

Executive Summary

Enhancement in the Productivity of Major Hill Crops

During the year 2008-09, eight varieties/hybrids (two maize, two oilseed, one pulse, one millet and two vegetables) developed by the institute were released by Central Sub-Committee of Crop Standards, Notification and Release of Varieties (CSCSNRV).

An extra-early single cross hybrid **Vivek QPM 9** (VQL 1 x VQL 2) was released and notified for Zone-I (Uttarakhand, Himachal Pradesh, Jammu and Kashmir and NEH Region) and Zone-IV (Tamil Nadu, Andhra Pradesh and Maharashtra) and yielded 60 q/ha. It has 0.83% tryptophan as compared to 0.59% in 'Vivek Maize Hybrid 9' with high Fe and Zn content. Another extra-early single cross hybrid **Vivek Maize Hybrid 33** (V 372 x CM 212) was released for Zone-I (Uttarakhand and Himachal Pradesh). It yielded 60-61 q/ha in experimental trials. **VL Soya 59** (PB 1 x VLS 2) and **VL Soya 63** (VLS 2 x (Brass x VHC 3022) were released for Northern Hill Zone (Uttarakhand, Himachal Pradesh and Jammu and Kashmir). VL Soya 59 has low linolenic acid (C18:3 as 3.96) which improved oxidative stability of oil. VL Soya 59 and VL Soya 63 yielded 25.6 q/ha and 27.6 q/ha, respectively. **VL Gahat 15** (VLG 1 x NIC 7321) was released for northern and central India and exhibited an average yield of 7.8 q/ha in recommended areas. It has better digestibility (86.2%) and multiple disease resistance to anthracnose and leaf spot diseases (<10%). **VL Madira 207** (VL Madira 172 X GECH 506) was released for entire country except Gujarat and Tamil Nadu. It yielded 16.4 q/ha in recommended areas and found resistant to grain smut (6.67%). **Vivek Matar 10** (Azad pea 1 X PMR 3-19-2), an early maturing garden pea, was released for Zone-I (Jammu & Kashmir, Himachal Pradesh and Uttarakhand) and Zone-IV (Punjab, Uttar Pradesh, Bihar and Jharkhand) and gave average yield of 92.1 q/ha. **VL Bean 2** (VL Bauni bean 1 x Contender) was released for Uttarakhand hills with an average yield of 98.9 q/ha. Its pods are light green, long (14 cm), smooth, stringless and fleshy.

Nine Genetic Stocks (7 in maize and 2 in wheat) were registered with NBPGR, New Delhi for novel characters. Among them, INGR No. 09012: VQL 3, INGR No. 08078: VQL 5, INGR No. 09013: VQL 8, INGR No. 09014: VQL 12, INGR No. 09015: VQL 16, INGR No. 08079: VQL 17 and INGR No. 09016: VQL 30 maize inbred lines were registered for high tryptophan and lysine content developed through MAS approach. VL 852, a wheat germplasm, registered for diverse source for chapatti quality and INGR No. 09055: VL 875 for high bread loaf volume and good quality bread.

For seed production and wider coverage, the institute has entered in agreement with two seed producers *viz.*, Kirtiman Agro Genetics Ltd for commercialization of 'Vivek QPM 9' and 'VL Baby corn 1' and Venntura Crop Sciences Private Ltd for 'Vivek QPM 9'.

A total of 233.75 q breeder seed of 51 released varieties/inbred lines was produced. Besides, 50.95 q TL seed of released varieties was produced at Hawalbagh to meet the requirement of extension activities. In addition, the institute produced 16.11 q nucleus seed of 42 released varieties following standard methods to maintain

the genetic purity of the varieties. Out of seed produced, 174.01 q breeder seed was supplied to different seed producing agencies to take up further multiplication.

2. Crop Production

In studies on application of organic and inorganic fertilizers, application of FYM 20 t/ha gave highest yield (180.6 q/ha) followed by FYM 15 t/ha (147.3 q/ha) in French bean, whereas in okra, application of recommended NPK with FYM 10 t/ha gave highest yield (159.3 q/ha) followed by recommended NPK (148.1 q/ha). In horsegram, VLG 8, VLG 10 and VLG 15 were at par and produced higher grain yield than other varieties. All varieties of wheat produced better in Integrated Crop Management (ICM) than organic module.

In a long-term experiment, application of recommended NPK+FYM to soybean only gave yield of soybean as 22.0 q/ha and wheat (grown on residual fertility) gave yield of 14.1 q/ha, which were significantly higher than rest of the treatments except N+FYM. Imbalanced fertilization caused drastic reduction in yield of soybean (63-86%) and wheat (58-68%) in different treatments. Seven Colocasia based cropping systems were evaluated for their production potential and monetary returns against rice-wheat cropping system. The results showed that the Colocasia equivalent yield, net returns and B:C ratio varied from 101.62 to 571.34 q/ha and Rs. 43,557 to Rs. 4,26,310/ha and 1.49 to 3.82, respectively.

In soybean-wheat cropping system, application of phosphorus through SSP resulted highest grain yield of soybean (35.35 q/ha), which was comparable to yield received under P enriched compost (32.80 q/ha) or P enriched compost + SSP (34.48 q/ha). Yield of cauliflower and radish crop increased with increasing levels of magnesite waste up to 100 kg Magnesium/ha along with recommended NPK (328.94, 181.17 and 277.53 q/ha, respectively), which were 19, 41 and 12 per cent higher over recommended NPK for cauliflower, radish and potato (274.81, 128.55 and 247.53 q/ha, respectively). Sulphur deficiency was recorded on large scale in rice crop grown under rainfed upland coarse soil, which can be managed by 3- 4 sprays of 0.5% K₂SO₄.

Three chloroacetanilide herbicides at higher concentration caused enhancement of dehydrogenase activity. Similar trend was observed in β -glucosidase and acid phosphatase activity. Whereas, urease activity decreased upon incubation for 42 days as compared to initial soil. Half life of acetachlor, butachlor and pretilachlor was 9.3, 12.7 and 7.3 days.

The beneficial effects of nodulation were enhanced with the combined application of rhizobial inoculation and plant-growth-promoting bacteria (PGPB). Co-inoculation of *Pseudomonas* sp. strain PGERs17 and *Rhizobium leguminosarum*-PR1 increased nodulation by 15% over *Rhizobium* alone and 156% over the control (52 nodules). Seven endophytic bacterial isolates from six *Rabi* legumes were identified as *Bacillus thuringiensis* (*Bt*), based on their ability to produce spherical/bipyramidal crystal proteins during sporulation. *Exiguobacterium acetylicum* strain 1P (MTCC 8706) a rhizospheric, Gram positive, rod shaped, yellow pigmented bacterium was found to be the most potent in inhibiting the hyphal development of *Rhizoctonia solani*, *Sclerotium rolfsii*, *Pythium* and *Fusarium oxysporum* by 45.6, 41.4, 28.9 and 39.7 per cent, respectively under *in vitro* (volatile compound) assay.

Under the project, Design and development of small tools and farm machineries for hill agriculture, three prototypes of low cost light weight steaming plants for steaming of barnyard millet have been developed and a Vivek Channel Maker was designed and fabricated for easier construction of irrigation channel in hills.

Out of six entries, *Setaria* grass S-25 produced significantly higher (517.92 q/ha) green biomass than others. None of the entry of forage maize could surpass the green forage yield of African Tall (704 q/ha). Green forage yield did not affect significantly with different N fertilization in case of dual purpose wheat varieties VL-829 and VL-892. Barley variety BLB-103 gave the highest green forage (22 q/ha) along with 15 q/ha grain under rainfed condition. In fruit based agri-horti system, significant effect on grain yield was observed with the presence of different fruit trees. In silvi-horti system rhizome yield of different turmeric varieties was significantly higher (124.9 q/ha) with *Quercus leucotrichophora* than other treatments. Improved pit planting had the highest survival rate (94%) of plants. The highest green forage 379.59 q/ha was recorded in bio fertilizer + 75 % NPK. The same treatment had the highest resource use efficiency of 85.38% and the net return of Rs 22,472/ha.

The roof and surface water was harvested in trenches to increase ground water for maintaining the discharge of the ground water. The comparative study revealed that the discharge rate increased from 0.7 to 1.7 liter per minute during different months in 2008 in comparison to earlier records of 2000.

Soy Cow Machine (SC 20), installed at the institute, processed about 12 kg of soybean in 8 hours. It required about 2 man days for Tofu making. About 14 kg of Tofu was made in 8 hours with 12 kg Soybean per day. The initial investment to install the machine was Rs. 2,75,000/-. Based on the cost and return from the machine, economic indicators *viz.*, net present value (NPV) Rs. 2,45,203/-, benefit cost ratio (BCR) 1.7, internal rate of return (IRR) 26% and pay back period (PBP) 3.6 were calculated and found it beneficial.

3. Crop Protection

In rice, out of 20 genotypes tested under Donor Screening Nursery at various hot spots of the country, VOHP 3102 showed resistance to sheath rot, bacterial blight and grain discolouration in addition to blast. The blast donor VSR 8, registered with NBPGR (INGR No. 06002; IC 546941) continued showing resistance. Virulence pattern in the blast pathogen population was monitored. BL 122, *Oryza minuta*, A 57, BL 245, C101A51 and IR 64 showed blast resistant reaction. In maize, V 336, V 335, V 345, V 346, V 364, VQL 18, FH 3473, Vivek 25 and Vivek 17 showed resistance against turicum blight. The promising genotype possessing resistance to major diseases/ insect-pests were identified in finger millet, barnyard millet, soybean, horsegram, groundnut, reamash *etc.* IPM trial on rice was carried out in 5 ha at village Raulsera, as a collaborative programme with NCIPM. Improved varieties gave better B:C ratio compared to local/old susceptible cultivars. Among bio-agents, 12 isolates of *Pseudomonand* group showed antagonistic activity against the wilt pathogen, *Rhizoctonia solanacearum* under lab studies. These were Pf-3, Pf-30, Pf-52, Pf-96, Pf-106, Pf-118, Pf-123, Pf-131, Pf-132, Pf-149, Pf-151 and Pf-163. In garden pea, three modules *viz.*, IPM, chemical and organic one resulted in significant

reduction in the incidence of wilt (39 to 53%), leaf blight (32 to 74%), white rot (45 to >63%), powdery mildew (64 to >93%) and pod borer (61 to >78%) and yielded significantly higher over untreated check but IPM and chemicals modules were superior to organic module. Organic and inorganic products alone and in combinations reduced leaf blight (24-70%) and powdery mildew (32-92%), with yield increase of 28-60% over the check.

Three indigenous *Trichoderma harzianum* isolates and their combinations were evaluated to control root rot in lentil, and leaf blight and white rot diseases in garden pea. Tr-11 and Tr-11+34 reduced the disease and also improved yields. Tr-11, Tr-28 and Tr-34 isolates of *T. harzianum* applied as seed treatment and fortified compost were found effective in control of root rot in French bean. Foliar sprays of *T. harzianum* (Tr-34) and fermented extracts of *Urtica* (1:5) showed promise in controlling angular leaf spot of French bean. Nine brassicaceous plants were tested for their bio-fumigation potential against root rot. Minimum root rot was recorded with toria and broccoli (11.7%), with maximum yields 210.7 q/ha and 196.0 q/ha, respectively. Out of 8 bacterial isolates tested against white grub, *Brevibacterium frigoritolerans* strain HSB 15 and *Bacillus cereus* strain WGPSB-2 caused more than 80% mortality of first instar grubs of *Anomala dimidiata*. Cartap hydrochloride @ 1 g/l followed by batatin seed kernel extract 10% and Bt @ 10 kg/ha against pod borers in French bean and Deltamethrin 2.8 EC @ 0.5 ml/l against blister beetle in pigeon pea were found to be effective. VL Bt (MTCC 8997; *Bt* sub sp. *galleriae/colmeri*) out of 106 Bt strains from NW Himalayan region tested was found to be effective against Diamond Back Moth, leaf webber, semilooper, tobacco caterpillar, Bihari Hairy Caterpillar, cutworms, cabbage butterfly, tomato borer and amaranth caterpillar. Seed coating @ 3 g/kg seed along with either soil incorporation or drenching @ 200 g/nali (1 gm/m²) near the root zone of the talc based formulation of *B. cereus* strain WGPSB-2 against white grub in potato recorded maximum yield with minimum tuber damage. Among the various groups of insects trapped in VL Insect Trap-1, 56.7 to 64.7% were scarabaeids and only 0.3 to 0.6% were the natural enemies of insect pests. Thus, the trap was found to specific to scarabaeids and also eco-friendly. The technology has been commercialized. VL WAR has been developed as a repellent against wild animals and was released for farmers use.

4. Socio-Economic Studies and Transfer of Technologies

IRS (Intelligent Report System) program was installed successfully and data were entered for the quarters April-June 08, July-September 08, October – December 08 and January – March 09. Data collected from total 170 farmers in Almora, Bageshwar and Nainital districts of the institute outreach programmes revealed that the investment falls considerably short of normative investment in Almora (Rs 25,025/ha) and Nainital (Rs 27,964/ha) districts as compared to modest shortfall in Bageshwar (Rs 29,944/-). Employment generated per farm is highest in Nainital (29 mandays) whereas, Almora generates the lowest employment per farm (18 mandays). Three training programs, involving a total of 51 trainees, were conducted.

5. Other Research Projects

HTMM Projects

Under the project, "Production of Quality Seed and Planting Material (Vegetables)", a total of 507.5 kg seeds of garden pea, onion, okra, French bean and tomato were produced against the target of 308.0 kg. Besides, 25,000 seedlings of cauliflower (PSBK-1) were produced under protected condition and supplied to farmers of the North-West Kumaun region for the off season cultivation.

A total of 1,035 saplings of sub-tropical fruits (sweet orange, lemon, guava) including 400 papaya seedlings and 1,570 of temperate fruits (kiwi, nectrine, peach, plum, apricot, walnut and pear) were planted under the project "On-farm Sustainable Production and Demonstration of Fruits and Vegetables Farming Systems". A total number of 53 LDPE poly tanks, with an average capacity of 40 m³ were made, out of which 10 poly tanks were constructed in 2008-09. Out of these, 12 ponds are being used for fish cultivation also. Apart from tanks, 74 poly houses were also constructed. Protected cultivation of vegetables in poly houses included cauliflower, tomato, squash, cucumber and green vegetables that gave a gross return of Rs. 4.96 lakh.

Under the project, "Training and Demonstration on Micro-irrigation System for Enhancing Irrigation in Terrace Level for Vegetable Cultivation", 11 trainings on MIS were conducted for 496 participants. The Micro-irrigation system was demonstrated at the farmers' field at Bhagartola village to cover 10 nalis (0.2 ha). The perennial water sources were tapped from the hilly catchment (average slope varies from 60 to 100%, land cover of deciduous forest). The LDPE tank (Gross capacity 140 m³) was used for water harvesting and irrigation. The irrigation system was designed and installed considering the gravity head as 3.0m.

A total of 17 polyhouses and 26 polytanks were constructed and 5 light traps installed under the project, "Training and Demonstration of Growing Off-Season Vegetables under Protected Environment". A total of 301 demonstrations on pea (August & November sown), French bean, tomato (open field & under polyhouse), cabbage and cauliflower were conducted in an area of 13.85 ha in five villages of two blocks in Almora district and five villages of three blocks in Nainital district.

A total of 21 demonstrations of button mushroom and 11 of Dhingri Mushroom were laid at different farmers' sites places including two at experimental farm. Three growers of village Daulaghat, Govindpur & Sheetlakhhet has been making pickle, which was in great demand due to its good shelf life and selling it @ Rs. 200/kg.

Under the project, "Quality Seed Production of Capsicum and Squash under Protected Condition", a total of 1100 m² was allotted for capsicum seed production out of which 400 m² was under protected cultivation. On the other hand 1000 m² area was allotted for squash seed production which included 80 m² under protected condition. The total seed yield from capsicum was 3.65 kg (@ 33.2 kg/ha) and squash was 81kg (@ 810 kg/ha), out of which 1.65 kg (@ 41.3 kg/ha) and 11kg (@ 1,100kg/ha) seeds were produced from capsicum and squash respectively, under protected condition. Seed production of French bean (var. VL Bauni Bean 1 and 2) were taken in the *kharif* season inside the polyhouse. 1100 m² area was allotted under

protected cultivation. A total of 56.25 kg (@ 511.4 kg/ha) seed was produced inside polyhouses.

For the Management of scarabaeids in Uttarakhand hills, a two pronged strategy involving use of an efficient, eco-friendly, light based insect trap for capturing the adults and a novel entomopathogen, *Bacillus cereus* strain WGPSB-2 for the management of grubs was developed. Three years experimentation revealed drastic reduction in beetle population to the tune of 75.28, 78.17 and 80.59 per cent in low, mid and high altitude villages, respectively. A significant reduction of the grub population was recorded from 71.2 to 95.7 per cent across villages. As a result, mean per cent increase in yield was recorded in different crops from 38.7 to 95.3 per cent in the adopted villages over non-adopted villages.

Planned honey bee pollination has increased seed yield of radish, onion, coriander, broccoli, chinese cabbage, knol-khol and fenugreek by 27.04, 26.90, 26.30, 29.20, 12.14, 23.53 and 15.50 per cent, respectively over naturally pollinated crops. Similarly, average fruit yield of cucumber, apple, peach, pear and apricot were increased by 14 to 22 per cent in planned honey bee pollinated crops. Approximately 79 hectare area was covered under the project and 645 farm families were benefited.

Under the project, "Status of Horticulture & Market Opportunities in the State of Uttarakhand", the land holding of sampled farmers showed that cultivation was about 0.84 ha out of total 0.92 ha, of which area under vegetable cultivation was 32 percent, indicating enthusiasm of farmers for growing vegetables in view of higher profitability. Benefit cost ratio was highest in tomato (6.6), followed by cauliflower (5.6) and pea (4.9), though it is liable to change with supply-demand situation, price fluctuation and general inflation trends. Marketing fee in terms of middle men's commission, market tax etc has highest share in total marketing cost. The total marketing cost of tomato was the highest (Rs.182.4 per q) followed by capsicum and bean.

Under the project, "Training in Mechanization of Horticulture", the farmers' trainings were organized at 17 villages by which 800 farmers were benefited. Demonstrations of sickle, pruning tool, pruning saw, improved kutla (wooden and steel handle) khurpi, spade, circular blade type weeder, hand wheel hoe, hand hoe, sprayers (power and hand operated), hand fork, baryanth, sickle, Vivek Millet Thresher, VL Seed Drill, VL Paddy Thresher and Light Trap were carried out.

AMAAS Project

Under the project, "Development of A Bacterial Consortium to Alleviate Cold Stress", 12 cold tolerant bacterial isolates from Uttarakhand Himalayas were screened for ice nucleation activity. The isolates showed type III class ice nucleation activity (-6 to -12 log ice nuclei/cfu) at -10°C. All the isolates showed the presence of a ~160 bp major cold shock protein gene (*cspA*), which encodes a cold inducible protein which is responsible for cold adaptation. The gene sequence shows more than 90 per cent homology with the cold shock protein of several *Bacillus* sp.

The fermentation technology for the mass production of 14 cold tolerant PSB isolates was standardized under the project "Development of A Cold Tolerant Phosphate Solubilizing Bacterial Inoculant". Kings B medium supplemented with 1 per cent casein acid hydrolysate was found to be superior to the regular Kings B and

Pikovaskaya media in supporting the cell growth of the cold tolerant PSB isolates. Similarly, all the isolates recorded higher cell yields when a 5 per cent inoculum was used. RAPD primers were found to be most suitable for the generation of polymorphic bands for SCAR marker development. SCAR primers were developed for five isolates by sequencing the polymorphic bands.

CWC Project

A total of 67 LDPE film lined tanks were created and 4.8 ha area was brought under MIS against the targeted 60 tanks. Besides, 187 demonstrations, involving 153 farmers, on improved crop varieties for efficient water utilization were laid.

NAIP Project

For enhancement of livelihood security through sustainable farming systems and related farm enterprises in N-W Himalaya, the diversification to vegetables, livestock was undertaken in a big way. The sustainability of natural resources conservation and development of water resources included construction of 45 poly tanks and their efficient utilization for protected cultivation in 56 poly-houses, management of non-arable lands including fodder plantation in about 50 ha, plantation of MAPs and MPTs in the common lands in about 20 ha. Women empowerment and drudgery reduction was given the major thrust with formation of 10 SHGs and plantation of Napier Grass covering 10 ha area. Six farmers' trainings were conducted on various aspects of farming and processing.

KVKs

The KVKs at Chinyalisaur and Bageshwar conducted 65 and 59 training programmes on various topic in the disciplines of crop improvement, horticulture, plant protection, home science, animal husbandry and agricultural extension during with the participation of 1,390 and 1546 trainees, respectively including practicing farmers, farm women, rural youths and extension functionaries. Besides, front line demonstration on oilseed, pulses and other crops were conducted at the farmers' field in an area of 38.54 ha (*kharif* 18.54 ha and *rabi* 20.00 ha) and 19.54 ha area, which benefited 1,255 and 548 farmers in Chinyalisaur and Bageshwar, respectively. The KVK, Chinyalisaur produced and supplied around 80 quintal of truthfully labeled seeds of 23 released varieties of different crops and supplied to the farmers and govt. agencies.