjab, Sharbati, Florda Red, Florda Gold and Saharanpur Prabhat), plum (Satluj Purple, Kala Amratsari and Kabul Green) and pear (China and Patharnakh) was collected from horticulture research centre, Patherchata, GBPUAT, Pantnagar and planted in the nursery. Collected the germplasm of apple, pear, peach, plum, apricot, cherry, almond, walnut, olive and pomegranate from the HQ Srinagar and planted in the nursery. Brought six cultivars of kiwifruit namely Allison, Haward, Bruno, Monty, Abbot and Tomary from NBPGR, Bhowali and planted in the nursery for area expansion.

Apple

In evaluation of 30 apple cultivars belonging to Delicious group, spur type and colour strains for physico-chemical characteristics the highest fruit weight (209.35 g), fruit volume (226.67 cc), fruit length (7.27 cm) and fruit diameter (8.37 cm) was recorded in cultivar Mollies Delicious while the lowest fruit weight (54.46 g), fruit volume (53.33 cc), fruit length (4.46 cm) and fruit diameter (5.48 cm) was recorded in Early Shanburry cultivar. The highest T.S.S. was recorded in Stark Spur (13.60 °B) while lowest in Vermont Spur (8.20 °B), whereas highest acidity was recorded in Lord Lambourne (1.07%) and lowest in Chaubattia Anupam (0.10%). The highest values for ascorbic acid (17.49 mg/100 g) were recorded in Red Chief, Rich-A-Red and Bright-N-Early while lowest in Red Spur (3.28 mg/100 g). The highest reducing sugar (7.58%) and total sugars (8.75%) was recorded in Tydeman Early

Worcester while lowest reducing sugar (2.25%) and total sugars (5.90%) were recorded in Fanny and Mollies Delicious respectively. The highest carotene content (242.73 µg/100 g) was recorded in Lord Lambourne while lowest in Vermont Spur (69.12 µg/100 g). The highest total anti-oxidant activity (45.11 mMTE/L) was recorded in Royal Delicious while lowest in Golden Delicious (34.44 mMTE/L). The highest anthocyanin content (771.38 mg/100 g) was recorded in Prima while lowest in Mollies Delicious (68.14 mg/100 g). The cultivar Lord Lambourne is the most luminous (L^*=73.13) and having the highest yellow colour (b^*=52.12), whereas Early shanburry showed the highest red colour (a^*=47.14) and Chroma (C^*=61.68). The lowest hue angle (h°=20.09) was recorded in Prima while highest in Bukinghum (h°=103.97). From this investigation it can be inferred that the cultivar Mollies Delicious performed better in the region under prevailing climatic conditions.

In shelf life study of fifteen apple cultivars at ambient storage condition the cumulative physiological loss in weight, T.S.S., reducing sugars, total sugars and fruit decay percentage increased, while fruit firmness, acidity, ascorbic acid, carotene content and total anti-oxidant activity decreased on prolonging the storage period in all the cultivars. CITH Lodh Apple-1 cv. exhibited minimum physiological loss in weight, fruit decay percentage and rich in ascorbic acid content than other apple cultivars. The cv. Chaubattia Anupam exhibited highest T.S.S., a* (Red colour), C* (Chroma) value and lowest acidity percentage however, the cv. Red Gold exhibited highest reducing sugars, carotene content and organoleptic score as compared to other apple cultivars during 42 days of storage. Conclusively, CITH Lodh Apple-1, Chaubattia Anupam and Red Gold have better shelf-life than other apple cultivars under ambient storage conditions.

Peach

In evaluation of different peach cultivar for physico-chemical characteristics at Nainital district of Uttarakhand the highest fruit weight (159.79 g), fruit volume (166.67 cc), fruit length (6.68 cm) and pulp weight (151.76 g) was recorded in Red June, while the lowest fruit weight (36.41 g), fruit volume (28.33 cc), fruit length (4.01 cm) and pulp weight (33.90 g) was recorded in Red Nectarine. The highest pulp stone ratio was recorded in Reliance (24.87) while the lowest in Rio-Oso-Gem (6.72). The highest TSS was recorded in Red Nectarine (12.00 °B), while lowest in Flordasun (7.60 °B). The minimum acidity was recorded in Rio-Oso-Gem (0.23%), while maximum in Red June (1.98%). The highest ascorbic acid content was recorded in Red June (8.75 mg/100 g), while lowest in Red Nectarine (2.18 mg/100 g). Total sugars (7.30%) and reducing sugars (4.55%) were recorded highest in White Queen and Red June respectively, while lowest total sugars (4.32%) and reducing sugars (1.63%) were recorded in Asariya and Flordaking respectively. The maximum carotene content was recorded in Flordaking (1701.45 µg/100 g), while minimum in Golden Monarch (211.62 µg/100 g). The highest total anti-oxidant activity was recorded in Asariya (38.13 mMTE/L), while lowest in Reliance (4.37 mMTE/L). The cultivar White Queen is the most luminous (L^*=98.42). The highest red colour (a^*=48.46), Chroma (C^*=59.60) and lowest hue angle (h°=35.08) was recorded in Red Nectarine. The highest yellow colour (b^*=54.64) was recorded in Red June while lowest was recorded in Asraiya. The most of the physico-chemical characteristics of fruits was found superior in Red June as compared to other peach cultivars.

In shelf life study in six peach cultivars at ambient storage condition Red June exhibited minimum physiological loss in weight and fruit decay percentage, rich in T.S.S., reducing sugars,

carotene content and having highest total anti-oxidant activity than other peach cultivars. However, the cv. Flordaking exhibited highest ascorbic acid, L*, b* and Chroma value and the cv. Red Nectarine exhibited highest fruit firmness and total sugars and lowest hue angle as compared to other peach cultivars during 12 days of storage. Conclusively, Red June, Flordaking and Red Nectarine have better shelf-life than other peach cultivars under ambient storage conditions.

A survey was conducted in Kumaon hills of Uttarakhand for evaluation of physico-chemical characteristics in thirty Red June genotypes. The most of the physico-chemical characteristics were found superior in Collection-4 and Collection-26. Theses collections could further be utilized in the breeding programme for the improvement of crop.

Plum

Different plum cultivars were evaluated for physico-chemical characteristics at Kumaon hills of Uttarakhand. Among the evaluated cultivars the highest fruit weight (60.04 g), fruit volume (58.50 cc), fruit length (4.70 cm), fruit diameter (4.84 cm), pulp weight (58.49 g) and pulp stone ratio (37.46) was recorded in Satsuma cultivar, while the lowest fruit weight (28.42 g), fruit length (3.53 cm), pulp weight (26.13 g) and pulp stone ratio (12.51) was recorded in Green Gage. The highest TSS was recorded in Santa Rosa (10.80°B), while lowest in Late Plum (9.20°B). The minimum acidity was recorded in Green Gage (0.27%), while maximum in Satsuma (1.04%) and Kaleji (1.04%). The highest ascorbic acid content was recorded in Late Plum (33.58 mg/100 g), while lowest in Green Gage (5.63 mg/100 g). Total sugars (5.88%) and non-reducing sugars (3.21%) were recorded highest in Green Gage, while lowest total sugars (4.34%) and non-reducing sugars (1.04%) were recorded in Kaleji. The maximum carotene content was recorded in Kaleji (250.96 µg/100 g), while minimum in Late Plum (76.63 µg/100 g). The highest total anti-oxidant activity was recorded in Late Plum (40.38 mMTE/L), while lowest in Green Gage (6.18 mMTE/L). The cultivar Green Gage is the most luminous (L^*=71.93) and having the highest yellow colour (b^*=54.19). The highest red colour (a^*=36.37) and Chroma (C^*=42.88) was recorded in Late Plum. The lowest hue angle (h°=25.95) was recorded in Santa Rosa while highest in Satsuma (h°=25.95). The most of the physico-chemical characteristics of fruits was found superior in Satsuma as compared to other plum cultivars.

In shelf life study in five plum cultivars at ambient storage condition Satsuma cv. exhibited minimum physiological loss in weight and acidity, rich in reducing sugars and a* value and having highest total anti-oxidant activity than other plum cultivars. The cv. Green Gage exhibited highest T.S.S., total sugars, carotene content, L*, b* and Chroma value and lowest fruit decay percentage however, the cv. Santa Rosa exhibited highest fruit firmness and organoleptic score as compared to other plum cultivars during 15 days of storage. Conclusively, Satsuma, Green Gage and Santa Rosa have better shelf-life than other plum cultivars under ambient storage conditions.

A survey was conducted in Kumaon hills of Uttarakhand for evaluation of physico-chemical characteristics in twenty nine Santa Rosa genotypes. The most of the physico-chemical characteristics were found superior in Collection-20, Collection-1, Collection-25 and Collection-2. Theses collections could further be utilized in the breeding programme for the improvement of crop.

Persimmon

A survey was conducted in Kumaon hills of Uttarakhand for evaluation of physico-chemical characteristics in twelve persimmon genotypes. The most of the physico-chemical characteristics were found superior in Collection-4 and Collection-6. Theses collections could further be utilized in the breeding programme for the improvement of crop.

Vegetable and flower Crops

Kale

Fifty-three Kale genotypes were evaluated for yield and related parameters. The germplasm expressed marketable leaf yield of 1.00 to 30.78 t/ha.

Variability in kale germplasm maintained at ICAR-CITH, Srinagar

Cabbage

Hybridization of red cabbage was done with Golden Acre to obtain multicolored, nutritionally enriched cabbage hybrid for salad purpose. The F1 generation was evaluated.

Head of parents and F1

Exotic vegetables

Selections for yellow, magenta and orange colored petioles in Swiss chard were done. Selections were also done for conical shaped Chinese cabbage, drumhead cabbage and hybrids between kale and cabbage.

Development of CMS lines in long day onion (*Allium cepa* L.)

Two male sterile lines of short day background were planted in crossing nethouses for the purpose of hybridizing with promising long day onion genotypes of the institute both for the purpose of introgressing characteristics of short day onion and introducing male sterility.

Evaluation of tulip varieties for various growth and floral attributes

Twenty two varieties of tulip were evaluated for various growth and floral traits. The plant height among 22 varieties varied between 8.66cm (Candella) to 37.33cm (Ben Van Zaintin).The spike girth ranged 4.11mm (Candela) to 7.50 mm (Golden Parade). The cultivar Carton produced flower with number of petals and is a double flower variety while other produced single flowers. Maximum flower width (93.87 mm) was measured in Carton while maximum length (88.99 mm) and petal length (86.27 mm) was found in cv. Francoise. Maximum leaf length (20.61cm),

leaf width (7.75cm) was recorded in cultivars Francosie and Jambo Beauty respectively. The earliest flowering was observed in early Harvest on 19th March followed by Candela (20th March), Laptop(20th March), Carton (20th March), Illede France (22nd March), Hollindia (22nd March), Jambo Beauty (22nd March), Honeymoon (23rd March). The cultivar Ban Van Zaitin was last (16th April) to initiate flowering closely followed by Texas Gold 15th March and Texas Gold was cultivar which observed peak flowering and senescence at last. Maximum flowering duration (*in situ*) was observed in Jambo Beauty (15.66 days) followed by Texas Gold (12.33 days) , Honeymoom(11.33 days) Adream (10.66 days) and Laptop (10.66 days).Minimum duration 4.33 days was recorded in Pallada. Minimum days from planting to initiation of flowering (130.6 days) were taken by Early Harvest and maximum 159.3 and 158.3 days were taken by Ben Van Zaintin and Texas Gold respectively. Among 22 varieties , 8 were early ,10 mid and 4 late in flowering. Hence by planting the combination of these varieties the duration of flowering of tulip in garden can be extended.

ICAR-CITH, RS, Mukteshwar

Introduced 30 germplasm lines in various vegetable crops including Okra, Ashgourd, Amarenthus, Melon, Ram Karela besides, preserved/maintained 210 germplasm lines of various vegetable and 123 of various flower and ornamental crops.








Development of superior cultivars/hybrids in temperate fruits through conventional and non conventional methods

Apple

Fruit quality analysis of apple hybrids:

During 2017-18 thirteen hybrids were evaluated for fruit quality analysis. Most of the hybrids showed superior performance with respect to some traits under analysis. Hybrid "Starkrimson x Gold Spur" was found to be smaller in size with respect to its parents but was having higher TSS (21.5°Brix) than respective parents Starkrimson (13.6°Brix) and Gold Spur (11.9°Brix). In addition "L" values were much higher (70.75) than Starkrimson (43.03) and Gold Spur (34.95). Red Delicious and Mollies Delicious hybrid was heavier (260 g) than its respective parents and also fruits were firm (72.74 RI) with relatively higher TSS (17.73 °B). Ambri x Mollies Delicious hybrid was also good in size (223.63 g) with relatively higher TSS (16.7 °Brix) than parents. Prima x Red Delicious hybrid bear small fruits (76.02 g) with significantly high TSS (19.83) and moderate ascorbic acid content (7.17 mg/100g). Higher TSS (17.07 °Brix) was also found in Red Delicious x Silver Spur hybrid with relatively small ascorbic acid content (5.13mg/100g). Ambri x Maharaji, Red Delicious x Gala Mast, Golden Delicious x Red Fuji, Golden Delicious x Gala Mast, Golden Delicious x Cooper-IV, Golden Delicious x Oregon Spur, Well Spur x *Malus floribunda* and American Apirogue x *M. floribunda* hybrids showed significant variability in fruit size, TSS, ascorbic acid content and colour values with respect to their parents (Table 8)

Table 8: Fruit quality attributes of apple hybrids with respect to their parent genotypes

S. No.	Hybrid/ Genotypes	Weight (g)	Length (mm)	Breadth (mm)	Firmness (RI)	TSS (°B)	Acidity (%)	Ascorbic Acid (mg/ 100g sample)	L	a	b
1.	Starkrimson × Gold Spur	98.75	54.84	64.35	57.27	21.5	0.35	7	70.75	20.6	46.45
	Starkrimson	200.46	79.65	79.85	60.9	14.6	0.335	16.56	43.03	27.8	12.95
	Gold Spur	180	68.79	83.27	76.53	16.9	0.067	4.73	34.95	22.8	8.28
2	R.D × M.D	260	63.89	63.28	72.74	17.73	0.24	5.9	44.17	30.6	19.25
	Red Delicious	156	65.84	68.79	66.6	10.6	0.268	14.2	55.62	5.48	25.94
	Mollies Delicious	191	69.25	77.31	60	11.63	0.268	9.94	53.82	16.7	21.8
3	Ambri × M.D	223.63	70.22	78.28	60.18	16.7	0.25	6.23	52.74	27.1	24.58
	Ambri	139.24	65.22	68.28	64.23	13.63	0.268	16.56	53.88	27.3	16.58
	Mollies Delicious	191	69.25	77.31	82	11.63	0.268	9.94	53.82	16.7	21.8
4	Prima × R.D	76.02	47.70	56.66	70.27	19.83	0.36	7.17	56.41	25.8	25.77
	Prima	142.3	56.15	70.63	74.43	10.9	0.335	4.72	59.76	5.1	31.28
	Red Delicious	156.5	65.84	68.79	66.6	10.6	0.268	14.2	55.62	5.48	25.94
5	R.D × Silver spur	74.46	47.25	55.65	52.90	17.07	0.21	5.13	74.28	16.0	55.62
	Red Delicious	156.5	65.84	68.79	66.6	10.6	0.268	14.2	55.62	5.48	25.94
	Silver Spur	196.35	69.72	75.3	52.56	13.8	0.134	14.2	32.86	16.6	4.56

S. No.	Hybrid/ Genotypes	Weight (g)	Length (mm)	Breadth (mm)	Firmness (RI)	TSS (°B)	Acidity (%)	Ascorbic Acid (mg/ 100g sample)	L	a	b
6	Ambri × Maharaji	73.23	51.69	54.55	56.90	14.3	0.30	6.73	63.26	7.81	33.1
	Ambri	139.24	65.22	68.28	64.23	13.63	0.268	16.56	53.88	27.3	16.58
	Maharaji	212.16	67.91	83.36	69.36	12.46	0.268	9.46	51.45	29.4	22.95
7	R.D × Gala Mast	74.12	52.29	54.99	65.53	12.8	0.44	7.57	50.01	17.5	22.53
	Red Del	156.5	65.84	68.79	66.6	10.6	0.268	14.2	55.62	5.48	25.94
	Gala Mast	187	68.37	73.16	70.37	13.13	0.201	11.83	54.5	21.1	22.11
8	G.D × Red Fuji	129.49	56.56	67.73	63.70	18.43	0.41	7.37	55.70	15.6	21.23
	Golden Delicious	167.21	64.6	74.1	60.5	14.63	0.134	9.46	72.73	-6.71	41.05
	Red Fuji	151.2	14.79	24.59	68.3	16.96	0.2814	9.46	49.02	13.2	18.12
9	G.D × Gala Mast	139.16	63.73	65.28	58.87	21.23	0.38	7.33	62.28	21.8	42.81
	Golden Del	167.21	64.6	74.1	60.5	14.63	0.134	9.46	72.73	-6.71	41.05
	Gala Mast	187	68.37	73.16	70.37	13.13	0.201	11.83	54.5	21.1	22.11
10	G.D × Cooper-IV	165.15	62.15	74.61	61.67	17.77	0.35	6.9	52.91	25.0	20.83
	Golden Del	167.21	64.6	74.1	60.5	15.63	0.134	9.46	72.73	-6.71	41.05
	Cooper-IV	244.33	77.73	78.41	80.83	14.6	0.268	9.46	40.88	28.6	15.98
11	G.D × Oregon spur	109.19	61.13	60.63	64.57	17.03	0.57	7.53	60.42	–5.2	39.85
	Golden Del	167.21	64.6	74.1	60.5	14.63	0.134	9.46	72.73	-6.71	41.05
	Oregon Spur	186.22	67.12	74.62	56.63	14.06	0.201	11.12	34.74	20.4	5.6
12	Well spur × M. floribunda	21.92	32.67	36.31	68.30	22.33	0.52	7.23	36.66	28.6	31.14
	well Spur	177.76	68.39	70.74	74.53	10.06	0.268	4.72	47.91	23.7	15.53
	M. floribunda	7.72	22.16	25.95	49.46	15.76	0.5494	18.93	39.88	23.1	13.96
13	American Apirogue × M.floribunda	64.31	46.84	56.57	59.83	18.07	0.60	7.8	40.39	40.2	17.18
	American Apirogue	125.72	51.25	68.98	66.7	13.73	0.0402	4.73	61.54	19.3	26.3
	M. floribunda	7.72	22.16	25.95	49.46	15.76	0.5494	18.93	39.88	23.1	13.96
CD at 5%		7.2	3.5	4.2	4.5	3.6	0.2	3.2	6.5	NS	5.5

Molecular screening of hybrids for scab resistance:

Thirteen hybrids were screened for presence of resistance gene through gene specific PCR analysis. To confirm the presence of Vf gene conferring resistance against apple scab disease, in hybrids, five gene specific markers were used viz AL07, AM19, UI400, VfRvi6-(a), Vf2, amplifying 540bp, 550bp, 350bp, 600bp and 700bp respectively fragments of gene in resistant cultivar. The results revealed that three hybrids viz Prima x Red Delicious, Well spur × *M. floribunda* and American Apirogue × *M.floribunda* showed the presence of resistant gene Vf Rvi6. The resistant gene in these hybrids is contributed by their parents viz Prima and *M.floribunda* (Fig 2).

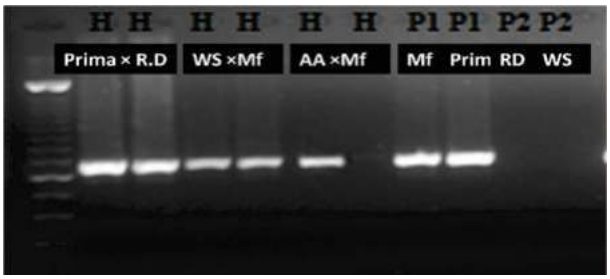
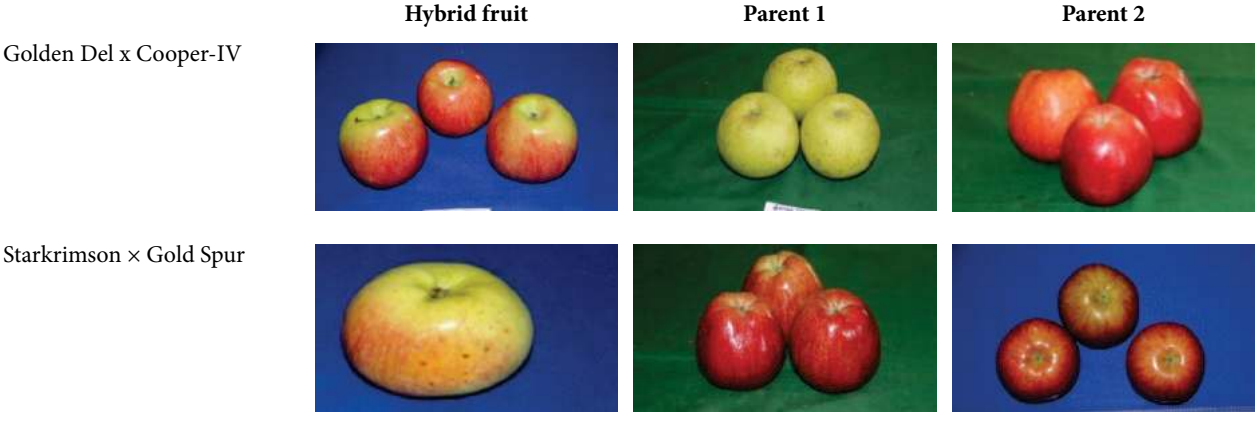


Fig 2: Amplification of Vf (Rvi6) gene in hybrids and their respective parents

Four hybrids viz Prima x *Malus floribunda*, American Apirogue x *Malus floribunda*, Prima x Red Delicious and Prima x Ambri were screened for presence of scab resistant genes. Eighteen primers amplifying scab resistant genes (vbj(Rvi11) 67/68, Vf1, vbj(Rvi11 69/70), vf (Rvi6)-b, Rvi6 53/54, Vf 2ARD 543/544, UI400 551/552, CH-vf, 35/536, AL07 547/548, Am-19 549/550, Vf (Rvi6)-a 61/62, vf1 537/538, *Vm Rvi5 65/66,* vf2 539/540, *vf2ARD-RT 545/546,* vf1 RSA 541/542, vf (Rvi6) 57/58 and vf (Rvi 6) 63/64) were used for screening the hybrids and their respective parents. Three primers (*Vm Rvi5 65/66,* vf2 539/540 and *vf2ARD-RT 545/546* produce monomorphic results between hybrids and parents and thus contribute non-significant results and two primers (vf1 RSA 541/542 and vf (Rvi6) 57/58) did not amplify any gene in either hybrids or parents. Whileas rest of the primers produce desirable results which can be utilized for identification of hybrids with resistant genes and their utilization in further crop improvement programme. Primers vbj(Rvi11) 67/68, Vf1, vbj(Rvi11 69/70), Vf 2ARD 543/544, and vf1 537/538 amplifying 800bp, 650bp, 250bp, 570bpand 650 bp respectively in Prima, *Malus floribunda*, Prima x *Malus floribunda,* American Apirogue *x Malus floribunda,* Prima x Red Delicious and Prima x Ambri and thus these loci are transferred from donor cultivars "Prima" and "*Malus floribunda*" to commercial cultivars "Red Delicious" and "Ambri". In addition primer specific for scab resistant genes "Vf (Rvi6)-a 61/62" amplify the gene in Prima, *Malus floribunda*, Prima x *Malus floribunda,* American Apirogue *x Malus floribunda* and Prima x Ambri. This gene does not show any amplification in "Prima x Red Delicious" revealing the absence of such loci in this hybrid. The extent of resistant towards scab due to absence of one such loci will further be tested through pathological screening tests. Similarly other primers also showed amplification in some hybrids which will be further tested by pathological screening of these hybrids.



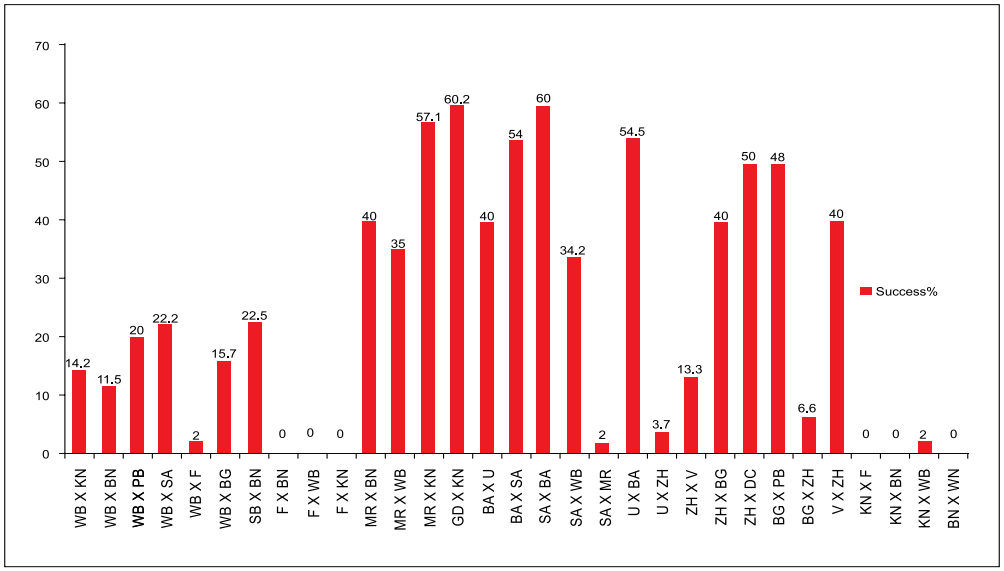
	Hybrid fruit	Parent 1	Parent 2
Red Delicious x Mollies Delicious			
Prima × R.D			
R.D × Silver spur			
R.D × Gala Mast			
G.D × Red Fuji			
G.D × Cooper-IV			
G.D × Oregon Spur			
American Apirogue × M.floribunda			
Ambri x Mollies Delicious			

Variability of fruit characteristic between hybrids and parents of apple

Pear

Cross compatibility studies in pear (European and Asian) cultivars.

From the orchard practice point of view, cross-pollination is necessary in pear to obtain high yields as well as properly shaped fruits. During the establishment of an orchard, it is very important to select compatible pollinators from diploid cultivars blooming in the same period. Keeping this in mind 32 crosses/ reciprocal different crossing combinations were performed during the year 2017, based on the synchronization of the flowering. Ten pear cultivars were used including William Bartlett, (WB), Santya Braskaya,(SB) Fertility (F), Max Red Bartlett (MR), Gent Drouard (GD), Beurre de Amanlis (BA), Severenta (S), Louise Bonne de Jersey (LJ). Z H Copaceae (ZH), Batteria Giffard (BG), Vickar of Winfield9(V), Kashmiri Nakh (KN), Badshah Nakh (BN), Pysua Behapa (PB) and Doyenne de Commice (DC). Among the crosses performed the success percentage ranges from 0%-60.2% (Fig 3). The highest fruit set (60.2%) was recorded in crosses between (GD X KN). Out of total crossing zero percent fruit set was achieved in six cross combinations (F x BN, F X WB, F X KN, KN X F, KN X BN, KN X BN). When local Kashmiri Nakh (Asian pear) was used as pollen parent satisfactory fruit set was recorded in some European cultivars, but very little success was recorded when Kashmiri Nakh was used as female parent.



*WB- William Bartlett, SB- Santya Braskaya, F-Fertility, MR-Max Red Bartlett, GD- Gent Drouard, BA- Beurre de Amanlis, SA-Severenta, LJ- Louise Bonne de Jersey, ,ZH- Z H Copaceae, Batteria Giffard, Vicker of Winfield, KN-Kashmiri Nakh, BN-Badshah Nakh, PB-Pysua Behapa and DC-Doyenne de Commice.

Fig 3: Percentage fruit set in different crosses between different pear (Asian and European) cultivars.

Apricot

Self fruit fullness studies in apricots

To study the effect of mode of pollination, data was recorded in selfing and open pollination. The open pollination improved the fruit set is most of the genotypes ,while selfing (bagging) resulted very less or no fruits set indicating partial fruitfulness or self unfruitfulness in some genotypes. These genotypes were CITH-AP 9, CITH- AP 11, CITH- AP 17, CITH- AP 18,Tokpopa, PAS 3 and PAS-4. This line of research require further investigation to find reason and suitable compatible pollen source.

Almond

Breeding for self fertility, Earliness, softness in shell, delayed blooming, rootstock characteristics, better nut and kernel quality in almond

To introgress the desirable traits like Earliness, softness in shell, lateness, self fruitfulness,

rootstock characteristics, better nut and kernel quality in almond various inter and intra-specific crosses were made using different cross combinations. The highest initial fruit set (%) was recorded in inter-specific cross of (California Paper Shell × peach) followed by (CITH-A-15 × Shalimar) and (CITH-A-14 × Pranyaj). However highest final fruit set (%) was observed in (CITH-A-10 × Pranyaj) followed by (Non Pareil × Bitter almond) and CITH-A-13 × Non Pareil (Table 9a & 9b).

Table 9 a: Status of initial and final fruit set in intra specific cross combination of almond

S. No.	Cross combination Female × male	Date of crossing	No. of flower	Fruit set	% Initial fruit set	Final fruit set	Final fruit set (%)
1	CITH-A-7 × Makhdoom	12/3/18	299	128	42.81	30	10.03
2	CITH-A-15 × Shalimar	13/3/18	817	464	56.79	42	5.14
3	CITH-A-6 × peach	7/3/18	887	370	41.71	4	0.45
4	CITH-A-17 × Makhdoom	9/3/18	241	85	35.27	6	2.49
5	CITH-A-14 × Pranyaj	16/3/18	316	173	54.75	19	6.01
6	CITH-A-10 × Pranyaj	16/3/18	166	84	50.60	37	22.29
7	CITH-A-13 × Non Pareil	17/3/18	377	167	44.30	41	10.88
8	CITH-A-11 × Non Pareil	19/3/18	538	98	18.22	4	0.74
9	Non Pareil × Bitter almond	20/3/18	539	230	42.67	61	11.32
10	Non Pareil × Bitter almond	20/3/18	414	155	37.44	10	2.42
11	California Paper Shell × peach	22/3/18	1041	664	63.78	4	0.38
12	IXL × CITH-A-4	26/3/18	603	202	33.50	1	0.17
13	IXL × CITH-A-13	27/3/18	622	99	15.92	9	1.45

Table 9 b: Status of initial and final fruit set in inter specific cross combination of almond

S.No.	Cross combination Female × male	Date of crossing	No. of flower	Fruit set	Final fruit set
1	Peach × Non Pareil	24/3/18	750	74	6
2	CITH-P-3 × IXL	28/3/18	692	327	23

Crossing in almond for development of superior hybrids

To investigate the self-fruitfulness in almond, a trail was conducted during 2017-18. To prevent cross and open pollination bagging of two branches in different direction was done in all the almond genotypes. In preliminary study it was found that significant fruit set (%) was observed in genotypes viz., CITH-A-1, CITH-A-15, CITH-A-16, Waris Makhdoom, CITH-A-14 however low fruit set was recorded in CITH-A-3, CITH-A-4, CITH-A-5, CITH-A-7, CITH-A-13,

CITH-A-19 whereas no fruit set was noticed in CITH-A-2, CITH-A-6, CITH-A-11, CITH-A-20, Drake, Primroskij, Pranyaj, IXL, Merced and Shalimar (Table 10). The initial results opined that CITH-A-1, CITH-A-15, CITH-A-16, Waris Makhdoom, CITH-A-14 could be exploited as self-fruitful genotypes and almond improvement programme.

Table 10: Degree of self-fruitfulness in exotic and indigenous almond genotypes maintained at ICAR-CITH, Srinagar

S. No.	Genotype	No. of flower	Fruit set	Fruit set (%)
1	CITH-A-1	199	68	34.17
2	CITH-A-2	256	0	0.00
3	CITH-A-3	88	5	5.68
4	CITH-A-4	240	24	10.00
5	CITH-A-5	190	16	8.42
6	CITH-A-6	291	0	0.00
7	CITH-A-7	221	23	10.41
8	CITH-A-9	267	42	15.73
9	CITH-A-10	81	7	8.64
10	CITH-A-11	95		0.00
11	CITH-A-12	112	8	7.14
12	CITH-A-13	205	9	4.39
13	CITH-A-14	252	46	18.25
14	CITH-A-15	232	77	33.19
15	CITH-A-16	221	72	32.58
16	CITH-A-17	190	27	14.21
17	CITH-A-18	50	6	12.00
18	CITH-A-19	223	19	8.52
19	CITH-A-20	266	0	0.00
20	Drake	247	0	0.00
21	Primroskij	237	0	0.00
22	Pranyaj	110	0	0.00
23	California Paper Shell	292	5	1.71
24	IXL	276	0	0.00
25	Non Pareil	222	23	10.36
26	Merced	275	0	0.00
27	Waris	212	50	23.58
28	Shalimar	211	0	0.00
29	Makhdoom	230	44	19.13

Self-fruitfulness study in almond genotypes

Cherry

To improve the fruit skin color and other fruit quality traits in cherry various possible cross combinations (inter and intra specific) were attempted. The highest initial fruit and final fruit set was recorded in Double × Makhmali followed by Sour cherry × Double (Table 11).

Table 11: Status of initial and final fruit set in inter and intra specific cross combination of cherry

S.No.	Cross combination Female × male	Date of crossing	No. of flower	Fruit set	% Initial fruit set	Final fruit set	Final fruit set (%)
1	Double × Makhmali	30/3/18	1065	572	53.71	166	15.59
2	Sour cherry × Double	4/4/18	1141	444	38.91	36	3.11

Crossing in cherry genotypes

To investigate the self-fruitfulness in cherry, a trial was conducted during 2017-18. To prevent cross and open pollination bagging of two branches in different direction was done in all the cherry genotypes. In preliminary study it was found that in cherry higher degree of self-fruitfulness was recorded in cultivars Van, Lambert, Awal No. (Guigne Pourpera Prece), Bing, Makhmali, Double (Bigarreau Noir Grossa) and Lapinus however among the selections CITH-C-02, CITH-C-14, CITH-C-15, CITH-C-10, CITH-C-11, CITH-C-11B, CITH-C-05 and CITH-C-03 (Table 12). These germplasm could be useful for introgression of self-fruitfulness in cherry improvement programme and also suits for sole genotype cultivation of cherry.

Table 12: Degree of self-fruitfulness in exotic and indigenous cherry genotypes conserved at ICAR-CITH, Srinagar

S. No.	Genotype	No. of flower	Fruit set	Fruit set (%)
1	CITH-C-02	265	37	13.96
2	CITH-C-12	185	42	22.70
3	CITH-C-06	243	15	6.17
4	CITH-C-14	219	49	22.37
5	CITH-C-15	322	108	33.54
6	CITH-C-07	236	57	24.15
7	CITH-C-10	220	111	50.45
8	CITH-C-08	264	90	34.09
9	CITH-C-11	196	89	45.41
10	CITH-C-15B	253	62	24.51
11	CITH-C-11B	202	130	64.36
12	CITH-C-09	386	113	29.27
13	Sweet Heart	160	47	29.38
14	CITH-C-18	193	24	12.44
15	CITH-C-19	192	65	33.85
16	CITH-C-20	329	26	7.90
17	CITH-C-01	406	153	37.68
18	CITH-C-05	276	111	40.22
19	CITH-C-03	372	135	36.29
20	CITH-C-04	175	36	20.57
21	Double	98	38	38.78
22	Mishri	274	45	16.42
23	Makhmali	497	161	32.39
24	Bing	435	187	42.99
25	Lapins	480	133	27.71
26	Awal No.	470	174	37.02
27	Van	450	202	44.89
28	Lambert	573	217	37.87

Self-fruitfulness study in cherry genotypes

Breeding for development of superior varieties/hybrids in Solanaceous crops ICAR-CITH, Srinagar

Characterization of chilli (*Capsicum annuum* L.) germplasm

Morphological characterization of chilli germplasm on the basis of bearing habit (single, cluster), earliness, lateness, productive period, fruit shape, fruit color and fruit size was done to determine morphologically visible and stable divergence in the present chilli germplasm of the institute. The top 50 promising genotypes expressed total marketable yield of 10.75 to 26.04 t/ha. Some new selections on the basis of yield, fruit shape, size and color were also done as represented in the following pictures.

Promising cultivars of chilli

Advanced evaluation of promising lines in chilli and sweet pepper (*Capsicum annuum* L.)

Ten promising lines each in chilli and sweet pepper were evaluated for uniformity, yield and fruit characteristics. The yield of chilli ranged from 10.33 to 17.04 t/ha and that of capsicum from 44.33 to 99.97 t/ha.

Breeding in tomato (*Solanum lycopersicum* L. and *Solanum lycopersicum* var. *cerasiforme*)

Hybridization between slicing tomato (*Solanum lycopersicum* L.) and cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) was done to introgress yellow color from latter into former and breed for other characteristics.

ICAR-CITH, RS, Mukteshwar

Tomato

Ten genotypes of tomato hybrid lines were evaluated during summer extended Kharif 2017-18 under polyhouse at ICAR–CITH Regional Station, Mukteshwar for their growth, yield and quality parameters. Most of lines exhibited significant differences for various growth, yield and quality parameters under study. Among the genotypes, maximum plant height (3.35 m) and stem diameter (6.28 mm) recorded in hybrid line CITH-M-TH-3, respectively. However, maximum plant spread (East-West 100.50 cm) recorded in line CITH-M-TH-4.

However, highest number of branches/plant, total number of fruits/plant, 3.33, 15.33, recorded in line CITH-TH-9 (Table 13). The highest total fruit yield/plant and total yield q/ha 561.67 and 124.80 q/ha recorded in line CITH-TH-10, respectively.

Table 13: Vegetative growth and yield of tomato hybrid lines at CITH Mukteshwar under Polyhouse

S. No.	Genotypes	Plant height (m)	No. of fruit/ plant	Plant spread (cm)		Stem diameter (mm)	No. of branches /plant	Branch length (cm)	Total yield q/ ha
				East-West	North-South				
1.	CITH-M-TH-1	2.21	8.33	64.56	64.26	5.73	2.00	139.96	23.70
2.	CITH-M-TH-2	2.57	7.66	77.00	66.73	5.80	2.00	173.43	18.88
3.	CITH-M-TH-3	3.35	8.66	83.70	72.03	6.28	3.00	277.53	116.88
4.	CITH-M-TH-4	3.18	8.83	100.50	85.60	5.14	3.00	234.63	25.92
5.	CITH-M-TH-5	3.18	8.50	89.20	88.90	5.91	2.30	204.60	69.48
6.	CITH-M-TH-6	0.79	6.16	28.66	25.06	4.70	2.00	54.73	17.77
7.	CITH-M-TH-7	2.84	6.83	80.20	87.73	5.10	3.00	184.03	5.33
8.	CITH-M-TH-8	3.02	7.67	76.00	72.23	4.21	3.00	199.83	50.50
9.	CITH-M-TH-9	3.25	7.33	94.86	96.50	4.27	3.33	230.76	47.92
10.	CITH-M-TH-10	2.83	7.33	86.73	88.69	4.54	3.00	160.76	124.80
	CD @ 5%	0.80	1.19	31.27	25.03	1.23	1.17	84.88	0.215

Tomato hybrid lines under polyhouse

Chilli

Three genotypes of chilli were evaluated during summer extended rabi 2017-18 at ICAR–CITH Regional Station, Mukteshwar, Nainital (UK) for their growth, yield and quality parameters. Most of lines exhibited significant differences for various growth, yield and quality parameters under study. Among the genotypes, Kashi Suraj recorded maximum plant height of 163.80 cm followed by 156.63 cm in Kashi Anmol. Maximum branch length of 156.66 cm was recorded in genotype Kashi Anmol followed by 88.50 cm in Kashi Suraj. However, maximum number of branches/plant was recorded in Kashi Tej (25.50) followed by in Kashi Suraj (23.16). The maximum plant spread East-West (83.68 cm) and north-south (99.03 cm) was recorded in Kashi Suraj and Kashi Tej, respectively. Among the genotypes, Kashi Anmol recorded maximum yield/plant of 0.953 Kg followed by 0.755 Kg/plant in Kashi Suraj and Kashi Anmol, respectively. The genotypes Kashi Suraj exhibited maximum number of fruits/plant (238.33) followed by Kashi Anmol (203.00). However, maximum fruit length (9.38 cm) and fruit diameter (8.74 mm) were recorded in Kashi Anmol (Table 14).

Table 14: Vegetative growth parameters of Chilli genotypes under polyhouse conditions

S. No.	Genotypes	Plant height (cm)	No. of branches /plant	Branch length (cm)	Plant spread	
					(East-West) cm	North-South) cm
1.	Kashi Tej	101.00	25.50	86.50	74.81	74.20
2.	Kashi Anmol	156.63	22.00	156.66	72.61	66.72
3.	Kashi Suraj	163.80	23.16	88.50	83.68	99.03
	Mean	140.47	23.55	110.55	77.03	79.98

S. No.	Genotypes	Fruit length (cm)	Fruit breadth (mm)	Total number of fruits/plant	Average fruit weight (g)	Total yield /plant (kg)
1.	Kashi Tej	6.69	6.73	156.00	2.00	0.206
2.	Kashi Anmol	9.38	8.74	203.00	5.13	0.755
3.	Kashi Suraj	9.04	6.82	238.33	3.40	0.953
	Mean	8.37	7.43	199.11	3.51	0.638

Breeding for nutra-rich varieties/hybrids in root vegetable crops

An experiment was conducted at ICAR-CITH, on different carrot, radish and turnip accessions were evaluated for hybridization programme. The different crosses of Purple Globe, Purple Round, Pink Top White Globe, Pink Top White Round, Pink Top White Flat, Mustard Yellow, Pink Round, White Round, White Globe, White Flat, Pink Flat, Pink Globe, Golden Ball and Pusa Chandrima were made into turnip hybridization programme and simultaneously got different F_2 programme of turnips whereas in radish (green, white, and pink) were crossed and got F_1 hybrids of radish. The 25 carrot accessions and local temperate types were crossed for improvement of anthocyanin, lycopene and β-carotene content in temperate carrot. The different twenty two radish types were made crossing for enhancement of anthocyanin pigments in F_1 generations.

Carrot:

Sixty four collections of carrot were evaluated for structural and economic traits; plant height (cm), leaf length (cm), number of leaves, root length (cm), root diameter (cm), root weight (g) and total weight (g) etc. The yield of the different germplasm ranged from 12.83 to 33.20t/ha, root length from 9.10 to 24.50cm, root diameter from 1.12 to 3.21cm, core diameter from 0.50 to 0.93cm and average weight form 0.015 to 0.194Kg. All these selections were chosen for hybridization and backcrossing of carrots for root colour and shape.

Turnip:

Twenty genotypes of turnip were evaluated for economic yield traits; plant height (cm), leaf length (cm), number of leaves, root length (cm), root diameter (cm), root weight (g) and total weight (g) etc. The root yield of the different germplasm ranged from 18.83 to 83.20t/ha, root equatorial diameter from 4.10 to 9.50cm,

Turnip Hybrids (White Long × Top purple round, Top Purple Round × White Long, White Long × Green Round)

root polar diameter from 3.12 to 10.21cm. All these selections were chosen for hybridization of turnips for root colour and shape.

Radish:

Thirty collections of radishes were evaluated for structural and economic traits; plant height (cm), leaf length (cm), number of leaves, root length (cm), root diameter (cm), root weight (g) and total weight (g) etc. The yield of the different germplasm ranged from 18.83 to 53.20t/ha, root length from 7.10 to 36.50cm, root diameter from 20.12 to 93.21cm, and average weight form 0.268 to 2.194Kg. All these selections were chosen for hybridization and backcrossing of radishes for root colour and shape.

Characterization and diversity analysis of flowering related gene/genes in almond

A total of 32 genotype of almond were screened for various flowering phenological stages. Among the different almond genotype, the full bloom (70-80 per cent flower open on tree) phenological stages was observed from 23rd March (CITH-A-2, CITH-A-17, CITH-A-21) to 6th April, 2017 (Merced) 14 days. On the basis of timing of full bloom almond genotypes can be categorized in early (1-5 days), mid (6-10 days) and late (11-15 days) flowering genotypes (Table 15 & Table 16).

Green Tip | Early Pink/Pink Tip | Mid Pink

Late Pink | Popcorn stage | Full Bloom

Petal Fall | Shuck Fall

Representative inflorescence and flowering Phenological stages observed in genotype CITH-A-12

Table 15: Categorization of almond genotype on the basis of flowering time

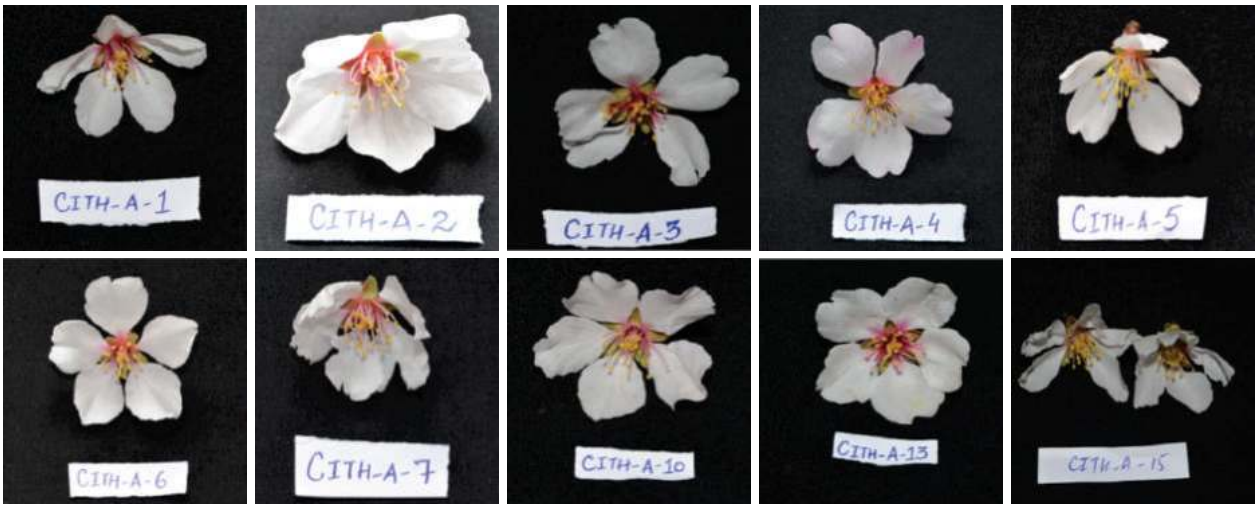
Category	
Early (23-03-17 to 28-03-17)	Makhdoom, Shalimar, CITH-A-1, CITH-A-2, CITH-A-3, CITH-A-4, CITH-A-7, CITH-A-9, CITH-A-12, CITH-A-13, CITH-A-14, CITH-A-16, CITH-A-17, CITH-A-18, CITH-A-19, CITH-A-20, CITH-A-21, CITH-A-22, CITH-A-23
Mid (29-03-17 to 03-04-2017)	Primorskij, Drake, Nonpareil, Waris, CITH-A-5, CITH-A-6, CITH-A-10, CITH-A-11, CITH-A-15
Late (04-04-17 onwards)	IXL, CPS, Merced, Pranyaj

Days taken from between two phenological stages i.e. early pink/pink tip to full bloom varied form 6-16 days between different almond genotype.

Table 16: Duration between early pink/pink tip to full bloom phenological stages in different almond genotype

Duration (days)	Genotype
4-8	Nonpareil, Drake, Waris, Pranyaj, Merced, Primorskij, CITH-A-20
9-12	CITH-A-14, CITH-A-11, Makhdoom, CPS, IXL, CITH-A-1, CITH-A-10, CITH-A-12, CITH-A-15, CITH-A-19, CITH-A-22, CITH-A-3, CITH-A-6, CITH-A-7, CITH-A-13
13-16	CITH-A-4, CITH-A-5, CITH-A-18, CITH-A-23, CITH-A-2, CITH-A-9, CITH-A-16 , CITH-A-17, Shalimar

A total of 30 almond indigenous and exotic genotypes were characterized for flower characteristics and significant variation was observed among the genotypes. The highest flower diameter was observed in genotype CITH-A-13 followed by CITH-A-4 and lowest in IXL. The flower length was measured maximum in Makhdoom followed by CITH-A-13 and minimum in IXL. The flower shape index was recorded higher in genotype CITH-A-20 followed by CITH-A-17 and lower in Ferragnes. Number of anthers per flower was found highest in CITH-A-2 followed by CITH-A-6 and lowest in Trady Non-Pareil. Length of filament was found maximum in CITH-A-16 and minimum in CITH-A-1 however number of petal were 5 in all the genotypes. Length of petal was maximum in CITH-A-11 and minimum in Pranyaj similarly width of petal was highest in CITH-A-13 and lowest in CITH-A-1. Petal shape index was maximum in IXL and minimum in Ferralise whereas largest stigma was found in CITH-A-6 and smallest in Waris. The no. of sepals were 5 in each genotype.



Flower morphology of different almond genotypes

To investigate the low temperature sensitivity, all the genotypes of almond were given *invitro* low temperature treatment (0°C) at popcorn and full bloom phenological stages of flowering and it was observed that highest (%) bud damage at popcorn stage of flowering was recorded in CITH-A-5 followed by CITH-A-1 and lowest in Primroskij followed by Drake. However, at full bloom stage of flowering maximum (%) damage of buds was observed in CITH-A-5 followed by CITH-A-4 and CITH-A-1 and minimum Merced, IXL and Non-Pareil. The percentage of bud damage was higher at full bloom as compared to popcorn stage which opined that fullbloom stage are more sensitive then popcorn stage of flowering for low temperature exposure. Further to check the pollen viability and germination capacity of normal and *in-vitro* low temperature (0°C) treated flower of popcorn and full bloom, all the genotype were tested for *in-vitro* pollen germination. The two types of medias having different chemical compositions (media 1: 5 % sucrose; 1 % agar; 300 boric acid; 50 calcium chloride) and media 2 (10 % sucrose; 1.5 % agar; 600 boric acid; 100 calcium chloride) was undertaken for *in-vitro* pollen germination studies. In normal sample collected at popcorn stage, the highest pollen germination was recorded in media 2 in genotype Pranyaj followed by California Paper Shell and lowest in CITH-3 followed by CITH-A-4. In *in-vitro* low temperature treated sample highest pollen germination was recorded in Shalimar followed by CITH-A-2 and CITH-A-3 however, lowest in genotype CITH-A-20 followed by Primroskij . In sample collected at full bloom, the maximum pollen germination was found in media 2 with genotype Drake followed by CITH-A-9 and lowest in Shalimar. Similarly In *in-vitro* low temperature treated sample highest pollen germination was observed in CITH-A-6 followed by CITH-A-16 in media 2. The proline content was also estimated in flower parts of different almond genotypes in normal and *in-vitro* low temperature treated sample collected at popcorn and full bloom stages of flowering. The highest proline content at popcorn was estimated in CITH-A-5 followed by CITH-A-1 and lowest in Primroskij followed by Drake however, maximum at full bloom stage maximum proline content was estimated in CITH-A-5 followed by CITH-A-4 and CITH-A-1 and minimum Merced, IXL and Non-Pareil (Fig 4).

Damage of buds under normal and *in-vitro* low temperature (0°C) treatment at Popcorn stage in different almond genotype

Condition of stamen of genotype CITH-A-10collected at Popcorn stage under Normal (a) and (b) low temperature (0oC) treatment

a

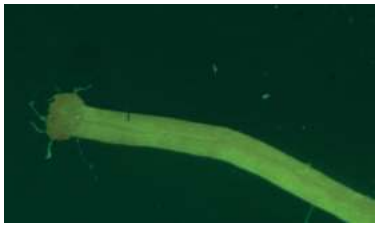
b

Condition of stamen of genotype Non-Pareil collected at Popcorn stage under Normal (a) and (b) low temperature (0oC) treatment

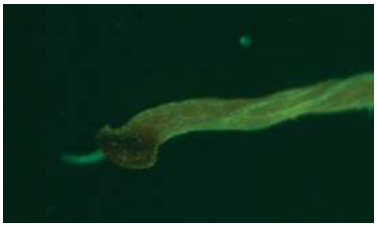
a

b

Condition of stigma of genotype Non-Pareil collected at Popcorn stage under Normal (a) and (b) low temperature (0oC) treatment

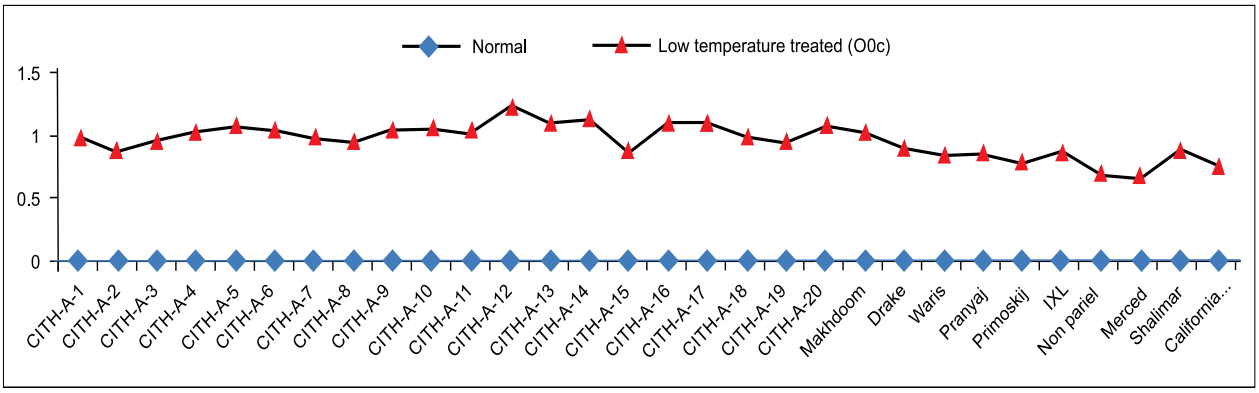


a



b

Condition of different flower parts under normal and low temperature conditions



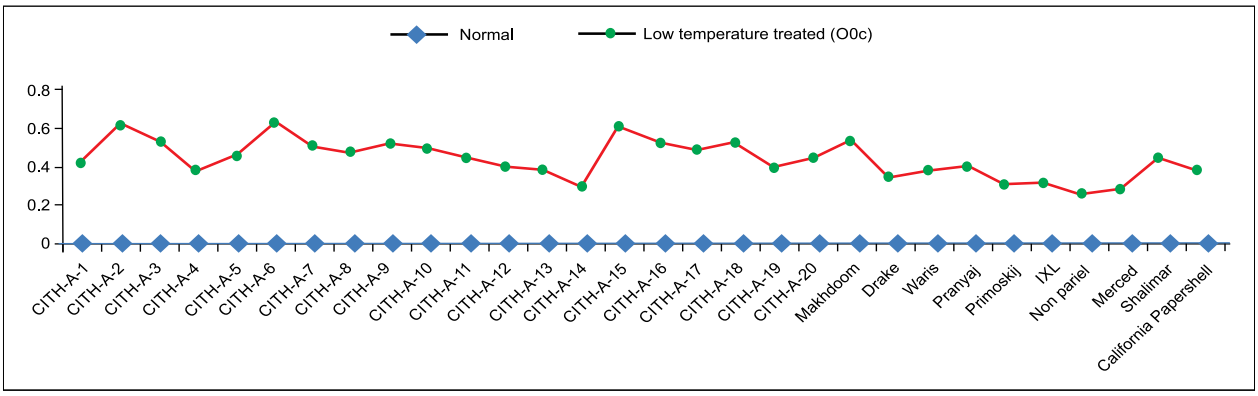


Fig 4: Variation in proline content (µmol g-1 of FW) estimated at full bloom stage of flowering of almond genotypes

Analysis of *PdFLC* sequence data

The partial sequence of *PdFLC* was amplified from the genomic DNA of various almond cultivars. The preliminary sequence data was used for the construction of phenogram using Multalin software. The phenogram (Fig 5) so created revealed three major groups. Group 1 included Primorskij, Makhdoom, Shalimar and California paper-shell. Group 2 included Pranyaj, Non-pareil and Merced while group 3 included IXL, CITH4A, Waris and Drake. Interestingly, late flowering genotypes like Drake, IXL and Waris fall in the same group (group 3).

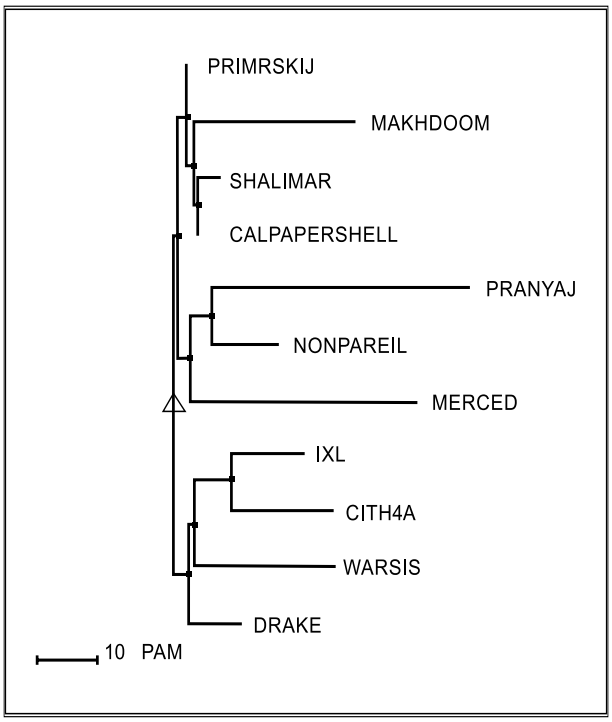


Fig 5: Phenogram constructed using genomic sequences of ***PdFLC*** gene amplified from almond genotypes.

The scale in the figure corresponds to 10 PAM units. Multalin software was used to generate the phenogram.

4 Crop Production

Production of quality planting material of temperate horticultural crops:

During 2017-18 about 33544 plants of apple (20312), walnut (6593), cherry (2756), peach (2288) and apricot (1595) were grafted on different rootstocks. In addition 5656 plants of almond (2075), apricot (1002), cherry (138), peach (1800), apple (288) and plum (353) were budded during July- August, 2017. About 6.0 quintals of quality vegetable seed, strawberry runners (20, 000) and vegetable seedlings (15, 000) were also produced during 2017-18. Bud-wood (> 50,000 sticks) of elite varieties of apple, pear, peach, plum, apricot, cherry, walnut, almond and olive were also provided to the stakeholders for popularization of elite varieties.

Studies on the multiplication of Apple clonal rootstocks through cuttings under polyhouse conditions

The present investigation with three treatment combinations involving IBA and NAA for enhancing rooting percentage in cuttings of five apple clonal rootstocks viz M-27, P-22, MM-106, M-9(Pajam-1), M-9(T337) & M9(T339) was done under polyhouse. IBA and NAA were used at 500, 1000 and 2000 ppm. The highest percentage of rooted cuttings (53.33%) and minimum success percentage (6.67%) was recorded in Pajam-1 treated with NAA (500ppm) and IBA (500ppm). The average percent success rate across all treatments was 28.56%. Among different rootstocks maximum rooting success (45.56%) was recorded in MM-106 followed by M9 (T339) with 38.89 % success rate against the control (6%).

Rooted cuttings of apple clonal rootstocks propagated under polyhouse conditions

Enhancing feathering through plant growth regulators for high quality nursery production in apple

To find out the effectiveness of BA and BA+GA_3 on the formation of feathers on one year old apple cvs. Gala Mast and Oregon Spur grafted on MM-106 rootstock, summer foliar spray of varying doses of BA and BA+GA_3 (200, 300, 400, 500, 600 and 700 ppm) were applied three times at weekly interval at ICAR-CITH, Srinagar during 2016 and 2017. All plant growth regulator treatments significantly increased number of feather, feather length, branching zone and per cent feathered trees compared to control in both tested cultivars. However, application of BA alone has stronger positive effect on studied parameters than combination with GA_3. In Gala Mast the unsprayed trees had an average of 1.95 useful feathers per tree, 1.1 m total feather length, 10.24 cm branching zone and 35 per cent feathered trees. Application of BA (700 ppm) resulted in four-fold increase in the number of feathers (7.8), more than two-fold increase in total length of feathers (2.44 m), around four-fold increase in branching zone (38.96 cm) and three-fold increase in per cent feathered plants (100%). The 100 per cent feathered trees were obtained with the application of BA (500, 600, 700 ppm) and BA+GA_3 (600, 700 ppm) in both experimental years. Moreover, these treatments obtained 2.78 to 2.90 values of trunk and mean feather diameter ratio. Some treatments with BA had a slightly negative influence on the tree height, trunk diameter and crotch angle. However, higher concentrations of BA had positive influence on trunk diameter. Further investigations revealed that Oregon Spur had strong apical dominance and applied plant growth regulators resulted in a significant increase in number of feathers (0.58 to 6.18 per tree) compared to untreated control (0.18 per tree). However, BA alone has more significant effect on number of feathers (1.45 to 6.18 per tree) than BA+GA_3 (0.58 to 4.35 per tree). The most significant induction in the number of feathers (6.18 per tree) has been obtained with 500 ppm BA treatment. This treatment also resulted in more uniform feather length (2.58 short and 2.55 medium length feathers per tree) and correct distribution of feathers along the trunk (20.63 cm branching zone) with appropriate feathers crotch angle (54.74° from vertical). Furthermore, this treatment resulted in 100 per cent feathered trees compared to none in control and 2.88 trunk and mean feather diameter ratio compared to 1.54 in control. Some treatments with BA had a negative influence on the tree height. Whereas, most treatments increased trunk diameter and crotch angle compared to control. The results of the two year study are represented in Figures 6 and 7.

During 2017 on the basis of preliminary results to find out appropriate concentration, spray interval and spray frequency factorial experiments carried out separately in Gala Mast and Oregon Spur trees using best performing three concentration of BA during 2016 (500, 600 and 700 ppm), two spray interval (one week and two week) and three spray frequency (3, 4 and 5). Preliminary results show that Gala Mast produce satisfactory feathers when sprayed three times with one week interval. Whereas, Oregon Spur needed five spray at two week interval to produce satisfactory feathers.

Furthermore to produce highly feathered tree suitable for vertical planner canopy orchard planting system, factorial experiments were laid out in both cultivar separately using higher concentration of BA (1000, 1500 and 2000 ppm), two spray interval (one week and two week) and three spray frequency (3, 4 and 5) during 2017. Preliminary results show that one year old Gala Mast nursery trees produce highly feathered nursery trees in second year of nursery cycle when three time sprayed with 1000 ppm BA at weekly interval. In contrast during second year of nursery cycle Oregon Spur produce highly feathered trees when sprayed five times with 2000 ppm BA at two week interval.

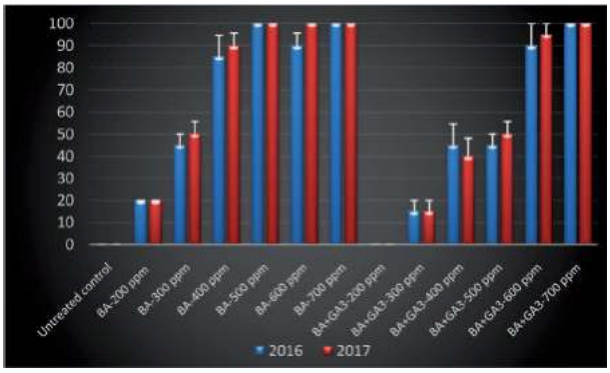


Fig 6: Feathered trees (%) obtained in different plant growth regulators treatments in Oregon Spur. The bars represent ±S.E.

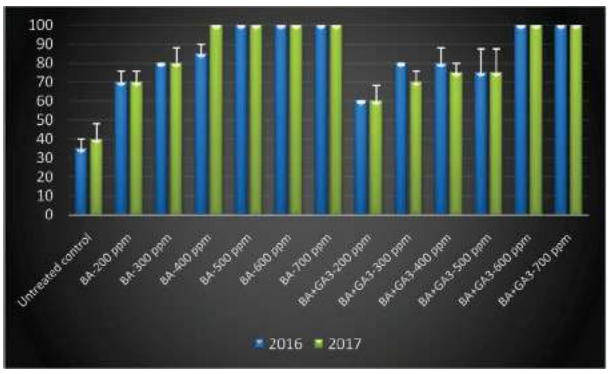


Fig 7: Feathered trees (%) obtained in different plant growth regulators treatments in Gala Mast. The bars represent ±S.E.

Fertigation: An efficient soil management stratagem for escalating nutrient and water use efficiency.

Five years experimental data revealed a significant impact of fertigation on apple yield. High yield enhancement along with good nutrient saving was observed on applying 75% of the recommended fertilizer through fertigation in two splits. Hence, 25% of the nutrient from recommended/prevailing practice could be saved along with little but noticeable increase in fruit yield (Table 17). Statistically significant partial factor productivity of macronutrients was also observed in same treatment (Table 18). It can be concluded that fertigation offers a good potential to save nutrients as well as to enhance yield by precise and timely delivery of nutrients to the root zone of apple crop.

Macronutrient concentration (% of leaf NPK) in fruit as influenced by various fertilization treatments is depicted in Fig. 8. It was observed that in case of N, fruit contained 12 to 14 per cent of leaf N concentration, which was 26 to 35 per cent in case of P and 33 to 49 per cent in case of K. As far as fertilization of different treatments is concerned, highest N (14% of leaf N), P (35% of leaf P) and K (49% of leaf K) in fruits was observed in fertigation treatment with 100% RF in two splits followed by treatment where 75% RF in two splits was applied through fertigation with the values being 13, 32 and 48 per cent for N, P and K, respectively.

Table 17. Macronutrient saving and yield elevation as influenced by fertigation treatments in apple

Treatment	Macronutrients saved (in comparison to recommended/prevailing practice) (kg ha^{-1})			Yield change/difference over control (t ha^{-1})	Interpretation
	N	P (P_2O_5)	K (K_2O)		
Control (C)	532	218	946	-	NS; NYE
BA	-	-	-	+0.61	NNS; VLYE

Treatment	Macronutrients saved (in comparison to recommended/prevailing practice) (kg ha^{-1})			Yield change/difference over control (t ha^{-1})	Interpretation
	N	P (P_2O_5)	K (K_2O)		
100% RF (1S)	-	-	-	+3.66	NNS; LYE
100% RF (2S)	-	-	-	+15.10	NNS; HYE
75% RF (1S)	133	55	237	+7.28	GNS; SYE
75% RF (2S)	133	55	237	+15.92	GNS; HYE
50% RF (1S)	266	109	473	+7.50	HNS; SYE
50% RF (2S)	266	109	473	+7.17	HNS; SYE

RF: Recommended fertilizer (through fertigation), NS: Nutrients saving; NYE: No yield enhancement; NNS: No nutrient saving; VLYE: Very little yield enhancement; LYE: Little yield enhancement; HYE: High yield enhancement; SYE: Some yield enhancement; GNS: Good nutrient saving; HNS: High nutrient saving

Table 18. Apple yield, yield fertilizer ratio (YFR) and partial factor productivity (PFP) as influenced by fertigation treatments

Treatment	Yield (t ha^{-1})	YFR (kg kg^{-1})	Partial factor productivity (kg kg^{-1})		
			Nitrogen	Phosphorus	Potassium
Control (C)	14.9 (±0.30)	-	-	-	-
BA	15.5 (±0.31)	5.4 (±0.51)	30.1 (±2.94)	73.5 (±2.88)	16.9 (±1.56)
100% RF (1S)	18.6 (±0.55)	6.5 (±0.51)	35.8 (±2.99)	87.5 (±7.41)	20.1 (±1.58)
100% RF (2S)	30.0 (±0.84)	10.5 (±0.91)	58.0 (±5.260)	141.8 (±12.95)	32.6 (±2.79)
75% RF (1S)	22.2 (±0.50)	10.3 (±0.92)	57.2 (±5.34)	139.9 (±13.33)	32.1 (±2.80)
75% RF (2S)	30.8 (±1.36)	14.3 (±0.91)	78.9 (±5.43)	192.8 (±13.61)	44.3 (±2.79)
50% RF (1S)	22.4 (±1.04)	15.9 (±2.30)	88.3 (±13.13)	215.2 (±32.09)	49.5 (±7.10)
50% RF (2S)	22.1 (±0.91)	15.7 (±2.13)	86.8 (±12.22)	211.5 (±29.88)	48.7 (±6.60)
CD (5%)	2.43	2.30	12.98	31.59	7.11
SE (d)	1.16	1.07	6.13	14.92	3.36
SE (m)	0.82	0.77	4.34	10.55	2.37
CV	7.44	13.65	13.95	13.90	13.61

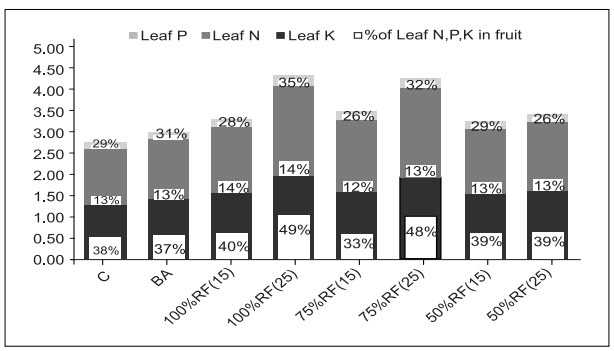
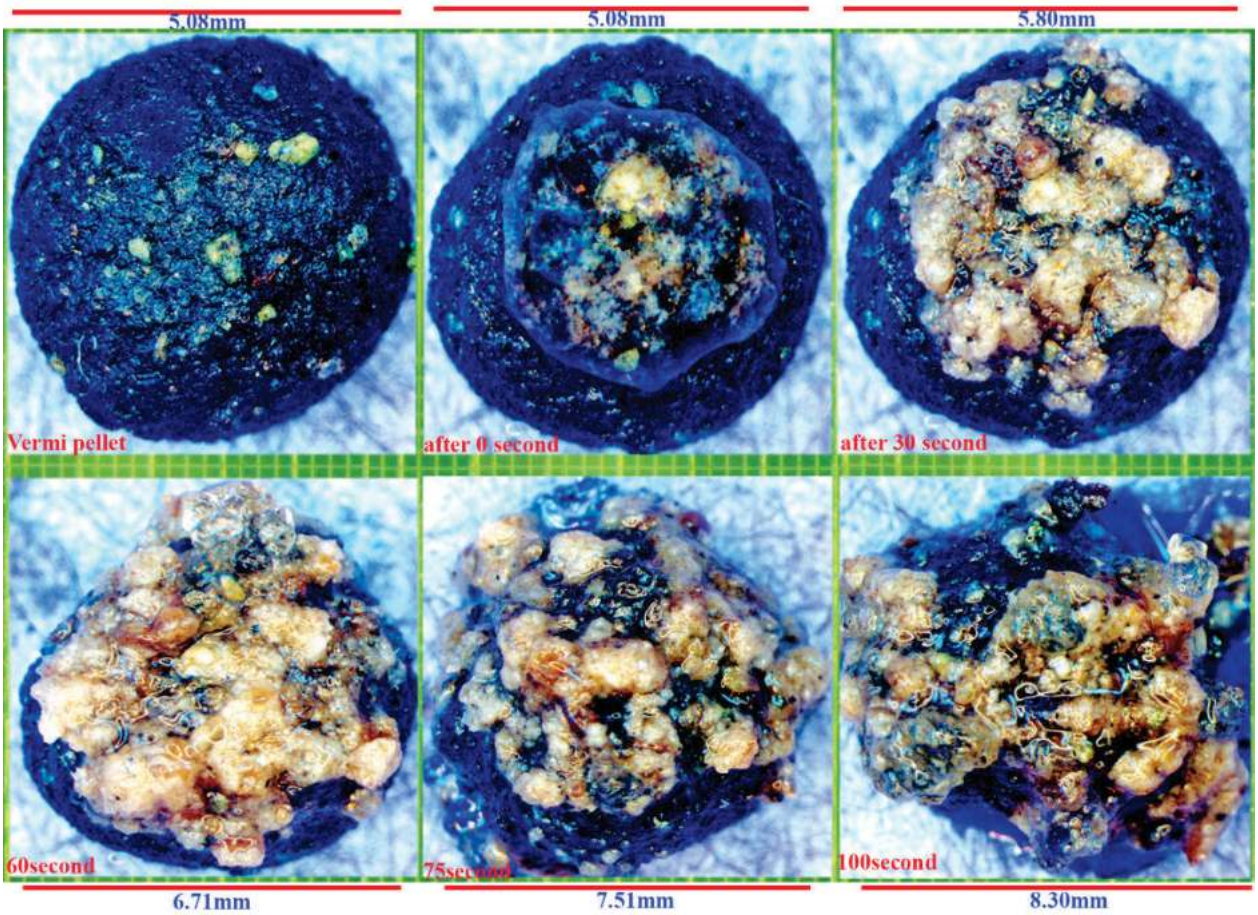


Fig 8. Macronutrient concentration (% of leaf NPK) in apple fruit as influenced by fertigation in apple

Aquatic Dissipate/waste management through vermitechnology

Vermicompost prepared from aquatic weeds was again used to prepare enriched vermipellets. These vermi-pellets are dispersible in nature and starts dispersing as soon as these come in contact with water (Table 19). The dispersion rate is given in the figure 9 below. These vermipellets have following important properties:

- Dispersible



- Antagoniser for soil born diseases
- High in nutrients
- Low CN ratio
- Slow nutrient release
- Total organic
- Controls weed

Table 19. Change in size of vermi-pellets after getting in contact with moisture

Vermi pellet dispersion rates				
Time (s)	Size (mm)			
	Attempt I	Attempt II	Attempt III	Average
0	4.94	5.19	5.11	5.08
30	5.75	6.13	5.54	5.80
60	6.27	7.03	6.84	6.71
75	6.67	8.12	7.76	7.51
100	7.86	8.88	8.36	8.30

Divulging the adept mode of fertilizer application to optimize saffron yield

Adroit mode of fertilizer application to get optimum quality saffron yield and corm multiplication rate, without polluting the environment was standardized. Midrib fertilizer placement upper to corms in two splits (MRPU-2S) enhanced the quantity and quality of saffron with low nitrate leaching, well below the permissible limit, and low nitrous oxide emissions (Fig 10). The mode of fertilizer application, having least pollution potential and high nutrient use efficiency, for saffron crop has been standardized for the first time. Clay minerals play an important role in nutrient mineralization and mobility. So in order to reveal the dominating clay minerals of these soils X-ray study was conducted. X-ray diffractogram is shown below as Fig 11. XRD showed that Illite is the dominating clay mineral in these soils followed by Kaolinite.

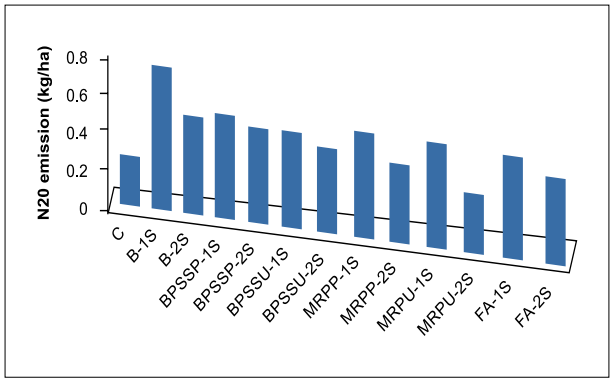


Fig 10. Nitrous oxide emission as influenced by various modes of fertilizer application in saffron growing soils.

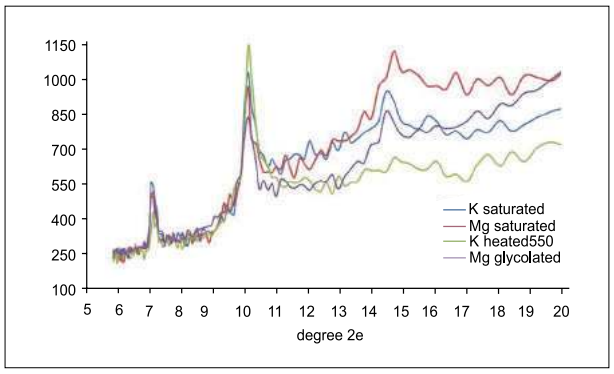


Fig 11. XRD of saffron growing soils of Kashmir

Development of almond based intercropping system involving saffron

In almond based intercropping system, non significant effects were observed for most of growth and floral traits. Significant differences were noticed for flower length, flower diameter, style and stigma length. During 2017 very less saffron yields were recorded which may be due to erratic climatic conditions during flowering period. Maximum saffron yield (1.45 kg/ha.) were recorded in saffron grown along with erect type of almond varieties while highest almond yields (2.95 kg/plant) were recorded in spreading type of variety. The equivalent saffron yield (3.08 kg/ha) was recorded in spreading type of varieties which is due to high almond yield followed by semi erect (2.73 Kg/ha), erect (2.57 kg/ha) and sole (0.96 kg/ha). Minor differences were recorded for crocin contents. The crocin contents were maximum in sole (2.92 mg/100mg), followed by semierect (2.60mg/100mg), erect (2.32 mg/100mg) and spreading (2.28 mg/100mg) as shown in Fig 12. As there is less effect of almond and its varieties on saffron, so the almond+ saffron is the best combination especially with erect type of varieties to fetch additional income to the farmers.

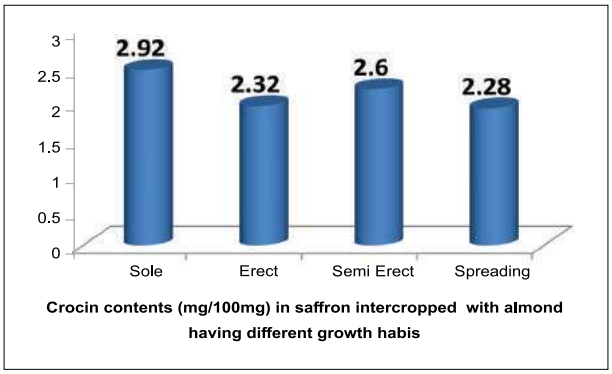


Fig 12: Variability of apocarotenoid content in saffron under different conditions

Evaluation of different substrates and systems for soilless strawberry (Fragaria x ananassa Duch.) production in naturally ventilated conditions

Effect of different substrates on soilless strawberry production.

At present, alternative soilless cultivation production systems under protected conditions is an intense cultivation method that can provide more efficient use of water and fertilizers. In present study the individual/combination of three different substrates, viz., coco peat, vermiculite and perlite were used and sand as control. Sixteen treatments with different concentrations (V/V) were studied for different growth and quality parameters of strawberry cultivars Chandler and Katrine sweet in a separate set of experiments under protected conditions. The results revealed that in case of cultivar chandler the treatment "coco peat+ vermiculite 25:75" produced the maximum petiole length (16.77cm), canopy spread (42.75cm), crown diameter (2.10cm), shoot fresh wt. (17.16g), shoot dry weight (4.36g), root fresh weight (16.53g), root fry wt. (5.13g), number of leaves (17), total leaf area (1542cm^2), fruit wt. (10.76g), fruit dia (27.48mm), fruit length (29.89mm) whereas the treatment "coco peat+ vermiculite 50:50" produced maximum plant height (28.36), shoot length (23.13), root

length (32.40cm) and TSS (10.8 B°) and lowest acidity (0.86%). the treatment "sand 100%", produced minimum plant height (15.10cm), no. of leaves (8) canopy spread (21.17cm), crown dia (1.50cm), root length (9.43cm), shoot fresh wt (5.60g), shoot dry wt (1.20g), root fresh wt (7.70g), root dry wt.(1.63g), leaf area (479.0cm^2). the colour characteristics (L*, a* and b*) of each fruit was done with a chromameter. L* values range from 31.53 to 41.90, values for a* scale range from 23.02 to 37.67 and values for b ranges from 16.82 to 27.60. Hence form current study it can be concluded that coco peat in combination with vermiculite (25:75) and (50:50) produced maximum growth as well as quality parameters in cv. Chandler.

In case of strawberry cultivar Sweet Katrian, the results revealed that the treatment "coco peat+ vermiculite 50:50" produced the maximum Plant height, number of leaves, petiole length, crown diameter, fruit weight, fruit length and fruit diameter. Whereas the treatment "coco peat+ vermiculite 75:25" produced maximum shoot length, shoot fresh weight, shoot dry weight. leaf area. The treatment Perlite + Vermiculite (25%:75%) produced maximum root length, root fresh weight and root dry weight The colour characteristics (L*, a* and b*) of each fruit was done with a chromameter. L* values of fruits range from 27.07 to 51.36, values for a* scale range from 17.95 to 56.52 and values for b* ranges from 7.61 to 37.56. Hence from the current study it can be concluded that coco peat in combination with vermiculite (50:50) produced maximum growth as well as fruit quality parameters in cv. Sweet Katrian under open ventilated polyhouse condition.

Different growing stages of strawberry in a soilless condition in protected conditions.

Evaluation of apple germplasm for pre harvest fruit drop response

During the year 2017, 80 apple cultivars established in apple germplasm bank of CITH has been evaluated for response to preharvest fruit drop. The apple genotypes at a spacing of 4m x 4m (625 plants/ ha) on a seedling rootstock were evaluated for the preharvest fruit drop propensity under uniform management conditions. Based on pre harvest fruit drop the cultivars have been categorized into 10 groups. The group first represents the cultivars in which the drop percentage is from zero to 5%, likewise Group 10 represents the cultivars where the drop percent was 45% to 50%. These groups are arbitrary groups and will serve the purpose of information for the researchers who are working or going to work on this field. Furthermore the information needs to be further re-validated as lot of other factors such as soil; weather and management factors are associated with it (Table 20)

Table 20: Grouping of apple germplasm based on propensity of pre harvest fruit (PFD) drop

Group	Range (%)	Apple Varieties
I	0-5	Red Fuji, Coe-Red Fuji.
II	5-10	Ambri, Luxton' Fortune, Star Summer Gold, Skyline Supreme, Red Spur, , Jonica, Cooper-IV, Firdous, Oregon Spur, Braeburn Gala, Royal Delicious, Granny Smith, Well Spur, Starkrimson, Silver Spur, Stark Cardinal, Red Velox, Braeburn.
III	10-15	Pink Lady, Summer Queen, Michal, Tallisare, Starking Delicious, Fanny, Yellow Transparent, Ambrosia, Spartan, Starkrimson, Red Chief, Gala Mast, Golden Delicious, , Silver Spur, Red Delicious, Lal Ambri, Vance Delicious
IV	15-20	Rich-A-Red, American apirouge, King Luscious, Rome Beauty, Salva Probedetalian, Scarlet Gala, *M. Robusta*, Top Red, Mollies Delicious, Tydeman's Early Worcester.
V	20-25	Summer Red, Lemon Guard, Binoni, Akbar
VI	25-30	Maharaji, Belle-De-Bescope, Hardeman, Commerical-7, Winter Commerical, Early Shanburry,
VII	30-35	Red Baron, Stark Earliest, CITH Apple SR(1), King Lucious, Amartara Pride, Shireen, Gold spur
VIII	35-40	Prima, Tropical Beauty, Yellow Delicious, vista Bella
IX	40-45	Apple Queen, Welson, Green Sleeves, Karkitchoo, Brookfield.
X	45-50	Parkin's Beauty, Wealthy Apple, June Eating,

Effect of rootstock on pre-harvest fruit drop (PFD) and quality of apple (*Malus domestica* Borkh.)

During the year 2017, two apple cultivars Gala Mast (mid-season variety) and Golden Delicious (Late season variety) planted in the apple block of CITH, Srinagar on four rootstocks were chosen to study the effect of rootstock on pre harvest fruit drop, fruit seed number and fruit quality of the persisting and abscised fruit and in a field experiment at CITH, Srinagar. Four different growth inducing apple rootstocks were used for both cultivars: M.9 (dwarf), MM.106 (semi-vigorous) and, MM-111(semi vigorous) and seedling (vigorous). The highest percentage of pre harvest fruit drop was recorded on M-9 rootstock and lowest on seedling in both the cultivars. The rate of fruit drop was closely related to the seed number and seed weight of the fruit; where low seed number and less seed weight was associated with the largest amount of drop. The lowest seed number and seed weight for both cultivars was on M-9 rootstock. The more no. of bold seeds was recorded in persistent fruits as compared to abscised fruits and more number of aborted seed was recorded in abscised fruits. Fruit quality evaluations showed that persisting fruits have more fruit weight, length, fruit dia and TSS as compared to the abscised ones in all the rootstocks. Colour parameters (L* a* b*) has not shown any significant difference between the persistent and abscised fruits. Flesh firmness of persisting fruit was highest in all rootstocks in comparison to that of abscised ones. Fruit firmness was recorded highest in fruit from trees on seedling in comparison to dwarfing and semi vigorous rootstocks. Starch iodine rating of the persistent and abscised fruits indicate that abscised fruits were more mature and ripe in compared to persistent fruit in on all rootstocks in both the varieties which indicates that ripe

Difference between fruit, seed and number of ovules in persistent and abscised fruits

fruits with less no of seeds and more aborted seeds are most prone to preharvest drop. The reasons for which can be attributed to lack of proper pollination. So from the above study it can be concluded that along with other management practices orchardists should adopt picking of ripe fruits in comparison to harvesting of whole tree at one time and should assure proper pollination in orchards to reduce the losses occurred due to pre harvest fruit drop.

Round the year cultivation of kale under Kashmir valley conditions

Three different dates of transplanting were chosen to evaluate 27 promising genotypes of kale for year round production at vegetable experimental fields of ICAR-CITH, Srinagar. The July and August transplanting dates were found congenial for germination, emergence and growth of all genotypes. However, the September was found to be less favorable for germination and seedling development in most of the genotypes. Transplanting in July, resulted in highest leaf yield (t/ha) in Khanyari (41.90), which was at par with NW-Saag-42 (37.57), NW-Saag-1 (36.66) and CITH-KC-26 (33.91). With respect to August transplanting, the highest yield was observed in Japanese Green (34.77) at par with CITH-KC-18 (29.52), CITH-KC-Sel-23 (25.38), CITH-KC-Sel-3 (24.00), CITH-KC-38 (23.82) and NW-Saag-42 (23.01). Hence, overall, NW-Saag-42 with an average leaf yield of 30.29 t/ha was consistently promising yielder for July – August transplanting. However, the above mentioned genotypes against their respective favorable month of transplanting can also be selected for profitable cultivation.

Standardization of integrated nutrient management of vegetables as intercrop in apple orchard

Data on effect of intercropping on fruit quality *i.e.* fruit length, fruit diameter, fruit weight, fruit firmness and yield of apple were recorded. In both the intercrops treatment comprising FYM + Vermi-compost + Bio-fertilizer + Inorganic registered highest fruit length, fruit diameter, fruit weight, fruit firmness and yield of apple per tree

Intercropping with cauliflower var. Snow Crown and pea var. VL-7 in apple orchard

as compared to other treatments. This treatment also improved the fruit quality like TSS. Data on effect of Integrated Nutrient Management (INM) on different growth parameters of intercrops such as plant height, number of leaves, curd diameter, curd weight and yield in cauliflower; and plant height, number of branches, pod length and yield in pea were recorded. From the recorded data, the treatment comprising of FYM + Vermi-compost + Biofertilizer + inorganics was found best in both pea and cauliflower intercrops in apple orchard exhibiting highest growth and yield followed by FYM + Vermi-compost + inorganics treatment.

Characterization of soil and nutritional survey in apple and peach growing areas of Uttarakhand

Available zinc (mg kg^{-1})

The data related to available Zn status is presented in Fig. 13. It was observed that about half of the soil samples, irrespective of soil depth or orchard, were found to be deficient in available Zn. Available Zn level increased sharply from topsoil to subsoil at peach orchards of Talla Ramgarh and Nathukhan, and apple orchard of Chilianaulla.

Available copper (mg kg^{-1})

The available Cu level in all of the investigated fruit orchards was found to be well above the critical limit of 0.2 mg kg^{-1} soil (Fig. 14). However, Cu levels decreased with the increase in soil depth. Highest available Cu was recorded at the peach orchards of Bhagaon (3.4 mg kg^{-1}) and Nathuakhan (2.1 mg kg^{-1}) at the topsoil and subsoil, respectively.

Available manganese (mg kg^{-1})

The data related to available Mn is presented in Fig. 15. Like available Zn, Mn levels also increased sharply from topsoil to subsoil at three out of five studied orchards, and they were also significantly different ($p< 0.05$) between soil depths. Maximum availability was observed at Chilianaulla (16.3 mg kg^{-1}) and Nathuakhan (35.0 mg kg^{-1}) at topsoil and subsoil, respectively. The available Mn levels in all of the investigated soil depths were found to be well above the critical limit of 2.0 mg kg^{-1}

Available iron (mg kg^{-1})

The data pertained to available Fe is presented in Fig. 16. The available Fe levels in all of the investigated soil depths were found to be well above the critical limit of 4.5 mg kg^{-1} soil. Like Cu, Fe levels also decreased with the increase in soil depth; however, its concentration is not significant ($p< 0.05$) between soil depths. Maximum availability was observed at Bhadgaon (43.6 mg kg^{-1}) and Nathuakhan (40.9 mg kg^{-1}) at topsoil and subsoil, respectively.

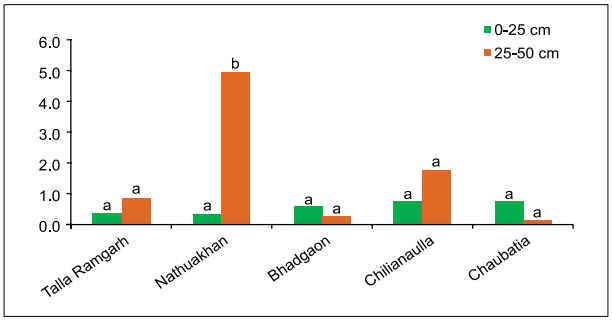


Fig. 13. Soil available Zn contents of soils collected from different orchards of apple and peach. Bars followed by letter in common within a site do not differ significantly at $p< 0.05$ based on Duncan's multiple range test (DMRT).

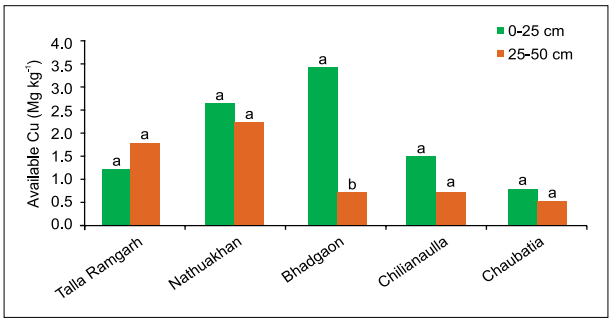


Fig. 14. Soil available Cu contents of soils collected from different orchards of apple and peach. Bars followed by letter in common within a site do not differ significantly at $p< 0.05$ based on Duncan's multiple range test (DMRT).

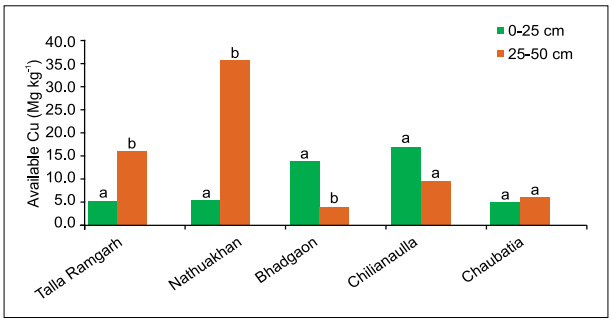


Fig. 15. Soil available Mn contents of soils collected from different orchards of apple and peach. Bars followed by letter in common within a site do not differ significantly at $p< 0.05$ based on Duncan's multiple range test (DMRT).

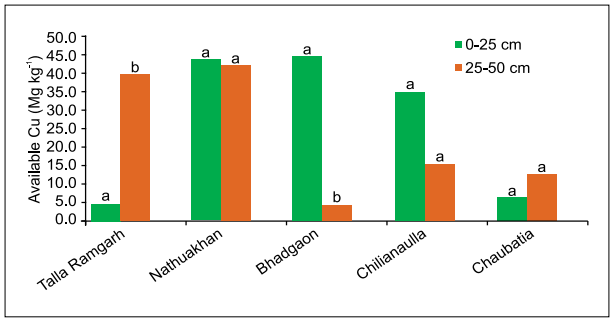


Fig. 16. Soil available Fe contents of soils collected from different orchards of apple and peach. Bars followed by letter in common within a site do not differ significantly at $p< 0.05$ based on Duncan's multiple range test (DMRT).

Standardization of growing/nutrients media and growing conditions for cost effective production of quality vegetables and their seedlings

Tomato

Treatments exhibited significant differences for most of the seedling characteristics of tomato except for number of leaves seedlings for both the year and seedling root length during 2016-17. The maximum seedling length of 25.33 cm and 25.03 cm were recorded from the treatment FYM+FL and S+FYM+VC+FL, respectively in the year 2016-17 and 22.63 cm with treatment FL and also in S+FYM+VC+FL with the highest mean of 23.83 cm in this treatment (S+FYM+VC+FL). However, the highest mean values for number of seedling secondary roots/seedling (49.33) fresh and dry weight of seedlings (7.37 and 1.00 gm, respectively) were exhibited in the treatment combination of soil+VC.

The treatments exhibited significant differences for most of the growth and yield traits of tomato under study except plant height for both the year and number of fruits/plant and fruit yield/plant in the year 2017-18. Highest fruit yield of 2.32 Kg/plant was recorded in 2017-18 from the plants of which seedlings were raised in soil+FYM medium, however, it was highest (4.80 Kg/plant) in the treatment FYM during 2016-17 and the mean fruit yield (2.95 Kg/plant) found highest with the plants of which seedlings were raised in FYM medium. Likewise mean of average fruit weight of both the year was also found highest in FYM treatment. The fruit size (fruit length and fruit width) were recorded maximum (60.31 and 66.63 mm) during 2017-18 with highest mean of 56.41 and 65.36 mm, respectively in the treatment FL. In general, there is no definite was observed and different exhibited highest values for different traits.

Capsicum (Cv. California Wonder)

Most of seedling growing mediums exhibited significant differences for various traits except few like seedling girth for both the years, number of leaves/ seedling in 2017-18. Highest seedling length, girth, and number of leaves/seedling were recorded in the seedling raised in FYM medium during 2017-18 with highest mean values too while as for other parameters no one treatment showed superiority for more than one seedling traits. Numbers of secondary roots/seedling were recorded maximum in the treatment combination of soil+vc in 2016-17 and 2017-18.

Significant difference in the treatments were observed for most of the traits under study except plant height, fruit length, fruit width and average fruit weight of capsicum in the year 2017-18. In 2017-18, fruit yield 1.14 Kg/plant was recorded from the plants of which seedlings were grown in the FYM+VC+FL medium, whereas it was highest of 1.84 Kg/plant in 2016-17 with the treatment FYM. The highest mean of fruit yield/plant was also recorded from the plants of which seedlings were raised in FYM+VC+FL growing medium. But, average fruit weight was found maximum in both year with Soil+FYM+VC+FL treatment. However, no certain trend was observed in the treatments.

Cucumber (cv. Local)

Treatments exhibited significant differences for most of the seedlings traits under study except for seedling girth in 2016-17, number of secondary roots/seedling and fresh weight of seedlings in 2017-18. Maximum seedling length, seedling girth, number of leaves/seedling and fresh weight of seedling length, seedling girth, number of leaves/seedling and fresh weight of seedling were recorded in 2017-18 with seedlings raised in FYM medium showed maximum root length and dry weight of seedling of cucumber in 2017-18.

Treatments responded significant for most of the traits of cucumber under study except fruit/ length, fruit width, number of fruits/plant and fruit yield/plant in 2017-18. The plants of which seedlings were raised in Soil+FYM produced highest fruit yield of 7.15 Kg/plant in 2017-18 which was highest in treatment combination of FYM+VC+FL in 2016-17 and mean of fruit yield (5.31 Kg/plant) and average fruit weight (2.05 Kg) recorded highest in plants of which seedlings were produced in FYM+VC+FL growing medium. The fruit length and fruit width recorded maximum of 36.51 and 35.61 cm in 2017-18 from the plant of which seedlings were raised in soil growing medium. However, the maximum number of fruits of 5.00 and 5.33 were harvested in 2016-17 and 2017-18, in FYM and Soil+FL treatment, respectively.

Lettuce (cv. Iceberg)

Treatment showed significant differences for most of the seedling traits of lettuce except number of leaves/seedling in 2017-18. Mean seedling length, dry weight of seedling and seed germination were recorded maximum value with treatment FYM growing medium. Growing of seeds in FYM medium exhibited highest values for seedling length in both the years (2016-17 & 2017-18). Likewise, growing medium of soil+ Vermicompost mixture produced the seedling's roots with maximum secondary roots/seedling and the growing medium mixture Soil + FYM + vermicompost recorded maximum seedling root length in both the year of study. In general, no definite trend was observed and no one treatment proved better for more than one seedling traits in both the year. Treatments exhibited significant differences for various traits under study except for number of leaves/plant in 2017-18. The treatment combination of Soil+FYM+ vermicompost+ Forest litter exhibited highest mean values over the years for plant height, number of leaves/plant and average leaf yield/plant. This treatment also recorded highest values for these traits either in 2016-17 or 2017-18. However, no one treatment proved better for any one trait in both the year.

Chinese cabbage (cv. Solan Band Sarson)

Most of the traits except seedling length, seedling girth and number of secondary roots/ seedling showed significant difference for the treatments. The highest values for fresh and dry weight of seedling as well as number of leaves/ seedling was recorded in both the year from the growing media consist of vermicompost + Forest litter. However, seed germination and seedling root length were recorded maximum in both the year when sown in sole soil and FYM medium, respectively. The highest mean seedling length was recorded in FYM growing medium; whereas highest mean seedling girth was found in the growing medium consist of FYM+VC in Chinese cabbage var. Solan Band Sarson. Treatments exhibited significant differences for the traits under study during the year 2016-17, however treatments showed non significant differences for most of the traits studied during the year 2017-18 except for east-west plant spread, head length, head weight and total head weight (Kg). Highest total head weight was recorded from the plants of which seedlings were raised in FYM+FL growing medium in 2017-18, whereas average head weight, head length and head breadth were recorded maximum from the plants of which seedlings were grown in medium consist of sole soil. Average numbers of non-wrapper leaves were found maximum in plants of which seedlings were raised in FL growing medium.

Broccoli (cv. KTS-1)

Treatments exhibited significant differences for most of the seedling traits of broccoli under study except for seedling girth, number of leaves/ plant, fresh and dry weight of seedlings in 2017-18. The maximum values in both the year (2016-17 & 2017-18) with maximum mean values over the years were recorded for seedling length in Soil+FYM treatment, number of leaves/seedling, in FYM+VC growing medium, fresh weight of seedling in Soil+FL growing medium and seed germination in FYM growing medium. However, maximum mean seedling girth, seedling root length, number of secondary roots and dry weight

of seedlings were recorded in the treatment consist of growing medium Soil+FYM, FL, Soil+ FYM+FL and FYM+VC+FL, respectively.

Crop diversification technology for round the year vegetable production under protected conditions in mid and high hills of Uttarakhand

Tomato

Seven genotypes of tomato were evaluated during summer extended Kharif 2017-18 under polyhouse at one location of ICAR–CITH Regional Station, Mukteshwar and other location at Pokhrad village of Nainital (UK) for their growth, yield and quality parameters. Most of lines exhibited significant differences for various growth, yield and quality parameters under study. Among the genotypes, maximum plant height (138.43 cm) and (274.76 cm) recorded in genotype Manisha and VL-4 at Pokharad and CITH location, respectively. Whereas, the maximum average mean of plant height (197.58 cm) recorded in variety VL-4 at both location. However, highest branch length (107.26 cm) and (165.30 cm) recorded in genotypes VL-4 and Manisha at Pokhrad and CITH locations, respectively. The maximum number of branches/ plant 4.00 and 2.66 recorded in genotypes Badshah and Laxmi at Pokhrad and CITH, respectively.

Vegetable production under protected cultivation at RS, Mukteshwar

However, the number of fruits/plant 17.33 and 16.33 recorded in genotype Manisha and Badshah, at Pokhrad and CITH locations, respectively. The maximum fruit length 58.06 mm & 48.04 mm and fruit diameter 51.83 mm & 43.85 mm recorded in genotype Badshah at both locations, respectively.

The fruit weight 92.06 g and 60.18 g recorded in genotype Badshah at Pokhrad and CITH locations, respectively. The maximum yield/plant 606.00 g & 583.66 g recorded in genotype Laxmi and Badshah at Pokhrad and CITH locations, respectively. The maximum TSS 4.43^0 brix & 4.93 ^{0} brix recorded in genotype Dev and Laxmi at Pokhrad and CITH locations, respectively.

Capsicum

Eleven genotypes of Capsicum were evaluated during summer extended Kharif 2017-18 under polyhouse condition at first location of ICAR–CITH Regional Station, Mukteshwar and other location at Pokhrad of Nainital (UK) for their growth, yield and quality parameters. Most of lines exhibited significant differences for various growth, yield and quality parameters under study. Among the genotypes, maximum plant height (75.00 cm) and (117.80 cm) recorded in genotype Bombay and V-1 at Pokhrad and CITH, respectively. However, maximum number of branches/plant (4.66) and (7.00) recorded in genotype Sel-2 and Arka Basant at Pokhrad and CITH locations, respectively. Among the genotypes, maximum branch length (45.33 cm) and (49.63 cm) recorded in genotype Bombay and Sel-4 at Pokhrad and CITH, respectively. The maximum fruit volume (85.00 g/cc) and (153.33g/ cc) recorded in genotype Orobelle and Bombay at Pokhrad and CITH, respectively. The fruit length (85.88 mm) and (110.80 mm) recorded in genotype Arka Basant at both locations,

respectively. However, fruit diameter (71.15 mm) and (82.85 mm) recorded in genotype Orobelle and Sel-4 at Pokhrad and CITH, respectively. The maximum number of fruits per plant 9.67, 24.00 recorded in Sel-5 and CW at Pokhrad and CITH location, respectively. However, genotype Orobelle exhibited highest fruit weight 75.98 g and 133.27 g at both locations, respectively. The maximum yield/plant 630.00 g and 1230.00 g recorded in Orobelle and Sel-4 at Pokhrad and CITH location, respectively.

Cucumber

Six genotypes of Cucumber were evaluated during summer extended Kharif 2017-18 under polyhouse at first location of ICAR–CITH Regional Station, Mukteshwar and other location at Pokhrad of Nainital (UK) for their growth, yield and quality parameters. Most of lines exhibited significant differences for various growth, yield and quality parameters under study. Among the genotypes, maximum plant height (362.93 cm) and (337.80 cm) recorded in genotype Swarna Ageti and PS at Pokhrad and CITH, respectively. However, maximum number of branches/plant (4.33) and (6.33) recorded in genotype JLG and PS at Pokhrad and CITH, respectively. Among the genotypes, maximum branch length (311.10 cm) and (244.33 cm) recorded in genotype Swarna Ageti and JLG at Pokhrad and CITH, respectively. The genotype JLG exhibited highest fruit length (33.2 cm) and (32.50 cm) at both locations, respectively. However, fruit girth (18.94 cm) and (15.23 mm) recorded in genotype Swarna Ageti and Nazia at Pokhrad and CITH, respectively. The maximum fruit weight 251.33 g and 358.67 g recorded in JLG and Malini at Pokhrad and CITH location, respectively. However, the highest yield 2.08 Kg and 5.44 Kg recorded in Hashini and PS at Pokhrad and CITH locations, respectively.

Lettuce

The lettuce genotypes exhibited significant differences for most of the traits except total leaf weight/plant at Pokhrad and for plant height and number of leaves/plant at Mukteshwar as well as at both the locations during 2017-18. The genotype Lolla Rosa recorded maximum plant height of 34.50 cm and 35.03 cm, plant spread 28.60 cm and 37.60 cm East- West) and (26.50 cm and 37.77 cm North-South) at Pokhrad and Mukteshwar locations, respectively. However, the variety C-1 exhibited highest 40.00 and 42.00 number of leaves/plant and total leaf weight of 330.00 g and 466.67 g at Pokhrad and Mukteshwar, respectively. The variety C-1 exhibited highest yield 244.44 q/ha and 345.68 q/ha at Pokhrad and Mukteshwar locations, respectively.

Broccoli

The genotypes significant differences were observed for most of the traits at both the locations during 2018-18. The genotype KTS-1 recorded maximum plant height of 61.30 cm at Pokhrad site whereas, 40.42 cm recorded at Mukteshwar. The genotypes Head-1 exhibited maximum plant spread East-West of 67.50 cm at Pokhrad whereas North-South plant spread of 45.20 cm was recorded in Lucky F-1 at Mukteswar. The genotype Canavera exhibited highest number of leaves/plant (20.00) and total leaf weight (90.00g) at Pokhrad location. However, Lucky F-1 exhibited highest of 16.33 number of leaves/plant and total leaf weight of 105.00 g at Mukteshwar location. The variety Canavera exhibited highest yield 66.67 q/ha at Pokhrad and Lucky F-1 recorded maximum 77.78 q/ha at Mukteshwar location.

Chinese cabbage

The Chinese cabbage var. Solan Band Sarson exhibited highest values for number of non-wrapper leaves/plant (8.66), weight of non wrapper leaves/plant (223.33 g) and head weight/plant (360.00g) and yield 266.66 q/ha at Mukteshwar location. Whereas other traits viz. plant height, plant spread and head breadth were recorded highest at Pokhrad location.

Promising cultivars of Chinese cabbage grown at ICAR-CITH, RS, Mukteshwar

Crop Protection

5

Characterization of pathogens associated with apple canker disease and evaluation of botanicals against most prevalent canker in Kashmir valley

Survey of Apple canker disease in Kashmir valley

During 2017-18 survey of various apple orchards in Anantnag, Kulgam, Pulwama, Shopian and Bandipora districts of Kashmir valley was conducted to record the status of apple canker disease. During the course of survey, two types of canker diseases were observed on different parts of apple trees with varied degrees of incidence and intensity. The cankers observed were smoky and stem bark canker. The smoky canker was more prevalent in all the districts surveyed. It was observed on all major tree parts like trunks, scaffold branches and twigs, while, the stem bark canker was observed on main trunks and scaffold branches of apple trees. Among the five districts surveyed, maximum Smoky canker incidence and intensity of 31.10 and 17.38 percent, respectively were observed in Shopian district followed by Pulwama district with 28.75 and 15.64% respectively, while minimum disease incidence and intensity of 24.03 and 12.93 percent, respectively was observed in district Bandipora. The overall disease incidence and intensity of smoky canker in all the surveyed districts and location are shown in Table 21. Stem bark canker was observed in districts Pulwama and Shopian with disease incidence of 10.48 and 9.79 percent, and disease intensity of 4.45 and 4.29 per cent, respectively.

Table 21: Disease incidence and intensity of smoky canker at various locations in five districts of Kashmir valley

District	Location	Avg. Incidence	Avg. Intensity	Latitude	Longitude
Pulwama	Kangan	27.38	15.20	33.865023	74.875845
	Payar	13.97	7.76	33.871692	74.894714
	Koil	49.81	26.21	33.878789	74.947349
	Drabgam	28.06	15.76	33.821136	74.817466
	Gabarpora	24.54	13.26	33.812986	74.893074
	Mean	28.75	15.64		
Shopian	Batpora	27.99	14.73	33.722182	74.826486
	Zawoora	24.45	13.21	33.72779	74.843557
	Memandar	23.41	13.37	33.708067	74.839394
	Chandrigund	45.65	24.67	33.707067	74.839354
	Shirmal	35.88	21.10	33.765805	74.844124
	Naadpora	29.27	17.21	33.7432	74.7654
	Mean	31.11	17.38		

District	Location	Avg. Incidence	Avg. Intensity	Latitude	Longitude
Anantnag	Badsgam	25.70	13.52	33.637021	75.226113
	Hardpora	32.97	19.38	33.647826	75.22332
	Achabal	35.87	25.61	33.682647	75.221645
	Hatigam	12.63	6.82	33.819846	75.184168
	Mean	26.79	16.33		
Kulgam	Udura	24.53	14.42	33.6451329	75.01849
	D.H.Pora	28.27	16.62	34.40021	74.5123
	Mean	26.40	15.52		
Bandipora	Malangam	24.50	12.35	34.532443	75.145043
	Quilmukam	23.50	13.60	34.42129	74.60196
	Onagam	22.50	11.45	34.431706	74.60929
	Aloosa	25.60	14.30	34.4234167	74.544857
	Mean	24.03	12.93		
	GM	27.41	15.55		
	S.D	2.64	1.64		

GM: General mean, **S.D:** Standard deviation

Symptomatology

Smoky canker

The symptoms of this canker appeared as small sunken reddish brown well demarcated elliptical areas on the outer surface of tree trunks and limbs, exhibiting series of concentric or alternate rings, turning smoky and completely girdling the affected trunks and limbs. On branches and twigs, the symptoms observed were browning of the bark with simultaneous yellowing of the leaves. As the infection advanced deep into the wood it caused cracking of the bark exposing reddish brown stained wood. Numerous black pimple like protuberances which were the pycnidia of the fungus were observed over the bark of blighted/ dead branches and twigs

Stem bark canker

This canker mostly developed on the sun burnt tree parts viz. trunks, limbs and branches of younger trees as small, sunken, oval, reddish brown lesion with or without a fissure, which on enlargement became depressed and formed

Symptoms of Smoky Canker *(Diplodia seriata)*

Symptoms of Stem Bark Canker *(Fusicoccum aesculi Corda.)*

elliptical cankers with transversal and longitudinal slits causing loosening of the bark and complete girdling of affected limbs or branch in severe cases.

Morphological Studies of Pathogen

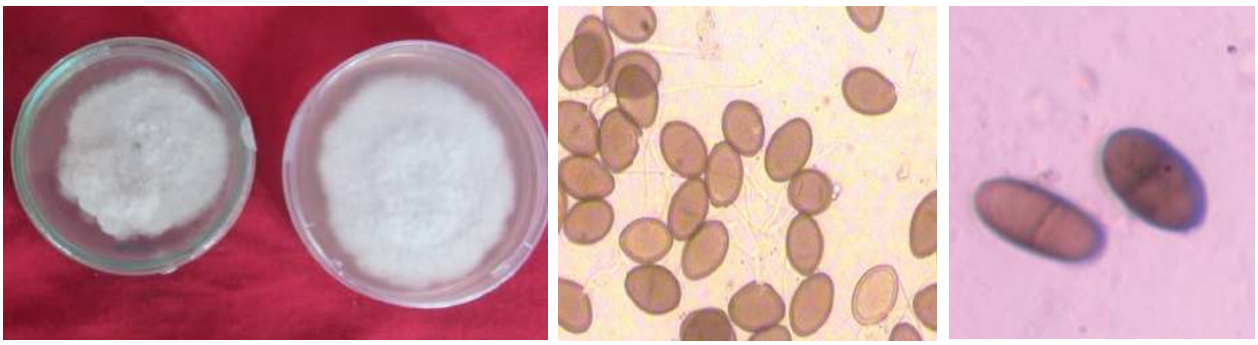
Smoky canker

The morphological characters of the fungus (*Diplodia seriata*) causing smoky canker were studied both *in vitro* and *in vivo*. On potato dextrose agar medium, the fungus exhibited cottony growth. The white colour of the fungal colony finally changed to grayish or dark grayish after 21 days of incubation at 25 ± 1°C.The hyphae were initially hyaline, smooth, septate, branched and measured 2.8-4.0 µm. The conidia initially hyaline to light yellowish, ornamented with deposits of droplet like structures, later becoming dark brown in colour, were ellipsoidal to cylindrical with an obtuse apex and truncate to round base, with a distinct basal scar, developing a central transverse median septum at later stages of growth and measured 17.93-30.0 × 9.12-13.35 µm, with an average size of 25.15 × 11.42 µm.

Characterization and botanical evaluation against *Stemphylium vesicarium* an incitant of Stemphylium blight (SB) of onion

Disease incidence and intensity

The current study was undertaken, to know the cultural, morphological, pathogenic and molecular variability in *Stemphylium vesicarium*



(a) **(b)** **(c)**

a-Seven days old culture of Diplodia seriata, b, c- Conidia under microscope at 400X magnification

an incitant of Stemphylium blight of onion and to evaluate botanicals against it for its ecofriendly management. During 2017-18, incidence and intensity recorded at ICAR-CITH farm was 65.5% and 23.3% respectively irrespective of cultivar studied. The highest disease incidence was recorded in month of June and remained high in the month of June under hot and dry climate.

Symptomatology and pathogen studies

The symptoms were observed on leaves and flower stalks as small, yellowish flecks with purple colored margins. The fungus was isolated from the infected leaves of onion collected from ICAR-CITH onion field and the culture was purified and maintained in the laboratory. Cultural characters such as colony colour, colony texture and radial growth were recorded on the seventh day of inoculation. The fungal colonies were over 25-30 mm in diameter after seven days of inoculation Morphological characters like mycelium, shape, length, width and septa of conidia and conidiophore were studied by microscopy. The mycelium was septate, length and width of conidia varied between 59.3-71.2 µm and 9.3-12.5 µm, respectively. Number of horizontal and vertical septa ranged from 3.6-5.0 and 1.4-3.2, respectively

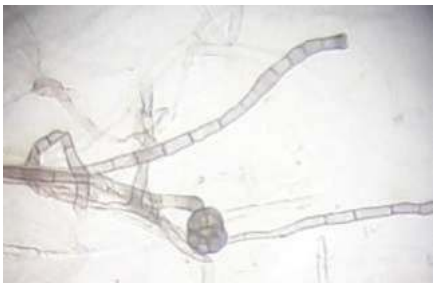
Botanical Evaluation

Six botanicals viz., Artichoke (B_1), Flex (B_2), Oreganum (B_3), Geranium (B_4), Iris (B_5), *R officinalis* (B6) were collected, shade dried and ground into a fine powdered material. The methanol extract was prepared and the extracts were kept at -20°C. The extracts were evaluated (*in vitro*) using poisoned food technique at three different concentrations 100 ppm (C_1), 500 ppm (C_2), 1000 ppm (C_3) against, *Stemphylium vesicarium*. Each treatment was replicated three times in completely randomized design (CRD) and inoculated with 3 mm diameter mycelia

a-Symptoms

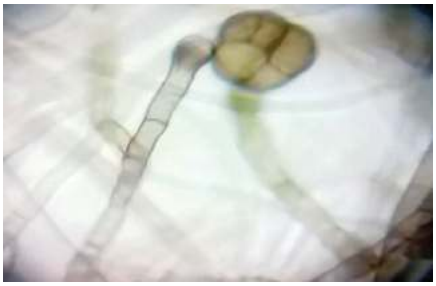
b-Culture

c-Septate Mycelium



d-Conidia

e-Conidiophore with conidia



f-Tuft of Conidiophore with conidia

(a): Symptoms of SB, (b)-Culture, (c)-Septate Mycelium, (d)-Conidia, (e)-Conidiophore with conidia and (f)-Tuft of Conidiophore with conidia

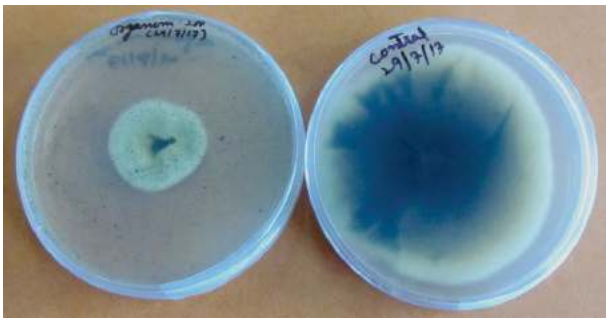
disc taken from 20 days old culture. The relative efficacy of different treatments was ascertained by taking the radial mycelia growth inhibition of fungi over control by using the formula as:

Where, C = mycelial growth in control, T = mycelial growth in treatment

The results of current study shown in Table 22 revealed that, the B_3C_3, B_4C_3 gave highest per cent inhibition followed by B_4C_2, B_1C_3. Treatments B_1C_2, B_3C_3, B_6C_2 were statistically at par. In conclusion the 1000 ppm concentration of oreganum showed the best inhibition percentage as compared to control. Among all the botanicals evaluated oreganum was found to be best botanical to control the growth of *Stemphylium vesicarium* under *invitro* conditions.

Table 22: Radial growth inhibition (%) of *Stemphylium vesicarium* under invitro conditions using different botanicals

Treatment combination	Radial growth inhibition (%)
B_1C_1	27.45^{f}
B_1C_2	38.43^{e}
B_1C_3	61.46^{c}
B_2C_1	16.10^{hi}
B_2C_2	16.18^{hi}
B_2C_3	23.16^{fg}
B_3C_1	13.72^{i}
B_3C_2	21.06^{gh}
B_3C_3	84.51^{e}
B_4C_1	47.71^{d}
B_4C_2	68.23^{b}
B_4C_3	81.34^{a}
B_5C_1	27.45^{f}
B_5C_2	27.06^{f}
B_5C_3	22.54^{fg}
B_6C_1	21.02^{gh}
B_6C_2	37.87^{e}



Radial Growth Inhibition of *Stemphylium vesicarium* by oreganum at concentration of 1000 ppm under invitro conditions

Treatment combination	Radial growth inhibition (%)
B_6C_3	44.36^{d}
Pr> F	<.0001

Values within a column followed by the same letter are not significantly different at P>0.05, as established by the Duncan's Multiple Range Test

Diagnosis and prognosis of apple viral diseases – Spatial and temporal variation in virus infection in apple

Seasonal variation in virus infection as detected by DAS-ELISA:

Periodic detection of all the four viruses in different plant parts was done in four seasons, *viz.*, spring, summer, and autumn/fall and winter/ dormant. The virus titre varied from one season to another in the same plant. It was observed that all four viruses showed seasonal variation with respect to infectivity in different tested tissues. During spring, maximum infection was detected in leaves followed by buds, flowers, bark and pollen. In spring, flowers and pollen were found infected with the viruses which can be threatening because pollen flow can transfer the viruses to the healthy plants. During fall, ACLSV and ASPV were detectable both in leaves and bark. During winter season, ASPV & ASGV infection was observed in bark. ASPV and ASGV were detected in bark and leaf tissue during spring and summer while low detection was done in buds and flowers (Table 23).

Table 23: Detection of apple viruses in different plant parts by using DAS-ELISA

Tissue	Virus	Dormant (December)	Spring (April)	Summer (July)	Fall (September)
Leaf	APMV	-	++	+	-
	ACLSV	-	+++	+++	++
	ASPV	-	++	++	+
	ASGV	-	++	++	-
Buds (Vegetative)	APMV	-	+	-	-
	ACLSV	-	+	-	-
	ASPV	-	+	-	-
	ASGV	-	+	-	-
Flower	APMV	-	+	-	-
	ACLSV	-	+	-	-
	ASPV	-	+	-	-
	ASGV	-	+	-	-
Pollen	APMV	-	+	-	-
	ACLSV	-	+	-	-
	ASPV	-	-	-	-
	ASGV	-	-	-	-
Bark	APMV	-	+	-	-
	ACLSV	-	+	+	++
	ASPV	+	+	++	+
	ASGV	+	+	++	-
Fruit	APMV	-	-	-	-
	ACLSV	-	-	-	-
	ASPV	-	-	-	-
	ASGV	-	-	-	-
Seed coat	APMV	-	-	+	+
	ACLSV	-	-	+	+
	ASPV	-	-	+	+
	ASGV	-	-	-	-
Endosperm & embryo	APMV	-	-	+	+
	ACLSV	-	-	+	+
	ASPV	-	-	+	+
	ASGV	-	-	+	+
Positive control		+	+	+	+
Negative control		-	-	-	-

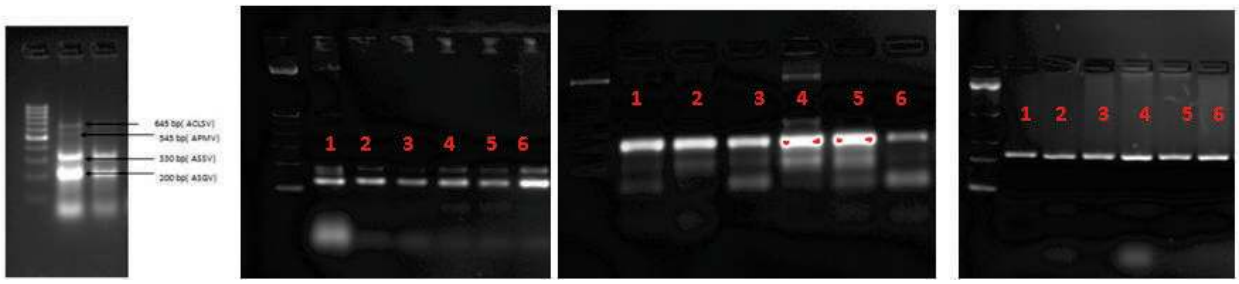
-: No concentration, +: Low concentration, ++: Medium concentration and +++: High concentration

Seasonal variation in virus infection as detected by Reverse Transcription PCR (RT-PCR)

Results obtained through DAS-ELISA were validated through RT-PCR and it was observed that variation in gene expression exist among the tissues during different seasons. Serological diagnosis revealed the existence of mixed infection in apple cultivars and therefore, multiplexing diagnostic PCR was developed for simultaneous detection of all the viruses in single reaction. Semi-Quantitative RT PCR analysis was done (Fig 17), which showed variation in gene expression of ApMV, ACLSV, ASPV & ASGV from different tissues during spring, summer, autumn and winter seasons. Those tissues were used which showed positive serological reaction through DAS-ELISA.

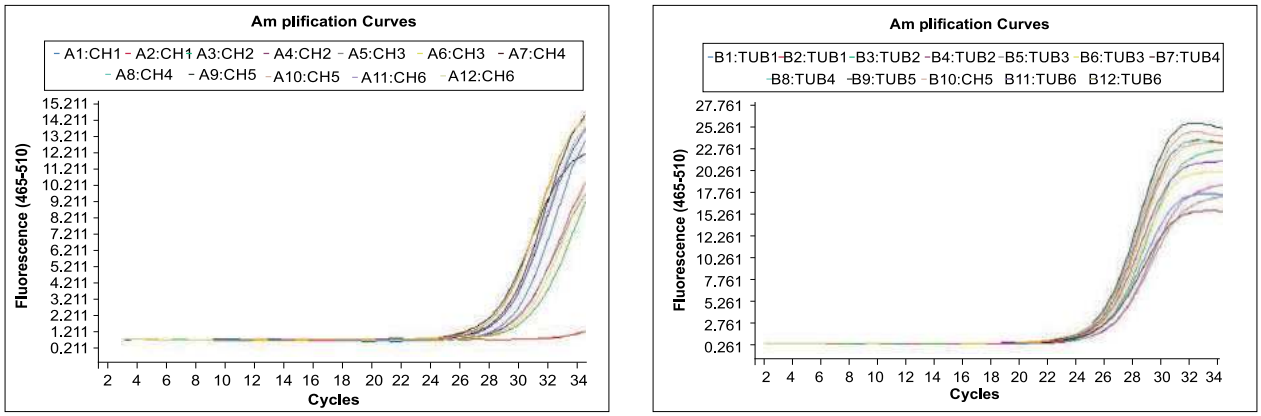
Gene expression studies for diagnosis of Apple viruses

Relative expression of genes specific to ApMV, ACLSV, ASPV & ASGV was done through Real Time PCR analysis for comparison. ApMV showed 13.8%, 22.5%, 22.3%, 9.27% , 12.5% and 16.37% , ACSLV showed 14%, 42.23%, 10%, 9.2%, 26.2%, and 15.2% expression, ASPV showed 11%, 15%, 8%, 5.2%, 27.9%% and 6.2% and ASGV showed 4.2%, 8.3%, 12.5%, 7.2%, 80.7% and 9.2% expression in sepals, stigmas, petals, bark, anther and whole flower respectively with respect to leaf as positive calibrator. In fully developed fruits comparative expression of genes specific to all four apple viruses was done in fruit and seed. ApMV, ACSLV, ASPV & ASGV showed 61.4%, 59.4%, 39.2% and 80.7% expression in seed and 11.7%, 14.7%, 13.2% and 39.2% expression in fruit tissues respectively (Fig 18).



PCR-Multiplexing | RT-PCR for ASGV (200bp) | RT-PCR for ASPV (370bp) | RT-PCR for ACLSV (645bp)

Fig 17: PCR multiplexing for simultaneous detection of apple viruses and reverse transcription PCR for semi-quantitative diagnosis of ASGV, ASPV & ACLSV in sepals (1), stigmas (2), petals (3), bark (4), anther (5) and whole flower (6) of infected apple plant



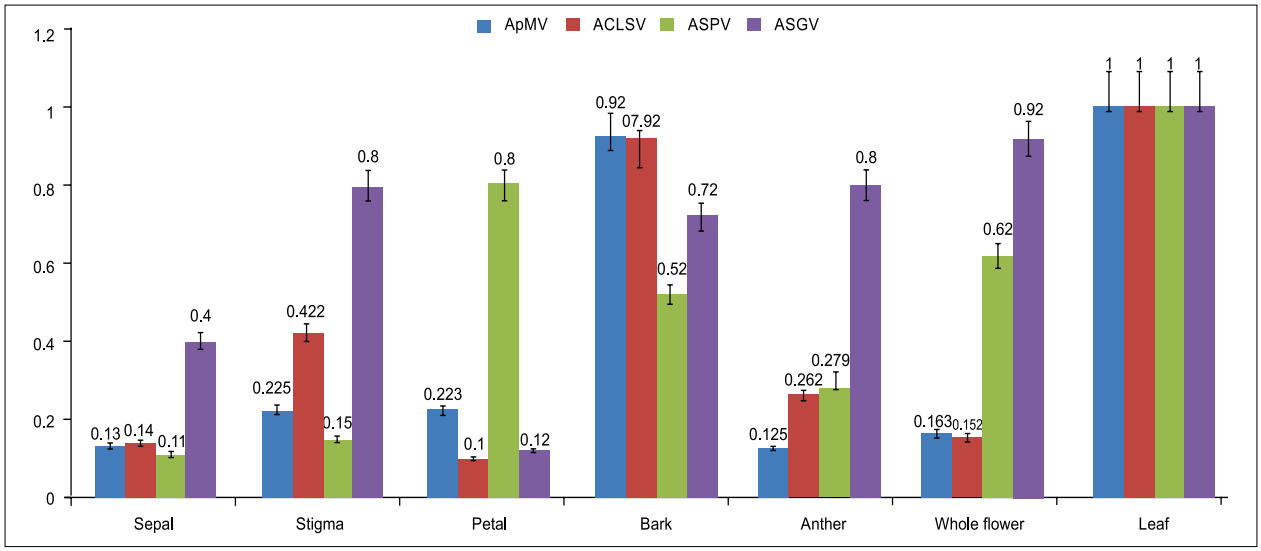


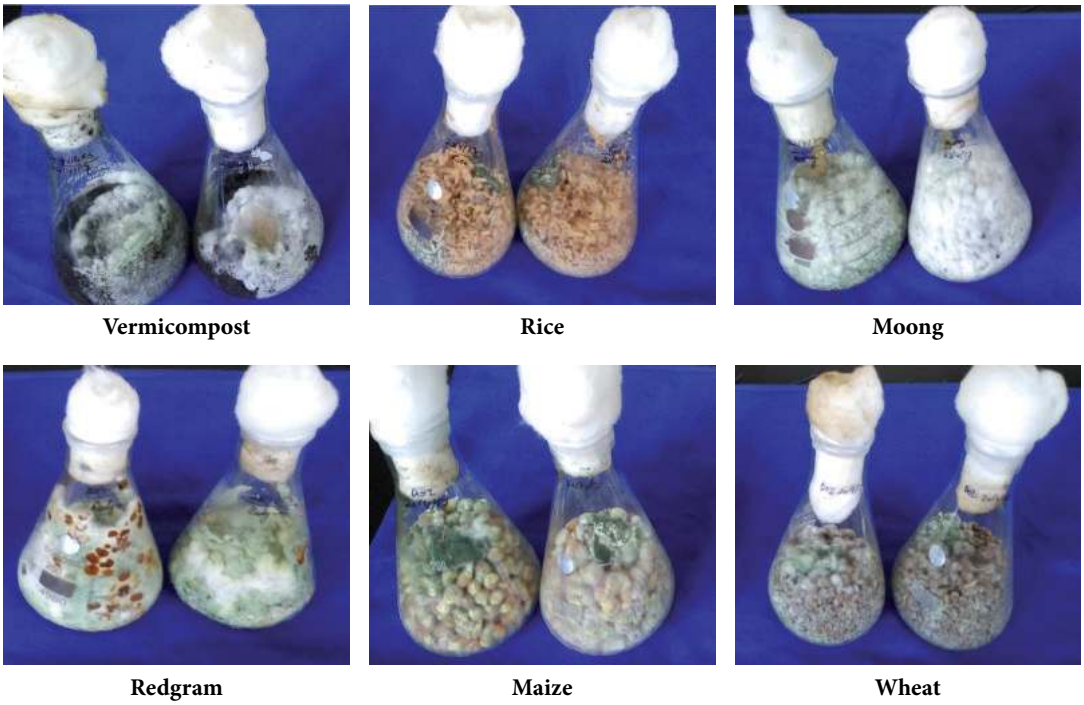
Fig 18: Relative gene expression of ApMV, ACSLV, ASPV & ASGV in sepals, stigmas, petals, bark, anther and whole flower of virus infected apple plant.

Other Studies

Evaluation of different substrates for development of Trichoderma harzianum based stock cultures and their utilization in management of chilli wilt disease

Cultures on different substrates

Different substrates like cereals, pulses and vermicompost, were evaluated for development of stock cultures, fast biomass production of *Trichoderma harzianum* and their utilization in management of chilli wilt disease. Among six evaluated substrates, vermicompost produced highest biomass (Fig 19) of *Trichoderma harzianum* followed by pulses and cereals, after two weeks of inoculation. Conidial quantity assessment revealed that after 15 days vermicompost followed by moong, produced



Trichoderma harzianum on different substrates

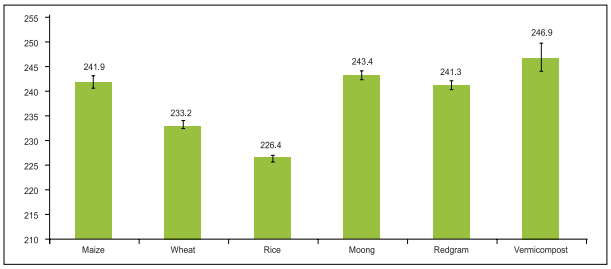


Fig 19. Average weight (gm) of biomass produced on different substrates

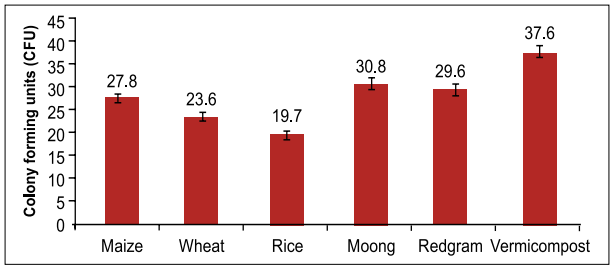


Fig 20. Colony forming unit (CFU) at 10-8 dilution

T. harzianum stock cultures on different substrates

highest colony forming units (CFU) at 10^{-8} dilution as shown in Fig 20. The *Trichoderma harzianum* laden substrates after shade drying in laminar airflow were ground to powder and stored at 4° C in small polythene bags for further use. The fungus showed rapid multiplication on vermicompost as compared to other substrates evaluated during study. Soft texture and readily available nutrients in well decomposed vermicompost may have enhanced the growth of *T. harzianum*.

Management of chilli wilt

All the six treatments evaluated whether individually or in combination significantly reduced chilli wilt, increased yields as well as other growth parameters (data not shown) as compared to control. The data shown in Table 24 revealed that T5 reduces chilli wilt incidence significantly as compared to other treatments followed by T1, which may be due to large spore load of *T. harzianum* from all stock cultures with varied colony forming units. Statistical analysis showed that treatments T1, T2, T3 and T4 were *at par*.

Table 24 Average incidence of chilli wilt at different stages of crop using various treatments

Stock cultures	Treatments	Average % incidence at flowering	Average % incidence at fruit maturity
Vermi compost	T1	10.83	14.10
Market Trichoderma	T2	14.60	19.90
Cereals	T3	12.96	16.79
Pulses	T4	16.43	19.53
Vermi compost + Cereals + Pulses	T5	10.01	12.80
Control	T6	30.56	34.3
C.D at 5%		**8.70**	**9.60**

6 Post Harvest Technology

Biochemical evaluation of chili germplasm for estimation of oleoresin content and pungency

Variability in antioxidative potential of different hot pepper (Capsicum annuum var hortense) breeding lines

Antioxidant activities of the extracts were evaluated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) assays. Highest percentage of scavenging potential of about 15.57 followed by 15.44 was observed in Sel-836-1-2 and Sel-1055/11 (Table 25). FRAP observations ranged from 87.41 µM Fe^{2+}/g FW to 394.294 µM Fe^{2+}/g FW. Our results divulge two superlative breading lines of *Capsicum annuum* namely, CITH-HP-91/13 and CITH-HP-92-13 in terms antioxidant potential. Positively significant correlation coefficients were observed between Phenol–FRAP, CP– FRAP, DICAP–FRAP, TP–DPPH and DPPH–FRAP. From principal component analysis (PCA), first two PCs explained 67.3 %of total variance and it was contributed mainly by TP, DPPH, CP, DICAP and FRAP activities. Twenty two Capsicum landraces were grouped into three clusters based on the standardized squared Euclidean distance using Ward's hierarchical clustering method and separation based on PCA biplot. The study has established that the landraces of *Capsicum annum* L. are effective resources of natural antioxidants which modulate oxidative stress.

Table 25. Variation in antioxidant potential and total phenolics content in various chilli breeding lines

Variety	(DPPH)	% inhibition	FRAP (µM Fe2+/100g dry wt. of sample)	Total Phenols (mg/g GAE)
SEL 136-1-2	8.70H	54.38	121.29L	4.92JK
SEL-1052/11	9.02GH	55.52	223.06I	4.36 L
CITH-HP-92/13	11.51F	64.28	122.00L	4.90 JK
SEL-836-1-2	15.57A	78.61	332.24DE	7.38C
SEL-1011(E)	3.25 J	35.15	170.00G	5.16J
SH-HP-1154 (TT)	11.89F	65.64	317.88EF	6.48EF
SH-HP-1154/3-1	3.60J	36.41	363.588B	8.06B
SH-HP-111/TT	4.86I	40.84	314.00FG	6.56 DE
SH-HP-1154-1	14.09C	73.38	357.706BC	6.19EFGH
CITH-HP-91/13	1.35K	28.44	302.24FG	6.08 FGH
CITH-HP-85/13	9.51G	57.22	300.65FG	6.12FGH
SEL 1065	12.67E	68.37	274.94H	8.56A
CITH-HP-42/13	11.28 F	63.48	229.41I	4.78 JK
SEL-1050	14.96AB	76.45	394.294 A	6.88D

Variety	(DPPH)	% inhibition	FRAP (µM Fe2+/100g dry wt. of sample)	Total Phenols (mg/g GAE)
SH-HP-114/13	14.73B	75.65	346.94BCD	5.68I
SH-HP-111/1	3.28 J	35.27	341.88CD	5.93GHI
SH-HP-56/13	13.41D	70.99	356.65BC	6.58DE
SEL-1055/11	15.44 A	78.16	298.59G	7.53C
AL-4	9.38G	56.77	121.88L	5.89HI
SH-HP-1154-2-1	11.54F	64.39	315.53EFG	4.97 J
SEL-89	3.18 J	34.93	160.76JK	4.55L
SEL-1011	3.09 J	34.58	87.41M	6.31EFG
KA2-SEL-1	4.67 I	40.16	148.35K	4.31 L

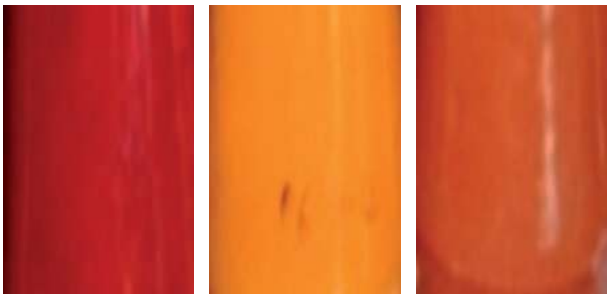
Standardization of packaging systems and storage conditions for quality retention of shelled walnut

To enhance shelf life and retain the post-harvest quality of shelled walnut, research trail was initiated to assess the effect of packaging condition and storage period on shelled walnut kernals. The study consisted a total of six treatments (Traditional air packaging + light, Traditional air packaging + dark, Vacuum packaging + light, Vacuum packaging + dark , Vacuum packaging + Oxygen absorber + light, Vacuum packaging + Oxygen absorber + light and shelled kernels of CITH-W-4 was used as experimental materials. Various observation on sensory attributes (astringency, taste, mildew, worm) , change in percent fat content, changes in physiological loss in weight, firmness, color coordinates (kernel L^*, a^*, b^*) was recorded at 0 days, 4 month, 8 month and 12 month interval . Maximum reduction of sensory attributes (astringency, taste, mildew, worm), fat content, physiological loss in weight, firmness, color coordinates (kernel L^*, a^*, b^*) was recorded in the treatment traditional air packaging + light as compared to vacuum packaging + Oxygen absorber + dark. The initial results revealed that at 12 month of storage period, vacuum packaging + Oxygen absorber + dark enhanced maximum shelf life and retains the post-harvest quality (fatty acid constituents) of walnut kernel characteristics as compared to traditional air packaging + light.

Studies on dried prunes in relation to cultivars and drying technology

Plum has high consumption rates throughout the world while drying as a common way for increasing its shelf-life is inevitable. But, drying this agricultural product is highly energy-intensive since it has high moisture contents. The drying process has undoubtedly effects on quality of fruits and it is a significant objective to have it in such a way that leads to minimization of the adverse effects such as decrease in nutritional value and color changes. Present study employed two drying methods osmo-dehydration and cabinet dehydration (60°C) alone and in combination to find out the minimal dehydration time and retention of quality parameters. Three varieties *viz*. Grand Druke, President Plum and Italian Plum were used for dehydration experiment. Drying through osmo-dehydration followed by cabinet drying at 60°C took least time (3 hours 10 minutes OD + 8 hours CD) in Italian Prune with maximum retention of colour and ascorbic acid. Cabinet drying at 60°C took minimum dehydration time (10 hours) in Italian plum. After 180 days of storage at low temperature (4° C), maximum colour (L^*, a^* and b^*), ascorbic acid retention was recorded in Italian plum when osmo dehydrated with little loss of some quality attributes. Therefore osmotic dehydration followed by cabinet drying is one of the best and suitable method to increase the shelf life of prunes. This process is preferred due to their color, flavor and taste retention property.

Osmo-dehydrated Italian plum - prune



Plum juice | Apricot juice | Blended juice (Plum + apricot)

Standardization of technology for blending of temperate stone fruit juices

Stone fruit juices have nutritional and pharmaceutical potential which can further be improved through blending two or more juices together. In order to find out the blending combinations different fruit juices *viz*. sweet cherry, sour cherry, apricot and plum were blended in different combinations. Blending of sweet cherry with sour cherry (50% of each) retained maximum desirable colour i.e. brightness, redness, freshness, ascorbic acid, acidity and TSS when compared with other blending combinations. Blending of apricot with plum in the ration of 25% apricot + 75 % plum retained maximum desirable colour i.e brightness, redness, freshness, ascorbic acid, acidity and TSS when compared with other blending combinations. Both the blends were found to retain their properties upto 8 months.

Determination of maturity indices in olive

In olive various parameters such as fruit moisture content, fruit skin color, fruit firmness, oil content, oil quality in terms of fatty acid were recorded to determine the maturity indices for getting maximum oil yield from the fruits. The noted parameters were used to calculate maturity index and the preliminary results showed that last week of October month is optimum time for the genotypes *viz*., Frontoio, Cerignola, Etnea, Itrana and Belice whereas, second week of November month was found best for genotypes *viz*., Tonda Ibea, Zaituna, Cornicobra and Ottobratica.

Frontoio Belice Cerignola Cornicobra Etnea

Harvested fruits of Etnea

Harvested fruits of Frontoio

Optimum harvest stages in different olive genotypes

Externally Funded / Consortia Research Platform/ Network Projects

7

Development of an electronic nose sensor to determine the optimum harvesting time for apple and papaya

Biochemical evaluation and anti-oxidative potential of apple cultivars under different storage conditions

Four apple cultivars (Vista Bella, Red Delicious, Shireen and Golden Delicious) were evaluated for physicochemical and biological potential assays. Physical parameters (fruit weight, length and breadth), colour parameters (L, a, b and Tint), phenolic compounds (rutin, catechin and quercetin), total phenols, flavanols, flavanoids, TSS, firmness, pH, acidity, ascorbic acid etc along with free radical scavenging and anti-oxidative potential through DPPH and FRAP assays were estimated. Quantification of rutin, quercetin and catechin was done through RP-HPLC. Four varieties showed significant variation with respect to all the parameters studied. Also storage conditions influence the level of these compounds. It was found that phenolic compounds like catechin and rutin were stable under low temperature conditions but there are little changes in other parameters. Apple samples at different growth development stages were send to IIT, Roorkee for evaluation of volatile compounds and development of 'e-nose' for optimizing harvesting time in apple.

Red Delicious | Golden Delicious

Vista Bella | Shireen

Apple verities selected for development of e-nose

National Saffron Mission

Flower enhancement in saffron under controlled conditions using plant growth regulators

The greenhouse trial was conducted in 2016-17 at ICAR-CITH Srinagar in which, saffron corms of size 15-30 mm in diameter, varied between 6-8 g used as initial mother corm. Before planting corms were treated with Bavistin@2gm/L of water followed by mixture of GA3 (400PPM) + NAA (400PPM) + CCC (1000PPM). The flower data, revealed that, treatment "cocopeat +soil(1:1), colchicines(0.5%)+GA3(150ppm)+NAA(150ppm)+CCC (500ppm)" and "cocopeat+ vermiculite +soil(1:1:1), colchicines (0.5%)+GA3 (100ppm) +NAA(200ppm)+CCC (500ppm)" yielded maximum number of flowers, while as the treatment soil and water were having least number of flowers. The data revealed that the treatments having colchicines shows maximum number of flowers, hence provides clue that there is some direct role of colchicines for enhancement of flowering in saffron. Hence the treatments colchicines (0.5%) + GA3 (150ppm) + NAA (150ppm) + CCC (500ppm) and cocopeat +vermiculite+soil(1:1:1),colchicines(0.5%)+GA3 (100ppm) +NAA(200ppm)+CCC (500ppm)] can be used for enhancing the flowering in saffron for better returns and economic benefits under controlled conditions.

Enhanced corm multiplication of saffron under protected/forced conditions:

For enhancing corm multiplication of saffron under controlled conditions different media combination comprising of cocopeat, vermiculite and soil supplemented with different phytohormone combinations including colchicines, GA3, NAA and CCC were used. After planting mother corms of initial weight of approx. 6-8 grams in the month of June, 2016 on different treatments. Maximum corm multiplication with maximum number of daughter corms (06) were found in media combination comprising of cocopeat+vermiculite+Soil (1:1:1) supplemented with colchicines (0.5%)+GA3 (100ppm)+NAA(200ppm)+CCC (500ppm) followed by media combination of vermiculite : soil (3:1) supplemented with GA3(150ppm)+ NAA(150ppm)+CCC (400ppm) under which five daughter corms were obtained. On an average the size of daughter corms in all the treatments was 3-4 g.

DUS Centre for Temperate Fruits and Nuts

Characterization of reference and candidate varieties

A total of 267 reference varieties of temperate horticultural crops like peach (31), plum (18), apricot (17), cherry (10), apple (50), pear (21), almond (28), walnut (27) and strawberry (65) were characterized as per DUS descriptor developed by ICAR-Central Institute of Temperate Horticulture, Srinagar for each crop. All the characters (flowering, plant, fruiting etc) were taken into consideration while characterizing the reference varieties. The stability of the traits and essential characters were ascertained. In addition a detailed description of 27 genotypes of walnut based on morphological characters, *viz*., growth habit, bearing habit, foliage, fruit and kernel characteristics was developed. The erect growth habit was noticed in genotype CITH-W-12, while semi erect growth habit was noticed in majority of the genotypes. Three types of leaf shapes were recorded *i,e* narrow elliptic, elliptic, and broad elliptic. Walnut genotypes could also be categorized based on leaf characteristics, viz., pubescence as glabrous, slightly pubescent and pubescent. On the basis of fruit maturity group, genotypes were categorized into early, mid and late. High variability was recorded for fruit shape *viz*, round, cordate, ovate, long trapezoid, and elliptic. The descriptor clearly characterized each genotype and all the genotypes can be identified or grouped individually based on this descriptor. On-site DUS testing of five candidate walnut varieties viz., CITH-W1, CITH-W-2, CITH-W-3, CITH-W-4 & CITH-W-5 was done and inspection by DUS review team was also conducted for these varieties on 24th November, 2017. About 66 new applications of farmer's varieties for protection under PPV&FRA, New Delhi were received during 2017-18.

Inspection of candidate walnut varieties applied for protection under PPV&FRA by ICAR-CITH, Srinagar

National agriculture innovation fund/ intellectual property management and transfer/commercialization of agriculture technology

Identification, documentation, registration etc of technologies and varieties

During 2017-18 technologies and varieties developed by the institute were documented. Passport data for 80 new collections was prepared and send to NBPGR for allotment of IC numbers and IC numbers were allotted for walnut (32), almond (22), apple (9), oreganum (8) and peach (8) collections. All these new collections are being maintained at field gene bank of ICAR-Central Institute of Temperate Horticulture, Srinagar. Registration of germplasm through NBPGR has been initiated and one accession of walnut has been submitted for online registration. In addition protection of plant varieties through PPV &FRA, New Delhi is being done in coordination with DUS.

All india network research project on onion and garlic (AINRPOG)

This project was implemented as per technical programme at ICAR-CITH Srinagar and Regional Station Mukteshwar. The various activities carried out in this project were, Germplasm collection, evaluation and maintenance, effect of sulphur application on bulb yield, pungency and storage quality of garlic,eEffect of zinc and boron application on rabi onion production, effect of zinc and boron application on yield and storage quality of garlic, effect of organic sources of plant nutrients and plant protection measures on onion production,effect of weed management strategies in *rabi* onion, population dynamics of onion thrips and seasonal incidence of foliar diseases of onion in different parts of India, population dynamics of thrips in garlic in different parts of India, effect of foliar application of boron, sulphur and $CaCl_2$ on storage life of onion bulbs. At Mukteshwar 12 long day garlic, were evaluated in germplasm evaluation and AVT II trial, while 16, 12, 23 onion genotypes were evaluated under germplasm evaluation, AVT II and IET respectively.

Garlic and Onion germplasm evaluation at Mukteshwar

All india co ordinate research project on vegetable crops (AICRP -VC)

This project was implemented as per technical programme at ICAR-CITH Srinagar and Regional Station Mukteshwar. The various activities carried out at ICAR-CITH Srinagar as shown in the Table 26 and one new entry each in chilli and capsicum was proposed for IET (variety) for the year 2018-19. Also 11 genotypes/varieties of tomato, 15 cucumber genotypes/varieties, 9 french bean genotypes/varieties in IET, 6 in AVT were evaluated for different growth parameters at ICAR-CITH, RS-Mukteshwar

Table 26: List of trials conducted during the reporting year

Crop	Trial	Number of entries tested
Chilli	IET (variety)	9
	AVT-II (variety)	11
	AVT-I (hybrid)	8
Capsicum	IET (variety)	7
Brinjal	IET (long variety)	6
	IET (round variety)	7
Tomato	IET (variety)	15
	AVT-II (variety)	12
	IET (hybrid)	8
	AVT-II (hybrid)	7
Cherry tomato	IET	3
Broccoli	IET (hybrid)	6

Different trials conducted at Mukteshwar

National Mission for Sustaining Himalayan Eco System (NMSHE-TF-6)

ICAR- CITH, Srinagar

Secondary data was collected and compiled on different vulnerability parameters in Jammu and Kashmir as per format given for further onward submission to IISWC, Dehradun. In the changing climatic scenario spring frost is very common phenomena and it occur mostly at the time of flowering in almond and causes severe damage to flower and bee activities, which leads to ultimately low yield. Therefore preliminary survey of almond growing areas of Kashmir valley, particularly district Pulwama was done at the time of flowering to identify early, mid and late bloomers with superior nut traits. The early and late bloomers were collected and budded at ICAR- CITH, Srinagar field gene bank and are under evaluation. Analysis of mother tree nut and kernel quality parameters of different selections revealed that Sel-3, Sel-6, Sel-7, Sel-13 were found promising types. Preliminary survey was done for different apricot and apple growing areas of Leh and some of the promising germplasm scion-sticks were collected and grafted in CITH field gene bank. To overcome challenges of climate change and low productivity of apple and other crops and expansion of area under temperate fruit crops, a high density planting of with superior and high yielding varieties of walnut, apple and apricot was completed at the identified locations in Leh, Ladakh. Five training programmes on different aspects at different regions of J&K were organized and 175 farmers participated in said training programmes.

ICAR-CITH, RS-Mukteshwar

Under this project, activities were also carried out at Regional Station Mukteshwar in which, total 1130 plants of different fruit crops namely apple (Golden Delicious, Oregon Spur, Skyline Supreme, Chaubattia Princess, CITH Lodh Apple-1, Mayan, Fenny, Tydemans Early, Red Delicious, Red Gold, Chaubattia Anupam, Ambri, Starkrimson), Peach (Red June, Paradelux, Florida Prince, Shan-a-Panjab and Early Grande), plum (Santa Rosa, Satsuma, Satluj Purple and Kala Amritsari), apricot (CITH-A-1 and CITH-A-3), kiwifruit {Allison, Hayward, Monty, Bruno, Abbot and Tomari (P)} and walnut (CITH-W-1, CITH-W-2) were planted in approximately 4.068 ha area at 67 farmers in selected villages (Sunkiya, Jurkafun) in Uttarakhand and Kumbhali in Himachal Pradesh, during the year 2016-17 and 2017-18 of which apple (358), peach (39), plum (59), walnut (1) and apricot (27) plants were planted during 2017-18 an area of approximate 1.71 ha in selected villages. Total 29000 seedlings

Various training programmes organized at different places in J&K under NMSHE

Demonstrations of various technologies

of different vegetable crops were planted in approximate 9261 m^2 area at 174 farmers of selected villages during the year 2016-17 and 2017-18 of which 21100 seedlings of tomato, capsicum, cucumber, kale, brussel sprouts, knol khol and onion were planted in 1746.25 m^2 area during 2017-18. Various trainings, demonstrations and awareness programmes were organized.

National innovations on climate resilient agriculture

A significant impact of climate change on phenological stages of different varieties of apple was observed (Fig 21.). The impact could be due to climatic variability especially temperature. The impact on various phenological stages has consequently affected fruit yield too.

Walnut propagation for production of quality planting material

The Project walnut propagation for production of quality planting material was started in year 2017-2018 for promotion of walnut in Uttarakhand with the aim to develop facilities for large scale multiplication of quality walnut plants at ICAR-CITH,Srinagar and CITH-RS, Mukteshwar; to multiply large large scale quality planting material of walnut under controlled polyhouse conditions ;to supply planting material for Uttarakhand Forest Resource Management Project & to develop mother block of elite walnut varieties at Uttarakhand. This project is funded by Japan International Cooperation Agency (JICA). During the year, 1500 grafted walnut plants were

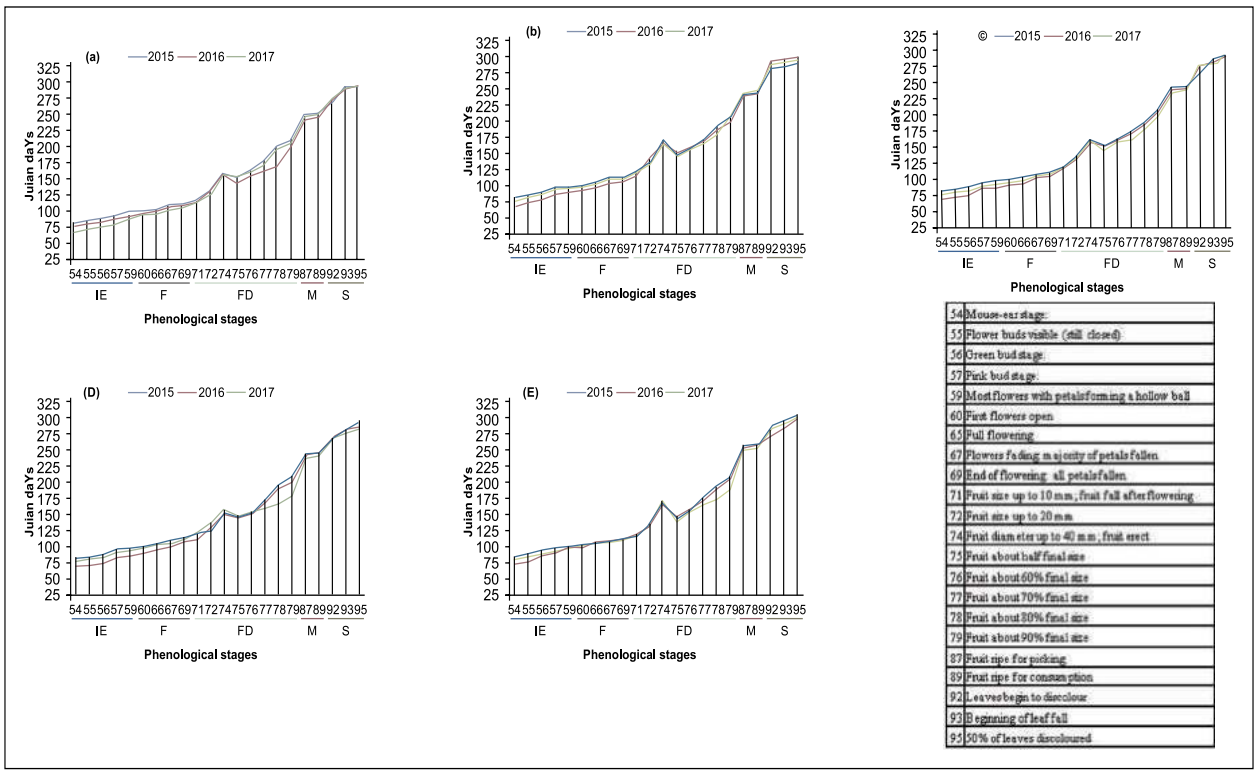


Fig 21. Advancement/Delay in phenological stages as influenced by mean temperature in (a) Red Delicious, (b)Golden Delicious, (c) Royal Delicious, (d) Oregon Spur and (e) Coe Red Fuji apple

supplied to Department of Forest, Uttarakhand under this project and sufficient planting material was propagated in polyhouses at ICAR-CITH, Srinagar for next year supply to Uttrakhand. One three days training programme on "Advances in Walnut Propagation" was organized by ICAR-CITH, Srinagar for forest officials of Uttarakhand w.e.f. 19th to 21st February,2018 and one two days training programme was organized for officers and progressive farmers at ICAR-CITH, RS Mukteshwar on 1& 2nd February, 2018.

Grafting of walnut plants in poly house at ICAR-CITH, Srinagar

All India network project on outreach of technologies for temperate fruit crops

For testing and dissemination of new varieties and technologies eleven different sub projects were implemented in different states. This project was implemented at 8 different centers, viz., Srinagar, Mukteshwar, Bhaderwah, Solan, Bajaura, Ranichauri, Kodai Kanal and Dirang. Based on agro climatic conditions 11 different sub projects were implemented in these centers as per technical programme formulated according to agroclimatic conditions. The sample fruiting has came in many centers. Depending upon the agroclimatic conditions different varieties and technologies excelled differently at different centers. As far as Srinagar station is concerned various crops like apple almond,walnut and apricot were studied. Six apple cultivars were evaluated under different training systems for yield and other quality traits. Canopy management system "Vertical axis" in variety Oregan spur gave maximum yield. Almond varieties were evaluated under medium density and maximum plant height, girth and spread was found in Calfornia Paper Shell. In walnut ten genotypes (CITH-W-1 to CITH-W-10) along with Hamdan and Turtle were evaluated under medium density. Maximum plant height, girth, was observed in CITH-W-1. Four apricot varieties were evaluated under medium density and maximum plant height and girth was observed in CITH-AP-3.

High density planting of apple and fruiting in apricot at Srinagar

Challenge Programme on Canopy management and plant architectural engineering in temperate fruit crops'

Canopy management and plant architectural engineering in temperate fruit crops' was started during 2015-16 to develop efficient plant architectural systems using different rootstocks and scion cultivars; to harvest solar energy through increased light interception and improve sink source relationship; to utilize maximum vertical space & energy and to maximize production and improve color and quality of produce. Project was implemented in 8 centres with different temperate fruit crops of their regional importance viz Srinagar (Apple & Pear), Mukteshwar (Apple & Peach), Dirang (Apple), Solan (Peach), Kullu (Apple & Plum), Ludhiana (Pear & Plum), Kodai Kanal (Pear & Plum) and Meghalaya (Kiwifruit & Peach).

At Srinagar Centre, apple and pear was selected for experimentation. The plants are in initial stage of fruiting. In apple highest fruit weight, length and diameter was observed in the fruits harvested from Oregon Spur on MM-111 trained on modified central leader system. Colour parameters viz. "L" "a" "b" was found highest in Oregon Spur on MM-106 trained on modified central leader system however firmness in terms of Relative Index (RI) was observed highest in Red Delicious on M-9 trained on vertical Axis. Highest light interception was recorded in Red

Delicious on seedling rootstock trained as spindle bush system. Pear architectural engineering block was established in year 2015. Overall growth performance was significantly better however Kashmiri Nakh on both BA-29-C and Quince-C recorded highest plant height, girth and spread. Highest fruit weight, diameter and length was noticed in William Bartlett on BA-29-C trained on espalier system whereas TSS was highest in espalier training system in Red Bartlett on BA-29-C. Colour parameters viz. "L" "a" "b" was found highest in espalier system

Fruiting in apple under different training systems

Pear varieties under vertical axis system

8 Meetings and Events

During 2017-18, various meetings and events organized at ICAR-CITH Srinagar and its Regional Station Mukteshwar are presented below and summarized in Table 27.

Workshop on olive research and development in India

Two-day workshop on "Olive Research and Development in India" was jointly organized by Oilseeds Division, Department of Agriculture and Corporation & Farmers Welfare and ICAR-Central Institute of Temperate Horticulture Srinagar from October 24-25, 2017 at ICAR-CITH, Srinagar. Workshop was inaugurated by Shri Gajendra Singh Shekhawat, Union Minister of State for Agriculture and Farmers welfare who in his inaugural address emphasized the role of research and development for combating the challenges faced by the farmers. This workshop was participated by officials from SKUAST (K), Srinagar, IARI, New Delhi, State Horticulture Department J& K, State Agriculture Department J & K, participants and farmers from various states like Meghalaya, Mizoram, Tamil Nadu, Jammu and Kashmir etc. During the workshop deliberations on various research and developments in India were made and discussed in detail.

Glimpses of Olive workshop at ICAR-CITH Srinagar

Two days Workshop at Leh

ICAR-Central Institute of Temperate Horticulture, Srinagar in collaboration with ICAR-CPRI, Shimla, ICAR-IIVR, Varanasi, ICAR-IIHR, Banglore, ICAR-CAZRI RS Leh and HMAARI, SKUAST-K, Leh organized two days workshop on *"Development of horticulture under cold arid region of Ladakh for enhancing quality production and improving livelihood"* at SKUAST-K Campus Leh from 23rd to 24th August, 2017. The workshop was attended by around 135 participants including farmers from different areas of Ladakh, officers from line departments and scientists from ICAR and SKUAST Kashmir. Honble Executive Councillor (Agriculture) Sh. Tsering Wangdus was the chief guest on the occasion. During the workshop various issues related to horticulture in Ladakh region were addressed. Involvement of farmers in discussions helped in resolving their problems and issues.

Glimpses of Two days workshop at Leh (Ladakh)

Table 27. Summary of various events organized at ICAR-CITH during 2017-18

Event	Date	Venue	Organizer
Workshop on olive research and development in India	24-25th October, 2017	ICAR-CITH, Srinagar	Dr.Shiv Lal
Workshop on Development of horticulture under cold arid region of Ladakh for enhancing quality production and improving livelihood	23rd - 24th August,2017	Leh (Ladakh)	Dr.O.C.Sharma Dr.A.Sharma Dr.S.Lal
Seminar on Emerging trends in Hi tech hill horticulture under changing climate	6-7th of March, 2018	RS-ICAR-CITH, Mukteshwar	Dr.Rajnarayan Dr.J.I.Mir Dr.A.Kishore Dr Shiv Lal
State-wise coordination committee for doubling the farmers' income by 2022	11th May, 2017 & 30th October, 2017	SKUAST-J	Dr.D.B.Singh Dr.J.I.Mir
13th Institute Research Council Meeting	29 - 30th April 2017	ICAR-CITH, Srinagar	Dr.O.C.Sharma
14th Research Advisory Council Meeting	3rd - 4th August, 2017	ICAR-CITH, Srinagar	Dr.O.C.Sharma
Vigilance Awareness Week	30th October, 2017 to 4th November, 2017	ICAR-CITH, Srinagar	Dr.O.C.Sharma

Event	Date	Venue	Organizer
Intersession meeting of the consultative committee	3rd July, 2017	SKICC, Srinagar	Dr. D.B.Singh Dr. A.Sharma Dr.J.I.Mir
Swacch Bharat Abhiyan	15th Sept to 02nd October 2017	ICAR-CITH, Srinagar	Dr.W.H.Raja
Hindi Week	14 to 20th September, 2017	ICAR-CITH, Srinagar	Sh.Mukul Raj Singh Sh.Ramesh Dr.O.C.Sharma
Apple Day	18th August -2017	RS-ICAR-CITH, Mukteshwar	Dr.Rajnarayan Dr.A.Kishore
International Yoga Day	21st June, 2017	ICAR-CITH, Srinagar	Dr.K.L.Kumawat
Blossom Day	6th April, 2017	ICAR-CITH, Srinagar	Dr.J.I.Mir Dr.W.H.Raja
Agriculture Education Day	3rd December 2017	ICAR-CITH, Srinagar	Dr.W.H.Raja Sh.Sajad Un Nabi
Root Crop Carnival	27th December, 2017	ICAR-CITH, Srinagar	Dr.Selvakumar R Dr.W.H.Raja
World Soil Day	5th December 2017	ICAR-CITH, Srinagar	Dr.A.Sharma Dr.Geetika Malik Dr.W.H.Raja
Kale Day	5th December 2017	ICAR-CITH, Srinagar	Dr.A.Sharma Dr.Geetika Malik

Seminar on Emerging trends in Hi tech hill horticulture under changing climate Organized

Two days seminar on "Emerging trends in Hi tech hill horticulture under changing climate" at RS-ICAR-CITH Mukteshwar from 6&7th of March, 2018 was organized. Keeping in view the effect of climate change on horticulture, deliberations and discussions were made by various experts from different states. The scientists, from various organizations, officers/officials from line department and progressive farmers participated in the seminar. Exhibition was also organized to highlight the various technologies of ICAR-CITH.

Glimpses of Two days Seminar at RS-ICAR-CITH, Mukteshwar

State-wise coordination committee for doubling the farmers' income by 2022

Two meetings were organized by Dr Desh Beer Singh, Director, ICAR-Central Institute of Temperate Horticulture, Srinagar, and Member Secretary, under the Chairmanship of Dr Pradeep K Sharma, Vice Chancellor, SKUAST of Jammu, on May 11, 2017 and October 30, 2017 at Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Chatha. Dr D. B. Singh, Director, ICAR-CITH, Srinagar, convener of the committee made a presentation on the Objectives and Agenda of the meeting. Dr Pradeep K. Sharma, Vice Chancellor of SKUAST-J observed that three pronged approach was needed to double the income of farmers in a given time-frame viz (a) increasing the productivity, quality production and reducing the cost of production, (b) access to assured market and (c) Policy support. Shri Shyam Sunder Agarwal, Deputy Director, MoFPI, felt the need to decipher the existing production level of important agricultural commodities, their wastage at farm level and economic status of farmers, separately for each climatic zone. The meeting focused on farm income potential of Jammu and Kashmir State and the strategies for doubling Farmers' Income in the State by 2022. Role of approaches like increasing farm productivity, quality production and reducing the cost of production, access to market for better realization of farmers' produce, policy support, infrastructural development, HRD and extension for achieving the target of 2022 were discussed. Directors of State Development Departments and other Senior Officials of State Government Departments attended the meetings and provided significant inputs. Strategy document for doubling farmer's income of Jammu and Kashmir by 2022 was compiled and submitted to the council.

13th Institute Research Council Meeting

Institute Research Council Meeting was held on 29 - 30th April 2017 (For CITH, Main campus) and 19th May, 2017 (for Regional Station , Mukteshwar) at CITH, Srinagar under chairmanship of Dr D B Singh, Director, CITH, Srinagar. The All the scientists of CITH participated in the meeting. Besides these, scientists from IGFRI, RS Srinagar and KVK, Baramulla also participated in the meeting. Project-wise presentations were made by respective PI's and results/ outcomes along with the activities to be taken up in next year were presented and discussed in details. Chairman gave critical inputs on experimentation for obtaining realistic and reproducible results. New Institute projects were also proposed and some were approved by the house.

Director and scientists discussing the outcomes of projects during 13th IRC meeting

14th Research Advisory Council Meeting

The 14th RAC Meeting was held on 3rd and 4th August, 2017 at ICAR-CITH, Srinagar under the Chairmanship of Dr K R Dhiman, Former Vice Chancellor, Dr YSPUH&F, Solan. The members who attended the meeting were Dr J C rana, Dr A. Das Munshi, Dr M K Verma, Dr Hina Shafi, Sh Desh Kumar Nehru, Dr W. S Dhillon, Dr Desh Beer Singh and Dr O C Sharma. The Scientists of CITH and NBPGR RS Srinagar also attended the meeting. The Chairman and members gave critical input on experimentation and new areas for research in temperate horticulture. The committeee members also visited the experiments in the field.

RAC team interacting with scientists at field experimental block at ICAR-CITH Srinagar

Vigilance Awareness Week

The Vigilance Awareness Week was observed at ICAR-CITH, Srinagar From 30th October, 2017 to 4th November, 2017 on the theme " My Vision-Corruption Free India". On 30th October, 2017, the staff of ICAR- CITH, Srinagar was sensitized regarding corruption and its eradication from the country by the Vigilance officer of ICAR- CITH, Srinagar. The role of the individuals to achieve the theme was also highlighted. A pledge ceremony was also organized in which all staff took pledge. On 2nd November, 2017, small talks on corruption and measures to stop it to achieve corruption free India were delivered by various staff members and all staff members shared their views. The banners were also displayed in the Institute.

ICAR-CITH Staff taking pledge for corruption free India during Vigilance week

Intersession meeting of the consultative committee

ICAR-CITH organized Intersession meeting of the Consultative Committee of the Ministry of Agriculture and Farmers Welfare on the subject "Farm Mechanization" at SKICC Srinagar on 3rd July, 2017. Meeting was chaired by Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers Welfare.

Hindi Week

Hindi week was observed by ICAR-Central Institute of Temperate Horticulture, Srinagar. from 14 to 20th September, 2017 for compliance of official language policy. Institute organized some competition for staff members. Hindi pakhwada was also celebrated at regional station Mukteshwar, Uttarakhand from 14 to 29th of Sept., 2017.

Director ICAR-CITH distributing prizes among the participants of Hindi week

International Yoga Day

ICAR-Central Institute of Temperate Horticulture has celebrated third International Yoga Day on 21st June, 2017. Dr. Manoj Kumar, Dr. D.B. Singh and Dr. G.A. Hajani gave brief talk about the importance, and need of yoga invigorating overall mental and physical status of a person. All scientific, administrative, technical and supporting staff of ICAR-CITH, Srinagar, and scientific staff of ICAR-NBPGR-RS, Srinagar and ICAR-IGFRI-RS, Srinagar has performed different asanas of yoga under the guidance of Dr. Manoj Kumar, Dr. D.B. Singh, Dr. Shiv Lal and Mr. Ramesh.

International Yoga Day celebration at ICAR-CITH, Srinagar

Blossom Day

ICAR- Central Institute of Temperate Horticulture, Srinagar organized "Blossom Day" on 6th April, 2017 at its main campus Srinagar. The theme of the event was "Bloom in Temperate Fruits - Boon for Productivity and Horti-Tourism". Expert scientists from NBPGR, Regional Station, Srinagar, IGFRI, Regional Station, Srinagar, SKUAST-K etc participated in the event along with the local farmers. Dr Desh Beer Singh, Director, ICARCITH, Srinagar

Director ICAR-CITH highlighting the importance of Blossom Day

enlightened the participants on the importance and role of temperate horticulture crop blossom on prediction of productivity and horti-tourism. He gave emphasis on the aesthetic role of diverse horticultural crop bloom like almond, peach, plum, pear, apple, cherry etc on Horti-tourism in the state. Horti-tourism can play important role in increasing farmer's income if these crops and orchards become the part of tourism linkages.

Root Crop Carnival

Root Crop Carnival was organized on 27th December, 2017 at ICAR-Central Institute of Temperate Horticulture, Srinagar, Jammu and Kashmir in which about 50 farmers from district Budgam participated. The farmers were made aware about importance of various root crops and various nutra enriched hybrids/varieties of carrot, turnip and radish were displayed in the carnival. The programme was organized to create awareness regarding huge potential and benefits of root crop in the region.

Root crop varietal show and discussion during root crop carnival

World Soil Day

ICAR-Central Institute of Temperate Horticulture, Srinagar celebrated World Soil Day on 5th December, 2017. The function was attended by farmers from various districts of Kashmir, along with all the scientific, technical and administrative staff of ICAR-CITH. During the function farmers were made aware about the importance of soil sampling and testing through various audio-video aids and lectures by the experts. Address of hon'ble Minister of Agriculture & Farmers Welfare, Shri. Radha Mohan Singh was extended to the house through a video clip.

World Soil Day celebration at ICAR-CITH Srinagar

Agriculture Education Day

The ICAR- Central Institute of Temperate Horticulture, Srinagar celebrated Agriculture Education Day at ICAR- CITH, Srinagar, J & K, for promoting the spirit of agriculture and allied subjects among the participants. The programme was marked with the participation of staff members of ICAR-CITH including RA's, SRF'S, Field/Lab assistants and other contractual staff.

Discussion and presentation during Agricultural Education Day

Kale Day

ICAR-Central Institute of Temperate Horticulture, Srinagar celebrated Kale Day at the Institute premises, on 5th December, 2017. The function was attended by 60 farmers from various districts of Kashmir along with scientific, technical and administrative staff of ICAR-CITH, Srinagar. During the function farmers were informed about the importance of kale crop and its nutritive value. An exposure visit to the field was organized for the farmers by the institute.

Scientist-Farmer interaction during Kale Day

Swacch Bharat Abhiyan

ICAR-CITH Organized "Swachhta Hi Seva" w.e.f. 15th Sept to 02nd October 2017 under Swachh Bharat Mission at ICAR-CITH, Srinagar. All staff of the Institute actively participated in the programme. Different activities were performed at different places as per the programme.

ICAR-CITH staff taking swacch pledge and cleanliness drive at ICAR-CITH Srinagar

Apple Growers meet-Apple Day

An apple grower's meet-Apple day was organized on 18th August -2017 at ICAR-CITH-RS, Mukteshwar in which many farmers from

Uttarakhand participated and farmers were acquainted with different aspects of apple production and protection practices, during this day an exhibition was also organized.

Interaction and exhibition during Apple Day at RS-ICAR-CITH, Mukteshwar

Extension and Other Programmes

9

Extension Activities

The temperate regions of country like J&K, Himachal Pradesh, Uttarakhand and parts of North-eastern states like Arunachal Pradesh, Sikkim etc are hub of temperate fruit cultivation. These states being hilly, endowed with different agro-climatic conditions and topography, having great scope for horticulture sector. Major challenges in horticulture sector include sustainability, higher levels of production, competitiveness to stay in market, regular production, land, water and more importantly threat of climate change. The temperate fruit industry in India is associated with many production problems and lack of knowledge of latest technologies which leads to low productivity in these crops as compared to other countries. There is a great scope to increase the productivity of quality produce in temperate horticultural crops if farmers/ stake holders are made aware of latest and scientific technologies generated by various institutions. The ICAR- CITH has made continuous efforts through various research programmes to generate farmer friendly technologies, and recognized as nodal working institute on temperate horticultural crops in the country. The Central Institute of Temperate Horticulture, Srinagar and its Regional stations are putting continuous efforts to make the farmers/ officers of line departments aware of various new technologies generated in temperate horticultural crops for improving productivity and quality. The Institute has tried to disseminate various technologies by organizing number of programs for human resource development. For the quick adoption of technologies, ICAR-CITH is continuously organizing vocational trainings, model training courses, crop days, on campus and off campus trainings as well as demonstrations, ghoshtis, farm visits, diagnostic visits, supply of quality planting material, publication in local language, participation in farmer fairs, radio talk, TV shows and display of exhibits on various occasions/ farmers fair etc. The details of various programmes organized at ICAR-CITH during the year are presented below

Training Programme conducted for Department Personnel

The line departments form the bridge between research organisations and farmer for implementation of technologies and schemes at farmer's field. ICAR-CITH Srinagar organized. Training programmes/ farm visits for the officials of line departments/ scientists during the year 2017-18. The details of training programmes conducting are presented in Table 28.

Hybridization techniques in root vegetable crops (carrot, radish, turnip and beet root)

A three days training programme on 'Hybridization techniques in root vegetable crops (carrot, radish, turnip and beet root)" was conducted for line department officers from Deptt. Of Agriculture Govt. of J&K, technical and supporting staff of ICAR-CITH Srinagar. Twenty six officers/ officials participated in the training programme. The officers/officials were made acquainted to learn the techniques for development of hybrids in various root crops during the programme

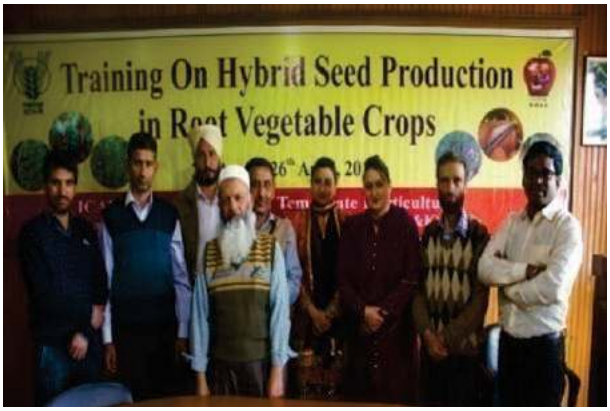
Scope of Temperate Horticulture crops in cold arid region of Ladakh

Two days Training Programme on, "Scope of Temperate Horticulture crops in cold arid region of Ladakh" was organised for officials/officers from Ladakh region from 22th to 23rd September, 2017 at ICAR-CITH Srinagar. Total 15 officials/officers participated in said programme. The participants

were made acquainted with the various aspects of crop diversification in cold arid region of Ladakh.

Production Technology of Winter Vegetables in Jammu and Kashmir

Two 3-days training programmes entitled 'Production Technology of Winter Vegetables in Jammu and Kashmir" was organized separately at the Division of Vegetable Science and Floriculture for line department officers from Kashmir and Jammu divisions. Seventeen officers including AEA, AEO and JAEO from both the divisions participated in the trainings. The aim of these training programmes was to acquaint the officers with advances in scientific and profitable cultivation techniques of winter vegetables popular in different agroclimatic zones of Jammu and Kashmir. The major emphasis was on open and protected cultivation of exotic green leafy vegetables (Chinese cabbage, red cabbage, Swiss chard, lettuce, parsley, and celery), broccoli, cabbage, long day onion, garlic, European type root crops and kale along with their plant protection regimes and post harvest handling and processing. In addition, seeds of exotic vegetable crops were also provided to the participants for promotion of their cultivation in their respective districts.



Glimpses of various training programmes imparted to line departments

Table 28. Training programmes organised for officials/officers of line department personnel during 2017-18

Training Programme	No. of Days	Date	No. of participants	Organizer
Hybridization techniques in root vegetable crops (carrot, radish, turnip and beet root)	03	24th to 27th April, 2017	26	Dr.Selvakumar R Dr.Geetika Malik
Scope of Temperate Horticulture crops in cold arid region of Ladakh	02	22nd to 23rd September, 2017	15	Dr.Geetika Malik Dr.W.H.Raja Sh.Sajad Un Nabi
Production technology of winter vegetables in Jammu and Kashmir for Kashmir Region	3	14-16th November 2017	7	Dr.Geetika Malik Dr.Selvakumar R Sh.Sajad Un Nabi
Production technology of winter vegetables in Jammu and Kashmir for Jammu region	3	16-18th November 2017	10	Dr.Geetika Malik Dr.Selvakumar R Sh.Sajad Un Nabi

Training Programmes/Visits of Students

Apart from well established experimental orchards, the well equipped laboratories are also present at ICAR-CITH Srinagar has become the centre of learning for students and scholars. During the year 8 student groups visited the Institute and were trained on various aspects of temperate horticultural crops. The detail of various visits/ trainings is presented in the Table 29.

Table 29. Training programmes/Visits organised for Students during 2017-18

Training Programme/Visit	No. of Days	Date	No. of participants	Organizer
Training programme on Canopy management of Temperate Fruits for BHT students of KVK, Kargil	06	6th to 11th Dec 2017	8	Dr. A. Sharma Dr. W. H. Raja
Visit of Students of Degree college Baramulla (3rdYear Science students)	1	10.08.2017	60	Dr. D.B. Singh Dr. O.C. Sharma Dr. J.I. Mir
Visit of Students of Jamia ul uloom B.K.Pora Budgam (5th class)	1	16.08.2017	39	Dr. W.H. Raja Mr. Muneer Ahmad
Visit of Chinar Brigade school children Rengreth, Srinagar	1	11.10.2017	60	Dr. O.C. Sharma Dr. Anil Sharma Dr. W.H. Raja
BAPSS, JAKLI Rangreth	1	18.9.2017	47	Dr. Geetika Malik Sh. Sajad Un Nabi
B.Sc 3rd Yr Horticulture Students from SKUAST-K	01	4.11.2017	33	Dr. O.C. Sharma
B.Sc 4TH Yr Forestry Students from SKUAST-K	01	13.11.2017	28	Dr. O.C. Sharma
B.Sc 4TH Yr Agriculture Students from SKUAST-K, Wadura campus	01	18.11.2017	60	Dr. O.C. Sharma

Visit of various student groups to ICAR-CITH

Canopy management of Temperate Fruits for BHT students of KVK, Kargil

Six days training programme on "Canopy management of Temperate Fruits" was organized for BHT students of KVK, Kargil , from 6th to 11th Dec 2017 at ICAR-CITH, Srinagar. During the training programme maximum emphasis was given to practical and hands on canopy management and architectural engineering. Canopy management and plant architectural engineering of apple, pear, peach, kiwi fruit etc were demonstrated through lectures and on farm training.

Training Programme/Visits of farmers

During the year several groups of farmers sponsored by various agencies from different areas visited the Institute and were made aware of various technologies generated at ICAR-CITH. The details of various on and off campus programmes are presented in the Table 30.

Post-Harvest Management and Value Addition of Stone Fruits for farm Youth of Kargil District

Three days training programme on "Post-Harvest Management and Value Addition of Stone Fruits for Farmers of Kargil District" was organised for unemployed youth of Kargil district from 24th to 26th July, 2017 at ICAR-CITH Srinagar. Total 15 number of farmers participated in said training programme. During the training programme maximum emphasis was given on practical and hands on training for development of value added products of stone fruits.

Training on value addition of stone fruits to farm youth of Kargil

Table 30. List of Training programmes/Visits organised for farmers at ICAR-CITH Srinagar during 2017-18

Training Programme/Visit of farmers from different Area/ District	No. of Days	Date	No. of participants	Organizer
Post-Harvest Management and Value Addition of Stone Fruits for Farmers of Kargil District	03	24th to 26th July, 2017	10	Dr.K.L.Kumawat Dr W. H. Raja
One day training program on modern aspects of temperate fruit production organized by ICAR-CITH, Srinagar and state advisory board of farmers.	01	24th May 2017	80	Dr.Geetika Malik Dr.K.L.Kumawat Dr W. H. Raja
Different methods of training /pruning in apple for farmers of Rahmoo, Distt. Pulwama	01	11th January 2018	26	Dr.O.C.Sharma Dr W.H.Raja Sh. Sajad Un Nabi Sh. Shoaib Kirmani
Dangiwachi, Distt. Baramulla	01	03.04.2017	30	Dr.O.C.Sharma
KVK Budgam	01	24.08.2017	25	Sh.Sajad Un Nabi
SKIRKAT NGO, Distt. Pulwama	01	30.08.2017	20	Dr W.H.Raja Dr. Geetika Malik
Training to farmers of District Kargil regarding protected Cultivation of vegetables and fruits	01	06.09.2017	20	Dr W.H.Raja
Farmers from Nyoma Distt. Leh	01	25.09.2017	12	Dr.O.C.Sharma
Officers /Farmers from Distt. Ramban	01	01.11.2017	22	Dr.O.C.Sharma
Farmers and staff from Distt. Kargil	01	03.11.2017	30	Dr.O.C.Sharma
Officials and Farmers from Distt. Poonch	01	04.11.2017	26	Dr.O.C.Sharma
Farmers from Distt.Leh	01	15.11.2017	36	Dr.O.C.Sharma, Mrs. Saima Zahoor
Farmers from Distt. Pulwama	01	15.11.2017	60	Dr.O.C.Sharma Sh.Sajad Un Nabi Mrs. Saima Zahoor
Farmers from District Baramulla	01	19.12.2017	50	Dr. O.C.Sharma Dr.W.H.Raja Dr. Megna

Training Programme/Visit of farmers from different Area/ District	No. of Days	Date	No. of participants	Organizer
Distt.Doda	01	22.12.2017	21	Dr.O.C.Sharma, Mrs. Saima Zahoor
B.K.Pora Distt. Budgam	01	02.01.2018	25	Dr W. H. Raja Sh.Sajad Un Nabi
Trainees (Officers) from Afghanistan	01	02.01.2018	13	Dr. O.C.Sharma
Kellar, Distt. Shopian	01	08.01.2018	10	Dr Geetika Malik Dr.W.H.Raja
District Srinagar	01	10.01.2018	100	Dr Selva Kumar Sh. Sajad Un Nabi
Sub Division Pattan Zone Nihalpora, Distt. Baramulla	01	15.01.2018	80	Dr W.H.Raja Sh. Sajad Un Nabi Sh. S.N.Kirmani
District Srinagar	01	09.01.2018	35	Dr. Geetika Dr. W.H.Raja Dr Selva K
Sub Division Sumbal Distt. Bandipora	01	27.01.2018	80	Dr J.I.Mir Mrs Saima Zahoor Ms. Megna
Chadoora Distt. Budgam	01	08.02.2018	50	Dr O.C.Sharma
Distt. Budgam	01	14.02.2018	50	Dr.W.H.Raja Sh. Sajad Un Nabi
Shogapora Distt. Budgam	01	15.02.2018	28	Dr.W.H.Raja Sh. Sajad Un Nabi
Soibugh Distt. Budgam	01	19.02.2018	28	Dr O.C.Sharma Mrs.Saima Zahoor Miss.Danish Bashir
Soibugh Distt. Budgam	01	20.02.2018	28	Dr O.C.Sharma Sh.Sajad Un Nabi
Distt. Budgam	01	21.02.2018	30	Dr O.C.Sharma Sh.Sajad Un Nabi Sh.S.N.Kirmani
Distt. Budgam	01	22.02.2018	25	Dr.W.H.Raja Sh. Sajad Un Nabi
Distt. Budgam	01	23.02.2018	25	Dr.W.H.Raja Sh. Sajad Un Nabi
Shogapora Distt. Budgam	01	24.02.2018	28	Dr O.C.Sharma
District Budgam	01	26.02.2018	150	Dr. D.B.Singh Dr. O.C.Sharma Dr. W.H.Raja
District Budgam	01	26.02.2018	28	Dr. O.C.Sharma Dr. W.H.Raja
Razwen District Budgam	01	27.02.2018	28	Dr. O.C.Sharma
District Budgam	01	28.02.2018	25	Dr. O.C.Sharma Dr. W.H.Raja
Khandah Zone District Budgam	01	8.03.2018	25	Dr O.C.Sharma Dr. W.H.Raja

Training Programme/Visit of farmers from different Area/ District	No. of Days	Date	No. of participants	Organizer
Nagam District Budgam	01	8.03.2018	50	Dr. O.C.Sharma Dr. W.H.Raja Mrs.Saima Zahoor Miss.Danish Bashir
Charari-Sharief District Budgam	01	10.03.2018	25	Dr. O.C.Sharma
District Bandipora	01	19.03.2018	50	Dr O.C.Sharma Dr. W.H.Raja
District Pulwama	01	19.03.2018	64	Dr O.C.Sharma Dr. W.H.Raja
Tangmarg Distt. Baramulla		29.03.2018	20	Dr.D.B.singh




























Trainings/Visits of different groups of farmers at ICAR-CITH

Table 31: Off Campus training programmes conducted during 2017-18

Training Prgramme	Venue	No. of Days	Date	No. of Participants	Organizers
Training programme on Production and Protection practices of CITH-G1	Solan, Himachal Pradesh	01	7th July 2017	20	Sh.Sajad Un Nabi Sh.Mudasir Magray
Diversification in Temperate Horticultural Crops for Sustainable Income	West Kameng ,Arunachal Pradesh	01	16th June, 2017	20	Dr.S.Lal Dr.K.L.Kumawat
Modern aspects of Temperate fruit production (Under MIDH)	Udooru, Distt. Kulgam	01	04th January. 2018	78	Dr.W.H.Raja Sh. Sajad Un Nabi Mr. Muneer


Various off Campus training programmes

Exhibitions

The ICAR-CITH, Srinagar and Regional station Mukteshwar displays its technologies by putting exhibition stalls on various occasions and programs. The details of various exhibitions displayed during 2017-18 are presented in Table 32.

Table 32: Participation in various exhibitions during 2017-18

Date	Occasion	Organizer/Venue	Participating Team
3rd July to 6th July 2017	Rising Kashmir, 2017	Sansa Foundation, at SKICC, Srinagar	Dr W.H.Raja Mr.Sajad Un Nabi Mr Eshan Ahad Mr Muneer Ah. Sheikh Mr Istiyaq Ahmad Mr Aijaz Ah Wani
4th July 2017	Kisan Mela	SKUAST-K, Shalimar Srinagar	Dr O.C.sharma Dr W.H.Raja Mr.Sajad Un Nabi Mr Muneer Mr Istiyaq
23-24th August 2017	Two Days Workshop	Leh	Dr O.C.sharma Dr.A.Sharma Dr.S.Lal Mr.G.N.Bhat

Date	Occasion	Organizer/Venue	Participating Team
28th February to 31st Feb 2018	Vision Jammu and Kashmir, 2018	Sansa Fouudation , at Nand Palace Dhar Road, Udhampur	Dr W.H.Raja Mr Muneer A.Sheikh
February, 23-25, 2017	North Zone Farmer Fair	ICAR-IIVR, Varanasi	Dr.A.Sharma Dr. K.L.Kumawat Mr. G.N.Bhat
6-7th March 2018	Two days Seminar	ICAR-CITH,RS, Mukteshwar	Dr Rajnarayan Dr.J.I.Mir Dr.S.Lal Dr.A.Kishore
11-12th March 2018	Kisan Mela	SKUAST-K, Shalimar,	Dr O.C.Sharma Dr W.H.Raja Dr Selva Kumar Mr Muneer A Sheikh Mr Istiyaq Ahmad
16-19th March	Krishi Unnati Mela	Mela Ground, ICAR-IARI, New Delhi	Dr Selva Kumar Mr.Sajad Un Nabi Mr Istiyaq ahmad

Exhibitions displayed by ICAR-CITH at different occasions

Training Programmes conducted at RS-ICAR-CITH Mukteshwar

For the dissemination of technologies in Uttarakhand, ICAR-CITH, RS Mukteshwar is continuously organising various extension activities for the farmers, officers of line department and students. The various training programmes organised are presented in Table 33.

Table 33: Training/conducting programmes/demonstration/workshops/seminars during 2017-18

S. No.	Name of the programmes	Date & place	Number of participants	Organizer/coordinator
1.	One day awareness programme on "Swachchhata abhiyan and waste decomposition"	22.05.2017 Sunkiya village	16	Dr Raj Narayan, Dr Anil Kumar, Dr Arun Kishor, Mr Sovan Debnath
2.	One day awareness programme on "Swachchhata abhiyan and waste decomposition"	23.05.2017 Pokhrad village	39	Dr Raj Narayan, Dr Anil Kumar, Dr Arun Kishor, Mr Sovan Debnath
3.	Awareness camp on "Waste/ garbage and harmful chemical containers management/disposal"	29.05.2017 G.I.C., Kasiyalekh village	29	Dr Raj Narayan, Dr Anil Kumar, Dr Arun Kishor,
4.	Awareness programme on "One health concept"	31.05.2017 ICAR-CITH, RS, Mukteshwar	42	Dr Raj Narayan, Dr Anil Kumar, Dr Arun Kishor,
5.	One day training cum awareness programme on Sabji, phal avam phalotpadan taknik	17.06.2017 ICAR-CITH, RS, Mukteshwar	17	Dr Arun Kishor, Dr Raj Narayan
6.	One day training cum exposure visit	19.07.2017 ICAR-CITH, RS, Mukteshwar	23	Dr Arun Kishor, Dr Raj Narayan
7.	One day training program on soil health management for sustainable horticultural crops	31.07.2017 ICAR-CITH, RS, Mukteshwar	88	Mr Sovan Debnath, Dr Raj Narayan, Dr Arun Kishor
8.	One day district training cum exposure visit	31.07.2017 ICAR-CITH, RS, Mukteshwar	18	Dr Arun Kishor, Dr Raj Narayan
9.	Apple day/show cum apple grower's meet	18.08.2017 ICAR-CITH, RS, Mukteshwar	159	Dr Arun Kishor, Dr Raj Narayan
10.	One day training cum exposure visit	07.09.2017 ICAR-CITH, RS, Mukteshwar	22	Dr Arun Kishor, Dr Raj Narayan
11.	Three days training program on Akhrot Nursery avam Akhrot Utpadan	20-22 September, 2017 ICAR-CITH, RS, Mukteshwar	7	Dr Arun Kishor, Dr Raj Narayan
12.	One day training program on training and pruning in temperate fruits	07.12.2017 farmer field, Dutkanidhar village	15	Dr Arun Kishor, Dr Raj Narayan
13.	One day training program on FAP cum workshop on doubling farmers income through hi-tech horticulture	30.11.2017 ICAR-CITH, RS, Mukteshwar	164	Dr Raj Narayan, Dr Arun Kishor

S. No.	Name of the programmes	Date & place	Number of participants	Organizer/coordinator
14.	Two days training program on Walnut promotion and planting material production in Uttarakhand	01-2 February, 2018 ICAR-CITH, RS, Mukteshwar	36	Dr Raj Narayan, Dr Arun Kishor
15.	Two days seminar on emerging trends in hi-tech hill horticulture under changing climate	6-7 March, 2018 ICAR-CITH, RS, Mukteshwar	160	Dr Raj Narayan, Dr Arun Kishor
16.	FAP on protedcted vegetable cultivation and diagnosis visit	22-4-2017 Kausani, Almora	-	Dr Raj Narayan
17.	Organized exposure visit of students of Hermann Miner School, Bhimtal on.	14.05.2017 ICAR-CITH, RS, Mukteshwar	120	Dr Raj Narayan, Dr Arun Kishor
18.	Organized exposure visit of U.G. students of Delhi University, Delhi	on 27.10.2017 ICAR-CITH, RS, Mukteshwar	25	Dr Raj Narayan, Dr Arun Kishor
19.	Organized exposure visit of B.Sc. students of G.B.P.U.A. & T., Pantnagar on.	26.11.2017 ICAR-CITH, RS, Mukteshwar	25	Dr Raj Narayan, Dr Arun Kishor
20.	Organized exposure visit of students of botany (Honours), Miranda House, Delhi University, Delhi on	24.02.2018 ICAR-CITH, RS, Mukteshwar	21	Dr Raj Narayan, Dr Arun Kishor

Radio/TV Talks

The institute is continuously using mass media (Radio/Television/News paper) for dissemination of various technologies generated at institute for the benefit of the farmers. The detail of radio/TV talks delivered by scientists is presented in Table 34.

Table 34. Radio/TV talks delivered by scientists during 2017-18

S.No.	Scientist	No. of Talks
1	Dr.D.B.Singh	4
2	Dr.Raj Narayan	1
3	Dr.J.I.Mir	4
4	Dr.Shiv Lal	2
5	Dr.A.Kishore	2
6	Dr.Wasim H. Raja	2
7	Sh. Sajad Un Nabi	2

Implementation of Mera Gaon Mera Gaurau Programme

Jammu & Kashmir

Anantnag

For implementation of Mera Gaon Mera Gaurav programme planting material of apple, peach, apricot, almond, cherry and vegetable seeds were distributed among 60 beneficiaries at Hatigam village of district Anantnag, Jammu & Kashmir on 27th February, 2018. Team led by Dr Javid Iqbal Mir, Senior Scientist and Mr Sajad Un Nabi, Scientist, ICAR-CITH, Srinagar implemented this programme at Hatigam village under which various visits were made during 2017-18 for generating awareness among the farmers of the village about MGMG scheme. Under this programme two demonstrations were laid down on High Density Plantation in apple in the village in collaboration with Horticulture Department of the District.

Distribution of planting material under MGMG at Hatigam

Pulwama

Under MGMG scheme, Planting material, vegetable seed and seedlings were distributed among the 30 beneficiarie of village Urcharso District Pulwama. Team led by Dr W.H.Raja, Scientist and Mr S N.Kirmani, STO, ICAR-CITH interacted with the farmers regarding the benefits of the scheme and various aspects of temperate fruit production.

Demonstrating planting to farmers of Urcharsoo District Pulwama (MGMG)

Uttarakhand

In Uttarakhand various activities under MGMG were carriedout at Sunkiya village. Total 86 plants of different fruit crops namely Apple (Oregon Spur, Chaubattia Princess, CITH Lodh Apple-1), Plum (Santa Rosa, Satsuma) and Walnut (CITH-W-1) were planted in approximately 3096 m^2 area at 4 farmers in selected villages (Sunkiya,) during the year 2017-18. However, the fruit crops plants are in growing stage. In vegetables, total 20080 seedlings of different vegetable genotypes Chinese Cabbage (Solan Band Sarson), Lettuce (Solan Kirti), Tomato (VL-4, Manisha, H-86, Laxmi, Aman, Shahansha, Dev, Badshah, PS-2225, Navin, Abimanyu),

Capsicum (California Wonder, Orobelle, Yamuna, Bomby, Bharat, Lucky Star, Sel-2, Sel-4, Sel-5), Onion, Local Cucumber, Brussels Sprout and 6 Kg seeds of Garden Pea (VL-10) were planted in approximate 1950 m^2 area at 54 farmers and animal medicines were distributed for 30 cattle's in 26 farmers at selected villages during the year 2017-18. Besides many trainings and demonstrations on various technologies were carried out in this village.

Tribal Sub Plan (TSP)

District Ganderbal

Implementation of Tribal Sub Plan Scheme for district Ganderbal was done by Dr Javid Iqbal Mir, Senior Scientist, ICAR-CITH, Srinagar and his team on 8th February, 2018 during which planting material of apple, pear, peach, plum, apricot, almond and vegetable seeds were distributed among 101 tribal farmers of Babanagri, Kangan. Also a visit was made to the area for checking the performance of plants distributed during previous years under the scheme.

Correction pruning and training was done to the plants which were not properly managed. On-spot guidance was provided to the farmers for proper pruning, training, nutrition management, irrigation etc for obtaining higher productivity. Training to 50 tribal farmers on "Canopy management and plant architecture engineering of apple and other horticultural crops under HDP" under TSP programme on 8th February, 2018 at Babanagri, Ganderbal.



Distribution of planting material, correction training and pruning under TSP at Babanagri, Ganderbal

District Poonch

A three day TSP and NMSHE programme for the 'Benefit of tribal farmers of Poonch district through popularization of technologies, distribution of planting material/vegetables seed and training on technological advances in quality fruit production in higher Himalayan region' was organized at, Daradullian and Shahpura villages of Poonch district from 28/03/2018 to 02/03/2018 by ICAR-Central Institute of Temperate Horticulture, Srinagar. The programme was exclusively conducted for the tribal farmers of Poonch district under TSP Scheme to create awareness about production technology of temperate fruit crops and vegetables for livelihood security. A total, fifty (65) farmers consisting of 11 females and 54 males participated in the programme. Awareness and training were imparted to Farmers regarding the scientific cultivation of temperate fruit crops and orchard management practices for better returns and nutritional security. Technologies related to pome and stone crops, new varieties, planting methods, training and pruning was popularized among the participating farmers through practical demonstration. Besides at various sites in Poonch on-farm demonstrations in farmer's field for training and pruning of unproductive orchards were also provided. During the programme, the planting material of apple, peach, cherry and apricot in addition seed of Turnip, Cabbage peas and Swiss chard were also distributed free of cost among the participating tribal farmers. The monitoring and supervision of previous years sites under TSP at District Rajouri were carried out and on spot instructions and guidance were provided

Distribution of planting material, and demonstration of training and pruning under TSP at in Distt. Poonch

to farmers for proper upkeep and maintenance of plants on scientific lines so that maximum benefits can achieved.

District Udhampur

One day training programme was organized for tribal farmers of Basantgarh area of district Udhampur under Tribal Sub-Plan on March 10th, 2018. Around 60 farmers participated in the programme. Planting material was distributed to these farmers. Officers from state horticulture department and local sarpanch were also present during the programme.

Distribution of planting material under TSP at Basantgarh in Distt. Udhampur

Trainings and Capacity Building 10

Participation in trainings

Dr J I Mir, Sr. Scientist

- Attended winter school on "Next generation sequencing for crop improvement" at NRCPB, New Delhi w.e.f. 1st to 21st December 2017.

Dr Shiv Lal, Scientist (Fruit Science)

- Attended 21 days winter school on "Enhancing the productivity of rainfed agro-ecosystem through suitable interventions" organized at Dryland Farming Research Station, Maharana Pratap University of Agriculture & Technology, Udaipu, Bhilwara w.e.f.14th Dec.,2017 -3rd, Jan.2018

Dr Geetika Malik, Scientist (Vegetable Science)

- Attended 21 days summer school on 'Modeling and advances in micro irrigation for improving water use efficiency' at SKUAST-K, Shalimar w.e.f. 5 to25th July, 2017.

Dr Wasim Hassan Raja, Scientist (Fruit Science)

- Attended 21 days CAFT, training programme on Importance of molecular markers for study of genetic diversity and crop improvement at RARI, Durgapur, Rajasthan. W.e.f.1st to 21st November, 2017.

Mr Sajad Un Nabi, Scientist (Plant Pathology)

- Attended short course on synthesis and characterization of nanomaterial for plant protection and growth held at MPUAT, Udaipur Rajasthan w.e.f. 5th -14th March 2018

Dr Selvakumar R, Scientist (Vegetable Science)

- Attended winter school on "Molecular breeding for higher productivity, quality, food colourants, nutraceuticals and bioactive health compounds in vegetable crops" by IARI-Division of Vegetable Science from 13th February -5th March, 2018 at New Delhi

Dr Raj Narayan, Principal Scientist (Vegetable Science)

- Attended one day institutional arranged learning training on GeM on 20.12.2017 at ICAR-DCFR, Bhimtal, Nainital, Uttarakhand.

Trainings attended by Technical Staff

- Sh Muneer Ahmad Sheikh, Sr Technical Assistant attended 10 days training programme on advanced tissue culture and molecular biology held at division of plant biotechnology, SKUAST-K Shalimar, Srinagar w.e.f. 20th to 29th March, 2018.

Trainings attended by Administrative Staff

- Sh. Mukul Raj Singh, Administrative Officer attended training on administrative and financial management for Under Secretaries, SAO's, SFAO's, AO's &FAO's of ICAR held at ICAR-NAARM, Hyderabad w.e.f.17th to 23rd August, 2017.
- Sh. Mukul Raj Singh, administrative officer attended national training on procurement &PFMS held at ICAR-CPRI, Shimla w.e.f.10th to 15th September, 2017.
- Sh. Fayaz Ahmad Dar, AF&AO attended training on general financial rules-2017 held at ISTM- New Delhi w.e.f.22nd to 23rd August, 2017.
- Sh. Akhil Thukral, AAO attended one day institutional arranged learning training on Gem held at ICAR-DCFR- Bhimtal on 20th December, 2017.
- Sh. Akhil Thukral, AAO attended institutional arranged learning training on PFMS held at ICAR-DCFR- Bhimtal w.e.f.19th to 22nd February, 2018.
- Sh. Showkat Ahmad Mir, assistant attended training on pension and other retirement benefits (PRB-10) held at ISTM New Delhi w.e.f.3rd to6th July, 2017.

- Sh. Showkat Ahmad Mir, assistant attended training on reservation in services held at ISTM New Delhi w.e.f.13th to 15th November, 2017.
- Smt. Shahida Rafiq, personal assistant attended training on enhancing efficiency and Behaviour Skills of Stenographers Grade-iii, PA, PPS&Sr PPS of ICAR held at CIFE, Mumbai w.e.f.3rd to 9th September,2017.
- Sh. Pushpendra Kumar, LDC attended one day institutional arranged learning training on Gem held at ICAR-DCFR- Bhimtal on 19th to 22nd February, 2018.
- HRD Fund Allocation and Utilization (2017-18):
- Rs in Lakhs

Head	Allocation	Expenditure
Unified Budget	2.50	1.70

Awards/Rewards/Recognition received during the year

11

Dr D B Singh (Director)

- Received Dr J C Anand Memorial Gold Medal In Post Harvest Technolgy-2017 on 6th November, 2017 at Dr B P Pal Auditorium , IARI, Pusa, New Delhi.

Dr D B Singh, receiving J C Anand Memorial Gold Medal in Post Harvest Technology

Dr Raj Narayan (Principal Scientist)

- Received first prize for lead lecture in the seminar on hi-tech hill horticulture in changing climate, 6-7 March, 2018, organized by ICAR-CITH, RS, Mukteshwar, Nainital, Uttarakhand. P. 5-11.

Dr O C Sharma (Principal Scientist)

- Received Bharat Jyoti Award 2017 by IIFS, New Delhi on 20th Dec, 2017 during seminar on National Growth and National Integration.

Dr JI MIR (Sr Scientist)

- Received Best Researcher Award during National Seminar on Saffron Production and Promotion at SKUAST-K on August, 7, 2017
- Received best poster award during National Seminar on Saffron Production and Promotion at SKUAST-K on August, 8, 2017

Dr J I Mir, receiving Best Researcher Award

- Received Best poster award during National Conference on "Climate Change and Agricultural Production" organized by BAU, Bhagalpur and Indian Ecological Society, Ludhiana from 6-8 April, 2017
- Received best Lead Lecture Award during Seminar on "Emerging trends in hi-tech horticulture in changing climate" organized at ICAR-CITH, Regional Station Mukteshwar from March 6-7, 2018 at Mukteshwar.

Dr Shiv Lal (Scientist, Sr Scale)

- Received Dr B.R. Barwale Young Researcher Award in Horticultural Biotechnology -2017 conferred by Horticulture Society of India, Cash prize 12500/- certificate, medal and citation was presented during the function held at New Delhi.
- Received Young Scientist Award-2017 by The Society of Tropical Agriculture, New Delhi (India).
- Received KanwarVirender Singh Memorial All India Best Publication Awards in Fruit Science 2017 by Society for Advancement of

Dr. Shiv Lal receiving Dr. B.R. Barwale young researcher award

Human and Nature, Dr YS Parmar University of Horticulture and Forestry Nauni, Solan 173 230 Himachal Pradesh, India. Rs.1000 cash prize, citation and certificate.

- Best oral presentation award for paper presented on "Olive cultivation under horticulture farming system during seminar entitled "Emerging trends in Hi tech Hill Horticulture under changing climate" held from March 6-7, 2018 at ICAR-CITH RS Mukteshwar (Uttarakhand).

Dr Arun Kishore, Scientist (Fruit Science)

- Received first prize for best oral research paper in the seminar on emerging trends in hi-tech hill horticulture in changing climate, 6-7 March, 2018, organized by ICAR-CITH, RS, Mukteshwar, Nainital, Uttarakhand.

Dr Shiv Lal, Receiving Young Scientist Award-2017

Dr Selvakumar R (Scientist)

- Received "Young Scientist Award" during 'International Conference on Agriculture, Horticulture and Plant Science organized by Indian Society of Tropical Agriculture at Anandam Resort, Rishikesh, Uttarkhand on June 24-25, 2017
- Received "Young Researcher Award" during International Conference on Advances in Agriculture and Crop Science organized by Clyto Access at Hyatt Regency, Gurgaon on October 9, 2017.
- Received "Young Scientist Award" during National Seminar on Farmer Centric Cinema at ICAR-IISR on October 14-16, 2017 at Lucknow.
- Received "Gold Medal – Dwarika Nath Memorial Award-2017" for Best PhD Thesis during the National Conference on Food and Nutritional Security through Vegetable Crops in relation to Climate Change (NCVEG-17) organized by ICAR-Indian Institute of Vegetable Research and Indian Society of Vegetable Science from December 9-11 at Varanasi.
- Received "Best Poster Award" during National Conference on Food and Nutritional Security through Vegetable Crops in relation to Climate Change (NCVEG-17) organized at ICAR-Indian Institute of Vegetable Research and Indian Society of Vegetable Science from December 9-11 at Varanasi.
- Received "Excellence and Innovation Research Award" in Horticultural Sciences during National Education Summit-2017, Madurai on December 10th, 2017.

Dr Selvakumar R recieving "Dr Dwarka Nath Award-2017" at ICAR-Indian Institute of Vegetable Research, Varanasi

Dr Selvakumar Recieving "Young Scientist Award-2017" at ICAR-Indian Institute of Sugarcane Research, Lucknow

- Received "Official Spotlight Certificate Award" during 6th Academic Brillance Award, 28th January 2018 at Noida.
- Received "Best PhD Thesis Award in Vegetable Science" during National Conference on Innovative Technological Interventions for Doubling Farmers Income" organized by Society for Integrated Development of Agriculture, Veterinary and Ecological Science (SIDAVES) from February 8 -10, 2018 at SKUAST-Jammu.

Mr Sajad Un Nabi (Scientist)

- Received Young Scientist Award-2017 in Agriculture from Society of Photochemistry and Pharmacognosy for the year 2017
- Received best poster award during National Seminar on Saffron Production and Promotion at SKUAST-K on August, 8, 2017

12 Publications

Research Papers (International/ National)

- Attri BL, Kumar A, Mer MS and Kishor A. (2017). Standardization of novel technique for preparation of ginger (*Zingiber officinale*)-blended wine from different cultivars of pear (*Pyrus communis*). *Indian Journal of Agricultural Sciences*; 87(7): 878-82.
- Chand L, Singh DB, Sharma OC , Mir JI, Kumawat KL, Rai KM , Rather SA, Qureshi I, Lal S and Dev I .(2017). Lateral Bearing Trait in Indian Walnut (*Juglans regia* L.) Germplasm: a Potential Yield Contributing Trait in Early Age of the Tree. *International Journal of Bio-resource and Stress Management.* 8(5):605-610.
- Choudhary DK , Kumar A and Nabi SU. 2017, In-vitro evaluation of Arabidopsis thaliana ecotypes against *Ralstonia solanacearum* Race 4, *International Journal of current microbiology and Applied science* 6(5):575-579.
- Choudhary N, Bawa V, Paliwal R, Singh B, Bhat MA, Mir JI, Gupta M, Sofi PA, Thudi M, Varshney RK, Mir RR .(2018). Gene/QTL discovery for Anthracnose in common bean (*Phaseolus vulgaris L.)* from North-western Himalayas. *PLOS ONE*, 13(2): e0191700 .
- Debnath S, Attri BL, Kumar A, Bhatt SC, Kishor A, Narayan R and Singh DB. (2017). Relationship among different forms of soil potassium and availability as influenced by the contrasting management practices in apple (*Malus domestica* Borkh.) orchards of kumaon region. *The Bioscan*; 12(1): 477-484.
- Debnath S. Patra, AK. Purakayastha TJ. (2017). Assessment of methods for measuring soil microbial biomass carbon in temperate fruit-tree based ecosystems. *Communications in Soil Science and Plant Analysis* 48(21): 2534-2543.
- Kishor A, Narayan R, Brijwal M, Attri BL, Kumar A and Debnath S. (2017). Studies on physico-chemical characteristics of different apple strains collected from Nainital district of Uttarakhand. *International Journal of Chemical Studies*; 5(5): 47-50.
- Kishor A, Narayan R, Brijwal M, Attri BL, Kumar A and Debnath S. (2017). Comparative assessment of physico-chemical characteristics among different peach cultivars under mid hill conditions of Uttarakhand. *Chemical Science Review & Letters*; 6(23): 1677-1680.
- Kishor A, Narayan R, Brijwal M, Kumar A, Attri BL, Debnath S and Joshi KK. (2017). Variability in physico-chemical characteristics of plum genotypes collected from kumaon hills of Uttarakhand. *Chemical Science Review & Letters*; 6(21): 520-524.
- Kishor A, Verma SK, Brijwal M, Narayan R, Kumar A, Debnath S and Mer MS. (2017). Yield and physico-chemical performance of different kiwifruit cultivars in Kumaon hills of Uttarakhand. *Research on Crops*; 18(2): 256-259.
- Kumar D, Lal S and Singh DB .2018. Genetic diversity of 23 indigenous almond (*Prunus amygdalus*) genotypes under North West Himalayan region of India. *Indian Journal of Agricultural Sciences* 88 (2): 333–339.
- Kumar S, Sharma A, Sharma VK, Ahmed N, Rosin KG and Sharma OC. (2018) Integrated fertilization: An approach for higher apple (*Malus domestica*) productivity and ecological health of soil. *The Indian Journal of Agricultural Sciences*; 88(2):222-227.
- Kumawat KL, Sarolia DK , Kaushik RA and Jodha AS. (2017). Effect of irrigation and fertigation scheduling on growth, flowering,

yield and economics of guava cv. Lalit under ultra high density planting system. *Indian J. Hort.* 74(3): 362-668.

- Lal S, Sharma OC and Singh DB .2017. Effect of tree architecture on fruit quality and yield attributes of nectarine *(Prunus persica* var. nectarina) cv. Fantasia under temperate condition. *Indian Journal of Agricultural Sciences.* 87 (8): 1008–12.
- Lal S, Sharma OC and Singh DB .2017. Genetic diversity and character association analysis based on pomological traits in olive (*Olea europaea* L.). *Journal of Applied and Natural Science* 9 (3): 1551-1556.
- Lal S, Sharma OC, Singh DB, Rather SA and Qureshi I. (2018). Tree growth, fruit quality and yield attributes as affected by tree spacing and varieties of peaches/nectarine under temperate climate. *International Journal of Chemical Studies* 6(2): 308-311.
- Lal S, Sharma OC, Singh DB, Rather SA, Padder BA and Qureshi I .2017. Genetic divergence of horticultural traits among olive (*Olea europea* L.) genotypes grown in temperate climate. *Int.J.Curr.Microbiol.App. Sci.,* 6(8): 2120-2130.
- Lal S, Singh AK, Singh SK, Srivastav M, Singh BP, Sharma N and Singh NK. 2017. Association analysis for pomological traits in mango (*Mangifera indica* L.) by genic-SSR markers. *Trees.* 31(5):1391-1409 .
- Lal S, Singh DB, Sharma OC, Rather SA and Qureshi I .2017. Assessment of genetic variability among antioxidant constituents in Husk tomato (*Physalis ixocarpa* Brot.) selections grown in temperate region. *Journal of Pharmacognosy and Phytochemistry* 6(6): 1188-1193.
- Malik G, Mahajan V, Dhatt AS, Singh DB, Sharma A, Mir JI, Wani SH, Yousuf S, Shabir A and Malik AA. (2017). Present status and future prospects of garlic (*Allium sativum* L.) improvement in India with special reference to long day type. *Journal of Pharmacognosy and Phytochemistry*. 6 (5): 929-933.
- Malik AH, Nathar VN and Mir JI. (2017). Gas Chromatography-Mass Spectrometry (GC-MS) analysis in Callus Extracts of *Ruta graveolens* L. *World Journal of Pharmaceutical Research*. 6(12): 1195-1210.
- Malik AH, Nathar VN and Mir JI. (2017). GC-MS analysis of Methanolic Extracts of *Ruta Graveolens* L. for Bioactive Compounds. *Am. J. PharmTech Res*. 7(2): 315-324
- Malik G , Dhatt AS and Malik AA .(2017) Isolation of male sterile and maintainer lines from North Indian onion (*Allium cepa* L.) populations with the aid of PCR based molecular marker. *Vegetos* 30 (2) *doi: 10.5958/2229-4473.2017.00142.2*
- Mir JI , Nabi SU, Sharma OC, Sharma A, Lal S, Singh DB , Raja WH, Kumawat KL, Sheikh MA , Shafi W, Jan S and Afzal A .(2018). Flower enhancement in saffron under controlled conditions using plant growth regulators. *International Journal of Fauna and Biological Studies*. 5(1): 171-173.
- Mir JI, Ahmed N, Itoo H, Sheikh MA, Wani SH, Rashid R and Mir H. (2017). Technique to minimize phenolics in walnut in vitro culture initiation. *Indian J. Hort.* 74(2): 285-287
- Mir JI, Ahmed N, Singh DB, Padder BA , Shafi W, Zaffer S, Hamid A and Bhat HA. (2017). Diversity evaluation of fruit quality of apple (*Malus domestica* Borkh.) germplasm through cluster and principal component analysis. *Indian Journal of Plant Physiology*. 22(2):221–226.
- Mishra G, Debnath S, Rawat D. (2017) Managing Phosphours in terrestrial ecosystem: a review *European Journal of Biological Research*. 7 (3): 255-270.
- Nabi SU, Raja WH, Sharma A, Malik G, Selvakumar R, Singh DB , Mir JI , Sheikh MA and Wani SH. (2017) Evaluation of Different Substrates for Development of *Trichoderma harzianum* Based Stock Cultures and Their Utilization in Management of Chilli Wilt Disease, *Chem Sci Rev Lett*. 6(24), 2229-2235.
- Sarkate A, Banerjee S, Mir JI, Roy P and Sircar D .(2017). Antioxidant and cytotoxic activity of bioactive phenolic metabolites isolated from the yeast-extract treated cell culture of apple. *Plant Cell Tiss Organ Cult.*

DOI 10.1007/s11240-017-1253-1260.

- Selvakumar R, Kalia P and Raje RS .(2017). Genetic analysis of root yield and its contributing traits in tropical carrot (*Daucus carota* L.) *Journal of Indian Horticulture*. 74(2): 214-219.
- Shah UN, Mir JI, Ahmed N, Jan S, Fazili KM. (2018). Bioefficacy potential of different genotypes of walnut *Juglans regia* L. *J Food Sci Technol*. 55(2):605–618
- Sharma A, Ahmed N, Kumar S, Kumar D, Sharma OC and Khan S. (2017). Production efficiency based land use planning for Almond- A new modus operandi. *Fruits*. 72(4):247-257
- Sharma A, Kumar S, Lal S, Malik G, Sharma OC, Mir JI, Singh DB, Raja WH and Arora S. (2018). Nutrient Saving and Yield Enhancement through fertigation in Apple-Growing Cold Humid Regions of North-west Himalayas. *Journal of the Indian Society of Soil Science*. Vol. 66, No. 1, pp 96-102.
- Sheikh AA, Jabeen N, Sheikh AA, Yousuf N, Nabi SU, Bhat TA and Sofi PA. (2017) Evaluation of French Bean Germplasm Based on Farmer Specified Attributes through Participatory Varietal Selection (PVS) In Kashmir Valley. *International Journal of Pure Applied Bioscience*. 5(2): 585-594.
- Sheikh MA, Bhat KM, Mir JI, Mir MA, Nabi SU, Bhat MA, Ahmad H, Shafi W, Zaffer S, Jan S and Raja WH .(2017). Phenotypic and molecular screening for diseases resistance of apple cultivars and selections against apple scab (*Venturia inaequalis*). *International Journal of Chemical Studies*. 5(4): 1107-1113.
- Sheikh MA, Wani SH, Mir JI, Singh DB, Sharma OC, Nabi SU, Bashir D, Dar G, Shafi W, Jan S and Rashid M .(2018). Effects of IBA and GA3 on Rangpur lime (*Citrus limonia* Osbeck). *Journal of Pharmacognosy and Phytochemistry*. 7(1): 1559-1561.
- Singh A, Srivastav M, Singh SK and Lal S .2017. Effect of microbial-inoculants on growth and biochemical parameters of mango plantlets during bio-hardening. *Indian J. Hort*. 74(1): 20-26.
- Srivastava KK, Singh DB, Kumar D, Singh SR, Sharma OC and Lal S .2017. Effect of planting densities and varieties on yield and yield associated characters of apple (*Malus x dometica*) on semi-dwarfing rootstock. *Indian Journal of Agricultural Sciences* 87(5):593-596.
- Srivastava KK, Kumar D, Mir JI and Singh SR. (2017). Tree architecture influenced productivity and quality attributes in apple under HDP. *Indian J. Hort*. 74(4):486-490.
- Wani SH, Bhat HA, Mir JI, Akbar SA, Nabi SU, Singh DB, Ahmad N. (2017). Quantitative Analysis of Irigenin in the Different Species of *Iris Plant* by RP- HPLC and its Efficacy against Different Plant Pathogens. *Pharmacogn J*. 9(6): 23-27..
- Wani SH, Bhat HA, Mir JI, Singh DB, Ahmad N, Dar SA and Mantoo SA. (2017). Quantitative Analysis of Iridin in the Different Species of Iris Plant by Reverse Phase High Pressure Liquid Chromatography. *Chemical Science Review and Letters*. 6 (21): 88-93.
- Wani SH, Padder BA, Mokhdomi T, Mir JI, Bhat HA, Qazi PH and Qadri RA. (2017). Antiproliferative activity of methanolic extracts of different *Iris* plant species against A549 and caco-2 cell lines. *Journal of Pharmacognosy and Phytochemistry*. 6(6): 1034-1037.

Review Articles

Scientific/teaching reviews

- Choudhary DK, Nabi SU , Dar MS and Khan KA , Ralstonia solanacearum: A wide spread and global bacterial plant wilt pathogen, *Journal of Pharmacognosy and Phytochemistry* 2018; 7(2): 85-90.
- Lal S, Singh DB , Sharma OC , Mir JI , Sharma A, Raja WH, Kumawat KL, Rather SA. 2018. Impact of climate change on productivity and quality of temperate fruits and its management strategies. *International Journal of Advance Research in Science and Engineering*.7(4):1833-44.
- Nabi SU, Raja WH, Kumawat KL, Mir JI, Sharma OC , Singh DB and Sheikh MA. (2017). Post Harvest Diseases of Temperate

Fruits and their Management Strategies-A Review. *Int. J. Pure App. Biosci*. 5 (3): 885-898.

- Sheikh AA, Khursheed I, Ahmad MJ, Ahad I, Tali FA and Nabi SU. (2017). Role of infochemicals to enhance the efficacy of biocontrol agents in pest management, *International Journal of Chemical Studies* 5(3): 655-662.

Technical/popular articles:

- Lal S, Singh DB, Sharma OC, Mir JI, Sharma A and Padder BA.2017. Olive cultivation. Technical bulletin 02/2017, ICAR-CITH, Srinagar. 18 pp.
- Lal S, Singh DB, Sharma OC, Mir JI, Sharma A, Rather SA. 2017. Scientific olive cultivation. Extension folder-2/2017. Published by Director, ICAR-Central Institute of Temperate Horticulture, K.D. Farm, Old Air Field, Srinagar, J&K, (India).
- Malik G, Masoodi L, Nabi SU, Sharma A and Singh DB . (2017). Production Technology of Cherry Tomato in Kashmir. Extension booklet published by Director, ICAR-CITH, Srinagar. 11p.
- Malik G, Shabir A, Sharma A and Singh DB. (2017). Scientific Production of Vegetable Nursery. Extension folder published by Director, ICAR-CITH, Srinagar.
- *Malik G, Singh DB , Sharma A, Sharma OC , Mir JI , Magray M.(2017) 'Production technology of exotic vegetables in Jammu and Kashmir'. Technical bulletin published by Director, ICAR-CITH, Srinagar. 44p.*
- Mir J I, Singh DB, N Ahmad, Sharma OC , Sharma A, Srivastava KK, Lal S, Kumawat KL, Raja WH, Jan A and Kirmani SN. 2017. High density plantation in apple. Published by Director ICAR-Central Institute of Temperate Horticulture, Srinagar. 24p.
- *Nabi SU, Malik G, Singh DB , Sharma A, Mir JI , Selvakumar R, Magray M. (2017) Production and Protection Practices of garlic variety CITH-G-1. CITH garlic cultivation folder-1/2017 published by Director, ICAR-CITH, Srinagar. 6p.*
- Narayan R, Singh DB and Kishor, A. (2018). Souvenir on emerging trends in hi-tech hill horticulture in changing climate, 6-7 March, 2018, organized by ICAR-CITH, RS, Mukteshwar, Nainital, Uttarakhand. P. 1-164.
- Sharma A, Lal S, Malik G , Singh DB , Sharma OC and Mir JI.(2017) Preparing Vermicompost at Home-An Easy Way. Extension folder published by Director, ICAR-CITH, Srinagar.
- Sharma A, Singh DB, Lal S, Malik G, Sharma OC, Mir JI and Raja WH. 2018. Bulletin on Promising technologies in natural resource management for Temperate regions. Published by Director ICAR-Central Institute of Temperate Horticulture, Srinagar, Vol I, 28p.
- शिव लाल, देश बीर सिंह, ओंम चंद शर्मा, जावेद इकबाल मीर, अनील शर्मा, बिलाल अहमद पदर. 2017. जैतून उत्पादन. तकनीकी पुस्तिका, प्रकाशन, केन्द्रीय शीतोष्ण, बागवानी संस्थान, श्रीनगर, जम्मू व कश्मीर.
- शिव लाल, देश बीर सिंह, ओंम चंद शर्मा, जावेद इकबाल मीर, अनील शर्मा. 2017. जैतून की खेती. विस्तार ऩत्रिका–1/2017. भाकृअनुप.–केंद्रीय शीतोष्ण बागवानी संस्थान, के. डी. फार्म, ओल्ड एयर फील्ड, रंगरेथ, श्रीनगर, जम्मू व कश्मीर–191132, भारत

Books

- Kanaujia, S.P; Maiti, C.S. and Narayan, R. 2017. Text Book on "Vegetable Production". Today & Tomorrow's Printers and Publishers, Daruyaganj,New Delhi. Pp. 1-345.
- Lal S, Verma M.K, Ahmed N, Singh DB. 2016. Olive: Improvement, Production and Processing. Daya Publishing House. 224 pp, ISBN 9789351247685.
- Mir JI, Singh DB, Ahmed N, Rashid M, Singh SR, Sharma OC , Lal S, Sharma A, Chand L and Shafi W. (2017). Morphological Description of Walnut Genotypes under Agro Climatic Conditions of Jammu and Kashmir (Edition-I). Pp-1-170.

- Muthukumar P and Selvakumar R. (2017). Glaustas Horticulture, 2nd Edition, New Vishal Publications, New Delhi.
- Nabi SU, Ahmad A and Ahmad K.(2017). A Text Book on Phytoplasmas, published from Brosis Publishers and Distributors from Daryaganj New Delhi with ISBN No. 9789350881309, pp1-98.
- Narayan R, Singh NP, Kanaujia SP and Narayan S. (2018). Book on "Sabji Utpadan Takniki" (Edited by Prof. Shiv Shankar). Today & Tomorrow's Printers and Publishers, Daruyaganj, New Delhi. Pp. 1-345.

Popular Article

- Chand L , Singh DB , Raja WH , Kumawat KL , Rai KM and Handa AK. (2017). Potential Traits Available in Persian Walnut Collections for Varietal Development. *Agroforestry Newsletter*, 29(2): 4-6.
- Kumawat KL, Raja WH , Chand L and Rai KM. (2017). Nutritional value and health benefits of nuts. *Indian Farmer*, 4(8): 627-637.
- Kumawat KL , Nabi SU and Raja WH .(2017). Nutritional Value and Health Benefits of Almonds. *Popular Kheti*, 5(4): 122-125.
- Kumawat KL and Rai KM .(2017). Application of Plant Growth Regulators in Pear Production. *Popular Kheti*, 5(2): 51-55.
- Lal S, Singh DB, Sharma OC, 2017. Role of omics in Crop Improvement. *Biotech Article. https://www.biotecharticles.com/Agriculture-Article/Role-of-Omics-in-Crop-Improvement-3948.html* .
- Lal S, Singh DB, Sharma OC, Padder BA and Chand L. 2017. Exploring olive potential. *Indian Horticulture*, 62(2): 6-10.
- Malik G, Sharma A and Singh D B (2017). The exotic vegetables of Jammu and Kashmir - A lucrative and off beat enterprise for farmers. News paper Shankh Dhun, Pp 3.
- Nabi SU , Raja WH , Kumawat KL , Mir JI and Singh DB. (2017). Canker Disease: An Emerging and Serious Problem of Apple Fruit in Kashmir. *Popular Kheti*, 5(3): 90-93.
- Nabi SU , Sharma A, Sharma OC , and Singh DB , Impact of Climate Change on Apple Scab Disease and Its Mitigation strategies, *Newpaper Shankdoon*, Published from Jammu.
- Nabi SU, Malik G, Sharma A. (2018). "*Trichoderma harzianum*: A Potential Bioagent and Plant Growth Promoter". *EC Microbiology* 14.3 : 147.
- Nabi SU, Raja WH, Kumawat KL and Singh DB. (2017) Effect of Climate Change on Food Security vis-à-vis Plant Diseases, *Indian Farmer* 4 (6):492 - 495
- Nabi SU, Sharma OC, Singh DB.(2018). "Apple Canker Disease: Symptoms, Cause and Managements". *EC Microbiology* 14.3 : 128-129.
- Raja WH, Nabi SU , Kumawat KL , and Sharma OC. (2017). Pre harvest Fruit Drop: A Severe Problem in Apple. *Indian Farmer*, 4(8): 609-614.
- Srivastava KK, Kumar D, Singh SR, Mir JI and Sharma OC. (2017). Increasing apple productivity through high density planting. *Indian Horticulture*. Pp19-20

Participation in Workshops/ Conferences/ Meetings

13

Dr. Desh Beer Singh, Director

- Attended Interactive meeting with ICAR SMDs/Institutes on 20th April. 2017 at ICAR, New Delhi.
- Attended Doubling Farmers Income Meeting on 11-05-2017 and 30.10.2017 at SKUAST(J), Jammu.
- Attended EFC Meeting on 12-05-2017 with DDG(H) at KAB-II, New Delhi.
- Attended Regional Committee Meeting III for NE Region from 30th to 31st May 2017 at Imphal, Manipur.
- Attended XXXV Group Meeting of All India Co-ordinated Research Project on Vegetable Crops at ICAR-IIHR, Bengaluru during 24th to 26th June 2017.
- Attended Director's Conference at ICAR, New Delhi on 16th July, 2017.
- Attended two day's Workshop/Interactive Meet on "Development of horticulture under Cold Arid Region of Ladakh for enhancing quality production and improving livelihood" w.e.f. 23-24th Aug., 2017 at Leh, Ladakh.
- Attended Presentation on strategies on doubling farmer's income for J&K as Convenor of the SLCC Committee during meeting with DG, ICAR on 10th October, 2017.
- Attended Meeting with Director General, ICAR and Prof. Swaminathan and presentation on Doubling Farmers Income on 03rd November, 2017 at NASC, New Delhi.
- Attended IHS Platinum Jubilee Celebration and to receive J.C. Anand Gold Medal on Post Harvest Technology on 06th November, 2017 at IARI, New Delhi.
- Attended Director's Conference from 8th & 9th March 2018 at ICAR, New Delhi.
- Attended workshop on Olive research and development in India held from 24th to 25th October, 2017 organized by Department of agriculture cooperation and farmers welfare, ministry of agriculture and farmers welfare at ICAR-CITH, Srinagar

Dr. Raj Narayan, Principal Scientist (Hort. Science)

- Attended official meeting with Directors/ HODs/I/c KVKs of different organizations on doubling farmer's income on 31st October, 2017 at GBPUAT, Pantnagar, Uttarakhand.
- Attended two day seminar on emerging trends in hi-tech hill horticulture under changing climate w.e.f. 6-7 March, 2018, at ICAR-CITH, RS, Mukteshwar, Nainital, Uttarakhand.
- Attended two days all India seminar on hi-tech cultivation of vegetables & flowers w.e.f. 10-11 March, 2018, organized by the institution of engineers (India) Uttarakhand State Centre, Dehradun in collaboration with horticulture department, government of Uttarakhand and ICAR-IISWC, Dehradun, Uttarakhand.
- Attended official meeting as expert member of Joint Inspection Team (JIT) of State Horticulture Mission, Uttarakhand for inspecting the performance of high density planting apple orchards at farmers field namely Billekh, Almora on 29th November, 2017 and Sundarkhal, Nainital on 30th November, 2017 established by State Horticulture Mission, Uttarakhand.
- Attended workshop on Olive research and development in India held from 24th to 25th October, 2017 organized by Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare at ICAR-CITH, Srinagar

Dr. O C Sharma, Principal Scientist (Horticulture)

- Attended two days National Workshop on Development of horticulture under cold arid region of Ladakh for enhancing quality production and improving livelihood from 23-24th, August, 2017 at HMAARI, SKUAST-Kashmir, Leh
- Atended two days national workshop on Olive Research and Development in India from 24-25 Oct.,2017 organized at ICAR-CITH, Srinagar.

Dr Anil Sharma, Sr Scientist (Soil Science)

- Attended 3rd International Conference on Bioresource and stress management w.e.f, 8th to 11th November, 2017 at Jaipur. organized by RKM foundation, Society for Bioresource and Stress Management, VB university and ICAR, New Delhi
- Attended National Conference on Innovative Technological Interventions for doubling farmers income (NaCITI-2018) organized by SIDAVES w.e.f 8th to 10th February, 2018 at SKUAST-Jammu.
- Attended 26th National Conference on Natural Resource Management for Climate Smart Sustainable Agriculture (NRMCSSA-2017) organized by Soil Conservation Society of India in collaboration with CAU, Imphall during 11th to 13th September, 2017 at Barapani, Meghalaya.
- Attended workshop on Olive research and development in India held from 24th to 25th October, 2017 organized by Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare at ICAR-CITH, Srinagar
- Attended two days National Workshop on Development of horticulture under cold arid region of Ladakh for enhancing quality production and improving livelihood from 23-24th, August, 2017 at HMAARI, SKUAST-Kashmir, Leh

Dr. J. I. Mir, Sr.Scientist (Biotechnology)

- Attended Indo-German workshop on seed sector at RHR&TS, Mashobra from June, 6-7, 2017
- Attended National seminar on Saffron Production and Promotion at SKUAST-K, Shalimar, Srinagar from August, 7-8, 2017
- Attended Seminar on "Emerging trends in hitech hill horticulture in changing climate" at Mukteshwar, UK from March 6-7, 2018
- Attended workshop on Olive research and development in India held from 24th to 25th October, 2017 organized by Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare at ICAR-CITH, Srinagar
- Attended Review meeting on HDP in apple under the Chairmanship of Hon'ble Chief Minister Jammu and Kashmir at Civil Sectriat, Jammu on 28th March, 2018
- Attended State-wise Coordination Committee meeting for doubling farmer's income in J & K by 2022 at SKUAST-J, Jammu on 11th May, 2017
- Attended Meeting at SMD (Horticulture Division, New Delhi) for finalizing EFC (2017-20) for CITH, Srinagar under the chairmanship of DG, ICAR at KAB-II, New Delhi on 17th September, 2017
- Attended Attended EFC meeting at New Delhi, Krishi Bhawan at KAB-II, New Delhi on 18th September, 2017
- Attended State-wise Coordination Committee meeting for doubling farmer's income in J & K by 2022 at SKUAST-J, Jammu on 30th October, 2017.
- Attended SLEC meeting on MIDH at Civil Secretariat Srinagar on 20.05.2017

Dr Shiv Lal, Scientist, Sr. Scale (Fruit Science)

- Attended National workshop on "Development of horticulture under cold arid region of Ladakh for enhancing quality production and improving livelihood" held at HMAARI, SKUAST-Kashmir, Leh w.e.f. 23-24th, August, 2017

- Attended seminar entitled "Emerging trends in Hi tech Hill Horticulture under changing climate" held from at ICAR-CITH RS Mukteshwar (Uttarakhand) w.e.f. 6-7th March, 2018
- Attended Zonal monitoring committee meeting of NMSHE-TF-6 project attended on at CAZRI, RRS, Leh w.e.f.8-9 September 2017
- Attended workshop on Olive research and development in India held from 24th to 25th October, 2017 organized by Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare at ICAR-CITH, Srinagar

Dr. Arun Kishor, Scientist (Fruit Science)

- Attended official meeting with Directors/ HODs/I/c KVKs of different organizations on doubling farmer's income on 31st October, 2017 at GBPUAT, Pantnagar, Uttarakhand.
- Attended two day seminar on emerging trends in hi-tech hill horticulture under changing climate w.e.f. 6-7 March, 2018, at ICAR-CITH, RS, Mukteshwar, Nainital, Uttarakhand.
- Attended two days all India seminar on hi-tech cultivation of vegetables & flowers w.e.f. 10-11 March, 2018, organized by the institution of engineers (India) Uttarakhand state centre, Dehradun in collaboration with horticulture department, government of uttarakhand and ICAR-IISWC, Dehradun, Uttarakhand.
- Attended official meeting as expert member of Joint Inspection Team (JIT) of State Horticulture Mission, Uttarakhand for inspecting the performance of high density planting apple orchards at farmers field namely Billekh, Almora on 29th November, 2017 and Sundarkhal, Nainital on 30th November, 2017 established by State Horticulture Mission, Uttarakhand.

Dr. Geetika Malik, Scientist (Vegetable Science)

- Attended State level seminar on 'Production and popularization of temperate spice crops for livelihood security' (CSS-MIDH) SKUAST-K, Shalimar 20-21 March, 2018
- Attended International conference on 'Recent Trends in Bioinformatics and Biotechnology for Sustainable Development' FVSc & AH, SKUAST-J w.e.f. 12-13 October, 2018
- Attended workshop on Olive research and development in India held from 24th to 25th October, 2017 organized by Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare at ICAR-CITH, Srinagar
- Attended VIII annual group meeting of AINRPOG RARI, Jaipur from 1-2 July, 2017

Dr. Wasim Hassan Raja, Scientist (Fruit Science)

- Attended Third International Conference on Bio resources and Stress Management, held from 8th to 11th November, 2017 at Jaipur, Rajasthan.
- Attended National conference on innovative technological interventions for doubling farmer's income held on February 08-10, 2018 at SKUAST-J.
- Attended workshop on Olive research and development in India held from 24th to 25th October, 2017 organized by Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare at ICAR-CITH, Srinagar

Mr Sajad un Nabi, Scientist (Plant Pathology)

- Attended National seminar on Saffron Production and Promotion organized at SKUAST-K, Shalimar, Srinagar w.e.f. 7-8 August,2017
- Attended International symposium on Horticulture at ICAR-IIHR, Bengaluru Karnataka w.e.f.4th- 9th September 2017
- Attended National conference on innovative technological interventions for doubling farmers income at SKUAST-J, Jammu w.e.f. 8-10th February, 2018
- Attended workshop on Olive research and development in India held from 24th to 25th October, 2017 organized by Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare at ICAR-CITH, Srinagar

14 List of Ongoing Projects

Institute Research Projects	
A. Project: Crop improvement and Biotechnology Sub projects:	
1.	Survey, collection, characterization and documentation of temperate horticultural crops (CITH-01)
2.	Breeding for development of superior varieties/hybrids in Solanaceous vegetables (CITH–07)
3.	Development of superior cultivars/ hybrids in temperate fruits through conventional and non conventional methods (CITH-40)
4.	Characterization and diversity analysis of flowering related gene/ gens in almond (CITH-72)
5.	Development of CMS lines in long day onion [*Allium cepa* L] (CITH-70)
6.	Breeding of nutrarich varieties or hybrids in root vegetable crops. (CITH-74)
B. Project: Crop Production and Propagation Sub projects:	
1.	Development of almond based saffron inter cropping system (CITH 11)
2.	Enhancing feathering through plant growth regulators for high quality nursery production in apple (CITH-71)
3.	Standardization of integrated nutrient management of vegetables as intercrop in apple orchard (CITH-57)
4.	Divulging the adept mode of fertilizer application to optimize saffron yield (CITH 60)
5.	Fertigation: An efficient soil management stratagem for escalating nutrient and water use efficiency in apple (CITH 61)
6.	Aquatic dissipate management (ADM) through vermitechnology (CITH 62)
7.	Characterization of soil nutritional survey in apple and peach growing areas of Uttrakhand (CITH-64)
8.	Standardization of growing /nutrients media and growing conditions for the cost effective production of quality vegetables and their seedlings (CITH-65)
9.	Development of diversification technology for round the year vegetable crops under mid and high hills of Uttrakhand (CITH-66)
10.	Evaluation of different substrates and systems for soilless strawberry (*Fragaria* x *ananassa* Duch.) production in naturally ventilated conditions (CITH- 76)
11.	Pre harvest fruit drop management in apple (CITH-78)

Institute Research Projects	
C. Project: Crop Protection Sub projects:	
1.	Diagnosis and progonisis of apple viral diseases. (CITH-75)
2.	Characterization of pathogens associated with apple canker disease and evaluation of botanicals against most prevalent canker in Kashmir valley (CITH- 77)
D. Project: Post Harvest Management Sub projects:	
1.	Studies on dried prunes in relation to cultivars and drying technology (CITH-67)
2.	Standardization of technology for blending of temperate stone fruit juice (CITH-68)
3.	Assessment of Kashmiri chilli for commercial traits (CITH-69)
4.	Effect of packaging systems and storage conditions for quality retention of shelled walnut (CITH-73)
E. Ongoing externally funded projects Sub projects:	
1.	Network project on outreach of technologies for temperate fruit crops (Main centre)
2.	Network project on onion and garlic (co-operation centre)
3.	All India Coordinated Research Project (Vegetable Crops)
4.	Intellectual property management and transfer/ commercialization of agricultural technology scheme
5.	National saffron Mission for economic revival of J & K saffron sector
6.	National innovations on climate resilient agriculture (NICRA)
7.	Challenge programme on canopy management and plant architectural engineering in temperate fruits
8.	National mission for sustainable Himalayan ecosystem (TF-6)
9.	DUS testing centre for temperate fruits
10.	Development of an electronic nose sensor to determine the optimum harvesting time for apple and papaya
11.	Walnut propagation for production of quality planting material

Research Review and Management Committees

15

Research Advisory Committee of ICAR-CITH, Srinagar

1.	**Dr. K. R Dhiman** Chairman, RAC, CITH, Srinagar, Former Vice Chancellor, Dr. YSPUHF, Nauni, Solan- 173230	Chairman
2.	**Dr. J. C. Rana** Head, Division of Germplasm Evaluation, ICAR-NBPGR, New Delhi	Member
3.	**Dr. D. B. Singh** Former Head, Plant Pathology, ICAR-IARI, New Delhi	Member
4.	**Dr. A. Prakash** Former Head, Entomology ICAR-NRRI, Cuttack, Odisha	Member
5.	**Dr. A. Das Munshi** Principal Scientist, Division of Vegetable Science, ICAR-IARI, New Delhi.	Member
6.	**Dr.M.K. Verma** Principal Scientist, Division of Fruit Science and Horticutural Technology, ICAR-IARI, New Delhi	Member
7.	**Dr. Hina Shafi** D/o Sh. M. S. Bhat, M.P. Lane, Kursu Rajbagh , Srinagar	Member
8.	**Shri Desh Kumar Nehru** S/o Syam Lal Panjla, Teh.: Rohama, Distt.: Baramullah (J&K)	Member
9.	**Dr. W. S. Dhillon** ADG (Hort-I), KAB-II ICAR, New Delhi	Member
10.	**Dr. D. B. Singh,** Director, ICAR-CITH, Srinagar	Member
11.	**Dr. O. C. Sharma,** Principal Scientist, ICAR-CITH, Srinagar	Member secretary

Institute Management Committee (IMC)

1.	Dr. Desh Beer Singh Director, ICAR-CITH, Srinagar		Chairman
2.	Director Horticulture Govt. of J&K, Raj Bagh, Srinagar		Member
3.	Director Horticulture and Food Processing, Department of Horticulture, Chaubattia Ranikhet, Almora (Uttarakhand)		Member
4.	Prof. & Head Div. of Fruit Science, SKUAST-K, Shalimar		Member
5.	Dr. Hina Shafi Bhat D/O Sh. M.S. Bhat R/O M.P. Lane Kursoo, Rajbagh, Srinagar -190008		Member / Progressive Farmer
6.	Sh. Desh Kumar Nehru S/O Sh. Sham Lal R/O Rohama, District Baramulla, J&K		Member / Progressive Farmer
7.	Dr. Major Singh Principal Scientist, Crop Improvement Division, ICAR-IIVR, Varanasi		Member
8.	Dr. O.P. Awasthi Principal Scientist (Fruit Science), ICAR-IARI, New Delhi		Member
9.	Dr. Anil Sharma Senior Scientist, ICAR-CITH, Srinagar		Member
10.	Dr. S.M. Sultan, Senior Scientist and I/C, ICAR-NBPGR, Regional Station, Srinagar		Member
11.	Asstt. Director General (HS I) ICAR, KAB-II, Pusa, New Delhi-110012		Member/Council representative
12.	Shri S.K. Sharma F&AO, ICAR, Krishi Bhawan, New Delhi		Member
13.	Shri Mukul Raj Singh AO, ICAR-CITH, Srinagar		Member Secretary

16 Distinguished Visitors

Visit of VIPs/ Dignitaries

Distinguished visitors

- Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture & Farmers Welfare visited ICAR-Central Institute of Temperate Horticulture, Srinagar on 4th July, 2017. Hon'ble Minister Shri. Radha Mohan Singh addressed all the staff members and discussed the achievements of the institute. He emphasized upon the plantation of trees along the border, intercropping, commercialization of technologies and varieties developed by the Institute. He also pointed out the need of cooperation and collaboration of the Institute with other agencies. Hon'ble Union Minister of Agriculture and Farmers Welfare appreciated overall contribution of ICAR-CITH, Srinagar for the betterment of horticulture sector in the temperate region of the country.
- Shri. Ghulam Nabi Lone, Minister for Agriculture Production, J&K visited ICAR-CITH, Srinagar on 4th July, 2017
- Shri. Sunil Kumar Sharma, Hon'ble Minister of State transport (independent charge), Revenue, Public works, Rural Development and Panchayati Raj, Agriculture Production YSS, Jammu and Kashmir visited ICAR-CITH, Srinagar on 4th July, 2017

Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture & Farmers Welfare interacting with ICAR-CITH, Staff

- Shri Sundeep Kumar Nayak, Principal Secretary Agriculture Production, Jammu and Kashmir visited ICAR-CITH, Srinagar on 4th July, 2017
- Shri Gajendra Singh Shekhawat, Union Minister of State for Agriculture and Farmers Welfare visited ICAR-CITH, Srinagar and inaugurated Two-day workshop on "Olive Research and Development in India on 24th October,2017.In his inaugural address, he emphasized the role of research and development for combating the challenges faced by the farmers.

Shri Gajendra Singh Shekhawat, Union Minister of State for Agriculture and Farmers Welfare interacting in olive field

- Shri Daljit Singh Chib (MoS & Vice Chairman Kisan Advisory Board) visited ICAR-CITH on 25th of May 2017

- Dr (Mrs.) Madhu Bala, Director, DIBER DRDO, Haldwani; Dr A. Pattanayak, Director, ICAR-VPKAS, Almora; Dr. B. Pattanayak, Director, ICAR-PDFMD, Mukteshwar; Dr A.K. Singh, Director, ICAR-DCFR, Bhimtal; Dr Major Singh, Director, ICAR-DOGR, Pune, Dr O.P. Yadav, Director, ICAR-CAZRI, Jodhpur; Dr B.P. Nautiyal, Dean UUHF, Bharsar visited ICAR-CITH, RS Mukteshwar during the year and were briefed with various research activities at farm and labs.
- Shri Mukul Rohatagi, Attorney General for India and Shri Subhash Srivastava, Member PM's Empowered Committee for Excellence in Public Administration visited ICAR-CITH, RS Mukteshwar on 30.05.2017 and were briefed about various research activities going on, in farm and labs at Mukteshwar.

Personnel

17

CITH Head Quarter, Srinagar

RMP

- Dr. Desh Beer Singh, Director

Scientific

- Dr. O. C Sharma, Principal Scientist (Horticulture)
- Dr. Anil Sharma, Senior Scientist (Soil Science)
- Dr. J.I. Mir, Senior Scientist (Plant Biotechnology)
- Dr. Shiv Lal, Scientist, Senior Scale (Fruit Science)
- Dr. Geetika Malik, Scientist (Vegetable Science)
- Dr. Kishan Lal Kumawat, Scientist (Fruit Science)
- Dr. Wasim Hassan Raja, Scientist (Fruit Science)
- Dr. Selvakumar R, Scientist (Vegetable Science)
- Mr Sajad Un Nabi Naingroo, Scientist (Plant Pathology)

Administrative

- Sh Mukul Raj Singh, Administrative Officer
- Sh. Fayaz Ahmad Dar, AF &AO
- Sh. Ramesh, Asstt. Admn. Officer
- Smt. Shahida Rafiq, P.A. to Director
- Sh. Showkat Ahmad Mir, Assistant
- Sh. Reyaz Ahmad Mir, Assistant
- Sh. Mukhtar Ahmad, Assistant (KVK, Baramulla)
- Sh. Tariq Ahmad Mir, Jr. Stenographer
- Sh. Mehraj-ud-Din Meer, UDC
- Sh. Mohd. Muzafer Lone, LDC
- Sh. Rouf Ahmad Sheikh, LDC

Technical

- Sh Shoaib Nissar Kirmani, Senior Technical Officer
- Sh. Eshan Ahad, Tech. Officer
- Sh Muneer Ahmad Sheikh, Sr. Technical Assistant
- Sh. Mehraj-ud-din Bhat, Sr. Technical Assistant (Driver)
- Sh. Farman Ali, Sr. Technical Assistant (Driver)
- Sh. Mohammad Ramzan Wani, Technical Assistant (T-1-3.)
- Smt. Mubeena, Sr. Technican (Computer / Data Operator)
- Sh. Ajaz Ahmad Wani, Technician (Field)
- Sh Ishtiyaq Ahmad Sheikh, Sr.Technician (Field)
- Sh. Puran Chandra, Sr. Technician (Field)

Skilled Supporting Staff

- Sh. Bashir Ahmad Dar,SSS
- Sh. Showkat Ahmad Dar, SSS
- Sh. Abdul Rashid Bhat,SSS (KVK, Baramulla)
- Sh. Bashir Ahmad Ganai, SSS
- Sh. Zubair Ahmad Swathi, SSS
- Sh. Madan Lal, SSS
- Sh. Khushi Ram, SSS
- Sh. Ghulam Nabi Bhat, SSS

CITH-RS, Mukteshwar

Scientific Staff

- Dr Raj Narayan, Principal Scientist (Vegetable Science)
- Dr Arun Kishor, Scientist (Fruit Science)
- Shri Sovan Debnath, Scientist (Soil Science)

Administrative

- Sh. Akhil Thukral, Asstt. Admn. Officer
- Sh. Diwan Chandra, Assistant
- Sh. Pushpendra Kumar, LDC

Technical Staff:

- Sh. Vinod Chandra, Technical Officer

Skilled Supporting staff:

- Sh. Narayan Singh, SSS
- Sh. Govind Giri, SSS
- Sh. Shabir Ahmad Mir, SSS

Appointments/Deputation/Transfers/ Retirements

18

Appointments

- Sh Mohammad Mudasir Magray, Senior Technical Officer was relieved from this Institute on 2nd August, 2017 after being selected as Assistant Professor at SKUAST-K, Srinagar
- Sh Akhil Thukral , Asst Admn Officer joined back ICAR-CITH, RS Mukteshwar after completion of his deputation at Competitive Commission of India, New Delhi on 11th December, 2018

Retirements

- Sh. Mushtaq Ahmad Khan, Senior Technician (Lab) superannuated from Council's services w.e.f 30th September, 2017 (AN)

Transfers

- Dr Anil Kumar, Scientist, Plant Pathology transferred from ICAR-CITH, RS Mukeshwar to ICAR-DMR , Solan on 7th June, 2017.

Deputation

- Shri Sovan Debnath, Scientist (Soil Science) ICAR- CITH, RS Mukeashwar was deputed for Ph. D on 8th August,2017.