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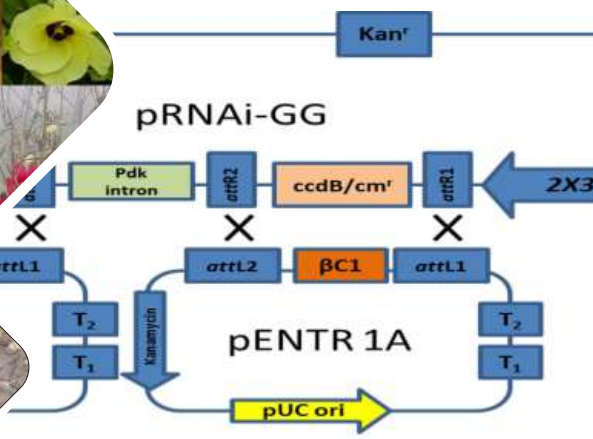

वार्षिक प्रतिवेदन
Annual Report
2019

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वाराणसी-221 305

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Preface

Vegetables can contribute to the transformation of our food systems towards healthier diets and more sustainable production systems while creating value and job opportunities. Vegetables cover 7.14 percent of the world's total agricultural area. Globally, vegetable production has grown intensively especially on a per capita basis. This trend is particularly strong in developing countries. India has witnessed significant increase in Vegetable production over the last two decades. The production of vegetables has increased from 93.85 million tonnes in 2000-2001 to 191.77 million tonnes in 2019-20 (2nd Advance estimate of DAC, GOI). Country's diverse climate offers vast production base for vegetables. Globally it ranks second in vegetable production, however, the county is largest producer of okra and ranks second in production of green peas, tomato, cabbage, cauliflower and brinjal. India witnesses nearly 4.6-15.9% wastage in vegetables annually, which is primarily attributed to substantial postharvest losses during various stages of production, handling and marketing.

ICAR-IIVR, ever since its inception, is striding forward to cater the demand of vegetable growers under ever-changing climatic conditions. The important institutional milestones which occurred in 2019 includes an MoU between World Vegetable Centre (*WorldVeg*), Taiwan and the Indian Council of Agricultural Research (*ICAR*) signed to guide future collaboration with ICAR institutions working on vegetable research in the month of November. Further, during the year ICAR-IIVR organized an International Training Program sponsored by Ministry of External Affairs, GOI, under Indo-African Forum Summit III on "*Value Addition and Product Diversification in Vegetables*" in which 15 participants from 5 different African countries participated. In our pursuit of bringing prosperity to vegetable growers, this year, a total of 35 varieties and hybrids (2 at National level and rest 33 for U.P. State) of different vegetable crops were notified for cultivation in various agro-climatic zones of the country. To further strengthen the breeding programmes for development of trait-specific varieties, the germplasm holding of the Institute was enriched. Vegetable varieties resistant to major pests & diseases and for improved yield attributes in tomato, chilli, pea, cowpea, *Luffa,* melons, okra, pumpkin *etc.* are being bred under Mega programme Integrated Gene Management. Under Biotechnological Interventions, work on RNAi based resistance in transgenic okra, CRISPR/Cas9 mediated genome editing in tomato for ToLCV resistance and *In-silico* mining of WRKY transcription factors and identification of SiWRKY53 as a source of resistance to bacterial wilt in brinjal have made significant strides. Besides varietal improvement, several input use-efficient technologies for production of vegetables both under field and protected environment has been standardized. One such technology for correcting micronutrient deficiencies in selected vegetable crops has been worked out and the outcome is in the form of a micronutrient formulation. In addition, more than 24,014.15 kg of quality seeds which includes 2415.05 kg of breeder seeds has been produced under the Mega Programme Seed Enhancement in Vegetables. Under Mega Programme Integrated Plant Health Management, a gamut of organic, chemical and integrated pest management modules were tested for keeping the pest populations below the economic threshold level and to provide choices to the growers. The Entrepreneurship Development Programme of the Institute has ushered, especially, the young entrepreneurs to profitable ventures of horticultural production.

Our accomplishments in 2019 were possible because of the continuous encouragement, guidance and support of the senior officials of ICAR. I place on record my deep sense of gratitude to Dr. Trilochan Mohapatra, Secretary, DARE & DG, ICAR, Dr. A.K. Singh, DDG (Hort.), ICAR, and Dr. T. Janakiram, ADG (Hort.), ICAR, New Delhi for their unconditional and incessant support in steering this institute on the path of excellence. I take this opportunity to congratulate all the staff members of this Institute whose sincere efforts have made ICAR-IIVR a name to reckon with.

I feel elated to present the Annual Report (2019) of this premier Institute, dedicated for vegetable research. The contributions of all the three Divisions, KVK's, Administration, Accounts & Other staff, especially, the publication committee in shaping this publication, are gratefully acknowledged.

Varanasi
March 31, 2020

Jagdish Singh
Director

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Executive Summary

To meet the challenges of vegetable production and ensuring nutritional security for the country, ICAR-Indian Institute of Vegetable Research has made concerted efforts in the field of basic, applied and strategic research for vegetables through six Mega-programmes.

This year, a total of 35 varieties and hybrids developed by IIVR in different vegetable crops were notified for cultivation in various ago-climatic zones of the country.

Under mega programme on Integreted Gene Management, the Institute is maintaining huge genetic resources of 44 major and minor vegetable crops with more than 6500 accessions. Germplasm kitty of the Institute was augmented by exploration trip of Institute's scientists in collaboration with ICAR-NBPGR to different parts of the country. Germplasm (1027 nos.) was aggressively shared and distributed to 40 different organizations through Material Transfer Agreement (MTA) for research purpose.

Under sub project for genetic improvement of tomato, promising hybrid VRT16-11 × VRT16-12 with medium fruit firmness yielded 116.3 tonnes/ha. Work on pyramiding of disease resistance genes (ToLCV, RKN and LB) in tomato was progressed. F_3 families derived by wide hybridization between Kashi Amrit × LA 2157 (*Solanum arcanum*) had shown resistance against root knot nematode. This year, new variety Kashi Tamatar-8 was identified thorugh AICRP (VC) for cultivation in zone-IV & VII (Punjab, UP, Bihar, Jharkhand, MP, Maharashtra & Goa).

In brinjal, 257 accessions including 23 accessions of 6 wild species were maintained in field. Fifty six F_1 hybrids including 22 round fruited and 34 long fruited type were evaluated for yield and yield components. Variety IVBL-23 was identified for release in 37th AICRP (VC) group meeting for cultivation in zone-IV (Punjab, UP, Bihar & Jharkhand).

In chilli, an inbred line IIVRC-18132 was found promising and identified for multi-location testing. Two unique mutants namely 'leafy rosette' and 'undifferentiated inflorescence' were identified and their inheritance pattern was studied by attempting new crosses. Hybrid A7 x F-5112 and GMS-3 x VR 339 were found promising after second consecutive year of testing. Confirmation of Chilli leaf curl virus resistance in F_7 families of Kashi Sindhri x BS-35 was done using molecular screening as well as grafting experiments. Two Hybrids, Kashi Ratna and Kashi Tej and one variety Kashi Abha were notified for cultivation in UP.

Fifty pea genotypes were evaluated for tolerance to high temperature and suitability for early sowing during October, and genotypes VRPE-101, VRPE-109, VRPE-17, VRPE-56 and VRPE-18 were found promising. A total of five new entries viz., VRPE-111, VRPE-101-5, VRPMS-919, VRP-500 and VRP-343 were submitted for various AICRP (VC) varietal trials. A unique Pea genotype (VRPM-901-5) bearing 3-5 pods on single node, has been registered with NBPGR.

Under genetic improvement of cowpea, two promising lines (VRCP-68-2 and VRCP-71-1) were included in varietal trial of AICRP (VC) for their multi location testing. After three year of screening, variety Ankur Gomti and Indra Lal were found highly resistant to Cercospora leaf spot disease.

In French bean, purple-podded and pole type variety Kashi Baingani was identified for cultivation in zones I, VII and VIII (J&K, HP, Uttarakhand, MP, Maharashtra, Goa, Karnataka, TN, Puducherry & Kerala). Nine parchment free genotypes of French bean (EC792393, FMGCV1187, FMGCV1006, Contender, Giolli, FMGCV 1129, Savannah, Cartagenta and Banoa) were identified. One hundred twenty one germplasm lines of Indian bean were maintained and several segregating populations were advanced.

Under sub project entitled genetic improvement of seed propagated gourds, bitter gourd lines VRBG-23 in small segment, VRBTG-2-1 in medium segment, VRBTG-4-1-1 long segment and VRBTG-10 in extra-long segment were found promising. Among gynoecious based hybrids, VRBTG-5(G) × VRBTG-10 was found most promising for yield (4.21 kg/ plant). Advance line of bottle gourd, VRBG-7 was found promising for yield

while cross VRBG-9-1-1 x VRBG-61-3 was highest yielder among tested hybrids.

In Luffa vegetables, 29 advance lines of sponge gourd were documented in NBPGR, New Delhi. Advanced breeding lines of sponge gourd VRSG-17-1, VRSG-17-2 *etc.* were found promising for yield and horticultural traits. Moreover, several experimental hybrids were found superior to commercial checks for yield and tolerance against downy mildew and viral disease. Ridge gourd germplasm viz. VRRG-35, VRRG-110 *etc.* and hybrids viz. VRRG-5A X VRRG-75-2016, VRRG-75-2016 x VRRG-5A *etc.* were found promising for horticultural traits and were free from Sponge Gourd Mosaic disease and downy mildew disease under field conditions. Ridge gourd genotype VRRG-75 recorded lowest incidence of melon weevil, whitefly and leaf miner.

In cucumber, advance lines VRCU Sel.-9-03, VRCU-Sel-12-36 and hybrid VRCUH-18-01 were found promising based on the fruit colour, appearance, non-bitterness and yield. Two new germplasm of pumpkin belonging to "Butter Nut Squash" type with high carotene were augmented. Work on development of parthenocarpic cucumber was further progressed. On the basis of total yield and attractiveness of the fruits, pumpkin hybrid VRPKH-19-02 and advance lines VRPK-11-06-02 and VRPK-63 were found promising. Genotype VRPK-04 was found highly resistant against pumpkin yellow mosaic virus. Summer squash line VRSS-17-05 showed stability for high frequency femaleness trait.

In melons, five new germplasm were augmented from districts of M.P, U.P. and Rajasthan. In mini segment, watermelon line VRW-514 and VRW-514-1 were found potential yielder with high TSS content. VRW-10, an andromonoecious line with round, orange fleshed fruits, high yield and TSS content was identified. Round melon genotypes VRM-5, VRM-5-2, VRM-1, VRM-11-1 and VRM-12 were found promising for yield, varietal purity and disease tolerance. Long melon genotypes VRLM-28 and VRLM-3, and muskmelon genotype VRMM-170 and VRMM-186 were found to be superior for yield and quality attributes.

Under genetic improvement of okra, cultivated and wild okra germplasm was enriched by augmenting 25 new germplasm from Odisha, Uttar Pradesh and Jharkhand. Several hybrids (VRO-120 × VRO-125, VRO-120×VRO-124 *etc.*) were found promising in comparison with popular checks while advance lines VRO-120 and VRO-125 performed consistently better in two consecutive cropping seasons for yield and disease resistance. Red fruited genotypes, VROR-160 and VROR-156 were found most promising for yield, quality and disease resistance. Significant increase of fertility was observed in the colchiploid interspecific hybrids developed for viral disease resistance. The unique red flowered interspecific hybrid derived from the cross of yellow flowered *A. moschatus* and red flowered *A. moschatus* subsp. *tuberosus* was characterized for various morphological traits.

In cole crops, several CMS based cauliflower hybrids VRCF-131×VRCF-75-1, VRCF-110×VRCF-75-1 *etc.* and genotypes VRCF-75-1, VRCF-86 *etc.* were found promising. The tropical kale genotypes VRKALE-1 (smooth leaf) and VRKALE-9 (trichome leaf) induced bolting and flowering during 3rd week of February in the North Indian plain condition without vernalization. Tropical cabbage VRCAB-111 was found promising for superior head qualities. Several carrot genotypes with higher root yield and better quality traits were identified *viz.* VRCAR-186 (red root), Kashi Krishna (black root), VRCAR-141 (orange root), VRCAR-153, (yellow root); VRCAR-160 (cream root), and VRCAR-171-1(rainbow-type root). Two genotypes of tropical carrot (VRCAR-206/red root and VRCAR-91-1/orange root) were documented with NBPGR, New Delhi. Four stable Ogura-CMS radish lines viz. VRRAD-11, VRRAD-13, VRRAD-198 and VRRAD-201 were developed through back-crossing which were found very similar to their respective maintainer for morphological traits. The radish genotypes Kashi Mooli-40 (white root), Kashi Lohit (red root) and VRRAD-134 (purple exterior) were found promising for yield and quality traits.

Under sub project of biotechnological interventions including transgenics for managing stresses in vegetables, work on development of transgenic okra plants against Okra enation leaf curl virus disease was progressed. With the help of golden gate cloning based system, the gateway RNAi clones pRNAi-GG:cBβC1 (OELCV βC1) was developed and transformed in *A. tumefaciens*. Tissue culture independent, in-planta transformation of okra in the cultivar Kashi Kranti was undertaken and presence of *npt II* gene was confirmed in 5 T1 events by PCR using *npt II* specific primers. Under CRISPR/Cas9 mediated genome editing work in okra, complementary gRNA oligonucleotide pairs were annealed and cloned into pORE-04 vector and further the cloned gRNA was transformed in *Agrobacterium*.

The *Agrobacterium* clones were then inoculated in okra via in-planta transformation. Similarly, targeting virus gene, CRISPR/Cas9 mediated genome editing work in tomato was undertaken and complementary gRNA oligonucleotide pairs were annealed and cloned into pORE-04 vector. Cloned gRNA was transformed in *Agrobacterium* and the *Agrobacterium* clones were mobilized in tomato through tissue culture technique. Moreover, to develop ToLCV resistant in tomato, two host factors/susceptibility genes were selected for knockout with the help of CRISPR/Cas9 technology. Respective complementary gRNA oligonuceotide pairs were ligated into pCR3-EF vector. Further, CRISPR/Cas9 knockout construct were cloned into pGWB401 vector which is a Gateway-compatible binary vector for plant transformation that enables selection of transgenic plants via kanamycin resistance. Sixty-six putative WRKY Transcription factors were identified in brinjal and up regulation of SiWRKY53 was characterized as a source of resistance to bacterial wilt in brinjal.

In underexploited and future vegetables, 40 new accessions of winged bean were augmented from NBPGR Regional Station, Akola; while 3 accessions of cluster bean were augmented from South Gujarat. Cluster bean genotypes VRCB-47, VRCB-48, VRCB-95 and Dilojan-3 were found promising for morphological traits in station trial. Faba bean genotypes Muradabad-103, EC- 628941, EC- 628929 and Cherry emerged as superior performer for yield, varietal purity and disease tolerance during 2nd consecutive year of testing. Vegetable soybean genotypes *viz.*, *Swarna Vasundhara*, AGS-447, AGS-459, AGS-461 *etc.* were found superior for pod yield per plant. Moreover, line EC-246, Kalla Bhatt, IC-316142, EC-39043, EC-39043, IC-338716, EC-162 and EC -161 found resistant against *Spodoptera* spp. damage. Water chestnut genotype VRWC-1 was found promising for average fruit weight, and VRWC-4 was adjudged promising for sweetness, dry matter content and fruit yield per plant. VRL-1 genotype of lotus was found promising for morphological traits, number of seed per plant and rhizome yield. Among 29 genotypes of water spinach evaluated, VRWS-1, VRWS-4, VRWS-9, VRWS-11, VRWS-25, VRWS-26 and VRWS-29 were found to be promising for different horticultural traits. Package of practices for water spinach cultivation in upland field condition was developed. Single cross sweet corn hybrid SC 32 × SC 10 was found performing well with total soluble solids 17.24° Brix higher than Sweet glory (TSS 13.9 ° Brix) and its green cob yield was found on par with the yield of Sweet glory. Baby corn hybrid BC-19 × BC-13 recorded lowest dead heart incidence (17.39%) by *C. partellus* under Varanasi conditions. Beet leaf (Palak) genotype 'VRPLK-2' was found better in comparision to popular variety All Green in twelve different dates of sowing. Two varieties of bathua *i.e.* Kashi Bathua-2 (green leaves) and Kashi Bathua-4 (purplish-green leaves) were maintained. Amaranthus genotypes VRAM–306, VRAM–312 *etc.* were found promising for horticultural, yield and yield contributing traits.

Among pointed gourd clones, VRPG-210, VRPG-19 (Desi segment) and VRPG-217 were found most promising with fruit yield of 13.5 kg, 12.25 kg and 12.00 kg per plant, respectively. VRPG-210 and VRPG-217 were also suitable for confectionary purpose due to their bigger fruit size. Study on storage behavior of 10 pointed gourd clones revealed VRPG-210, VRPG-217, VRPG-215 and Kashi Amulya as promising genotypes. Teasle gourd genotypes VRSTG-38, VRSTG-20 and VRSTG- 5; spine gourd genotypes VRSEG-32, VRSEG-11 and VRISEG-36; and Ivy gourd lines VRIG-14, VRIG-16 and VRIG-6 were found promising for yield and horticultural traits. Basella genotypes VRB–4, VRB–7, VRB–17, VRB–23 and VRB–61-1 were found promising for high yield per plant. Betalain pigmentation in basella was found to be governed by single dominant gene with simple Mendelian genetic ratio of 3:1 for pigmented and non-pigmented type plant.

Under mega programme on seed enhancement in vegetables, 24014.15 kg of seeds including 2415.05 kg of breeder seeds and 91 kg of hybrid seed of different vegetables varieties/hybrids was produced for distribution amongst the seed indenters and farmers. Apart from seed production at main campus, 43600 kg of seeds as well as planting material of different crops were produced at ICAR-IIVR-Regional Research Station, Sargatia. In priming, coating, ovule conversion and seed enhancement related studies, Okra cv. Kashi Kranti seeds primed with 0.5% of humic acid recorded significantly higher germination (93%), speed of germination (75.9) and found better for other seed quality parameters. Decreasing trend of seed quality parameters were recorded with increasing concentration of humic acid solution. In pollination studies for seed augmentation in vegetables including support of honey bees, combination of 5% sugar+5% jaggery+50ppm boron significantly enhanced the seed

yield and seed quality parameters in okra cv. Kashi Chaman. High pollinator's activity was observed in the treatment 5% sugar+5% jaggery+50ppm boron followed by 5% sugar+5% jiggery in comparison to open pollination. In studies related to drying and storage of vegetable seeds including Modified Atmosphere Storage, seed drying of cowpea cv. Kashi Kanchan with zeolite beads @ 1:3 (seeds:beads) was found faster with higher moisture absorption than silica gel. In study related to standardization of seed storage methods with zeolite beads and silica gel in radish cv. Kashi Hans, seeds stored with zeolite beads at room temperature recorded higher and on par germination with seeds kept in cold storage condition.

In the Division of Vegetable Production, studies carried out under naturally ventilated polyhouse conditions revealed that two-stem training was the most suitable system both in tomato and capsicum. Likewise, the Umbrella system followed by the Drape system recorded significantly higher values for yield and associated characters in cucumber. It was found that variety V-5 followed by V-2 were highly suitable for parthenocarpic cucumber production under protected conditions. Combined application of bio-regulators such as salicylic acid and azealic acid and microbes (AMF and *Azospirillum formosense*) facilitated higher yield than either microbes or bio-regulators applied alone.

Under cropping system studies, after completion of second cycle, the highest total cropping system productivity (275.83q/ha) in terms of rice equivalent yield (REY) was obtained with cowpea-tomato-okra cropping sequence followed by okra-tomato-cowpea (258.07 q/ha). The highest productivity during *Kharif* season was obtained with brinjal crop (142.08 q/ha) followed by bottle gourd (108.07 q/ha). Bottle gourd-wheat-amaranth cropping system was found the most profitable with the highest B:C ratio of 2.36 followed by maize-pea-pumpkin cropping system (B:C ratio 2.27).

Studies on bio-fortification in vegetables crops suggested that the foliar application of crop group specific micronutrient formulations resulted into yield enhancement by 13.6 to 17.8% in tomato, 11.9 to 18.5% in cabbage, 9.4 to 20.0% in cauliflower, 11.3 to 38.5% in cowpea and 6.9 to 16.2% in okra, respectively over control. Micronutrient profiling studies in 41 genotypes of okra and 53 genotypes of pointed gourd for Cu, Fe, Zn and Mn revealed a large variation in contents of these micronutrients across the genotypes in both the crops.

Under organic farming of vegetables, the total cropping system productivity measured in terms of REY was the maximum (17.632 t/ha) in green manure-tomato-mung bean system followed by green manure-broccoli-cowpea (15.116 t/ha). However, the net return and benefit: cost ratio was the highest in green manure-broccoli-cowpea sequence followed by green manure-vegetable pea-okra sequence. The quality of vegetables in terms of vitamin C content was better under organic system as compared to inorganic system in cowpea and okra. The ascorbic acid, total phenol and anti-oxidant content increased by 18.2, 13.6 and 9.2 % in cowpea and 21.8, 16.6 and 12.4 per cent in okra over inorganic system. The organic carbon content of the soil improved by 17.63 and 22.42 per cent, respectively due to application of NADEP compost and FYM @ 25 t/ha over the inorganic system.

Experiment conducted for enhancing water use efficiency in vegetables revealed that drip irrigation at 100% ET scheduled at 2 days interval enhanced the yield and water use efficiency significantly in tomato, cabbage and cauliflower, besides saving 30-35% water as compared to furrow irrigation.

Grafting study was carried out in cucumber, muskmelon and bitter gourd with different cucurbits rootstocks. For bitter gourd scion, sponge gourd was reported as the best rootstock as this combination registered 425%, 183% and 141% higher yields, respectively over non-grafted, bottle gourd and ridge gourd. In cucumber, the maximum fruit yield (1.154 kg/plant) was registered when ridge gourd was used as rootstock. This rootstock-scion combination yielded about 73% higher yields over un-grafted cucumber.

In cowpea, the maximum yield (15.6 t/ha) was noted with black polythene mulch followed by organic mulch (14.8 t/ha). Among herbicide treatments, the maximum pod yield (12.3 t/ha) was recorded with sequential application of pendimethalin 750 g/ha (pre emergence) + imazethapyr (post emergence).

In a weed control study in French bean, the maximum weed control index (WCI; 98.9 %) was recorded with black polythene mulch. Among the herbicide treatments, the maximum WCI (97.2 %) was observed with sequential application of pendimethalin 750 g/ha (pre emergence) + sodium acifluorfen + clodinafop 100 g/ha (post emergence), followed by application of pendimethalin 750 g/ha (pre-emergence) + imazethapyr 100 g/ha (post emergence; 95.7%).

Black polythene mulch treatment recorded

significantly higher yield (16.9 t/ha) among different mulch types. Among herbicide treatments, the maximum yield (13.4 t/ha) was attained with sequential application of pendimethalin 750 g/ha (pre emergence) + sodium acifluorfen + clodinafop 100 g/ha (post emergence).

Zero tillage with residue retention on soil surface produced the maximum green cob yield of sweet corn (130 q/ha) followed by conventional tillage with residue incorporation (126 q/ha) under conservation agriculture in vegetable based cropping system.

The shelf life extension studies in cauliflower using expanded polyethylene biopolymer films revealed that the moisture content decreased from 97.73 to 78.37% and from 97.73 to 79.42% in small and big size cauliflowers under MAP storage for 49 days at 3 ^{0}C while it decreased at faster rate during storage at 10 ^{0}C, from 97.73 to 86.85% and from 97.73 to 85.50% after 14 days of storage at 10 ^{0}C. The ascorbic acid content in small and big size cauliflowers in MAP decreased to 93.2% and 96% after 49 days of storage at 3 ^{0}C. Total phenol content decreased in both small and large size cauliflowers from 733.45 to 247.13 mg /100gm GAE and from 733.45 to 40.6 mg/100g GAE after 49 days of storage at 3 ^{0}C, respectively.

Results of the nutri-garden modules from 100 and 150 m^2 area showed that a total of 131.06 and 242.49 kg of vegetables, respectively can be fetched from a time span of about 100 days; whereas, daily availability of vegetables were 1.51 and 2.63 kg, which were sufficient for a family of 05 and 08 members, respectively.

For promoting entrepreneurship among rural youth, motivational and information support provided to a mushroom entrepreneur. As a result 1.25 tons mushroom could be produced with a earning of Rs. 2.0 lakhs. Besides, scope of vegetable juice selling as a small-scale entrepreneurship was examined in Varanasi city and 03 entrepreneurial development trainings were conducted.

Impact of okra var. Kashi Pragati was assessed in terms of seed sale from IIVR and estimated area covered under this crop. Kashi Pragati covers 908.96 ha estimated area from the total TL seeds sold of 10907.5 Kg. The estimated area covered due to the breeder seed sale was 145776 ha from 2014-15 to 2019-20. In total, cv. Kashi Pragati covers an estimated total area of 146684.96 ha during 2004-05 to 2019-20 covering 123 districts of 23 different states in the country.

Among the different pest management modules tested on bottle gourd (cv. Kashi Ganga), integrated pest management module comprising spraying of dichlorvos during 20 and 30 days after sowing, *Bacillus thuringiensis* var *Kurstaki*, imidacloprid, *Lecanicillium lecanii* and Azadirachtin 0.03% each at 10 days intervals was found superior in terms of reducing red pumpkin beetle (73.99 PROC), whitefly (85.57 PROC), white plume moth (84.04 PROC) and mirid bugs (70.12, 73.84 and 64.21 PROC) on leaf, fruit and twig, respectively. Similarly, in pumpkin (cv. Kashi Harit), the integrated pest management module was also found most promising in reducing the red pumpkin beetle (67.27 PROC), white fly (66.55 PROC) and mirid bug population on leaves (84.62 PROC), tender fruits (85.39 PROC) with significant increase in the yield (293 q ha-1).

During kharif, 91.62% reduction in okra fruit damage, 65.36 and 70.7% reduction in leaf hoppers and white fly population respectively in cyantraniliprole treated plots. Buprofezin was found to be most effective giving 89.33 per cent protection over untreated control against cabbage aphids. Spinetoram, indoxacarb, chlorantraniprole and spinosad were observed to be most effective giving 86.46, 83.27, 80.34 and 79.81 reduction in cowpea pod borer, *Maruca vitrata* population, respectively.

A zoophytophagous mirid bug, *Nesidiocoris tenuis* was identified in tomato feeding on soft-bodied as predator. However, in absence of suitable predators it also feed on aerial plant parts in tomato. The white halo fungus, *Lecanicillium lecanii* was found most promising against jassids and whiteflies in okra with maximum PROC of 56.95 and 53.07, respectively. Combination of *L.lecanii* and neem oil at 1:1 ratio showed lowest jassid (1.13) and whitefly (0.73) population per leaf and there by having maximum PROC (62.76 and 59.22, respectively). The entomopathgens, *Bacillus thuringiensis* var *Kurstaki* was found most promising with 33.3 and 67.1% mortality at 3 and 5 days after treatment against *Spodoptera litura*. Amongst the tested newer molecules, emamectin benzoate 5% SG and chlorantariniporle 18.5% SC at their recommended doses in okra were found relatively safe with 18.48, 25 and 9.80, 5.88 percent mortality over control (PMOC) against spiders and coccinellid beetles, respectively.

Among six different modules for nursery disease management, T5 comparising nursery bed solarization+ seed treatment by *Trichoderma asperllum* @0.5% + *Bacillus subtillis* (BS2) @0.5%+40 mesh nylon net covering on bed resulted bacterial free maximum seedling stand 73.5%

of Kashi Aman. Talc based *T. asperllum* mixed in vermicompost and NADEP separately and incubated for 60 days at ambient temperature in laboratory. The colony count was almost similar at 40 & 60 days of incubation and decreased from the original inoculum count of *T. asperllum.* A total of 14 old pure culture of *Fusarium oxysporum* f.sp. *lycopersici* stored in sterile water since long back was re-cultured and found that most of the culture isolates changed their characters from original mother cultures did not resemble the characteristics colony character of *F. oxysporum* f.sp. *lycopersici.*

Field trial with talc-based formulation of *B. subtillis* (CRB-7) on bottle gourd during summer season revealed that the treatment (T2) root dipping @ 1% solution, basal application of enriched NADEP compost (10g/kg), 3 soil drenching @1% at 15 days intervals gives maximum yield of fruits (8.62t/ha) in comparison to control (3.94t/ha). Actinomyces sp. strain N1.2 was evaluated in pot and nursery experiments using bioformulation coating on tomato, brinjal, and chilli seeds. However, efficacy of this bioagent is variable in different crops for seed germination and damping off.

Mosaic disease on sponge gourd caused by ToLCNDV is found transmissible through seed material to an extent of 44%. Out of 563 symptomatic cucurbit samples obtained from 9 agroclimatic zones of the Uttar Pradesh state tested, 52 samples were found to be infected with Polerovirus in RT-PCR assay. Sequence analysis revealed the association of polerovirus species such as cucurbit aphid-borne yellows virus (CABYV), luffa aphid-borne yellows virus (LABYV) and melon aphid-borne yellows virus (MABYV) with the cucurbit samples. Upon characterization of complete genome of the CABYV infecting squash and watermelon nucleotide sequences shared 94.7% identity among themselves and 87.8% with CABYV isolate of China infecting zucchini (HQ439023). This is the first complete genome of the CABYV infecting cucurbits in India.

Pest dynamics on ten cucurbits species, musk melon (1.30), cucumber (1.22), long melon (0.96) and bottle gourd (0.93 beetles/plant) hosted more population of red pumpkin beetle, *Aulacophora foveicollis* (Lucas) during the cropping season. Cucumber was found susceptible to the sucking insects such as thrips (25.41/leaf/plant) and whiteflies (55.04/leaf/plant), while long melon (153.24/leaf/plant) and bottle gourd (140.38/leaf/plant) susceptible to red mites. Maximum fruit fly damage was recorded in long melon (84.98%). Spiders and predatory beetles such as coccinellid and rove beetles were maximum on long melon (3.19/plant) and sponge gourd (3.61/plant), respectively. In cabbage and cauliflower, the highest *Spodoptera litura* moth catches was recorded during 44th SMW (237.50 moths/trap) and in tomato, during 51st SMW (52.75 moths/trap). From January to December 2019, three peaks of *L. orbonalis* moth activity was recorded at 14th (18.78 moths/trap), 40th (10.78 moths/trap) and at 52nd SMW (13.67 moths/trap), respectively. The peak incidence of cowpea pod borer incidence was observed 40th SMW.

Spinach plants expressing symptoms of flat stem, indicative of phytoplasma infection subjected to PCR assay and positive PCR amplicon of 16SrDNA and secA genes were purified and sequenced. sequence analysis showed the phytoplasma responsible for flat stem disease in spinach is belonging to the 16SrI group phytoplasmas.

Newer rhizosperic bacterial isolates were isolated from the rhizospheric soil of IIVR. Among 116 isolates, 11 isolates were found antagonistic to *Sclerotium rolfsii* under in vitro test. Percent mycelial inhibitions were in the range of 37.08% ± 0.72% for AC27 and CC6 to 56.67% ± 0.72% for AA17. 12 isolates were found antagonistic to *Macrophomina phaseolina* and percent mycelial inhibition were in the range of 49.58% ± 0.72% for AD28 to 62.92% ± 0.72% for AD29 and BE11. Further *T. asperllum*-2 highly antagonistic and mycelial inhibition was 84.29% ± 1.43% for *Sclerotium rolfsii* and 80.91% ± 0.91% for *Macrophomina phaseolina* and better than all bacterial isolates. Among 116 cultures 18 isolates were found to be effective with 80 to 87% inhibition of bean isolate of *Sclerotinia sclerotiorum* in vitro with maximum 87.92%. by AB18 and AH40 isolates. were tested against the obtained from beans.

A method was developed for estimation of kresoxim-methyl using gas chromatography model 7890B equipped with an autosampler and microelectron capture detector (μECD, 63Ni) and kresoxim-methyl appeared at retention time (RT) of 11.18 min. Dissipation pattern of fungicide kresoxim-methyl in green chilli revealed that the residues in green chilli were below the MRL (0.8 mg kg−1, fixed by EU) after 3 days for treatment of double dosage and incase of recommended dosage 0 day also below MRL. The half-life value for recommended dose is 6.3 days and double of the recommended dose is 5.3 days.

कार्यकारी सारांश

सब्जी उत्पादन में आसन्न चुनौतियों का सामना करने और देश के लिए पोषण सुरक्षा सुनिश्चित करने के लिए, भाकृअप–भारतीय सब्जी अनुसंधान संस्थान द्वारा छह वृहद्–परियोजनाओं के माध्यम से मौलिक, प्रायोगिक और रणनीतिक अनुसंधान के क्षेत्र में ठोस प्रयास किये गये हैं।

इस वर्ष, देश के विभिन्न कृषि–जलवायु क्षेत्रों में खेती के लिए कुल 35 किस्में और संकर अधिसूचित किये गये है। समन्वित जीन प्रबंधन पर वृहद् कार्यक्रम के अंतर्गत संस्थान 44 प्रमुख और अल्प दोहित सब्जी फसलों के 6500 से अधिक जननद्रव्यों के विशाल संग्रह का अनुरक्षण कर रहा है। भाकृअप–एनबीपीजीआर के सहयोग से, संस्थान के वैज्ञानिकों की देश के विभिन्न हिस्सों में अन्वेषण यात्रा के द्वारा, संस्थान के जननद्रव्य भण्डार को संवर्धित किया गया। शोध में उपयोग हेतु जननद्रव्य को सामग्री हस्तांतरण समझौते (एमटीए) के माध्यम से प्रभावी रूप से साझा और वितरित किया गया।

टमाटर के आनुवंशिक उन्नयन की उप परियोजना के तहत, मध्यम कठोर फल वाले वीआरटी 16–11 × वीआरटी 16–12 नामक संकर को 116.3 टन / हेक्टेयर पैदावार के साथ उत्कृष्ट पाया गया। टमाटर में रोग प्रतिरोधक जीन (ToLCV, RKN और LB) की पिरामिडिंग कार्य में प्रगति हुई। काशी अमृत × एल ए 2157 (सोलनम अर्केनम) के बीच व्यापक संकरण द्वारा प्राप्त एफ 3 वंशावलियों में जड़सूत्र कृमि के प्रति प्रतिरोध पाया गया। इस वर्ष, टमाटर की नई किस्म काशी टमाटर –8 को अखिल भारतीय समन्वित शोध परियोजना (सब्जी फसलें) द्वारा जोन–IV और VII (पंजाब, यूपी, बिहार, झारखंड, एमपी, महाराष्ट्र और गोवा) में खेती के लिए चिन्हित किया गया।

बैंगन की 6 जंगली प्रजातियों के 23 जननद्रव्यों सहित कुल 257 जननद्रव्यों का प्रक्षेत्र में अनुरक्षण किया गया। 22 गोल फल वाले और 34 लम्बे फल वाले संकरों सहित कुल 56 एफ 1 संकरों का उपज और उपज घटकों के लिए मूल्यांकन किया गया। आईवीबीएल–23 नामक किस्म को अखिल भारतीय समन्वित शोध परियोजना (सब्जी फसल) समूह की 37वीं बैठक में, जोन–IV (पंजाब, यूपी, बिहार और झारखंड) में खेती के लिए चिन्हित किया गया।

मिर्च की अंतः प्रजात प्रविष्टी आई. आई. वी. आर. सी.–18132, उत्कृष्ट पाई गयी तथा इसे अ. भा. स. शो. प. (सब्जी फसल) के अंतर्गत बहुस्थानिक परिक्षण के लिए चयनित किया गया। "पर्णी रोजेट" एवं "अविभेदित पुष्पक्रम" नामक दो अद्वितीय उत्परिवर्तन पहचाने गये तथा उनकी वंशागति को ज्ञात करने हेतु नए संकर बनाये गये। लगातार दो साल के परीक्षणों में ए 7 x एस –5112 एवं जी एम एस –3 x वीआर –339 नामक संकर संयोजन उत्कृष्ट पाए गये। काशी सिंदूरी बीएस–35 के एफ 7 वंशावलियों में आणविक चयन के साथ–साथ कलम–बंधन प्रयोगों द्वारा पर्ण कुंचन विषाणु प्रतिरोध की पुष्टि की गई। उत्तर प्रदेश के राज्य किस्म विमोचन समिति द्वारा यूपी में खेती के लिए काशी रत्ना और काशी तेज नामक दो संकर और एक किस्म काशी आभा विमोचित की गई।

उच्च तापमान हेतु सहनशील एवं अक्टूबर में अगेती बुवाई की उपयुक्त मटर की पहचान के लिए मटर के पचास प्रभेदों का मूल्यांकन किया गया था और वीआरपीई –101, वीआरपीई –109, वीआरपीई –17, वीआरपीई –56 और वीआरपीई –18 को आशाजनक पाया गया। विभिन्न अ.भा.स.शो.प.(सब्जी फसल) किस्म परीक्षणों हेतु कुल पाँच नई प्रविष्टियाँ वीआरपीई–111, वीआरपीई–101–5, वीआरपीएमएस–919, वीआरपी–500 एवं वीआरपी–343 सम्मिलित की गईं। प्रति नोड 3 से 5 फली देने वाली मटर की अनूठी जीनोटाइप को एनबीपीजीआर में पंजीकृत कराया गया।

लोबिया के आनुवंशिक सुधार के तहत, दो उत्कृष्ट प्रभेदों (वीआरसीपी –68–2 और वीआरसीपी –71–1) को उनके बहुस्थानिक परीक्षण के लिए अ.भा.स.शो.प.(सब्जी फसल) किस्म परीक्षण में शामिल किया गया। लगातार तीन साल के चयन उपरांत, अंकुर गोमती और इंद्र लाल किस्म को सर्कोस्पोरा लीफ स्पॉट रोग के लिए अत्यधिक प्रतिरोधी पाया गया।

फरास बीन की बैंगनी–फली वाली और खम्बनुमा किस्म काशी बैंगनी को विभिन्न क्षेत्रों I, VII और VIII (जम्मू एवं कश्मीर, हिमाचल प्रदेश, उत्तराखंड, मध्य प्रदेश, महाराष्ट्र, गोवा, कर्नाटक, तमिलनाडु, पुदुचेरी और केरल) के लिए चिन्हित किया गया। फरास बीन के नौ झिल्लीमुक्त प्रभेदों (ईसी 792393, एफएमजीसीवी 1187, एफएमजीसीवी 1006, कांटेंडर, जिओली, एफएमजीसीवी 1129, सवाना, कार्टाजेंटा और बनोआ) की पहचान की गई। सेम के एक सौ इक्कीस जननद्रव्यों का अनुरक्षण किया गया और इसके कई अलग–अलग वंशावलियोंध पीढ़ियों को उच्चीकृत किया गया।

बीज जनित गोर्ड्स फसलों के आनुवंशिक सुधार उप परियोजना के अंतर्गत, छोटे फल समूह में करेला की लाइन वीआरबीजी –23, मध्यम फल समूह में वीआरबीटीजी–2–1, लंबे

फल समूह में वीआरबीटीजी–4–1–1 और अति लंबे फल समूह में वीआरबीटीजी –10 उत्कृष्ट पायी गयी। गायनोसिअस आधारित संकरों में, वीआरबीटीजी –5 (जी) × वीआरबीटीजी –10 उपज (4.21 किग्रा / पौधा) को सबसे अधिक आशाजनक पाया गया। लौकी की अग्रिम पंक्ति, वीआरबीजी –7 उपज के लिए उत्कृष्ट पायी गयी, जबकि परीक्षण किए गए संकरों में संकर वीआरबीजी–9–1–1 X वीआरबीजी –61–3 में उच्चतम उपज दर्ज की गयी।

लुफ्फा वर्गीय सब्जियों में, चिकनी तोरई की 29 अग्रिम लाइनें भाकृअनुप–एनबीपीजीआर, नई दिल्ली में प्रलेखित की गयी। नेनुआ की वीआरएसजी–17–1, वीआरएसजी –17–2 आदि उन्नत प्रजनन पंक्तियाँ उपज और बागवानी लक्षणों के लिए आशाजनक पाई गयी। इसके अलावा, कई प्रयोगात्मक संकर पैदावार और मृदु रोमिल आसिता रोग के खिलाफ सहिष्णुता के लिए वाणिज्यिक नियंत्रक किस्म से बेहतर पाए गए। नसदार तोरई के जनन द्रव्य वीआरआरजी –35, वीआरआरजी –110 आदि और संकर वीआरआरजी –5 ए X वीआरआरजी –75–2016, वीआरआरजी –75–2016 • वीआरआरजी –5ए आदि को बागवानी लक्षणों के लिए आशाजनक पाया गया और ये प्रक्षेत्र की परिस्थितियों में स्पंजगोर्ड मोजेक रोग और मृदु रोमिल आसिता रोग से मुक्त पाए गए। नसदार तोरई के जननद्रव्य वीआरआरजी –75 में मेलोन विवील, सफेद मक्खी और लीफ माइनर का सबसे कम प्रकोप पाया गया।

ककड़ी की अग्रिम पंक्तियों वीआरसीयू सेल–9–03, वीआरसीयू सेल –12–36 और संकर वीआरसीयूएच–18–01 को फलों के रंग, आकार, कम कड़वाहट और उपज के आधार पर आशाजनक पाया गया। उच्च कैरोटीन वाले ''बटर नट स्क्वैश'' कद्दू के दो नए जननद्रव्य संवर्धित किए गए । पार्थेनोकार्पिक ककड़ी के विकास पर काम को आगे बढ़ाया गया। कुल उपज और आकर्षक फलों के आधार पर, कद्दू के संकर वीआरपीके –19–02 और अग्रिम पंक्तियों वीआरपीके –11–06–02 और वीआरपीके –63 को आशाजनक पाया गया। कद्दू का जीनप्रारूप वीआरपीके –04 पीले मोजेक वायरस के लिए अत्यधिक प्रतिरोधी पाया गया। चप्पन कद्दू की लाइन वीआरएसएस –17–05 में उच्च आवृत्ति मादाता लक्षण के लिए स्थिरता पायी गयी।

तरबूज समूह में, मप्र, उप्र. और राजस्थान के विभिन्न जिलों से पांच नए जननद्रव्यों को संवर्धित किया गया। छोटे फल समूह में, तरबूज की पंक्तियाँ वीआरडब्ल्यू –514 और वीआरडब्ल्यू –514–1 उच्च समग्र घुलनशील ठोस के साथ साथ उपज हेतु उत्कृष्ट पायी गयी। वीआरडब्ल्यू –10 नामक एंड्रोमोनोसियस पंक्ति की पहचान की गयी जिसमें गोल फल, गूदा नारंगी, उच्च उपज और अधिक समग्र घुलनशील ठोस की मात्रा जैसे गुण विद्यमान थे। टिंडे के प्रभेद वीआरएम –5, वीआरएम –5–2, वीआरएम –1, वीआरएम –11–1 और वीआरएम –12 को उपज, किस्म शुद्धता और रोग सहिष्णुता के लिए आशाजनक पाया गया और वीआरएम –1 को किस्म अनुमोदन के लिए संस्थान के प्रजाति अनुमोदन समिति को प्रस्तुत किया गया। ककड़ी के प्रभेद वीआरएलएम–28 व वीआरएलएम –3, तथा खरबूजे के प्रभेद वीआरएमएम–170 और वीआरएमएम –186 को अधिक उपज और गुणवत्ता मानकों के लिए श्रेष्ठ पाया गया।

भिन्डी के आनुवंशिक उन्नयन कार्यक्रम के अंतर्गत ओडिशा, उत्तर प्रदेश और झारखंड से 25 नए खेती योग्य एवं जंगली प्रजातियों के जननद्रव्य को संवर्धित किया गया। भिन्डी के कई संकर (वीआरओ–120 × वीआरओ –125, वीआरओ –120 × वीआरओ –124 इत्यादि) लोकप्रिय नियंत्रक किस्म की तुलना में उत्कृष्ट पाए गए, जबकि अग्रिम पंक्तियों वीआरओ –120 और वीआरओ –125 को पैदावार और रोग प्रतिरोधिता के लिए लगातार दो फसल ऋतुओं में बेहतर पाया गया। लाल फल वाले जीनी प्रारूप, वीआरओआर –160 और वीआरओआर –156 उपज, गुणवत्ता और रोग प्रतिरोध के लिए सबसे अधिक आशाजनक पाए गए। विषाणु रोग प्रतिरोधक क्षमता के लिए विकसित किए गए कोल्चीप्लोइड अंतरजातीय संकर की प्रजनन क्षमता में उल्लेखनीय वृद्धि देखी गई। पीले फूल वाले *ए मोसकैटस* और लाल फूल वाले *ए मोसकैटस* उपजाति ट्यूबरोसस के अंतरजातीय संकरण से प्राप्त लाल फूलों वाले अनोखे संकर का विभिन्न रूपात्मक लक्षणों के लिए निरूपण किया गया।

गोभी वर्गीय फसलों में, कोशिका नर बंध्य आधारित फूलगोभी के कई संकर वीआरसीएफ –131 × वीआरसीएफ –75–1, वीआरसीएफ –110 × वीआरसीएफ –75–1 इत्यादि एवं प्रभेद वीआरसीएफ –75–1, वीआरसीएफ –86 आदि को उत्कृष्ट पाया गया। उष्णकटिबंधीय केल का प्रभेद वीआरकेल–1 (चिकनी पत्ती) और वीआरकेल –9 (रोयेंदार पत्ती) में उत्तर भारत के मैदानी क्षेत्र के जलवायु की दशा में फरवरी के तीसरे सप्ताह के दौरान बिना वर्नेलाइजेसन के बोल्टिंग और पुष्पन देखा गया। उष्णकटिबंधीय पत्तागोभी वीआरसीएबी–111 बेहतर शीर्ष गुणों के लिए आशाजनक पायी गयी। उच्च जड़ उपज और बेहतर गुणवत्ता वाले लक्षणों से युक्त कई गाजर जीन प्रारूपों वीआरसीएआर–186 (लाल जड़), काशी कृष्ण (काली जड़), वीआरसीएआर –141 (नारंगी जड़), वीआरसीएआर –153, (पीली जड़)य वीआरसीएआर –160 (क्रीम रंग की जड़), और वीआरसीएआर –171–1 (इंद्रधनुषी–प्रकार की जड़) की पहचान की गई। । उष्णकटिबंधीय गाजर के दो प्रभेदों (वीआरसीएआर –206 / लाल जड़ और वीआरसीएआर –91–1 / नारंगी जड़) को भाकृअप–एनबीपीजीआर, नई दिल्ली में प्रलेखित की गया। चार स्थिर ओगुरा– कोशिका नर बंध्य आधारित मूली की पंक्तियों वीआरआरएडी–11, वीआरआरएडी –13, वीआरआरएडी –198 और वीआरआरएडी–201 को प्रतीप संकरण के माध्यम से विकसित किया गया तथा रूपात्मक लक्षणों के लिए ये सभी

अपने संबंधित मेन्टेनर के समान पाए गए। मूली के प्रभेद काशी मूली –40 (सफेद जड़), काशी लोहित (लाल जड़) और वीआरआरएडी–134 (बाहर से बैंगनी) को उपज और गुणवत्ता लक्षणों के लिए उत्कृष्ट पाया गया।

सब्जियों में तनाव के प्रबंधन के लिए पराजीनी एवं जैव–तकनीकी नवाचार की उप परियोजना के तहत, ओकरा एनेशन लीफ कर्ल वायरस रोग के खिलाफ पराजीनी भिन्डी के पौधों के विकास पर कार्य को आगे बढ़ाया गया। गोल्डन गेट क्लोनिंग आधारित प्रणाली की मदद से, गेटवे आरएनएआई क्लोन pRNAi-CG: cB βC_1 (OEL CV βC_1) विकसित किया गया एवं एग्रोबैक्टेरियम में रूपांतरित किया गया। भिन्डी की प्रजाति काशी क्रांति में स्वतंत्र, इन–प्लांटा रूपांतरण किया गया तथा npt II विशिष्ट प्राइमरों का उपयोग करते हुए पीसीआर द्वारा 5 टी–1 इवेंट्स में npt II जीन की उपस्थिति की पुष्टि की गई। भिन्डी में CRISPR / Cas9 मध्यस्थ जीनोम संपादन कार्य के तहत, पूरक gRNA ओलिगोन्यूक्लियोटाइड को जोड़ा गया और pORE –04 वेक्टर में क्लोन किया गया और आगे चलकर क्लोन gRNA को एग्रोबैक्टेरियम में रूपांतरित किया गया। इन एग्रोबैक्टेरियम क्लोनों को इन–प्लांटा रूपांतरण के माध्यम से भिंडी में निवेशन किया गया। इसी प्रकार, वायरस जीन को लक्षित करते हुए, टमाटर में CRISPR / Cas9 मध्यस्थ जीनोम संपादन कार्य किया गया और पूरक gRNA ओलिगोन्यूक्लियोटाइड को जोड़ा गया और pORE –04 वेक्टर में क्लोन किया गया। क्लोन gRNA को एग्रोबैक्टीरियम में रूपांतरित किया गया और उतक संवर्धन तकनीक के माध्यम से एग्रोबैक्टीरियम क्लोन को टमाटर में निवेषित किया गया। इसके अलावा, टमाटर में TOLCV प्रतिरोध विकसित करने के लिए, दो मेजबान कारकों / संवेदी जीन को CRISPR / Cas9 तकनीक की मदद से बाह्यगमन (नॉकआउट) के लिए चुना गया। बैंगन में छियासठ तथाकल्पित WRKY ट्रांसक्रिप्शन कारकों को पहचाना गया और SiWRKY53 ट्रांसक्रिप्शन कारक के उच्च नियमन को बैंगन में बैक्टीरियल विल्ट के प्रतिरोध–स्रोत के रूप में अभिलेखित किया गया।

अल्प दोहित और भविष्य की सब्जियों के आनुवंशिक सुधार के अंतर्गत, पंखिया सेम की 40 नई प्रविष्टियों को एनबीपीजीआर क्षेत्रीय स्टेशन, अकोला से संवर्धित किया गया। जबकि दक्षिण गुजरात से ग्वार की 3 नई प्रविष्टियाँ एकत्र की गयी। प्रक्षेत्र परीक्षण में रूपात्मक लक्षणों के लिए ग्वार के जीनी प्रारूप वीआरसीबी –47, वीआरसीबी –48, वीआरसीबी –95 और दिलोजान –3 उत्कृष्ट पाए गए। बाकला के प्रभेद मुरादाबाद –103, ईसी– 628941, ईसी– 628929 और चेरी लगातार दो वर्षों के परीक्षण में उपज, किस्म शुद्धता और रोग सहिष्णुता के लिए बेहतर पाये गये। सब्जी सोयाबीन के प्रभेद स्वर्ण वसुंधरा, एजीएस –447, एजीएस –459, एजीएस –461 इत्यादि प्रति पौध उपज के लिए श्रेष्ठ पाए गए। इसके अलावा, ईसी–246, कल्ला भट्ट, आईसी–316142, ईसी–39043, ईसी –39043, आईसी –338716, ईसी –162 और ईसी –161 नामक प्रविष्टियाँ में स्पोडोप्टेरा के खिलाफ प्रतिरोधकता पायी गयी। सिंघाड़ा के प्रभेद वीआरडब्ल्यूसी–1 को औसत फलों के वजन के लिए आशाजनक पाया गया तथा वीआरडब्ल्यूसी –4 को मिठास, शुष्क पदार्थ की मात्रा और प्रति पौध उपज के लिए आशाजनक पाया गया। कमल के वीआरएल–1 प्रभेद को रूपात्मक लक्षणों, प्रति पौध बीज की संख्या और प्रकंद उपज के लिए उत्कृष्ट पाया गया। करेमू साग के 29 जीनी प्रारूपों का मूल्यांकन किया गया एवं वीआरडब्ल्यूएस –1, वीआरडब्ल्यूएस –4, वीआरडब्ल्यूएस –9, वीआरडब्ल्यूएस –11, वीआरडब्ल्यूएस –25, वीआरडब्ल्यूएस –26 और वीआरडब्ल्यूएस –29 विभिन्न बागवानी लक्षणों के लिए उत्कृष्ट पाए गए। अपलैंड क्षेत्र में करेमू की खेती के लिए कृषि क्रियाओं का पैकेज विकसित किया गया। सिंगल क्रॉस स्वीट कॉर्न संकर एससी 32 × एससी 10 में कुल घुलनशील ठोस पदार्थों की मात्रा 17.24 × ब्रिक्स पाई गयी जो प्रचलित किस्म स्वीट ग्लोरी (13.9 × ब्रिक्स) से अधिक थी तथा इसका प्रदर्शन भी आशाजनक होने के साथ साथ इसमें हरे भुट्टे की उपज स्वीट ग्लोरी की उपज के बराबर पाई गई। बेबी कॉर्न संकर बीसी –19 × बीसी –13 में वाराणसी की परिस्थितियों में काइलो पार्टेलस द्वारा जनित डेड हार्ट के लक्षण सबसे कम (17. 39:) पाए गये। पालक का जीनी प्रारूप वीआरपीएलके –2 बुवाई की बारह अलग–अलग समयों में लोकप्रिय किस्म ऑल ग्रीन की तुलना में बेहतर पाया गया। बथुआ की दो किस्में काशी बथुआ –2 (हरी पत्तियां) और काशी बथुआ –4 (बैंगनी–हरी पत्तियां) का अनुरक्षण किया गया। चौलाई के प्रभेद वीआरएएम –306, वीआरएएम –312 आदि को बागवानी गुणों, उपज और उपज लक्षणों के लिए आशाजनक पाया गया।

परवल के परीक्षित कृन्तकों में , वीआरपीजी –210, वीआरपीजी –19 (देसी समूह) और वीआरपीजी –240 क्रमशः 13.50 किलोग्राम, 12.25 किलोग्राम और 12.00 किलोग्राम प्रति पौधे की फल उपज के साथ सबसे अधिक आशाजनक पाए गए। वीआरपीजी –210 और वीआरपीजी –217 भी बड़े फलों के आकार के कारण मिठाई बनाने हेतु उपयुक्त पाए गए। परवल के 10 कृन्तक (क्लोन) के भंडारण व्यवहार पर अध्ययन में वीआरपीजी, वीआरपीजी –217 वीआरपीजी –215 और काशी अमूल्य नामक जीनी प्रारूप उत्कृष्ट पाए गए। ककरोल के प्रभेद वीआरएसटीजी–38, वीआरएसटीजी –20 और वीआरएसटीजी – 5य करतोली के प्रभेद वीआरएसईजी –32, वीआरएसईजी –11 और वीआरएसईजी –36य और कुन्दरू के प्रभेद वीआरआईजी –14, वीआरआईजी –16 और वीआरआईजी –6 उपज और बागवानी लक्षणों के लिए आशाजनक पाए गए। पोई साग के जीन प्रारूप वीआरबी –4, वीआरबी –7, वीआरबी –17, वीआरबी –23 और वीआरबी–61–1 प्रति पौध उपज हेतु उत्कृष्ट

पाए गए। पोई साग में बीटालिन रंजक गुण का नियंत्रण एकल प्रमुख जीन द्वारा होना पाया गया क्योंकि रंजकयुक्त और रंजकरहित प्रकार के पौधों में 3 : 1 का सरल मेंडेलियन आनुवंशिक अनुपात प्राप्त हुआ।

सब्जियों में बीज वृद्धिकरण पर वृहद् कार्यक्रम के अंतर्गत, बीज की मांग की पूर्ति एवं किसानों में वितरण हेतु, विभिन्न सब्जियों की किस्मों / संकरों के 24014.15 किलोग्राम बीज उत्पादन किया गया जिसमें 2415.05 किलोग्राम प्रजनक बीज और 91 किलोग्राम संकर बीज सम्मिलित था। संस्थान के मुख्य परिसर में बीज उत्पादन के अलावा, सरगटिया स्थित क्षेत्रीय अनुसंधान केंद्र में 43600 किलोग्राम बीज के साथ–साथ विभिन्न फसलों की रोपण सामग्री का उत्पादन किया गया। प्राइमिंग, कोटिंग, बीजाण्ड रूपांतरण और बीज वर्धन संबंधित अध्ययन के अंतर्गत , भिन्डी की किस्म काशी क्रांति के बीजों में 0.5% ह्यूमिक एसिड के उपचार से सार्थक रूप से उच्चतम अंकुरण (93%) एवं अंकुरण की गति (75.9) दर्ज की गयी और अन्य बीज गुणवत्ता मापदंडों के लिए भी यह उपचार बेहतर पाया गया। ह्यूमिक एसिड की सांद्रता बढ़ाने पर बीज की गुणवत्ता के मापदंडों में गिरावट दर्ज की गई। सब्जी फसलों में मधुमक्खियों की सहायता से बीज संवर्धन के लिए किये गये परागण अध्ययन में, 5% चीनी + 5% गुड़ + 50 पीपीएम बोरान के उपचार संयोजन से भिन्डी की काशी चमन प्रजाति में बीज की उपज और बीज की गुणवत्ता के मापदंडों में वृद्धि पायी गयी। मुक्त परागण की तुलना में 5% चीनी + 5% गुड़ के उपचार के बाद 5% चीनी + 5% गुड़ + 50% बोरान के उपचार में उच्च परागण की गतिविधि पायी गई। परिवर्तित वातावरण भण्डारण तकनीक को सम्मिलित करते हुए सब्जी बीजों के शुष्कन और भंडारण से संबंधित अध्ययनों में, लोबिया की किस्म काशी कंचन को जिओलाइट बीड्स के साथ 1: 3 (बीजः बीड्स) के अनुपात से भंडारण करने पर सिलिका जेल की तुलना में अधिक एवं तीव्र नमी अवशोषण पाया गया। जिओलाइट बीड्स और सिलिका जेल के साथ बीज भंडारण विधियों के मानकीकरण से संबंधित अध्ययन में मूली की किस्म काशी हंस में कमरे के तापमान पर जिओलाइट बीड्स के साथ संग्रहीत बीज में, शीत भंडारण की स्थिति में रखे गए बीजों के बराबर ही उच्च अंकुरण पाया गया।

सब्जी उत्पादन विभाग में, प्राकृतिक रूप से संवाहित पॉलीहाउस परिस्थितियों के अंतर्गत किए गए अध्ययनों से ज्ञात होता है कि टमाटर और शिमला मिर्च दोनों में दो–तना प्रशिक्षण सबसे उपयुक्त प्रणाली थी। इसी तरह, अम्ब्रेला प्रणाली तत्पश्चात ड्रेप प्रणाली पर सधाई करने पर खीरे में उपज और उससे संबंधित गुणों में सार्थक वृद्धि हुई। खीरे की किस्म वी–5 तत्पश्चात वी–2 किस्म संरक्षित परिस्थितियों में बीज–रहित खीरे के उत्पादन के लिए अत्यधिक उपयुक्त पायी गयीं। पादप जैव–नियामकों जैसे कि सैलिसिलिक अम्ल और एजेलिक अम्ल और सूक्ष्म जीवाणुओं (माइकोराइजा और *अजोस्पिरिलम फोरमोसेन्स*) के संयुक्त अनुप्रयोग से जीवाणुओं या जैव–नियामकों के एकल प्रयोग की तुलना में उपज में सार्थक अभिवृद्धि अभिलेखित की गयी।

फसल पद्धति अध्ययन के अंतर्गत, दूसरे चक्र के पूर्ण होने के पश्चात, चावल के समतुल्य उपज के संदर्भ में उच्चतम कुल फसल प्रणाली उत्पादकता (275.83 कुंतल प्रति हेक्टेयर) लोबिया–भिंडी–टमाटर तत्पश्चात भिंडी–टमाटर–लोबिया (258. 07 कुंतल प्रति हेक्टेयर) पद्धति में प्राप्त हुई। खरीफ ऋतु में सबसे अधिक उत्पादकता बैंगन की फसल (142.08 कुंतल प्रति हेक्टेयर) में एवं इसके बाद लौकी (108.07 कुंतल प्रति हेक्टेयर) में देखी गई। लौकी–गेहूँ–चौलाई की फसल प्रणाली को उच्चतम लागतः लाभ अनुपात (2.36) के साथ सबसे अधिक लाभदायक पाया गया। इसके बाद मक्का–मटर–कुम्हड़ा फसल प्रणाली (लागतः लाभ अनुपात 2.27) को लाभप्रद पाया गया।

सब्जी फसलों में सस्य क्रियाओं द्वारा जैव–सुदृढीकरण के अंतर्गत फसल–समूह विशेष के लिए बनाए गए सूक्ष्म पोषक तत्वों के सम्मिश्रणों के पर्णीय छिड़काव से नियंत्रण की तुलना में टमाटर की उपज में 13.6–17.8 प्रतिशत, पत्तागोभी में 11.9–18.5 प्रतिशत, फूलगोभी में 9.4–20.0 प्रतिशत, लोबिया में 11.3– 38.5 प्रतिशत तथा भिंडी की उपज में 6.9–16.2 प्रतिशत की वृद्धि अभिलेखित की गई। भिंडी के 41 तथा परवल के 53 जीनप्रारूपों में सूक्ष्म पोषक तत्वों (तांबा, लोहा, जस्ता एवं मैंगनीज) के प्रालेखन में पाया गया कि दोनों ही फसलों के जीनप्रारूपों में इन सूक्ष्म पोषक तत्वों की मात्रा में काफी विविधता है।

सब्जियों की जैविक खेती के अंतर्गत धान के समतुल्य उपज के रूप में फसल प्रणाली की आँकी गई कुल उत्पादकता, हरी खाद– टमाटर– मूंग प्रणाली में सर्वाधिक (17.632 टन प्रति हेक्टेयर) पायी गई। दूसरा स्थान (15.116 टन प्रति हेक्टेयर) हरी खाद– ब्रोकोली– लोबिया का रहा। जबकि शुद्ध आय एवं लाभःलागत का अनुपात हरी खाद– ब्रोकोली– लोबिया प्रणाली में सर्वाधिक रहा। दूसरा स्थान हरी खाद– सब्जी मटर– भिंडी का रहा। जैविक प्रणाली में लोबिया एवं भिंडी की विटामिन सी के रूप में गुणवत्ता रासायनिक खेती की तुलना में ज्यादा अच्छी पायी गई। जैविक विधि से उगाई गई लोबिया एवं भिंडी में रासायनिक खेती की तुलना में एस्कॉर्बिक अम्ल, कुल फिनाल तथा प्रतिऑक्सीकारकों की मात्रा में क्रमशः 18.2, 13.6 एवं 9.2 प्रतिशत तथा 21.8, 16.6 एवं 12.4 प्रतिशत की वृद्धि दर्ज की गई। नाडेप कम्पोस्ट एवं गोबर की खाद के 25 टन प्रति हेक्टेयर की दर से प्रयोग करने पर रासायनिक पद्धति की तुलना में मृदा में जैविक कार्बन की मात्रा में क्रमशः 17.63 व 22.42 प्रतिशत की बढ़ोत्तरी अभिलेखित की गई।

जल उपयोग दक्षता के लिए किए गए अध्ययन से ज्ञात होता है कि 100 प्रतिशत ई.टी. पर 2 दिन के अंतराल पर बूंद–बूंद सिंचाई द्वारा कुड़ विधि की तुलना में 30–35 प्रतिशत पानी के बचत के अतिरिक्त टमाटर, पत्ता गोभी और फूल गोभी के

उत्पादन एवं जल उपयोग दक्षता में सार्थक वृद्धि हुई।

सब्जियों में किए गए कलम बंधन (ग्राफ्टिंग) संबन्धित अध्ययन दर्शाते हैं कि करेले के सांकुर के लिए चिकनी तोरई के मूलवृंत सर्वोपयुक्त हैं क्योंकि इससे अकलमी, लौकी तथा नसदार तोरई की तुलना में क्रमशः 425 प्रतिशत, 183 प्रतिशत एवं 141 प्रतिशत की उत्पादन में वृद्धि हुई। खीरे में सर्वाधिक फलोत्पादन (1.154 किलोग्राम प्रति पौध) नसदार तोरई मूलवृंत पर प्राप्त हुई। अकलमी पौधों की तुलना में इस सांकुर–मूलवृंत संयोजन से उत्पादन में 73 प्रतिशत की वृद्धि अभिलेखित की गयी।

लोबिया में सर्वाधिक उपज (15.6 टन प्रति हेक्टेयर) काली पालीथीन के प्रयोग से प्राप्त हुई। रसायनों के मध्य सबसे अधिक उपज (12.3 टन प्रति हेक्टेयर) पेंडिमेथेनिल (750 ग्राम प्रति हेक्टेयर उद्भव पूर्व) एवं इमेजेथेपायर (100 ग्राम प्रति हेक्टेयर उद्भवोपरान्त) के संयुक्त प्रयोग से प्राप्त हुई।

राजमा में पलवार एवं रसायनों के प्रयोग द्वारा खरपतवार प्रबंधन अध्ययन से स्पष्ट होता है कि काली पालीथीन की पलवार लगाने से अधिकतम खरपतवार नियंत्रण सूचकांक (98.9) प्राप्त हुआ। रसायनों के बीच सर्वाधिक खरपतवार नियंत्रण सूचकांक (97.2) पेंडिमेथेलीन (उद्भव पूर्व) एवं सोडियम एसिफ्लूआरफेन + क्लोडिनेफॉप प्रोपर्जिल 100 ग्राम प्रति हेक्टेयर (उद्भवोपरान्त) के संयुक्त प्रयोग से प्राप्त हुआ।

सबसे अधिक उपज (16.9 टन प्रति हेक्टेयर) काली पालीथीन की पलवार में दर्ज की गई जो कि अन्य उपचारों से सार्थक रूप में अधिक थी। रसायनों के बीच सर्वाधिक उपज (13.4 टन प्रति हेक्टेयर) पूर्व उद्भव (पेंडिमेथेलिन 750 ग्राम प्रति हेक्टेयर) एवं उद्भवोपरान्त (सोडियम एसिफ्लूआरफेन + क्लोडिनेफॉप प्रोपर्जिल 18 प्रतिशत ईसी) के संयुक्त प्रयोग से प्राप्त हुई जो कि पेंडिमेथेलीन 750 ग्राम प्रति हेक्टेयर (उद्भव पूर्व) एवं इमेजेथेपायर 100 ग्राम प्रति हेक्टेयर के संयुक्त प्रयोग से प्राप्त होने वाली उपज (12.9 टन प्रति हेक्टेयर) के समान थी एवं दोनों उपचार अन्य रसायनों के उपचार से सार्थक रूप से अधिक थे।

सब्जी आधारित फसल प्रणाली में संरक्षित खेती के अंतर्गत शून्य जुताई के साथ फसल अवशेष को भूमि की सतह पर बिछाए रखने पर मक्के के हरे भुट्टे की सर्वाधिक पैदावार (130 कुंतल प्रति हेक्टेयर) प्राप्त हुई जबकि परंपरागत जुताई के साथ फसल अवशेषों को मिट्टी में मिला देने पर यह 126 कुंतल प्रति हेक्टेयर रही।

विस्तारित पॉलीथीन बायोपॉलिमर फिल्मों का उपयोग करते हुए फूलगोभी में निधानी जीवन विस्तार अध्ययनों से ज्ञात हुआ कि नमी की मात्रा 97.73 से घटकर 78.37 प्रतिशत और 97.73 से घटकर 79.42 प्रतिशत, क्रमशः छोटे और बड़े आकार के फूलगोभी के 3 डिग्री सेल्सियस पर 49 दिनों के उपांतरित वातावरणीय पैकेजिंग भंडारण में हो गई, जबकि यह 14 दिनों के 10 डिग्री सेल्सियस भंडारण के दौरान, 97.73 से 86.85 प्रतिशत एवं 97.73 से 85.50 प्रतिशत तेजी से घटी। तीन डिग्री सेल्सियस पर 49 दिनों के उपांतरित वातावरणीय पैकेजिंग भंडारण के पश्चात, छोटे और बड़े आकार की फूलगोभी में एस्कॉर्बिक अम्ल की मात्रा 96 प्रतिशत से घटकर 93.2 प्रतिशत हो गई। इसी अवधि में, कुल फिनाल मात्रा छोटे और बड़े आकार के फूलगोभी में क्रमशः 733.45 से 247.13 मिलीग्राम और 733.45 से 40.6 प्रति 100 ग्राम गैलिक अम्ल समतुल्य घटकर हो गई।

सौ और 150 वर्ग मीटर क्षेत्र के पोषण–उद्यान मॉड्यूल के परिणाम से ज्ञात हुआ कि क्रमशः 131.06 और 242.49 किलोग्राम सब्जियां, लगभग 100 दिनों के समय अवधि से प्राप्त की जा सकती हैं जबकि, सब्जियों की दैनिक उपलब्धता 1.51 और 2.63 किलोग्राम थी, जो क्रमशः 05 और 08 सदस्यों के परिवार के लिए पर्याप्त थी।

ग्रामीण युवाओं के बीच उद्यमशीलता को बढ़ावा देने के लिए, एक मशरूम उद्यमी को प्रेरणा और सूचना सहायता प्रदान की गई। परिणामस्वरूप, 2.0 लाख रुपये की आय के साथ 1.25 टन मशरूम का उत्पादन हुआ। इसके अतिरिक्त, वाराणसी महानगर में छोटे पैमाने पर उद्यमिता के रूप में सब्जी के रस की बिक्री की संभावनाओं का अध्ययन किया गया एवं 03 उद्यमिता विकास प्रशिक्षण भी आयोजित किए गए।

भारतीय सब्जी अनुसंधान संस्थान द्वारा विकसित भिंडी किस्म काशी प्रगति के प्रभाव एवं इसके अंतर्गत आने वाले अनुमानित क्षेत्र का आंकलन संस्थान के विक्रय पटल से विक्रीत बीज के आधार पर किया गया। विक्रीत 10907.5 किलोग्राम के कुल सत्यरूप (ट्रुथफुल लेबल) बीजों के आधार पर काशी प्रगति 908.96 हेक्टेयर अनुमानित क्षेत्र में उगायी जाती है। प्रजनक बीज की बिक्री के आधार पर वर्ष 2014–15 से 2019–20 तक, काशी प्रगति को 145776 हेक्टेयर अनुमानित क्षेत्र में उगाया गया। कुल मिलाकर वर्ष 2004–05 से 2019–20 तक, किस्म काशी प्रगति देश के 23 राज्यों के 123 जिलों के 146684.96 हेक्टेयर क्षेत्रफल में फैल चुकी है।

लौकी (किस्म काशी गंगा) एवं कद्दू (किस्म काशी हरित) में एकीकृत पीड़क प्रबंधन घटक के अन्तर्गत बोनी के 20–30 दिन बाद डाइक्लोरवास, *बैसिलस थुरिन्जेन्सिस कुरस्टाकी*, इमिडाक्लोरवास, *लेकानीसीलियम लेकानी* एवं एजिडिरैक्टिन के 0.03 प्रतिशत का 10 दिन के अन्तराल पर छिड़काव से लालकद्दूभृंग (73.99 एवं 67.27 प्रतिशत), सफेद मक्खी (85.57 एवं 66.57 प्रतिशत), सफेद प्लुम शलम (84.04 प्रतिशत) एवं मिरिड बग (70.12 एवं 84.62 प्रतिशत) के प्रकोप में कमी एवं उपज (29.3 टन प्रति हे.) पायी गयी।

भिण्डी में सायनट्रानिलीप्रोल के उपचार से पर्ण फुदका (91.62 प्रतिशत) एवं सफेद मक्खी (70.7 प्रतिशत) के प्रकोप में कमी पायी गयी। पत्तागोभी में बुप्राफेजिन के उपचार से माहू के प्रकोप में 89.33 प्रतिशत जबकी लोबिया में स्पिनोट्राम (86.46 प्रतिशत), क्लोरनट्रानिलीप्रोल (80.37 प्रतिशत), इण्डोक्साकार्ब (83.27

प्रतिशत) एवं स्पिनोसाड (79.81 प्रतिशत) के उपचार से फली भेदक के प्रकोप में कमी पायी गयी।

परभक्षी मिरिड बग (*नेसिडियोकोरिस टेन्युइस*) की टमाटर में पहचान की गयी। भिण्डी में *लेकानीसीलियम लेकानी* के प्रयोग से जैसिड (56.95 प्रतिशत) एवं सफेद मक्खी (53.07) के प्रकोप में कमी पायी गयी। इसी प्रकार ले. लेकानी एवं नीम के तेल (1:1) एवं *बै. थुरिन्जोन्सिस कुरस्टाकी* के प्रयोग से भिण्डी में जैसिड (1:13) एवं फली छेदक (33.3 –67.1 प्रतिशत) कं प्रकोप में कमी पायी गयी। इमामेक्टिन बेन्जोएट 5 प्रतिशत एसजी, क्लोरनिट्रानिलीप्रोल 18.5 प्रतिशत एस सी. का भिण्डी में प्रयोग मकड़ी (18.48 एवं 9.80 प्रतिशत) एवं भृंग (25 एवं 5.88 प्रतिशत) के प्रति प्रभावी पाया गया।

टमाटर (किस्म काशी अमन) की पौधशाला में रोग प्रबंधन के घटकों में उपचार (टी–5) के अन्तर्गत पौधशाला की क्यारी का मृदा सौर्यीकरण, *ट्रा. एस्पेरेलम* के साथ *बै. सबटिलिस* (बी एस–2) के 0.5 प्रतिशत से बीजोपचार के बाद 40 मेशवाली नायलोन की जाली से ढकने पर रोगमुक्त स्वस्थ पौध तैयार की गयी।

टाल्क आधारित *ट्रा. एस्पेरेलम* के जैव संरूपण को केंचुये की खाद (वर्मीकम्पोस्ट) एवं नडेप में मिलाने के बाद 60 दिन तक उष्मायित करने पर समय के साथ प्रति ग्राम में *ट्रा. एस्पेरेलम* की संख्या में कमी पायी गयी। *फ्यूजैरियम आक्सीस्पोरम* एफ स्पी. *लाइकोपर्सिकी* के 14 प्रभेदों को उनके लक्षणों के आधार पर पहचान कर शुद्ध संवर्ध प्राप्त किये गये।

लौकी में *बै. सबटिलिस* (सी आर बी–7) के जैव संरूपण से जड़ का उपचार (1 प्रतिशत), नडेप मिश्रित खाद (10 ग्राम प्रति किग्रा.) एवं मृदा भिंगाव (1 प्रतिशत) का 15 दिन के अन्तराल पर प्रयोग करने से अनुपचारित नियंत्रण (3.94 टन प्रति हे.) की तुलना में अधिकतम उपज (8.62 टन प्रति हे.) प्राप्त हुई।

एक्टिनोमाइसीज प्रभेद एम 1.2 का टमाटर, बैंगन एवं मिर्च में बीजोपचार के लिये प्रयोग किया गया। *बै. सबटिलिस* (बी. एस. –2) से बीजोपचार (4 ग्राम प्रति किग्रा.), मृदा उपचार (10 ग्रा. / वर्ग मी.) एवं मृदा भिंगाव (5 प्रतिशत) का मिर्च (काशी अनमोल), बैगन (काशी तरू) एवं टमाटर (किस्म काशी अमन) में प्रयोग से पौध अंकुरण (75, 80 एवं 73 प्रतिशत) के साथ आर्द्र गलन रोग के प्रकोप में (1.2, 10 एवं 27 प्रतिशत) कमी पायी गयी।

नेनुआ में बीजजनित मोजैक विषाणु की ताव्रता 44 प्रतिशत तक पायी गयी। उ.प्र. के 9 जलवायुवीय क्षेत्रों से 563 कद्दूवर्गीय सब्जियों के नमूनों को एकत्रित किया गया जिनमें आरटी–पीसीआर परीक्षण में 52 नमूने पोलेरोविषाणु से संक्रमित पाये गये। पोलेरोविषाणुओं में सी.ए.बी.वाय.वी., एल.वी.वाय.वी. एवं एम.ए.वी.वाय.वी. पाये गये जिनमें सी.ए.वी.वाय.वी. के आण्विक प्रतिरूपण में 94.7 प्रतिशत समानता पायी गयी।

पीड़क गतिकी के अध्ययन में कद्दूवर्गीय फसलों जैसे खरबूज, खीरा, ककड़ी, लौकी में भृंग का प्रकोप क्रमशः 1.30, 1. 22, 0.96 एवं 0.93 प्रति पौधा पाया गया। खीरा में थ्रिप्स (25.41 प्रति पत्ती प्रति पौधा) एवं सफेद मक्खी (55.04) जबकी ककड़ी (153.24) एवं लौकी (14.38) में लाल मकड़ी का प्रकोप कम पाया गया। इसी प्रकार ककड़ी में मकड़ी (84.98 प्रतिशत), मेलन व नेनुआ में रोग भृंग क्रमशः 3.19 व 3.61 प्रति पौधा अभिलेखित किया गया।

44वें सप्ताहिकी में *स्पोडोप्टेरा लिटुरा* का पत्तागोभी व फूलगोभी में (237.50 शलभ प्रति प्रपंच) एवं 51वें सप्ताहिकी में टमाटर में (52.75 शलभ प्रति पौध) प्रकोप पाया गया। 52वें सप्ताहिकी में तना एवं फलछेदक का सर्वाधिक प्रकोप (13.67 शलभ प्रति प्रपंच) पाया गया।

पलक में फायटोप्लाज्माजनित रोगजनक 16 एसआर–1 का पीसीआर द्वारा पता लगाया गया। संस्थान में पौधजड़तंत्र की मृदा से 116 सूक्ष्मजीवीय प्रभेदो में 11 प्रभेद *स्कलेरोषियम रोल्फसाई* के प्रति प्रभावी पाये गये। प्रभेद एडी–28 एवं बीई–11 की *मैक्रोफोमिना फेसियोलिना* के प्रति जैव प्रभाविता 62.92 0.72 प्रतिशत पायी गयी। *ट्रा. एस्पेरेलम*–2 की जैव प्रभाविता *स्कलेरोषियम रोल्फसाई* (84.29 1.43 प्रतिशत) एवं *मै. फेसियोलिना* (80.91 0.91 प्रतिशत) के प्रति अत्यधिक पायी गयी। अन्तःपात्रे परीक्षण मे प्रभेद एबी–18 एवं एएच–40 को *स्क. रोल्फसाई* के प्रति प्रभावी पाया गया।

क्रेसोक्सिम–मिथाइल के अभिधारण की विधि का मानकीकरण किया गया। हरी मिर्च में दस रसायन के उपचार के 3 दिन बाद अधिकतम अवशेष संचयन की मात्रा (एम आर एल) 0.8 मि.ग्रा. प्रति कि.ग्रा. पायी गयी। इस रसायन की अनुशंसित प्रयोग की मात्रा एवं दुगुनी अनुशंसित मात्रा की अर्धआयु क्रमशः 6.3 एवं 5.3 दिन पायी गयी।

Abbreviations

a.i.	Active Ingredient
AICRP(VC)	All India Coordinated Research Project (Vegetable Crop)
AIR	All India Radio
ASCI	Agriculture Skill Council of India
ATIC	Agricultural Technology Information Centre
ATMA	Agricultural Technology Management Agency
AU	Astronomical Unit
BOLD	Barcode of Life Database
B-S PE	Black-Silver Polyethylene Mulch
CAPS	Cleaved Amplified Polymorphic Sequences
CD	Critical Difference
CDD	Conserved Domain Database
CMS	Cytoplasmic Male Sterile
CMS	Cytoplasmic Male Sterility
CT	Conservation Tillage
CTC	Co-toxicity Coefficient
CV	Coefficient of Variation
DAI	Days After Inoculation
DAS	Days After Sowing
DAT	Days After Transplanting
DDG	Deputy Director General
DFF	Days Required to First Flowering
DNA	Deoxyribonucleic Acid
DS	Drought Stress
DSI	Drought Sensitivity Index
DTPA	Diethylene Triamine Pentaacetic Acid
DW	Dry Weight
DWR	Directorate of Weed Research
EC	Emulsifiable Concentrate
EDTA	Ethylene Diamine Tetraacetic Acid
EPN	Entomopathogenic Nematodes
FD	Fruit Diameter
FL	Fruit Length
FLD	Front Line Demonstration
FSB	Fruit & Shoot Borer
FW	Fresh Weight
GDD	Growing Degree Days
GDP	Gross Domestic Product
GMS	Genetic Male Sterility
GMV	Golden Mosaic Virus
HAT	Hours After the Treatment
IAA	Indole Acetic Acid
IC Numbers	Indigenous Collection Numbers
ICAR	Indian Council of Agricultural Research
IIVR	Indian Institute of Vegetable Research
INLFH	Inter Node Length at First Harvest
IRM	Insecticide Resistance Management
KVK	Krishi Vigyan Kendra
LC_{50}	Lethal Concentration 50

MI	Mycelial Growth Inhibition
MTA	Material Transfer Agreement
MtCOI	Mitochondrial Cytochrome Oxidase I
NAIP	National Agricultural Innovation Project
NBAIR	National Bureau of Agricultural Insect Resources
NFP	Number of Fruits per Plant
NNFH	Number of Node at First Harvest
NPTC	Network Project on Transgenic CROP
NT	Not Tested
NUE	Nutrient Use Efficiency
OC	Organic Carbon
OD	Optical Density
OFT	On Farm Trials
PBNV	Peanut Bud Necrosis Virus
PCR	Polymerase Chain Reaction
PDI	Per cent Disease Index
PHI	Pre Harvest Interval
PLW	Physiological Loss in Weight
PPM	Parts Per Million
PPOC	Per cent Protection Over Control
PPP	Public Private Partenership
PR	Percent Reduction
PRP	Proline Rich Protein
PTC	Pre-Treatment Count
QTL	Quantitative Trait Loci
R&D	Research and Development
RAPD	Random Amplified Polymorphic DNA
RBD	Randomized Block Design
RH	Relative Humidity
RILs	Recombinant Inbred Lines
RNA	Ribonucleic Acid
RT	Reduced Tillage
Sc	Number of Sclerotia
SD	Standard Deviation
SDI	Sub-surface Drip Irrigation
SEM	Standard Error Mean
SNPs	Single Nucleotide Polymorphism
SPS	Single Plant Selection
SR	Survival Rate
SSDI	Sub Surface Drip Irrigation
SSR	Simple Sequence Repeat
TI	Tolerance Index
ToLCV	Tomato Leaf Curl Virus
TSS	Total Soluble Solids
WBNV	Watermelon Bud Necrosis Virus
WEY	Wheat Equivalent Yield
WFPP	Weight of Fruit Per Plant
WG	Water Dispersible Granules
WUE	Water Use Efficiency
YVMV	Yellow Vein Mosaic Virus
ZT	Zero Tillage

Division of Vegetable Improvement

MEGA PROGRAMME 1: INTEGRATED GENE MANAGEMENT

Programme Leader : Dr. P. M. Singh

Project 1.1 : Genetic improvement of tomato

Germplasm augmented : Four tomato genotypes (AVTO1219, AVTO1314, AVTO1315 and AVTO1424) were introduced from World Vegetable Centre, Taiwan and their seed is being multiplied.

Promising tomato hybrid : Based on the station trial performance, hybrid VRT16-11 × VRT16-12 was sent for multiplication testing under AICRP-VC. The test hybrid VRT16-11 × VRT16-12 yielded 116.3 tonnes/ha. The fruits of VRT16-11 × VRT16-12 hybrid exhibited medium firmness with a pericarp thickness of 0.5-0.6 cm and recorded average fruit weight of 80-110 g.

Pyramiding of disease resistance genes (ToLCV, RKN and LB) : Genotyping of F_4 plants from root genotype with *Ty2, Ty3, Ph2* and *Ph3* was done. Thirteen plants were homozygous for all four genes, 26 plants were homozygous for *Ty3, Ph2* and *Ph3,* 23 plants were homozygous for *Ty2, Ph2* and *Ph3* and many plants were segregating for one or more targeted genes (Fig. 1).

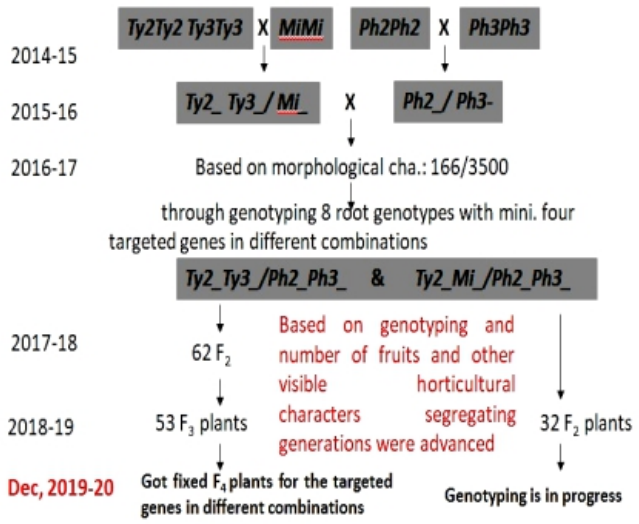

Fig.1: Status of gene pyramiding program being followed for ToLCV, RKN and LB genes

Wide hybridization for heat stable root knot nematode resistance: Fifty F_3 plants from seven F_3s of Kashi Amrit × LA 2157 (*Solanum arcanum*) cross along with parents were screened against root knot nematode *Meloidogyne incognita* under pot condition by inoculating 2000 second stage infective juveniles per plant during April-May, 2019. Ten F_3 plants, each of two separate F_3 families, have shown resistance and no segregation was observed. Due to high temperatures during fruiting period, there was very poor germination in F_4 generation. Only one F_4 plant reached flowering stage which is now being used in back cross programme.

Evaluation of tomato advanced lines and hybrids for cultivation of tomato in rainy season (Tropical Tomato) : Thirty advance lines (F_9 to F_{12}) and 190 F_1s (Developed in CRP-HT project) were evaluated for cultivation in rainy season (transplanted in third week of July). Data recording and crop management are in progress.

Evaluation of nutrition rich (high TSS, lycopene, β-carotene and acidity) segregating populations : Eight segregating populations in F_7-F_8 generations were transplanted in field. Selection of superior segregates and crop management is in progress.

Cherry tomato : Fourteen red fruited cherry tomato of F_7-F_8 generations, eleven yellow fruited cherry tomato F_7-F_8 generations and thirteen β-carotene tomato lines of F_8-F_9 were transplanted in open field condition. Selection of superior segregates and crop management is in progress.

Germplasm Maintenance : 265 germplasm accessions were multiplied for reviving the seeds. Data recording and crop management are in progress.

Entries under AICRP trials : Eleven entries *viz*., VRT-19, VRT-1, VRTToLCV-32, VRT-06, VRT-13, VRT-28, VRT-34, VRT-50 and VRT-51, VRT-30, CRPVRTH-3, CRPVRTH-4 and CRPVRTH-70 are under evaluation in different trials. One variety Kashi Tamatar-8 has been identified for release in AICRP (VC) group meeting held in June 2019 for cultivation in zone-IV & VII (Punjab, UP, Bihar, Jharkhand, MP, Maharashtra & Goa).

Project 1.2 : Genetic Improvement of Brinjal

Germplasm maintenance : 257 accessions of brinjal including 23 accessions of 6 wild species are being maintained in field in this crop season. Promising accessions identified in last cropping season are being used to develop new F_1 hybrids.

Evaluation of hybrids and segregating populations : 56 F_1 hybrids including 22 round fruited and 34 long fruited type are being evaluated for yield and yield components. The segregating generations are being advanced to next higher generation and promising advanced lines shall be identified for station trials before submitting for multi-location testing.

AICRP (VC) trials : 12 yield trials of different stages were planted in field, but due to heavy downpour of water in early rainy season just after transplanting the seedlings, all the entries of only Brinjal Hybrid Round AVT II trial could survive, for which data is being recorded. One variety IVBL-23 has been identified for release in AICRP (VC) group meeting held in June 2019 for cultivation in zone-IV (Punjab, UP, Bihar & Jharkhand).

Project 1.3 : Genetic Improvement of Chilli

During 2019, in chilli, an inbred line IIVRC-18132 derived from the cross of VR 339 x VR 338 was found promising and identified for multi-location testing through AICRP (VC). Among hybrids, Hybrid A7 X EC 519625 and A1 X VR 339 were found promising and VR 339 emerged as superior combiner for yield and disease resistance in many hybrids. Twenty F_6 families derived from an inter-specific cross of chilli such as IIVRC-GT-191-2-2-4-2 and IIVRC-GT-183-2-1-4-2 were promising with respect to ChiLCV resistance based on field and molecular screening. Two Hybrids, Kashi Ratna and Kashi Tej and one variety Kashi Abha were released for cultivation in UP by SVRC of Uttar Pradesh. Detailed report of progress made has already been published in annual report of 2018-19.

Utilization and maintenance of germplasm : Four hundred accessions of chillies and sweet pepper were planted during August-September and are being maintained. The chilli collections included stuff pickle type chillies, paprika lines, wild accessions, two genetic and nine sets of cytoplasmic-genetic male sterile lines and other germplasm. Nucleus seeds of Kashi Anmol, Kashi Gaurav, Kashi Sinduri, Kashi Abha and Pusa Jwala and sufficient amount of elite parental lines are being produced.

Germplasm augmentation/creation : Twenty hybrids from private seed companies have been collected and planted during 2019-20 for their comparative evaluation with newly developed chilli hybrids of the institute. Besides, 10 accessions of pickle type chilli, ornamental and weedy relatives have been collected from local area.

Study on unique mutants : During the previous year, two unique chilli mutant plants were obtained namely 'leafy rosette' forming mutant and 'undifferentiated inflorescence'. The rosette forming mutant identified in LCA-235 variety, has now became stable for this trait as all the progenies are similar to parental line. F_1 cross of this line with tall chilli accession Kalyanpur Chanchal and Perennial (Fig. 2) have been successfully developed. Moving further, F_2 and backcross generations involving both parents, are being advanced for its potential utilization in genetic studies of many traits like plant height, disease resistance etc.

In case of 'undifferentiated inflorescence', the line is still segregating for this unique trait. Grafting/alternate grafting with normal sister-plants in the same line was found to develop phenotype of root stock. This mutant will be further characterized through molecular studies for confirmation of genes involved in the process on un-differentiation.

Fig. 2 (a) : F_1 hybrid of leafy rosette with K. Chanchal

Fig. 2: (b) Leafy Rosette Mutant

Fig. 2 (c) : F1 hybrid of leafy rosette with Perennial

Evaluation and development of hybrids : A total of 40 F_1 hybrids including commercial hybrids from the private seed sectors are being evaluated for various characters. A7 x F-5112 and GMS-3 x VR 339 emerged as superior cross combination after second consecutive year of testing (Fig. 3). The hybrids exhibited wide variability for different traits like fruit length (4.8 – 17.3 cm), fruit width (0.80 – 1.7 cm), fruits per plant (25-100) and ten fruit weight (24 – 125 g). A total of 80 new hybrid combinations utilizing elite lines (including wild relatives) as pollen parent are being developed on the cytoplasmic male sterile and other potential combiners.

A7 x FS-112

Kashi Anmol × Japani Longi

Fig. 3: Promising F_1 hybrids

Screening and identification of Chilli leaf curl virus resistant lines : Chilli leaf curl virus (ChiLCV) disease is one of the most threatening viruses of chilli causing considerable yield losses to the farmers. Currently, there is lack of resistant cultivar against this disease. A population has been developed using resistant line BS-35, a natural interspecific derivative of *C. frutescens* and *C. chinense* and paprika variety Kashi Sinduri. Based on the performance of population of 109 families in F_6 generation during last year, 20 virus free plants were isolated. These plants were symptom-less for leaf curl disease under heavy infestation in field condition. Their resistance was also confirmed through molecular screening with both universal primer for begomovirus as well as beta satellite particles. Out of 20, 5 lines along with susceptible check Pusa Jwala were grown in pots in glass house during May (off season). None of the plants has developed leaf curl symptoms and seed has been harvested (Fig. 4). These plants are being maintained in screen house for further evaluation and grafting experiment.

Line development : Advanced population developed utilizing selected chilli lines, wild species and natural interspecific derivatives are being maintained in different generations for various traits. Lines in F_9 generation and onwards have been coded as IIVRC-18001 to IIVRC 18255 (Fig. 5). Apart from this, four RIL populations *viz*. Kashi Sinduri x AKC 89/38 (F_{10}), Pusa Jwala X IIVRC-452 (F_7), Kashi Anmol x Japani Longi (F_6), PT-12-3 x Bhut Jolokia (F_{10}) and Kashi Sinduri X BS-35 (F_7) are also being advanced to next generation and these RILs will be utilized for mapping of important quantitative traits (Table 1).

Project 1.4 : Genetic improvement of Pea

Screening of germplasm for high temperature tolerance, suitable for early (Oct) sowing : A total of 50 genotypes including the released cultivars were evaluated for tolerance to high temperature suitable for early sowing during October. The sowing was delayed

Fig. 4 : Identification of leaf curl virus resistant plants in chilli

Fig. 5 : IIVRC 18151: a promising advance line

Table 1 : RILs of chilli for various traits

S. No.	RIL	Generation	No of families	Trait
1	Kashi Sinduri × AKC 89/38	F_{10}	142	Morphological traits
2	Pusa Jwala × IIVRC-452	F_7	250	Anthracnose
3	Kashi Anmol × Japani Longi	F_6	380	Thrips, mites tolerance and pungency
4	PT-12-3 × Bhut Jolokia	F_{10}	78	Leaf curl virus, morphology and pungency
5	Kashi Sinduri × BS-35	F_7	109	Leaf curl virus, anthracnose and pungency

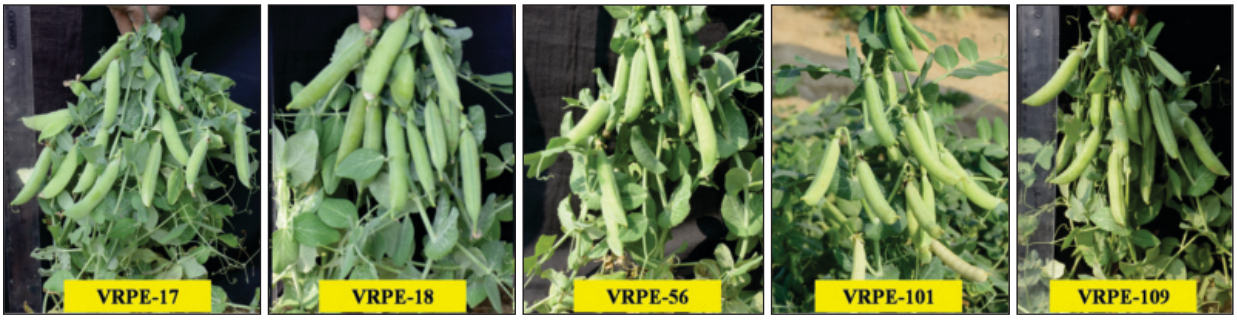

Fig. 6 : Field performance of promising genotypes of garden peas

by two weeks due to continuous rains during early October, 2019 and was done on 20th October. The average maximum temperature for October and November, 2019 was recorded as 32.6 and 28.7°C, respectively. Among the 50 genotypes, 11 genotypes took minimum days for 50 % flowering (24-29 days). However, for days to first picking, Kashi Nandini, VRPE-29 and VRPE-17 were found earliest with first picking ready in 47 days. Pod length in these genotypes was found to vary from 5.99 (VRPE-2) to 9.49 cm (VRPE-6), while pod width from 1.17 (VRPE-14) to 1.48 cm (VRPE-33). Similarly, a variation of 4.80 to 8.80 for seeds/pod and 5.0-8.0 g for average pod weight was recorded. Based upon earliness, yield and other pod quality parameters, the genotypes *viz*., VRPE-101, VRPE-109, VRPE-17, VRPE-56 and VRPE-18 were found promising for October sowing (Fig. 6).

Entries in AICRP trials : A total of five new entries were submitted for AICRP (VC) varietal trial *viz*., VRPE-111 and VRPE-101-5 for Early IET; VRPMS-919 and VRP-500 for Mid IET and VRP-343 for IET (Powdery mildew resistance).

Project 1.5 : Genetic improvement of Cowpea

Salient achievements : Three hundred and eighty four genotypes of cowpea were grown and maintained. $20F_1$, $4BC_1F_1$, $19F_2$, 16 F_4, 16 F_5, $10F_6$ and 10 F_7 were advanced to next generation through SPS. During Kharif 2019, a total of 20 F_1 cross combinations were made based on yield, quality and resistance to cowpea golden mosaic resistance. Two promising lines (VRCP-68-2 and VRCP-71-1) were included in IET of 2019-20 AICRP (VC) for their multi location testing. Out of the sixty nine advanced breeding lines evaluated for various yield and yield related traits, eleven lines (Table 2.) were found promising. Maintenance breeding of IIVR released vegetable cowpea varieties *viz*., Kashi Kanchan, Kashi Nidhi, Kashi Gauri, Kashi Unnati and Kashi Shyamal was done by pureline selection for nucleus seed production. Based on the cercospora leaf spot screening in eighty three genotypes of cowpea under natural epiphytotic conditions during 2016-17, 2017-18 and 2018-19, two genotypes Ankur Gomti and Indra Lal were found highly resistant to this disease and Kashi Unnati was found highly susceptible to this disease.

Table 2: Elite vegetable cowpea breeding lines for various yield and yield related traits during *Kharif*, 2019

Line	Plant Height (cm)	Pod length (cm)	10 Pod Weight (g)	Number of Pods/plant	Yield/plant (g)
VRCP-167-3	46.00	41.00	160.00	32.20	514.00
VRCP-49-5	41.80	29.20	105.00	34.20	362.60
VRCP-65-8	42.00	43.60	200.00	27.40	548.00
VRCP-71-1	39.80	30.80	110.00	31.80	350.30
VRCP-147-2	42.20	31.80	95.00	37.60	356.10
VRCP-216-3	45.40	31.00	110.00	30.20	330.30
VRCP-221-2	45.80	34.60	140.00	29.80	415.80
VRCP-223-2	40.00	30.60	120.00	29.20	347.50
VRCP-227-4	42.00	37.00	110.00	36.40	398.80
VRCP-229-2	42.60	35.20	140.00	22.20	309.10
VRCP-230-3	52.40	27.40	130.00	24.20	313.30
Kashi Nidhi	42.00	30.60	116.00	31.40	364.24
Kashi Kanchan	40.00	28.00	141.67	21.47	304.16
CD (0.05)	3.51	5.67	8.08	7.19	79.56
CV (%)	6.30	13.30	5.10	18.87	16.94

Project 1.6 : Genetic improvement of Indian bean and French bean

French bean

Germplasm management : Fifty genotypes of French bean were grown and maintained including one scarlet bean genotype. Nineteen genotypes of new French bean genotypes were collected and seed was multiplied for further evaluation. All the french bean genotypes were screened for selection of parchment free genotypes. Nine parchment free genotypes of french bean were EC792393, FMGCV1187, FMGCV1006, Contender, Giolli, FMGCV 1129, Savannah, Cartagenta and Banoa. These identified genotypes can be used for breeding parchment free snap bean cultivars, the main breeding objective for improvement of snap beans.

Hybridization and Selection : Out of the 10 F_1 cross combinations attempted, seed set was observed in 5 cross combinations whereas in another 5 cross combinations, pod set was observed without any seed. 11 F_2, 3 F_3 populations of bush type french bean along with 7 F_2 populations of pole type were advanced to next filial generation after single plant selections in every filial generation.

Variety released : VRFBP-14 (Kashi Baingani) variety of pole type French bean was identified for release in XXXVII AICRP (VC) group meeting held in June 2019 for zones I, VII and VIII [J&K, HP, Uttarakhand, MP, Maharashtra, Goa, Karnataka, TN, Puducherry & Kerala]. It is a purple-podded variety of vegetable French bean, The pods are green for first 5-7 days, and then turn completely purple in the next 8-10 days with a pod length of 14-15 cm.

Maintenance of Varieties : Two varieties Kashi Rajhans and Kashi Sampann of Vegetable type French bean which were released and notified for commercial cultivation in Uttar Pradesh are sown in field for maintenance of the variety.

Indian bean (Dolichos bean) : A total of 177 populations comprising F_5 to F_{11} were sown in field. One hundred twenty one germplasm lines were maintained and five AICRP (VC) trials planted. The data recording is in progress.

Project 1.7 : Genetic improvement of seed propagated gourds

Bitter Gourd

Evaluation of newly augmented germplasm : During this year, 4 new germplasm were collected and evaluated for different morphological traits. All collected genetic stocks were grouped under small category. There was no significant different with respect to germination (days), 50% flowering and fruits circumference (Table 3). Significant differences were observed with respect to number of fruits/plant (16.33-19.67), and yield/plant (0.33-0.60 kg).

Evaluation of advanced lines : Ten advanced lines in different segments (small, medium, long and extra-long) were evaluated for desirable horticultural traits. Maximum yield per plant was reported in VRBTG-10 (4.06 kg) followed by VRBTG-8 (3 kg) in the extra-long category. For individual fruit weight, maximum value recorded in BT-1B (205 g) followed by VRBTG-10 (103 g) at edible stage. Maximum number of fruits per plant was reported in VRBTG-10 (39.33 fruits/plant) followed by VRBTG-8 (36.0 fruits/plant). On the basis of overall yield performance, VRBG-23 in small segment, VRBTG-2-1 in medium segment, VRBTG-4-1-1 long segment and VRBTG-10 in extra-long segment were found promising (Fig. 7).

VRBTG-10 VRBTG-47-1

Fig. 7: Promising advance lines of bitter gourd

Development and evaluation of hybrids : During the year, 48 hybrids in different segments were developed but only 44 hybrids (long=17, medium=25 and small=2) were evaluated for different horticultural traits. The cross combination VRBTG-10 × VRBTG-2-1 gave

Table 3: Performance of newly augmented germplasm

Germplasm	Germination (days)	50% flowering (days)	Node of 1st female flower	No. of fruits /Plant	Fruits length (cm)	Fruits circumference (cm)	Fruits weight (g)	Yield/ plant (kg)
CLO-1	9	37	17.33	19.67	5.27	5.87	16.67	0.33
CLO-2	10	38	16.67	17.00	5.53	6.33	23.33	0.40
CLO-8	9	38	14.67	16.33	6.27	7.17	21.67	0.35
CLO-7	10	38	14.33	22.33	6.20	6.93	26.67	0.60

maximum yield of 4.24 kg per plant with the heterosis of 39.68%. The range of heterosis observed 36.4-39.6% in evaluated combinations. Few selected hybrids on the basis of yield and desirable horticultural traits are VRBTG-2-1 x IC-44438 and VRBTG10 x VRBTG-4-1-1 (Fig. 8).

(a) VRBTG-2-1 x IC-44438 (b) VRBTG10 x VRBTG-4-1-1

Fig. 8: Promising hybrids of bitter gourd

Development and evaluation of gynoecious based hybrids: Sixteen hybrids were developed by using two female parents (gynoecious) and eight diverse male parents (monoecious) during summer season. These hybrids were evaluated along with the parents in *kharif* season of 2019. VRBTG-5(G) × VRBTG-10 was high yielder (4.21 kg/ plant) followed by VRBTG-5(G) × VRBTG-5(G) × VRBTG-8 (3.87kg/ plant) and VRBTG-5(G) × IC-212504 (3.63 kg/plant), respectively.

Inheritance Study of Root Knot Nematode in Bitter gourd (*M. incognita*): -The study was conducted with 13 germplasm/genotypes (VRBTG-5-1, VRBTG-11-1, VRBTG-47, VRBTG-29-1, VRBTG-29-1, IC-44428, BBGS-09-1, IC-44438, VRBTG-43, IC-212504, VRBTG-10, VRBTG-15, VRBTG-1-1 and VRBTG-47. On the basis of observations (Gall index scale 0-5 (Gaur et al., 2001).), genotypes were grouped as resistance (R), moderately resistance (MR), susceptible (s) and highly susceptible (HS). In these genotypes, resistance (IC44428 and IC44438; GI=2), moderately resistance (VRBTG11-1, IC212504, and VRBTG-10; GI=3), susceptible (VRBTG5-1, VRBTG47, VRBTG29-1, BBGS-09-1, VRBTG43, VRBTG-15 and VRBTG-1-1; GI=4) and highly susceptible (VRBTG47-1; GI=5) response was observed (Fig. 9).

In view of these results, the inheritance of nematode resistance was studied. In summer season 2019, 4 cross combinations were developed using resistance (IC-44428 and IC-44438) and highly susceptible genotypes (VRBTG-47-1) and also with improved lines (VRBTG-5, VRBTG-10 etc.). After getting seeds of F_1s (8) in previous season, parents and F_1s were raised in kharif season 2019 for population development. In current season, seeds of F_1s were selfed to obtain F_2 progenies and parents were crossed with F_1s to get back cross progenies. At present populations (P1, P2, F_1 BC1, BC2 and F_2) have been developed for screening.

IC-44438 (R) VRBTG-47-1 (HS) IC44428 (R)

Fig. 9: Resistant and highly susceptible bitter gourd genotypes for root knot nematode.

Bottle gourd

Development and evaluation of advanced lines: Thirty advanced lines were evaluated for different horticultural traits in 2019. Maximum yield per plant was reported in VRBG-7. (9.30kg/plant) followed by VRBG-34 (8.50 kg/plant) and VRBG-27-1 (7.69 kg/plant). Maximum no. of fruits was observed in VRBG-7 (11 fruits/plant) followed by VRBG-34 (10 fruits /plant). On the basis of overall performance, five lines in four segments VRBG-14 (medium long), VRBG-7 (oblong) VRBG-27-1(Round), VRBG-34 (Round) and VRBG-67(Long) were found promising for yield attributing traits among all advance lines.

Development and evaluation of hybrids: During the year, 15 hybrids were developed in different segments (Long=7, medium long=6 and round=2) and evaluated for different horticulture traits. VRBG-9-1-1 x VRBG-61-3 (11.93 kg/plant) gave high yield followed by VRBG-67 x VRBG-61 (9.62 Kg/plant) and VRBG-2-1 x VRBG-61(8.69 Kg /plant) among the developed cross combination (Fig. 10).

Fig. 10: VRBG-2-1 x VRBG-61

Ash gourd

Two kg seeds of Kashi Dhawal, Kashi Ujwal and Kashi Surbhi were produced and SPS were selected for maintenance of the variety.

Project 1.8 : Genetic Improvement of Luffa

Sponge gourd

Promising germplasm : Out of 102 germplasms (92 old +10 new collection) of sponge gourd evaluated, VRSG-195, VRSG-136, VRSG-18, VRSG-171, VRSG-9, VRSG-13, VRSG-28, VRSG-57, VRSG-2-12 and one aromatic line *i.e.* VRSG-7-17 were found promising for horticultural traits. These lines except VRSG-7-17 were free from Sponge Gourd Mosaic disease symptoms under field conditions (Fig. 11).

Promising Advance Breeding Lines (2019) : Among the 71 advanced breeding lines of sponge gourd VRSG-17-1, VRSG-17-2, VRSG-17-3, VRSG-17-4, VRSG-17-5, VRSG-17-6, VRSG-17-10, VRSG-17-11, VRSG-17-12, VRSG-17-15 and VRSG-19-1 were found promising for various horticultural traits and showed tolerance against Sponge Gourd Mosaic Virus and downy mildew disease under field conditions.

Development and evaluation of F_1 genotypes: A total of 96 F_1 cross combinations were developed by using 16 Lines × 6 Testers. Among the 96 F_1(s) of sponge gourd, 10 *viz.* VRSG-195 x Pusa Sneha, VRSG-195 x Pusa Supriya, VRSG-57× Kashi Shreya, VRSG-136 x Pusa Supriya, Kashi Jyoti × VRSG-7-17, VRSG-136 × VRSG-2-12, VRSG-2-12 × Kashi Shreya, VRSG-214 × VRSG-1-12, VRSG-17-10 × Pusa Sneha, and VRSG- 57×VRSG-7-17 were found promising for various horticultural traits over the checks *i.e.* Priya (Golden Seeds), Utsav (Clause Seeds), VNR Alok (VNR Seeds) from Pvt. Sector hybrids, Kashi Rakshita & Kashi Saumya and showed tolerance against downy mildew and virus disease under field conditions.

Promising genotypes/hybrids under multi-location testing of AICRP (VC) trials during 2019 : A total of 6 OP improved genotypes *i.e.* VRSG-195 and VRSG-2-12 in AVT-II, VRSG-17-1& VRSG-17-2 in AVT-I, VRSG-17-3 and VRSG-57 in IET and 2 F_1 hybrids namely, VRSGH-4 and VRSGH-5 in IET are under multi-location testing of AICRP (VC) trials. Whereas, 2 OP genotype *i.e.* VRSG-17-10 & VRSG-19-1 and 1 F_1 genotypes namely, VRSGH-6 were submitted to PC Cell for multi-location testing of AICRP (VC) trials during 2019-20.

Germplasm documented in NBPGR, New Delhi: Under the germplasm conservation and documentation program, a total of 29 advance lines/germplasm of sponge gourd were documented in NBPGR, New Delhi (IC-0630858 to IC-0630886).

Generation advancement: Under the generation advancement programme of sponge gourd, 4 population from F_{10} to F_{11}, 7 populations F_9 to F_{10} 20 population from F_3 to F_4 were advanced. Whereas the one RIL population of Luffa cylindrical x Luffa hermaphrodita advanced from F_8 to F_9 (45 families).

Maintenance breeding: Two varieties *i.e.* Kashi Shreya and Kashi Jyoti are being maintained by producing nucleus seed (2-3 kg each) and parental lines of two hybrids *i.e.* Kashi Rakshita and Kashi Saumya (350g (F) and 150g (M) each.

Ridge gourd

Germplasm collection and evaluation: Out of 53 germplasm (47 old and 6 new collection) of ridge gourd evaluated, 12 *i.e.* VRRG-35, VRRG-110, VRRG-7-2016, VRRG-6A, VRRG-8-17, VRRG-5-17, VRRG-26, VRRG-12-10, VRRG-1-16, VRRG-10-17, VRRG--17 and VRRG-75-2016 were found promising for horticultural traits and were free from Sponge Gourd Mosaic disease and downy mildew disease symptoms under field conditions.

Development and evaluation of F_1 genotypes: A total of 15 F_1 cross combinations were developed using 6 parents in HDMD. Among the 15 F_1(s) of ridge gourd, 7 *i.e.*

VRSG-195 VRSG-9 VRSG-171 VRSG-7-17

Fig. 11: Promising lines of sponge gourd

VRRG-5A X VRRG-75-2016, VRRG-75-2016 x VRRG-5A, Kashi Shivani x VRRG-75-2016, VRRG-75-2016 x VRRG-26, VRRG-26 X VRRG-75-2016, VRRG- 6A×VRRG-5A and VRRG- 75-2016 × VRRG-6A were found promising for various horticultural traits and showed tolerance against Sponge gourd Mosaic and downy mildew disease under field conditions (Fig. 12).

VRRG-5A X VRRG-75-2016 VRRG-27 X VRRG-75-2016 VRRG-75-2016 X VRRG-26

Fig. 12: Promising sponge gourd hybrids

Generation advancement of Ridge gourd: Under this program, 15 populations of ridge gourd were advanced from F_4 to F_5.

Varietal screening of sponge and ridge gourd genotypes against its major insect pests: Fourteen genotype of ridge gourd and one hundred two germplasm including advance lines of sponge gourd were screened during *Kharif* season, 2019 against its major insect pest *viz*., melon weevil (*Acythopeus curvirostris citrulli*), leaf miner (*Liriomyza trifolii*) and whitefly (*Bemisia tabaci*). Amongst the ridge gourd genotype, VRRG-75 had lowest incidence of melon weevil (0/plant), whitefly (0.14 whitefly/ leaf) and leaf miner (3% leaf damage) followed by VRRG-6A (3.57 % fruit damage by melon weevil, 5% leaf damage due to leaf miner and 0 whitefly/leaf) during the observation. In case of sponge gourd, the genotype *viz*., VRSG-17-31, VRSG-17-13, VRSG-17-18, VRSG-17-4, VRSG-17-23, VRSG-17-22, VRSG-17-20, VRSG-17-29, VRSG-17-7, VRSG-17-30, VRSG-17-8, VRSG-17-19 and VRSG-18-1 suffered lowest incidence against these major insect pests (melon weevil, leaf miner and whitefly) under Varanasi condition.

Maintenance breeding: The variety Kashi Shivani is being maintained by producing nucleus seed (3 kg).

Satputia

Germplasm collection and evaluation: Out of 38 germplasms (37old+1 new collection), eight *i.e.* VRS-1-18, VRS-11, VRS-20-1, VRS-22, VRS-24-1, VRS-28-1, VRS-36 and VRS-25 were found promising for horticultural traits (Fig. 13).

Project 1.9 : Genetic improvement of pumpkin and cucumber

Cucumber

Germplasm evaluation and maintenance: A total of 57 germplasm/genotypes of cucumber were evaluated for flowering, yield and related traits in summer and 62 germplasm during rainy season. The results indicated that the number of days required for anthesis of first female flower ranged from 32.0 (VRCU-78) to 53.0 (VRCU-06) and number of days required for anthesis of 50% female flower ranged from 34.0 (VRCU-78) to 55.0 (VRCU-122). The average fruit weight for 119 genotypes ranged from 64.5 (VRCU-12-12) to 236 g (VRCU-12-19). Yield per plant ranged from 554.72 (VRCU-7) to 1415.32 (VRCU-12-18) with a general mean value of 724.56 g.

Hybridization and advancement of segregating generation: 15 cross combinations (F1 s) were made for transfer of gene governing high frequency female flowering and earliness. Selected individuals/crosses were advanced to subsequent generation from the segregating lines, *i.e.* 50 combinations in F_2 generation, 24 in F_3, 14 in F_4, 12 in F_5, 10 in F_6 and 5 families in F_7 generations were advanced.

Evaluation of advanced lines: A total of 5 advanced

VRS-24-1 VRS-28-1 VRS-11 VRS-1-18 VRS-36

Fig. 13: Promising Satputia genotypes

Table 4: Performance of selected cucumber hybrids in mottle green segments

Hybrids	Days to 50% female flowering	No. of fruits / plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Yield / plant (g)	Fruit colour (at edible maturity)
VRCUH-18-01	47	8.50	22.50	4.48	200.00	1600.50	Light green
VRCUH-18-06	48	6.80	20.90	4.32	178.00	1000.40	Light green
VRCUH-18-08	45	7.30	20.20	4.15	174.50	1073.85	Green
VRCUH-18-12	43	7.40	19.80	3.76	155.25	948.85	Light green
VRCUH-18-15	42	7.50	20.40	4.00	176.50	1123.75	Light green
PCUCH-3	49	5.10	20.50	4.70	195.50	897.05	Green
Malini	43	7.50	18.25	4.12	150.25	926.88	Light green

lines along with checks PCUC-09 were evaluated for yield and its contributing traits in mottle green and long segment. The best performing lines based on the fruit colour, appearance and yield were VRCU Sel.-9-03 followed VRCU-Sel-12-36. Fruits of these lines were non-bitter in taste.

Evaluation of hybrids: A total of 20 hybrids were evaluated for yield and its contributing traits in mottle green and long segment. Out of 20 hybrids, 5 were found promising based on the fruit colour, appearance and yield. These hybrids were non-bitter in taste. The yield and contributing traits of promising hybrids are given below (Table 4).

Development of parthenocarpic inbred lines: Breeding for higher yield is an important objective of cucumber breeding. Gynoecious parthenocarpic cucumber has 5 times more yield as compared to monoecious lines. Five parthenocarpic F_1s were collected from different sources and all had been transplanted in poly house. The plants were treated with the silver thio-sulphate at 3-4 leaf stage and repeated two times at 7 days interval to induce the male flowers. The F_2 seed of these hybrids were obtained for further advancement and selection through selfing. Two new germplasm of pumpkin belonging to Butter Nut Squash have been added in germplasm for development of high carotene pumpkin lines (Fig. 14).

Fig. 14: Butternut pumpkin having better flesh quality and carotene content

Pumpkin

Evaluation of germplasm: Eighty nine germplasm were evaluated for yield and quality attributes. A total of 110 lines including identified/released varieties were maintained as active collections. Level of variation for different characteristics was observed. Fruit yield per plant ranged between 2.20 kg per plant (VRPK-08) to 15.20 kg/plant (VRPK-11-6-1). Number of fruits per plant varied between 1.75 (VRPK-80) to 4.50 (VRPK-11-6-1). Individual fruit weight ranged from 0.85 kg (VRPK-87) to 9.25 kg (VRPK-07-4) at mature stage. All the lines have been maintained through selfing/sibbing for their further utilization and their seeds were also increased through selfing and sibing.

Development of hybrids and evaluation: A total of 10 F_1 hybrids of pumpkin were evaluated along with the parents for number of fruits/plant, average fruit weight (kg), polar and equatorial diameter of fruit (cm), flesh thickness and total yield/plant. On the basis of total yield and attractiveness of the fruits hybrids, VRPKH-19-02 was found promising and selected for validation. This hybrid has high flesh thickness (4.21 cm), mottle green in colour, flat round shape and has yield potential of 450-470 q/ha.

Evaluation of advance lines: Seven advance breeding lines were evaluated for important horticultural traits. Maximum yield per plant was reported in VRPK-63 (13.12 kg/plant) followed by VRPK-11-6-2 (12 kg/plant). Maximum number of fruit was observed in VRPK Sel-11-02 (4.65) followed by VRPK-05-01 5.10 kg). The maximum fruit weight was observed VRPK-19-02 (10.21 kg) followed by VRPK-90 (6 kg) at mature harvest stage. On the basis of overall performance, VRPK-11-06-02 and VRPK-63 were found promising.

Screening of pumpkin cultivars for pumpkin yellow mosaic virus: Based on previous screening, fourteen cultivars (variety/advanced line) of pumpkin were

grown during Kharif season and observations were recorded on disease incidence and yield per plant (kg) before last harvesting of the crops. On the basis of percent disease incidence, the genotype VRPK-04 was found highly resistant and cultivar 350 had highly susceptible reaction. The pumpkin line VRPK-54 showed disease reaction in later stage of crop and good economic yield was harvested.

Summer squash (*Cucurbita pepo*)

Maintenance and evaluation of advance lines: Four promising advance lines and one check of *Cucurbita pepo* (summer squash), 5 advance lines of round and oval segment and 60 germplasm lines were evaluated and maintained. Among these, the advance lines VRSS-65 (mottle green, cylindrical) VRSS-66 (dark green cylindrical), VRSS-50 (mottle green round), VRSS-51(mottle green oval) and VRSS-52 (pear shaped light yellow) were found promising. All these advance lines are resistant to viruses. The germplasm lines of summer squash had major variation in colour and shape. These lines were maintained through selfing for further utilization. Among the germplasm, one line VRSS-17-05 showed the stability towards high frequency femaleness. The high frequency female line has been maintained by sibing/selfing. Seeds of Kashi Subhangi were also multiplied and 1 kg seed has been produced.

Project 1.10 : Genetic Improvement of Melons

Watermelon

Augmentation, characterization and evaluation of germplasm: Seventy two germplasm accessions were maintained including wild (*C. lanatus* var. *citroides*), small/medium/large fruited, different flesh colour/skin colour, small/medium/large seeded genotypes. Under augmentation programme, five germplasm were introduced from district Sheopur of M.P, Mirzapur, U.P and Tonk, Rajasthan, which will be multiplied for evaluation and further use in breeding programme.

Hybrid development and generation advancement: A total of 21 F_1 hybrids were developed using seven different parents (VRW-514-1, VRW-10, VRW-8, VRW-11, VRW-12-3-1, Wild Citron and VRW-14-1) during spring summer season of 2019. The target of hybrid development in red/yellow/pink fleshed was for yield, quality, virus resistance and inheritance studies of different traits in Ice-box/Mini watermelon segment. A total of 47 segregating lines which included F_2 (8), F_3 (10), F_4 (8), F_5 (7), F_6 (5), F_7 (4), and F_8 (5) were evaluated, selfed and further selection were made to advance as next generation.

Maintenance and evaluation of advance lines for various economic traits: In summer season, 36 promising line/germplasm having various flesh colour (red, scarlet red, canary yellow, Salomon yellow, orange and white) were evaluated for several economic traits. Among these, following lines were found potential yielder with high TSS such as VRW-514, VRW-514-1, VRW-514-2 and VRW-511 (Mini segment <3.5 kg, scarlet red flesh/pink); VRW-14-1 (yellow fleshed) and VRW-9-1, VRW-12-3-1, VRW-10, VRW-55 VRW-58 (Orange fleshed), VRW-53 and VRW-53-1 (Ice-box segment 3-5.5 kg). Maximum yield per plant and average fruit per plant was observed in VRW-514-1 (10.2 kg/plant) followed by VRW-514 (10.0 kg/ plant).

Same germplasm/lines were again raised for evaluation and multiplication in late *kharif* 2019. Although, watermelon is not generally grown in *rainy* season in northern plains, however it yielded more than main season with at par sweetness/TSS.

Germplasm identified for registration: VRW-10, an andromonoecious line with round, orange fleshed fruits with high yield and TSS ranges from 11-12□ Brix. The stable line was maintained and multiplied under polyhouse.

VRW-14-1, an unique inbred line having yellow vein leaf marker with fruits having yellow skin and yellow flesh. The number of fruits varied from 2 to 4 with an average of 3.6. The fruit having an average TSS of 12.4. For studying the inheritance pattern of yellow vein, skin colour and flesh colour population was advanced to F_2 and subsequent backcrosses were developed. This trait can be utilized as a morphological marker in hybrid/triploid/resistant breeding programme for identification of hybrid.

A promising advance line, VRW-514 was submitted for multi-location testing in AICRP (VC) after station trials while another advance line VRW-514-1 was submitted to IVRC committee for varietal identification at Institute Level (Fig. 15).

VRW-14-1 and VRW-513

VRW-514-1

VRW-514

Fig. 15: Promising genotypes of watermelon

Round melon

Evaluation of Advance lines : Fifteen lines were evaluated in augmented design during summer 2019 for yield and horticultural traits. All genotypes were characterized for traits like early horticultural maturity, high yield, fruit quality and resistance/tolerance to disease. A range of variability was observed for all the recorded traits such as days to 50% flowering (36-40 days), plant height (3-3.5 m), number of fruits per plant (4-7), and fruit weight (60-150 g). Maximum number of fruits per plant was observed in VRM-5-2 (7.0) while maximum fruit weight was recorded in VRM-12 (150 g). VRM-5 was earliest flowering genotype (36 days). All these lines were susceptible to viruses under field condition. Some promising genotypes were a VRM-5, VRM-5-2, VRM-1, VRM-11-1 and VRM-12 for yield, varietal purity and disease tolerance (Fig. 16). All the genotypes were maintained true to type by selfing and successfully harvested. A promising advance line, VRM-1 selected for high yield and better fruit quality of late seed development submitted to IVRC committee for varietal identification at Institute Level after yield trial at station.

Fig. 16: VRM-1 and VRM-5-2

Longmelon

Collection, characterization and evaluation of germplasm: Forty five germplasm accessions were maintained including wild bitter type, small/medium/long fruited, different skin colour, small/medium/large seeded genotypes. Under augmentation programme, five germplasm were introduced from district Morena and Bhind of M.P which will be multiplied for evaluation and further use in breeding programme.

Thirty two lines were evaluated in augmented design during *summer* and *kharif* 2019 for yield and horticultural traits. All genotypes were characterized for traits like early harvest, high yield, fruit quality and resistance/tolerance to disease. A range of variability was observed for all the recorded traits such as days to 50% flowering (29-34 days), node of first female flower (9-19), number of fruits per plant (3-6) and fruit weight (50-150 g).

Early flowering was observed in VRLM-1 (29 days after sowing) followed by VRLM-8 (30 days after sowing). Maximum fruit length was recorded in VRLM-1 (45 cm) and minimum in VRLM-143 (15 cm). From the present study, the genotypes VRLM-1, VRLM-40, VRLM-24-1 (Dark green), VRLM-13-1 (Dark green), VRLM-28 and VRLM-3 were found to be superior for yield and quality attributes (Fig. 17). All the lines are being maintained through selfing. A promising advance line, VRLM-01 selected for high yield and better fruit quality, was submitted to IVRC committee for varietal identification at Institute Level after yield trial at station.

Fig. 17: Promising genotypes of Long melon VRLM-143, VRLM-24 and VRLM-1

Muskmelon

Evaluation of monoecious lines: Twelve improved genotypes with stable monoecious sex expression were evaluated for various horticultural traits. Fruit shape of these genotypes were either oval, round or oval round. Fruit skin colour varied from warty green to yellow, while flesh colour was creamish white, yellow and

Fig. 18: VRMM-302, VRMM-301, VRMM-170 and VRMM-186

orange. These lines were 5-7 days early in term of productive flower initiation than the andromonoecious lines. Days required for anthesis of first productive flower ranged from 45 to 50 days. Number of fruits/plant, average fruit weight, yield/plant and TTS varied from 3-6, 350-900g and 9-12°Brix, respectively. Beside VRMM-170 (Yield: 4.25 kg/plant; TSS: 9.50-10° Brix) and VRMM-186 (Yield: 3.80 kg/plant; TSS: 9° Brix), VRMM-301 (Yield: 3.50 kg/plant; TSS: 10 Brix) and VRMM-302 (Yield: 3.00 kg/plant; TSS: 11 Brix) also identified as most promising genotypes in monoecious segment (Fig. 18).

Evaluation of F_1 hybrids: Ten F_1 hybrids which consisted of andromonoecious × andromonoecious, andromonoecious × monoecious, monoecious × andromonoecious and monoecious × monoecious were developed and evaluated for various horticultural traits. Sex form of these hybrid was either monoecious or andromonoecious depending upon the cross combination. Earliness was observed in combination VRMM-170× Kashi Madhu and VRMM-170× VRMM-301. Fruit shape of these hybrids varied from flatty round to oval round. Fruit skin colour varied from yellow to greenish yellow and flesh colour was either orange or yellow. Equatorial and polar diameter ranged from 10.50-17.00 cm and 10-14 cm, respectively. Number of fruits/plant, average fruit weight, yield/plant and TSS varied from 4-7, 700-1500g, 3.5-4.5 kg/plant and 10-12° Brix.

Project 1.11 : Genetic Improvement of Okra

Status of germplasm: A total of 695 diverse germplasm accessions of cultivated okra which included bush type, plant with short internodal length, thin fruited, ridge less, five to nine ridged, red fruited, cut leaf, YVMV and ELCV resistant genotypes were maintained and multiplied. ICAR-IIVR also maintained 138 accessions of 10 different crops wild relatives (CWRs) of okra *viz*., *Abelmoschus caillei* (15), *A. tuberculatus* (17), *A. ficulneus* (15), *A. tetraphyllus* (64), *A. moschatus* (21), *A.enbeepeegearense* (1), *A. crinitus* (1), *A. angulosus* (2), *A. manihot* (1) and *A. moschatus* subsp. *tuberosus* (1) for seed multiplication. During 2019-20, the kitty of cultivated and wild okra germplasm also enriched by augmenting 25 new germplasm which included 9 cultivated okra, 2 *A. caillei*, 2 *A. tuberculatus,* 2 *A. ficulneus,* 3 *A. crinitus,* 3 *A. tetraphyllus and* 4 *A. angulosus var. grandiflorus* from Odisha, Uttar Pradesh and Jharkhand. Among the wild germplasm, *A. crinitus* and *A. angulosus* var. *grandiflorus* collected from Simlipal National Park and Manjhipani hill of Odisha showed enormous promise for utilizing in resistance breeding against YVMV and ELCV as these two species were found free from these disease at the place where they naturally occur.

Development and evaluation of F_1 hybrids: During spring summer season of 2019, one hundred fifteen F_1 hybrids were developed using twenty seven diverse inbreds *viz*., Kashi Pragati, Kashi Kranti, Kashi Chaman, Arka Anamika, Pusa Swani, Parbhani Kranti, HRB-55, VRO-102, VRO-103,VRO-104, VRO-105, VRO-110, VRO-111, VRO-112, VRO-112-1, VRO-113, VRO-114,VRO-115, VRO-119, VRO-120, VRO-124, VRO-125, VROB-178, VROB-178-1, VRO-145, Kashi Lalima and VROR-156. Among the 10 best performing hybrids which were superior over the check in all respect VRO-120 × VRO-125, VRO-120×VRO-124, VRO-120× Kashi Chaman, VRO-178 × VRO-145 and VRO-120× VRO-114 in green segment and VROR-156× VRO-120 were found most promising (Table 5).

Evaluation of advance lines in green fruited segment: A total of 48 advance lines were evaluated during kharif season for yield, uniform dark green fruit, devoid of seed bulging and high degree of tolerance to YVMV and ELCV diseases. Five genotypes *viz* VRO-124 (Fruit yield/plant: 370g; YVMV PDI: 0.00; ELCV PDI: 0.00), VRO-145(Fruit yield/plant: 350g; YVMV PDI: 0.00;

Table 5: Ancillary observation of 10 promising hybrids along with public and private check hybrids

Sl. No.	Promising hybrids	Day to 50% flowering	Plant height (cm)	Number of fruits/plant	Average fruit weight (g)	Fruit colour
1.	VRO-120 × VRO-125	43	110	44.15	13.10	Dark green
2.	VRO×VRO-124	42	140	42.00	13.00	Green
3.	VRO-120×Kashi Chaman	41	135	39.25	12.90	Dark green
4.	VRO-178 × VRO-145	44	95	38.00	12.50	Green
5.	VRO-120× VRO-114	43	125	35.50	13.09	Dark green
6.	VRO-120× VRO-110	42	133	35.00	12.77	Dark green
7.	VROR-156× VRO-120	46	155	33.35	13.00	Red
8.	VRO-178-1 × VRO-145	45	102	33.00	12.85	Dark green
9.	VRO-125× VRO-145	47	110	32.10	13	Dark green
10.	VRO-120× VRO-145	44	122	32.00	12.75	Green
11.	Public sector hybrids (C)	48.33	160.35	25.50	12.45	Green
12.	Private sector hybrids (C)	49	141.40	30.75	13.25	Dark green

ELCV PDI: 0.00), VRO-120 (Fruit yield/plant: 335g; YVMV PDI: 0.00; ELCV PDI: 0.00), VRO-125(Fruit yield/plant: 320g; YVMV PDI: 0.00; ELCV PDI: 0.00) and VROB-178-1(Fruit yield/plant: 300g; YVMV PDI: 0.00; ELCV PDI: 0.00) were identified as most promising genotypes for fruit yield, fruit quality and disease resistance during field evaluation of advance lines of okra (Fig. 19). Among these genotypes, VRO-120 and VRO-125 performed consistently better for two consecutive cropping seasons for yield and disease resistance.

Fig. 19: VRO-124 & VRO-145

Evaluation of red fruited lines of okra: A total of fifteen red fruited lines of okra *viz*., VROR-150, VROR-151, VROR-152, VROR-153, VROR-154, VROR-155, VROR-156, VROR-158, VROR-159, VROR-160, VROR-161, VROR-162, VROR-163, VROR164, VROR-165 were evaluated along with Kashi Lalima for growth habit, branching pattern, uniform red fruit colour, fruit quality, yield and tolerance to viral diseases. In the evaluated genotypes, fruit colour ranged from reddish purple to dark purple, fruit length ranged from 10-15 cm, number of fruits per plant ranged from 10-30 fruits and yield per plant varied from 175g-250g. Among these red fruited genotypes, VROR-160 and VROR-156 were found most promising for yield, quality and disease resistance.

Transfer of Genetic Male sterility (GMS) in desirable background: BC_1 generation of GMS based crossed involving desirable parents like VRO-109, VRO-110, VRO-112-1, Kashi Lalima, VRO-120, VRO-125 and No.315 were grown during summer season of 2019. All the plants in BC_1 generation were male fertile and self-seeds harvested as BC_1F_2. BC_1F_2 generation of these crosses involving improved genotypes were grown during kharif season and plants were segregated for male sterility. Sterile plants were identified in each combination and again back crossed with the recurrent parent to harvest BC_2F_1 which will be grown during summer season of 2020.

Generation advancement and characterization of $F_{2:7}$ RILs of VROR-156 × VRO-5: During the spring summer season of 2019, seeds of 255 $F_{2:6}$ which consist of both red and green fruited recombinant inbred lines were grown and F_7 seeds were harvested from 255 RILS. In the rainy season all the 255$F_{2:7}$ RILs were sown for generation advancement to F_8 generation and also characterized for various morphological and horticultural traits. Fruit colour is either red or green, growth habit is erect or bushy and plant are either tall or semi dwarf. Considerable variation was observed for all traits under consideration.

Evaluation of *Abelmoschus caillei* accessions: Several accessions of *Abelmoschus caillei* were maintained for years and 15 accessions among them were evaluated during kharif season of 2019 for various horticultural traits and disease resistance. In four accessions *viz*. VRcaillei-1, VRcaillei-1, VRcaillei-1 and

Swasthiracaillei, fruits were almost looking like cultivated okra with respect to shape, size (12-15cm long) and colour, while in other genotypes fruits are bell shaped, small (4-8 cm long), thick (3-5 cm in diameter) and green (Fig. 20). Number of fruits and fruit yield per plant varied from 6-20 and 125g to 190g per plant, respectively. All the evaluated accessions were highly susceptible to ELCV and YVMV diseases except VRcaillei-1, VRcaillei-1, VRcaillei-1 and *Swasthira caillei* which showed tolerance to these viral diseases.

Fig. 20: Full grown plant with fruit variability in *Abelmoschus caillei*

Screening of newly augmented wild relatives of okra: A total of fifty accessions of newly augmented wild okra viz., *Abelmoschus tertrphyllus* (36), *A. tuberculatus* (9) and *A. ficulneus* (5) collected from western Uttar Pradesh and Odisha were evaluated and screened for morphological character and viral diseases, respectively. Among these wild relatives only 12 accessions of *A. tetraphyllus* showed resistance to YVMV and ELCV under field condition. Among the *A. ficulneus* accessions, one accession RCM/PK-16 was identified for erect growth habit. In *A. tuberculatus* lobed leaf is very common and cut leaf is rarely observed. The accessions RCM/PK-31 collected from Odisha identified for cut leaf (Fig. 21).

Fig. 21: Fully grown plant of cut leaf *tuberculatus* accession RCM/PM-31

Evaluation of colchiploid interspecific hybrids for viral disease resistance and fertility restoration: Nine colchiploid interspecific hybrids like VRO-109 × *A. caillei* (Susthira*caillei)*,VRO-115 × *A. caillei* (VR*caillei*-1),VRO-115 × *A. caillei* (VR*caillei*-2),VRO-113 × *A. caillei* (VRcaillei-1),VRO-115 × *A. tuberculatus,* VRO-109 × *A. tetraphyllus,*VRO-112-1 × *A. tetraphyllus,*VRO-6 × *A. tetraphyllus,* Kashi Kranti × *A. tetraphyllus* were screened against YVMV and ELCV infestation for almost two year as perennial plant under field condition and evaluated for fertility restoration. VRO-6 × *A. tetraphyllus* and Kashi Kranti × *A. tetraphyllus* were identified as susceptible crosses to YVMV and ELCV, though later showed resistant reaction to these diseases in the first year and other colchiploid interspecific crosses showed very high degree of resistance consistently for two years. There was significant increase of fertility in the colchiploid crosses, also observed in term of seed set which will be helpful in back crossing as well as in the advancement of these crosses.

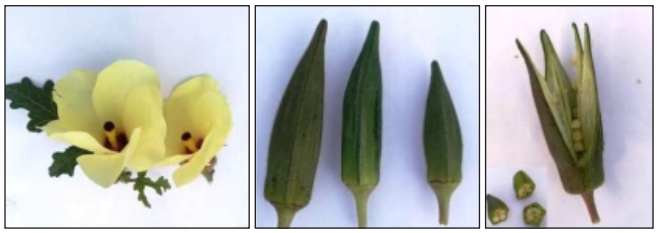

Fig. 22: Fertile colchiploid cross VRO-109 × *A. tetraphyllus*

Characterization of red flowered in interspecific hybrid *A. moschatus* × *A. moschatus* subsp. *tuberosus*: This red flowered interspecific hybrid was identified during 2018 and characterized for many traits during Kharif season of 2019. This unique hybrid was derived from the cross of yellow flowered *A. moschatus* and red flowered *A. moschatus* subsp. *tuberosus*. This hybrid had ornamental value as it produced large scarlet red flower year round. All the morphological characters except growth habit of this hybrid resembled to its paternal parent. Similar to *A. moschatus* subsp. *Tuberosus,* this hybrid also posses tuberous root. Unlike other distant

Fig. 23: Red flowered fertile interspecific hybrid

hybrid, it produced fertile pollen grain and set few seeds on selfing. Besides, it can be also propagated through stem cutting. This hybrid showed immune reaction to YVMV and ELCV diseases (Fig. 23) and can be utilized for introgression of resistant gene in to cultivated okra.

Development and evaluation of interspecific hybrids of *A. esculantas* with *A. ficulneus* and *A. moschatus*: New combinations of interspecific crosses were attempted using Kashi Chaman and Kashi Kranti of cultivated okra as female parent and *A. ficulneus* and *A. moschatus* as pollen parents. Maximum fruit set was observed in *A. ficulneus* derived crosses (41%) followed by *A. moschatus* derived crosses (8%). Poor seed set (only 6-8 seed/fruit) was observed in crosses involving *A. moschatus* as compared to crosses having *A. ficulneus* as male parent with 10-16 seed/fruit. Seed germination was also better in *ficulneus* based crosses than the cross having moschatus. Growth habit, leaf morphology, branching pattern, flower colour except fruit trait of the *A. esculantus* × *A. ficulneus* was observed to be wild type while intermediate plant morphology was observed in *A. esculantus* × *A. moschatus* (Fig. 24).

Fig. 24: Full grown plant of *A. esculantus* × *A. ficulneus* and *A. esculantus* × *A. moschatus*

Maintenance breeding of IIVR released varieties and parental lines of the hybrid: Eight different okra varieties *viz.* Kashi Kranti, Kashi Pragati, Kashi Sathdhari, Kashi Lila, Kashi Vibhuti, Kashi Vardaan, Kashi Chaman and Kashi Lalima are being maintained by producing nucleus seed (1-5 kg each). Besides, 3 kg hybrid seeds of Kashi Bhairo and Kashi Shristi were produced and their parental lines were also maintained by self-pollination.

Project 1.12 : Genetic improvement of cole and root crops

Cole Crops

CMS lines and F_1 hybrids in cauliflower: Back-crossing was followed to advance 19 BC populations (BC_1F_1-BC_5F_1) of Ogura-CMS system to various backgrounds *i.e.* plant type (Semi-spreading/Semi-erect), curd maturity (Early/Mid/Mid-late) and curd colour (White/Orange). Among these, four Ogura-CMS lines *i.e.* VRCF-41, VRCF-131, VRCF-132 and VRCF-110 were found to be very similar to their respective maintainers; and crosses were made with 11 pollen parents for hybrid development. The CMS line VRCF-41 developed curd at about 28-30 °C temperature *i.e.* 2nd fortnight of October, semi-spreading plant type, marketable curd weight of 330-360 g, hemispherical curd, cream-white curd colour, medium curd compactness and initiates flowering during last week of November. Among 44 hybrids evaluated for plant morphology and curd related traits, six best promising CMS-based F_1 hybrids expressing 12-20% heterosis for curds and higher degree of uniformity at different temperatures were VRCF-131×VRCF-75-1, VRCF-110×VRCF-75-1 and VRCF-41×VRCF-75-1 (28-30 °C); VRCF-110×VRCF-50, VRCF-131×VRCF-86 and VRCF-131×VRCF-75-1 (24-28 °C); and VRCF-110×VRCF-104 (20-25 °C). The parental lines of CMS-based F_1 hybrids are ready for commercial use.

Evaluation of cauliflower: The following genotypes were found to be promising for curd yield such as VRCF-75-1 during 1st fortnight of October (28-32 °C); VRCF-86, VRCF-75-1, VRCF-35 and VRCF-118 during 2nd fortnight of October (28-30 °C); Kashi Gobhi-25, VRCF-120, VRCF-27 and VRCF-32 during 1st fortnight of November (24-28 °C); and VRCF-104 and VRCF-202 during 1st fortnight of December (22-25 °C).

Orange and green cauliflower: The orange curd genotypes possessing '*Or*' gene have been grouped in five categories depending upon orange curd colour intensity (light orange to dark orange) and β-carotene

Fig. 25: White, orange and green cauliflower

content (0.60-1.50 mg/100g FW); and the segregating population has been advanced. Further, green curd genotypes have been advanced to next generation and seeds multiplied for further evaluation (Fig. 25).

Maintenance breeding in cauliflower: Maintenance breeding of a variety Kashi Gobhi-25, and 4 CMS lines & their maintainers are being done by producing nucleus seed (50-2000 g of each) in flexible nylon-net cage.

Tropical kale: As like tropical cauliflower, the tropical kale also induces bolting and flowering, sets seeds in the North Indian plain without vernalization. Institute is having two genotypes such as VRKALE-1 (smooth leaf) and VRKALE-9 (trichome leaf) which initiates bolting and flowering during 3rd week of February. Seed boldness or 1000 seed weight of VRKAKE-1 is showing increasing trend during course of acclimatization *i.e.* 1.512 g, 1.502 g, 1.555 g, 1.746 g, 1.832 g and 2.450 g since 2013-14, 2014-15, 2015-16, 2016-17, 2017-18 and 2018-19, respectively. The leaves of VRKALE-1 are ready for first picking in 25-30 days after transplanting and thereafter at 7-10 days interval. In the preliminary trait study, the trichomes on leaf surface reflect the impression to be monogenic recessive in nature.

Tropical cabbage and broccoli: As like Indian/tropical cauliflower, back-crosses have been made in seven backgrounds to transfer Ogura-CMS system in cabbage/broccoli (BC_1F_1). Eight genotypes of tropical cabbage and seven germplasm of tropical broccoli have been evaluated for various traits such as head shape, size and compactness, and advanced to next generation. A genotype of tropical cabbage VRCAB-111 was found promising with small frame size (40 cm), higher harvest index (65-68%), and head is medium in size and weight (14-15 cm & 0.900-1.000 kg), round in shape and compact (Fig. 26).

Fig. 26: Heading and flowering in VRCAB-111

Documentation, conservation and maintenance of cole crops: Fourteen genotypes of Indian cauliflower and tropical kale have been documented with NBPGR, New Delhi whose IC number is 0631226 (VRCF-32), 0631227 (VRCF-75-1), 0631228 (VRCF-41), 0631229 (VRCF-9), 0631230 (VRCF-77), 0631231 (VRCF-27), 0631232 (VRCF-76), 0631233 (VRCF-118), 0631234 (VRCF-44), 0631235 (VRCF-105), 0631236 (VRCF-131), 0632941 (VRCF-110), 0632942 (VRCF-111) and 0632940 (VRKALE-1). A sum of 88 genotypes/accesions, including 73 of cauliflower, 6 of cabbage, 7 of broccoli and 2 of kale are being maintained.

Carrot

Transfer of CMS system in carrotVRCAR-91-1**:** Regarding transfer of petaloid-CMS system, 15 back-cross populations have been advanced to various stages (BC1F1-BC4F1) in red, black, orange, rainbow and yellow coloured roots for harnessing the heterotic potential through heterosis breeding in carrot (Fig. 27).

Fig. 27: Black, red, yellow, orange and rainbow carrot

Evaluation of carrot: Seventy-nine genotypes including varieties, promising lines, germplasm and hybrids of tropical carrot with different root colour (red, black, orange, yellow, cream and rainbow) were evaluated and characterized for various traits of economic importance. The most promising genotypes with higher root yield and better quality traits (self-coloured core, fewer secondary roots, lesser root scars) are VRCAR-186, VRCAR-201, VRCAR-185 and VRCAR-86 (red root); Kashi Krishna, VRCAR-124 and VRCAR-89-1 (black root); VRCAR-141, VRCAR-91-1 and VRCAR-91-2 (orange root); VRCAR-153, VRCAR-127 and VRCAR-154 (yellow root); VRCAR-160 (cream root); and VRCAR-171-1, VRCAR-107-1 and VRCAR-107-2 (rainbow-type root). Red carrot genotypes VRCAR-186 (Kashi Arun) and VRCAR-185 outperformed for economic traits *i.e.* uniformity for root shape and colour, root yield (300-350 q/ha), root weight, root length, marketable roots, and self-coloured roots.

The black carrot variety Kashi Krishna is having root yield potential of 225-250 q/ha, root weight of 115-

130 g, root length of 21-22 cm, marketable roots of 87-92%, self-coloured roots of 93-95%, high antioxidant ability (20-25 times higher than red/orange), and one of the excellent sources of anthocyanins (270-300 mg/100 g) *i.e.* able to produce anthocyanins to the tune of 65-70 kg/ha. For transfering the traits of temperate carrot (dark orange colour, smooth and scar free roots) in tropical genotypes, eight population of cross between temperate and tropical carrot have been advanced in next generation.

Maintenance breeding: Two varieties *i.e.* Kashi Krishna and Kashi Arun are being maintained by producing nucleus seed (2-3 kg of each) in flexible nylon-net cage.

Documentation, conservation and maintenance of carrot: Two genotypes of tropical carrot have been documented with NBPGR, New Delhi whose IC number is 0631237 (VRCAR-206, red root) and 0631238 (VRCAR-91-1, orange root).

Radish

CMS lines and F_1 hybrids in radishVRCAR-91-1**:** For developing robust Ogura-CMS system in the backgrounds of different economic traits (leaf morphology, root colour, root shape and heat tolerance), 18 back-cross population have been advanced to various stages (BC_1F_1-BC_6F_1) to harness heterotic potential. Four stable Ogura-CMS lines *i.e.* VRRAD-11, VRRAD-13, VRRAD-198 and VRRAD-201 have been developed at IIVR, Varanasi through back-crossing which are very similar to their respective maintainer for leaf morphology; plant growth habit; colour and shape of root; flowering; and seed maturity. Seven best promising CMS-based F_1 hybrids namely VRRAD-11 × VRRAD-213, VRRAD-11 × VRRAD-203, VRRAD-201 × VRRAD-203, VRRAD-201 × VRRAD-216, VRRAD-201 × VRRAD-90, VRRAD-13 × VRRAD-200 and VRRAD-201 × VRRAD-200 with different leaf morphology, root shape, sowing season and yield potential have been identified and their parents are ready for commercial use (Fig. 28).

Fig. 28: Heat tolerant CMS-based F_1 hybrid (VRRAD-201×VRRAD-200)

Evaluation of radish: Total of eighty-two genotypes (promising lines, varieties, germplasm, hybrids) were evaluated and characterized for various traits such as leaf morphology (lyrate, sinuate & entire), root colour (white, red, purple & black), root shape (tapering, blunt & globose), heat tolerance and flower colour (white, purple & dark purple). The following genotypes were found to be promising for yield and quality traits *i.e.* Kashi Mooli-40 (VRRAD-203), VRRAD-200, VRRAD-202, VRRAD-150 and VRRAD-216 (white root); Kashi Lohit (VRRAD-131-2), VRRAD-170, VRRAD-171 and VRRAD-173 (red root); and VRRAD-134, VRRAD-131 and VRRAD-151 (purple exterior). The coloured radishes possess 20-250% higher amounts of phytonutrients, namely ascorbic acid (20-25 mg/100 g FW), anthocyanins content (100–200 µg/g FW) and antioxidant-FRAP value (3.25–6.15 µmol/g FW) as compared to white-coloured commercial cultivars; and also dressing salads with coloured radish makes salad more nutritious and decorative. In a study of inheritance pattern of different leaf morphology (Entire, Sinuate, Lyrate) using F_1 hybrids, test crosses and F_2 population; it reflected the following dominance pattern: Lyrate > Entire > Sinuate leaf shape.

Maintenance breeding: Maintenance breeding of four varieties (Kashi Sweta, Kashi Hans, Kashi Lohit and Kashi Mooli-40), and four CMS lines/Maintainers are being done by producing nucleus seed (100-2000 g) in flexible nylon-net cage.

Documentation, conservation and maintenance of radish: Total 98 varieties, genotypes and accesions of white, red and purple coloured radish are being maintained at this institute; and IC number was alloted for a unique genotype *i.e.* 0632943 (VRRAD-4).

Identification of variety through AICRP(VC): One variety VRRAD-150 has been identified for release in AICRP (VC) group meeting held in June 2019 for cultivation in zone-II (West Bengal and Assam).

Project 1.13 : Biotechnological interventions including Transgenics for managing stresses in vegetables

RNA interference-based resistance in transgenic okra plants against Okra enation leaf curl virus (OELCV) and its associated betasatellite

Suppression of silencing activity by βC1 Effector in 16c *Nicotiana benthamiana*: The pGWB408 : cBβC1 and pGWB409 : nBβC (Fig. 29) were agro-inoculated in 3 each plant of *N. benthamiana* line 16c plants grown in insect free condition. The GFP signal in the leaves were

visualized using a hand held UV transilluminator at 7 dpi. All the plants with clones of βC1 showed distinct GFP signals. The suppression of silencing in host is first observed on the petiole of the infected leaves and gradually spreads to the new emerging leaves. This result showed that the silencing suppression activity of βC1 clones of BYVMB and its movement across the cell towards the apical leaves.

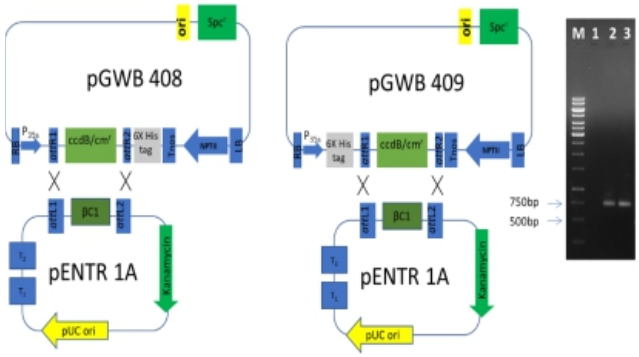

Fig. 29: Recombination of pENTR1A c-ter βC1 and n-ter βC1 of BYVMB (A) pGWB 408 & 409 destination vectors. Colony amplification of the c-ter βC1 and n-ter βC1 of BYVMB, using forward 35s promoter specific primers and reverse gene specific primer without a stop codon, .M, Marker.

Cloning of βC1 gene in gateway RNAi vectors: pRNAi-GG is used for the construction of intron-containing hairpin RNA vector for RNAi in Plants. It is a Golden Gate Cloning-based system. The gateway RNAi clones pRNAi-GG:cBβC1 were obtained by cloning between pENTR1A:cBβC1 and pRNAi-GG vector using BsaI enzyme. The gene of interest flanked with *BsaI* recognition sequence cloned into pRNAi-GG at both sense and antisense orientations simultaneously to form ihpRNA construct. Only true colonies were obtained due to disruption of the *ccdB* gene and chloramphenicol resistance marker. These clones were further confirmed by kanamycin resistance marker and colony PCR using and gene specific primers. (Fig. 30). The clone pRNAi-GG:cBβC1 was transformed in *A. tumefaciens*. The *Agrobacterium* clones were then co-cultivated with explants of *N. benthamiana* grown in pathogen free condition.

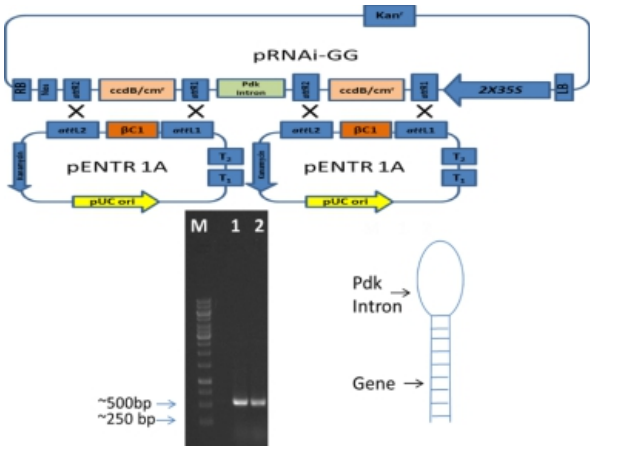

Fig. 30: (A) Diagrammatic presentation of recombination model of pRNAi-GG with pENTR1A:cBβC1. (B) Colony PCR amplification of the cBβC1 from pANIC: cBβC1. using βC1 gene specific primers. (D) RNAi strategy of pRNAi-GG vector forming hairpin loop mRNA, separated by a Pdk intron. M; 1kb Marker.

In-planta transformation in okra: Tissue culture independent, in-planta transformation of okra in the cultivar Kashi Kranti was repeated. For Agrobacterium mediated in-planta transformation, a vertical cut was made at the junction of cotyledonary leaves, superficially along the length of the shoot apex, partially bisecting the shoot tip and exposing meristem cells, without damaging the apical meristem. A total 176 seedlings were raised from 20 T0 events in pots under containment proof insect house and 20 days old seedlings were sprayed with 100 mg/l of kanamycin. After five to six successive sprays, the Bt-positive plants survived but the non-transgenic plants died. Further, from survived plants total DNA was extracted, the presence of *npt II* gene confirmed in only 5 T1 events by PCR using *npt II* specific primers. Selfing was performed on fully grows plants for multiplication and Ti seeds of mature selfed fruits from three plants were harvested and stored. Further, in-planta transformation of okra in the cultivar Kashi Kranti was repeated. The *npt-II* positive plants were transferred to big pots further growth and development. A total 3000 seedlings were transformed.

Genome editing in Okra: CRISPR/Cas9 mediated genome editing work in okra was undertaken to progress the work towards the development of vector for plant transformation. The guide RNA construct

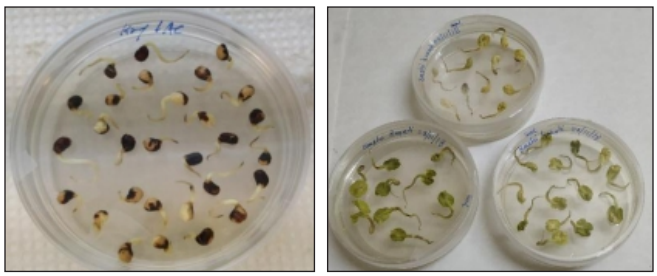

Fig. 31: *In vitro* germinated seedlings on Kanamycin supplemented medium after co-cultivation with Agrobacterium

targeting replicase (*rep*) and coat protein (*cp*) gene of Okra enation leaf curl virus (OELCV) was artificially synthesized. Complementary gRNA oligonucleotide pairs were annealed and cloned into pORE-04 vector by Ligation. The clone pORE-04:OL was transformed in *A. tumefaciens*. The *Agrobacterium* clones were then inoculated in okra seeds (in-planta transformation) grown in pathogen free condition (Fig. 31).

Genome editing in tomato: CRISPR/Cas9 mediated genome editing work in tomato was undertaken to progress the work towards the development of vector for plant transformation. The guide RNA construct targeting replicase (rep) of Tomato leaf curl virus (ToLCV) was artificially synthesized. The target region of replicase gene was identified manually from a conserved sequence by multiple sequence alignment of major strains of ToLCV to achieve broad spectrum resistance. Complementary gRNA oligonucleotide pairs will be annealed and cloned into pORE-04 vector by ligation.

To develop ToLCV resistance in tomato, two host factors/susceptibility genes were selected for knockout with the help of CRISPR/Cas-9 technology. Two gRNAs were designed for each gene in the study. As the objective was to knock out these genes, gRNAs were designed to target their exon regions. Exon sequences of the ABC transporter genes were obtained from the SOL Genomics database available at https://solgenomics.net/. The prediction site http://crispor.tefor.net/was used to design gRNA sequences. To make sure that the designed gRNAs had completely matching sequences in the susceptible tomato cultivars (Panjab Chuhhara, Kashi Visheas and Kashi Amrit), primers were designed for each target gene to amplify and sequence the genomic regions encompassing the CRISPR/Cas9 targets. Sequencing results confirmed the presence of target sequences.

The pCR3-EF Gateway entry vector was used for preparation of single-gene knockout constructs. Respective complementary gRNA oligonuceotide pairs were ligated into BsaI digested pCR3-EF (Golden Gate Ligation). In this process, the lacZ sequence in the entry vector was replaced with gRNA sequence. This was transformed into chemically competent E. coli DH5alpha cells. With the help of a blue and white colorimetric assay based on the presence or absence of lacZ, entry clones were selected and confirmed through colony PCR, double digestion and sequencing. Gateway LR clonase II mix was used to transfer the CRISPR/Cas9 knockout construct into pGWB401 vector, which is a Gateway-compatible binary vector for plant transformation that enables selection of transgenic plants via kanamycin resistance. Clones were confirmed through colony PCR and restriction digestion. In this way, two single gene knock out constructs for each of the gene were prepared. For plant transformation, Agrobacterium tumefaciens (LBA 4404) and Agrobacterium rhizogenes (Arqua1) were transformed with CRISPR/Cas-9-gRNA (Fig. 32).

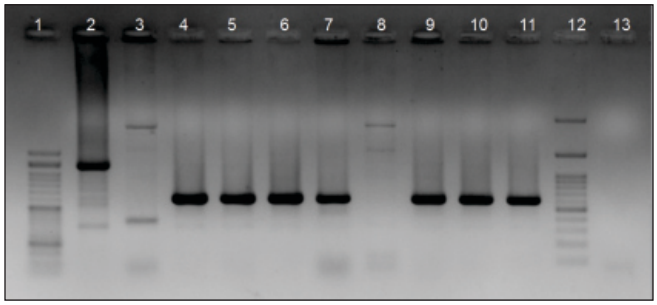

Fig. 32: Confirmation of entry clones 1. 100 bp ladder, 2. pCR3-EF vector, 3. Blue colony 4, 5, 6, 7, 9, 10, 11 white colonies with successful ligation, 8. White colony with no ligation success 12 50bp ladder and 13. Negative PCR

In-silico mining of WRKY Transcription factors in brinjal and identification of SiWRKY53 as a source of resistance to bacterial wilt in brinjal: Sixty-six putative WRKY TFs (32 in *S. melongena* and 34 and *S. incanum)* were identified, and were annotated as WRKY1 to WRKY 75. These TFs were classified into groups I, IIA-E, and III following the fundamental classification of WRKY TFs in eukaryotes. Phylogenetic analysis of all the *SmWRKY* and *SiWRKY* showed significant correlation with this classification system. Further, quantitative RT-PCR expression profiling of selected WRKY genes was carried out at different time intervals in eggplant infected by *R. solanacearum* cultures. Expression analysis revealed the drastic up-regulation of group III *SiWRKY53* during 7th day (12.6 folds) and 10th day (27.1 folds) of infection, confirming it as an ideal target gene for enhanced tolerance to bacterial wilt and molecular breeding for development of resistant eggplant cultivars.

Project 1.14 : Genetic Improvement of Underexploited and Future Vegetables

Winged bean

Germplasm augmentation and seed multiplication: With the aim to identify the Winged bean germplasm lines suitable for vegetable purpose, a total of 40 new

accessions of Winged bean were augmented from NBPGR Regional Station, Akola, Maharashtra during 2019-20. These lines were sown to characterize them for various horticultural traits. Characterization of newly augmented lines along with others observations are in progress. Germplasm characterization, hybridization and advancement of segregating populations are in progress.

Cluster bean

Germplasm augmentation and characterization: During 2019, three new genotypes of cluster bean namely Gujarat Collection -1, Gujarat Collection -2 and Gujarat Collection -3 were augmented from South Gujarat. A total of 150 genotypes of cluster bean are being evaluated for high yield, earliness, better pod quality and resistant/tolerant to viruses. Significant variability has been observed among these genotypes for many traits specially plant growth habit and pod quality (Fig. 33). An in-house trial comprising of 18 entries (selected on the basis of previous two year's performance) are being evaluated for yield and horticultural traits in replicated block design (RBD) with 2 replications. VRCB-47, VRCB-95 and Dilojan-3 are looking promising for morphological traits. Under breeding programme, 24 F_1 and 16 F_2 populations are being advanced to next generation with an aim to develop superior variety of cluster bean for vegetable purpose. Data recording of all the trials are in progress.

Fig. 33: (a) Cluster bean trial in progress (b) Variability for pod size in in-house trial

Standardization of package of practices for early cultivation of cluster bean: To get early crop produce; four varieties/germplasm namely Pusa Navbahar, Avani-117, Dilojan-3 and RSC 052 of cluster bean were sown on four different dates *i.e.* on 28th March, 28th April, 28th May and 28th June, 2019 with standard package of practices. First fruit harvesting was done 55 days after seed sowing. Pod length varied from 9.5 – 15.5 cm, number of pod per plant varied from 30-65. March 28th, 2019 date of sowing was found best date of sowing to get maximum number of pod per plant and yield per plant followed by 28th June, 2019 date of sowing. Hence, early sowing (second fortnight of March) is found to be most suitable date of sowing to get early crop of cluster bean which may fetch high price returns after sell of produce in the market.

Faba bean

A total of 115 faba bean genotypes were evaluated during rabi 2019-20. Muradabad-103, EC- 628941, EC-628929 and Cherry emerged as superior genotypes for yield, varietal purity and disease tolerance during 2nd consecutive year of testing. A station trial comprising 5 entries in RBD design with two replications was also conducted and data recording is in progress.

Vegetable Soybean

Advancement of generation and maintenance breeding of germplasm: A total of six F_1 were grown during the seasons that were advanced to their next higher generation F_2 using single plant selection approach. A total of 102 germplasm lines of soybean were grown and maintained during the season. The genotypes were grown in Augmented Block Design. The maintenance breeding was done through true to type single plant selection.

Characterization of promising lines: A total of 102 genotypes of vegetable soybean were grown and characterized for various horticultural traits during July, 2019. A wide range of genetic variation was observed among genotypes for various horticultural traits *viz.*, days to 50 % flowering, flower colour, hair and pod colour, leaf shape, pod length (cm), pod width (cm), average pod weight (g), days to flower termination, 100 - green and dry seed weight (g) and pod yield per plant (g). The lines *viz.*, AGS-339, AGS-447, AGS-457, AGS-430 and AGS-461 were found earliest for days to flowering (≤30 days). Pod length was found to vary from 3.3 to 5.8 cm, pod width from 0.8 to 1.4 cm, average pod weight from 0.40 to 3.16 g, pods per plant from 12 to 243, 100-green seed weight from 10.3 to 80 g, plant height from 17.0 to 102 cm, and pod yield per plant from 19.6 to 272.0g. Based on overall performance the genotypes *viz.*, *Swarna Vasundhara*, AGS-447, AGS-459, AGS-461, AGS-328, AGS-423, AGS-430, AGS-456, AGS-466, AGS-472, GC03004-602, GC02008206-1, 431/GC04008-YO-2-1, AGS-366, AGS-429 and AGS-910 were found superior for pod yield per plant.

Screening of soybean germplasm against *Spodoptera* spp. damage: A total of 87 lines were screened for *Spodoptera* damage resistance. The incidence was recorded during the vegetative and pod formation stage

Table 6 : Disease rating and correspondence number of genotype for YMV based on 0-9 scale of uniform method of disease rating

Score	No of genotypes	Name of genotypes
0	13	AGS-339, AGS-406, AGS-447, AGS-457, AGS-466, 431/GC04008-YO-2-1 AGS-465, 56/GC05012-197-2, AGS-429, IC-281641, IC-393195 IC-281641 and EC-162
3	51	AGS-459, AGS-460, AGS-461, AGS -328, AGS -423, AGS -429 AGS -456,AGS-469, AGS -472, 8/GC04008-154-8-1-2, GC02008206-1, AGS -346, AGS -610, AG S-123, 470, 124, IC -355999, IC -419766, IC-771221, IC-282885, EC-36998, IC -7711213, EC-37112, IC-356021, IC-785680 IC-279676, IC-341322, IC-418345, IC-273990 EC-39061, EC-34113, IC -393199, IC-39054, EC-37115 EC-39049, EC-148, EC-155, EC-160, EC-188, EC-215, EC-218, EC-222, JS-335, EC-151, EC-156, 193, 203, VLS-47, Palam soya, 9560 and EC-161
5	19	*Swarna Vasundhara* , EC-228, EC -124, IC -393230, IC-316194, IC -77118, EC -34354, IC -279342, IC -391361, IC-393197, IC-317428, IC-316142, EC-393183, IC-338716, EC-172, EC-234, MAC-10, EC-187 and EC-236
7	06	AGS-910, EC-39043, EC-167, EC-155, EC-217 and MAC-11
9	05	EC-232, EC-230, EC-209, EC-186 and EC-234

of the crop. Screening was done on the basis of leaf damage rating scale for *Spodoptera* spp. which varies from 0-9 (0-No visible leaf damage, 9-Leaves destroyed on 70% of leaves).The line EC-246, Kalla Bhatt, IC-316142, EC-39043, EC-39043, IC-338716, EC-162 and EC -161 found resistant; 30 were found moderately resistance; 40 were found moderately susceptible and 09 were highly susceptible.

Phenotypic screening for YMV under field conditions: A total of 94 diverse soybean genotypes were screened for YMV disease during *kharif* 2019, using 0-9 scale (Lal *et al.*, 2005). Average score for different germplasm lines on a scale of 0-9 is summarized in Table 6. A total of 13 genotypes were recorded with disease rating score of score of 0; 51genotypes with 3 and 30 genotypes with score varied from 5 to 9.

Water chestnut

Germplasm augmentation and multiplication: With the aim to identify promising the water chest nut germplasm lines suitable for vegetable purpose, a total of 2 new accessions (VRWC-11 and VRWC-12) were augmented from different part of the country and multiplied for next season.

Germplasm characterization: Twelve genotypes of water chestnut grown in water pond / drainage channel of Institute were characterized for different horticultural traits *viz.*, average number of leaves per plant, average number of fruit per plant, average leaf length (cm), average leaf width (cm), average fruit pedicel length (cm), number of spine per fruit, average fresh fruit weight (g), average shelled fruit weight (g), dry weight (g), dry matter content (%) and TSS (0 Brix). Average number of leaves per plant varied between (28.0 -39.0), number of fruit per plant (4 - 5), average leaf length (4.8 - 5.25 cm), average leaf width (6.45- 6.9 cm), average fruit pedicel length (4.0 – 6.0 cm), number of spine per fruit (2.0 - 2.0), average fresh fruit weight (19.56 – 25.20 g), average shelled nut weight (10.6 –14.86 g), average shelled rind weight (9.71 – 13.54 g), dry nut weight (0.089 – 0.19 g), dry matter content (8.79 – 19.26 %) and TSS (4.5 – 5.75 ^{0} Brix). Among all genotypes, VRWC-1 was adjudged as promising genotype for average fruit weight, and VRWC-4 was adjudged promising for sweetness, dry matter content and fruit yield per plant (Fig. 34).

Genotype VRWC-1 Genotype VRWC-2 Genotype VRWC-4

Fig. 34: Variability for fruit, shelled nut and rind colour in water chestnut genotypes

Lotus

Germplasm augmentation: With the aim to identify the suitability of lotus cultivation as vegetable, 4 new germplasm line were augmented from different parts of the country. VRL-1 genotype was found promising for leaf length, leaf width, number of leaf per plant, number of anther per flower, number of seed per plant and rhizome yield. Standardization of vegetative propagation of lotus was done. Nursery was raised in pots and lotus plants were planted in pond (Fig. 35).

Nelumbo nucifera | *Nelumbo lutea* | Harvested rhizome of *Nelumbo nucifera*

Fig. 35: Variation in different species of *Nelumbo spp.*

Water spinach

Germplasm augmentation: With the aim to identify the promising genotype of water spinach, 04 new germplasm lines (VRWS-26, VRWS-27, VRWS-28 and VRWS-29) were augmented from different parts of country. These lines were characterized for various horticultural traits.

Germplasm characterization: A total of 29 germplasm lines of water spinach were characterized for different horticultural traits *viz*., leaf length (5.30 -15.5 cm), petiole length (4.5 - 6.0 cm), leaf width (2.5- 9.5 cm), number of vine/plant (4.0- 6.8), vine length (40.0- 80.0 cm), internodal length (3.5 -9.5 cm), number of nodes / vine (6-15), number of cuttings /month (2-5) and fresh weight of 50 leaves (45.0 - 175.0 g). The genotypes VRWS-1, VRWS-4, VRWS-9, VRWS-11, VRWS-25, VRWS-26 and VRWS-29 were found to be promising for different horticultural traits.

Development of package of practices for Water spinach cultivation in field condition: Water spinach is commonly grown in waterlogged areas. However, such cultivation requires cumbersome practices for plant protection measures and harvesting. This also invites water pollutants harmful for human health. Therefore, an attempt was made for cultivation of water spinach in "upland field condition" and promising results were obtained (Fig. 36) for the same. This technology can prove to be simple and can be cultivated round the year. It may serve as boon for the socio-economic upliftment of farmers of this region with added advantages of 3-4 cuttings per month. It can be grown in upland field condition, submerged condition is not needed, produce is free from water pollutants, and technology promises "Safe Biomass" as "Upland Field Water Spinach". VRWS-1 is being promoted for socio-economic prosperity among water spinach growers.

Fig. 36: Cultivation practices of water spinach as 'Upland field water spinach' in field condition

Baby corn and Sweet corn

Germplasm maintenance: One red maize genotype was augmented from Bhadoi, UP and thirty two sweet corn inbreds and sixty baby corn inbred lines were maintained (Fig. 37).

Fig. 37: Red maize genotype

Hybrid evaluation: Eighteen sweet corn single cross hybrids including one private hybrid Sweet Glory (Indus seeds) were evaluated for yield and quality characters. Hybrid SC 32 × SC 10 was found performing well with total soluble solids 17.24° Brix, higher than Sweet glory (TSS 13.9 ° Brix) and its green cob yield was on par with the yield of Sweet glory. Twenty six baby corn single cross hybrids including popular baby corn hybrid HM -4 were evaluated for yield and quality characters. Eight hybrids (SC4 × BC61, SC16 × BC13, SC35 × BC61, SC35 × BC62, SC6 × BC62, BC3 × BC4, BC35 × BC51 and BC46 × BC51) gave relatively better yield than HM-4. Finger length of all the hybrid ranged from 7.64 cm to 10.08 cm and diameter ranged from 0.98 cm to 1.26 cm.

Screening of against stem borer (*Chilo partellus*): During the *Kharif* season – 2019, eighteen sweet corn hybrids, 32 sweet corn inbred lines, 60 baby corn inbred and 26 baby corn hybrids were screened against its stem borer, *Chilo partellus* (Swinhoe) (Crambidae: Lepidoptera) under field conditions at ICAR-IIVR,

Varanasi. Among the sweet corn hybrids evaluated, three hybrids *viz*., SC-3 × SC-10, SC-3 × SC-32 and SC-32 × SC-10 were recorded with lowest dead heart with 0, 7.6 and 9.52% dead heart incidence, respectively. Similarly, in case of inbred lines, per cent dead heart varied from 0 to 100% with minimum dead heart per cent recorded in SC-16 (0%) and SC-20 (5.88%). Amongst the sixty baby corn inbred lines screened, the genotype BC-15, BC-29, BC-30, BC-36 and BC-53 had minimum dead heart incidence with 9.52, 4.54, 9.52, 5 and 5% dead heart, respectively. The baby corn hybrid *i.e.,* BC-19 × BC-13 had lowest dead heart incidence (17.39%) by *C. partellus* under Varanasi conditions.

Beet leaf (*Beta vulgaris* var. *bengalensis*)

Eight genotypes/variety of beet leaf (Palak) were evaluated for morphological traits and seed multiplied for further evaluation. Further, the best performing genotype 'VRPLK-2' was compared with popular variety All Green by continuous sowing in mid of every month *i.e.* mid-September 2018 to mid-August 2019. In different 12 date of sowings, the respective biomass yield (q/ha) of VRPLK-2 and All Green was 885 & 646 q/ha in mid-September, 709 & 503 q/ha in mid-October, 515 & 355 q/ha in mid-November, 171 & 112 q/ha in mid-December, 151 & 58 q/ha in mid-January, 121 & 49 q/ha in mid-February, 234 & 119 q/ha in mid-March, 188 & 110 q/ha in mid-April, 181 & 109 q/ha in mid-May, 195 & 113 q/ha in mid-June, 202 & 121 q/ha in mid-July, and 490 & 305 q/ha in mid-August; which is correspondingly 36.9%, 40.9%, 45.0%, 52.7%, 159.4%, 148.9%, 96.1%, 70.7%, 66.2%, 72.6%, 72.6%, 66.9% and 62.2% higher than check variety All Green. Further, VRPLK-2 showed delayed bolting habit *i.e.* 22-30 days late as compared to other varieties/genotypes. A sum of 13 genotypes/accesions of beet leaf are being maintained.

Bathua (*Chenopodium album*)

Maintenance breeding of two varieties *i.e.* Kashi Bathua-2 (green leaves) and Kashi Bathua-4 (purplish-green leaves) are being done by producing basic seed (3-4 kg of each). Additionally, eight accessions/varieties of leafy chenopods are grown for evaluation (Fig. 38).

Fig. 38: Kashi Bathua-4

Amaranthus

During summer season of 2019, the amaranth crop was grown at the ICAR-IIVR research farm. A total of 152 genotypes comprising of *Amaranthus tricolor*, *A. dubious, Amagnostenus, A. blitum, A. caudatus, A. hybridus and A. blitumvaroleraceous* were evaluated for horticultural, yield and yield contributing traits. The leaf length among these genotypes ranged from 1.33 cm to 14.56 cm, leaf width ranged from 0.96 cm to 11.16 cm, stem diameter at harvestable stage was 0.6 to 2.82 cm and plant height at maturity was 18.2 to 168 cm. Top high yielding genotypes were VRAM–306, VRAM–312, VRAM–323, VRAM–324, VRAM–364, VRAM–367, VRAM–370, VRAM–1, VRAM–2A, VRAM–9, VRAM–17 and VRAM–64 (Fig. 39).

Fig. 39: Promising Amaranthus genotypes a. VRAM-306, b. VRAM-324 and c. VRAM-44

Project 1.15: Genetic Improvement of clonally propagated and perennial vegetables

Pointed gourd

Status of germplasm: In pointed gourd, 147 accessions were maintained at ICAR-IIVR which included female clones with different fruit size, fruit shapes and colour *i.e.,* round, oval, epitical and oblong; Dark green, green fruited, light green fruit colour; fruits with or without white stripes on the surface and seeded, less seeded or seedless. A total of 14 accessions belonging to 4 different species of crops wild relatives (CWRs) of pointed gourd were also maintained at IIVR. During 2019-20, six accession of wild relatives also collected from Mayurbhanj and Keonjhar of Odisha.

Evaluation of pointed gourd germplasm for yield and its contributing traits: A total of 147 female clones of pointed gourd were evaluated during summer and rainy season 2019-20. Data was recorded for various horticultural traits like days required to first flowering, number of node at first harvest, inter nodal length, fruit

length, fruit diameter, average fruit weight, number of fruits per plant, yield per plant and seed per fruit. There was considerable variation observed for all the traits under consideration. Days to first flowering and number of node at first harvest varied from 60-80 days with a mean value of 70 days and 7-18 with mean of 12, respectively while internodal length also had differentiable variation (range: 9.5-21.00 cm; mean: 16.50 cm). Fruit length, fruit diameter and average fruit weight ranged from 4.5-12 cm with mean of 9.2 cm, 3.5-5 cm with mean 4 cm and 10.50-50.00g with mean 31.25g, respectively. Number of fruits/plant, yield/plant and seeds/fruit had range and mean value of 95-430 & 235, 3.00-12.00 kg & 5.85 kg and 5-28 & 18, respectively. Among the ten best performing female clones VRPG-210, VRPG-19 (Deshi segment) and VRPG-217 were found most promising with fruit yield of 13.5 kg, 12.25 kg and 12.00 kg per plant respectively (Fig. 40). Beside yield performance clone VRPG-210 and VRPG-217 were also suitable for confectionary purpose due to their bigger fruit size.

VRPG-210 VRPG-217 VRPG-19

Fig. 40: Promising germplasm of pointed gourd

Storability of pointed gourd clones: Storage behavior of 10 pointed gourd clones comprised of various shape, size and colour was studied at ambient room temperature. For this experiment, fruits of Kashi Alankar, Kashi Suphal, Kashi Amulya, VRPG-5, VRPG-103, VRPG-141, VRPG-215, VRPG-210, VRPG-217 and VRPG-220 were used. For each genotype, 500g fresh fruit of same maturity stage were kept at room temperature and physiological weight loss and observations was recorded from second day for four days. Among them, genotypes with dark green fruit colour, white stripe and glossy skin (VRPG-210, VRPG-217, VRPG-215, Kashi Amulya) remained fresh for two days and weight loss was minimum and shrinkage of skin was visible after two days while in other genotypes weight loss and shrinkage of fruit surface was faster and lost its freshness after first day itself.

Variation in asexual reproduction in pointed gourd: Effect of genotype on asexual reproduction in terms of time taken for sprouting, initiation of adventitious root initiation and percentage of sprouted and rooted cutting was studied using 20 genotypes of pointed gourd which included 18 female clone and 2 male clones. For each genotype, 60 vine cuttings were planted in nursery black polythene bag. Significant effect of genotypes was observed on various aspect of clonal propagation. Male clones were more efficient than the female clones as they sprouted and rooted faster and reported 100% sprouted and rooted cutting. There was considerable variation recorded for days required for sprouting, initiation of adventitious root and percentage of sprouted and rooted cutting which ranged from 9-28 days, 6-25 days and 15-100%, respectively. Among the female clone, seedless genotype VRPG-105 was found less efficient for clonal propagation through vine cutting. Maximum percentage of sprouted and rooted planting materials was observed in Kashi Alankar followed by Kashi Suphal and VRPG-210.

Production of planting material and clonal multiplication of selected clones in pointed gourd : About 10000 planting materials of Kashi Alankar, KashiSuphal and Kashi Amulya were produced and 6000 planting materials distributed to the farmers of Mirzapur, Varanasi, Jaunpur, Sonbhadra, Ghazipur and Barabanki district of U.P and Sambalpur district of Odisha. All the selected clones of pointed gourd were clonally multiplied to enhance the plant population. Beside this, approximately 100 planting materials were produced for all the improved clones *viz*., VRPG-141, VRPG-103, VRPG-05, VRPG-17, VRPG-73, VRPG-215, VRPG-216, VRPG-217 and VRPG-85.

Teasle gourd

Germplasm characterization: A total 52 lines of Teasle gourd were characterized for various horticultural traits at ICAR-IIVR-RRS, Sargatia, Kushinagar, Uttar Pradesh during summer and rainy season, 2019. A highly significant variability has been observed in germplasm for the traits like node number to first pistillate flower appearance, days to first pistillate flower anthesis, days

VRSTG-38 VRSTG-20 VRSTG-5

Fig. 41: Promising genotypes of Teasle gourd

to first fruit harvest, peduncle length, polar and equatorial circumference of fruit, number of fruits per plant, average fruit weight and fruit yield per plant. Maximum fruit yield per plant found in VRSTG-38 (2.29 kg) followed by VRSTG-20 (1.89 kg) and VRSTG- 5 (1.84 kg) (Fig. 41).

Spine gourd

Germplasm augmentation: With the aim to identify the potential spine gourd genotype, 10 new germplasm lines were augmented from District Kushinagar, Uttar Pradesh *viz*. VRSEG-31, VRSEG-32, VRSEG-35, VRSEG-36, VRSEG-37 and VRSEG-38, VRSEG-39, VRSEG-40, VRSEG-42 and VRSEG-44.

Germplasm characterization: A total of twenty six lines of spine gourd were evaluated for various horticultural traits at ICAR-IIVR-RRS, Sargatia, Kushinagar, Uttar Pradesh during summer and rainy season, 2019. Significant variability was observed in germplasm for the characters like node number to first pistillate flower appearance, days to first pistillate flower anthesis, days to first fruit harvest, peduncle length,

polar and equatorial circumference of fruit, number of fruits per plant, average fruit weight and fruit yield per plant. Based on the primary screening, some potential genotypes have been identified for various horticultural traits. The genotype VRSEG-32 (1.82kg) gave maximum fruit yield per plant followed by VRSEG-11 (1.44kg) and VRISEG-36 (1.16kg) (Fig. 42).

VRSEG-32 VRSEG-11 VRSEG-36

Fig. 42: Promising genotypes of Spine gourd

Ivy gourd

Germplasm augmentation: With the aim to identify the promising ivy gourd genotype, 12 germplasm lines were augmented from different districts Uttar Pradesh (Gorakhpur, Varanasi, Basti) and Bihar (Purnia and Katihar) *viz*. VRIG-9, VRIG-17, VRIG-18, VRIG-19, VRIG-21, VRIG-22, VRIG-23, VRIG-24, VRIG-25, VRIG-26, VRIG-27 and VRIG-28.

Germplasm characterization: A total of twenty two lines of Ivy gourd were evaluated for various horticultural traits at ICAR-IIVR-RRS, Sargatia, Kushinagar, Uttar Pradesh during summer and rainy season, 2019. Significant variability has been observed in germplasm for the traits like node number to first pisttilate flower appearance, days to first pistillate flower anthesis, days to first fruit harvest, peduncle length, polar and equatorial circumference of fruit, number of fruits per plant, average fruit weight and fruit yield per plant. Highest fruit yield per plant was observed in line VRIG-14 (13.34 kg) followed by VRIG-16 (12.12 kg) and VRIG-6 (8.69 kg) (Fig. 43).

VRIG-14 VRIG-16 VRIG-6

Fig. 4 : Promising genotypes of Ivy gourd

Basella

Characterization of basella genotypes: A total of 65 basella genotype were grown in augmented block design during summer *kharif* season of 2019-20. Among the genotypes, maximum vein thickness was observed to be 10.9 mm and minimum was 2.94 mm in VRB-5 and VRB-16. Maximum yield per plant was found to be 4.32 kg in VRB-3, the promising genotypes with good per plant yield were VRB–4, VRB–7, VRB–17, VRB–23 and VRB–61-1. To decipher the genetics of betalain pigmentation, a cross was made between the parent VRB–48–1 and VRB–43–1. The F_2 generation comprising of a population of 196 plants was evaluated in the field for segregation with respect to color of the mature seeds and stem pigmentation. The segregation for pigmentation showed that the genetics of pigmentation is governed by single dominant gene and followed the simple Mendelian genetic ratio of 3:1 for pigmented and non-pigmented type plant (Fig. 44).

Fig. 44: Segregation for pigmentation at the early stage of the F_2 generation of VRB-48-1 × VRB 43-1 cross.

Development of rapid screening protocol for screening against collar rot pathogen : Confirmation for the rapid evaluation technique of charcoal rot in basella was carried out in 20 well protrays. The methods include, **a.** mycelial solution drenching without injury, **b.** mycelial solution drenching with injury, **c.** attachment of mycelial disc to stem without injury, **d.** attachment of mycelial disc to stem with injury, **e.** infested toothpick Insertion at base, **f.** root dipping in mycelial suspension and **g.** soil infestation with grains. It was observed that the infected toothpick insertion method was most promising in the development of the disease and produced symptom of charcoal rot in almost 100 % of the inoculated plants. This confirms our results for the last two year experiments and it can be concluded that inoculated toothpick insertion method can be exploited for screening of resistant source of germplasm.

Varieties and Hybrids Notified during 2019 : The following hybrids and varieties developed from ICAR-IIVR, Varanasi have been notified during the year 2019 vide notification no. 692 (E), 05.02.2019:

Table 7: National Release

S. No	Crop	Hybrids/ Varieties	Recommended States
1.	Sponge gourd	Kashi Shreya	Punjab, U.P., Bihar & Jharkhand
2.	Sponge gourd	Kashi Rakshita (hyb)	Punjab, U.P., Bihar & Jharkhand

Table 8 : State Release (for U.P. State)

S. No	Crop	Hybrids/ Varieties
1.	Amaranthus	Kashi Suhavani
2.	Basella (Poi)	Kashi Poi-1
3.	Basella (Poi)	Kashi Poi-2
4.	Basella (Poi)	Kashi Poi-3
5.	Bathua [Chenopod]	Kashi Bathua-2
6.	Bathua [Chenopod]	Kashi Bathua-4
7.	Bitter gourd	Kashi Mayuri
8.	Bottle gourd	Kashi Kiran
9.	Bottle gourd	Kashi Kirti
10.	Bottle gourd	Kashi Kundal
11.	Brinjal	Kashi Himani
12.	Carrot	Kashi Krishna
13.	Cauliflower	Kashi Gobhi-25
14.	Chilli	Kashi Abha
15.	Chilli	Kashi Ratna (hyb)
16.	Chilli	Kashi Tez (hyb)
17.	Cucumber	Kashi Nutan (hyb)
18.	Dolichos Bean	Kashi Khushhaal
19.	Dolichos Bean	Kashi Sheetal
20.	French bean	Kashi Rajhans
21.	French bean	Kashi Sampann
22.	Okra	Kashi Chaman
23.	Okra	Kashi Lalima
24.	Okra	Kashi Shrishti (hyb)
25.	Pointed Gourd	Kashi Amulya
26.	Pointed Gourd	Kashi Suphal
27.	Pumpkin	Kashi Shishir (hyb)
28.	Radish	Kashi Lohit
29.	Radish	Kashi Mooli-40
30.	Satputia	Kashi Khushi
31.	Sponge gourd	Kashi Jyoti
32.	Sponge gourd	Kashi Saumya(hyb)
33.	Summer squash (Pepo)	Kashi Shubhangi

Table 9: Details of the germplasm supplied to various organizations through Material Transfer Agreement

Crop	Organizations
Tomato (134)	College of Agriculture, SVPUAT, Modipuram, Merrut (10); College of Horticulture, Mundigere, Chikkamangaluru (19); SKUAST- Jammu (2); Anand Agriculture University, Anand (2); College of Horticulture and Forestry, Central Agriculture University, Pasighat (10); Real Agri Creation, Nagpur (2); BBA University, Lucknow (20); NDUA&T, Faizabad (19); UP College, Varanasi (5); Integral Univeristy, Lucknow (3); SHUATS, Naini, Prayagraj (35); BHU, Varanasi (9)
Pea (42)	RARS Shillongani,, Nagaon, Assam (6), CCKHPKV, Palampur (14), SKUAST-Jammu, Main Campus (16), SHUATS, Naini, Prayagraj (6);
Cowpea (152)	Dr YSR Horticulture University, Kadapa (20), Horticulture and Forestry, Rani Lakshmi Bai Central Agriculture University, Jhansi (51); University of Agricultural Science, Dharwad (5); ICAR -IIPR, Kanpur (51); PG College, Ghazipur (25)
Brinjal (139)	University of Agricultural Sciences, GKVK, Bengaluru (31); College of Horticul ture and Forestry, Rani Lakshmi Bai Central Agriculture University, Jhansi (16); College of Horticulture, Mundigere, Chikkamangaluru (8); SKN College of Agriculture, Jobner, Jaipur (5); Dr. Rajendra Prasad Central

	Agriculture University, Pusa, Samastipur (30); Dr.YSPUH&F, Nauni, Solan (3), BHU, Varanasi (30); Integral Univeristy, Lucknow (6); TD Post Graduate College, Jaunpur (6); KVK Hamirpur (Banda Agri and Tech University, Banda) (4)
Indian Beans (16)	College of Agriculture, Vellayani, Thiruananthpuram (13); KVK Hamirpur (Banda Agri and Tech University, Banda) (3)
Muskmelon (30)	Dr YSR Horticulture University, West Godavari (30)
French bean (26)	Dr YSR Horticulture University, West Godavari (20); BBA University, Lucknow (6)
Cluster bean (50)	University of Horticultural Science, Bagalkot (50)
Watermelon (23)	Dr YSR Horticulture University, Kadapa (14), Horticulture College and Research Institute, Tamil Nadu Agriculture University, Palur (9)
Cucumber (14)	Dr. Rajendra Prasad Central Agriculture University Pusa, Samastipur (14)
Chilli (165)	SKN College of Agriculture, Jobner, Jaipur (14); College of Agriculture, RVSKVV, Gwalior (20); CCS Haryana Agriculture University, Hisar (30); ICAR-IARI, New Delhi (20); SKUAS&T, Jammu (15); SKUAST-Kashmir (32); Real Agri Creation, Nagpur (2); NDUA&T, Faizabad (25); KVK Hamirpur (Banda Agri and Tech University, Banda) (6); CCSHAU, Hisar (1)
Winged bean (20)	Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia (20);
Okra (182)	SKUAST-Jammu (25); ICAR -CSSRI, Karna l (1); Govt. Degree College, Jakhini (20); NDUA&T, Faizabad (25); Integral Univeristy, Lucknow (41); KVK Hamirpur (Banda Agri and Tech University, Banda) (5); Dr. Rajendra Prasad Central Agriculture University, Pusa, Samastipur (30); SHUAT, Naini, Prayagraj (25); PG College, Ghazipur (10)
Bottle gourd (12)	Rajasthan College of Horticulture, Maharana Pratap University of Agriculture & Technology, Udaipur (10); KVK Hamirpur (Banda Agri and Tech University, Banda) (2)
Sponge gourd (10)	NHRDF, Deoria (8); KVK Hamirpur (Banda Agri and Tech University, Banda) (2)
Bitter gourd (11)	SHUATS, Naini, Prayagraj (11)
Pumpkin (1)	KVK Hamirpur (Banda Agri and Tech University, Banda) (1)
1027 in 17 crops	40 organizations

MEGA PROGRAMME 2: SEED ENHANCEMENT IN VEGETABLES

Program Leader : Dr. P.M. Singh

Project 2.1 : Priming, Coating, Ovule Conversion and Seed Enhancement

Okra cv. Kashi Kranti seeds were primed with different concentration of humic acid (T1-0.5%, T2-1.0%, T3-1.5%, T4-2.0%, T5-2.5%, T6-3.0%, T7-3.5%, T8-4.0%, T9-4.5%, T10-5.0%, T11-Distilled water, T12-Dry seeds without priming) for 12h at 25°C (Fig. 45). The priming duration was restricted to 12h, because extending duration results radicle protrusion. After priming, the seeds were dried back to their original moisture content. The seed quality parameters were tested with four replications of 100 seeds in each treatment in a seed germinator at 25±2°C. Among the treatments, seeds primed with 0.5% of humic acid recorded significantly highest germination (93%), speed of germination (75.9), seedling length (20.4cm), dry weight (23.0 mg/seedling), vigour index I (1897) and vigour index II (2134) (Table 10). Decreasing trend of seed quality parameters were recorded with increasing concentration of humic acid solution. But all the priming treatments recorded better performance then unprimed seeds.

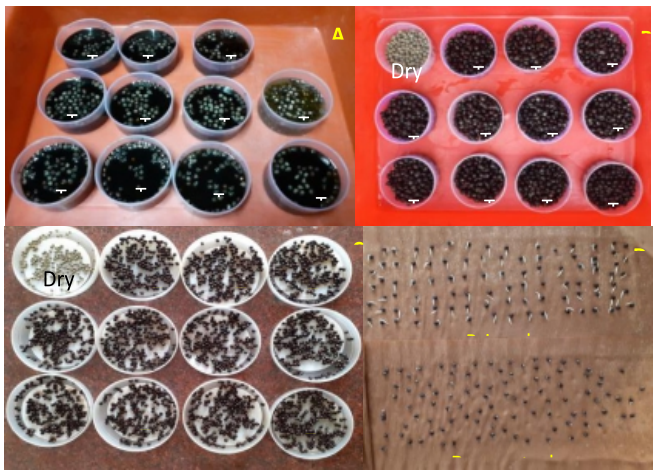

Fig. 45: Okra seed priming with humic acid. (A: Seed priming, B: Primed seeds after washing, C: Drying of primed seeds, D: Enhancement in speed of germination of primed seed

Breeder and TL seed production of important vegetable crops: Total quantity of seeds of ICAR-IIVR varieties of different vegetables produced for distribution amongst the seed indenters and farmers was 24014.15 kg (Table 11 & Table 12). It included 2415.05 kg breeder seeds which were produced (Fig. 46) as per national indent for further multiplication in seed production chain and for other indenters like licensees

Table 10 : Effect of humic acid priming on seeds of okra cv. Kashi Kranti

Treatment	Germination (%)	Speed of germination	Seedling length (cm)	Dry weight (mg/seedling)	Vigour index I	Vigour index II
T1	93 (74.6)a	75.9a	20.4	23.0	1897a	2134a
T2	91 (72.5)ab	73.8ab	20.2	21.9	1834ab	1988b
T3	91 (72.0)ab	74.5ab	20.3	22.1	1833ab	1966b
T4	86 (68.0)c	70.7bcd	20.2	21.8	1733c	1871cd
T5	89 (70.1)bc	71.5bc	20.0	22.2	1770bc	1965b
T6	88(69.3)bc	70.2bcd	20.2	22.0	1763bc	1925bc
T7	87 (68.8)bc	66.7de	19.9	21.3	1731c	1853cd
T8	86 (67.6)c	64.8e	19.7	21.6	1680c	1847d
T9	87 (68.8)bc	65.5e	19.8	21.5	1723c	1866cd
T10	85 (66.8)c	64.1e	19.9	21.7	1682c	1834de
T11	88 (69.3)bc	67.3cde	19.6	21.3	1711c	1859cd
T12	84 (66.4)c	46.5f	18.7	21.0	1567d	1760e
CD (0.05)	3.90	4.35	NS	NS	99.65**	76.56
CV (%)	2.57	2.95	3.79	3.46	2.62	1.84

Table 11 : TL Seed produced during 2019 at ICAR-IIVR, Varanasi

Crop	Variety	Qty TL Seed (Kg)
Ash gourd	Kashi Dhawal	80.00
	Kashi Surabhi	15.00
Bitter gourd	Kashi Mayuri	5.30
	VRBTG-10	8.40
Bottle gourd	Kashi Ganga	5.60
Brinjal	Kashi Taru	0.30
	Kashi Uttam	15.00
Carrot	Kashi Arun	200.00
Cauliflower	Kashi Gobhi -25	13.00
Chilli	Kashi Anmol	77.00
Cowpea	Kashi Kanchan	670.00
	Kashi Nidhi	455.00
Dolichos bean	Kashi Haritma	360.00
Drumstick	VRMO-1	32.00
French bean	Kashi Rajhans	170.00
	Kashi Sampann	240.00
Musk melon	Kashi Madhu	0.40
Okra	Kashi Kranti	316.40
	Kashi Pragati	279.00
Palak	All Green	225.00
Pea	Kashi Ageti	355.00
	Kashi Mukti	1500.00
	Kashi Nandini	7905.00
	Kashi Samriddhi	150.00
	Kashi Shakti	70.00
	Kashi Uday	8090.00
Pumpkin	Kashi Harit	52.70
Radish	Kashi Hans	29.00
	Kashi Shweta	52.00
Ridge gourd	Kashi Shivani	34.60
Satputia	Kashi Khushi	22.00
Sponge gourd	Kashi Shreya	26.40
Tomato	Kashi Adarsh	44.00
	Kashi Aman	89.00
	Kashi Amrit	2.50
	Kashi Anupam	0.50
	Kashi Vishesh	9.00
	Total	21599.10

Table 12 : Breeder seeds produced at ICAR-IIVR, Varanasi (2019)

Crops	Varieties	Quantity (Kg)
Ash gourd	Kashi Dhawal	5.00
	Kashi Surabhi	5.00
Bitter gourd	Kashi Mayuri	1.00
Bottle gourd	Kashi Ganga	15.00
Brinjal	Kashi Taru	1.00
Chilli	Kashi Anmol	3.00
Cowpea	Kashi Kanchan	190.00
	Kashi Nidhi	90.00
Indian bean	Kashi Haritima	50.00
Muskmelon	Kashi Madhu	1.25
Okra	Kashi Kranti	160.00
	Kashi Pragati	175.00
Pea	Kashi Ageti	85.00
	Kashi Mukti	500.00
	Kashi Nandini	495.00
	Kashi Samridhi	70.00
	Kashi Udai	510.00
Pumpkin	Kashi Harit	7.00
Radish	Kashi Hans	9.00
	Kashi Shweta	13.00
Ridge gourd	Kashi Shivani	11.00
Satputia	Kashi Khushi	1.00
Sponge gourd	Kashi Shreya	1.00
Tomato	Kashi Adarsh	1.00
	Kashi Aman	5.00
	Kashi Amrit	0.50
	Kashi Anupam	0.50
	Kashi Vishesh	3.00
	Total	2415.05

to whom different varieties have been provided as part of commercialization activities. Apart from OP varieties, 91 kg of hybrid seeds of brinjal, chilli, bottle gourd and cucumber (Table 13) were also produced. Single plant selections was carried out as a part of maintenance breeding in all the varieties. Kitchen garden packets of ICAR-IIVR varieties were prepared

for 17 vegetable crops and were provided for the farmers. Apart from seed production at main campus, the seeds of different crop varieties were produced at ICAR-IIVR-Regional Research Station, Sargatia also (Table 14 and Fig. 47). To fulfil the need of the KVKs and local farmers, 15.3 q of lentil, 26.0 q of mustard, 163.0 q of wheat and 221.5 q of paddy were also produced at RRS, Sargatia.

Fig. 46: Monitoring of Breeder seed production at ICAR-IIVR, Varanasi

Table 13: Hybrid seed produced at ICAR-IIVR, Varanasi (2019)

Crop	Hybrid	Quantity (Kg)
Bottle gourd	Kashi Bahar	40.00
Brinjal	Kashi Sandesh	24.00
Chilli	Kashi Tej	23.00
	Kashi Ratna	3.10
Cucumber	Kashi Nutan	0.90
	Total	91.00

Table 14: TL seed production at RRS, Sargatia (2019)

S. No.	Crop	Variety	Seed Yield (kg)
1.	Cowpea	Kashi Kanchan	50.00
2.	Cowpea	Kashi Nidhi	200.00
3.	Pumpkin	Kashi Harit	185.00
4.	Bottle gourd	Kashi Ganga	320.00
5.	Sponge gourd	Kashi Jyoti	42.00
6.	Sponge gourd	Kashi Divya	35.00
7.	Ash gourd	Kashi Dhawal	155.00
8.	Okra	Kashi Chaman	25.00
9.	Lentil	IPL-316	1530.00
10.	Mustard	RH-749	2602.00
11.	Wheat	HD-2967	14372.00
12.	Wheat	PBW-550	1934.00
13.	Paddy	S-52	21500.00*
14.	Paddy	BPT-5204	650.00*
		Total	43600.00

*(unprocessed)

Fig. 47: TL Seed production at ICAR-IIVR-RRS, Sargatia, Kushinagar.

Project 2.2 : Pollination studies for seed augmentation in vegetables including support of honey bees

A study was conducted with the following treatments in okra cv. Kashi Chaman to know the effect of pollinator attractant spray on seed yield and quality enhancement. The spray was carried out once in a week during flowering period. Increase in pollinator visit was also observed (Fig. 48).

T1	5% sugar solution	T6	5% sugar solution +50ppm boron
T2	5% jaggery soltion	T7	5% jaggery soltion+50ppm boron
T3	5% sugar+5% jaggery	T8	5% sugar+5% jaggery+50ppm boron
T4	Hand pollination	T9	Hand pollination+50ppm boron
T5	open pollination	T10	No pollination

The results revealed that a combination of 5% sugar+5% jaggery+50ppm boron (T8) significantly enhanced the seed yield and seed quality parameters

Fig. 48: Insect visit in flowers of Okra cv. Kashi Chaman seed production crop

Table 15 : Effect of pollinator attractant spray on enhancement in yield parameters and seeds yield of okra cv. Kashi Chaman

Treatments	Number of pods per plant	Pod length (cm)	Number of seeds per pod	Seed yield per plant (g)	Seed yield per plot (kg)	Seed yield (q/ha)
T1	7.3cde	14.3e	47.4bc	17.22e	1.94cd	12.11e
T2	7.8ab	14.6cde	46.8c	18.46cd	2.23abc	12.97cd
T3	7.7abc	14.4e	48.1abc	17.33e	2.07bc	13.56c
T4	7.1e	14.5de	48.3abc	17.13e	1.99cd	12.46de
T5	7.2de	14.5de	46.5c	16.83e	1.98cd	12.39de
T6	7.5bcde	15.2abc	49.3ab	17.64de	2.11bc	13.19c
T7	8.0a	15.4ab	49.8a	19.76b	2.37ab	14.78b
T8	8.1a	15.7a	50.2a	20.83a	2.49a	15.59a
T9	7.6bcd	15.0bcd	49.5ab	19.32bc	2.31ab	14.45b
T10	7.4bcde	14.7cde	44.2d	14.73f	1.76d	11.02f
CD (0.05)	0.46**	0.59**	2.21**	1.03**	0.30**	0.67**
CV (%)	3.56	2.3	2.7	3.36	8.30	2.96

Table 16 : Effect of pollinator attractant spray on seed quality enhancement in okra cv. Kashi Chaman

Treatments	100 seed weight	Germination (%)	Seedling length (cm)	Dry weight (mg per seedling)	Vigour index I	Vigour index II
T1	5.2	82 (64.9)	21.7a	21.9e	1779cd	1793d
T2	5.5	85 (67.2)	20.4cd	22.1de	1731d	1872cd
T3	5.2	87 (68.8)	22.1a	23.6abc	1919ab	2042ab
T4	5.4	84 (66.4)	22.3a	23.4abcd	1872abc	1964bc
T5	5.5	89 (70.6)	21.4abc	22.8bcde	1898abc	2020abc
T6	5.3	85 (67.2)	21.6ab	24.1a	1838abcd	2045ab
T7	5.4	83 (65.6)	21.9a	23.9ab	1808bcd	1977bc
T8	5.6	89 (70.6)	22.1a	24.4a	1956a	2168a
T9	5.7	87 (68.8)	20.5bcd	22.2cde	1792cd	1941bcd
T10	5.0	85 (67.2)	20.3d	21.8e	1729d	1861cd
CD (0.05)	NS	NS	1.12**	1.43**	121.9**	168.9**
CV(%)	6.56	3.17	3.05	3.61	3.88	5.00

(Values in parenthesis are arcsine transformed values)

like number of pods per plant (8.1), pod length (15.7cm), number of seeds per pod (50.2), seed yield per plant (20.83g), seed yield per plot (2.49kg), total seed yield (15.59q/ha), enhanced seedling length (22.1cm), dry weight (24.4 mg per seedling), vigour index I (1956) and vigour index II (2168). No significant difference in 100 seed weight and germination (%) was observed. Though pollen load was high in hand pollination, it didn't show significant enhancement in seed yield (Table 15 & 16).

The different pollinators visiting Okra cv. Kashi Chaman flowers during peak flowering period were recorded and their activity was studied. It was observed that ants were the major flower visitors followed by lepidopteran insects mainly butterflies followed by *Apis* species mainly *Apis cerana indica* and *Apis florea* followed by dipteran insects followed by coleopteran insects in okra. Pollinator's activity was observed more in the treatment 5% sugar+5% jaggery+50ppm boron followed by 5% sugar+5% jaggery. Relatively less pollinator activity was observed in the treatment 5% sugar solution and open pollination (Fig. 49).

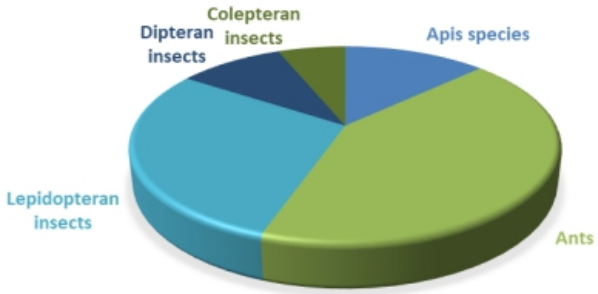

Fig. 49: Insect visitors (%) in okra flower

Project 2.3 : Drying and Storage Studies on Vegetable Seeds including Modified Atmosphere Storage

Standardization of seed storage methods with zeolite beads and silica gel in cowpea: Seed drying methods

for vegetable cowpea cv. Kashi Kanchan by using fully recharged desiccants like zeolite beads and silica gel (Fig. 50) under room temperature were standardized with the following treatments.

- T1-Seeds with zeolite beads in the ratio of 1:0.5
- T2-Seeds with zeolite beads in the ratio of 1:1
- T3-Seeds with zeolite beads in the ratio of 1:2
- T4-Seeds with zeolite beads in the ratio of 1:3
- T5-Seeds with silica gel in the ratio of 1:0.5
- T6-Seeds with silica gel in the ratio of 1:1
- T7-Seeds with silica gel in the ratio of 1:2
- T8-Seeds with silica gel in the ratio of 1:3
- T9-Control

The initial moisture content of seeds (12.4%) was estimated by hot air oven method. Seeds were separated from desiccant and seed moisture estimated after 24h, 48h, 72h, 96h and 120h of drying. At the end of the experiment, final moisture content and seed quality of dried seeds were estimated.

This study revealed that seed drying of cowpea cv.

Fig. 50: Recharging zeolite beads and silica gel at 200°C for 24h

Table 17: Effect of desiccants on moisture loss of cowpea cv. Kashi Kanchan seeds

Treatments	Moisture loss (%) between				
	0-24h	25-48h	49-72h	73-96h	97-120h
T1	1.982f	0.412f	0.215ef	0.106f	0.092de
T2	2.264d	0.737d	0.378d	0.185d	0.116cd
T3	2.395b	0.936b	0.628b	0.318b	0.157b
T4	2.542a	1.086a	0.751a	0.513a	0.294a
T5	1.861g	0.451f	0.188f	0.096f	0.073e
T6	2.195e	0.632e	0.247e	0.141e	0.092de
T7	2.246d	0.748d	0.365d	0.189d	0.125c
T8	2.331c	0.869c	0.488c	0.273c	0.169b
CD (0.05)	0.04**	0.05**	0.036**	0.027**	0.026**
CV (%)	1.05	3.84	5.13	6.87	10.89

Table 18: Effect of seed drying with desiccants on seed quality of vegetable cowpea cv. Kashi Kanchan

Treatments	Germination (%)	Speed of germination	Seedling length (cm)	Dry weight (mg/Seedling)	Vigour index I	Vigour index II
T1	95 (76.6)	37.92	16.29	67	1543	6314
T2	94 (75.4)	38.45	16.45	63	1540	5937
T3	93 (74.3)	37.85	16.93	62	1569	5719
T4	94 (76.2)	38.32	17.31	64	1633	6072
T5	93 (75.0)	37.00	16.78	66	1566	6197
T6	93 (74.6)	37.66	16.43	65	1528	6072
T7	92 (73.5)	38.11	16.36	67	1505	6159
T8	94 (76.2)	38.56	16.40	65	1547	6158
T9	92 (73.9)	37.52	16.39	64	1514	5914
CD (0.05)	NS	NS	NS	NS	NS	NS
CV (%)	4.56	1.79	2.47	4.69	4.37	6.11

(Values in parenthesis are arcsine transformed values)

Kashi Kanchan with zeolite beads @ 1:3 (seeds: beads) (T4) is faster with higher moisture absorption than silica gel (Table 17 and Fig. 51). Fastest and higher moisture reduction was not affecting seed viability and vigour (Table 18) immediately after drying. Further work is necessary to know the storability of ultra-dried seeds under air tight condition.

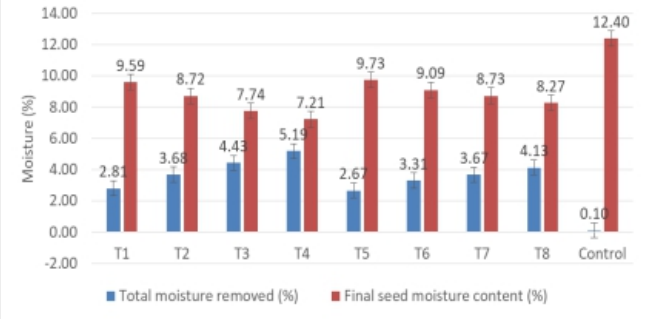

Fig. 51 : Effect of chemical desiccants on total moisture removed (%) and final moisture content (%) of seeds after 120h drying with desiccants

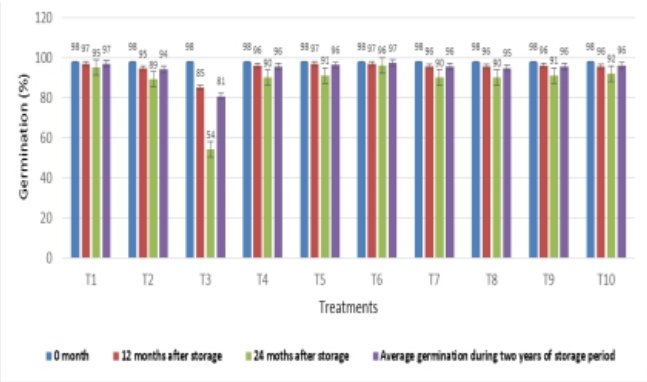

Fig. 52 : Germination (%) of radish cv. Kashi Hans seeds after storage in different condition

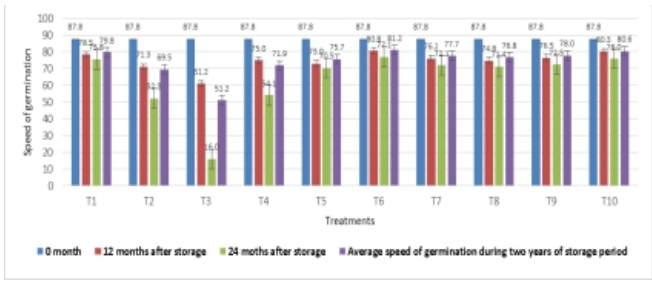

Fig. 53 : Speed of Germination (%) of radish cv. Kashi Hans seeds after storage in different condition

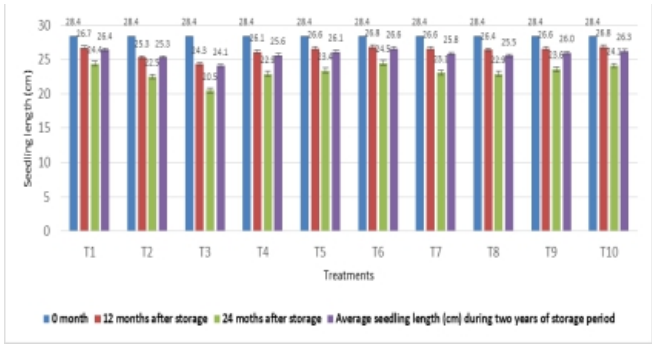

Fig. 54 : Seedling length (cm) of radish cv. Kashi Hans seeds after storage in different condition

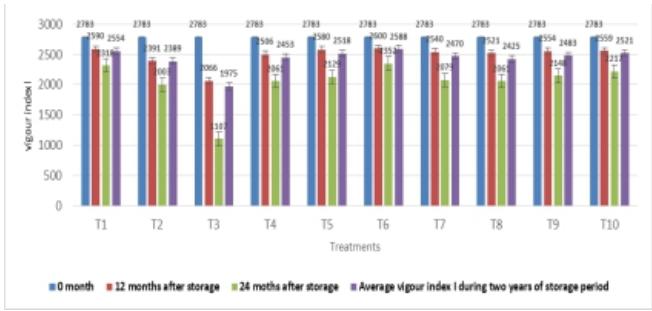

Fig. 55 : Vigour index I of radish cv. Kashi Hans seeds after storage in different condition

Division of Vegetable Production

MEGA PROGRAMME 3 : PRODUCTIVITY ENHANCEMENT THROUGH BETTER RESOURCE MANAGEMENT

Programme Leader : Dr. R.N. Prasad

Project 3.1 : Technologies for protected vegetable production

Studies carried out under naturally ventilated polyhouse conditions revealed that two-stem training system in tomato was most suitable recording the yield of 11.3 kg per plant in cv. NS-4266 as compared to single stem trained and unpruned plants. Spray of plant growth regulators (PGRs) comprising NAA@15ppm + SA was found to be the best in terms of yield (10.63 kg), fruit length (4.78 cm), fruit diameter (5.63 cm) followed by GA_3+ salicylic acid in tomato cv. NS-4266 (Fig. 1). Choice of training system in capsicum may depend upon market aimed as two-stem gives fewer but larger fruits, which are suitable for export/sale in Malls. Likewise, three-stem produces some but fairly good size fruits, suitable for local market.

Fig. 1 : Performance of tomato on two-stem training under poly-house conditions

Evaluation of gynoecious cucumber hybrids for greenhouse production: There was a significant variation for different plant growth parameters and yield among the greenhouse cucumber hybrids (Table 1 and Fig. 2). Vine length was the highest in V_2, while the lowest in V_3. Results demonstrate a significant difference in days to first harvest among the cucumber hybrids. The days to first fruit harvest ranged from 35.37 to 45.72 with being the earliest in V_5 followed by V_3 and V_1, whereas V_4 and V_2 were found to be delayed in fruit harvesting. Cucumber fruit yield significantly varied among the studied hybrids, which ranged from 1.89 kg to 3.40 kg per plant (Table 1). It was found that Y-225 followed by Defender were highly suitable for parthenocarpic cucumber production under protected conditions.

Fig. 2 : Evaluation of gynoecious cucumber F_1 under polyhouse (Inset: harvested fruits)

Influence of different training systems in cucumber under naturally ventilated polyhouse: In order to

Table 1 : Evaluation of parthenocarpic F_1 cucumber hybrids under naturally ventilated polyhouse conditions

Variety	Vine length (m)	Days to first flower	Days to first picking	No. of fruits per vine	Fruit length (cm)	Fruit dia. (cm)	Fruit weight (g)	Yield (kg/plant)
V_1	3.53	22.10	38.59	22.82	13.66	4.03	105.7	2.46
V_2	4.57	29.93	45.72	25.53	12.97	4.06	127.2	3.25
V_3	2.96	19.85	36.09	21.65	13.08	3.47	88.31	1.89
V_4	4.43	25.29	41.83	24.14	13.49	3.85	130.4	3.14
V5	3.71	22.74	35.37	22.25	15.86	4.26	148.9	3.40
$CD_{0.05}$	0.40	3.83	1.66	1.82	0.94	0.35	28.93	0.51

Table 2 : Effect of training systems on growth and fruit characteristics of parthenocarpic F_1 cucumber hybrids under polyhouse conditions

Variety	Vine length (m)	Days to first flower	Days to first picking	No. of fruits per vine	Fruit length (cm)	Fruit dia. (cm)	Fruit weight (g)	Yield (kg/plant)
Drape	4.59	25.5	42.1	24.78	13.54	3.87	129.36	3.21
Pinch	4.14	26.4	42.9	20.76	13.47	3.75	141.92	2.94
Umbrella	3.97	27.3	43.3	25.60	13.31	3.63	133.65	3.43
Control	3.79	27.6	44.5	26.13	13.28	3.67	108.7	2.83
$CD_{0.05}$	0.37	1.98	2.01	1.97	1.13	0.34	15.76	0.38

Table 3 : Effect of microbial inoculation and bio-regulators on performance of parthenocarpic F_1 cucumber hybrids under naturally ventilated polyhouse conditions

Treatment	Vine length (m)	Days to first flower	Days to first picking	No. of fruits per vine	Fruit length(cm)	Fruit dia.(cm)	Fruit weight (g)	Yield (kg/plant)
AMF	3.95	21.6	37.4	22.13	16.08	4.31	170.7	3.77
AZO	3.83	22.3	36.8	23.25	16.15	4.22	156.3	3.65
AMF+SA	4.29	21.5	36.8	22.14	16.18	4.36	173.8	3.83
AMF+AZA	4.35	21.2	38.2	23.19	16.27	4.33	170.9	3.95
AZO+SA	4.14	21.9	37.1	21.99	16.11	4.27	169.2	3.71
AZO+AZA	4.23	21.9	36.2	22.82	15.98	4.28	164.3	3.74
SA	3.89	22.0	36.6	23.37	16.16	4.31	157.7	3.68
AZA	3.98	21.8	36.7	23.44	16.03	4.29	155.4	3.65
Control	3.77	22.6	35.5	22.61	15.96	4.24	152.6	3.46
$CD_{0.05}$	0.35	1.36	1.59	1.74	1.02	0.23	17.95	0.34

develop a suitable training system in F_1cucumber, four training systems were followed *viz*., Drape (the apical meristem is not removed and the plant is draped over the top cable wire at 8 feet height; all other side branches are removed), Pinch (the apical meristem is removed at 8 feet height and a lateral shoot is trained over the cable wire at 8 feet height and back down to the floor), Umbrella (the apical meristem is removed at 8 feet height and allowing two stems to develop, which are then draped over the trellis to grow) and the Control (without any pruning). It was revealed that the Umbrella system followed by the Drape system recorded significantly higher values for yield per plant, fruits per plant, days to first picking, days to first flower *etc*. (Table 2).

Assessment of plant performance as affected by pre-inoculation of vegetable nursery with microbes and phenolic growth regulators: The synergistic effect of microbes such as AMF (commercial mycorrhizal culture from IARI) and *Azospirillum formosense* (AIM38), and exogenous salicylic acid (SA) and azealic acid (AZA) over the plant growth performance and yield were studied in gynoecious cucumbers. The longest vine length was noted in combined application of AMF+AZA/ SA followed by AZO+AZA/ SA (Table 3). Likewise, the highest fruit weight and fruit yield was noted in the same combination. However, the control was found to be earliest as far as days to first harvest were concerned (Table 3). Combined application of bio-regulators and microbes at nursery facilitated higher yield than either microbes or bio-regulators applied alone.

Project 3.3 : Vegetable based cropping system

The evaluation of ten different cropping systems was continued during 2018-19. After completion of second cycle, the system productivity in terms of rice equivalent yield (REY) was worked out. The data presented in Table 4 revealed that the highest total productivity (275.83 q/ha) was obtained with cowpea-tomato-okra cropping sequence followed by okra-tomato-cowpea (258.07 q/ha) (Fig. 3).

Fig. 3: Performance of different crops under vegetable based cropping system

Table 4 : Crop productivity (q/ha) in different cropping sequences during 2018-19

Cropping Sequence	Yield (q/ha)			Rice Equivalent Yield (q/ha)			
	Kharif	*Rabi*	*Zaid*	*Kharif*	*Rabi*	*Zaid*	Total
Paddy –wheat	51.40	41.20	-	51.40	43.32	0.00	94.72
Paddy -wheat- coriander	52.00	40.50	9.95	52.00	42.58	11.37	105.95
Paddy–tomato-*mung* bean	49.24	486.60	10.24	49.24	111.22	40.96	201.42
Paddy -cauliflower-cowpea	51.60	315.58	127.53	51.60	108.58	72.87	233.05
Bottle gourd-wheat -amaranth	315.23	41.80	122.36	108.07	43.94	69.92	221.93
Maize- pea–pumpkin	158.54	102.34	298.28	86.59	84.72	65.18	236.39
Brinjal- cowpea	310.08	0	125.21	142.08	0	71.54	213.62
Okra-tomato-cowpea	133.61	485.67	128.62	45.81	138.76	73.50	258.07
Paddy -pea-okra	51.20	95.20	130.24	51.20	81.60	44.65	177.45
Cowpea-tomato-okra	134.80	495.12	132.25	77.03	141.46	45.34	275.83

Table 5 : Crop yield under different cropping sequences during *Kharif* season of 2019

Cropping sequence	Yield(q/ha) of *Kharif* crops	Rice equivalent yield (q/ha)	Variety
Paddy –wheat	51.40 (Paddy)	51.40	HUR-3032
Paddy -wheat- coriander	52.00 (Paddy)	52.00	HUR-3032
Paddy–tomato-*mung* bean	49.20 (Paddy)	49.24	HUR-3032
Paddy -broccoli-cowpea	51.60 (Paddy)	51.60	HUR-3032
Bottle gourd- wheat-amaranth	315.23 (Bottle gourd)	108.07	Kashi Ganga
Maize-pea–pumpkin	158.54 (Maize)	90.59	Naveen
Brinjal-cowpea	l 348.80 (Brinjal)	142.08	Kashi Sandesh
Okra-tomato-cowpea	133.61 (Okra)	45.81	Kashi Kranti
Paddy -pea-okra	51.20 (Paddy)	51.20	HUV-3032
Cowpea-tomato-okra	134.80 (Cowpea)	77.03	Kashi Nidhi

Table 6 : Soil fertility status under different cropping systems after second cycle

Cropping sequence	pH	EC (ds/ m)	OC (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)
Paddy –wheat	7.46	0.18	0.37	217.0	37.5	215.0
Paddy -wheat - coriander	7.45	0.19	0.38	230.6	38.8	220.5
Paddy–tomato-mung bean	7.48	0.17	0.36	235.0	37.6	220.0
Paddy -broccoli-cowpea	7.46	0.16	0.38	238.0	37.4	225.2
Bottlegourd-wheat-amaranth	7.45	0.19	0.36	228.7	38.8	214.4
Maize- pea – pumpkin	7.48	0.17	0.36	224.8	38.9	228.3
Brinjal- cowpea	7.44	0.16	0.36	240.5	35.6	228.7
Okra-tomato-cowpea	7.45	0.19	0.37	224.8	33.6	227.2
Paddy -pea-okra	7.48	0.17	0.38	227.0	37.0	226.0
Cowpea-tomato-okra	7.48	0.19	0.38	232.6	32.7	218.7
Initial	7.50	0.17	0.34	210.2	31.0	210.4
CD	NS	NS	NS	18.42	3.17	12.54

Price of different crops (Rs./kg) : Rice -17.50, wheat-18.40, bottle gourd-6.00, maize-10.00, brinjal- 8.00, okra-6.00, cowpea-10.00, tomato- 5.00, cauliflower-6.00, pea-15.00, coriander-20.00, mung bean-70.00, amaranth-10.00, pumpkin-4.00.

Crop yield during *Kharif* 2019 : During *Kharif* season, the yield of crops was calculated and compared in terms of rice equivalent yield. The highest productivity was obtained with brinjal crops having 142.08 q/ha of REY followed by bottle gourd *i.e.* 108.07 q/ha (Table 5).

Soil fertility status : Soil fertility status under different cropping systems after completion of second cycle revealed that there was a significant difference for N, P and K content in the soil, but no considerable change was observed in pH, EC and organic carbon content in the soil under different cropping systems (Table 6).

Benefit : cost (B : C) ratio : Bottle gourd-wheat-amarath cropping system was found profitable with the highest BC ratio of 2.36. This system was followed by 2.27 Benefit : cost ratio of Maize-pea-pumpkin cropping system. Cowpea-tomato-okra cropping system ranked at third place with the highest net returns of Rs. 257531.5 per ha which included all the three vegetable crops in the year with a B : C ratio of 2.06.

Project 3.10 : Agronomic bio-fortification studies in vegetable crops

Preparation and evaluation of crop group specific micronutrient formulations : Crop-group specific micronutrient formulations (Micromix A, Micromix B, Micromix C and Micromix D) for solanaceous crops, cole crops, legumes and okra were prepared and evaluated for their efficacy under field conditions on tomato, cabbage and cauliflower during *Rabi*-2018-19, cowpea during *Zaid*-2019 and okra and cowpea during *Kharif*-2019. A commercial formulation available in the market as well as the "Vegetable Special" formulation from ICAR-IIHR, Bengaluru were also taken for comparison. In control plot, only water was sprayed for similarity.

Rabi 2018-19

Cabbage, cauliflower and tomato : The results indicate that all the micronutrient formulations significantly improved the yield and yield attributing parameters as compared to the control where no micronutrients were applied. Although all the tested micronutrient formulations proved statistically equally effective in improving the growth and yield, however, among the four prepared formulations, Micromix B proved better recording numerically higher values for all the parameters in cabbage and cauliflower (Fig. 4). Micromix A proved slightly better recording numerically the maximum fruit yield (357.8 q/ha) in tomato cv. Kashi Aman.

Fig. 4 : Response of cabbage to foliar spray of micronutrient formulations

Zaid 2019

Cowpea : The data presented in Fig. 5 revealed that foliar application of the micronutrient formulations significantly influenced the number of pods/plant and pod yield of cowpea over control. The highest pod yield of 101 q/ha was recorded with Micromix A and B.

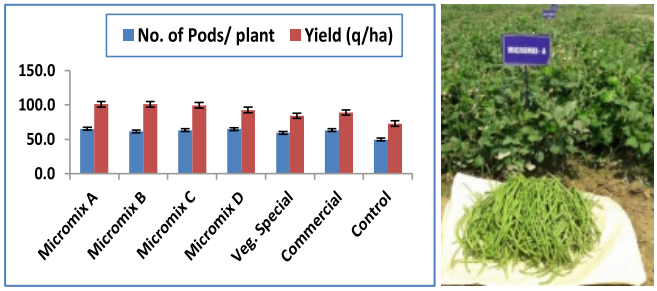

Fig. 5 : Response of cowpea to micronutrient formulations

Kharif 2019

Okra : The results presented in Fig. 6 revealed that the micronutrient formulations did not differ significantly among themselves, however, Micromix A resulted into numerically the maximum number of fruits/ plant (69.0) and total fruit yield (118.1 q/ha). The lowest number of fruits/ plant (59.0) and total fruit yield (101.6 q/ha) was recorded under control.

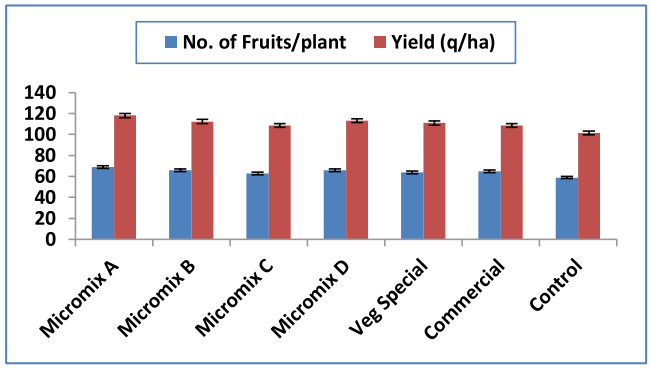

Fig. 6 : Response of okra to micronutrient formulations

Cowpea: No significant difference was observed among different formulations (Fig. 7). The pod yield under

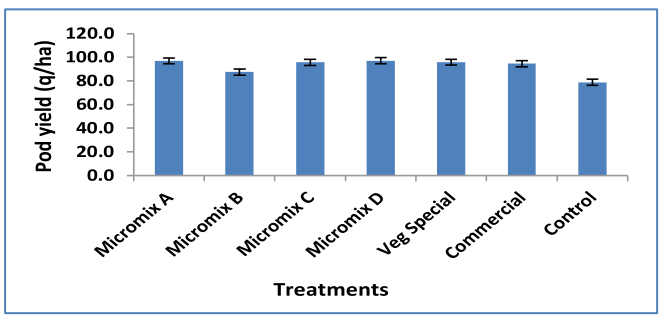

Fig. 7 : Pod yield of cowpea in relation to micronutrient formulations

different micronutrient formulations ranged between 87.6 q/ha to 97.0 q/ha whereas under control, it was found lowest (78.7q/ha).

Studies on micronutrients profiling in vegetable crops: With a view to identifying micronutrient rich varieties/ lines in, okra and pointed gourd at edible stage, 41 lines of okra, and 53 lines of pointed gourd were analyzed for different micronutrients.

Micronutrients profile in okra: There was a large variation in the micronutrients contents in pods of different okra genotypes. The level of Cu ranged from 1.5 ppm in *A. moschetus* IC-14985 to 37.0 ppm in VROB-178 with a mean value of 14.0 ppm. The iron content varied from a minimum of 30.0 ppm in *A. moschetus* IC-14985 and EC-360345 to a maximum of 87.6 ppm in VROR -158. Its mean content across the evaluated genotypes was 56.6 ppm. Zn content ranged between 9.7 ppm in *A. moschetus* IC-94985 to 59.7 ppm in IC-93892 x VRO-156 with a mean value of 31.5 ppm. The Mn content in okra pods varied from 11.9 ppm in EC -360345 to 53.8 ppm in IC-93892 × VRO 156with a mean concentration of 31.3 ppm.

Micronutrients profile in pointed gourd: The data on micronutrients profile in pointed gourd genotypes presented in Fig. 8 revealed that Cu content varied from 0.31 ppm in VRPG-24 to 10.85 ppm in VRPG-208 with a mean value of 4.86 ppm. Iron content was found to be the maximum (407.35 ppm) in VRPG-151 whereas its lowest content (62.23 ppm) was recorded in VRPG-3. The mean Fe concentration across the genotypes was 150.57 ppm. Zn content ranged from 37.58 ppm in VRPG-24 to 180.88 ppm in VRPG-160 with a mean value of 60.47 ppm. The lowest Mn content (7.85 ppm) was recorded in VRPG-172 where as it was maximum (42.55 ppm) in VRPG-89. The mean Mn concentration across the genotypes was 18.52 ppm.

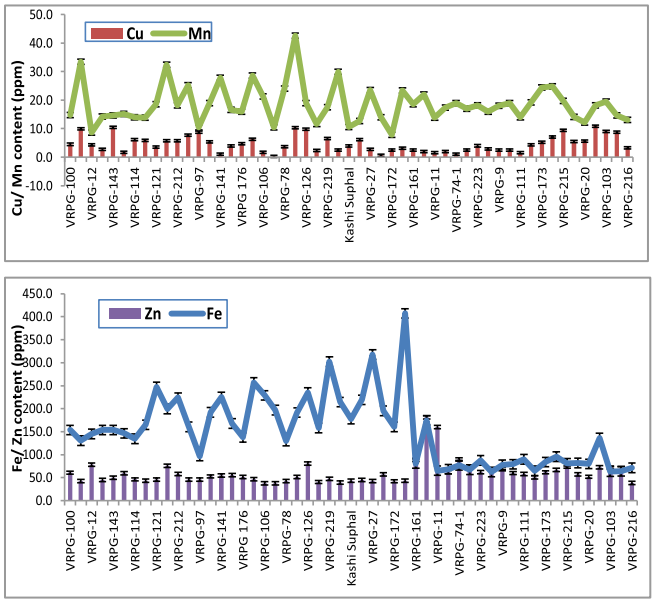

Fig. 8 : Micronutrients profile in pointed gourd genotypes

Project 3.11 : Development of agro-techniques for organic farming in vegetable crops

During *Rabi* season, tomato, broccoli, pea, carrot, and *Kasuri methi* crops were taken. The growth and yield performance of *Rabi* crops has been was reported in the annual report of 2018-19.

Zaid 2019

During summer season, okra, cowpea and *mung* bean crops were grown succeeding *Rabi* crops of pea, tomato and broccoli, respectively.

Performance of okra: The highest yield of okra *i.e.* 12.41 t/ha was recorded under inorganic cultivation, which was 26.9, 24.7, 37.6, 28.90, 38.9 and 43.4 per cent higher than the yield recorded with application of farm yard manure (FYM) @ 25t/ha, vermicompost (VC) @ 10t/ha, NADEP compost @ 25t/ha, FYM @ 10t/ha + VC @ 3.5t/ha, FYM @10 t/ha+ NADEP compost @ 10 t /ha and NADEP compost @ 10 t/ha + VC @ 3.5 t/ha, respectively. Though there was no significant difference in terms of average fruit length and average fruit weight, however, the number of fruits/plants and average fruit yield/plant was significantly higher in inorganic cultivation as compared to organic treatments, which influenced the yield significantly. Among the organic sources, there was no significant difference between sole application of FYM, VC and NADEP compost or their combinations. The increasing dose of organic manures improved the yield of okra. The yield of okra recorded with application of FYM @25 t/ha and VC @ 10 t/ha were significantly higher than rest of the organic treatments (Fig. 9).

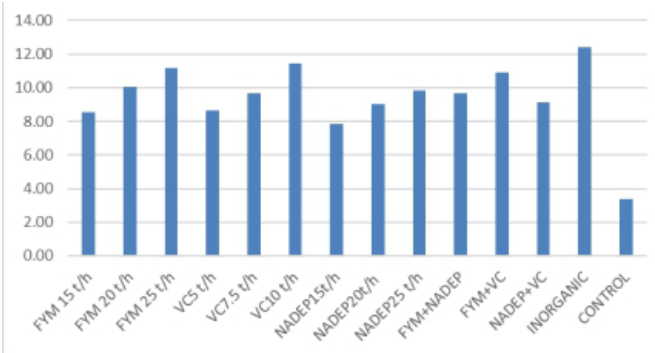

Fig. 9 : Yield of okra as influenced by organic treatments

Performance of *mung* bean: The highest grain yield was recorded with application of FYM @ 25 t/ha (1.73 t/ha) closely followed by NADEP compost @ 20 t/ha (1.69 t/ha) as against 1.55 t/ha recorded under inorganic system with application of chemical fertilizers at recommended dose. Among the three organic manures, FYM was the best followed by NADEP compost. The combined application of organic manure did not influence the yield significantly (Fig. 10).

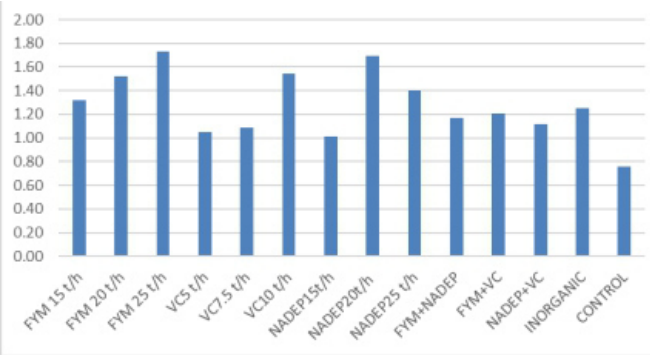

Fig. 10 : Yield of *mung* bean grain as influenced by organic treatments

Performance of cowpea: There was no significant difference in pod yield recorded under organic and inorganic cultivation of cowpea (Fig. 11). The highest pod yield (10 t/ha) was recorded with application of NADEP compost @ 25 t/ha followed by FYM @ 25t/ha (9.24 t/ha) as against pod yield of 8.26 t/ha recorded under inorganic system. Among the three organic manures, FYM was the best followed by NADEP compost.

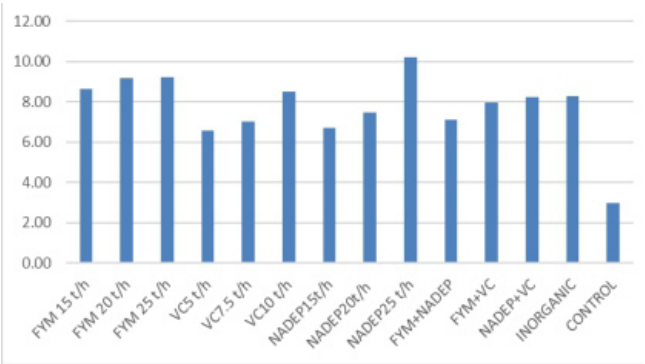

Fig. 11 : Yield of cowpea as influenced by organic treatments

Cropping System: The statistical analysis of the first year's data revealed that there was no significant difference in productivity of the three cropping systems (Fig. 12) The productivity measured in terms of rice equivalent yield was the maximum in green manure - tomato-*mung* bean system (17.632 t/ha) followed by green manure-broccoli-cowpea (15.116 t/ha) and green manure-vegetable pea-okra system (14.579 t/ha). However, the net return and benefit: cost ratio was the highest in green manure-broccoli-cowpea sequence followed by green manure-vegetable pea-okra sequence (Fig. 13).

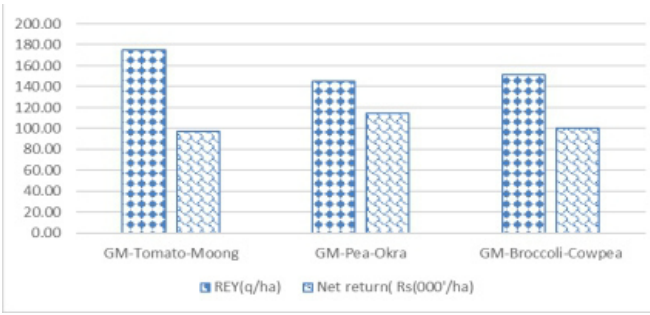

Fig. 12 : Productivity and net return (Rs.) of cropping systems as influenced by organic treatments

Fig. 13 : Field view of organic vegetable production

The rate of organic manures significantly influenced the productivity of the cropping systems (Fig. 14). The highest productivity (17.648 t/ha) was observed with application of FYM @ 25 t/ha followed by NADEP @ 25 t/ha and VC @ 10 t/ha to all the crops. The productivity of inorganic system was at par to the organic system. There was a significant interaction effect of cropping system and rate of organic manure application. In green manure-tomato-*mung* bean cropping system, the highest yield was noted with application of FYM @ 25

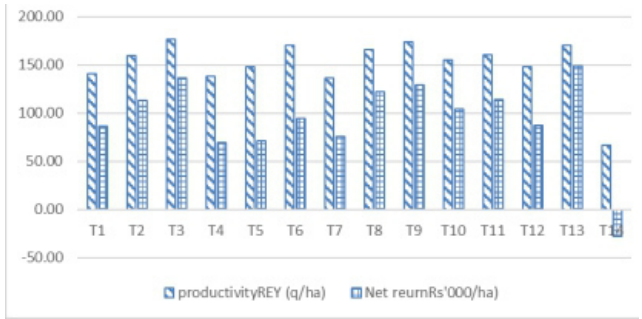

Fig. 14 : Productivity (REY) and net return (Rs.) of cropping systems under organic treatments

t/ha followed by NADEP compost @ 20 t/ha to all the crops. In green manure-vegetable pea-okra sequence, the highest yield was noted with combined application of FYM @ 10 t/ha + NADEP compost @ 10 t/ha followed by FYM @ 25 t/ha to all the crops. Similarly in green manure-broccoli- cowpea sequence, the highest yield was noted with application of NADEP compost @ 25 t/ha followed by VC @ 10 t/ha to all the crops.

Quality parameters: The quality of vegetables in terms of vitamin C content was better under organic system as compared to inorganic system in cowpea and okra. The ascorbic acid, total phenol and anti-oxidant content increased by 18.2, 13.6 and 9.2 % in cowpea and 21.8, 16.6 and 12.4 per cent in okra over inorganic system.

Soil quality: The organic carbon (OC) content of the soil improved by 17.63 and 22.42 per cent, respectively due to application of NADEP compost and FYM @ 25 t/ha over the inorganic system. Among different organic manures, there was no appreciable variation in OC content of the soil. The different rate of organic manure application do influenced significantly the OC content of the soil and the highest OC content was noticed with application of FYM @ 25 t/ha and NADEP compost @ 25 t/ha and VC @ 10 t/ha. However, the OC content was not influenced significantly due to cropping systems.

***Kharif* season:** During *Kharif*, each plot was divided in to two equal parts. One-part was subjected to green manuring with *Dhaincha* and in other part bottle gourd crop was grown.

Performance of bottle gourd: During *Kharif* season, bottle gourd was grown under flat bed and bower system for comparison to find the best system for organic cultivation (Fig. 15). The result revealed that between the two systems, significantly higher yield was recorded under flatbed system (23.24 t/ha) as compared to bower system (19.53 t/h). The higher yield obtained under flatbed was associated with significantly higher number of fruits/unit area though the average fruit weight was higher under bower system.

Among organic manures, FYM application @ 25 t/ha produced highest yield (32.70 t/ha), which was significantly higher than rest of the treatments. This treatment was 35.17, 33.72 and 29.63 % higher over VC, NADEP compost and inorganic fertilizer. The combination of FYM @ 10 t/ha + VC @ 3.5 t/ha and FYM @ 10 t/ha + NADEP @ 10 t/ha was at par to sole FYM application @ 20 t/ha. The increasing rate of organic manures increased the yield of bottle gourd irrespective of bower or flatbed system.

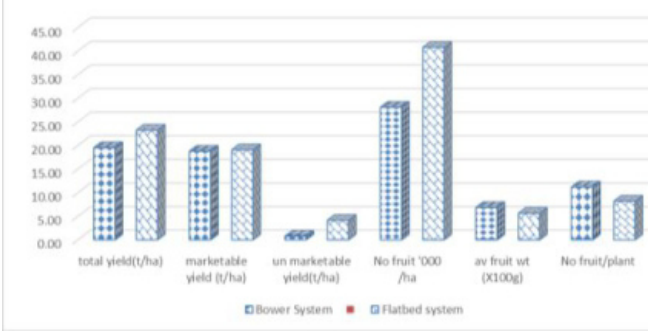

Fig. 15 : Yield of bottle gourd as influenced by method of training under organic treatments

Green manuring with *dhaincha:* The average dry matter added, owing to incorporation of *dhaincha*, in the organic treatments ranged between 1.4 to 2.21 t/ha, while in the control and inorganic treatments, it was 1.04 and 1.63 t/ha, respectively (Fig. 16 & 17). Among the cropping systems, the highest green manure dry matter was produced with broccoli-cowpea sequence (1.91 t/ha) followed by pea-okra sequence (1.66 t/ha) and tomato-*mung* bean sequence (1.46 t/ha).

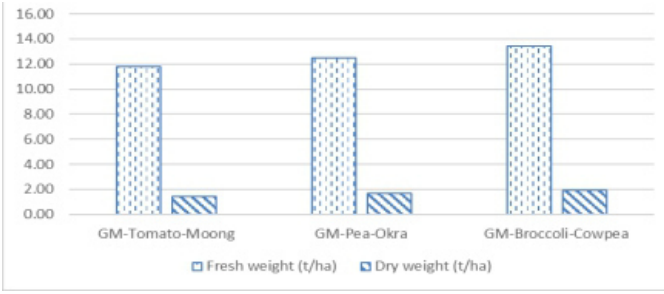

Fig. 16 : Fresh and dry weight of green manure produced under cropping system as influenced by organic treatments

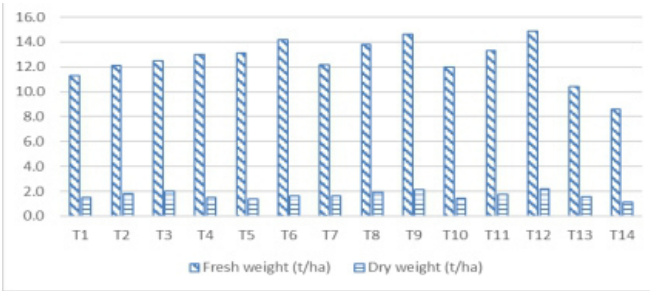

Fig. 17 : Fresh and dry weight of green manure produced under cropping system as influenced by organic treatments

Project 3.12 : Improving water productivity of vegetable crop sequences through drip irrigation system

Okra

Drip irrigation and mulching study was conducted

Table 7 : Effect of drip irrigation scheduling on yield attributed and water use efficiency in okra

Treatment	Plant height (cm)	CCI	No. of fruits/ plant	Fruit yield/ plant (g)	Fruit yield (q/ha)	WUE (kg/ha-mm)	Weeds (g/m²)
Irrigation							
Surface irrigation at 100% PE (I_1)	73.00	35.83	32.1	468.33	88.15	11.34	132.10
Drip irrigation- DI) at 60% PE (I_2)	66.71	34.98	29.9	444.33	79.13	24.84	71.18
DI at 80% PE (I_3)	76.92	38.49	33.5	491.42	98.70	20.86	82.08
DI at 100% PE (I_4)	83.04	41.54	37.3	555.42	112.05	18.94	88.83
SEm±	1.10	0.94	1.16	12.42	3.85	1.13	3.33
CD $_{0.05}$	3.53	3.00	3.71	39.69	12.31	3.62	10.65
Mulching							
Organic mulch (M_1)	80.94	44.54	36.8	585.13	112.30	22.78	54.70
Black-silver PE mulch (M_2)	83.03	39.40	34.1	486.25	90.62	18.37	8.51
No mulch (M_0)	60.78	29.19	28.6	398.25	80.61	15.84	217.44
SEm±	0.93	0.83	0.89	14.44	2.64	0.97	2.97
CD $_{0.05}$	2.71	2.40	2.59	42.07	7.69	2.83	8.66
Irrigation x Mulch							
I_1M_1	76.00	44.85	36.0	517.50	93.83	13.45	100.08
I_1M_2	80.75	38.93	34.3	465.25	67.50	9.68	16.48
I_1M_0	62.25	23.73	26.0	422.25	76.05	10.90	279.75
I_2M_1	75.50	41.73	33.3	546.25	111.92	31.53	32.58
I_2M_2	77.38	37.00	31.8	431.25	86.85	24.47	4.73
I_2M_0	47.25	26.23	24.8	355.50	65.70	18.51	176.25
I_3M_1	83.13	44.48	37.0	592.75	118.13	24.96	41.60
I_3M_2	83.25	38.88	34.0	515.50	97.88	20.68	5.88
I_3M_0	64.38	32.13	29.5	366.00	80.10	16.93	198.75
I_4M_1	89.13	47.13	41.0	684.00	125.33	21.19	44.55
I_4M_2	70.75	42.80	36.5	533.00	110.25	18.64	6.95
I_4M_3	69.25	34.70	34.3	449.25	100.58	17.00	215.00
SEm±	1.86	1.65	1.78	21.88	7.17	3.11	5.95
CD $_{0.05}$	5.41	NS	NS	63.71	20.88	9.06	17.33

during summer season with four irrigation and three mulch treatments. The maximum plant height (83.04 cm), CCI (41.54), number of fruits (37.3), fruit yield (555.42 g/plant and 112.05 q/ha) were recorded in drip irrigation at 100% PE (Table 7). This treatment noticed 27% higher yield over conventional surface irrigation. However, the maximum WUE of 24.84 kg/ha/mm with the minimum weed growth (71.78 g/m^2) was recorded in drip irrigation at 60% PE. As far as mulching was concerned, the maximum CCI (44.54), number of fruits (36.8), yield (585.13 g/plant; 112.30 q/ha) and WUE (22.78 kg/ha/cm) was recorded with the use of organic manures (pea straw @ 7.5 t/ha). The lowest weed growth (8.51 g/m^2) was observed under black-silver mulch.

Interaction of irrigation and mulch was significant for the most of the traits except CCI and fruits/plant. The highest fruit yield of 684 g/plants or 125.33 q/ha was recorded under drip irrigation with 100% PE + organic mulching (I4 M1) followed by I_3 M1 (118.13 q/ha). The maximum WUE (31.53 kg/ha-mm) was recorded in I_2 M1 while minimum weed growth *i.e.* 4.73 g/m^2 was observed under I_2M_2 (DI at 60% PE +B-S mulch).

Tomato

Study on drip irrigation scheduling in tomato was carried out in 2018-19 with two quantities of water through drip irrigation (100% and 75% ET) and was compared with conventional furrow irrigation (Table 8). Drip irrigation was scheduled at 2 or 3-days intervals. In this study, the maximum number of fruits (55.8) and yield (3.98 kg/ plant, 387.42 q/ha) was obtained with drip irrigation at 2 days interval with 100% ET (T1), however fruits yields obtained under this treatment was at par to DI 100% ET scheduled at 3 days intervals (T2). T1 treatment registered 18.77% higher yield over conventional irrigation and 24-29.8% more yield over 75% ET (T3 and T4). Water use efficiency among the drip

Table 8 : Effect of drip irrigation scheduling on yield and water use efficiency in tomato

Irrigation scheduling	Fruits/ plant	Fruit weight (g)	Yield/ plant (kg)	Fruit yield (q/ha)	Water used (mm)	WUE (q/ha-cm)
T1= Drip irrigation at 2 days with 100% ET	55.8	72.68	3.98	387.42	247.6	15.65
T2= Drip irrigation at 3 days with 100% ET	51.5	70.45	3.58	359.84	247.6	14.53
T3= Drip irrigation at 2 days with 75% ET	47.0	72.43	2.79	312.39	192.2	16.25
T4= Drip irrigation at 3 days with 75% ET	41.3	68.19	2.38	298.33	192.2	15.52
T5= Conventional furrow irrigation	43.8	79.73	2.85	326.21	357.5	9.12
SEm±	1.84	2.16	0.27	8.34	-	-
$CD_{0.05}$	5.36	6.29	0.786	24.29	-	-

Table 9 : Effect of drip irrigation scheduling on yield and water use efficiency in cabbage

Irrigation scheduling	Head weight (kg)	Head circum. (cm)	TDM (g)	Head Yield (q/ha)	Water used (mm)	WUE (Q/ha - cm)
T1= Drip irrigation at 2 days with 100% ET	2.617	60.43	212.6	527.45	167.1	31.56
T2= Drip irrigation at 3 days with 100% ET	2.330	56.67	205.4	474.86	167.1	28.42
T3= Drip irrigation at 2 days with 75% ET	1.965	52.00	138.4	436.67	125.3	34.85
T4= Drip irrigation at 3 days with 75% ET	1.767	49.50	118.9	385.50	125.3	30.77
T5= Conventional furrow irrigation	1.425	47.07	204.4	270.28	240.4	11.24
SEm±	0.17	1.88	7.51	12.42	-	-
$CD_{0.05}$	0.50	5.49	21.93	36.26	-	-

irrigation treatments did not differ significantly, however it was noticed remarkably higher over conventional irrigation (9.12 q/ha/cm).

Cabbage and cauliflower

Drip irrigation scheduling study was also conducted in cabbage and cauliflower during November to March 2018-19. There were five treatments with 5 replications including control (conventional irrigation). In cabbage, the maximum head weight (2.617 kg), circumference (60.43 cm), dry matter production (212.6 g/ plant) and head yield (527.47 q/ha) was recorded in treatment comprising DI at 100% ET with scheduling at 2 days interval (T1), however, the maximum WUE (34.85 q/ha-cm) was achieved under T3 (DI at 2 days with 75% ET) (Table 9 and Fig. 18).

In cauliflower, T1 (DI 100% ET at 2 days interval) registered the maximum curd weight (1.322 kg), polar diameter (19.36 cm), yield (491.05 q/ha) and WUE (36.37 q/ha-cm) followed by T2 (DI 100% ET at 3 days). Results showed that 93.88% and 83.86% higher curd yields were achieved in T1 and T2, respectively as compared to conventional furrow irrigation. In T1, there was an appropriate portioning of biomass in different parts of cauliflower plants, and there was proportional higher biomass in curd than stems and roots.

As far as water saving was concerned, there was 30.5% and 33% less water used, respectively in cabbage and cauliflower under drip irrigation at 100% ET as compared to conventional furrow irrigation system.

Fig. 18: Performance of cabbage under DI at 100% ET

Table 10 : Effect of rootstocks on survival and yield attributes in bitter gourd and cucumber

Scion	Rootstock	Survival (%)	Fruits/ plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (Cm)	Fruit yield (kg/plant)
Bitter gourd	Sponge gourd	87.3	30.67	44.17	19.27	2.40	1.535
	Ridge gourd	80.0	14.00	43.40	19.13	2.14	0.637
	Bottle gourd	55.0	12.00	44.83	20.20	2.05	0.543
Bitter gourd(control)		-	7.67	39.23	15.80	2.17	0.292
CD $_{0.05}$			2.45	3.22	3.04	0.31	0.088
Cucumber	Ridge gourd	86.7	9.33	118.67	11.53	4.11	1.154
	Ash gourd	73.3	6.33	123.07	13.63	3.84	0.776
	Bottle gourd	60.0	8.67	103.00	9.97	3.77	0.930
	C. hardwikii	82.6	7.33	127.20	13.43	4.35	0.979
Cucumber (control)		-	6.33	111.69	12.58	4.27	0.667
CD $_{0.05}$			1.32	9.87	2.11	0.38	0.121

Project 3.13 : Enhancing productivity, quality and tolerance to biotic and abiotic stresses in vegetables by grafting technology

Grafting studies in cucurbits : Grafting study in muskmelon during summer season reveals that there was about 45% graft survival on bottle gourd rootstocks. Also the grafted cucumber seedlings could not survive 15-20 days after transplanting in open field. In bitter gourd (Fig. 19), three rootstocks i.e. sponge gourd, ridge gourd, and bottle gourd were used. The maximum graft success (87.3%) was recorded with sponge gourd rootstock followed by ridge gourd (80.0%). The maximum fruits (30.67/ plant) and fruit yield (1.535 kg/ plant) was obtained when bitter gourd was grafted over sponge gourd. This combination registered about 425%, 183% and 141% higher yields, respectively over non-grafted, bottle gourd and ridge gourd. In cucumber, the maximum graft success (86.7%) was recorded with ridge gourd rootstock followed by *Cucumis hardwikii* (80.0%) and ash gourd (73.3%). In the present study, the maximum number of fruits (9.33/ plant) and fruit yield (1.154 kg/plant) was registered when ridge gourd was used as rootstock. This rootstock-scion combination yielded about 73% higher yields over un-grafted cucumber (Table 10).

Fig. 19: Fruiting in bitter gourd on sponge gourd

Project 3.14 : Weed management in vegetable crops

Weed control studies in cowpea recorded maximum yield (15.6 t/ha) with black polythene mulch followed by organic mulch (14.8 t/ha). Among herbicide treatments, maximum pod yield (12.3 t/ha) was recorded with sequential application of pendimethalin 750 g/ha (pre-emergence) + imazethapyr (post emergence).

In French bean, the maximum weed control index (WCI) 98.9 %, was recorded with black polythene mulch. Among the herbicide treatments, the maximum WCI (97.2 %) was observed with sequential application of pendimethalin 750 g/ha (pre-emergence) + sodium acifluorfen + clodinafop 100 g/ha (post emergence), followed by application of pendimethalin 750 g/ha (pre-emergence) + imazethapyr 100 g/ha (post emergence; 95.7%).

Black polythene mulch treatment recorded significantly superior yield (16.9 t/ha). Among herbicide treatments, the maximum yield (13.4 t/ha) was attained with sequential application of pendimethalin 750 g/ha (pre-emergence) + sodium acifluorfen + clodinafop 100 g/ha (post emergence).

Project 3.15 : Conservation agriculture under vegetable based cropping system

Under conservation agriculture in vegetable based cropping system, zero tillage with residue retention produced the maximum green cob yield (13.0 t/ha) followed by conventional tillage with residue incorporation (12.6 t/ha).

Project 3.16 : Offseason Cultivation of Vegetables under Protected Environment.

The parthenocarpic cucumber lines/ varieties namely PPC-2, PPC-3, King Star, Multi Star, Hiltan etc. were sown under poly house condition in Rabi season of 2019 for screening. The best performing varieties/lines will be used for cultivation as per technical programme in the coming year under different

training system during off season. Similarly, varieties / lines of Musk melon and better gourd were also sown under poly house condition for screening

MEGA PROGRAMME 4 : POST HARVEST MNAGEMENT AND VALUE ADDITION

Programme Leader : Dr. Sudhir Singh

Project 4.3 : Modified atmosphere storage for retaining the quality assurance of vegetables

Gaseous composition of O_2 decreased from 20% to 12.1% and from 20% to 11%, respectively in small and big size cauliflower after 2 days of MAP storage (with expanded polyethylene biopolymer films) at 3^{0}C, while oxygen content varied 12.1-20.5% and 11-20.3% in small and big size cauliflower, respectively under MAP storage for 49 days at 3^{0}C. The moisture content decreased from 97.73 to 78.37% and from 97.73 to 79.42% in small and big size cauliflower under MAP storage for 49 days at 3^{0}C. In contrast to storage at 3^{0}C, moisture content decreased at a faster rate during storage at 10 ^{0}C, the moisture content decreased from 97.73 to 86.85% and from 97.73 to 85.50% after 14 days of storage at 10 ^{0}C. The firmness of the head decreased during MAP storage at 3 and 10 ^{0}C. The decrease in firmness of small and big size cauliflower under MAP storage was from 5.78 N to 2.74 N and from 5.78N to 2.51N at 3 ^{0}C for 49 days, respectively. The softening in fully control cauliflower was at much faster rate, which decreased from 5.78 N to 1.52 N after 42 days of storage at 3 ^{0}C. Ascorbic acid content in small and big size cauliflower in MAP also decreased to 93.2% and 96% after 49 days of storage at 3 ^{0}C. Total phenol content decreased in both small and large size cauliflower from 733.45 to 247.13mg /100gm GAE and from 733.45 to 40.6 mg /100g dm GAE after 49 days of storage at 3 ^{0}C, respectively. TPC content at 3^{0}C in fully control cauliflower is decreased at faster rate and it was decreased from 733.45 to 32.43 mg /100gm dm GAE after 42 days. The antioxidant activity in small and big cauliflower was 80.40 to 34.29 µM TEAC/g dm and 23.03 µM TEAC/g dm, respectively at 3^{0}C after 49 days of MAP storage. However, antioxidant activity of fully control cauliflower decreased at faster rate and it decreased from 80.40 to 11.17 µM TEAC/g dm.

Variability analysis for functional attributes in eggplants: With the aim to investigate variations in functional quality attributes in eggplant, 23 genotypes were evaluated for their antioxidant capacity, flavonoids and phenolics contents. The maximum phenolics content was recorded in Kashi Taru (81 mg GAE/100 g FW) which was about 4-fold higher than PB x Uttara (19 mg GAE/100 g FW). The flavonoids content was recorded to be the highest in Kashi Uttara x Navin (5.8 mg RE/100 g FW) followed by Kashi Himani, Kashi Komal, PR-5 x Pusa Upkar and Kashi Taru (Fig. 20). The lowest flavonoids content was recorded in PR-5 x BR-14 (1.9 mg RE/100 g FW). The variation observed in antioxidant capacity among the 23 genotypes studied ranged between 0.88 (PR-5 x BR-14) and 1.15 µmol TE/g FW (Kashi Taru), depicting only about 1.3-fold variation. However, the mean value for free radical scavenging capacity in most of the genotypes was observed to be ~1.0 µmol TE/g FW (Fig. 21), leading to the observation that despite higher variation in total phenolics and flavonoids; the antioxidant capacity showed similar potential for free radical scavenging.

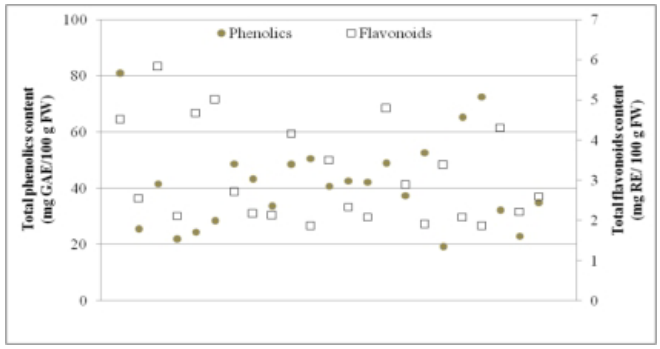

Fig. 20 : Variation in total phenolics and flavonoids content among eggplant genotypes

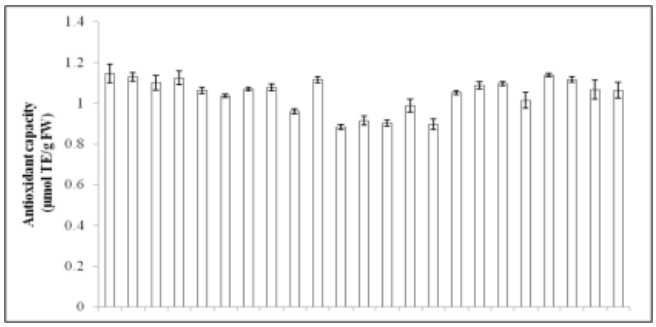

Fig. 21 : Variation in antioxidant capacity among eggplant genotypes

Project 4.4 : Influence of Polyamines on Postharvest Senescence and Quality of High Value Vegetables

Preliminary trials were done to assess the chilling injury incidence and extent in cucumber fruit. It was found that cucumber showed symptoms like pitting, water soaking, rapid moisture loss and increased susceptibility to rotting. Polysaccharide based edible

coating treatment (carboxymethyl cellulose @ 0.5%, 1% and 1.5%) on cucumber were done to analyse the reduction in moisture loss of cucumber fruits stored at low temperature. CMC based edible coating delayed rate of moisture loss in cucumber.

MEGA PROGRAMME 5 : PRIORITIZATION OF R&D NEEDS AND IMPACT ANALYSIS OF TECHNOLOGIES DEVELOPED BY ICAR-IIVR

Programme Leader : Dr. Neeraj Singh

Project 5.3 : Development & promotion of nutri-garden module for rural households

During 2019, trials of 02 nutri-garden modules for small family size were conducted at IIVR Research Farm in an area of 100 m^2 and 150 m^2. Results of the first module from 100 m^2 area (Table 11) showed that a total of 131.06 kg of vegetables can be fetched from a time span of about 100 days; whereas, daily availability of vegetables was 1.51 kg which was sufficient for a family of 05 members. Dietary-fibre rich crops like maize and drumstick were also introduced in 100 m^2 nutri-garden module along with vegetables. Similarly, trials of nutri-garden module were conducted in 150 m^2 area (Table 12) during *Kharif* 2019 showed that a total of 242.49 kg of vegetables can be fetched from a time span of about 100 days whereas daily availability of vegetables was 2.63 kg which was sufficient for a family of 08 members.

The 100 m^2 nutri-garden module were also demonstrated at 24 farmers' field of Laskariya, Baburam Ka Pura and Paniyara villages of Varanasi district and Nakkupur village Mirzapur district. In villages, women

Table 11 : Availability of vegetables from 100 m^2 *Kharif* season nutri-garden module

Crops	Variety	Cropped area (m^2)	DOS/DTP	Crop duration (Days)	Total yield (Kg)	Per day availability (kg)
Amaranths	K. Suhavani	7.51	12-07-2019	86	8.85	0.10
Sponge Gourd	K. Shomya	5.82	23-07-2019	85	21.1	0.25
Bottle Gourd	K. Ganga	3.75	19-07-2019	97	12.57	0.13
Bitter Gourd	K. Mayuri	3.75	19-07-2019	101	3.4	0.03
Pumpkin	K. Harit	7.51	19-07-2019	93	20.55	0.22
Okra	K. Kranti	11.63	19-07-2019	78	13.77	0.18
Cowpea	K. Nidhi	11.63	19-07-2019	89	15.54	0.18
Ridge Gourd	K. Khushi	5.82	23-07-2019	79	6.64	0.08
Brinjal	K. Sandesh	5.82	20-08-2019	105	11.1	0.11
Pointed Gourd	K. Alankar	4.13	23-07-2019	65	2.9	0.05
Moringa	PKM-2	4.13	23-09-2018	100	2.6	0.03
Maize	Navin	7.51	21-07-2019	73	8.67	0.12
Cauliflower	VRCFH-55	4.13	12-08-2019	100	3.37	0.03
Total		83.14*			131.06	1.51

**rest 16.86 m^2 area was covered under nutri-garden pathway, ridges and furrows*

Table 12 : Availability of vegetables from 150 m^2 *Kharif* season nutri-garden module

Crops	Variety	Area (m^2)	DOS/DTP	Crop Duration (Days)	Total Yield (Kg)	Per day availability (kg)
Sponge Gourd	K. Shomya	8.69	23-07-2019	87	33.67	0.39
Ridge Gourd	K. Khushi	8.69	23-07-2019	79	19.09	0.24
Okra	K. Kranti	17.38	19-07-2019	91	20.93	0.23
Cowpea	K. Nidhi	17.38	19-07-2019	91	18.17	0.20
Bottle Gourd	K. Ganga	11.22	19-07-2019	93	30.13	0.32
Bitter Gourd	K. Mayuri	5.61	19-07-2019	97	3.93	0.04
Snake Gourd	Jaunpuri	11.22	12-07-2019	104	40.37	0.39
Pumpkin	K. Harit	5.61	19-07-2019	90	20.53	0.23
Cucumber	K. Swarn	11.22	12-08-2019	82	5.67	0.07
Brinjal	K. Sandesh	8.69	20-08-2019	105	13.1	0.13
Chilli	K. Anmol	8.69	20-08-2019	115	2.47	0.02
Pointed Gourd	K. Shufal	6.16	23-07-2019	61	1.63	0.03
Onion	Nashik Red	6.16	20-08-2019	95	26.6	0.28
Cauliflower	VRCFH-55	6.16	12-08-2019	100	6.2	0.06
Total		**gourd**			242.49	2.63

**Rest 17.12 m^2 area was covered under nutri-garden pathway, ridges and furrows*

and children showed more interest in demonstrated nutri-garden and said that this secured them a source of regular income of Rs. 150-200/- per week as well by selling excess vegetables (Fig. 22 & 23).

Fig. 2 2: A view of different nutri-garden modules

Fig. 23 : Demonstration of nutri-gardens at farmers' field

Fig. 24 : Entrepreneurship development in mushroom production

Fig. 25 : Exploring marketing opportunities for vegetable juice

Fig. 26 : Entrepreneurship development training for small scale vegetable production and processing

Project 5.4 : Empowering rural youth for vegetable based entrepreneurship

Under this project, different business opportunities were explored for the rural youths as per the availability of resources to them and their technical capabilities. A rural youth Sh. Dilip Kumar Pandey of Ashwari village, Badagaon of Varanasi, interested in mushroom production, was provided with all relevant information about production technologies, especially, of button and oyster mushroom. In the second year of his venture of mushroom production, he produced around 1.25 tons of mushrooms with annual turnover of Rs. 2.00 lakhs. Further, the opportunity of marketing of vegetable juice was explored in Varanasi market (Fig. 24, 25 & 26). Based on the interviews with juice sellers, it was revealed that demand for vegetable juice was not high except among few patients and health-conscious people.

In addition, 03 entrepreneurship development trainings were organized to promote small scale vegetable farming and processing among the rural women who are already member of SHGs formed under National Rural Livelihood Mission (NRLM).

Project 5.5 : Economic impact assessment of IIVR developed technologies

Kashi Pragati (developed in 2002), one of the promising varieties of okra was recommended for cultivation in the states of Rajasthan, U.P., A.P., Bihar, West Bengal, Chhattisgarh, Odisha, Uttrakhand and Delhi. The data from 2004-05 to 2017-18 were analysed for its estimated area coverage across the country. The estimated area covered under the variety is 908.96 ha from the total TL seeds sold of 10907.5 Kg. Similarly, the data on quantity of breeder seeds sold to different private firms was collected and an estimated conversion to foundation seeds and certified seeds was done. The estimated area covered due to the breeder seed sale was 145776 ha from 2014-15 to 2019-20. In total, cv. Kashi Pragati covers an estimated total area of 146684.96 ha during 2004-05 to 2019-20 covering 123 districts of 23 different states in the country

Division of Vegetable Protection

MEGA PROGRAMME 6 : INTEGRATED PLANT HEALTH MANAGEMENT

Programme Leader : Dr. K.K. Pandey

Project 6.1 : Bio-intensive management of important pests of vegetable crops

Evaluation of different pest management modules in bottle gourd: Different pest management modules were evaluated against insect pests of bottle gourd (cv. Kashi Ganga). Among the tested modules, module 2 (M2) *i.e.*, Integrated pest management module comprising spraying of dichlorvos @ 0.75 ml/l during 20 and 30 days after sowing (DAS), *Bacillus thuringiensis* var *Kurstaki* @ 2 g /lit at 40 DAS, imidacloprid @ 0.4 ml/l at 50 DAS, *Lecanicillium lecanii* @ 5 g/l at 60 DAS and azadirachtin 0.03% @ 10 ml/l at 70 DAS was found superior in terms of reducing red pumpkin beetle (73.99 per cent over control), whitefly (85.57 PROC), white plume moth (84.04 PROC) and mirid bugs (70.12, 73.84 and 64.21 PROC) on leaf, fruit and twig, respectively (Table 1).

Evaluation of different pest management modules in pumpkin: Among the three pest management modules *viz*., bio-intensive module (M1), integrated module (M2) and chemical module (M3) against major insect pests of pumpkin including red pumpkin beetle (*Raphidopalpa foveicollis*), whitefly (*Bemisia tabaci*) and mirid bugs (*Nesidiocoris cruentatus*), the integrated module (M2) comprising sprayings of DDVP 76% EC @ 0.75 ml/l at 20 and 30 days after sowing (DAS), *Bacillus thuringiensis*

Table 1 : Effect of different pest management modules against insect pests in bottle gourd

Treatments	Red pumpkin beetle (per 5 leaves /plant)		Whitefly / leaf		White plume moth / apical bud		Mirid bugs per					
							Leaf		Fruit		Twig	
	After spray	PROC	After spray	PROC	After spray	PROC	After spray	PROC	After spray	PROC	After spray	PROC
M1	1.51	61.87	0.84	71.13	0.67	68.55	1.39	57.62	1.68	54.22	5.84	53.76
M2 Integrated	1.03	73.99	0.42	85.57	0.34	84.04	0.98	70.12	0.96	73.84	4.52	64.21
M3 Chemical	1.22	69.19	0.59	79.73	0.51	76.06	1.17	64.33	1.20	67.30	5.04	60.10
Control	3.96	--	2.91	--	2.13	--	3.28	--	3.67	--	12.63	--
SEm (±)	0.21	--	0.17	--	0.16	--	0.17	--	0.12	--	0.53	--
LSD (5%)	0.48	--	0.37	--	0.42	--	0.45	--	0.34	--	1.38	--

Table 2: Effect of different pest management modules against insect pests in pumpkin

Treatments	Red pumpkin beetle (per 5 leaves /plant)			Whitefly / leaf			Mirid bugs per								
							Leaf			Tender fruit			Twig		
	Before spray	After spray	PROC	Before spray	After spray	PROC	Before spray	After spray	PROC	Before spray	After spray	PROC	Before spray	After spray	PROC
M1	2.39	1.35^{b}	50.91	2.84	1.20^{a}	57.30	2.73	0.60^{a}	79.45	1.57	0.22^{a}	75.28	4.12	1.60^{b}	31.91
M2	2.51	0.90^{a}	67.27	2.39	0.94^{a}	66.55	2.36	0.38^{a}	84.62	1.44	0.13^{a}	85.39	4.08	0.84^{a}	64.26
M3	2.17	1.05^{a}	61.81	3.17	1.47^{a}	47.69	2.60	0.44^{a}	82.19	1.69	0.17^{a}	80.90	3.83	1.06^{a}	84.89
Control	2.89	2.75^{c}	--	3.22	2.81^{b}	--	2.92	2.47^{b}	--	1.51	0.89^{b}	--	3.94	2.35^{a}	--
SEm (±)	--	0.17	--	--	0.26	--	--	0.38	--	--	0.11	--	--	0.22	--
LSD (5%)	--	0.43	--	--	0.58	--	--	0.87	--	--	0.24	--	--	0.52	--

var *Kurstaki* @ 2 g /l at 40 DAS, imidacloprid 17.8 SL @ 1 ml/3l at 50 DAS, *Lecanicillium lecanii* @ 5 g/l at 60 DAS and azadirachtin 300 ppm @ 10 ml/l at 70 DAS was most effective in reducing the red pumpkin beetle (67.27 per cent reduction over control), white fly (66.55) and mirid bug population on leaves (84.62), tender fruits (85.39) with significant increase in the yield (293 q/ ha) in comparison to control (221 q/ha) Table 2.

Project 6.2 : Toxicological investigations on the novel and botanical insecticides against major insect pests of vegetables

Field bio efficacy of cyantraniliprole 10% OD against sucking pests of okra: The result revealed that among three different doses of cyantraniliprole 10% OD, dose @1.5 ml/l was found to be effective against leaf hoppers population with 33.97 % reduction over control (Table 3). Imidacloprid 17.8% SL @0.5 ml/l was effective in reducing the whitefly population with 63.20% reduction as compared to control.

Comparative field bio-efficacy of diamide insecticides against major insect pests of okra (cv. Kashi Pragati)**:** Among different diamides insecticides, cyantraniliprole 10% OD @1.8 ml/l and spinosad 2.5% SC @1.3 ml/l were found to be most effective with 91.62 and 90.79% reduction in fruit damage, respectively. cyantraniliprole 10% OD @1.8 ml/l was effective in reducing leaf hoppers and white fly population with 65.36 and 70.74 % reduction, respectively. Cyantraniliprole 10% OD @ 1.8 ml/l (96.49%), chlorantraniliprole18.5% SC @0.25 ml/l (95.61%) and spinosad 2.5% SC @1.3 ml/l (92.11%) were found to be effective in reducing the population of defoliators over control (Table 4).

Table 3 : Bio efficacy of cyantraniliprole 10% OD against sucking pests of okra

Treatments	Dose (ml or g/L	Avg. no. of leafhoppers* (3 leaves/plant)			Avg. no. of whitefly* (3 leaves/plant)			BCAs (Avg. no./plant)
		PTC	Avg.	PROC	PTC	Avg.	PROC	
Cyantraniliprole 10% OD	1.2	16.00	4.82^{ab}	30.51	3.20	0.91^{a}	56.27	0.55
Cyantraniliprole 10% OD	1.5	15.73	4.58^{a}	33.97	2.73	0.90^{a}	56.80	0.50
Cyantraniliprole 10% OD	1.8	16.00	5.63^{cd}	18.79	3.33	0.93^{a}	55.47	0.42
Chlorantraniliprole18.5% SC	0.25	12.73	4.66^{ab}	32.86	5.33	1.03^{a}	50.40	0.65
Emamectin benzoate 5% SG	0.35	10.60	6.35^{de}	8.49	5.07	1.82^{bc}	12.80	0.67
Imidacloprid 17.8% SL	0.5	13.93	5.44^{bc}	21.59	2.87	0.77^{a}	63.20	0.54
Thiamethoxam 25% WG	0.35	14.13	5.28^{abc}	23.94	3.00	1.30^{ab}	37.60	0.54
Untreated control		16.53	6.94^{e}		2.27	2.08^{c}		0.79
SEm±			0.12			0.09		
CD (0.05)			0.36			0.28		
CV			3.97			14.78		

*Pooled data of three sprays; PPOC = Percent reduction over control

Table 4 : Field bio-efficacy of diamide insecticides against major insect pests of okra

Treatments	Dose (ml or g/L	Fruit damage (%)			Avg. no. of leafhoppers* (3 leaves/plant)			Avg. no. of whiteflies* (3 leaves/plant)			Defoliators (no. of larvae per plant)			BCAs (Avg. no./plant)
		PTC	Avg.	PROC	PTC	Avg.	PROC	PTC	Avg.	PROC	PTC	Avg.	PROC	
Cyantraniliprole 10% OD	1.8	15.40	1.57^{a}	91.62	10.27	3.27^{a}	65.36	1.67	0.41^{a}	70.74	0.67	0.03^{a}	96.49	0.93
Chlorantraniliprole 18.5% SC	0.25	17.52	3.52^{c}	81.24	21.93	5.05^{b}	46.43	8.00	0.95^{bc}	31.91	0.20	0.04^{a}	95.61	1.26
Flubendiamide 40% SC	0.3	12.05	2.46^{b}	86.91	14.93	6.41^{bcd}	31.97	7.67	0.66^{ab}	52.66	0.20	0.13^{ab}	85.09	1.17
Emamectin benzoate 5% SG	0.3	12.92	3.27^{c}	82.61	18.20	6.90^{cd}	26.87	3.00	0.87^{abc}	37.23	0.27	0.16^{ab}	81.58	1.27
Spinosad 2.5% SC	1.3	15.85	1.73^{a}	90.79	12.60	5.95^{bc}	36.92	4.67	1.17^{bc}	15.96	0.40	0.07^{a}	92.11	1.27
Cypermethrin 25% EC	0.5	11.33	6.70^{d}	64.33	15.40	7.83^{de}	16.97	4.00	0.83^{abc}	40.43	0.65	0.53^{bc}	37.72	0.91
Nimbecidine 0.03%	5.0	16.56	6.47^{d}	65.53	17.27	6.06^{bc}	35.74	3.00	1.00^{bc}	28.19	0.74	0.57^{bc}	32.46	1.37
Untreated control		15.83	18.78^{e}		13.53	9.43^{e}		3.67	1.39^{c}		0.33	0.84^{c}		1.41
SEm±			0.04			0.10			0.10			0.13		
CD (0.05)			0.14			0.31			0.31			0.40		
CV			6.29			7.00			19.13			15.51		

*Pooled data of three sprays; PROC = Percent reduction over control

Project 6.3 : Biological control of major insect pests of vegetable crops

Record of a zoophytophagous mirid bug in tomato: A zoophytophagous mirid bug, *Nesidiocoris tenuis* (Miridae: Hemiptera) was identified in tomato. This polyphagous mirid bug feed on soft-bodied insects like whiteflies, leafminers, thrips, aphids and eggs and larvae of lepidopterans in tomato as predator. However, in absence of suitable predators it also feed on aerial plant parts in tomato resulting in necrotic rings on the main stems, shoots, leaf petioles and flower stalks (Fig. 1).

Fig. 1 : *N. tenuis* fed on tomato seedling

Bio-efficacy of different entomopathogens & botanicals against sucking pests of okra: Bio-efficacy of different entomopathogenic fungi (EPF) alone and their 1:1combination with neem oil (0.5%) at half of their recommended doses were evaluated against okra jassids (*Amrasca biguttula biguttula*) and whitefly (*Bemisia tabaci*) under field conditions. Amongst the three EPF tested *Lecanicillium lecanii* @ 5 g/l was found most promising against jassids and whiteflies with maximum per cent reduction over control (PROC) 56.95 and 53.07, respectively. When these EPF and neem oil were blended at half of their recommended doses were found compatible. Combination of *L. lecanii* and neem oil at 1:1 ratio treated plots showed lowest jassid (1.13) and whitefly (0.73) population per leaf and there by having maximum PROC (62.76 and 59.22, respectively). Interestingly, all the bio-pesticides treated plots harbored higher spider's population per plant as compared to the imidacloprid treated plots (Table 5).

Evaluation of different entomopathogens against *Spodoptera litura*, a polyphagous insect pest in vegetable ecosystem: To control the polyphagous *S. litura*, a series of entomopathogens were evaluated under laboratory condition by leaf residue method. Third instar larvae of *S. litura* were fed to the treated cabbage leaves and observations were recorded up to 5 days after the treatment at an interval of 24 hour.

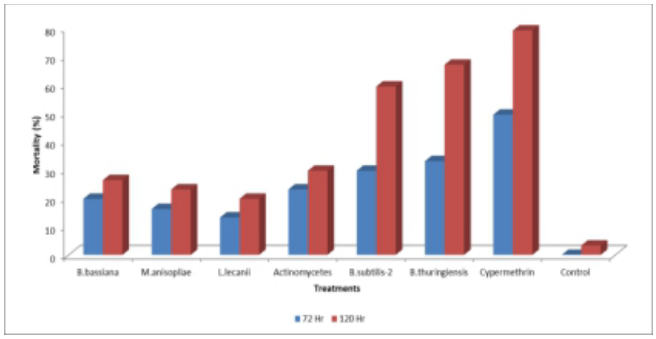

Fig. 2 : Bio-efficacy of different entomopathogens against third instar larvae of *S. litura*

Table 5 : Effect of different EPF and neem oil alone and their 1:1 combination against major sucking pests of okra

Treatments	Jassids/ leaf			Whiteflies/ leaf			Spiders/ plant
	Before spray	After spray	PROC	Before spray	After spray	PROC	
T1 = *Beauveria bassiana*	3.43	1.33	54.92	2.51	0.96	46.37	3.31
T2 = *Metarhizium anisopliae*	3.22	1.39	52.88	2.47	0.93	48.04	3.36
T3 = *Lecanicillium lecanii*	3.09	1.27	56.95	2.63	0.84	53.07	3.31
T4 = *B. bassiana* + Neem oil	3.36	1.21	59.32	3.13	0.77	56.98	3.31
T5 = *M. anisopliae* + Neem oil	3.16	1.25	57.63	3.19	0.79	55.87	3.34
T6 = *L. lecanii* + Neem oil	3.47	1.13	62.76	3.16	0.73	59.22	3.32
T7 = Imidacloprid	3.65	1.26	57.29	2.64	0.79	55.87	1.07
T8 = Control	3.70	2.95	--	3.16	1.79	--	3.91
SEm(±)	--	0.29	--	--	0.18	--	0.37
LSD (5%)	--	0.65	--	--	0.48	--	0.86

Table 6 : Biosafety evaluation of some new insecticide molecules on spiders and coccinellid beetles in okra ecosystem

Treatments	Dose (ml or g/L	PTC#	No. of Spiders / plant*	PMOC@	PTC	No. of coccinellid beetles / plant*	PMOC@
Cyantraniliprole 10% OD	1.2	0.60	0.33^{a}	34.78	1.13	0.22^{ab}	23.53
Cyantraniliprole 10% OD	1.5	0.53	0.34^{a}	33.70	1.40	0.16^{ab}	43.14
Cyantraniliprole 10% OD	1.8	0.60	0.28^{a}	44.57	1.07	0.13^{a}	52.94
Chlorantraniliprole 18.5% SC	0.25	0.60	0.38^{ab}	25.00	1.13	0.27^{ab}	5.88
Emamectin benzoate 5% SG	0.35	0.40	0.42^{ab}	18.48	0.80	0.26^{ab}	9.80
Imidacloprid 17.8% SL	0.5	0.60	0.36^{ab}	29.35	1.07	0.18^{ab}	37.25
Thiamethoxam 25% WG	0.35	0.87	0.37^{ab}	27.17	1.20	0.17^{ab}	41.18
Untreated control	--	0.33	0.51^{b}	--	1.07	0.28^{b}	--
SEm (±)			0.04			0.04	
CD (0.05)			0.12			0.13	
CV			11.15			17.07	

Pre-treatment count, *Pooled data after three sprays; PMOC = Percent mortality over control

Amongst the entomopathgens, *Bacillus thuringiensis* var Kurstaki @ 2 g/l were found most promising with 33.3 and 67.1 per cent mortality followed by *B. subtilis*-2 with 29.7 and 59.4% mortality. However, amongst the entomopathogenic fungi, *Beauveria bassiana* @ 5 g/l was superior by registering 19.8 and 26.4% mortality (Fig. 2).

Biosafety evaluation of cyantraniliprole 10% OD and other new insecticide molecules on spiders and coccinellid beetles in okra ecosystem: New diamide insecticide *i.e.,* cyantraniliprole 10% OD and other newer molecules were tested against spiders and coccinellid beetles in okra. Amongst the tested molecules, emamectin benzoate 5% SG and chlorantariniporle 18.5% SC at their recommended doses were found relatively safer with 18.48, 25 and 9.80, 5.88 percent mortality over control (PMOC) against spiders and coccinellid beetles, respectively (Table 6).

Project 6.4 : Development of effective integrated management package for important fungal diseases of vegetable crops

Evaluation of different modules for management of fungal diseases of tomato: Six different management modules developed and evaluated for the management of fungal diseases started from nursery to harvesting of tomato. Kashi Aman variety was sown in solarized nursery beds in last week of August. Total 800 seeds in each treatment sown by maintaining proper line and seed distance in 1m^2 nursery area and all the treatments were covered by 40 mesh insect-proof net to protect seedlings from insect-vectors. The maximum 73.5% seedling stand was obtained after 26 days of sowing in T5 comprising seed treatment by *Trichoderma asperllum* @0.5% + *Bacillus subtilis* IIVR strain (BS2 @0.5% and it was closely followed by T4 (69.75%) seed treatment by *Trichoderma* sp. IIVR strain (BATF-43-1) @1% + nursery application of BATF-43-1 @25 g/m^2 of nursery area (Table 7 and Fig. 3)

Fig. 3 : Seedling stand of tomato

Table 7 : Different modules for the management of fungal diseases in nursery of tomato

Treatment	Seedling stand %
T1 ST- carbendazim @0.2%	58.25
T2 ST- BATF-43-1@1%	63.75
T3 Seed soaking cow urine + Neem cake @50g/m2	69.12
T4 ST- BATF-43-1 @1% + SA BATF-43-1@25 g/m2	69.75
T5 ST- *T. asperllum* @ 0.5% + BS-2 @0.5%	73.50
T6 Control	69.62
LSD (5%)	3.12
CV	11.4

The seedlings produced in each module were transplanted separately in respective modules having various management sequential activities. By the end of

December three schedule has completed at 25 days interval and the tomato is at fruiting stage and no fungal, bacterial and viral diseases has appeared in any of the treatment. The fourth schedule yet to completed and accordingly thereafter observations will be recorded.

Characterization of tomato *Fusarium* isolates : A total of 14 cultures viz, FWT-3, FOL-3, FOL-4, FWT-5, FWT-14, FWT-15, FWT-20, FWT-56, FWT-60, FWT-67, FWT-71, FWT-74, FWT-85 and FWT-89 of *Fusarium oxysporum* f.sp *lycopercsici* kept in cold chamber since long back in sterile water were isolated and purified based on colony characters. The cultures were microscopically characterized based on macroconidia, microconidia and chlyamadospore production. It was observed that majority of the isolates changed their colony characters and lost the virulence because its non-resemblance to the characteristic original mother culture of *F. oxysporum* f.sp *lycopercsici*.

Two different sources of organic matter viz., vermicompost and NADEP were inoculated by talc-based *T. asperllum* 5g to 50g per pot having inoculum of 1.9 $x10^8$ were mixed in 200g of the above organic substrate and incubated at ambient room temperature for 40 days as well as 60 days and accordingly viable colony was recorded on total fungi media. Viable colony count of *T. asperllum* varied from $1.5x10^6$ to $32.6x10^6$ cfu/gram of organic matter at 60 days of incubation and it was almost same on 40 days of incubation. There was no relation in *T. asperllum* count with its increasing dose of amendment. Pathogenic fungi like *Fusarium*, *Pythium, Sclerotinia, Rhizoctonia, Alternaria* while non-pathogenic fungi *Aspergillus* spp. and *Curvularia* were counted in control of both the organic matter. It was clear from the present study that *T. asperlllum* population decreased after mixing and incubating in the above two organic substrate (Table 8 and Fig. 4).

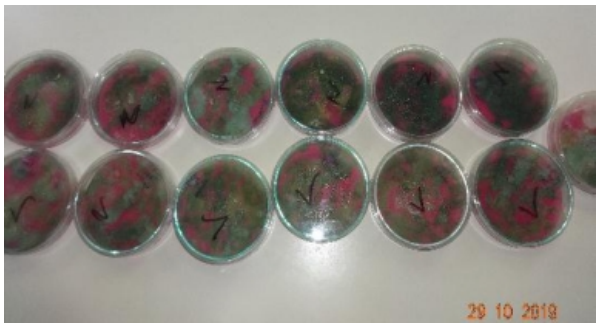

Fig. 4 : *T. asperllum* colony

Evaluation of *Actinomyces* sp. strain N1.2 talc formulation coated tomato, brinjal, and chilli seeds in pot and nursery : Colony forming unit (cfu/gram) of talc-based bio formulation of *Actinomyces* sp strain N1.2 was reported to be $5.3x10^6$. Tomato (Kashi Aman), Brinjal (Kashi Taru), and Chilli (Kashi Anamol) seeds were treated with N1.2 talc bioformulation @5, 10, 20, 40, and 50 g/kg of seeds. Treated seeds along with control were sown in the soil filled pots and were kept in net house. T1 treatment (5 g/kg) showed best average seed germination percentage (87.14%) in case of tomato when compared with the control (74.29%, Table 9). While T3 treatment (20 g/kg) showed minimum average percentage of post emergence damping off (5.4%) when compared with the control (21.27%). In brinjal pot experiment T2 treatment (10 g/kg) showed best overall performance in all the aspects when compared with the control (Table 10). While in chilli pot experiment T3 treatment showed best average seed germination percentage (72%) compared with control (56%) and T1 treatment gave best average percentage reduction of post emergence damping off and root length (Table 11). Further nursery experiments were conducted using brinjal and chilli seeds coated with best selected treatments (T1 and T2). In brinjal nursery experiments T2 treatment gave the best overall performance when compared with the control (Table 12).

Table 8 : Multiplication status of *Trichoderma asperllum* in the organic matter

Treatments	*T. asperllum* 1 $x10^6$ cfu/ gram	*Fusarium* spp. $1x10^5$cfu/ gram	*Aspergillus* spp. $1x10^5$ cfu/ gram	Treatments	*T. asperllum* $1x10^6$ cfu/ gram	*Fusarium* spp. $1x10^5$cfu/ gram	*Aspergillus* spp. $1x10^5$cfu/ gram
V5	2.0	1.0	1.0	N5	1.67	1.3	0.6
V10	2.6	0.6	0.3	N10	2.36	0.3	0.3
V20	1.5	0.3	-	N20	2.06	0.3	-
V30	2.0	0.3	1.3	N30	2.05	-	-
V40	2.4	2.0	2.3	N40	2.45	-	-
V50	2.25	-	-	N50	2.6	-	-
VC	-	5.7	5.3	NC	*Trichoderma* spp. 2.3	1.9	

Table 9 : Effect of N1.2 on tomato seeds & seedling in pots

Treatments	Average % seed germination	Average post emergence damping off (%)	Average root length (cm)	Average stem length (cm)
T1 (5g/kg seed)	87.14	11.43	7.68	17.23
T2 (10g/kg seed)	74.29	11.59	7.87	17.13
T3 (20g/kg seed)	67.14	5.40	7.53	16.93
T4 (40g/kg seed)	61.90	8.41	7.23	16.87
T5 (50g/kg seed)	70.95	7.30	7.13	16.34
Control	74.29	21.27	6.00	13.90

Table 10 : Effect of N1.2 on brinjal seeds & seedling in pots

Treatments	Average % seed germination	Average post emergence damping off (%)	Average root length (cm)	Average stem length (cm)
T1 (5g/kg seed)	54.67	7.11	3.13	13.93
T2 (10g/kg seed)	57.33	2.22	3.15	14.43
T3 (20g/kg seed)	46.67	4.00	2.93	14.03
T4 (40g/kg seed)	50.67	6.89	3.03	13.97
T5 (50g/kg seed)	53.33	3.33	3.09	14.01
Control	45.33	11.33	2.3	12.9

Table 11 : Effect of N1.2 on chilli seeds & seedling in pots

Treatments	Average % seed germination	Average post emergence damping off (%)	Average root length (cm)	Average stem length (cm)
T1 (5g/kg seed)	61.33	5.55	2.86	17.23
T2 (10g/kg seed)	58.67	8.67	2.33	18.22
T3 (20g/kg seed)	72.00	8.22	2.53	16.32
T4 (40g/kg seed)	56.67	12.89	2.61	16.93
T5 (50g/kg seed)	65.33	12.22	2.39	17.13
Control	56.00	12.45	2.13	16.03

Table 12 : Effect of N1.2 on brinjal seed germination in nursery

Treatments	Average % seed germination	Average post emergence damping- off (%)	Average root length (in cm)	Average stem length (in cm)
T1 (5 g/kg seed)	49.00	0.5	2.8	13.6
T2 (10 g/kg seed)	52.75	0.0	2.9	13.5
T3 (Control)	49.00	2.5	2.7	13.3

Project 6.5 : Bio-prospecting of microorganisms associated with vegetables against plant pathogens

Isolation of new bio-agent from rhizospheric soil: Rhizobacteria were isolated from the rhizospheric soil of opuntia, bamboo and *Ficus religiosa* plants. Totally 13 isolates were isolated on the nutrient agar medium and pure cultures were established. Pure cultures of 13 rhizospheric bacterial isolates are being stored in -80°C as glycerol stocks and the fungal cultures were stored in PDA slants at 4°C for future study (Fig. 5).

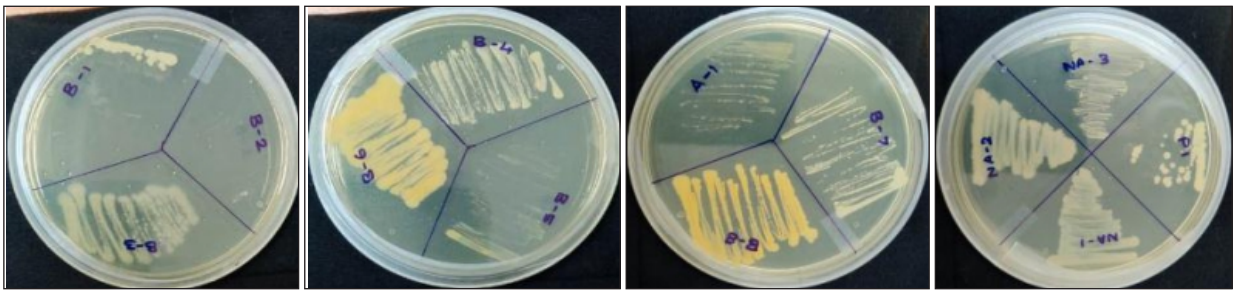

Fig. 5 : Pure cultures of rhizospheric bacterial isolates

***In-vitro* evaluation of bacterial newly isolated microbes and available *Trichoderma* sp. against vegetable pathogens:** Among 116 rhizobacerial isolates, 11 isolates were found antagonistic to *Sclerotium rolfsii* and maximum percent mycelial inhibition was 56.67% ± 0.72% for AA17 isolate. A total of 12 isolates were found to be antoagonistic against *Macrophomina phaseolina* and the maximum percent mycelial inhibition was 62.92% ± 0.72% for AD29 and BE11isolates (Fig.7).

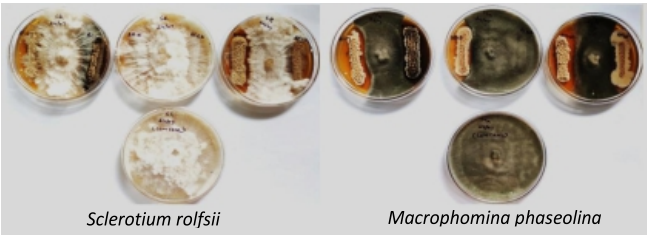

Fig. 7 : Bio control assay of bacterial cultures against *S. rolfsii* and *M. phaseolina*

IIVR *Trichoderma* isolates viz. BATF-43-1, T.asp1, T.asp2, TCV-2 and TTV-1 were also tested against *S. rolfsii* and *M. phaseolina* (Fig. 8). Isolate T.asp2 performed better as compared to other isolates with percent mycelial inhibition of 84.29% ± 1.43% for *S rolfsii* and 80.91% ± 0.91% for *M. phaseolina*. Higher mycelial inhibition in the range of 70% to 80% was observed with all the *Trichoderma* isolates as compared to rhizobacerial isolates.

Field trail on bottle gourd with *Bacillus subtilis* strain CRB-7 : Field trial of biocontrol and plant growth promoting rhizobacteria *Bacillus subtilis* strain CRB-7 was conducted on bottle gourd cv Kashi Ganga in summer season (Table 13)

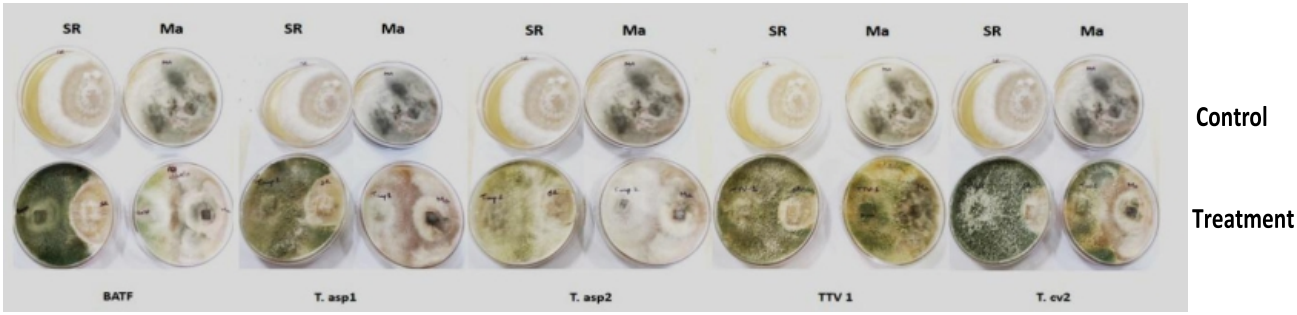

Fig. 8 : Bio control assay of *Trichoderma* sp. against *S. rolfsii* (SR) and *M. phaseolina* (Ma)

Table 13 : Effect of *Bacillus subtilis* CRB-7 on growth and yield of bottle gourd

Treatments	Fruit yield (tons/ha)	Plant height (cm) 30/04/2019	No. of leaves per plant 30/04/2019	Plant height (cm) 15/05/2019	No. of leaves per plant 15/05/2019	Male to female flower ratio
T1- Root dipping@1% PGPR solution and 3 soil drenching @ 1%	5.31	16.09	9.80	40.39	20.43	1.97
T2 - Root dipping@1% PGPR solution, Basal application of enriched NADEP compost (10g/kg) and 3 soil drenching @ 1%	8.62	17.84	9.63	47.91	23.16	1.67
T3- Root dipping@1% PGPR solution, Basal application of enriched FYM (10g/kg) and 3 soil drenching @ 1%	6.38	19.38	9.80	63.13	28.34	1.58
T4- Root dipping@1% PGPR solution, Basal application of enriched Vermicompost (10g/kg) and 3 soil drenching @1%	6.59	18.22	8.40	47.45	23.86	1.84
T5- Control	3.94	13.97	9.00	38.10	18.53	2.05
C.D.	N/A	N/A	N/A	13.56	N/A	N/A
SE(m)	1.69	1.65	0.77	4.35	2.58	0.24
SE(d)	5.71	2.34	1.08	6.16	3.65	0.34
C.V.	45.21	19.32	16.48	18.37	22.55	26.56

Fig. 9 : Response of different treatments under field condition

The analysis of recorded data revealed that the treatment (T3) root dipping@1% PGPR solution, basal application of enriched NADEP compost (10g/kg), 3 soil drenching @ 1% at 15 days intervals was better for growth parameters and male to female flower sex ratio whereas (T2) was best for maximum yield in comparison to control (Fig. 9).

Project 6.6 : Management of important bacterial diseases of vegetables crops

Evaluation of various modules under field condition for management of important bacterial diseases of tomato and cabbage: Under field condition modules comprises (T-1 biological module- I spray of *B. subtilis* (BS2) talc based formulation @1%, II spray *P. fluorescens* talc based formulation @1%, III spray Actinomycetes N.1.2 talc based formulation @1%, IV spray of CRB 7 @1%; T-2 botanical module- all four spray with azadirachtin 0.03% @0.3%; T-3 chemical module- I spray of copper oxychloride @0.3%, II spray streptocycline @150 ppm, III spray copper hydroxide 53.8 DF @2 g/l, IV azoxystrobin 23 SC @0.1%; T-4 chemical & biological- I spray of copper oxychloride 2.5 g/l, II BE-IIVR strain (Bacterial endophyte-IIVR strain) talc based formulation @1%, III spray Actinomycetes N.1.2 talc based formulation @1%, IV spray streptocycline @150 ppm, T-5 chemical & botanical- I spray of copper oxychloride @0.3%, II spray with azadirachtin 0.03% @3 ml/l, III spray copper hydroxide @2g/l; IV spray streptocycline @150 ppm; T-6 integrated disease management (IDM) module- I spray of copper oxychloride 0.3%; II BE–IIVR strain @1%, III spray of *P. fluorescens* talc based formulation @ 1%, IV spray streptocycline @100 ppm mix with azadirachtin 0.03% @3 ml/l; T-6 untreated control were evaluated in tomato (cv. Kashi Aman) and cabbage (cv Cab- III) against bacterial diseases as four subsequent foliar spraying at 20 days interval after 20 days of transplanting; all four scheduled spray in tomato while one scheduled spray in cabbage have completed and data recording under progress.

Evaluation of *Bacillus subtilis* IIVR strain BS2 against nursery diseases in chilli, brinjal and tomato: In case of chilli var. Kashi Anmol treatment with bio-agent *Bacillus subtilis* (IIVR) strain BS-2 as seed treatment @4g/kg seed, soil application as 10g/m^2 and soil drenching @5% gave germination percentage (75%), and lowest incidence of damping off (1.2%) In use of bio-agent *Bacillus subtilis* (IIVR) strain BS-2 as seed treatment @ 4g/kg seed, soil application as 10g/m^2 and soil drenching @5%, found effective in brinjal cv Kashi Taru (germination 80% and damping off 10%) and tomato cv Kashi Aman (germination percentage 73% and damping off 27%.

Project 6.7 : Characterization of viruses infecting vegetable crops and their management

Detection of ToLCNDV in sponge gourd seeds collected from infected plants: With seeds collected from infected sponge plant, grow-out study was conducted with 150 seeds sown under insect-proof net for testing the plant samples through Dot-IBA assay. Out of 150 seeds sown, 138 seeds were germinated and produced good plant growth. Among them 18 plants (13%) were produced typical field symptoms of mosaic under screen house conditions too and were tested positive for the presence of virus in Dot-IBA assay. Further 120 non-symptomatic plants also tested using Dot-IBA showed specific positive reaction in 37 plants (31%) for the presence of virus. These results confirmed the transmission of virus through seed material to an extent of 44% to the seedlings. Detection of virus in the symptom free plants shows the latency of virus presence.

Characterization of polerovirus infecting cucurbits : A total 563 samples were collected across 14 different cucurbitaceous vegetable crops in all the 9 agro climatic zones comprising districts i.e., Bareilly, Allahabad, Gonda, Basti, Mirzapur, Varanasi, Sultanpur, Pratapgarh, Sitapur, Agra, Mathura, Chitrakoot, Phillibheet, Meerut and Ghaziabad of the state. Among them 52 samples subjected to the reverse transcription polymerase chain reaction (RT-PCR) assay using universal polerovirus primer pair yielded an amplicon of approximately 600 bp in infected samples (Fig 10).

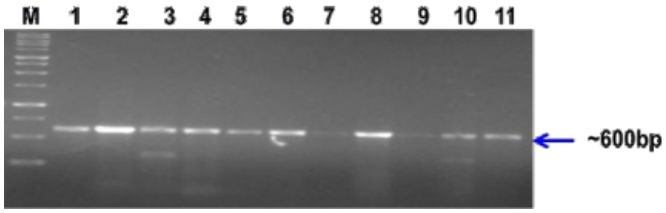

Fig 10. RT-PCR amplification of *Polerovirus* genome using PolGenUp2 / PolGenDown2 primer

Poleroviruses infected plants (bitter gourd, pumpkin, bottle gourd, sponge gourd, squash and ivy gourd) shows stunted growth with yellowing, thickening and green vein banding of younger leaves while older leaves exhibit chlorosis (Fig 11).

Fig. 11: Symptoms of *Polerovirus* infection on different cucurbits

Sequence analysis of universal primer amplified region of ~600bp in the RT-PCR assay revealed the association of cucurbit aphid-borne yellows virus (CABYV), luffa aphid-borne yellows virus (LABYV) and melon aphid-borne yellows virus (MABYV) with the cucurbits samples (Fig 12).

Complete genome of the CABYV infecting squash and watermelon has been characterized using newly designed 6 set of overlapping primers (Fig 13).

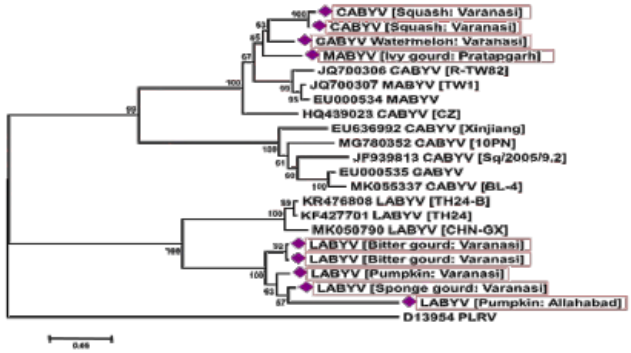

Fig. 12: Phylogeograph of poleroviruses infecting cucurbits in UP with reference strains

Amplified region has been cloned and sequenced. Sequence has been aligned using CLUSTALW and complete genome of squash and watermelon has been deduced and submitted to GenBank database (MN688219-20). Genome of squash (5650 bp) and watermelon (5647 bp) isolate sharing 94.7% identity among themselves and 87.8% with CABYV isolate of China infecting zucchini (HQ439023). This is the first complete genome of the CABYV infecting cucurbits in India

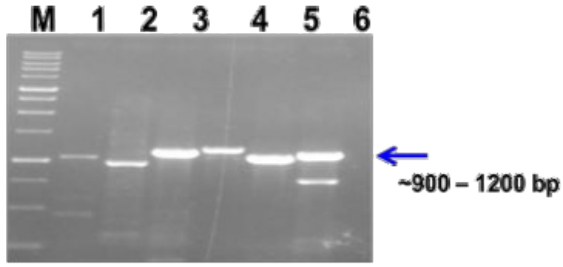

Fig. 13: RT-PCR amplification of complete Polerovirus genome infecting watermelon

IDM for the management of viral diseases in tomato: In tomato (cv. Kashi Amrit) for the management of viral diseases, different modules comprising of chemical module 1 (Seed treatment with imidacloprid @1ml/l, Rotational spray with imidacloprid (0.3ml/l), thiomethoxam 25%WG (0.35g/l), dimethoate30 EC (1ml/l) and lambda cyhalothrin 9.5%ZC+ thiomethoxam 12.6% (0.25ml/l) at 10 days interval), chemical module 2 (Seed treatment with thiomethoxam, Rotational spray with dimethoate 30 EC(1ml/l)), cyantraniliprole (1.8ml/l), spiromesifen (1.25ml/l) and thiomethoxam 17.5% w/w SC+ chlorantraniliprole 8.8% w/w(0.3ml/l) at 10 days interval), Non chemical module (Seed treatment with CRB-7, seedling root dip in talc based CRB-7 @ 1% for 30 minutes after 21 days after sowing; soil drenching with humic acid @5ml/l at 25 DAT; followed by rotational foliar spray with *Lecanicillium lecanii*, *Beauveria bassiana* and *Metarhizium anisopliae* @ 5g/l at 10 days interval; neem oil spray @0.3% twice at 20 days interval) and Integrated module (Seed treatment with thiomethoxam, seedling root dip in talc based CRB-7 @1% for 30 minutes after 21 days after sowing; black silver mulching; border cropping with bajra; soil drenching with humic acid @5ml/l at 25 DAT; installation of yellow sticky traps; foliar sprays of micronutrient @0.3% twice at 30 days interval; rotational foliar spray of *Beauveria bassiana* (5g/l), cyantraniliprole (1.8ml/l), spiromesifen (1.25ml/l), salicylic acid (2mM), thiomethoxam (0.35g/l), neem oil

(0.3%), thiomethoxam+ lambdacyhalothrin (0.25ml/l) and chlorantraniliprole+ thiomethoxam (0.3ml/l) at 10 days interval) is under evaluation. Initial 3 sprays were being made and the trial is under progress.

Project 6.9 : Pest and disease dynamics, and behavior modifying strategies for major insect pests of important vegetable crops in relation to changing weather system

Relative abundance of major insect pests on different cucurbitaceous vegetables: Out of ten cucurbits species, musk melon (1.3), cucumber (1.2), long melon (0.9) and bottle gourd (0.9 beetles/plant) hoasted more population of Red Pumpkin Beetle, *Aulacophora foveicollis* (Lucas) during the cropping season. Sponge gourd and long melon supported a greater number of leaf eating caterpillar, *Diaphania indica* (Saunders) (2.0 larvae/plant) and serpentine leaf miner, *Liriomyza trifolii* (Burgess) (14.7 live mines/plant). Cucumber was found susceptible to the sucking insects such as thrips (25.4/leaf/plant) and whiteflies (55.0/leaf/plant), while long melon (153.2/leaf/plant) and bottle gourd (140.4/leaf/plant) susceptible to red mites. Maximum fruit fly damage was recorded in long melon (84.98%). Spiders and predatory beetles such as coccinellids and rove beetles were maximum on long melon (3.2/plant) and sponge gourd (3.6/plant), respectively (Table 14).

Incidence of *Spodoptera litura* during the cropping period of tomato, cabbage and cauliflower: Population dynamics of *S. litura* infesting tomato, cabbage and cauliflower was studied by installing the sex pheromone traps. The incidence of *S. litura* was recorded during the crop growth period and throughout the year from January 2019 to December 2019 at IIVR farm, Varanasi, Uttar Pradesh, India. A considerable fluctuation in the pest incidence and moth catches in the trap was observed during the cropping period of all the three vegetable crops. In tomato crop, the first peak of moth catches (24.7 moths/trap) was recorded during 14th SMW (1st week of April, 2019) and no moth activity was observed from 15th to 31st SMW. Trap catches was highest

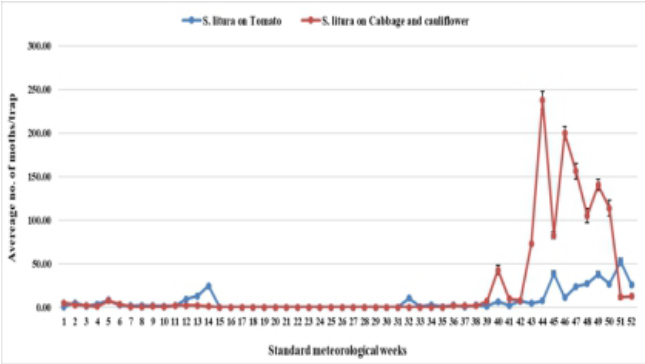

Fig. 14: Population dynamics of *Spodoptera litura* during the cropping period of tomato, cabbage and cauliflower

Table 14 : Population of major insect pests on different cucurbits

Host plant	Variety	Average number of insects per plant*								
		Red Pumpkin beetle	Leaf caterpillar	Thrips**	Whiteflies**	Serpentine leaf miner	Mites**	Fruit flies damage (%)	Spiders	Predatory beetles
Ash gourd	Kashi Dhawal	0.22	0.71	16.74	19.63	5.96	57.76	0.00	2.15	2.00
Bottle gourd	Kashi Ganga	0.93	1.00	2.93	10.56	3.96	140.38	0.00	2.33	1.17
Musk melon	Kashi Madhu	1.30	1.38	10.78	16.52	9.63	42.62	16.67	2.41	1.61
Pumpkin	Kashi Harith	0.30	0.10	4.33	29.33	7.59	121.86	36.67	2.52	0.94
Sponge gourd	Kashi Shreya	0.15	2.00	7.41	20.93	9.44	33.00	20.00	2.74	3.61
Water melon	VRW-3	0.19	0.62	11.19	9.37	8.15	38.76	0.00	1.19	0.63
Cucumber	Kashi Nutan	1.22	1.33	25.41	55.04	9.33	63.95	0.00	2.89	3.39
Long melon	VRLM-2-2	0.96	0.90	15.67	17.78	14.67	153.24	84.98	3.19	2.33
Bitter gourd	Kashi Mayuri	0.07	0.05	1.04	16.52	0.04	0.23	0.00	1.67	0.28
Round melon	VRM-12	0.15	0.48	5.37	3.07	5.19	114.00	2.33	1.52	0.11
	SEm±	0.08	0.12	0.24	0.22	0.21	0.31	0.05	0.12	0.17

*Overall mean of weekly observations; **Average of three leaves/plant

during 51st SMW (52.7 moths/trap, 3rd week of December, 2019) (Fig. 14). In cabbage and cauliflower, little and/or no moth activity was observed from 15th to 35th SMW. Trap catches was high from 40th SMW (1st week of October, 2019) onwards with the highest peak during 44th SMW (237.5 moths/trap, 5th week of October, 2019) and 46th SMW (200 moths/trap, 2nd week of November, 2019), respectively.

Population dynamics of *Leucinodes orbonalis* during the cropping period of brinjal: The dynamics of brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* in brinjal was recorded by installing sex pheromone traps. Large fluctuation in the incidence of BSFB in brinjal was observed with the 1st highest peak during 14th SMW (18.8 moths/trap, 1st week of April, 2019) and no moth activity was observed from 15th to 31st SMW. While, the 2nd and 3rd peaks of maximum moth catches were recorded during 40th (10.8 moths/trap, 1st week of October, 2019) and 52nd SMW (13.7 moths/trap, 4th week of December, 2019), respectively (Fig. 15).

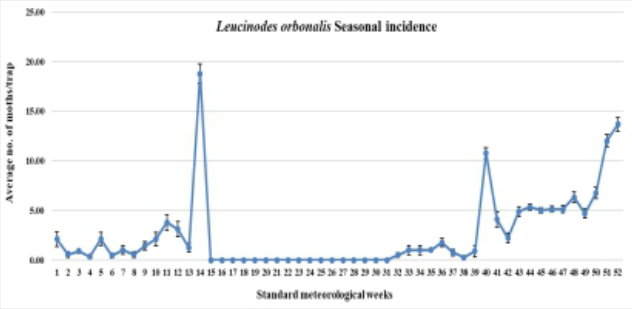

Fig. 15: Population dynamics of *Leucinodes orbonalis* during the cropping period of brinjal

Project 6.10 : Mapping and characterization of Phytoplasma infecting vegetable crops and its management

Spinach plants (var. All Green) expressing symptoms of flat stem, indicative of phytoplasma infection were observed at seed production block of research farm (Fig 16). The disease incidence ranged from 10-20%. A total of 5 symptomatic samples along with a healthy sample were collected from the field and total DNA was extracted from the stem tissue of infected and healthy plants. Amplification of ribosomal DNA was done with universal primer pairs P1/P7 followed by nested primer pair 3Fwd/ 3Rev and secA gene primer pairs, SecAfor1/SecArev3 and SecAfor2/SecArev3 in semi-nested PCR assay. Amplicon of ~1.3kb corresponding to 16S rDNA region and ~480bp were yielded only in symptomatic samples, whereas no amplification was seen in any of the healthy samples. The positive nested PCR amplified product of 16Sr DNA and secA genes from two samples were purified and sequenced. Sequences were aligned using ClustalW and consensus sequence has been deduced and deposited in the NCBI database (MN414278-79). Pairwise analysis of 16S rDNA and secA gene indicated highest identity of 99.46% with *Mallotus japonicus* phytoplasma strain from South Korea (Accession No KC558500) and 99.8% with Sesame phyllody phytoplasma from Thailand (KT335272), respectively belonging to the 16SrI group phytoplasmas (Fig 17).

Fig. 16: Flattening of spinach stem

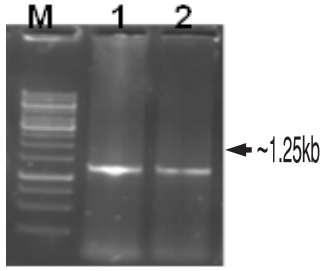

Fig. 17: Nested PCR amplification of 16S rRNA

Evaluation of entomopathogenic fungus and growth regulator on the little leaf disease of brinjal: In brinjal (cv. Kashi Taru) for the management of little leaf disease, different treatments comprising of spray of market based liquid formulation of *L. lechanii* @5ml/l at 10 days, market based liquid formulation of *M. anisopliae* @5ml/l, talcum based formulation of IIVR *B. bassiana* strain @5g/l [individually and also in combination with imidacloprid (1:1)], salicylic acid @2mM, spray of gibberellic acid @10ppm and indole acetic acid @10 ppm at 10 days interval are under investigation. Three sprays were completed on the crop and trial is under observation.

Project 6.11 : Bio-management of post-harvest diseases in major vegetable crops

Isolation of microorganisms: Soil samples were collected from sick plot of research farm. Serial dilution

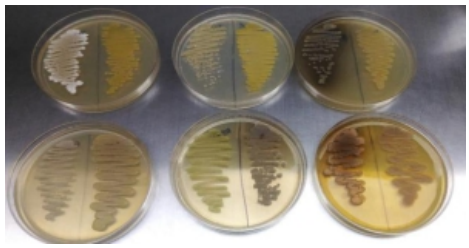

Fig. 18: Colony morphology of different isolates on NA medium

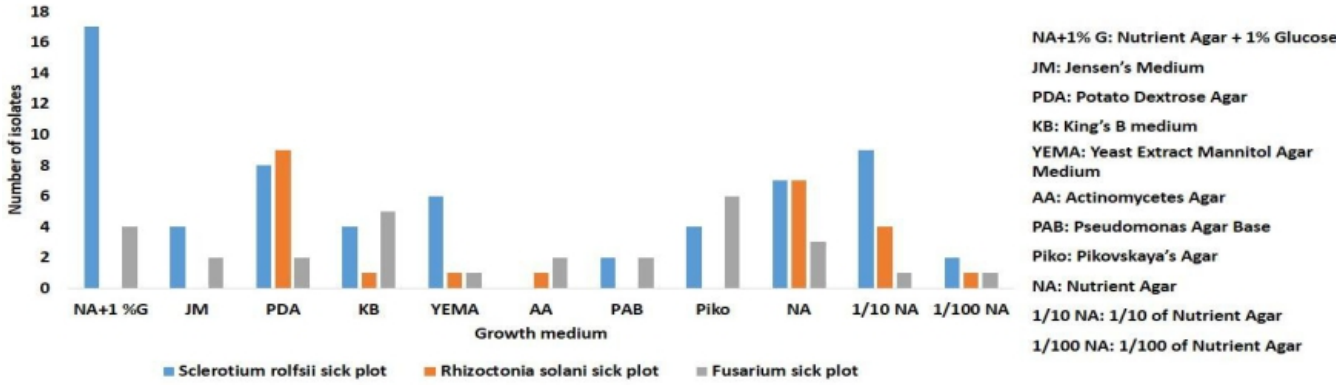

Fig. 19 : Relative distribution of microbial isolates obtained on eleven different growth media

with spread plate technique was used to obtain pure culture of isolated bacteria on eleven different media. Among 11 culture media, nutrient agar and potatao dextrose agar was effective for supporting maximum bacteria colony from three different types of sick soil therefore nutrient agar was selected and 116 isolates with diverse colony characteristics were purified on nutrient agar plate (Fig. 18 and Fig. 19).

Isolation of postharvest pathogen from beans, tomato and brinjal: White rot of bean caused by *Sclerotinia sclerotiorum* was isolated for antagonism test. Bacterial pathogen was isolated from rotten tomato and brinjal fruit. Two bacterial strains BB1 and TB1 were obtained from brinjal and tomato fruit, respectively. The isolated BB-1 bacterial pathogen from brinjal fruit could cause disease in tomato as well. Pure culture of the isolated TB-1 and BB-1 bacterial pathogen can be seen in figure 20(a). Diseased brinjal of market collected to isolate postharvest pathogen. Pure culture of the isolated fungal pathogens was obtained by periodic re-inoculation and was named as BF-1 (Fungal pathogen obtained from brinjal). Pathogenicity test of the isolated pathogens were carried out in healthy fruits and symptoms were confirmed as shown in figure 20(b).

Fig. 20 : (a) Pure cultures of isolated pathogen from diseased tomato on NA slant (b) Pathogenicity test of isolated fungal BF-1 from brinjal

Isolated bacterial cultures were tested against TB-1 pathogen obtained from tomato. Bacterial lawn of TB1 pathogen was made by spread plating 100µl of broth on NA plate. Wells of uniform size were carefully cut and 200µl of bacterial broth was added into the well. Twenty-one isolates were found to be antagonistic against pathogen TB1. Zone of inhibition ranged from 1.47cm in AA1 to 3.03cm in CI28 (Fig. 21).

Biocontrol assay for analyzing antagonistic activity of isolated bacterial cultures against fungal and bacterial disease: All the isolated 116 cultures were tested against *S. sclerotiorum* obtained from beans by *in vitro* dual

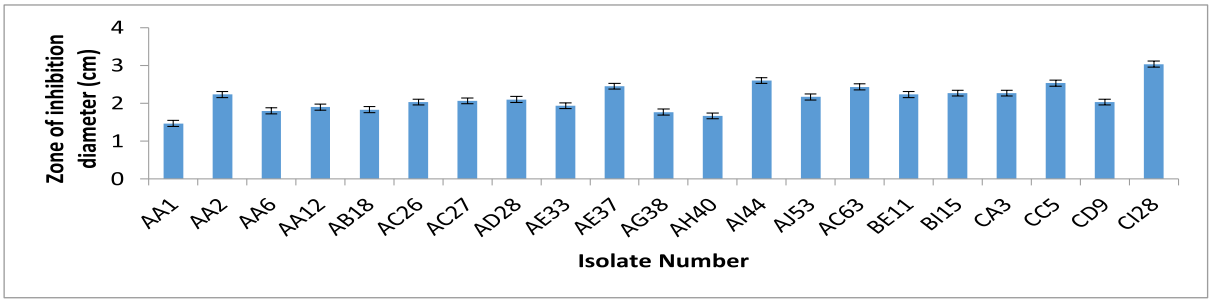

Fig. 21 : Antagonistic activity of isolated bacterial culture against pathogen TB1

culture technique. Only 18 isolated cultures were found to be antagonistic to the pathogen in which 10 isolates were inhibited >80% mycelial growth of the pathogen as shown in table 15. Isolate AB18 and AH 40 were highly efficient as they could inhibit mycelial growth by 87.92%. Percent mycelial inhibition was calculated based on the following formula:

$$\text{Percent mycelial inhibition} = \frac{\text{Colony diameter in control plates} - \text{Colony diameter in test plates}}{\text{Colony diameter in control plates}} \times 100$$

Table 15 : Percent mycelial inhibition of *S. sclerotiorum* by the bacterial isolates

Sl. No.	Isolate No.	Percent mycelial inhibition
1	AA16	85.42 ± 0.72
2	AA17	87.50 ± 1.25
3	AB18	87.92 ± 0.72
4	AC26	87.08 ± 0.72
5	AC27	87.08 ± 0.72
6	AD28	84.17 ± 0.72
7	AD29	80.83 ± 0.72
8	AH39	87.08 ± 0.72
9	AH40	87.92 ± 0.72
10	BC7	37.92 ± 0.72
11	BC8	69.58 ± 1.44
12	BJ21	12.08 ± 0.72
13	BJ23	36.67 ± 1.44
14	CA3	50.00 ± 1.25
15	CA4	36.67 ± 0.72
16	CC6	87.92 ± 0.72
17	CG18	19.17 ± 0.72
18	CK26	38.33 ± 1.44
	SE(m)	3.66
	CV	1.47
	CD (5%)	1.57

Project 6.12 : Residue dynamics, safety evaluation and decontamination of chlorantraniliprole, deltamethrin, azoxystrobin and kresoxim-methyl in tomato, brinjal and chilli

A method for the estimation of kresoxim-methyl by GC-µECD, ^{63}Ni: For estimation of KM, standard solution was prepared by dissolving 10 mg of KM in 10 mL of solvent. The intermediate standard of 1 µg/mL was prepared by appropriate dilutions. The calibration standards, ranging within 0.1-0.5 µg/mL, were prepared by means of serial dilution with ethyl acetate. An Agilent gas chromatography model 7890B equipped with an autosampler and microelectron capture detector (µECD, ^{63}Ni) were used for the detection of KM. A standard syringe split/splitless injector was used in the split injection mode at a ratio of 10:1 at 250°C with an injection volume of 1 µL. A HP-5 capillary column (30 m length, 320 µm id, 0.25 µm film thickness with nitrogen gas flowing at 2 mL/min) was used for separation. The detector was maintained at 300 °C with makeup gas (N_2) flowing at 60 mL/min. The oven temperature was set to 100°C for 1 min, ramped to 280°C at 15 °C /min, and held for 2 min. Under these conditions, KM appeared at retention time (RT) of 11.18 min (Fig.22). An Agilent open lab EZchrom used for chromatogram acquisition.

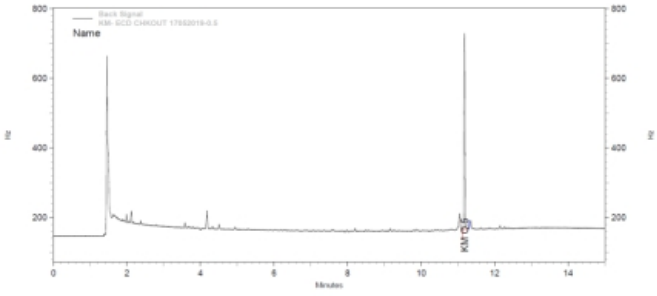

Fig. 22 Chromatogram for Kresoxim-methyl

Dissipation pattern of fungicide kresoxim-methyl in green chilli: Kresoxim-methyl is a fungicide used to control powdery mildew, fruit rot, die-back and twig blight in chilii. An Agilent gas chromatography model 7890B equipped with an autosampler and microelectron capture detector (µECD, ^{63}Ni) were used for the detection of kresoxim-methyl. A standard syringe split/splitless injector was used in the split injection mode at a ratio of 10:1 at 250°C with an injection volume of 1 µL. A HP-5 capillary column (30 m length, 320 µm id, 0.25 µm film thickness with nitrogen gas flowing at 2 mL/min) was used for separation. The detector was maintained at 300°C with makeup gas (N_2) flowing at 60 mL/min. The oven temperature was set to 100°C for 1 min, ramped to 280°C at 15°C /min, and held for 2 min. Under these conditions, kresoxim-methyl appeared at retention time (RT) of 11.18 min. Analysis of kresoxim-methyl residue and its dissipation rate in chilli were studied. Green chilli samples were analyzed at ICAR-Indian Institute of Vegetable Research, Varanasi (India). The dissipation pattern of kresoxim-methyl 44.3% SC @250 g a.i ha^{-1} for recommended dose (RD) and 500 g a.i ha^{-1} for double of the recommended dose (DD) were studied collecting samples at regular intervals i.e. 0, 1, 3, 5, 7, 10, 15 and 21 days after last spray. Residues of kresoxim-methyl were extracted from green chilli fruit matrices with ethyl acetate, and cleanup given by using primary secondary amine (PSA) and magnesium sulfate and then determined by GC with ECD-detector. The

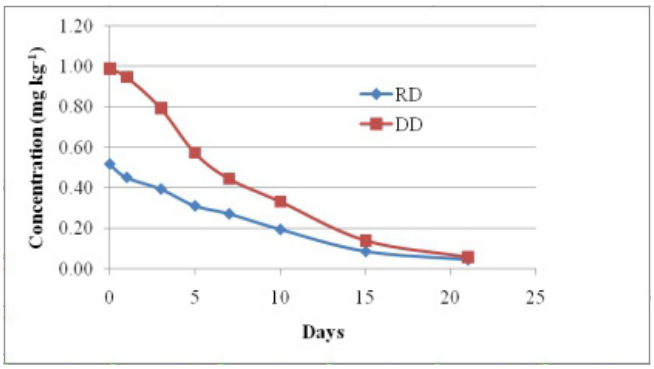

Fig. 23 : Degradation pattern of kresoxim-methyl in green chilli fruits

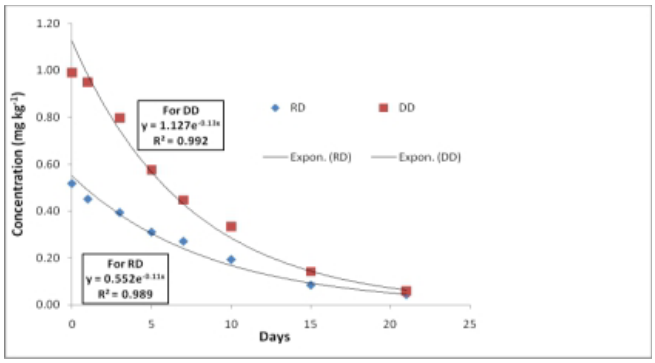

Fig. 24 : Exponential graph for recommended dosage and double the recommended dosage

initial deposits of 0.52 and 0.99 mg kg^{-1} recorded at 2 hours after last spray for recommended dosage and double the recommended dosage, respectively (fig. 23). The present study revealed that the residues in green chilli were below the MRL (0.8 mg kg^{-1}, fixed by EU) after 3 days for treatment of double dosage and incase of recommended dosage 0 day also below MRL. The half-life value for recommended dose is 6.3 days and double of the recommended dose is 5.3 days were calculated by exponential graph (Fig. 24).

Externally Funded Projects

Project 1 : Introgression of Begomovirus Resistance Genes in Tomato (*Solanum lycopersicum* L.) through MAS and Genomic Approaches

Pyramiding of resistance genes from diversified sources to develop stable ToLCV resistant tomato cultivars and hybrids was undertaken. Pyramiding involved two backcross programs for two different recurrent parents *viz*. Kashi Vishesh and Kashi Aman. In the first program with Kashi Vishesh as recurrent parent, tomato lines VRT 8-6-1 and VRT 2-2-3 were used as donors for *Ty*-2 and *Ty*-3 genes, respectively. This year, genotyping of F_1 & F_2 plants from BC_3F_1 × BC_3F_1 and F_2 from selfed BC_3F_1 plants from both sides was done. In this, 15 plants were *Ty*-3 homozygous, 20 plants were Ty-2 homozygous and three plants were homozygous for both the genes. Many plants were heterozygous for one or more genes (Fig. 1).

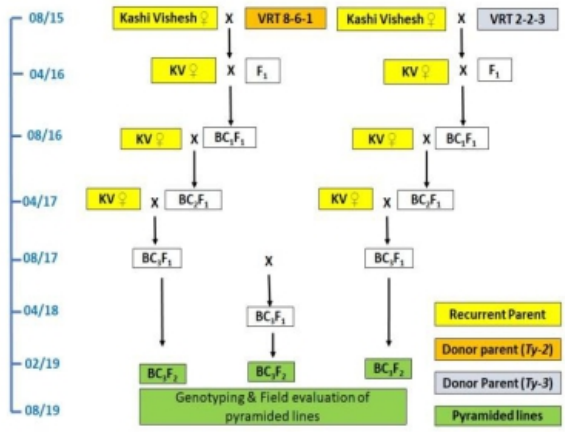

Fig. 1 : Status of backcross program being followed for pyramiding *Ty*-2 and *Ty*-3 genes in the background of 'Kashi Vishesh'. The timeline is provided as the vertical bar on the left (Month/Year).

In the second backcross program, Kashi Aman is being used as recurrent parent, tomato lines VRT 8-6-1 and FLA 456 are being used as donors for *Ty*-2 and *ty*-5/*Ty*-6 genes, respectively. This year, genotyping of F_1 & F_2 plants from BC_3F_1 × BC_3F_1 and F_2 from selfed BC_3F_1 plants from both sides was done. Two plants were homozygous for all the four genes, two plants were homozygous for *Ty*-3, *ty*-5 and *Ty*-6 genes, two plants were homozygous for *Ty*-2, *Ty*-3, and *ty*-5 genes, two plants homozygous for *Ty*-3, and *Ty*-6 genes, four plants were *Ty*-3, and *ty*-5 genes, and thirteen plants were homozygous for *Ty*-2 and *Ty*-3 genes (Fig. 2).

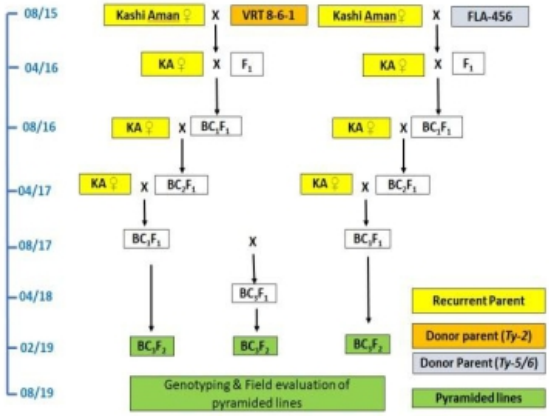

Fig. 2 : Status of backcross program being followed for pyramiding *Ty*-2 and *ty*-5/*ty*-6 genes in the background of 'Kashi Aman'. The timeline is provided as the vertical bar on the left (Month/Year).

Many plants were in different combination of genes and segregating for one or more genes. All plants are in field and evaluation for resemblance to recurrent parents, disease resistance, yield and other characters is in progress.

Development of lines and hybrids: Because *Ty*-3 carrying lines are holding up resistance, several *Ty*-3 carrying lines were developed using MAS. Promising advanced lines are being evaluated for horticultural traits. These advanced lines were developed in the diverse genetic background to generate diverse inbred lines for leaf curl resistant hybrid development. Based on the station trial performance, one hybrid VRT 16-01 × P 18-3 was sent for multi-location testing under AICRP-VC. Seedlings of the hybrid were given to farmers for demonstration purpose. The commercial checks used in station trials comprised hybrids Abhilash, NS585, Devika and TO3150. The test hybrid VRT 16-01 × P 18-3 yielded 118 tonnes/ha. The fruits of VRT 16-01 × P 18-3

hybrid show medium firmness with a pericarp thickness of 0.6-0.7 cm and recorded average fruit weight of 70-100 g. Fruits are round in shape with light green shoulder (Fig. 3).

Fig. 3 : VRT 16-01 × P 18-3

Project 2 : National Innovations in Climate Resilient Agriculture (NICRA)

Development of F_1s for high temperature stress tolerance: 127 new F_1s developed during rabi 2018–19 were transplanted in the field in Feb, 2019 along with private sector hybrids as check for evaluation of high temperature tolerance during summer 2019 (Mar–June, 2019). Out of 127 hybrids tested, 12 hybrids *viz*. VRNTH-19095, VRNTH-19072, VRNTH-19074, VRNTH-19090, VRNTH-19088, VRNTH-19085, VRNTH-19070, VRNTH-19091, VRNTH-19069, VRNTH-19067, VRNTH-19083 and VRNTH-19089 were found superior over all the checks for their yield and fruit quality traits. A total of 48 new F_1s, including 12 promising hybrids identified in summer 2019 along with private sector hybrids as check, have been transplanted in field for evaluation during summer 2020.

Fig. 4 : Tomato trial field during summer 2019

Development of F_1s tolerant to moisture deficit condition: Five earlier identified moisture deficit tolerant F_1s *viz*., VRNTH-18-1, VRNTH-18-2, VRNTH-18-3, VRNTH-18-4 and VRNTH-18-5 along with four popular private sector hybrids as a check were transplanted in field under moisture deficit condition as well as a control (without stress). Analysis of data revealed that there was no significant difference for yield attributes in selected as well as private sector hybrids under both the conditions (control and moisture deficit) because of 50.8 mm rainfall from flowering to harvesting stage of crop.

Validation and evaluation of brinjal rootstocks for waterlogging tolerance: Nine graft combinations consisting of 3 rootstocks (IC-354557, IC-111056 and Surya) on 3 scions (Kashi Aman, Kashi Adarsh and Kashi Chayan) along with non-grafted controls were exposed to waterlogging condition for 96h at vegetative stage in field under natural rainfall condition in the month of Sep-Oct, 2019. IC-354557 and IC-11056 exhibited better survival with all the three tomato scions but more than 75% non-grafted plants could not survive the water logging exposure. The yield improvement was observed in all the grafts over non-grafted and the rootstock IC-354557 emerged as highest yielder except with Kashi Chayan. Three scion cultivars of tomato, as mentioned above, were grafted on five eggplant rootstocks *viz*. IC-111056, IC-354557, Surya, *Solanum macrocarpon*, *Solanum laciniatum* and *Solanum aeithiopicum,* transplanted in pots and were exposed to waterlogging stress during Oct, 2019 in water tank at reproductive stage (96 and 120 h) along with non-grafted scion cultivars. Highest reduction in all the physiological and biochemical activities was observed in non-grafted exposed plants.

Fig. 5 : Grafted and ungrafted tomato plant exposed to water logging stress

SNP genotyping for identification of QTLs linked to high temperature stress tolerance: DNA samples of 265 genotypes in F_2 generation were sequenced for library preparation. The genomic DNA of each sample was digested respectively with proper restriction enzymes for in silico analysis. Quality control of raw sequencing data for clean data filtration, mapping clean reads to reference genome, and SNP and InDel detection was finally carried out. Average phred quality score was good as per the sequencing results with 34% GC content.

Development of mapping population: F_2 population was raised in field to get $F_{2:3}$. Selfed seeds of 265 individual F_2 plants were harvested separately to get 265 $F_{2:3}$ progenies. Genomic DNA was isolated from 265 F_2 individuals and GBS started. $F_{2:3}$ populations (265 progeny rows) were raised in field for phenotyping under high temperature. Separate analysis of variance (ANOVA) was carried out for each character assuming an augmented design. Based on the analyzed data and adjusted mean values for each trait, 20 top performing genotypes were categorized. Highest fruit set was observed in genotype HTMP-034 which also had better

trait values for pollen viability, CCI, total chlorophyll and carotenoid. This explains that these characters have a positive correlation with fruit set percentage which is also supported by the correlation analysis. ANOVA for all the traits revealed that genotypic differences were significant for many traits.

Dissemination of evolved grafting technology to the farmers' field: About 1000 grafted tomato plants were distributed to farmer (Fig. 6) and awareness program on grafting technology for vegetable production was organized. Observation was also recorded on performance of grafted plants at farmer's field and it was observed that tomato scion grafted on brinjal root stocks (IC-111056 and IC-354557) performed better compared to non-grafted tomato.

Fig. 6 : Distribution and performance of grafted plants at farmer's field

Project 3 : CRP on hybrid technology project

Testing Hybrid tolerant to tomato leaf curl virus: 90 F_1s were transplanted in field. Data recording and crop management are in progress. There are three hybrids for multilocation testing while three hybrids tolerant to moisture deficit are also being tested. This year, 42 new crosses have been developed.

Project 4 : Network Project on Transgenic Crops (NPTC)

Fruit and shoot borer resistant transgenic brinjal– *Cry1Aa3* gene: Homozygous T7 generation plants of three *cry1Aa3* transgenic brinjal (cv. Kashi Taru) events (A2, A3, and A7) developed earlier were grown in a glass house.

Fruit and shoot borer resistant transgenic brinjal – *Cry1Ac* gene: Generation advancement of *Bt*-brinjal lines (*viz*. Pant Rituraj, Uttara, Punjab Barsati, VR-14, IVBL-9, VR-5, EV-1 and EV-4) with high protein expression and similar to recurrent parent were selected and further selfing was repeated in this season again. Plants were again raised for seed multiplication. *Bt*-brinjal seeds were sown in pots in containment proof insect house. After 20 days of germination, six successive kanamycin sprays (200 mg/l) were applied to find any escape of transgenic or low expression on the transgene. All the seedlings survived after kanamycin sprays showing optimum expression of the transgene. Further, the positive plants of each line were transplanted in net house.

Fruit borer resistant transgenic tomato – *Cry1Ac* gene: Eight events of transgenic tomato plants *cv*. Kashi Vishesh carrying *Cry1Ac* gene were advanced to T11generation. Seeds of the best events IVTT-5 and all other events were germinated in a glass house. After 30 days of germination, six successive sprays of kanamycin (200 mg/l) were applied to find any escape of transgenic or low expression of the transgene. All the seedlings survived after kanamycin spray showing optimum expression of the transgene. Ten seedlings of each event were transplanted in insect-proof net house.

Drought, Salt and Cold stress tolerant transgenic tomato- *AtDREB1A:* Transgenic tomato lines D41, D53, D76 and D86 expressing *AtDREB1A* gene were advanced to T9 generation. The seeds of all events were germinated in a glass house. After 30 days of germination, screening was done with kanamycin sprays (200 mg/l) to find any escape of transgenic or low expression on the transgene. All the seedlings survived after kanamycin spray showing optimum expression of the transgene. Eight seedlings of each event were transplanted in insect-proof net house.

Drought, Salt and Heat stress tolerant transgenic tomato- *BcZAT12:* Drought, salt and high temperature stress tolerant transgenic tomato lines ZT1, ZT5 and ZT6 expressing *BcZAT12* gene were advanced to T9 generation. The seeds of all events were germinated in a glass house. After 30 days of germination, screening with kanamycin sprays (200 mg/l) was done to find any escape of transgenic or low expression on the transgene. All the seedlings survived after kanamycin spray showing optimum expression of the transgene. Eight seedlings of each event were transplanted in insect-proof net house.

Pyramiding of *AtDREB1A and BcZAT12* transgenes for abiotic stresses: Pyramiding of *AtDREB1A* and *BcZAT12* transgenes were done by crossing both the transgenic lines in a reciprocal manner. The F_4 plants expressing *AtDREB1A* and *BcZAT12* transgenes gene

were tested by PCR amplification for both *AtDREB1A* and *BcZAT12* specific primers and scored according to banding patterns. Progenies having both the transgenes were further used for morphological and physiological characterization for generation advancements.

Project 5 : CRP on Agrobiodiversity

During 2019, 506 okra accessions were screened for YVMV and ELCV diseases and 88 accessions of *A. moschatus* ssp. *moschatus* were also evaluated for YVMV and ELCV disease resistance in rainy season. Among 506 accessions, 4 were red fruited, 6 were semi dwarf, 6 genotypes were *A. caillei* type, 3 genotypes showed moderately resistance to YVMV and four exhibited moderately resistance to both YVMV and ELCV diseases. Among the 88 *A. moschatus* ssp. *Moschatus* evaluated, all the accessions showed considerable variation for growth habit, leaf morphology and fruit morphology. All the accessions exhibited high degree of resistance to both the viral diseases, except IC141068 & EC361129 as they showed YVMV symptom. The summary of the evaluation report of 506 okra accession in kharif-2019 are presented in the Table 1.

Project 6 : Central Sector Scheme for Protection of Plant Varieties and Farmers' Rights Authority (DUS Testing of tomato, brinjal, okra, cauliflower, cabbage, vegetable pea, French bean, bottle gourd, bitter gourd, pumpkin and cucumber)

Name of the crops/species earmarked for the center: Tomato, Brinjal, Okra, Vegetable pea, French bean, Pumpkin, Bottle gourd, Bitter gourd, Cucumber and Pointed gourd. During the year, 7 cucumber, 12 bitter gourd, 18 bottle gourd, 3 pumpkin, 15 okra, 1 brinjal, and 20 tomato entries were evaluated and monitored under DUS testing. The crop wise details are given in Table 2.

Project 7 : Agri-Business Incubator (ABI)

To facilitate technology commercialization, development of agri-entrepreneurships and to provide human resource development support for empowering entrepreneurs through training for industry-oriented vocations, an ABI unit has been established by the Council under NAIF at ICAR-IIVR, Varanasi.

Fig. 7 : Trainees being shown seed production under protected condion

Table 1 : Evaluation of 506 okra accession in kharif-2019

Red fruited	Semi dwarf	*A. Callei* type	Moderately resistant to YVMD	Moderately resistant to both YVMD & OELCD
IC624180 IC620569 IC506028 IC506147	IC621454 IC284824 EC305630 EC305631 EC305632 IC598240	IC506029 IC506032 IC506037 IC510719 EC901833 EC306706	IC360655 IC284824 IC611595	IC620570 IC620571 IC611698 JBS/17-87-A

Table 2: Crop wise detail of candidate varieties for DUS testing (2019-20)

Crop / Type of variety	New		VCK	FV	Total	Remarks/ Date of monitoring
	1st year	2nd year				
Cucumber	-	-	5	2	7	29.05.2019
Bitter gourd	-	12	-	-	12	29.05.2019
Bottle gourd	-	6		3	9	20.06.2019
Bottle gourd	-	-	-	9	9	19.08.2019
Pumpkin	-	-	-	3	3	20.06.2019
Okra	11	1	-	3	15	14.10.2019
Brinjal	-	-	-	1	1	-
Tomato	14	6	-	-	20	-
Total	25	25	5	21	76	

Fig. 8 : Awareness programme on Vegetable Seed Production and Marketing organized on 13 March, 2019 for Diploma students of Seed Technology

The ABI unit organized awareness program on "Vegetable Seed Production and Marketing" for 19 diploma students of seed technology from BHU, Varanasi on 13th March 2019 (Fig. 7 & 8). The students were apprised of various seed production, processing and marketing techniques and were given practical training on different aspects related to vegetable seeds. They were also made conversant about the importance and marketing of vegetable seeds.

An Entrepreneurship development program on Vegetable Seed Production and Hybrid Seed Production was organized for 24 M.Sc. and Ph.D. students of seed technology from CSAUA&T, Kanpur on 19th March, 2019 (Fig. 9). The students were told about the techniques of vegetable seed production, processing and testing techniques and were given practical training on different aspects related to hybrid seed production techniques of vegetable crops. They were also made conversant about the importance of hybrid vegetable seeds to enhance productivity as well as production of vegetables in the country. With the shrinking of per unit land area and for enhancing the production of vegetables, the hybrids are becoming imperative.

The ABI unit also organized a 21 days Entrepreneurship Development Programme entitled "*Sabziyon Dwara Udyamita Vikas*" for young vegetable growers of east Champaran district of Bihar from 14th November to 4th December, 2019 (Fig. 10). The programme was attended by 18 growers. The participants were trained on different technologies, which can be taken-up by them as future entrepreneurs. During the training program, there were lectures on improved vegetable varieties, their cultivation under field and protected conditions,

Fig. 9 : Entrepreneurship development programme on Vegetable Seed Production and Hybrid Seed Production on 19 March, 2019

Fig. 10 : 21 days EDP entitled '*Sabziyon Dwara Udyamita Vikas*' from 14 November - 04 December 2019

marketing avenues and strategies, development of hybrid seeds in vegetable crops, seeds processing and storage, IPR issues in context of Indian agriculture and facilities at ICAR-IIVR, Varanasi for agri-business incubation.

Another 21 days Entrepreneurship Development Programme entitled "*Sabzi Evam Sambandhit Kshetron Mein Udyamita Vikas*" for young vegetable growers of east Champaran district of Bihar was organized from 10th December to 30th December, 2019 (Fig. 11) at the institute, which was attended by about 16 growers.

Fig. 11 : 21 days EDP entitled '*Sabzi Evam Sambandhit Kshetron Mein Udyamita Vikas*' from 10 - 30 December 2019

During the year 2019, eight technology commercialization license agreements were executed for commercialization of IIVR technologies as a result of the efforts undertaken in this direction by ABI unit. Overall, a revenue of Rs. 22.40 lakhs was generated through licensing and royalties during this year. Two entrepreneurs Mr. Vikas Singh and Dr. Umesh Singh got enrolled as an incubate of the ABI unit, ICAR-IIVR, Varanasi during 2019.

Project 8 : Zonal Technology Management Unit (ZTMU)

To help ITMUs of the zone in commercialization of technologies, showcasing of technologies, management of IP portfolio, helping in IPR related issues and to serve as a link between IPTM unit of the Council and ITMUs of the zone, a Zonal Technology Management Unit has been established by the Council under NAIF at ICAR-IIVR, Varanasi. The unit has eleven different ICAR Institutes under its umbrella *viz*. ICAR-Central Institute of Arid Horticulture, Bikaner; ICAR-Central Institute of Sub-Tropical Horticulture, Lucknow; ICAR-Central Institute of Temperate Horticulture, Srinagar; ICAR- Central Potato Research Institute, Shimla; ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand; ICAR-Directorate of Mushroom Research, Solan; ICAR-National Research Centre for Litchi, Muzaffarpur; ICAR-National Research Centre on Orchids, Pakyong, Sikkim; ICAR-National Research Centre on Seed Spices, Ajmer, ICAR- Central Island Agricultural Research Institute, Port Blair and ICAR-Indian Institute of Vegetable Research, Varanasi.

The reports from all the ITMUs in domain on management of IP portfolio, commercialization of technologies, outreach activities, capacity building in IP Management, training/workshop/seminar etc. organized, was compiled and sent to IPTM unit of the Council on a regular basis.

With the intent of popularizing IIVR technologies among the growers, the improved cultivars of pointed gourd developed from IIVR, Varanasi were planted on a farmer's field in Badagaon area of Varanasi. It created a lot of curiosity among the growers of the area and many growers started enquiring about the availability of its planting material from the institute. More than 4000 rooted cuttings of pointed gourd were distributed to growers from the institute. The DDG (Hort. Sci.) Dr. A.K. Singh also visited the site on 21 June, 2019. He said that eastern Uttar Pradesh in general and Varanasi, Mirzapur, Gazipur and Ballia in particular are having great potential of growing pointed gourd but due to low yield and more disease infestation in local cultivars, the area under this crop is not increasing at a faster pace. He appreciated the efforts made by ICAR-IIVR to promote improved varieties of pointed gourd as well as other vegetables in the farmers' field (Fig.12).

Fig. 12 : VRPG-141 a yield potential clone of pointed gourd [275q/ha] having light green spindle shaped fruit being inspected by DDG (Hort. Sci.), at farmers' field

The ZTMU organized a market sensitization programme for okra varieties/hybrids and promising lines on 3rd October 2019 (Fig. 13). The program was inaugurated by Dr. D.P. Ray, Former Vice Chancellor, Odisha University of Agriculture and Technology, Bhubaneshwar (OUAT) and was attended by more than 30 breeders and marketing strategists from 17 private sector seed companies like Ankur Seeds, Mahyco Seeds, Advanta Seeds, Gemini Seeds, Eagle Seeds, Shipra Vegetables, Nunhems Seeds, JK Agri-Genetics, Metahelix Life Sciences, Sakata Seeds, Ascen Hyveg, Kalash Seeds, Doctor Seed, Sayaji Seeds, Lucky Seeds, Namdhari Seeds, Swarna Hybrids and others. *Kashi Lalima*-the Red coloured *Bhindi* along with advance breeding lines tolerant to Okra Yellow Vein Mosaic Virus and Enation Leaf Curl Virus like VRO-120 and VRO-124 were the center of attraction for the delegates.

Fig. 13 : Okra Field Day organized on 3rd October, 2019 at ICAR-IIVR, Varanasi

Project 9 : Cowpea Golden Mosaic Disease (CPGMD) Resistance: Agro-infectious clone development, Screening, Genetics of inheritance, Molecular tagging and Mapping for CPGMD resistant gene(s) in cowpea by using linked markers

Mapping Population development: Mapping population for cowpea golden mosaic disease was developed by using three highly resistant genotypes BC244002, EC528398 and IC202776 and one susceptible genotype VRCP-144-5. Three cross combinations made between these genotypes were BC244002 × VRCP-144-5, EC528398 × VRCP-144-5 and IC202776 × VRCP-144-5. In *summer* 2019, the F_1s of these three cross combinations were sown to get the F_2 seed which were sown in *Kharif* 2019, to raise the mapping population F_2. To check the genetics of inheritance to cowpea golden mosaic disease F_2 population is sown along with Backcross population BC_1. During *Kharif*-2019, P_1, P_2, F_1, F_2, BC_1 and BC_2 were sown for all the three cross combinations. Spreader rows of susceptible genotype VRCP-144-5 were sown for every four rows. The F_2 plants and BC_1 plants were also grafted with cowpea golden mosaic disease infected susceptible genotypes VRCP-144-5. For developing backcross population, F_1 plants of the above three crosses were crossed with susceptible parent VRCP-144-5 to develop BC_1.

Genetics of Inheritance: The genetics of inheritance studies revealed a segregation ratio of 3:1 ratio for resistant plants to susceptible plants in the F_2 population in all the three crosses and 1:1 ratio of resistant to susceptible plants in the backcross population with susceptible genotype indicating monogenic dominant gene action for the cowpea golden mosaic disease resistance.

Project 10 : Monoecious sex expression in muskmelon (*Cucumis melo* L.): Inheritance and molecular mapping of monoecism using linked markers

A total of 500 SSR primers selected from the melon data base covering the all 12 linkage group of muskmelon. 250 SSR primers covering first six linkage group and other PCR related chemicals procured for this project. After procuring, the SSR primers and other related chemicals, DNA was isolated from andromonoecious genotype Kashi Madhu having round fruit and monoecious lines VRMM-170 with round fruit and B-159 with oblong fruit. DNA was isolated from all the three genotypes using young leaves. 250 SSR primers covering first six linkage group of *Cucumis melo* were surveyed to identify the polymorphic SSR associated for monoecious and andromonoecious sex expression. Several polymorphic SSR primers were identified for monoecious and andromonoecious sex expression and were also validated subsequently. In order to develop mapping population, andromonoecious (Kashi Madhu) and monoecious (VRMM-170 and B-159) inbreds were crossed to develop F_1s which will be self pollinated in the

second year to produce F_2 mapping population.

Project 11 : Efficient water management in horticultural crops (under Agri-CRP on Water Project)

Study on drip fertigation and crop geometry revealed that crop sequence okra- sweet pepper- baby corn registered the maximum cowpea equivalent yield (CEY) of 65.78 t/ha with the maximum land engagement (330 days/ year). Thus, this crop sequence can be recommended to get the maximum productivity, especially, where water is not a constraint. In this crop sequence, the average WUE was 4.63 q/ha/cm, FUE 45.41 kg/ha/kg, fertilizer and water savings was 37.62%. This crop sequence also used the maximum total water (102 mm). Crop sequence II, however, produced relatively less CEY (52.54 t/ha) but used less water (70.32 cm) with the maximum WUE (10.66 q/ha/cm) and FUE (83.60 kg yield/ kg NPK). Crop sequence III produced the lowest CEY of 26.87 t/ha with the minimum cropping period (215 days/year) and water savings (17.64%) (Fig. 14 & Table 3).

Fig. 14 : A view of experimental field.

Project 12 : Development of shelf stable intermediate moisture leafy vegetables using radiation processing

Leafy vegetables such as Moringa leaves and curry leaves were dried to intermediate moisture range of 16-20%. Dried leaves are packaged in polypropylene pouches and were sent to BARC for radiation treatment of 1 kGy and 2 kGy dosage. The treated leaves were evaluated for sensory, biochemical and microbiological analysis during 15 days interval at storage temperature of 10°C. Moisture content in Moringa leaves decreased during storage in IM amaranth leaves in all the treatment. The decrease in ascorbic acid in Moringa leaves was 46.8% and 52.2% during 150 days of refrigerated storage at 10°C in 1 kGy and 2 kGy, respectively. Total phenol content also decreased to 32%

Table 3 : Effect of drip fertigation and crop geometry on yield, water and fertilizer use efficiency of different vegetable crop sequences

Crop sequence	Best treatment	Yield (t/ha)	WUE (q/ha-cm)	Crop duration (days)	Water used	Water saving (%)	CEY (t/ha)	FUE (kg/ha/ kg NPK)
Okra	120% NPK + 2-Plants	16.12	4.78	70	33.7	28.75	12.09	55.98
Sweet pepper	140% NPK + 2-Plants	17.25	3.84	170	44.9	38.91	25.88	37.34
Baby corn	140% NPK + 3-Plants	12.36	5.28	90	23.4	45.20	27.81	42.91
		15.24	4.63	330	102.0	37.62	65.78	45.41
Cow pea	120% NPK + 3-Plants	11.28	5.87	65	19.2	23.20	11.28	58.73
Summer squash	140% NPK + 3-Plants	44.13	18.69	115	23.62	37.84	33.10	131.35
Amaranths	140% NPK + 4-Plants	20.40	7.42	75	27.5	39.56	8.16	60.71
		25.27	10.66	255	70.32	33.53	52.54	83.60
Okra	120% NPK + 2-Plants	14.65	3.78	70	33.7	28.75	10.99	53.24
Pea	120% NPK + 3-Plants	8.73	7.22	75	12.1	-27.37	6.55	51.98
Bitter gourd	140% NPK + 2-Plants	9.33	2.71	70	34.4	51.55	9.33	27.75
		10.90	4.57	215	80.2	17.64	26.87	44.32

and 46.0% after 150 days of refrigerated storage in 1 kGy and 2 kGy, respectively. Antioxidant activity also decreased and the decrease in IM Moringa leaves was 34.8% and 24.13% during 150 days of refrigerated storage in 1 kGy and 2 kGy, respectively. Sensory score of IM Moringa leaves decreased during refrigerated storage and 1 kGy and 2 kGy IM and Moringa leaves were acceptable to judges for flavour, colour and appearance, body and texture and overall acceptability for 100 days and 75 days, respectively during refrigerated storage.

Microbial count was on increasing pattern in all radiated and control samples during 150 days of refrigerated storage. Microbial population was not counted upto 30 days of refrigerated storage. However, it showed an increasing trend (3.93-5.50 log CFU/g dm upto 120 days of refrigerated storage. Similarly, IM Moringa leaves treated with 2 kGy were not assessed for microbial count during 90 days of storage due to non-receipt of treated leves from BARC, Mumbai. Microbial count also had increasing pattern (4.77-5.76 log CFU/g dm) during 60 days of refrigerated storage.

Moisture content in 1 kGy and 2 kGy treated Bathua leaves also decreased during refrigerated storage. There had been 65.4% and 74.8% decrease in ascorbic acid during 120 days of refrigerated storage in 1 kGy and 2 kGy treated IM Bathua leaves. Total phenol content also decreased and the decrease was 45.4% and 55.6% in 1 kGy and 2 kGy treated Bathua leaves, respectively during 120 days of refrigerated storage. Similarly antioxidant activity also decreased and the decrease was 38.5% and 42.3% in 1 kGy and 2 kGy treated IM Bathua leaves, respectively during 120 days of refrigerated storage. Sensory score also decreased during storage in IM Bathua leaves during storage. Radiation treated 1 kGy and 2 kGy Bathua leaves had the overall acceptability sensory score 6.85 during 120 days of refrigerated storage.

Microbial count showed and increasing pattern in all radiated and control samples during 120 days of refrigerated storage of IM Bathua leaves. Microbial population was not counted upto 30 days of refrigerated storage. However, it showed and increasing trend (2.25-6.75 log CFU/g dm upto 90 days of refrigerated storage. Similarly, IM Bathua leaves treated with 2 kGy were not evaluated for microbial count during 30 days of storage due to non-receipt of treated leaves from BARC, Mumbai. Microbial count also had increasing pattern (3.57-4.88 log CFU/g dm) during 90 days of refrigerated storage.

Project 13: Farmer FIRST program on "Intervention of improved agricultural technologies for livelihood and nutritional security adhering local resources and working knowledge of the farmers"

Farmers FIRST project was operated in 06 villages of Araziline block in Varanasi district of U.P. namely, Upadhyaypur, Baburam Ka Pura, Paniyara, Dhanapur Rajapur and Laskariya. The interventions made under this project were categorized in three modules as follows:

Horticulture based module: Small and marginal categories of farmers were beneficiaries of this module. The main focus was given on promotion of improved vegetable varieties through demonstrations and comparing with existing cultivar in both quality and yield. In this context, the most promising variety of okra (Kashi Kranti) and cowpea (Kashi Nidhi) demonstrated in an area of 42 ha at 361 farmers' field reported not only better quality but also yielded 19.3% more than practicing varieties. Early variety of Garden pea (Kashi Nandini) was demonstrated at 192 farmers' field in an area of 22.8 ha. area in between rice-wheat cropping system. It fetched an extra remuneration of Rs. 92000/- per ha. to the farmers. Other successful vegetable varieties demonstrated were Kashi Aman in tomato, Kashi Uttam in brinjal, Kashi Anmol in chilli, Kashi Ganga in bottle gourd, Kashi Harit in pumpkin, Kashi Swetha in radish, Kashi Arun in carrot, Kashi Rajhans in French bean *etc*. Owing to these demonstrations, 31.47% increase in average production in vegetables was observed as compared to the existing cultivar in non-adopted villages (Fig. 15).

Fig. 15: Kashi Rajhans in the field of Rupkala of Dhanapur

Kitchen garden: Seasonal kitchen garden kit prepared at ICAR-IIVR, was provided thrice to 816 farmers mainly for their household consumption. It was

observed that 47% beneficiary of kitchen garden harvested vegetables round the year for their families.

Crop based module: This module was mostly followed for medium to large farm categories that usually follow rice-wheat cropping system. Zinc fortified wheat var. CBW-38 & WB-02 was introduced in the selected villages during 2018-19 and 2019-20 (Fig. 16). Besides, a high yielding wheat variety, HD-2967, was also demonstrated in an area of 44 ha. However, its productivity was lesser than commercial varieties and growers could not get a premium price owing to its appearance similar to conventional.

Livestock based module: This module was operational mainly for landless labourers and marginal farm categories. Backyard poultry was promoted and day-old-chicks (6300 Nos.) of CARI-Debedra, CARI-Nirbheek and Kadaknath were procured from ICAR-CARI, Izatnagar and demonstrated among 107 landless beneficiaries along with starter feed and water feeder. Trainings were provided on poultry nutrition and hygiene. Master trainer on poultry vaccination were developed among the village youths (Fig. 17).

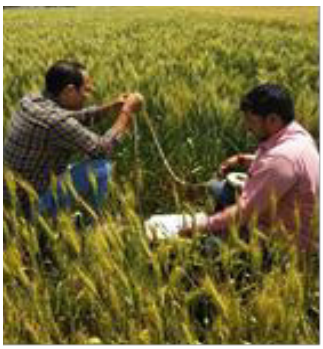

Fig. 16 : WB-02 grown in the field of Tarshankar Singh of Paniyara village

Fig. 17 : Kadaknath breed at the house of Jugunu Rajbhar from Lashkariya

Project 14 : Scheduled Tribes Component (earlier Tribal Sub Plan) for Tribal of Sonbhadra district in Uttar Pradesh (National Assignment by ICAR, DARE, Ministry of Agriculture and Farmers Welfare, Govt. of India)

Scheduled Tribe Component (earlier TSP) was introduced in 1512 tribal households of Chopan block in Sonbhadra district. In this process, demonstrations of crop based interventions in wheat (HD-2967), paddy (Bina Dhan-11) and pigeon pea (Narendra Arhar-2) were conducted in an area of more than 110 hectare of 914 tribal farmers, which not only fetched better crop quality but also up to 31% more yield than existing varieties. Similarly under demonstrations of vegetables based interventions, cucurbits *viz*., bottle gourd (Kashi Ganga); sponge gourd (Kashi Divya) and pumpkin (Kashi Harit) in rainy season were conducted in the field of 415 tribal farmers in an area of 28.4 ha, which fetched an average increase of 29.7% yield compare to other cultivars. Demonstrations of tomato (Kashi Aman), brinjal (Kashi Uttam) and chilli (Kashi Anmol) were conducted at 516 tribals' field in an area of 26.2 ha, which showed an increase in yield up to 27.3% compare to local cultivars with much superior quality. Demonstration of vegetable pea cvs. Kashi Nandini and Kashi Uday in near about 25 ha area fetched the net income of Rs. 69000/- per ha. Demonstrations of other legume vegetables *viz*., cowpea (Kashi Kanchan), *sem* (Kashi Haritima) and French bean (Kashi Rajhans) were conducted at 347 tribals' field, while of root crop & leafy vegetables *viz*., radish (Kashi Hans), carrot (Kashi Arun) and *palak* (All Green) were conducted at 69 tribals' field in an area of 9.3 ha, which showed significant increase in quality and yield as compared to previous year. Apart from vegetable crops demonstrations, 1600 kitchen garden packets were also provided to tribal households. Eleven on/off campus training/interaction programme were also organized on different aspects of agriculture, which were attended by 1633 tribal farmers.

Project 15 : Validation & promotion of sustainable and Adaptable IPM Technology for Brinjal crop

The IPM technology that was synthesized and validated in brinjal fields of selected farmers in the villages Marachh, Arazaline sultanpur, Adalpura of Mirzapur and Villages Nidur, Kurauna and Dilkoeran of Bhadohi district for the management of major insect pests and diseases of brinjal was as followed: seed treatment with *Trichoderma viride* (@ 5 g/kg seed; seedling root dip in carbendazim 1 g/lit for 20 min followed by rynaxpyr @ 0.5 ml/lit solution for three hours against seed borne diseases and shoot and fruit borer, respectively; clipping of borer damaged shoots and early infested fruits at weekly intervals; installation of pheromone traps @ 25-30 traps/ha for mass trapping of brinjal shoot and fruit borer (*Leucinodes orbonalis*); need based spray (ETL > 5%) of chlorantraniliprole 18.5 % SC @ 0.35 ml/lit or emmamectin benzoate 5 SG @ 0.4 g/lit or fenpropathrin 30% EC @ 0.33 ml/lit against brinjal shoot and fruit borer; need based spray of imidacloprid 17.8 SL (@ 0.4 ml/lit) or thiamethoxam 25

WG @ 0.35 g/lit or fenpropathrin 30% EC @ 0.3 ml/lit against sucking pests; collection and destruction of *Phomopsis*, *Sclerotinia* wilt damaged fruits and little leaf affected plants periodically; during winter rains and foggy weather need based application of carbendazim 0.5-0.75 g/lit for management of leaf spot and fruit rot. The treatment imposition and data recording are in progress as the crop is in its early reproductive phase (Fig. 18 & 19).

Fig. 18 : Validation of IPM in brinjal at farmers' field

Fig. 19 : Interaction with the IPM farmers at Arazliline Sultanpur

Project 16 : Agroinfectious clones development for probing resistance to chilli leaf curl diseases caused by begomoviruses and devising integrated management strategy

Evaluation of developed agro-infectious clone efficacy: Agrobacterium culture harbouring dimer constructs of chilli leaf curl virus (C11 and CH82X) and tomato leaf curl Joydebpur virus (CHVNS) along with tomato leaf curl Bangladesh β-satellite were chosen for inoculation on *Nicotiana benthamiana*, tomato and chilli plants. Inoculation buffer containing acetosyringone, $MgCl_2$ and MES were used for inoculation. Out of 10 plants inoculated, only one *N. benthamiana* plant produced yellowing symptoms on 35 DAI. Symptomatic plants along with asymptomatic and mock inoculated plants were tested for the presence of virus through PCR using universal begomovirus primer pair PAL1c1960: 5′-ACNGGNAARACNATGTGGGC-3′ and PAR1v722: 5′-GGNAARATHTGGATGGA-3′, targeting 3' end of the coat protein region to produce an amplicon size of □1,200 bp. The PCR settings comprised with an initial denaturation of 94°C for 2 min followed by 30 cycles of denaturation at 94°C for 1 min, annealing at 55°C for 2 min, extension at 72°C for 3 min and a final extension of 72°C for 10 min. Symptomatic plants and mock inoculated plants were shown positive for the presence of virus. Similarly, *Agrobacterium* cultures of above constructs were also inoculated on 20 days old tomato and chilli seedlings. But none of the tomato and chilli plants were failed to produce any symptoms. Upon testing through PCR, they showed negative for the virus presence.

Development of Diagnostic kit for detection of ToLCJoV through LAMP assay: Previously LAMP assay has been validated using total DNA extracted from ToLCJoV infected chilli samples showing leaf curl symptoms collected from IIVR farm. Infected samples were detected with virus where as other samples infected with other begomoviruses such as mungbean yellow mosaic India virus, tomato leaf curl New Delhi virus were not detected with this assay. Upon running the reaction mixture in 3% agarose gel, ladder like separation was observed . Also, upon staining with ethidium bromide, fluorescence was observed visually only in positive samples but not in negative samples . Upon testing the sample with the crude sap extract extracted using GEB buffer, virus has been detected. Hence this assay can be very much useful in specific detection of ToLCJoV with in 90 min time.

Project 17 : Establishment of Integrated Beekeeping Development Centre (IBDC) / Centre of Excellence (CoE) on Beekeeping

Isolation of microbes from honey mixed with water: The raw honey contaminated with osmophilic yeasts and bacterium including very few pathogens, which causes sugar fermentation and destroy the quality of honey. However, pure honey preventing the multiplication and survival of microbes. The presence of microbes in low colony forming unit/g (cfu/g) in honey cannot build the toxins. Processing of honey is essential for reduction of moisture and maintaining of quality of honey. Honey always be of top quality and pure, free

from bees' legs, scraps of beeswax, pesticides or any other contaminant/adulteration (sugar syrups). The main contamination for the different bee products is honey (antibiotics), wax (persistent lipophylic acaricides), propolis (persistent lipophylic acaricides, lead), pollen (pesticides, bacteria), royal jelly (antibiotics). During May 2019, five different samples of honey were collected from IBDC-ICAR-IIVR Varanasi. These samples used for microbial culturing on agar based fungal and bacterial media for microbial profiling followed by serial dilution method for further identification of potential microbial contaminants.

Foraging behaviour of different insect fauna visiting sponge gourd: Diurnal activity of different insect fauna was also observed during the summer months to know about activity of different pollinators, the dominant pollinator and the time of maximum activity of the pollinators. The observations indicate that the maximum pollinators' activity was recorded during 6 to 10 AM. Pollinators included honeybees, bumblebees, carpenter bees, solitary bees, hoverflies, beetles, butterflies and moths. The dominant honey bee species was *Apis florea*. Among the four crops mustard was recorded with higher honey bee visit during the observation period. The pea crops provided least period for honey bee foraging which ended in the last week of the February. (Fig.20)

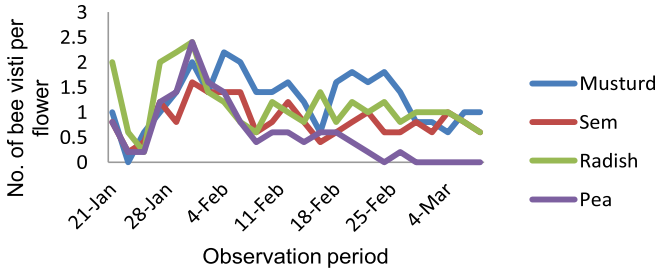

Fig.20 : Honey bee foraging activity study

Estimation of kresoxim methyl residue in honey: An Agilent gas chromatography model 7890B equipped with an autosampler and microelectron capture detector (μECD, ^{63}Ni) were used for the detection of kresoxim-methyl. A standard syringe split/splitless injector was used in the split injection mode at a ratio of 10:1 at 250 °C with an injection volume of 1 μL. A HP-5 capillary column (30 m length, 320 μm id, 0.25 μm film thickness with nitrogen gas flowing at 2 mL/min) was used for separation. The detector was maintained at 300 °C with makeup gas (N_2) flowing at 60 mL/min. The oven temperature was set to 100 °C for 1 min, ramped to 280 °C at 15 °C /min, and held for 2 min. Under these conditions, kresoxim-methyl appeared at retention time (RT) of 11.18 min in standard. However, in honey sample no kresoxim-methyl residue was found. An Agilent open lab EZchrom used for chromatogram acquisition.

Achievement of All India Coordinated Research Project on Vegetable Crops

During the year 2019-20, 2215 trials were conducted at 36 regular and 24 voluntary centres of AICRP on Vegetable Crops (Table 1).

Table 1 : Details of the trials conducted during 2019-20 through AICRP (VC)

	Trials	No. of Trials	No. of Trials conducted by the centre
Crop Improvement	Plant Genetic Resources	29	112
	Varietal Trials	53	1042
	Hybrid Trials	31	530
	Resistant Varietal Trials	7	140
Crop Production	Vegetable Production Trials	15	73
	Protected Cultivation	9	56
	Seed Production Trials	19	47
	Physiology & Biochemistry Trials	5	14
Crop Protection	Integrated pest management	22	94
	Integrated disease management	9	107
Total		199	2215

The following recommendations under Crop Improvement, Crop Production and Crop Protection were made during 37th Group Meeting of AICRP (VC) held at TNAU, Coimbatore, Tamilnadu from 22-25th June, 2019 (Table 2, 3 & 4).

Crop Improvement

Variety evaluation trials: Thirteen entries of 7 crops were identified for release and notification for different agro-climatic zones of the country.

Hybrid evaluation trials: Seven entries of 6 crops were identified for release and notification for different agro-climatic zones of the country.

Resistant evaluation trials: Two entries of two crops were identified as Okra yellow vain mosaic virus and tomato leaf curl virus for release and notification for different agro-climatic zones of the country.

Table 2 : Varieties identified for release and notification

S. No.	Crop	Code	Name of the entry	Source	Zone
1.	Brinjal Long	2015/BRLVAR-3	PBL-232	PAU, Ludhiana	VI, VII
2.	Brinjal Long	2015/BRLVAR-5	IVBL-23	IIVR, Varanasi	IV
3.	Brinjal Round	2015/BRRVAR-2	DBPR-23	IARI, New Delhi	IV
4.	Cherry Tomato	2015/TOCVAR-5	VT-95	VPKAS, Almora	I, III, VII
5.	Tomato Indet.	2015/TOINDVAR-3	BT19-1-1-1	OUAT, Bhubaneswar	I
6.	Tomato Indet.	2015/TOINDVAR-5	Kashi Tamatar-8	IIVR, Varanasi	IV, VII
7.	Capsicum	2015/CAPVAR-2	KTC-1	IARI (RS), Katrain	I
8.	Yard Long Bean	2015/COPBVAR-4	Arka Mangla	IIHR, Bengaluru	IV, VIII
9.	French Bean (Pole Type)	2015/FBPVAR-1	VPFBP-14	IIVR, Varanasi	I, VII, VIII
10.	Radish	2015/RADVAR-3	VRRAD-150	IIVR, Varanasi	II
11.	Radish	2015/RADVAR-4	UHFR-12-1	Ranichauri	I
12.	Pea (Early)	2015/PEPVAR-3	Mattar Ageta-7	PAU, Ludhiana	IV
13.	Pea (Early)	2015/PEPVAR-4	VP 1305	VPKAS, Almora	I

Table 3 : Hybrids identified for release and notification

S. No.	Crop	Code	Name of the entry	Source	Zone
1.	Tomato Det.	2015/TODHYB-3	NTH-3072	Nirmal Seeds	I
2.	Tomato Det.	2015/TODHYB-4	CTH-1	TNAU, Coimbatore	VI, VII, VIII
3.	Chilli	2015/CHIHYB-6	CH-27	PAU, Ludhiana	IV
4.	Capsicum	2015/CAPHYB-3	NCCH-705	Nirmal Seeds	I, VIII
5.	Cauliflower (Mid)	2015/CAUMHYB-2	KTH-301	IARI (RS), Katrain	I, VI
6.	Cabbage	2015/CABHYB-1	KTCBH-822	IARI (RS), Katrain	I, VI
7.	Cucumber	2015/CUCUHYB-4	DGCH-18	IARI, New Delhi	I

Table 4 : Resistant varietal trials identified for release and notification

S. No.	Crop	Code	Name of the entry	Source	Zone
1.	Okra (YVMV)	2015/OKYVRES-4	AOL 12-52	AAU, Anand	V
2.	Tomato ToLCV	2015/ToLCVRES-5	IIHR-331	IIHR, Bengaluru	VIII

Production Technologies Developed (20)

Vegetable Production

Integrated Nutrient Management

1. From the three year study at Bhubaneswar centre on INM in broccoli it may be concluded that the application of (Vermicompost @2.5t/ha+1/2 of the recommended dose of NPK through fertilizer gave maximum curd yield (164.56 q/ha) with maximum B:C ratio 1:3.16.
2. At Kalyanpur, integrated nutrient management package for French bean cv. Azad Rajmah-1 with the application of 75% NPK through inorganic source + 25% N through vermicompost was found suitable for realizing optimum green pod yield (77.08 q/ha) and highest B:C ratio (2.67). Hence, it is recommended for agro-climatic condition of Zone-IV.
3. Three years study at Bhubaneswar on production in coriander radish sequence revealed that recommended FYM @20t/ha + fertilizer@80:60:80 NPK kg/ha +PP chemicals +IIHR microbial consortium @ 12.5 kg/ha gave highest yield in radish- coriander sequence with a B: C ratio of 3.46.
4. The three year study at Bhubaneswar centre on Integrated nutrient management in cucumber revealed that the maximum fruit yield of 142.17 q/ha was recorded with application of half recommended dose of NPK + FYM @ 10t/ha + Vermicompost @ 2t/ha + Biofertilizer with B:C ratio 2.33 .

Drip Irrigation

5. In the sub humid laterite soils of Kerala, for growing okra in summer season, drip irrigation on alternate days at 60%PE along with laying of black –silver polyethylene mulch, can be recommended for obtaining more plant height (3.0cm), lower number of days to flowering (32.5 days), more fruit length (20.4 cm), fruit girth(12.8cm), early maturity (77.6 days) consequently high yield (208.2q/ha) and a high cost benefit ratio of 2.1.

Organic

6. Experiment conducted at IIVR Varanasi revealed that maximum fruit yields of Okra 108.69 and 103.43 q/ha were recorded when drip irrigation was scheduled daily or alternate day with 100% PE coupled with black-silver mulching with B:C ratio of 1.72 and 1.68, respectively.
7. A three year study on weed management in okra at IIHR Bangaluru and Bhubaneswar revealed that, Pre-emergence application of pendimethalin @ 6 ml/L + one hand weeding 30 days after sowing was found suitable for maximum fruit yield of 85.5 q/ha with the BC ratio of 1.51 and 122.46q/ha with B:C ratio of 1.49 at IIHR Bangaluru and Bhubaneswar respectively, and hence can be recommended for weed management in okra in this Agro climatic region.

Grafting

8. At IIHR, grafting study revealed that maximum and significantly highest fruit yield (740.8 q/ha was observed when M-9 hybrid brinjal grafted on wild *S. torvum* root stock with the no bacterial wilt incidence in all the 3 years with the Highest B:C ratio of 3.11
9. Grafting study in brinjal at IIVR revealed that grafting of hybrid brinjal (Kashi Sandesh) on vigorous rootstocks, IC 354557 and IC 111056 though enhanced yield by 10-20% over non grafted plant, however, it was not economical for cultivation of brinjal.

Seed production

10. In the tropical sub humid lateraite soils of Vellanikara (Kerala) of zone-VIII, use of mulching with black polythene (200 gauge) had given seed yield (5.7q/ha) with higher seed quality with reduced weed intensity in bitter gourd cultivar Preethi.
11. The transplanting of stecklings of carrot c v. Pusa Kesar at 30 x 30 cm (1,11,111 plants/ha) given seed yield of 8.03 q/ha in Keymore Plateau &Satpura Hills of Madhya Pradesh under zone-VII.
12. Spray of micro nutrients mixture (Ferrous sulphate @0.2%, calcium nitrate @ 0.2% and boron @ 0.1%) at 60, 90 and 120 days after transplanting in chilli cv.Kashmir Long-1 given higher seed yield of 9.61 q/ha under Srinagar condition of zone-I.
13. Kashi Kranti variety of okra when sown on third week of June recorded significantly highest seed yield (11.8q/ha) in Varanasi condition of zone-IV.
14. To get maximum seed yield (13.78q/ha) and quality in okra under Punjab conditions of zone-IV, it should be sown during third week of March
15. The trial 6.91 Effect of salicylic acid in seed yield and quality in tomato during water stress period could not be concluded due to unstability of seed yield during three year of trial conduct. There is need to conduct the trial for one more year before its final recommendation.

Protected cultivation

16. At Jabalpur, in cherry tomato, maximum fruit yield (865.9 q/ha) along with net return of Rs 8,53,717/ha and B:C ratio of 4.14 was recorded when hybrid Suncherry Extra Pure was planted at 100 x 45 cm spacing with Pinching & staking. Hence this practice is recommended for Keymore Plateau & Satpura Hills Agro-climatic zone of Madhya Pradesh.
17. At Jabalpur, it has observed that the maximum fruit yield (200.0 q/ha) along with net return of Rs 2,27,680/ha and B:C ratio of 4.15 was recorded when tomato was grown in Rain Shelter with a spacing of 100 x 60 cm and hence it is recommended for Keymore Plateau and Satpura Hills Agro-climatic zone of Madhya Pradesh.
18. At IIHR, for Parthenocarpic cucumber hybrid, fertigation using 150:112:188 NPK kg/ha was found optimum with a yield of 983 q/ha and B:C ratio of 2.07. Hence, it is recommended for polyhouse cultivation of parthenocarpic cucumber in Agroclimatic Zone VIII.
19. At Srinagar, Capsicum hybrid Bombay planted under naturally ventilated poly houses at 60X45cm spacing with 4 stem training gave maximum yield of 546.07 q/ha with B:C ratio 7.80. Hence it is recommended for temperate conditions of Kashmir.

Physiology, Biochemistry and Processing

20. Oxalate content in tomato varieties was estimated at PAU, Ludhiana and IIVR, Varanasi. Both centres have estimated oxalate content and acidity content as citric acid in different AVT-I and AVT-II tomato lines of AICRP trials at ripe stage of harvest. Oxalate content varied from 6.24 and 6.38 mg/100g in 2017/TODVAR-6 and 2016/TODVAR-9 in AVT-I and AVT-II lines, respectively. Acidity level varied 0.33-0.47% as citric acid in 2017/TODVAR-6 and 2017/TODVAR-10 in AVT-I lines.

Protection Technologies Developed (12)

Integrated Disease Management

Nursery disease management using bio-agents

1. At Varanasi, application of talc based formulations of Bacillus subtilis (BS2-IIVR strain) having minimum cfu of 2.5X108 as seed treatment @ 4g/kg seed, soil application as 10g/m2and soil drenching @5%, has recorded reduced damping off incidence on tomato var. Kashi Aman (15.22%) and brinjal var. Kashi Taru (33.18%) with maximum cost benefit ratio (CBR) 1: 79.98 and 1: 36.69, respectively with improved germination percentage over control. In case of chilli var. Kashi Anmol, use of carbendazim (12%) + mancozeb (63%) (T-6) has recorded lowest incidence of damping off (13.30%) with cost benefit ratio (CBR) 1: 90.79. In addition it has improved germination percentage (86.58) and vigour index (479.52) of chilli seedlings.

Integrated management of vector borne virus diseases of chilli

2. At Lam, Bhubaneswar, Hessarghatta, Parbhani and Coimbatore, treatment integrated management include application of neem cake @ 1.0kg/sq.mt in the seed bed, spraying of Cyazpyr @ 1.8ml/liter (T5) 2-3 three days before transplanting, seed treatment with imidacloprid @ 8gm/kg, seedling dip of imidacloprid @ 0.5ml/L and growing of two rows of maize/sorghum (jowar) as border crop in the main field along with sliver agrimulch sheet + rotational spray of insecticides (Acephate @ 1.5 g/L + Neem

Oil @ 2.0ml/L) + (Fipronil @ 1.0 ml/L + Neem Oil @ 2.0ml/L) + (Imidacloprid @ 2 g/15L + Neem oil @ 2.0ml/L) + (Cyzpyr @ 1.8ml/L) at 7 days interval till fruit formation have significantly reduced the incidence of vector borne viral diseases in chilli. Residual analysis of pesticides used in the best treatment has indicated that the acephate @ 1.5g/L, fipronil @1.0 ml/L imidacloprid @ 2g/15L and cyzpyr @ 1.8 ml per liter were not detected in HPLC/GLC testing. The CB ratio varied from 1:3.07 to 1:1.92. Therefore, this treatment has been recommended for management of vector borne virus diseases of chilli at Lam (cv. LCA 620), Bhubaneswar (cv. Utkal AVA), Hessarghatta (cv. Arka Kyathi), Parbhani (cv. Pusa Jwala) and Coimbatore (hy. Chilli CO1).

3. However at Ludhiana, in treatment comprising of application of neem cake @ 1.0kg/sq.mt in the seed bed, spraying of Cyazpyr @1.8ml/liter 2-3 three days before transplanting, seed treatment with imidacloprid @ 8gm/kg, seedling dip of imidacloprid @ 0.5ml/L and growing of two rows of maize/sorghum (jowar) as boarder crop in the main field along with sliver agrimulch sheet + spray of imidacloprid @ 2g/15L + Neem oil @ 2.0ml/L at 7 days interval till fruit formation followed by treatment T-5. Initial two years availability of Cyantraniliprole has recorded leaf curl incidence of 7.4% with maximum yield (113.0 q/ha) and CB ratio (1:1.42).

IDM package for tomato diseases

4. At Coimbatore, Parbhani and Hessaraghatta, integrated management module comprising of Covering of nursery with 40-60 mesh white nylon net until transplanting, Border crop with maize in main field Nursery treatment (application of Seed Pro bio-formulation: Seed priming @ 4g/kg, ii) soil application @10 g/Kg of soil while potting, and iii) soil drenching @ 5% after seed germination) and main field treatment (Seedling Dip with 0.1 % (Carbendazim 12% + Mancozeb 63% WP) + spray with Acephate 75% WP @1.5 g/l on 10 days after transplanting + spray with Fipronil 5% SC @ 1.5 ml/l on 20 DAT+ spray with Copper hydroxide 77% WP (2.0 g/l) on 25 DAT + spray with imidacloprid 70% WG @ 2g / 15 l on 40 DAT + spray with Fenamidone 10% + Mancozeb 50% WDG (0.25%) two to three times from 45 DAT at 10 days intervals) was found most effective in the management of tomato diseases (damping off, early blight, late blight, bud necrosis and leaf curl disease) and maximum fruit yield. Pesticide Residue Analysis for this treatment revealed that no pesticides have been detected. The C:B ratio was varied from 1:2.54 to 1:10.30. Therefore, this treatment has been recommended for management of tomato diseases at Coimbatore (hy.Tomato Co3), Parbhani (S-22) and Hessaraghatta (NS501).

IDM packages for cucurbit diseases

5. At Lam (Ridge gourd cv.Local), Junagadh (Bottle gourd cv. Pusa Naveen) and Parbhani (Cucumber cv. Pune Khira) Integrated management practice module involving growing of two rows of maize as border crops and use of agri silver mulch sheet followed by seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of captan 70% + hexaconazole 5%WP @ 0.1% 15 days after germination followed by spraying of tebuconazole 50% + trifloxystrobin 25% @ 1g/l + spray with (imidacloprid 17.8 SL @ 7.5 ml/ 15 L+ Neem oil 0.2%) followed by fosetyl-Al @ 0.1% followed by spraying of tebuconazole 50% + trifloxystrobin 25% @1g/l + spray with (imidacloprid 17.8 SL @ 7.5 ml/ 15 l + neem oil 0.2%) followed by fosetyl-Al @0.1% at 10 days interval was highly effective in reducing severity of damping off (0.9 – 7.01), alternaria leaf blight (4.08%), cercospora leaf spot (5.43%), downy mildew (4.04-6.37%) and mosaic diseases (6.56-23.58%). Pesticide Residue Analysis for this treatment revealed that no pesticides have been detected. The C:B ratio for the above treatment was ranging between 1:1.34 to 1:17.91.

6. At Varanasi (Bitter gourd cv. Kalyanpur Barahmasi) and Bhubhaneswar (Cucumber cv. Kumuda) integrated module comprising of growing of two rows of maize as border crops and use of agri silver mulch sheet followed by Seed treatment with carbendazim 12% + mancozeb 63% @ 3g/kg and drenching with captan 70% + hexaconazole 5% WP @ 0.1% at 15 daysafter germination followed by spray with (imidacloprid 17.8SL @7.5ml/ 15L+Neemoil 0.2%) followed by spraying of captan 70% + hexaconazole 5% WP @ 0.1% followed by Fosetyl-Al @0.1% followed by spraying of captan 70% + hexaconazole 5% WP @ 0.1% + spray with (imidacloprid 17.8SL @7.5ml/ 15L + Neemoil 0.2%) followed by Fosetyl-Al @0.1% at 30 days drenching has recorded minimum severity of mosaic (14.3-

54.21), downy mildew (17.8-35.82%), leaf spot (54.64%), powdery mildew (64.0%) and collar rot diseases (12.7%). The C:B ratio for the above treatment was ranging between 1:2.07 to 1:3.5.

Integrated Disease Management

7. In search of suitable new alternatives to neonicotinoid insecticides against sucking insect pests of okra,two sprays of Flupyradifurone 200 SL @ 250 g a.i/ha at 10 days interval starting with initiation of infestation of leaf hoppers and whiteflies on okra is recommended first for their management based on the three years experiments under Hyderabad condition which recorded maximum marketable yield(11.56 t/ha) and lowest whitefly (4.02 whiteflies/5 leaves) and jassid (1 jassid/5 leaves) population as against (5.69 t/ha) in untreated control. Similarly two sprays of Flonicamid 50 WG @ 100 g a.i. /ha at an interval of 10 days staring from initiation of sucking pest infestation in okra was also found equally effective.
8. Based on the three years observations, the integrated module comprising seed treatment with Thiomethoxam 70WS @ 5-10 g/kg seed, removal of infested cotyledonary leaves 7 days after germination, spraying Emamectin benzoate 25 WG @ 0.4 g/l, Neem oil 3000 ppm @ 5 ml/l, Spinosad 45 SC @ 0.3 ml/l and installation of cuelure traps @ 15/acre was superior in terms with lowest red pumpkin beetle population and fruit fly damageaccompanied with significantly highest fruit yields of 16.06 t/ha under Hyderabad conditions.So, this integrated module could be taken advantage for the insect pest management in cucurbits.

Nematology

9. The experiment on "Bio-efficacy of liquid formulation of biopesticide in the management of Meloidogyne incognita infecting tomato" conducted for three years (2015-16, 2016-17, 2017-18) in tomato revealed substrate treatment with Bacillus subtilis or B. amyloliquefaciens1% A.S. (2.3 x 109 cfu per ml) @ 5 ml/ kg cocopeat in portrays and soil application of 20 tons of FYM enriched with either of themat 5 l/ha recorded significantly higher yield (29.06-30.82% increase over control) and lower nematode population in soil and roots of tomato (70.33-71.02% decrease)with cost benefit ratio (1:2.10 – 1:2.12) under Bangalore conditions.
10. In tomato, substrate treatment with Bacillusamy loliquefaciens1% A.S. (2.3 x 109 cfu per ml) @ 5 ml per kg of coco peat for producing seedlings of tomato in portrays + application of 20 tons of FYM enriched with 5 lit of B. amyloliquefaciens1% A.S. (2.3 x 109 cfu per ml) /ha was effective with 44% reduction in final population of root knot nematode, M. incognita and 18.9% increase in marketable yield with C:B ratio 1:1.47 under Punjab condition.
11. Pooled analysis of three years (2015-16, 2016-17, 2017-18) of the experiment on 'Bioefficacy of liquid formulations of biopesticides in the management of Meloidogyne incognita infecting okra' revealed that seed treatment of okra with Bacillus pumilus1% A.S. or Pseudomonas putida 1% A.S. (2.5 x 109 cfu per ml) @ 10 ml/kg seed and application of 20 tons of FYM enriched with B. pumilusor Pseudomonas putida1% A.S. (2.5 x 109 cfu per ml) @ 5 lit per ha recorded maximum decrease in *M. incognita* population (66.51% - 67.57%) and higher yield (29.44% - 30.83%) with the C:B ratio of 1:1.91 to 1: 1.93 under Bangalore conditions.
12. In okra grown under Punjab conditions, seed treatment with Pseudomonas putida 1% A.S. (2.5 x 109 cfu per ml) @ 10 ml/kg and application of 20 tons of FYM enriched with Pseudomonas putida 1% A.S. (2.5 x 109 cfu per ml) @ 5 lit per ha reduced *M. incognita* population (39.82%) and increased yield (42.8%) with the C:B ratio of 1:2.06.

Breeder Seed Production

During the year 2018-19 a total of 25936.410 kg breeder seed produced against the indent of 14126.660 for 187 varieties of 34 vegetable crops by 21 coordinating centres. During the year 2019-20, an indent of 15563.950 kg breeder seed for 127 varieties of 31 vegetable crops have been received from the Deputy Commissioner (Seed) DAC,GOI, New Delhi and the same have been allotted to 20 coordinating centres for under taking the production. A total of 757.320 kg of Breeder Seeds has been produced against the indents till December 2019. However, the final production figures are awaited from many centres.

Krishi Vigyan Kendras

ICAR- KRISHI VIGYAN KENDRA, BHADOHI

Training Programme: KVK-Bhadohi conducted 78 training programme to the farmers, rural youths and extension personnel to orient them in the frontier areas of technology development under cereals, oilseeds, pulses, vegetables, fruits, livestock and home science covering a total of 1694 beneficiaries including 1104 male and 590 female participants (Table1 & Fig. 1&2).

Table 1 : Training programmes organized

Clientele	No. of Courses	Male	Female	Total participants
Farmers & farm women	70	1063	466	1529
Rural youths	04	25	38	63
Extension functionaries	04	16	86	102
Total	78	1104	590	1694

Fig. 1 : On Campus Training on Mushroom Production

Fig. 2 : Off Campus Training on NARI Project

Front Line Demonstration: A total of 13 front line demonstrations (FLDs) on pulses, oilseeds, paddy, wheat, vegetables and fodder crops were conducted in 94.42 ha area in order to establish the production potential of improved technologies at the 428 farmers' fields (Table 2; Fig. 3 & 4).

Table 2 : Front Line Demonstration on crops

Crop	Variety	No. of Farmers	Area (ha)	Yield (q/ha)				% Increase in yield
				Demo			Check	
				High	Low	Average		
Mustard	RH-749	77	30.0	33.75	22.50	27.80	17.90	55.31
Mustard	P-30	15	2.5	21.25	16.20	19.9	17.9	11.17
Moong	HUM-16	39	10.0	12.0	8.2	9.9	7.5	32.0
Chickpea	GNG-1581	32	10.12	28.5	18.40	21.55	17.20	25.29
Field pea	Aman	78	20.0	29.45	16.80	20.75	16.65	24.62
Lentil	PL-08	22	10.0	21.66	12.15	16.35	11.0	48.63
Paddy	P-2511	14	3.0	55.70	43.50	51.0	33.0	54.54
Wheat	HD-2967	22	2.8	68.00	55.30	62.10	48.20	28.84
Bajra	NBH-4903	11	2.0	22.5	15.5	20.2	15.2	32.89
Tomato	Kashi Aman	35	1.0	473.7	382.6	457.2	273.7	67.0
Vegetable Pea	Kashi Mukti	44	1.0	146.7	112.2	128.8	113.9	13.0
Cowpea	Kashi Nidhi	33	1.0	142.7	118.6	131.6	96.8	35.5
Berseem	Vardan	06	1.0	1240	810	986	701	40.65
Total		428	94.42					

Fig. 3 : CFLD on Moong (HUM-16)

Fig. 4 : FLD on Paddy (P-2511)

Front Line Demonstration on Livestock: Under livestock production, 02 demonstrations were conducted on disease management in dairy animals and sheep & goat (Table 3).

FLD on Other Enterprise: A total of 02 demonstrations on kitchen gardening under nutritional security and 01 demonstration in drudgery reduction under women empowerment conducted at 21 and 05 farmers' field respectively as details given in (Table 4 & 5).

Technology Assessment and Refinement

A total of 03 On Farm trials (OFTs) were conducted in different villages of KVK Bhadohi for assessment of selected technologies in agriculture & allied subjects.

- **Intercropping of turmeric in established mango orchard after centre cropping:** An OFT was conducted at 05 farmers fields in mango orchard after centre opening. The turmeric varieties Megha was shown in month of April 2018. At the time of harvesting yield was recorded 171.6 q/ha and net

Table 3 : Front Line Demonstration on livestock

Category	Thematic Area	Name of the technology demonstrated	No. of Farmers	No.of Units (Animal/ Poultry/ Birds, etc)	Major parameters		% change in major parameter
					Demo	Check	
Cattle & Buffalo	Disease Management	Control of endo-parasite	52	125	123 disease free	85 disease free	43.53
Sheep & Goat	Disease Management	Control of liver fluke endo-parasite	19	1125	1112	856	29.9

Table 4 : FLD on Nutritional Security

Category and Crop	Thematic area	No. of Farmer	No. of Units	Yield (Kg)		% change in yield
				Demonstration	Check	
Nutrition Garden (Zaid) 19	Nutritional Security	11	11	702	560	25.33
Nutrition Garden (kharif) 19	Nutritional Security	10	10	1515.5	990	53.08

Table 5 : FLD on Women Empowerment

Category	Name of technology	No. of demonstrations	Name of observations	Demonstration	Check (Average)
Drudgery Reduction	Serrated Sickle	05	Working heart rate	97.2 beat/min (Average)	103beat/min
			Harvesting rate	18.25sqm/h (Average)	15.75sqm/h

Table 6 : Performance of Turmeric as inter crop in mango

Technology	No. of trials	Yield q/ha	Cost of Cultivation	Gross Income	Net Income	B.C. Ratio
Mango (Langra)	5	122.5	35200	220500	185300	6.26
Turmeric (Megha)	5	171.6	65236	171600	106364	2.63

Table 7 : Effect of Seed treatment and spray of Propiconazole in management of false smut of Rice

Technology Option	No. of trials	No. of infested ears / m^2	Yield (qt/ha)	% Increase in yield over farmer's practice
Farmer practice (No control measure adopted/improper use of fungicides)	5	9	52.9	--
Seed treatment with Carbedazim @ 2.5 gm/ kg seed + Spraying of Propiconazole 25%EC @ 0.1% during panicle initiation (booting stage/ initiation of 5% Ear)		2	55.6	5.1

income was Rs. 106364.00 / ha as additional income after the new intervention of intercropping in mango orchard. Whereas farmer practices they are using orchard for mango production. The cost benefit ratio was 2.63 (Table 6 and Fig. 5).

Fig. 5 : OFT- Intercropping of turmeric in Mango Orchard

- **Management of False smut in rice:** Rice is an important crop of Eastern Uttar Pradesh and high infestation of false smut resulting in yield loss. Seed treatment with *Carbedazim* @ 2.5 gm/ kg seed + spraying of *Propiconazole* 25%EC @ 0.1% during panicle initiation (booting stage/ initiation of 5% Ear) reduced the no. of infested ears / m^2 from 9 to 2 and yield was increased by 5.1% (Table 7).
- **Improvement of fertility by uses of UMMMB and dewormer supplementation in dairy animals due to deficiency of micro and macro nutrients:** In dairy cattle due to deficiency of macro and micro nutrient the animals does not come into heat & show the estrus, which is a great loss for the dairy owners. Keeping in view UMMM- Azolla Block (Urea Molasses Mineral Mixture Azolla Block) were used to active the hormones responsible for the cycle again with normal physiology. Under trial 66% animals come into heat & conceived as against 10 percent in farmers practices. In lactating animal the use of UMMM Azolla Block daily the milk production were increased about 0.87 litre per day per animal. The additional cost Rs. 4-5 per day/ animal against farmers practices (Fig. 6).

Fig. 6 : OFT- Distribution of UMMM Azolla Block among the farmers

Extension Activities : Extension activites were conducted to disseminate and popularize improved agricultural technology for the benefit of the stakeholders of the farming community. During the period under report KVK has organized 09 special days like KisanDiwas, MahilaKrishakDiwas and Parthenium Awareness Programme involving 802 beneficiaries. For the dissemination of the technology KVK has organized 09 field days on Cow Pea (Kashi Nidhi), Paddy(P-2511), Vegetable Pea (Kashi Mukti), Mustard (RH-749), Lentil(PL-08), Chick Pea(GNG-1581) and Wheat(HD 2967), where 368 farmers & farm women participated. Besides these, KVK organized Jal Shakti Kisan Mela, Exhibition, KrishakGoshthi, Field Visit, Diagnostic Visits and Film Show benefitted 14079 farmers. In category of other extension programme 23 newspaper coverage published, 04 Radio Talk and 13 ETV Talk were broadcasted (Fig. 9&10).

Fig. 9 : Jal Shakti Mela

Fig. 10 : Vaccination under NADCP

ICAR-KRISHI VIGYAN KENDRA, DEORIA

Training programme: To increase the income of farming communities, a total of 66 including on and off campus training courses were organized in different thematic areas in which 1549 farmers & farm women benefitted. In addition, 11 training programmes on agriculture entrepreneurship for rural youth / school dropout were organized at on and off campus in which 291 rural youth participated (Table 8 and Fig. 11 & 12).

Table 8 : Training Programmes Organized

Clientele	No. of Courses	Male	Female	Total participants
Farmers & farm women	66	1060	489	1549
Rural youths	11	163	128	291
Total	77	1223	617	1840

Front Line Demonstration: FLD programme under oilseed, pulses, cereals, vegetables, livestock, other enterprises a total of 189.79 ha. and 237 units/animals were the conducted during the year at 900 beneficiaries farmers fields (Table 9, 10; Fig. 13 & 14).

Fig. 11: Training on Mushroom

Fig. 12: On Campus Training Programme

Table 9 : Front Line Demonstration on Crops

Crop	Variety	No. of Farmers	Area (ha)	Yield (q/ha)		% Increase in yield	Economics of demonstration (Rs./ha)	Economics of check (Rs./ha)
				Demo	Check		BCR	BCR
Groundnut	HNG 123	122	20.00	14.20	11.30	25.66	2.20	1.75
Sesamum	RT 351	14	6.00	6.16	4.85	27.01	2.43	1.92
Mustard	RH 749	12	4.00	20.60	16.90	21.89	2.68	2.27
	PM 30	5	2.00	20.40	17.50	16.57	2.64	2.37
	Pusa Tarak	103	36.00	18.40	16.52	11.38	2.78	2.43
Pigeonpea	IPA 203	54	20.00	14.46	13.00	11.23	2.48	1.95
Greengram	IPM 2-3	44	20.00	9.30	7.10	30.99	3.29	2.78
Chickpea	GNG 1581	125	25.00	21.49	13.40	60.37	2.46	1.62
Fieldpea	Prakash	55	10.00	15.80	10.00	58.00	1.65	1.28
Lentil	PL 8	120	25.00	15.84	11.20	41.43	1.83	1.45
	Pusa Shivalik	3	0.34	15.50	11.50	34.78	2.02	1.71
Paddy	Pusa Sambha	2	0.25	43.60	35.70	22.13	2.21	1.93
	HUR 917	30	8.00	44.20	36.50	21.10	2.31	2.00
Scented Rice	PS 2511	6	1.50	57.60	42.60	35.21	2.92	2.02
Wheat	HD 2967	6	2.50	51.00	41.50	22.89	2.38	2.11
Wheat Zero till sowing	HD 2967	13	5.00	57.60	51.20	12.50	2.46	1.92
Tomato	Kashi Aman	11	1.00	300.00	240.00	25.00	5.33	4.54
Chilli	Kashi Anmol	10	1.00	148.00	112.00	32.14	6.17	4.52
Cow Pea	Kashi Nidhi	21	1	158.4	130.6	21.28	4.97	4.44
Okra	Kashi Kranti	20	1.2	142.20	112.48	26.42	4.44	3.88
Total		776	189.79					

Table 10 : Front Line Demonstration on Livestock

Category	Thematic area	No. of Farmer	No. of Units (Animal)	Major parameters		% change in major parameter	Economics of Demo. (Rs.)	Economics of check (Rs.)
				Major parameters	Major parameters			
Cattle	Disease Management	68	85	7.72	6.28	22.93	1.97	1.62
Cattle	Disease Management	56	152	9.9	6.3	57.14	1.78	1.64
Total		124	237					

Fig. 13 : CFLD on Pigeon Pea (IPA 203)

Fig. 14 : CFLD on Green Gram (IPM 2-3)

Technology Assessment & Refinement

- **Poor yield in pigeon pea due to low moisture during pod filling**-An on-farm trial was conducted to assess the irrigation management in pigeon pea at pod formation stage at 4 deferent locations. The results indicated that the application of irrigation at pod formation stage in raised bed sown pigeon pea crop gave 76.08 per cent increase in yield over no irrigation at pod formation stage and 45.65 percent increase in yield over irrigation at pod formation stage in broadcasted sown of pigeon pea crop.
- **Poor yield in wheat due to low moisture** -KVK, Deoria conducted an on-farm trial to assess on performance of Hydro gel in wheat crop at 4 deferent locations. The results indicated that the application of three irrigation at 20, 60 and 85 days after sowing of wheat crop gave 16.03 percent increase in yield over one irrigation at 20 days after sowing of wheat crop and 4.31 percent increase in yield over application of one irrigation at 20 days after sowing + hydro gel in wheat crop
- **Low income due to sowing of Sugarcane as mono crop**. Today, intercropping play a great role to uplift the economic status of farmers. The KVK, Deoria laid out an on-farm trail on intercropping of cowpea with spring sown sugarcane to assess the increase income through intercropping. The intercropping of cowpea in double row with sugarcane gave yield of cowpea 72.4 q/ha where as cowpea in single row crop the yield of 54.28 q/ha. Thus, farmer get additional income through intercropping in sugarcane.
- **Low yield due to pod borer infestation in Pigeon Pea**- Pigeon pea is an important pulse crop of Deoria district and high infestation of pod borer resulting in yield loss. Use of NPV 250 LE/ha + use of bird perches + spraying of Emamectin benzoate @ 100 gm/ha reduced the percentage of pod damage from 15 to 7 and yield was increased by 4.76%.
- **Loss of the farmers due to low milk production and longer inter-calving period**- A trails was conducted to evaluate the effect of Methomin based chelated mineral mixture fortified with pro-biotic in the ration of crossbred cattle on 4 cattle. It is found that supplementation of Methomin based chelated minerals fortified with probiotics @ 25 g/day/animal for a period of 06 weeks showed 12.66% increases in milk production than farmers practice.

Fig. 15: Field Day on Chickpea (GNG 1581)

Extension Activities: A total of 496 extension activities were organized during the period January to December, 2019 by the KVK (Table 11; Fig. 15 & 16).

Table 11 : Extension Programme

Activities	No. of programmes	No. of farmers	No. of Extension Personnel	Total
Advisory Services	320	215	18	233
Diagnostic visits	54	26	0	26
Field Day	6	123	7	130
Group discussions				0
Kisan Ghosthi	14	1314	28	1342
Kisan Mela	1	3150	50	3200
Exhibition	4	11025	134	11159
Scientists' visit to farmers field	89	110	0	110
Method Demonstrations	1	45		45
Celebration of important days	5	153	0	153
Special day celebration	2	243	5	248
Total	496	16404	242	16646

Fig. 16: Celebration of Farm Women Day

ICAR- KRISHI VIGYAN KENDRA, KUSHINAGAR

Training Programmes: Krishi Vigyan Kendra, Kushinagar organized 82 need based on and off–campus training programmes under human resource development comprising diverse aspects of production technologies of cereals, oilseeds, pulses, vegetables, livestock, soil health management, value addition, household food security, and women empowerment benefitting a total of 1780 participants comprising 463 female and 1317 male farmers, rural youth and extension functionaries (Table 12 & Fig. 17).

Table 12 : Training programmes organized

Clientele	No. of Courses	Male	Female	Total participants
Farmers & Farm Women	69	1015	421	1436
Rural Youths	06	60	24	84
Sponsored Training	4	178	-	178
Extension functionaries	3	64	18	82
Total	82	1317	463	1780

Fig. 17 : Training on Crop Diversification

Frontline demonstration: Front line demonstration were conducted in 47.48 ha area with 392 unit at 341 farmers field on Paddy, Mustard, Lentil, Wheat, Onion, Sugarcane inter cropping, Fodder production, Nutritional Garden and Drumstick plant (Fig. 18 & 19; Table 13).

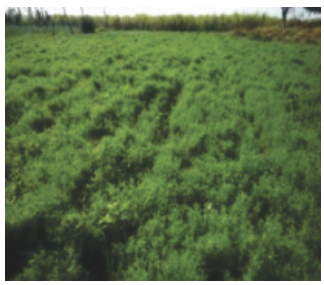

Fig. 18 : CFLD on Lentil

Fig. 19 : FLD on onion Var.- Agri- found Light Red

Technology Assessment and Refinement

- **Assessment of planting method on yield of sugarcane:** KVK (ICAR-IIVR), Kushinagar assessed

Table 13 : Frontline Demonstration on Crops

S.N.	Crop	Technology demonstrated	Horizontal spread of technology				
			No. of farmers	Area in ha	Demo Yield	Check Yield	Yield Increase %
1.	Paddy	Drum Seeder	15	5.0	52.8	40.5	30.37
2.	Paddy	Drum Seeder	20	15	58.55	44.60	23.83
3.	Onion	Agri found Light Red	18	1.0	287.4	240.8	19.35
4.	Intercropping Potato + Sugarcane	(K. Sinduri) + (CO-0238)	6	0.48	115.5 Potato + 710-5 Sugarcane	734.2	12.5
5.	Cowpea	Kashi Kanchan	7	1.0	43.8 Cowpea + 676-5 Sugarcane	664.4	8.41
6.	Drumstick	PKM-1	250	250 (nos.)	Consumption of leaves per head-40g g/day		Consumption-300 g/day, use for compost making
7.	Nutritional garden	Nutritional garden (Zaid -2019)	15	15 (150 m²)	313	235	33.19
8.	Nutritional garden	Nutritional garden (Kharif 2019	10	10 (150 m²)	401	271	47.9
Total			341	47.48 (392)			

the technology Effect of planting method on sugarcane in the year 2017- 2019 and result shows that planting of sugarcane in paired row (T_1) gave higher yield i.e.725.35q/ha with B.C. ratio 2.14:1 in comparison to flatbed sowing (T_0) i.e. 350.57 q/ha with B:C ratio 1.2:1. Sowing of sugarcane in paired row save, seeds, fertilizers, fuels, water and man power and increases the productivity of crop. This technology also improves the physical properties of soil and also helps to increase the root length of sugarcane (Fig. 20).

Fig.20 : Standing crop of sugarcane

- **Effect of farm mechanization on soil health and wheat yield:** KVK, Kushinagar assessed the technology effect of farm mechanization on soil health and wheat yield in the year 2018-2019 rabi at 05 farmers fields. Use of zero till for sowing of wheat ($\mathbf{T_3}$) gave higher yield i.e.38.55 q/ha with B.C. ratio 2.85:1.Comparison to other practices of wheat sowing use of zero till for sowing of wheat ($\mathbf{T_3}$) save seed, fertilizer, fuels, water and man power and increases the productivity of wheat crop. This technology improver the physical properties of soil and also helps to increase the root length of wheat and prevent lodging of wheat during storms. Soil samples taken before sowing and after residue incorporation in soils after harvesting. Maximum soil sample values falls under low to medium category of nutrients. After residue incorporation in soils or after harvesting soil samples have taken but report preparation is under progress. It is observed that the increase in soil health after use of zero till for sowing of wheat ($\mathbf{T_3}$) cultivation in the district (Fig. 21).

Fig.21 : Sowing of seed

- **Effect of residue management on soil health and wheat yield:** KVK, Kushinagar assessed the technology effect of residue management on soil health and wheat yield in the year 2018-2019 rabi at 05 farmers fields. Full residue management in wheat

and zero till sowing (**T2)** gave higher yield i.e.55.05 q/ha with B.C. ratio 3.96:1 comparison to other practices of wheat sowing use of zero till for sowing of wheat (**T2)** save seed, fertilizer, fuels, water and man power and increases the productivity of wheat crop. This technology improver the physical properties of soil and also helps to increase the root length of wheat and prevent lodging of wheat during storms. Soil samples taken before sowing and after residue incorporation in soils after harvesting. Maximum soil sample values falls under low to medium category of nutrients. After residue incorporation in soils or after harvesting soil samples have taken but report preparation is under progress. It is observed that the increase in soil health after use of zero till for sowing of wheat (**T2)** cultivation in the district (Fig. 22).

Fig. 22 : Full residue management

- **Intercropping of onion with sugarcane for increasing income per unit area:** Krishi Vigyan Kendra Kushinagar conducted On farm trial in rabi, 2018-19 on effect of intercropping of onion variety NHRDF Red with sugarcane (CO-0238) at three (03) selected farmer's field to enhance the total income per unit area of the farmers. Average yield of onion 135.3 q/ha and sugarcane 690.3 q/ha was harvested with the trial of intercropping of onion + Sugarcane while only sugarcane yield was noted 721.6 q/ha as mono-crop. Farmers are grown sugarcane as mono-crop usually. Average net return was recorded from intercropping of onion + Sugarcane Rs. 218087.5 per hectare with benefit cost ratio 2.90:1 whereas only Rs. 141920 per hectare found from Sugarcanes mono-crop with benefit cost ratio 2.53:1.
- **Supplementary feeding of the children:** Krishi Vigyan Kendra Kushinagar conducted On Farm Trial on supplementary feeding covering 45 children of age group 2-5 years during the year 2018-19. To conduct the OFT 173 children were anthropometrically measured with the help of Anganwadi workers of the village Abhinayakpur. Forty-five respondent was selected for three trial. In trial one supplementary food was not provided to the respondent. The supplementary food consist of Whole Wheat Flour : Green Gram and Till in the ratio of 70:25:5 was given to the children as a trial two and the supplementary food consist of Whole Wheat Flour : Soyabean and Till in the ratio of 70:25:5 was given to the children as a trial three .The number of respondents was same in the all three trials i.e., 15. The result of trial three showed the maximum increase in health parameters (increase in height 5.59 % & Increase in weight 2.5 %) of children.

Extension Activities: To expedite the process of transfer of technology programme the KVK, organized 3 kisan gosthis where in 286 farmers participated. One field day were organized covering 28 farmers for demonstration of technologies. One kisan mela was organized covering 2256 farmers. KVK participated in 2exhibitions for awareness creation of farmersbenefitting a total of 749 farmers. A total 265 scientific visits to farmer's field visits by KVK officials and 265 diagnostic visits were made by the KVK scientists and S.M.S. for the benefit of 1695 farmers. Three soil health camp were undertaken to the ultimate benefit of 3065 farmers. 61 lectures were delivered as resource person benefitting more than 3065 farmers of Kushinagar and adjoining districts 4238 farmers visited KVK during 2018-19 (Table 14, 15; Fig. 23).

Table 14 : Mobile Advisory Services

No. of KVKs	No. of SMSs sent	No. of farmers benefited
1	9	19181

Table 15 : Seed and Planting Material

Samples	Quintal/Number	Farmer
Seed (q)	2513.062	508
Planting material (No.)	11026	513
Bio-Products (q)	29	3
Fish Production	12.62	11

Fig. 23 : Mahila Kisan Diwas at KVK

Institutional Activities

TRAINING PROGRAMME AND OTHER ACTIVITIES

Scheduled Caste Sub Plan (SCSP)

"Scheduled Castes Sub-Plan" has been initiated by the Government of India with an objective to promote economic development through family-oriented agricultural schemes by providing improved agricultural technologies to scheduled caste farmers. Under the guidance of Dr. Jagdish Singh, Director, Indian Institute of Vegetable Research, Varanasi, scientists have adopted 1574 SC families from 31 villages in 07 clusters for this SCSP in Varanasi, Mirzapur, Sonbhadra and Chandauli districts of Uttar Pradesh. Most of the SC families living in these selected villages, often suffer from nutritional disorders due to lack of balanced diet. Considering this problem, during 2019 a total of 2500 kitchen garden seed packets were provided to selected SC households during different cropping season which help them in not only meeting the daily requirement of vegetables in their family but also provide an extra remuneration of Rs. 500-600 per month by selling excess vegetables from kitchen garden in the village. Apart from kitchen garden, demonstrations of improved vegetable varieties developed by IIVR along with wheat (HD 2967), mustard (NDR 8501), gram (Pusa 362) and lentil (NDL 1) were conducted in more than 194 ha area which showed a significant increase in yield (13.3%) compare to existing cultivar. In vegetables, demonstrations of 18 varieties/hybrids developed by institute i.e. Okra (Kashi Kranti), Cowpea (Kashi Kanchan, Kashi Nidhi), Bottle gourd (Kashi Ganga), Sponge gourd (Kashi Jyoti, Kashi Shreya, Kashi Rakshita & Kashi Saumya), Ridge gourd (Kashi Shivani), Chilli (Kashi Anmol), Brinjal (Kashi Taru and Kashi Sandesh), Tomato (Kashi Adarsh, Kashi Aman and Kashi Vishesh) , Pumpkin (Kashi Harit), Sem (Kashi Haritima), Pea (Kashi Nandini) and Cauliflower (Kashi Gobhi-25) were conducted at 978 farmers' field in an area of 88.48 ha which fetched an average increase in yield of 17.83% compare to existing cultivar.

For promotion of small scale entrepreneurship, 35 adolescent girls from Bhalukudar village of Sonbhadra district were provided training for vegetables' nursery raising in portrays. This adolescent group was provided with seeds of tomato, brinjal, chilli and cauliflower along with portrays, cocopit, vermiculite and perlite mixture for seedling production. As the result these girls earned upto Rs. 900/- by selling nursery in villages

itself. One grafted plants of each Mango variety Amrapali and Malika were provided to 100 SC farmers in Badagaon cluster in Varanasi. Apart from 23 interactions meeting with growers of selected villages, 05 Farmer Field School on vegetables for small scale entrepreneurship were also organized for SC rural youth.

International Training Programme of Indo-Africa Forum Summit III on Value Addition and Product Diversification in Vegetables

ICAR-IIVR, Varanasi has organised Short Term International Training Programme under Indo-Africa Forum Summit III on "Value Addition and Product Diversification in Vegetables" during 2 - 16 August, 2019 which was inaugurated by Sri Surya Pratap Shahi, Hon'ble Agricultural Minister, Govt. of Uttar Pradesh. Seven participants from Malawi, Comoros, Kenya and Ghana of African continent had participated in this training programme. The participants were of heterogeneous background like Soil Scientist, Extension officer, Biotechnology Engineering, Biotechnology and Microbiology Engineering, Agribusiness officer and Agribusiness and Marketing Officer. There had been 22 lectures delivered from faculty members of Institute of Agricultural Sciences, BHU, Varanasi, National Seed Research Training Centre, Varanasi and faculty members of IIVR, Varanasi. The lectures covered topics like strategies and challenges of vegetable processing, value addition in vegetables through product diversification, application of market intelligence and information communication technology in vegetable value chain, role of Agri Business incubator in total value chain, role of agricultural extension in transferring vegetable processing technologies and prospects of self-help group in vegetable processing industries. Practical classes were also conducted on biochemical analysis of vegetables, texture profile analysis, shellac based edible coating for extending the shelf life and quality attributes of vegetables and low-cost drying technology of leafy vegetables. Participants had also visited Centre of Food Technology, Banaras Hindu University, Varanasi, Surabhi Shodh Sansthan, Dagmagpur and relevant tourist places in and around Varanasi. During the training programme, there had been significant improvement in the knowledge of the participants. A manual consisting of all lectures and practical session conducted has been compiled and given to the participants for future reference.

Dr Arvind Kumar, Director, International Rice Research Institute, South Asian Regional Centre, Varanasi was the Chief Guest during valedictory function of this training programme and he expressed the need of value addition and product diversification in his valedictory remark as there had been ample opportunities of product diversification in vegetables. Dr Jagdish Singh, Director, ICAR-Indian Institute of Vegetable Research, Varanasi also highlighted the importance of value addition to meet the nutritional and food security and he told that It is expected that Indo-African training programme would be fruitful to the participants of 4 African countries to update their knowledge in value addition and product diversification in vegetables which would ultimately help in minimizing the post-harvest losses of perishable vegetables with substantial value chain. This whole training programme was coordinated by Dr. Sudhir Singh and Dr. Neeraj Singh, Principal Scientists of this institute.

Okra Field Day

A field day on Okra was organized at ICAR-IIVR, Varanasi by its Zonal Technology Management Unit on 03 October, 2019 to showcase and commercialize the promising okra varieties, hybrids and advanced lines developed by the Institute. The event was inaugurated

by Dr. D.P. Ray, Former Vice Chancellor, Odisha University of Agriculture and Technology, Bhubaneshwar (OUAT) and was attended by more than 30 breeders and marketing strategists from 17 private vegetable seed-companies like Ankur Seeds, Mahyco Seeds, Advanta Seeds, Gemini Seeds, Eagle Seeds, Shipra Vegetables, Nunhems Seeds, JK Agri-Genetics, Metahelix Life Sciences, Sakata Seeds, Ascen Hyveg, Kalash Seeds, Doctor Seed, Sayaji Seeds, Lucky Seeds, Namdhari Seeds, Swarna Hybrids and others. The representatives' of seed-companies visited the okra field of the Institute and appreciated the varieties, hybrids and other advanced breeding lines developed by the Institute. Kashi Lalima-the Red coloured Bhindi along with advance breeding lines tolerant to Okra Yellow Vein Mosaic Virus and Enation Leaf Curl Virus like VRO-120 and VRO-124 were the centre of attraction for the delegates. The representatives critically observed the promising materials and expressed their desire to get some of the promising advanced breeding lines, combining virus-resistance and high-yield. The Director, Dr. Jagdish Singh expressed his keen desire for an effective collaboration with the private sector in PPP mode to extend the technologies of the Institute into farmers' field within the ambit of ICAR guidelines.

Pointed Gourd Field Day cum Kisan Gosthi

The Zonal Technology Management Unit of ICAR-IIVR, Varanasi organized Pointed Gourd Field Day cum Kisan Gosthi on 21 June, 2019 at Haripur (Kaniyar) village in Badagaon block of Varanasi (U.P.) which was inaugurated by Dr. A.K. Singh, DDG (Hort. Science), ICAR, New. On this occasion, more than 100 vegetable growers from nearby villages visited the demonstration plots of pointed gourd varieties developed by ICAR-IIVR in the village wherein, 02 promising varieties of pointed gourd viz., Kashi Alankar and Kashi Suphal along with advance line VRPG-141 were demonstrated in more than 5ha. area along with improved production technologies like plastic mulch, drip irrigation and fruit fly trap. The farmers showed their great satisfaction on the performance of demonstrated pointed gourd cultivars and said it not only gave better quality but also more yield and revenue than existing local varieties. Addressing the farmers during Kisan Gosthi, Dr. A.K. Singh, DDG (Hort. Science) said that Eastern Uttar Pradesh in general, and Varanasi, Mirzapur, Gazipur and Ballia in particular, are having great potential of growing pointed gourd but due to low yield and more disease infestation in local cultivars, area under this crop is reducing. He appreciated the efforts made by ICAR-IIVR to promote improved varieties of pointed gourd as well as other vegetables in the farmers' field.

World Honey Bee Day

World Honey Bee Day was organized by ICAR-Indian Institute of Vegetable Research, Varanasi on 20 May, 2019 at Village Paniara in Araziline block of Varanasi which was attended by more than 50 male and female farmers. On this occasion, Dr. K.K. Pandey, HOD (Crop Protection) and Principal Investigator (Integrated Beekeeping Development Centre) said that beekeeping is an agricultural enterprise to create employment and income for the rural farmers and youth. Farmers should adopt beekeeping along with farming. This initiative will help in making 'Madhu kranti' successful in Uttar Pradesh and doubling the income of farmers. Beekeeping leads to the attainment of honey, wax, royal Jelly, etc., as well as pollination in pulses, oilseeds and vegetable crops. In order to maintain the quality of honey in the international market, beekeepers should follow the prescribed norms and process in honey

production and visit Institute's Integrated Beekeeping Development Centre for further training and advice in management of diseases and pests in honey bee keeping, processing and storage of honey, adulteration of pesticides and antibiotics in honey. Farmers were also informed about the medicinal and economic benefits of bee-keeping products like honey, wax, propolis, royal jelly and pollen.

Institute Celebrated its 29th Foundation Day

ICAR-Indian Institute of Vegetable Research, Varanasi celebrated its 29th foundation day on 28 September, 2019. Prof. Arvind Kumar, Vice-chancellor, Rani Lakshmi Bai Central Agricultural University, Jhansi, inaugurated the programme in presence of Dr Mangala Rai, Former Secretary DARE & DG, ICAR &; Dr Gautam Kalloo, Former DDG (HS), ICAR; Dr Ramesh Chand, Director, Institute of Agricultural Sciences, BHU; Dr. Arvind Kumar, Director, IRRI-South Asia Regional Centre, Varanasi and other dignitaries On this occasion, Prof Arvind Kumar said that India has attained self-dependency in the area of food production, but for securing nutritional and livelihood security production

of value added vegetables will be playing an important role. Today production of horticultural crops is higher compared to food crops. It will help in the fight for achieving the nutritional security. He appreciated the improved varieties and technologies developed by the institute. Dr. Mangala Rai emphasized on sustainable agriculture for vegetable farmers by maintaining soil health and water management practices in the present era of climate change. He asked the scientists to develop the technologies for solving the problems associated with vegetable processing, value addition, and storage. Founder director of the institute Dr. Gautam Kalloo elaborated in detail the interesting stories linked with the establishment of the IIVR, and said that because of hard efforts of this vegetable family, institute has achieved a new height in the area of vegetable research.

On this occasion Dr. Jagdish Singh, Director, ICAR-Indian Institute of Vegetable Research elaborated the research achievements of the institute since its inception and how the farmers are getting benefitted by scientific research through different extension programs like Mera Gao Mera Gaurav, SC/ST sub plan, Farmers' FIRST etc. More than 400 farmers from different adopted villages were present on this occasion and three innovative farmers Ananda Kumar Patel, Mannu Yadav, and Shitala Devi were honoured with the letter of appreciation.

37th Annual Group Meeting of AICRP on Vegetable Crops

The ICAR-Indian Institute of Vegetable Research, Varanasi organized the 37th Annual Group Meeting of All India Coordinated Research Project on Vegetables at Tamil Nadu Agricultural University, Coimbatore from 22 - 25 June, 2019. The Scientists from 54 Centres, 40 Private Seed Companies and invited farmers had

participated in this 04 days meeting The Chief Guest, Dr. Kirti Singh, Former Chairman, ASRB, New Delhi applauded the remarkable contributions of Dr. N. Kumar, Vice-Chancellor, TNAU and his team in the field of vegetable research. Dr. T. Janakiram, ADG (Horticulture Science), ICAR, New Delhi stated about the spread of varieties and technologies developed by the institute. He emphasized on the need for addressing the various challenges. Dr. Janakiram stressed upon the seed production system for North East, improvement of seed replacement, development of processable varieties and vertical farming research. Dr. D.P. Ray, Former Vice-Chancellor, Odisha University of Agriculture and Technology, Bhubaneswar delivered the special address. Dr. R. Rathinam, Former Director, National Research Centre on Oil Palm and Former Executive Director, Asia Pacific Coconut Community delivered the felicitation address. Earlier, Dr. K.S. Subramanian, Director (Research), Tamil Nadu Agricultural University, Coimbatore stressed on the importance of vegetable research in enhancing the nutrition to people. Dr. Jagdish Singh, Director, Indian Institute of Vegetable Research, Varanasi delivered the project remarks and coordinators report. The Annual Report 2018-19 along with the proceedings and recommendations of 1st Vegetable Science Congress along with 3 books, viz., Good Agricultural Practices in Vegetable Crops, A glance on Vegetable varieties of TNAU and Grafting Technology in Vegetable Crops were released on the occasion.

Interactive Meeting of KVKs from Eastern Uttar Pradesh

Interactive meeting with the heads of 13 Krishi Vigyan Kendras located in Eastern Uttar Pradesh - Varanasi, Mirzapur, Chandauli, Sonbhadra, Bhadohi, Ghazipur, Mau, Jaunpur, Baliya, Azamgarh, Prayagraj, Kaushambhi and Pratapgarh was organised at ICAR-Indian Institute of Vegetable Research, Varanasi on 08 April, 2019 under the chairmanship of Dr. A. K. Singh, DDG (Agricultural Extension), ICAR, New Delhi in presence of Dr. Panjab Singh, Former Secretary, DARE & DG, ICAR, New Delhi, Dr. Attar Singh, Director, ICAR-ATARI, Kanpur, Dr. Arvind Kumar, Director, IRRI-SARC, Varanasi, Dr. Ramesh Chand, Director, IAS, BHU, Varanasi, Dr. Jagdish Singh, Director, ICAR-IIVR, Varanasi, Scientists of IIVR and progressive farmers of Eastern Uttar Pradesh.

On the occasion, Dr. Jagdish Singh, Director, ICAR-IIVR focussed on the improved vegetables varieties and technologies developed by the institute for giving more benefit to the farmers. While chairing this meeting, Dr. A.K. Singh, DDG, Agriculture Extension emphasized on the transfer of technology to Krishi Vigyan Kendras and the role of private institutions. He asked all KVKs to select Farmers' Producer Organizations working in the area and provide necessary training and technical

knowledge to farmers. He laid special emphasis on making various schemes of KVKs such as Nari, Arya, Vatika etc. to reach out to more farmers and strengthened the spread of technologies through self-help groups. Other dignitaries also expressed their views to strengthen the role of KVKs for effective transfer of technologies.

21st Research Advisory Committee meeting

21st Research Advisory Committee meeting was held at ICAR-Indian Institute of Vegetable Research, Varanasi on 5 - 6 November, 2019 under the chairmanship of Dr. K. E. Lawande, former Vice Chancellor, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Other members of this research advisory committee include Dr. T. Janakiram, ADG, Horticulture, ICAR, New Delhi, Dr. P.S. Pandey, ADG, Education Planning and Home Science, ICAR, New Delhi, Dr. S. M. S. Tomar, Former Principal Scientist, IARI, New Delhi, Dr. P.S. Sirohi, Professor IARI, New Delhi and Mrs. Priyanka Patel who participated as member of the Management Committee. The RAC reviewed the research work of different in-house projects operational at the institute during last one year. During the review, Dr. P.M. Singh, Head, Vegetable Improvement Division, Dr. R.N. Prasad, Head, Vegetable Production Division and Dr. K.K. Pandey, Head, Vegetable Protection Division presented the achievements of the last year and the objectives for next year. Dr. Jagdish Singh, Director of the institute, welcomed the guests and gave information about the overall achievements of the institute. This committee interacted with all the scientists of the institute and visited the research farm and laboratories. The chairman and members of the committee expressed their satisfaction on the research work being done in the institute and appreciated the efforts of scientists.

Entrepreneurship Development Programme for Rural Youth

Agri-Business Incubation Unit, ICAR-IIVR, Varanasi in collaboration with National Horticulture Board, Gurugram organized 02 Training Program on – Entrepreneurship development in Vegetables for Rural Youth of East Champaran, Bihar of 21 days duration each during 14 November – 04 December and 10 – 30 December, 2019 in which 34 rural youth from East Chanparan district of Bihar had participated. During this EDP, participants were acquainted with various entrepreneurship module in vegetables and allied field

like fresh vegetable production, underutilized vegetable production, disease and pest management in vegetables, seed production in vegetables, post-harvest management and value addition in vegetables, protected vegetable cultivation, nursery management, water management, mushroom cultivation, beekeeping, organic farming, crop nutrient management, crop residue management, vegetable marketing, development of Farmers Producer Company etc. through 35 lectures and 13 practical conducted by experts from ICAR-IIVR, BHU, NSRTC,

NSC, NHB, NHRDF and UP State Seed Certification Agency. Apart from these residential training, participants were also exposed to BHU, IRRI-SARC, NSRTC, Surbhi Soodh Sansthan, FPO at Ghazipur, Azamgarh etc during 05 days internship programme. At the end of this training programme participants were provided with improved quality vegetable seeds developed by the institute along with various literatures including compendium prepared for the purpose. This whole EDP training was coordinated by ABI team under the dynamic leadership of Dr. Jagdish Singh, Director of the institute.

Certified Farm Advisor Training Programme

ICAR-Indian Institute of Vegetable Research, Varanasi in collaboration with MANAGE, Hyderabad organized 15 days Certified Farm Advisor Training Program on – Advanced Vegetable Production Technologies for Enhancing Productivity and Nutritional Security during 10 – 24 October, 2019. In this CFA training programme a total of 30 State Agriculture/Horticulture Officials had participated from 11 different states of the country viz., Himachal Pradesh, Haryana, Bihar, Jharkhand, Nagaland, Goa, Odisha, Telangana, Karnataka, Tamilnadu and Kerala. This completely residential training programme covered both theory and practical aspects of various advanced production technologies in vegetables like Organic vegetable production, protected cultivation, tissue culture, Integrated nutrient management, Integrated pest and disease management, hybrid/open pollinated vegetable seed production, processing and value addition in vegetables, vegetable marketing options etc. covering wide range of vegetable crops like tomato, brinjal, capsicum, cole crops, melons, gourds, vegetable pea, okra, cowpea, chilly, leafy vegetables and other underutilized vegetables. Field visits were also arranged to Jalan organic farm, Dhagmagpur, Institute of Agricultural Sciences, Banaras Hindu University (BHU) and National Seed Research & Training Centre (NSRTC), Varanasi. At the end of this training programme participants were provided with improved quality vegetable seeds developed by the institute along with various literatures including compendium prepared for the purpose.

Visit of Ms. Dolly Chakraborty, Additional Secretary, MoA&FW, Government of India

On 21 May, 2019, Ms. Dolly Chakraborty, Additional Secretary, Ministry of Agriculture and Farmers Welfare, Government of India visited the Research farm and Integrated Beekeeping Development Centre at ICAR-IIVR, Varanasi and reviewed the research and dissemination programs related to vegetable

cultivation. She expressed satisfaction and appreciated the efforts of scientists in the institute. She said that to cater to the demand of vegetables, the institute has developed many varieties and scientific techniques which will help the farmers in increasing their income by cultivating at low cost during the cropping season and off season. While visiting IBDC in the institute she said that Bee keeping has additional benefits in crop

production by enhancing productivity as well as generating more income by producing quality honey.

Visit of Shri Rajesh Verma, Additional Secretary, DAC&FW, MoA&FW, Government of India

Shri Rajesh Verma, Additional Secretary, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India visited the institute on 4 October, 2019. He visited vegetable seed processing and seed storage unit. Reviewing the programs being run for research and farmers related to vegetable cultivation and seed production of vegetables, he expressed satisfaction and appreciated the scientists of the institute. He said that there has been a record increase in the production of vegetables in the country, but there is a need to spread more technical knowledge and innovation in order to increase the holdings and productivity of vegetable cultivation so that farmers can be benefitted. To increase the productivity of vegetable crops, along with quality seed production, he suggested developing the advanced processing techniques to protect vegetables from damage. Director of the institute, Dr. Jagdish Singh gave information about research work being done in vegetables, seed production, vegetable production , preservation and processing techniques and other achievements.

Official language workshop

The Quarterly Official Language Workshops were organized by the institute on "Promotion of Official Language in Administrative Works" on 6 June, 2019; "How to do internal work in Hindi for office empowerment" during 4 September, 2019 and "Simplification of Agricultural Research for publication in Hindi" on 11 December 2019. The main objective was to encourage and suggest scientists and technical officers of the institute regarding the use of official language more and more in their official as well as day-to-day work. During these workshops, Dr. Sanjay Singh, Secretary, NARAKAS and Senior Official Language Officer, DLW, Varanasi said that the aim of Hindi translation should be not only conversion but dissemination of knowledge. On this occasion, Director of the Institute said that all languages have their own importance but the language which can easily connect with the public mind need to be emphasised. He said that agricultural scientists and technical officers have to work with the farmers, so they should fulfil their constitutional obligations by using Hindi in their writing and discussion. Dr. Hare Krishna, Principal Scientist of this institute stressed on various types of tools to make scientific writing easy in Hindi, such as e-Mahabdkosh, Leela, Google Translator and methods and benefits of using TDIL and CSTT website.

Hindi Chetana Mass

Hindi Chetna Mass was celebrated at Indian Institute of Vegetable Research Institute, Varanasi from 14 September – 13 October, 2019. Dr. Sharad Kumar, Head of Department, Government College, Zakkhini, Varanasi inaugurated this event and appreciated the work being done in Hindi at the Institute. He told about various aspects to use Hindi language easily. During

this Hindi Chetana Maas several programmes were organized for promoting Hindi language in institute e.g quiz competition, debate, extempore, essay writing etc. in which staff of the institute had participated. The closing ceremony of Hindi Chetana Mass 2019 was held on 14 October, 2019 at the institute. On this occasion winners of various competitions were awarded by the Director of the institute.

World Food Safety Day

ICAR-Indian Institute of Vegetable Research, Varanasi celebrated the World Food Safety day on 7 June, 2019. The programme started with taking pledge collectively by the staff of the institute regarding the issues related with food safety. Dr. Sudhir Singh, Principal Scientist (Food technology) presented briefly the importance of five pillars in food safety such as maintenance of personal hygiene, cooking and cleaning surrounding areas, follow keys to safer foods, check food for adulteration and spoilage before consumption and read the labels to know what you are eating. In India, Food Safety and Standards Authority of India (FSSAI) is responsible for protecting and promoting public health issues through the regulation and supervision of food safety. Posters on Food safety have also been displayed at the premises of ICAR- IIVR, Varanasi for general awareness on food safety.

Parthenium Awareness Week

Parthenium, known by different names in different parts of the country, such as congress grass, white cap, bright moonlight, perfumed herb etc. is a plant originally from the continent of North America. This plant is one of the world's ten most damaging weeds. Parthenium causes diseases like skin diseases, eczema, allergies, fever, asthma etc. in humans. This plant is also very harmful for animals. In view of its harmful effects,

Parthenium Awareness Week observed from 16 - 22 August, 2019 at ICAR-Indian Institute of Vegetable Research, Varanasi. On this occasion, Dr. Jagdish Singh, Director of the Institute, told that Parthenium was first reported from Pune during 1955. Due to its insensitivity to heat and light, it can flower in any season and capable of producing seeds under any extreme conditions. 10,000 to 15,000 seeds can be produced from one plant and year after year it is spreading rapidly across the country due to its capabilities. He emphasized to control this plant before flowering.

International Yoga Day

International Yoga Day was celebrated at ICAR-Indian Institute of Vegetable Research, Varanasi on 21 June, 2019. All the employees of the institute, including scientists, technical and administrative officials participated in the program with enthusiasm. In this programme, various yogic exercises, asanas, and pranayama were demonstrated by Yoga experts Sri Chandresh Dube and Sri Girish Upadhyay. They emphasized that regular practice of these asana and pranayama would be helpful in getting rid of various types of body pains and several diseases such as stress, diabetes, blood pressure and asthma. At the end of the session, all the employees of the institute resolved to practice yoga daily.

Campaign for *Swachhata Hi Seva* and "No Single Use Plastic"

Special *Swachhta* campaign "*Swachhata Hi Seva*" organized at ICAR-IIVR, Varanasi, with the *Swachhta* Pledge (Cleanliness Oath) by the Scientific, Technical, Administrative and Skilled Support Staff of the Institute during 11 September - 02 October, 2019 and 16 - 31 December, 2019. During Pledge, Director of the Institute highlighted the benefits of cleanliness and hygiene in the campus, surroundings and the residential areas. The

staff committed themselves for at least 100 hours of Cleanliness action on their part. During the program institute and its mini campus, laboratories, main gate and its adjoining roads, residential areas as well as guest house etc. were cleaned. One day also devoted to clean the individual office rooms as well as weeding out of obsolete records. Extensive Cleanliness Drive was undertaken by one and all during the campaign.

Campaign for "No Single Use Plastic" for encouraging less/ no use of plastic bags was also launched. Charts/ display boards were prepared. Drawbacks and health hazards associated with continuous uses of plastics in daily life were highlighted in the awareness program during 11 September – 2 October, 2019. As a part of the

awareness program, different crop/vegetable residues, rather than conventional burning and there by polluting the environment, are directed to make the compost in the residue management unit of the institute. Accordingly, residues of okra, bottle gourd, bitter gourd and pumpkin after their seed harvesting were extensively used for the vermicompost which is further used for organic manure for sustainable agriculture without zero pollution to the environment.

Apart from the above, a special *Swachhata* awareness programme was also organized amongst the 42 farmers

from Jharkhand and Uttar Pradesh attending a training programme at ICAR-IIVR, Varanasi. During the campaign they were sensitized about the fostering of different healthy practices viz., use of toilets, using of soap before meals, preparation of organic pit with kitchen/domestic wastes, removal of stagnant water around the house etc. in their daily life. They were also enlightened about the safe use of pesticides and organic farming for safe vegetable production.

Implementation of the Preamble of the Constitution

The officers and staff of the Institute took the oath of the Preamble of the Constitution on 26 November, 2019 in which Dr. Jagdish Singh, Director of the institute motivated everyone to participate in this campaign. While discussing the Constitution of India he said that the Indian Constitution is the largest and most comprehensive constitution in the world which establishes a dominating, democratic, secular, socialist republic. Our country is a democratic secular state. A parliamentary government has been established according to the federal system. The real power rests with the Council of Ministers, which is answerable to the legislature and is formed by its members. Another feature of the Indian Constitution is the declaration of fundamental rights and the mention of fundamental duties. The mention of 'Directive Principles of State

Policy' in Part 4 of the constitution is another feature of the Indian Constitution, which has been considered as a sacred duty of the state.

AWARDS, HONOURS, RECOGNITIONS AND PATENTS

- Harbhajan Singh Memorial Award conferred for the paper "Optimization of quality DNA isolation protocol from various mucilage rich cultivated and wild Abelmoschus sp. and its validation through PCR amplification" in Vegetable Science 45(1): 1-6 to Seth T, Mishra GP, Singh B, Kashyap S, Mishra SK, Tiwari SK and Singh PM during 37th Group meeting of AICRP (VC) from 22-25 June, 2019 at TNAU, Coimbatore.
- Fellow of Uttar Pradesh Academy of Agricultural Sciences (UPAAS) conferred on Dr. Rajesh Kumar during the National Seminar on "Priorities and strategies to boost farmers' income" at ICAR-IISR, Lucknow on 14 June, 2019.
- Hari Om Ashram Trust Award of ICAR for the Biennium 2016-17 conferred on Dr. Sudhir Singh during ICAR Annual Award Function held at New Delhi on 16 July, 2019.
- Best KVK Scientist Award conferred on Dr. Ajit Chaturvedi and Dr. Manoj Kumar Pandey in 2nd International conference on Recent advances in agricultural, environmental & applied sciences for global development (RAAEASGD- 2019) at Dr.Y S Parmar University of Horticulture and Forestry, Solan during 27-29 September, 2019.
- ISHRD Fellowship 2016 conferred on Dr. S.K. Verma for outstanding contribution in the field of Horticulture during Progressive Horticulture Conclave held at Lucknow during December 8-10, 2019.
- ISHRD Fellowship 2017 conferred on Dr. T. Chaubey for outstanding contribution in the field of Horticulture during Progressive Horticulture Conclave held at Lucknow during December 8-10, 2019.
- ISHRD Himadri Young Scientist Award 2014 conferred on Dr. Jaydeep Halder for outstanding contribution in the field of Horticulture by the Indian Society of Horticultural Research & Development (ISHRD), Uttarakhand, India during December, 2019.
- Patent No. 919/DEL/2013 by Dr. Sudhir Singh is in order of grant under Section 43 on "Method for preparation of green chilli powder" with an awaiting approval of National Biodiversity Authority, Chennai
- Best Poster Award in International Conference on Sustainable Agriculture Development in Changing Global Scenario for the poster on "Genetic diversity studies of Abelmoschus spp (wild okra) and its evaluation for horticultural traits and viral disease resistance"by Dr. Vidya Sagar, Pradip Karmakar, PM Singh, Bijendra Singh 11-13th October, 2019, BHU, Varanasi.
- Dr. Nagendra Rai inducted in the P.G. School faculty of IARI in the discipline of Vegetable Science, IARI, New Delhi, vide letter no. PGS/1-410/AC/2019 dated 17 September, 2019.
- Dr. Rakesh Kumar Dubey inducted in the P.G. School faculty of IARI in the discipline of Vegetable Science, IARI, New Delhi, vide letter no. PGS/1-410/AC/2019 dated 17 September, 2019.

HUMAN RESOURCE DEVELOPMENT

Training and Capacity Building

Training

Name of IIVR Scientists/KVKs SMS	Title of training	Duration	Held at
Vanitha, S. M.	CAFT programme on "Recent Advances in Statistical Modelling and Forecasting for Agricultural Data Analysis"	23 February – 15 March, 2019	ICAR-IASRI New Delhi
Rajeev Kumar	03 months professional attachment training	16 April – 15 May 2019	ICAR-NIASM Baramati
Pankaj Kumar Singh	Training programme on Hospitality Management	19-25 June, 2019	ICAR-NAARM Hyderabad
A.T. Rani	Training on "Plant Biosecurity and Incursion Management"	11 June – 1 July, 2019	ICAR-NIPHM Hyderabad
Anjali Sahu	Five days training programme on drudgery reduction	25-29 August, 2019	SHUATS Allahabad
Ashok Rai	Winter School on Innovations in Educational technology in agriculture	28 August- 17 September, 2019	UAS Bangalore
T. N. Rai	Short Term Training Course on "Recent advances in organic production systems involving oilseeds for soil health and export"	16-25 September 2019	ICAR-IIOR Hyderabad
S.K. Singh	Training-cum-Awareness Workshop on "J-Gate @CeRA for Northern Region"	11 October, 2019	NASC Complex New Delhi
P.M. Singh	Training on " Intellectual property Valuation & Technology Management"	15-19 October, 2019	ICAR-NAARM Hyderabad
Sujan Mujumder	Training on "Pesticide Residue Analysis"	24 October – 13 November, 2019	ICAR-NIPHM Hyderabad
Shamsher Singh	Short course on "Fruit Crop in Integrated Farming Systems for Nutritional, Environmental & Livelihood Security	2-11 November, 2019	ICAR-IIFSR Meerut
Pratap A. Divekar	21 days CAFT training on "Ecological & Molecular Approches for Host Plant Resistance to Insect Pests"	5-25 November, 2019	Department of Agricultural Entomology, TNAU Coimbatore.
A.K. Singh	Training programme on "Assets Management"	6-8 November, 2019	ICAR-IARI New Delhi
Jaydeep Halder	Short training course on "Molecular identification and DNA barcoding of insect pests and natural enemies including invasive species"	18-27 November 2019	ICAR-NBAIR Bengaluru
A. K. Chaturvedi	Winter School on " Advancement in Potato Production Technology and its Future Prospects"	19 November – 09 December, 2019	ICAR-CPRI RRS, Modipuram Meerut
S.K. Singh	Training programme on "Capacity Building programme towards a Secure & Resilent Workshop at ICAR	25-27 November 2019	ICAR-CPRI Shimla
Vijaya Rani	21 days CAFT training "Recent Advances in Endosymbiots of Plant and Insects	27 November – 17 December, 2019	Department of Agricultural Microbiology TNAU, Coimbatore
Manoj Kumar Pandey	21 days Winter school " Novel Technique in mass culturing of smart microbial bio-control agents for the development of bio-pesticides "	3-23 December, 2019	ICAR-NBAIR Bengaluru

A.K. Rai	21 days CAFT training on "Plant Diseases Monitoring for Timely Management Options"	4-25 December, 2019	ICAR-IARI New Delhi
K. Nagendran	21 days CAFT training on "Plant Diseases Monitoring for Timely Management Options"	4-25 December, 2019	ICAR-IARI New Delhi

Training and Skill Development of Farmers and Field Functionaries conducted

Sl. No.	Name of training programme	Date	Sponsored by	No. of participants
1.	Improved Vegetable Technology	8 May , 2019	ATMA, Ghazipur	39
2.	Improved Vegetable Technology	17 July, 2019	DAO, Pratapgarh	30
3.	Improved Vegetable Technology	30-31 July, 2019	NABARD, Mathura	37
4.	Organic Farming in Vegetables	20-24 August, 2019	ATMA, Patna	25
5.	Improved Production Technologies in Vegetable Crops	27-31 August, 2019	ATMA, Bhojpur	21
6.	Improved Vegetable Technology	3-4 September , 2019	NABARD, Azamgarh	49
7.	Improved Vegetable Technology	4-5 September, 2019	Agriculture Department, Narsinghpur, MP	20
8.	Improved Vegetable Technology	13 September, 2019	Agriculture Department, Anuppur, MP	30
9.	Improved Production Technologies in Vegetable Crops	17-21 September, 2019	ATMA, Dhanbad	39
10.	Improved Vegetable Technology	21 September, 2019	NABARD, Sonbhadra	48
11.	Improved Vegetable Technology	24-25 September, 2019	DHO, Lakhisarai, Bihar	25
12.	Improved Production Technologies in Vegetable Crops	24-28 September, 2019	ATMA, Kisanganj	20
13.	Improved Vegetable Technology	03October, 2019	ATMA, Jabalpur	20
14.	Improved Production Technologies in Vegetable Crops	14-18 October, 2019	DHO, Prayagraj	44
15.	Improved Production Technologies in Vegetable Crops	1-2 November, 2019	DHO, Banda	47
16.	Improved Vegetable Technology	5 November, 2019	Agriculture Department , Sidhi, MP	67
17.	Improved Vegetable Technology	6 November, 2019	Horticulture Department , Sonbhadra	101
18.	EDP on Vegetables	14 November – 4 December, 2019	NHB , Gurgaon	18
19.	Improved Production Technologies in Vegetable Crops	5-7 December, 2019	ATMA, Areriya	25
20.	Improved Vegetable Technology	6 December, 2019	NABARD, Sarguja, Chattisgarh	13
21.	EDP on Vegetables	10-30 December, 2019	NHB , Gurgaon	16

Training and Skill Development of ICAR/SAUs/State/KVKs Officials conducted

Sl. No.	Name of the programme	Date	Sponsored by	Number & Nature of participants
1.	Molecular breeding in vegetables	16-30 January, 2019	CSAUA&T, Kanpur	15 M.Sc / Ph.D students of Plant Breeding
2.	Short Term International Training Programme under Indo – Africa Forum Summit III on Value Addition and Product Diversification in Vegetables	02-16 August, 2019	Ministry of External Affairs, Government of India and DARE, Ministry of Agriculture & Farmers Welfare, Government of India	07 Senior Agricultural Officials from Malawi, Comoros, Kenya and Ghana of African continent
3.	CFA, Module II Course on Advanced Vegetable Production Technologies for Enhancing Productivity and Nutritional Security	10-24 October, 2019	MANAGE	30 State Agriculture/ Horticulture Officials from 11 states
4.	Certified Farm Advisor Programme on advance vegetable production technology for enhance production and nutritional security	10-24 October, 2019	MANAGE, Hyderabad	State officials

Seminar/symposium/conference/workshop attended

Name of Scientist	Title of seminar/ symposium/ conference/ workshop	Duration	Held at
International			
A. Bahadur	International Seminar on Agricultural Technology Innovation for South Asian Countries organized by Ministry of Agril. and Rural Affairs (MARA)	27 May - 4 June, 2019	Beijing, China
National			
J. Singh, R.N. Prasad, Sudhir Singh, S.N.S. Chaurasia, S.K. Singh, Raghvendra Singh, Hare Krishna, A. Bahadur, J. Halder and A.N. Tripathi	XXXVII Group Meeting of All India Coordinated Research Project (Vegetable Crops)	22-25 June, 2019	T.N.A.U., Coimbatore
A. Bahadur	Inter face meeting on enhancing the preparedness for agricultural contingencies	24 June, 2019	Lucknow
Sudhir Singh	Workshop on "Risk assessment framework structure novel food activities"	24 July, 2019	FSSAI, FDA Bhavan New Delhi
Y.S. Reddy and A N Tripathi	International Conference on Plant Protection in Horticulture: Advances and challenges (ICPPH-2019)	24-27 July, 2019	ICAR-IIHR, Bengaluru
Shamsher Singh	Annual zonal workshop of KVK zone – III	8-9 July, 2019	NDUAT, Faizabad
	Attended Meeting for finalizing Comprehensive District Agriculture Action Plan 2020-2021	26 September, 2019	NPC, New Delhi
Y.S. Reddy	Review and impacting assessment meeting of Indo-Australian carrier boosting gold fellowship	20 August, 2019	New Delhi

Manimurugan C. and P.A. Divekar	2nd International Conference on "Recent advances in Agricltural Environmental & Applied Sciences for Global Development" (RAAEASGD 2019)	27-29 September, 2019	Dr.YS Parmar Univesity of Horticulture & Forestry, Nauni, Solan H.P.
Jyoti Devi, Vidya Sagar, B.R. Meena, A.T. Rani and Anjali Sahu	International Conference on "Sustainable Agricultural Development in Changing Global Scenario	11-13 October, 2019	BHU, Varanasi
S.K. Singh	International Conference on "Crop residue management"	14-15 October, 2019	Patna
T.N. Rai	International conference on recent trends in Science, Technology, Agriculture and Management	20-21 October, 2019	FDDI, Fursatganj Amethi
	Mid Term Reviuw meeting of KVK	25-26 November, 2019	ICAR- ATARI, Kanpur
Anjali Sahu and R.P. Sahu	National Seminar on "Holostic approach for enhancing agricultural growth in changing rural scenario"	14-16 November, 2019	SKRAU, Bikaner
Ajay Rai	QRT meeting of KVKs	3-5 December, 2019	NDUAT, Faizabad
P.M Singh, N. Rai, A. Bahadur and Achuit Singh	VII NICRA Annual Review Workshop	17-19 December, 2019	NASC, New Delhi

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4. Halder Jaydeep, Kushwaha Deepak, Rai AB and Singh B 2019. Biology and biorational management of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae): A global challenge to tomato production. *Proceedings of the Zoological Society*, 72(2): 107-110. (DOI 10.1007/s12595-017-0232-0).
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11. Kumari S, Krishnan N, Rai AB, Singh B, Rao GP and Bertaccini A 2019. Global Status of phytoplasma diseases in vegetable crops. *Frontiers in Microbiology*, 10: 1349.
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18. Singh B, Chaubey T, Pandey S, Upadhyay DK, Singh RK, Jha A and Pandey SD 2019. Categorization of diverse and stable extant cultivars of brinjal (*Solanum melongena* L.) by using pheno-morphometric DUS characters. *The Indian Journal of Plant Genetic Resources* (Accepted).
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2. Krishna H, Tripathi AN, Singh N, Roy S and Singh J 2019. Advanced vegetable production technologies for enhancing productivity and nutritional security. *ICAR-IIVR Training Manual No. 86,* pp: 1-318.
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11. Manimurugan C, Singh Vikas, Divekar Pratap A, Gupta Nakul and Singh Priyanka 2019. Grow-out test for cultivar purity. In Training Manual of NSRTC: Seed certification for seed certification officers/inspectors, pp: 99-102.
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13. Manimurugan C, Singh Vikas, Divekar Pratap A, Gupta Nakul and Singh Priyanka 2019. Genetic purity testing through grow out test. In Training Manual of NSRTC: Seed testing for seed testing laboratory staff, pp: 81-84.
14. Manimurugan C, Singh Vikas, Divekar Pratap A, Gupta Nakul and Singh Priyanka 2019. Introduction to Indian Minimum seed certification standard. In National Training: Seed law enforcement for seed law enforcement officers/Inspectors at NSRTC, pp: 105-111.

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19. Pandey Sudhakar, Chaubey T, Haldar Jaydeep, Tripathi AN, Ansari WA and Khujur Subhra 2019. Improvement of cucurbit crops: Imersing Challanses and Strategies unde Cimate Change. In: Progressive Horticulture Conclave (PHC 2019) on "Futuristic Technologies in Horticulture organized by Indian Society of Horticultural Research and Development", pp:123-127.
20. Sharma S, Singh S and Prasad RN 2019. Scenario of postharvest management practices of vegetable crops. In Training Programme: India-Africa Forum Summit-III on "Value Addition and Product Diversification in Vegetables". ICAR-IIVR Training Manual 85, pp: 38-40.
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23. Singh B, Bahadur A, Singh DK, Krishna H and Singh J 2019. Fertigation techniques for higher vegetable production. In Manual: Protected Cultivation of Vegetable Crops under Centre for Advanced Agricultural Science & Technology on Nutritional Crops (CAAST-NC), pp: 88-98.
24. Singh N and Roy S 2019. Role of agriculture extension in transferring vegetable processing technology. In Training Programme: India-Africa Forum Summit-III on "Value Addition and Product Diversification in Vegetables". ICAR-IIVR Training manual 85, pp: 149-151.
25. Yadava RB 2019. Integrated nutrient management in vegetable crops for sustainability. In Training Programme: India-Africa Forum Summit-III on "Value Addition and Product Diversification in Vegetables". ICAR-IIVR Training manual 85, pp: 131-136.
26. Yadava RB and Prasad RN 2019. Integrated nutrient management in vegetable crops. In Certified Farm Advisor Programme (Module-II): Advanced Vegetable Production Technologies for Enhancing Productivity and Nutritional Security. ICAR- IIVR Training Manual No. 86, pp: 172-177.

Lead / Invited papers

1. Bahadur A. 2019. Invited talk on "Grafting technology to mitigate abiotic stress in vegetable crops" during Short Course Training on Seed Production and Processing of Vegetable Crops on 23 December, 2019, C.S.A.U.&T, Kanpur.
2. Lal B, Sahu RP 2019. Presented a lead talk on "Self help groups for women empowerment" during ISEE National Seminar on Holistic Approach for Enhancing Agricultural Growth in Changing Rural Scenario, November 14-16, Swami Keshwanand Rajasthan Agricultural University, Bikaner, pp: 13-18.
3. Singh Sudhir 2019. Presented a lead paper on "Shelf life extension of vegetables under MAP storage" during National Workshop in Food Packaging and Preservation, June 8, 2019, Deptartment of Animal Husbandry & Dairying, I.Ag.Sc., BHU, Varanasi.

4. Singh Sudhir 2019. Presented a lead paper on "Convenience processed vegetables to meet food challenges" during International Conference on sustainable agricultural development in changing global Scenario, October 11-13, 2019, I.Ag.Sc. BHU, Varanasi.

Book chapters/Proceeding chapters/Reviews

1. Bhatt Bhavin S and Singh Achuit K 2019. Engineering plastid pathways: An environment-Friendly alternative for in planta transformation. *In: Plant Pathogens Detection and Management for Sustainable Agriculture. Springer, Cham* (Hard ISBN: 9781771887885) pp: 287-311.
2. Bhatt Bhavin S, Chahwala Fenisha D, Sangeeta, Yadav Brijesh K, Singh Bijendra and Singh Achuit K 2019. Distribution of geminivirus in the Indian subcontinent. *In: Geminiviruses. Springer, Cham* (Print ISBN 978-3-030-18247-2), DOI.Org/10.1007/978-3-030-18248-9_3. pp: 39-64.
3. Girish PM, Sisodia A, Sharma S, Singh AK and Choudhary SK 2019. Flowers used as food dye. *In: Climate change and its impact on global food security and sustainability of agriculture. Publisher –Mahima Research foundation and social welfare. ISBN: 9788194337508,* pp: 168-172.
4. Pandey MK, Chaturvedi AK, Choudhary GK, Chaudhary RP and Singh PC 2019. Bundelkhand kshetra me kharif ki sabjiyon ke pramukh rog evam unka upchar. *In: Krishi Jiwan, Rani Laxmibayi Kendriya Vishwavidyalaya, Jhansi, Second Edition,* pp: 31-39.
5. Rai KK, Rai N and Rai SP 2019. Enhancing abiotic stress tolerance in hyacinth bean (*Lablab purpureus* L.) *In: Innovation in Life Science Research, Nova Science Publisher,* pp: 231-267.
6. Rai Trilok Nath, Rai Kedar Nath, Rai Sanjeev Kumar and Rai Sadhna 2019. Role of water for growth and development of crops. *In: Environmental Issues and Sustainable Agriculture. Published by Weser Books, First Edition: 2019.* ISBN: 978-3-96492-154-3, pp: 147-149.
7. Rai Trilok Nath, Rai Kedar Nath, Rai Sanjeev Kumar and Rai Sadhna 2019. Irrigation Management in Different Major crops of Kushinagar and Sultanpur District of U.P. *In: New Dimension for Crop Sciences. Published by Weser Books, First Edition: 2019,* ISBN: 978-3-96492-155-0 pp: 51-56.
8. Rai Trilok Nath, Rai Kedar Nath, Rai Sanjeev Kumar and Rai Sadhna 2019. Plant Nutrition: Meaning, Elements, Forms and Nutrition. *In: New Dimension for Crop Sciences. Published by Weser Books, First Edition: 2019,* ISBN: 978-3-96492-155-0, pp: 57-60.
9. Rai Trilok Nath, Rai Kedar Nath, Rai Sanjeev Kumar and Rai Sadhna 2019. Methods of fertilizer application. *In: New Dimension for Crop Sciences. Published by Weser Books, First Edition: 2019,* ISBN: 978-3-96492-155-0, pp : 61-81.
10. Rai Trilok Nath, Rai Kedar Nath, Sanjeev Rai Kumar and Rai Sadhna 2019. Analytical techniques for soil testing. *In: Environmental Issues and Sustainable Agriculture. Published by Weser Books, First Edition: 2019* ISBN: 978-3-96492-154-3, pp: 144-146.
11. Reddy B Rajasekhar, K Nagendran, Singh B, Singh PM, Singh J and Pandey Maneesh 2019. Accelerated plant breeding in cowpea [*Vigna Unguiculata* (L.) Walp.]. *In*: *Accelerated Plant Breeding, Volume 2. (Ed.) S.S. Gosal. Springer Nature, Switzerland.* (Accepted).
12. Roy S and Singh N 2019. Implications of historical extension experiments and learning for today. *In: Empowerment of rural people in India. Pratham Publications*, ISBN: 978-93-88742-14-6. pp: 130-139.
13. Sarkar DJ, Majumder S, Kaushik P, Shakil NA and Kumar J 2019. Controlled release of pesticide formulations. *In: Applications of Encapsulation and Controlled Release. Taylor and francis (CRC Press)*, pp: 239-248.
14. Srivastava R, Kumari AR, Kumar A, Meena K and Kumar B 2019. Early wheat sowing and escape mechanize to beat terminal heat. *In: New Front Year in Agriculture Extension,* 1:174-178.
15. Thyagaraja NE and Rani AT 2019. Techniques for determining the repellent and antifeedant activity to phytophagous insects. *In: Experimental Techniques in Host-Plant Resistance. Springer publication,* pp: 183-186.

Research Abstracts

1. Chahwala Fenisha D, Sabara Pritesh, Patel Sunita, Tomar Rukam Singh, Rathore Sangeeta, Desai Hiral, Padhiyar Shital, Kheni Jasmin, Achuit Singh K 2019. Exploration of defence mechanism involved

in *Solanum lycopersicum* by using high throughput RNA-Seq method against begomovirus infection. *In: 9th International Geminivirus Symposium and 7th ssDNA Comparative Virology Workshop,* pp: 23.

2. Chaubey T, Pandey S, Singh B, Bhardwaj DR, Karmakar P, Dubey RK, Haldar J, Singh PM, Singh B, Singh J and Singh RK 2019. Development and assessment of sponge gourd hybrids for better yield. *In: Progressive Horticulture Conclave (PHC 2019)on Futuristic Technologies in Horticulture* pp:39-40.
3. Devi Jyoti, Dubey RK, Verma Ravindra K, Kumar Sudhir, Singh PM, Singh B and Singh J 2019. Genetics and stability of multi-flowering trait in garden pea, and its possible contribution in yield improvement. *In: International Conference on Sustainable Agricultural Development in Changing Global Scenario,* pp: 97.
4. Halder Jaydeep and Rai AB 2019. Synthesis and development of pest management modules against major insect pests of pumpkin. *In: Progressive Horticulture Conclave (PHC 2019) on Futuristic Technologies in Horticulture,* pp: 9-10.
5. Halder Jaydeep, Rani AT and Divekar Pratap A 2019. Sucking Pests Problem in Chilli and their Management. *In: 1st National Agrochemicals Congress Country's status on Various Fronts of Agrochemicals*, pp: 85.
6. Lal B, Sahu RP and Kumar J 2019. Use of information and communication technologies (ICTS) by the farmers of hilly areas. *In: ISEE National Seminar on Holistic Approach for Enhancing Agricultural Growth in Changing Rural Scenario,* pp: 252
7. Lal B, Tandan V and Sahu RP 2019. A study of communication behavior of dairy farmers in hilly district of Reasi of J & K. *In: ISEE National Seminar on Holistic Approach for Enhancing Agricultural Growth in Changing Rural Scenario,* pp: 250
8. Manimurugan C, Vikas Singh, Pratap A. Divekar, Nakul Gupta, P.M. Singh, Jagdish Singh and Arun Pratap Singh 2019. Standardization of seed drying method by chemical desiccants for cowpea cv. Kashi Kanchan. *In: 2nd International Conference on Recent advances in agricultural, environmental and applied sciences for global development (RAAEASGD-2019),* pp: 131.
9. Paul A, Majumder S, Banerjee K, Bhattyacharyya A, Khan Z and Reddy D 2019. Developing and validation of sample homogeneity test for multiclass pesticide residue analysis in tobacco using LC-MS/MS/HRMS. *In: National symposium on approaches and strategies for management of tobacco farmers income,* pp: 70-71.
10. Rai Trilok Nath, Rai Kedar Nath and Rai Sanjeev Kumar 2019. Cauliflower production for vegetable nutritional security in the district sultanpur (U.P.). *In: International conference on "Recent trends in Science, Technology, Agriculture and Management,* pp: 29.
11. Rai Trilok Nath, Rai Kedar Nath and Rai Sanjeev Kumar 2019. Inter cropping in sugarcane. *In: International conference on recent trends in Science, Technology, Agriculture and Management,* pp: 28.
12. Rai Trilok Nath, Rai Kedar Nath, Rai Sanjeev Kumar and Singh Arun Pratap 2019. Inter cropping of potato in sugarcane. *In: International conference on recent trends in Science, Technology, Agriculture and Management,* pp: 8.
13. Rai Trilok Nath, Rai Kedar Nath, Rai Sanjeev Kumar and Singh Arun Pratap 2019. Effect of raised bed on maize yield and soil health. *In: International conference on recent trends in Science, Technology, Agriculture and Management,* pp: 27.
14. Rani AT, Shashank PR, Naresh M. Meshram, Chitra Srivastava, Rai AB and Singh B 2019. Ultrastructure of Antennal sensilla of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae). *In: International Conference on Sustainable Agricultural Development in Changing Global Scenario,* pp: 96.
15. Reddy Yerasu Suresh, Ma Lisong and Jones David 2019. Hairy Root Transformation Using *Agrobacterium rhizogenes*: a rapid method to test genome editing efficiency of gRNA-CRISPR/Cas-9 constructs. *In: International conference on Plant Protection in Horticulture-advances and challenges,* pp: 156.
16. Sagar Vidya, Karmakar Pradip, Singh PM, Singh Bijendra 2019. Genetic diversity studies of Abelmoschus spp (wild okra) and its evaluation for horticultural traits and viral disease resistance. *In: International Conference on Sustainable Agriculture Development in Changing Global Scenario,* pp: 321.
17. Sahu A, Awasthi N, Prasad RN and Singh R 2020.

Impact assessment of On Farm trials on nutritional garden in context of dietary diversity in Eastern Uttar Pradesh. *In: 2nd National Conference on Technological and Emerging Aspect in Agriculture and Community Science,* pp: 36.

18. Sahu A, Singh S, Rai TN, Rai AK, Sahu RP, and Prasad RN 2019. Popularization of inter-cropping to increase profitability in district Kushinagar, U.P. *In: ISEE National Seminar on Holistic Approach for Enhancing Agricultural Growth in Changing Rural Scenario,* pp:161
19. Sahu RP, Srivastava R and Meena K Sahu A and Rai AK 2019. Impact of Cluster Frontline Demonstration on Productivity and Profitability of Mustard crop in Deoria District of U.P. *In: ISEE National Seminar on Holistic Approach for Enhancing Agricultural Growth in Changing Rural Scenario,* pp: 143
20. Tripathi AN, Meena BR and Pandey KK. 2019. Evaluation of bio-agents of IIVR strains and new fungicides under nursery condition. *In: Souvenir and abstract International conference: Plant Protection in Horticulture: Advances and Challenges,* pp: 45.

Extension Folder

1. Tripathi AN, Pandey KK, Gupta S and Singh J 2019. *Madhumakhi Palan: Fasal Paragan evm Fasal Utpadan Ka Adhar.* Extension Folder No. 1/2019.

Radio Talks (AIR) : 23

TV Talks (ETV) : 11

APPOINTMENTS, TRANSFERS, PROMOTIONS AND SUPERANNUATION

Appointments

- Sh. Manish Dwivedi joined the post of Stenographer on 05.04.2019 at ICAR-IIVR.
- Sh. Manish Omar joined the post of Stenographer on 05.04.2019 at ICAR-IIVR.
- Sh. Rajeev Kumar joined the post of Scientist (Plant Physiology) on 15.04.2019 at ICAR-IIVR.
- Sh. Ankit Kumar Pandey joined the post of Stenographer on 22.04.2019 at ICAR-IIVR.
- Sh. Ankit joined the post of Stenographer on 22.04.2019 at ICAR-IIVR.
- Sh. Sujit Kumar Singh joined the post of Senior Administrative Officer on 21.05.2019 at ICAR-IIVR.
- Dr. Vishvendu Dwivedi joined the post of Senior Scientist & PC (Extension) on 10.12.2019 at ICAR-IIVR, KVK, Bhadohi.
- Dr. Sudarshan Maurya joined the post of Senior Scientist (Plant Pathology) on 16.12.2019 at ICAR-IIVR.
- Dr. Kuldeep Srivastava joined the post of Principal Scientist (Agriculture Entomology) on 23.12.2019 at ICAR-IIVR.
- Dr. Dhananjay Pratap Singh the post of Principal Scientist (Agriculture Biotechnology) on 24.12.2019 at ICAR-IIVR.

Transfers

- Sh. S.K. Jindal, Senior Administrative Officer transferred from ICAR-IIVR to CIRG, Makhdoom on 15.04.2019.
- Dr. D.K. Singh, Principal Scientist transferred from ICAR-IIVR, Varanasi to IIFSR, Modipuram on 30.04.2019.
- Sh. Ajayan P., Private Secretary transferred from ICAR-IIVR to NIAB & Physiology, Bangalore on 15.05.2019.
- Sh. Roshan Lal, Office Assistant transferred from ICAR-IIVR to ATARI, Kolkata on 20.05.2019.
- Dr. Raghwendra Singh, Principal Scientist transferred from ICAR-IIVR, Varanasi to ATARI, Kanpur on 30.11.2019.
- Sh. Manish Omar, Stenographer resigned from ICAR-IIVR on 23.12.2019.
- Sh. Ankit Kumar Pandey, Stenographer resigned from ICAR-IIVR to 23.12.2019.

Promotion

- Sh. Ajay Tiwari, Technical Officer (T-5), KVK, Deoria promoted from Rs.9300-34800 + GP 4200 to 9300-34800 + GP 4600 w.e.f. 03.03.2015.
- Sh. Arun Pratap Singh, Technical Officer (T-5), KVK, Kushinagar promoted from Rs.9300-34800 + GP 4200 to 9300-34800 + GP 4600 w.e.f. 26.03.2012.
- Sh. Prabhas Chandra Singh, Technical Officer (T-5), KVK, Bhadohi promoted from Rs.9300-34800 + GP 4200 to 9300-34800 + GP 4600 w.e.f. 16.02.2015.
- Sh. Moti Lal Kushwaha, Technical Officer (T-5), KVK, Deoria promoted from Rs.9300-34800 + GP 4200 to 9300-34800 + GP 4600 w.e.f. 21.02.2016.
- Sh. Dhananjay Prasad, Technical Officer (T-5), KVK, Bhadohi promoted from Rs.9300-34800 + GP 4200 to 9300-34800 + GP 4600 w.e.f. 14.02.2016.
- Sh. V.V. Diptikar, Technical Officer (T-5), KVK, Bhadohi promoted from Rs.9300-34800 + GP 4200 to 9300-34800 + GP 4600 w.e.f. 27.08.2014.
- Sh. Pankaj Kumar Singh, Technical Officer (T-5), ICAR-IIVR, Varanasi promoted from Rs.47600/- Level-06 to Rs. 49000/- Level-07 w.e.f. 21.02.2019.

Superannuation

- Sh. U.N. Tiwari, Assistant Administrative Officer, ICAR-IIVR superannuated from services on 31.07.2019.

Classified Abstracts of Expenditure
(2019)

ICAR-Indian Institute of Vegetable Research (Plan)

(In Lakhs)

Sub-head	Plan	
	Provision made in RE	Expenditure
Establishment Charges	1616.14	1616.13
Wages	0.00	0.00
O.T.A.	0.00	0.00
T.A.	22.50	22.38
Other Charges (Contingency)	477.50	472.68
H.R.D.	4.00	3.81
Works	65.00	64.23
Equipment	58.00	48.90
Library	0.00	0.00
Vehicle	10.00	7.50
Annual Repairs /Maintenance	11.00	10.59
Furniture & Fixture	10.00	7.28
Information Technology	10.00	4.40
TSP NEH	62.00	58.51
Total	2346.14	2316.41

Revenue generation

(In Lakhs)

Particulars	Target	Revenue generation
IIVR	87.67	176.09

Krishi Vigyan Kendra (Plan)

(In Lakhs)

KVKs	RE	Expenditure
KVK, Kushinagar	133.50	126.16
KVK, Deoria	117.50	108.03
KVK, Bhadohi	133.50	116.13
Total	384.50	350.32

Externally Funded Projects

Name of project	Funding agency	Duration of projects	Allocation & Expenditure 2019	
			Allocation	Expenditure
Crop Improvement				
Introgression of Begomovirus Resistance Genes in Tomato (Solanum lycopersicum L.) through MAS and Genomic Approaches	DBT	2015 – December, 2019	0.00	0.00
National Innovations in Climate Resilient Agriculture (NICRA)	ICAR	2017 - 2020	48.60	38.80
CRP on Hybrid Technology Project	ICAR	2015 - 2020	19.67	16.80
Network Project on Transgenic Crops (NPTC)	ICAR	2017 - 2020	6.85	4.68
CRP on Agrobiodiversity	ICAR	2015 - 2020	4.00	4.00
Central Sector Scheme for Protection of Plant Varieties and Farmer's Rights Authority (Dust testing of tomato, brinjal, okra, cauliflower, cabbage, vegetable pea, French bean, bottle gourd, bitter gourd, pumpkin and cucumber).	PPVFRA	2009 - 2020	22.34	21.71
Agri Business Incubator (ABI)	ICAR	2017 - 2020	16.50	6.73
Zonal Technology Management Unit (ZTMU)	ICAR	2017 - 2020	7.00	5.75
Cowpea golden mosaic disease (CPGMD) resistance: Agroinfectious clone development, Screening, Genetics of inheritance, Molecular Tagging and Mapping for CPGMD resistance gene(s) in cowpea by using linked markers	DST SERB	2017 - 2020	14.36	14.10
Monecious sex expression in muskmelon (Cucumis melo L.): Inheritance and molecular mapping of monoecisum using linked markers.	DST-SERB	2019 - 2022	18.68	10.17
Crop Production				
Efficient Water Management in Horticultural Crops (under Agri-CRP on Water Project)	ICAR	2016 - 2021	14.94	7.67
Development of shelf stable intermediate moisture leafy vegetables using radiation processing	BARC, Mumbai	2017 - 2020	20.22	10.22
Farmer FIRST Program on "Intervention of Improved Agricultural Technologies for Livelihood and Nutritional Security Adhering Local Resources and Working Knowledge of the Farmers	ICAR	2016 - 2021	15.5	15.0
Scheduled Tribes Component (Earlier Tribal Sub Plan) for Tribal of Sonbhadra district in Uttar Pradesh (National Assignment by Department of Agricultural Research & Education, Ministry of Agriculture and Farmers Welfare, Govt. of India)	ICAR	2012 - continue till date	15.0	14.0

Crop Protection				
Establishment of Integrated Beekeeping Development Centre (IBDC)/Centre of Excellence (CoE) on Beekeeping	NBB, DAC&FW, Govt. of India, New Delhi	2017 - 2020	99.75	64.72
Agro infectious clones development for probing resistance to chilli leaf curl diseases caused by begomoviruss and devising integrated management strategies	DST	2016 – September, 2019	9.04	7.88
AICRP on Biocontrol	ICAR-NBAIR	2018 - 2021	4.5	1.98
Validation & promotion of sustainable and adaptable IPM technology for brinjal crop	ICAR-NCIPM	2019 - 2022	3.0	0.4

Staff Strength

(as on 31.12.2019)

S.N.	Category	Sanctioned Strength	Staff in Position	Vacant
SCIENTIFIC				
1.	Scientist	45	42	03
2.	Senior Scientist	12	09	03
3.	Principal Scientist	06	04	02
	Total	63	55	08
TECHNICAL				
1.	Technician	11	10	01
2.	Senior Technician	-	-	-
3.	Technical Assistant	13	11	02
4.	Senior Technical Assistant	02	02	-
5.	Technical Officer	-	-	-
6.	Senior Technical Officer	-	-	-
7.	Assistant Chief Technical Officer	-	-	-
	Total	26	23	03
ADMINISTRATIVE				
1.	Senior Administrative Officer	01	01	-
2.	Finance & Account Officer	01	01	-
3.	Assistant Finance & Accounts Officer	01	-	01
4.	Assistant Administrative Officer	01	-	01
5.	Assistant	05	03	02
6.	Private Secretary	01	-	01
7.	Personal Assistant	02	01	01
8.	Stenographer Gr. III	02	02	-
9.	UDC	02	02	-
10.	LDC	04	01	03
	Total	20	11	09
SKILLED SUPPORTING STAFF				
1.	S.S.S	16	16	-
	Total	16	16	-
	Grand Total	125	105	20

Staff Strength of Krishi Vigyan Kendras

(as on 31.12.2019)

KVK Sargatia, Kushinagar

Sl. No.	Designation	Sanctioned strength	Staff in position	Vacant
1.	Programme Coordinator	01	-	01
2.	Subject Matter Specialist	06	06	-
3.	Farm Manager	01	01	-
4.	Programme Assistant	01	-	01
5.	Programme Assistant (Computer)	01	-	01
6.	Assistant	01	01	-
7.	Stenographer Gr. III	01	01	-
8.	Driver (T-1)	02	02	-
9.	SSS	02	-	02
	Total	16	11	05

KVK, Deoria

Sl. No.	Designation	Sanctioned strength	Staff in position	Vacant
1.	Programme Coordinator	01	-	01
2.	Subject Matter Specialist	06	06	-
3.	Farm Manager	01	01	-
4.	Programme Assistant	01	01	-
5.	Programme Assistant (Computer)	01	-	01
6.	Assistant	01	-	01
7.	Stenographer Gr. III	01	01	-
8.	Driver (T-1)	02	02	-
9.	SSS	02	-	02
	Total	16	11	05

KVK, Bhadohi

Sl. No.	Designation	Sanctioned strength	Staff in position	Vacant
1.	Programme Coordinator	01	01	-
2.	Subject Matter Specialist	06	04	02
3.	Farm Manager	01	01	-
4.	Programme Assistant	01	01	-
5.	Programme Assistant (Computer)	01	01	-
6.	Assistant	01	-	01
7.	Stenographer Gr. III	01	-	01
8.	Driver (T-1)	02	02	-
9.	SSS	02	-	02
	Total	16	10	06

Staff in Position

(as on 31.12.2019)

Sl. No.	Name	Designation	Email
1.	Dr. Jagdish Singh	Director (Acting)	directoriivr@gmail.com
Director's Cell			
2.	Sh. Ajay Uniyal	Personal Assistant	ajay.uniyal1@gmail.com
Project Coordinator Cell			
3.	Dr. S.K. Verma	Principal Scientist	skverma10@yahoo.com
4.	Dr. Ram chandra	Principal Scientist	rchandraiivr2016@gmail.com
5.	Dr. T. Chaubey	Principal Scientist	tchaubay@gmail.com
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7.	Dr. A.P. Singh	Senior Technical Officer	apsinghento@gmail.com
Division of Vegetable Improvement			
8.	Dr. P.M. Singh	Principal Scientist & I/C Head	pmsiivr@gmail.com
9.	Dr. Nagendra Rai	Principal Scientist	nrai1964@gmail.com
10.	Dr. D.R. Bhardwaj	Principal Scientist	dram_iivr@yahoo.com
11.	Dr. Rajesh Kumar	Principal Scientist	rajes74@gmail.com
12.	Dr. Sudhakar Pandey	Principal Scientist	sudhakariivr@gmail.com
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18.	Dr. Pradip Karmakar	Scientist	pradip9433@gmail.com
19.	Dr. Yerasu Suresh Reddy	Scientist	yerasusureshreddy@yahoo.co.in
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21.	Dr. Jyoti Devi	Scientist	jyoti17iivr@gmail.com
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25.	Dr. Vidya Sagar	Scientist	vidya.sagarkaushal@gmail.com
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30.	Sh. Subhash Chandra	Senior Technical Assistant	subhash301269@gmail.com
31.	Sh. Sudhir Kumar	Technical Assistant	sudhir2203@gmail.com
Division of Vegetable Production			
32.	Dr. R.N. Prasad	Principal Scientist & I/C Head	rnprasad_zcu@rediffmail.com
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42.	Dr. Swati Sharma	Scientist	swtsharma92@gmail.com
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45.	Sh. P.C. Tripathi	Technical Officer	tripa732003yahoo.co.in
46.	Sh. Pankaj Kumar Singh	Technical Officer	pksingh@gmail.com
Division of Vegetable Protection			
47.	Dr. K.K. Pandey	Principal Scientist & I/C Head	kkpiivr@gmail.com
48.	Dr. Kuldeep Srivastava	Principal Scientist	kuldeep.ipm@gmail.com
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Administration			
61.	Sh. Sujit Kumar Singh	Senior Administrative Officer	saoiivr@gmail.com
62.	Sh. U.K Saxena	Senior Finance & Account Officer	iivrfao@gmail.com
63.	Sh. Gopi Nath	Assistant	gopiiivr@gmail.com
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68.	Sh. S.K. Gupta	Upper Division Clerk	sushilskg@yahoo.co.in
69.	Sh. Sudeep Singh	Lower Division Clerk	singhabc16@gmail.com
70.	Sh. Ankit	Stenographer	Ankit@icar.gov.in
71.	Sh. Manish Dwivedi	Stenographer	Manish.Dwivedi@icar.gov.in
Farm Section			
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73.	Sh. Pankaj Kumar Singh	Technical Officer	pksinghiivr@gmail.com
74.	Sh. K.K. Upadhyay	Technical Officer	upadhyay@gmail.com

PME Cell			
75.	Dr. Sunil Gupta	Chief Technical Officer	gupta.sunil191@gmail.com
Library			
76.	Sh. S.K. Singh	Chief Technical Officer	sksinghiivr@gmail.com
Institute Service Unit			
77.	Sh. M.L. Vishwakarma	Technical Officer	madanlalvishwa@yahoo.in
Vehicle Section			
78.	Sh. Sanjay Kumar	Senior Technical Assistant	sanjay24071970@gmail.com
79.	Sh. Rajendra Kumar	Senior Technical Assistant	-
80.	Sh. Manoj Kumar	Senior Technical Assistant	mrai09048@gmail.com
81.	Sh. Ram Ashrey	Senior Technical Assistant	ramashrey2365@gmail.com
Skilled Supporting Staff (SSS)			
82.	Sh. Jagwat Ram	SSS	-
83.	Sh. Shiv Kumar	SSS	-
84.	Sh. Kailash Singh	SSS	-
85.	Sh. S.P. Mishra	SSS	-
86.	Sh. Naraini Singh	SSS	-
87.	Sh. S.K. Pandey	SSS	-
88.	Sh. Arun Kumar	SSS	aruniivr@gmail.com
89.	Sh. Ramraj	SSS	ramraj.iivr@gmail.com
90.	Sh. Suresh Kumar Yadav	SSS	-
91.	Sh. Suresh Kumar	SSS	-
92.	Sh. Virendra Prasad Gond	SSS	-
93.	Sh. Kamlesh Kumar Singh	SSS	-
94.	Sh. Anil Kumar Suman	SSS	-
95.	Sh. Ram Kunwar Chaubey	SSS	-
96.	Sh. Jata Shankar Pandey	SSS	-
97.	Sh. Shivajee Mishra	SSS	-
Regional Research Station, Sargatia, Kushinagar			
98.	Dr. Vikas Singh	Senior Scientist & I/C	vikaschf@gmail.com
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Krishi Vigyan Kendra, Sargatia, Kushinagar			
102.	Dr. R. P. Sahu	SMS (Agriculture Extension)	ramdrprakash@gmail.com
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104.	Sh. Yogesh Kumar Yadav	SMS (Animal Science)	yogeshkyadav001@rediffmail.com
105.	Smt. Anjali Sahu	SMS (Home Science)	anjalisahu13march@gmail.com
106.	Dr. T.N. Rai	SMS (Soil Science)	tnrai_78@rediffmail.com
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108.	Sh. Arun Pratap Singh	Technical Officer (T-5)	arunkuwarsingh76@gmail.com
109.	Sh. Prasant Kumar Gupta	Office Superintendent	pkg1981@gmail.com

110.	Sh. Motilal Kushwaha	Technical Officer (T-5) Lab.	motilalakushwaha@yahoo.com
111.	Sh. Pankaj Kumar Singh	(T-2) Driver	-
112.	Sh. Satish Kumar Singh	(T-2) Driver	sks.kvkkushinagar@gmail.com
Krishi Vigyan Kendra, Deoria			
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115.	Sh. Kamalesh Meena	SMS (Soil Science & Agronomy)	kamalaagronomy@gmail.com
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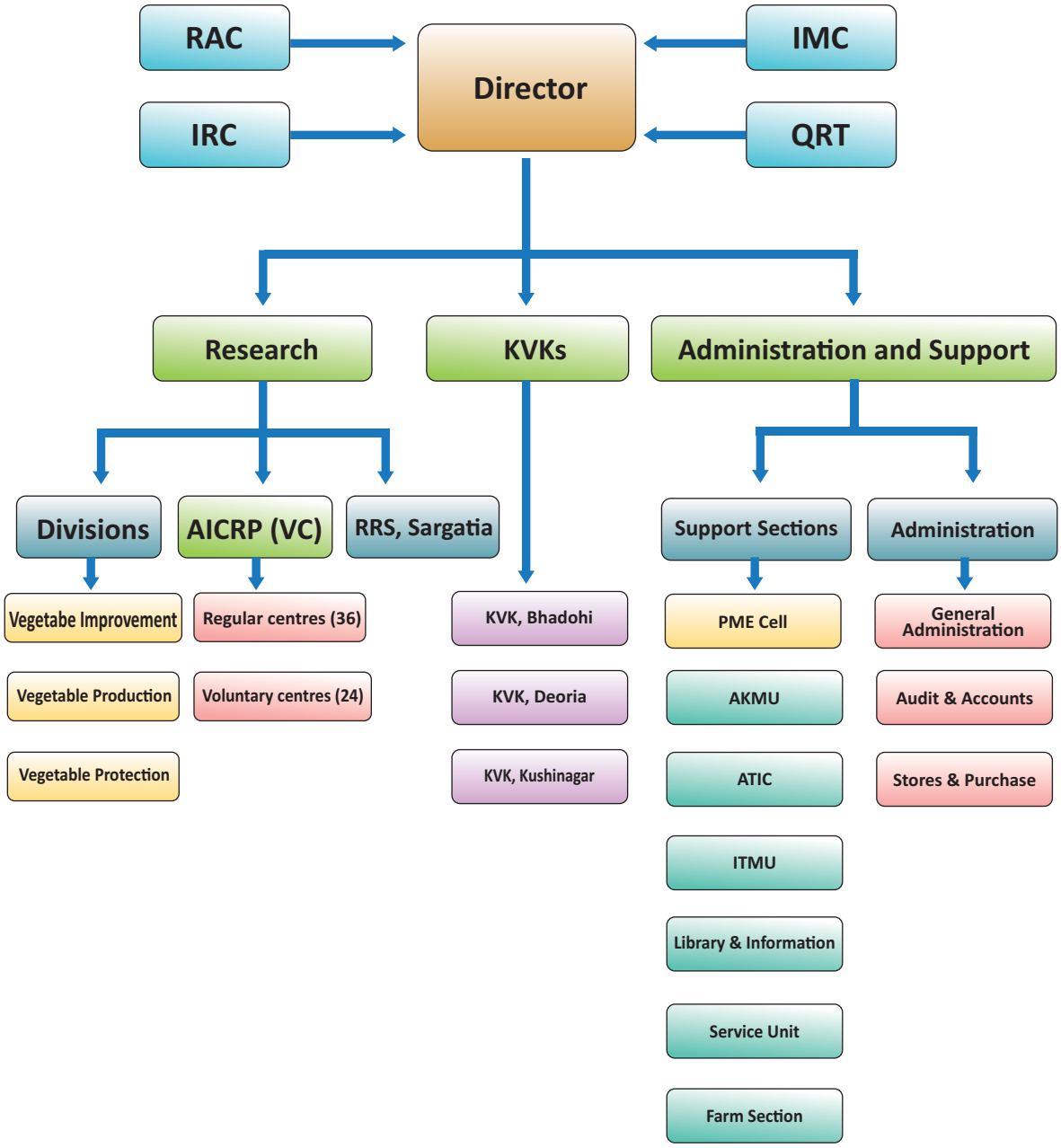
117.	Sh. Bharat Singh	(T-2) Driver	bharatiivr@gmail.com
118.	Sh. Sharad Chand Rai	(T-2) Driver	scrai76@gmail.com
Krishi Vigyan Kendra, Bhadohi			
119.	Dr. Vishvendu Dwivedi	Senior Scientist & PC	dwivedivishvendu@gmail.com
120.	Dr. A.K. Chaturvedi	SMS (Horticulture)	akciivr@gmail.com
121.	Dr. G.K. Choudhary	SMS (Animal Science)	drgovindvet@yahoo.co.in
122.	Dr. R.P. Choudhary	SMS (Agriculture Extension)	rudalpd@rediffmail.com
123.	Dr. Rekha Singh	SMS (Home Science)	rekhaiivr@gmail.com
124.	Dr. Manoj K. Pandey	SMS (Plant Pathology)	mkp_bxr@yahoo.co.in
125.	Dr. P.C. Singh	Technical Officer (T-5) Field/Farm	prabhashiivr@gmail.com
126.	Sh. V.V. Diptikar	Technical Officer (T-5) Comp.	v_v_diptikar@rediffmail.com
127.	Sh. D.P. Singh	Technical Officer (T-5) Lab.	dpsinghkvk@rediffmail.com
128.	Sh. Sanjay Kumar Yadav	(T-2) Driver	sanjay8765275294@gmail.com
129.	Sh. Pramod Paswan	(T-2) Driver	pramodpaswan1084@gmail.com

ORGANOGRAM


RAC
IRC
Director
IMC
QRT
Research
KVKs
Administration and Support
Divisions
AICRP (VC)
RRS, Sargatia
Support Sections
Administration
Vegetabe Improvement
Vegetable Production
Vegetable Protection
Regular centres (36)
Voluntary centres (24)
KVK, Bhadohi
KVK, Deoria
KVK, Kushinagar
PME Cell
AKMU
ATIC
ITMU
Library & Information
Service Unit
Farm Section
General Administration
Audit & Accounts
Stores & Purchase

Annexure I

Research Advisory Committee

Dr. K. E. Lawande Former Vice Chancellor Dr. BSKKV, Dapoli (M.S.)	Chairman
Dr. S.M.S Tomar Cytogenetist Division of Genetics & Plant Breeeding IARI, Pusa, New Delhi	Member
Dr. Anil Sirohi Professor Division of Nematology IARI, Pusa, New Delhi	Member
Dr. D.P. Wasker Director (Research) Dr. VNMKVK, Parbhani (M.S.)	Member
Dr. P.S. Pandey ADG (EP&HS) ICAR, Pusa, New Delhi	Member
Dr. T. Janakiram Asstt. Director General (Hort.-II) ICAR, Krishi Anusandhan Bhawan-II ,Pusa,New Delhi	Ex- officio Member
Dr. Jagdish Singh Director ICAR-IIVR, Varanasi	Ex- officio Member
Dr. Sudhakar Pandey Principal Scientist ICAR-IIVR, Varanasi	Member Secretary

Annexure II

Institute Management Committee

Dr. Jagdish Singh Director ICAR-IIVR, Varanasi	Chairman
Dr. T.K. Behera Principal Scientist Vegetable Science Division ICAR- IARI, Pusa Campus, New Delhi	Member
Dr. P.M. Singh Principal Scientist & I/C Head Vegetable Improvement Division, ICAR-IIVR, Varanasi	Member
Dr. P.M. Thomas Principal Scientist ICAR-IIHR, Bangalore	Member
Dr. Ambika Baldev Gaikwad Principal Scientist Division of Genomic Resources, NBPGR, Pusa, New Delhi	Member
Dr. T. Janakiram Asstt. Director General (Hort.-II) ICAR, Krishi Anusandhan Bhawan-II ,Pusa,New Delhi	Member
Shri Prakash Yadav August Kunda, Lalia Gali, Varanasi	Non- official Member
Smt. Priyanka Patel Jalalpurmaafi, Narayanpur, Chunar, Mirzapur	Non- official Member
Shri Sujit Kumar Singh SAO ICAR-IIVR, Varanasi	Member Secretary

Annexure III

List of Ongoing Research Projects

A. Institutional

MEGA PROGRAMME 1 : INTEGRATED GENE MANAGEMENT			
Programme Leader : Dr. P.M. Singh			
Code	**Title of the project**	**P.I.**	**Co-PIs & Associates**
1.1	Genetic Improvement of Tomato	YS Reddy	N. Rai Associates: P.A. Divekar (Insects), K.K. Pandey (Diseases), K. Nagendran (Viruses) and Manjunath Gowda (Nematodes)
1..2	Genetic Improvement of Brinjal	SK Tiwari	S.K. Verma Associates: P.A. Divekar, Shweta Kumari (Phytoplasma), A.N. Tripathi (Diseases)
1.3	Genetic Improvement of Chilli	Rajesh Kumar	Indivar Prasad and S.G. Karkute (on study leave) Associates: K.K. Pandey (Diseases), K. Nagendran (Viruses) , A.T. Rani (Insects) and Manjunath Gowda (Nematodes)
1.4	Genetic Improvement of Pea	Jyoti Devi	R.K. Dubey Associate: A.N. Tripathi
1.5	Genetic Improvement of Cowpea.	B. Rajasekhar Reddy	N. Rai Associates: P.A. Divekar (Ins ects), A.N. Tripathi (Diseases) and K. Nagendran (Viruses)
1.6	Genetic Improvement of Indian bean and French bean.	N Rai	B. Rajasekhar Reddy
1.7	Genetic Improvement of seed propagated gourds	D.R. Bhardwaj	Sudhakar Pandey, Vikas Singh and K.K. Gautam Associates: J. Haldar (Insects), M. Gowda (nematodes) and B.R. Meena (Diseases)
1.8	Genetic Improvement of Luffa	T. Chaubey	Sudhakar Pandey and R.K. Dubey Associates: J. Haldar (Insects), M. Gowda (nematodes) and B. Meena (Diseases)
1.9	Genetic Improvement of Pumpkins and Cucumber	Sudhakar Pandey	D.R. Bhardwaj, T. Chaubey, Vikas Singh and KK Gautam Associates: J. Haldar (Insects), M. Gowda (Nematodes), A.N. Tripathi (Diseases), K. Nagendran (Viruses)
1.10	Genetic Improvement of Melons	KK Gautam	Sudhakar Pandey , Pradip Karm akar and Vikash Singh Associates: K. Nagendran (Diseases/Viruses)
1.11	Genetic Improvement of Okra	Pradip Karmakar	Achuit Singh and Vidyasagar Associates: J Halder (Insects), M. Go wda (Nematodes) and K. Nagendran (Diseases/Viruses)
1.12	Genetic Improveme nt of Cole crops and Root crops	BK Singh	P. Karmakar Associates: A.T. Rani (Insects), B. R. Meena (Diseases)
1.13	Biotechnological interventions including Transgenics for managing stresses in vegetables	Achuit Singh	Sudhakar Pandey, SK Tiwari, YS Reddy, Jyoti Devi, Vidyasagar , Manimurugan C. and S.G. Karkute (on study leave) Associate: K. Nagendran (Diseases)

1.14	Genetic Improvement of under exploited & future vegetables	R.K. Dubey	B.K. Singh, Jyoti Devi, Y.S. Reddy, Vidyasagar and Indivar Prasad Associates: P.A. Divekar (Insects) and B.R. Meena (Diseases)
1.15	Genetic Improvement of clonally propagated & perennial vegetables	Vikas Singh	D.R. Bhardwaj, Ram Chandra, P. Karmakar and Vidyasagar Associates: J. Haldar (Insects), M. Gowda (Nematodes) and B.R. Meena (Diseases)
MEGAPROGRAMME 2: SEED ENHANCEMENT IN VEGETABLES			
Programme Leader :Dr. P.M. Singh			
2.1	Priming, Coating, ovule conversion and seed enhancement	P.M. Singh	Rajesh Kumar, T Chaubey, Vikas Singh , Manimurugan C. and Nakul Gupta (on study leave w.e.f. 09.02.2019) Associate: J. Halder (Insects) and A.N. Tripathi (Diseases)
2.2	Pollination studies for seed augmentation in vegetables including support of honey bees	Nakul Gupta (on study leave w.e.f. 09.02.2019) Rajesh Kumar	P.M. Singh, T. Chaubey, J. Halder, P.A. Divekar and Manimurugan, C. Associate: A.N. Tripathi (Diseases)
2.3	Drying and storage studies on vegetable seeds including modified atmosphere storage	Manimurugan C.	P.M. Singh, J. Singh Sudhir Singh, Rajesh Kumar, S. Roy and Nakul Gupta (on study leave w.e.f. 09.02.2019)
MEGA PROGRAMME 3: PRODUCTIVITY ENHANCEMENT THROUGH BETTER RESOURCE MANAGEMENT			
Programme Leader : Dr. R. N. Prasad			
3.1	Technologies for protected vegetable production	Hare Krishna	Anant Bahadur, and R.N. Prasad and Swati Sharma Associates: K.K. Pandey (Diseases)
3.3	Vegetable based cropping systems	R.N. Prasad	S.K. Singh, R.B. Yadava and Vanitha S.M.
3.10	Agronomic bio -fortification studi es in vegetable crops	R.B. Yadava	Jagdish Singh and Raghwendra Singh
3.11	Development of agro -techniques for organic farming in vegetable crops	S.K. Singh	R.B. Yadava and Sudhir Singh Associates: K.K. Pandey (Diseases), Jaydeep Haldar (Insects), Vijaya Rani and Ram Chandra.
3.12	Improving water productivity of vegetable crop sequences through drip irrigation system	D.K. Singh (upto 14.04-2019) Anant Bahadur (w.e.f. 15.04.2019)	Anant Bahadur Associates: Jaydeep Haldar (Insects)
3.13	Enhancing productivity, quality and tolerance to biotic and abiotic stresses in vegetables by grafting technology	Anant Bahadur	Hare Krishna Associates: K.K. Pandey (Diseases)
3.14	Weed management in vegetable crops	Raghwendra Singh (upto 30.11.2019) S. K. Singh (w.e.f. 01.12.2019)	Jagdish Singh Associates: A.N. Tripathi (Diseases)
3.15	Conservation agriculture under vegetable based cropping system	Raghwendra Singh (upto 30.11.2019) R. B. Yadav (w.e.f. 01.12.2019)	S.K. Singh
3.16	Offseason cltivation of vegetables under protected environment	S.N.S. Chaurasia	Anant Bahadur, Hare Krishna and Swati Sharma Associates: K.K. Pandey (Diseases) and A.T. Rani (Insects)

MEGA PROGRAMME 4: POST HARVEST MANAGEMENT AND VALUE ADDITION			
Programme Leader : Dr. Sudhir Singh			
4.3	Modified atmosphere storage for retaining the quality assurance of vegetables	Sudhir Singh	Swati Sharma
4.4	Influence of polyamines on postharvest senescence and quality of high value vegetables	Swati Sharma	R. N. Prasad and Hare Krishna
MEGA PROGRAMME 5: PRIORITIZATION OF R&D NEEDS AND IMPACT ANALYSIS OF TECHNOLOGIES DEVELOPED BY ICAR-IIVR			
Programme Leader : Dr. Neeraj Singh			
5.3	Development and promotion of nutri - garden module for rural households	Neeraj Singh	R. N. Prasad, S. N. S. Chaurasia, Subhadeep Roy and Vanitha S.M.
5.4	Empowering rural youth for vegetable based entrepreneurship	Subhadeep Roy	Neeraj Singh and Vanitha S.M.
5.5	Economic impact assessment of IIVR developed technologies	Vanitha S.M.	Subhadeep Roy and Neeraj Singh
MEGA PROGRAMME 6: INTEGRATED PLANT HEALTH MANAGEMENT			
Programme Leader :Dr. K.K. Pandey			
6.1	Bio-intensive management of important pests of vegetable crops	Jaydeep Halder	P.A. Divekar, K. Nagendran and Sujan Majumder Associates: Neeraj Singh
6.2	Toxicological investigations on the novel and botanical insecticides against major insect pests of vegetables.	A.T. Rani	P.A. Divekar, J. Halder and Sujan Majumder
6.3	Biological control of major insect pests of vegetable crops	Jaydeep Halder	A.T. Rani, P .A. Divekar, M . Gowda T . and A.N. Tripathi
6.4	Development of effective integrated management package for important fungal diseases of vegetable crops	K.K. Pandey	B.R. Meena, A.N. Tripathi, M. Gowda T. and Anurag Chaurasia
6.5	Bio-prospecting of microorganisms associated with vegetables against plant pathogens	B.R. Meena	A.N. Tripathi, K.K. Pandey, Anurag Chaurasia and Shweta Kumari
6.6	Management of important bacterial diseases of vegetable crops	A.N. Tripathi	B.R. Meena and Vijaya Rani
6.7	Characterization of viruses infecting vegetable crops and their management	K. Nagendran	Shweta Kumari, KK Pandey and Manimurugan C. Associates: Achuit K. Singh
6.9	Pest and disease dynamics, and behavior modifying strategies for major insect pests of important vegetable crops in relation to changing weather scenario	A.T. Rani	J. Halder, B.R. Meena and P.A. Divekar
6.10	Mapping and characterization of phytoplasmas infecting vegetable crops and its management	Shweta Kumari	K. Nagendran Associates: Shailesh K. Tiwari
6.11	Bio-management of post -harvest diseases in major vegetable crops	Vijaya Rani	B.R. Meena and Sujan Majumder Associates: Swati Sharma
6.12	Residue dynamics, safety evaluation and decontamination of chlorantraniliprole, deltametehrin, azoxystrobin and kresoxim-methyl in tomato, brinjal and chilli	Sujan Manjumder	Vijaya Rani, J. Halder, P.A. Divekar and K.K. Pandey

B. Externally Funded

Division of Crop Improvement			
S.N.	**Title of the project**	**P.I.**	**Co-PIs & Associates**
1.	Introgression of Begomo virus Resistance Genes in Tomato (*Solanum lycopersicum*L.) through MAS and Genomic Approaches	Achuit K. Singh	Y. Suresh Reddy
2.	National Innovations in Climate Resilient Agriculture (NICRA)	P.M. Singh	N. Rai, Anant Bahadur and Achuit Kumar Singh
3.	CRP on Hybrid Technology Project (NPTC)	N. Rai	Y. S. Reddy
4.	Network Project on Transgenic Crops (NPTC)	Achuit K. Singh	Nagendran Krishnan
5.	CRP on Agrobiodiversity	S.K. Tiwari	P. Karmakar and Vidyasagar
6.	Central Sector Scheme for Protection of Plant Varieties and Farmers' Rights Authority (DUS Testing of tomato, brinjal, okra, cauliflower, cabbage, vegetable pea, French bean, bottle gourd, bitter gourd, pumpkin and cucumber)	Sudhakar Pandey	T. Chaubey
7.	Agri Business Incubator (ABI)	P.M. Singh	SK Tiwari, Shubhdeep Roy, Neeraj Singh and Sudhir Singh
8.	Zonal Technology Management Unit (ZTMU)	P.M. Singh	SK Tiwari, Shubhdeep Roy, Neeraj Singh and Sudhir Singh
9.	Cowpea golden mosaic disease (CPGMD) resistance: Agroinfectious clone development, Screening, Genetics of inheritance, Molecular Tagging and Mapping for CPGMD resistance gene(s) in cowpea by using linked markers	B. Rajasekhar Reddy	Achuit K. Singh and K. Nagendran
10.	Monoecious sex expression in muskmelon (Cucumis melo L.): Inheritance and molecular mapping of monoecism using linked markers	P. Karmakar	-
Division of Crop Production			
11.	Efficient Water Management in Horticultural Crops (under Agri-CRP on Water Project)	Anant Bahadur	SNS Chaurasia
12.	Development of shelf stable intermediate moisture leafy vegetables using radiation processing	Sudhir Singh	
13.	Farmer FIRST Program on "Intervention of Improved Agricultural Technologies for Livelihood and Nutritional Security Adhering Local Resources and Working Knowledge of the Farmers"	Neeraj Singh	Shubhadeep Roy, R.N. Prasad, D.R. Bhardwaj, S.K. Singh, S.M. Vanitha, G.K. Chaudhary and J. Singh
Division of Crop Protection			
14.	Validation & promotion of sustainable and Adaptable IPM Technology for Brinjal crop	J. Halder	BR Meena & Manoj Kumar Pandey
15.	Agro infectious clones development for probing resistance to chilli leaf curl diseases caused by begomoviruss and devising integrated management strategies	K.Nagendran	Rajesh Kumar
16.	Establishment of Integrated Beekeeping Development Centre (IBDC)/Centre of Excellence (CoE) on Beekeeping	K.K. Pandey	Neeraj Singh, A.N. Tripathi, Jaydeep Halder, K. Nagendran, B.R.Meena, M. Gowda T and Sujan Majumadear (w.e.f. 13.03.2019)

Annexure IV

Distinguished Visitors

Dr. A. K. Singh DDG (Horticultural Science) ICAR, New Delhi	21.06.2019
Sri Surya Pratap Shahi Hon'ble Agricultural Minister Govt. of Uttar Pradesh	02.08.2019
Dr Arvind Kumar Director International Rice Research Institute South Asian Regional Centre, Varanasi	08.04.2019 16.08.2019 28.09.2019
Dr. D.P. Ray Former Vice Chancellor Odisha University of Agriculture and Technology (OUA&T) Bhubaneshwar	03.10.2019
Dr. Mangla Rai Former Secretary, DARE & Director General ICAR, New Delhi	28.09.2019
Dr. Gautam Kalloo Former Deputy Director General (Hort. Sci.) ICAR, New Delhi	28.09.2019
Dr Ramesh Chand Director Institute of Agricultural Sciences, BHU	08.04.2019 28.09.2019
Dr. Kirti Singh Former Chairman ASRB, New Delhi	11.01.2019
Dr. N. Kumar Vice-Chancellor TNAU, Tamil Nadu	25.06.2019
Dr. T. Janakiram Asstt. Director General (Hort.-II) ICAR, KAB -II, Pusa,New Delhi	05-06.11.2019
Dr. R. Rathinam Former Director National Research Centre on Oil Palm & Former Executive Director Asia Pacific Coconut Community	22.06.2019
Dr. K.S. Subramanian Director (Research) Tamil Nadu Agricultural University, Coimbatore	22.06.2019
Dr. A. K. Singh DDG (Agricultural Extension) ICAR, New Delhi	08.04.2019
Dr. Panjab Singh Former Secretary DARE & DG, ICAR, New Delhi	08.04.2019
Dr. Attar Singh Director ICAR-ATARI, Kanpur	08.04.2019

Dr. K. E. Lawande Former Vice Chancellor Dr. BSKKV, Dapoli (M.S.)	05-06.11.2019
Dr. P.S. Pandey ADG Education Planning and Home Science ICAR, New Delhi	05-06.11.2019
Dr. S. M. S. Tomar Former Principal Scientist IARI, New Delhi	05-06.11.2019
Dr. P.S. Sirohi Professor IARI, New Delhi	05-06.11.2019
Mrs. Priyanka Patel Members, Institute Management Committee Varanasi	05-06.11.2019
Dr. A.K. Srivastava Chairman, ASRB & Vice President, NAAS New Delhi	29.01.2019
Ms. Dolly Chakraborty Additional Secretary MoA&FW, Government of India, New Delhi	21.05.2019
Shri Rajesh Verma Additional Secretary DAC&FW, MoA&FW Government of India, New Delhi	04.10.2019
Dr. Sanjay Singh Secretary NARAKAS & Senior Official Language Officer DLW, Varanasi	06.06.2019
Dr. Sharad Kumar Head of Department Government College, Zakkhini, Varanasi	14.09.2019

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