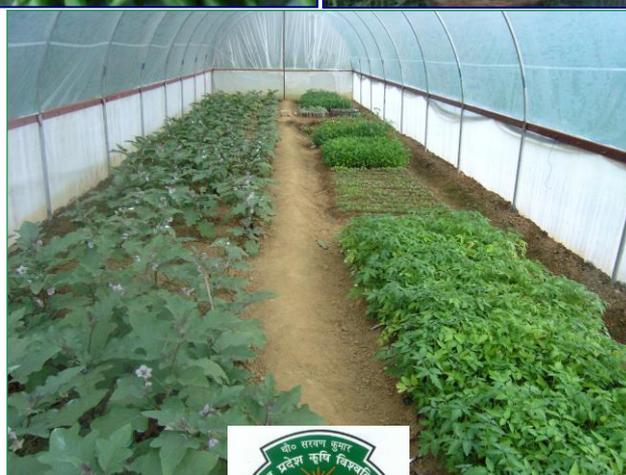


Workshop on Vegetable Crops (September 12, 2013)

RESEARCH ACHIEVEMENTS ON VEGETABLE CROPS



**CSK HP KRISHI VISHVAVIDYALAYA
PALAMPUR**

2013

RESEARCH ACHIEVEMENTS ON

VEGETABLE CROPS

Vegetables play a major role in Indian agriculture by providing food, nutritional and economic security and more importantly, producing higher returns per unit area and time. In addition, vegetables have higher productivity, shorter maturity cycle, high value and provide greater income leading to improved livelihood. In our country before independence vegetable production was less than 20 million tones which have now increased to 156.3 million tones from an area of 8.98 million ha. During the last five years vegetable productivity is increasing with an overall growth rate of 1.64% and production at 3.72% in total. With the increasing population in our country, the demand of vegetables will be 225 million tonnes by 2020 which will further increase to 350 million tonnes by 2030. The major challenge, which lies ahead, is to develop technologies that enhance quality and productivity of vegetables under reducing land, declining natural resources, increasing biotic and abiotic stresses and ever increasing population.

Himachal Pradesh, a north-western Himalayan state sprawling over 5567.3 thousand hectares has highly uneven terrain with altitude ranging from 350m to 6975 m above mean sea level. Agriculture continues to be a major source of livelihood for the majority of the people in the state. The state has witnessed tremendous agriculture transformation during the past four decades after it earned full state hood in 1971. Earlier the economy of our state was fruit based but in the era of crop diversification, vegetable cultivation in Himachal Pradesh in general has gained significant importance on account of favourable agro-climatic conditions for growing quality off-season vegetables. This produce fetches high price in plain markets and thus encourages Himachal growers to take up vegetable cultivation as a profession which has improved the living standards of the peasantry. Moreover, with the emergence of the urban middle class market having specific kitchen needs and health security, there is a growing demand for quality vegetables. The hill grown vegetables find a special liking in the plains on account of their characteristic flavor, freshness, sweetness and crispness. There is an additional advantage of comparatively low incidence of diseases and insect-pests in hills and thus our produce is pesticide residue free. At present, the area under vegetables in the state is 72000 ha and the production is 14 lakh tones with per annum growth rate of 6.5 % in area and 7.4 % in production. With a great pleasure I would like to mention that the vegetable productivity of Himachal Pradesh is 19.5t/ha which is higher than the national productivity (17.5t/ha). This increase in vegetable production in the state is due to

- The state has been bestowed with varied agro-climatic conditions ranging from sub-tropical to temperate, serving as an off-season hub for production of quality vegetables in one or the other region through out the year.
- The farmers of our state have marginal land holdings and around 80% of the area is rainfed. The protected cultivation has been a boon to such farmers of district Hamirpur, Bilaspur, Mandi, Sirmour, Kullu and Kangra as the state government is

Lecture delivered by Dr. S.P. Sharma, Director of Research, CSK H.P. Krishi Vishvavidyalaya, Palampur in the Agricultural Officer's Workshop on Vegetable Crops-2013 held at CSKHPKV, Palampur on September 12, 2013

providing increased policy support in form of subsidy to the tune of 85% for the construction of polyhouses. The farmers are earning lucrative returns by growing

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colored capsicums, cherry tomato and parthenocarpic cucumbers under protected structures.

- To promote diversification, Horticulture Technology mission and Japan International Cooperation Agency are playing significant role in promoting vegetable cultivation in the state.
- In Himachal, diversification from cereal based cropping system to vegetables is gaining momentum because of tourism industry. More area is being put under cultivation of exotic vegetables on account of suitable temperate climate which has proven as a remunerative venture.
- Climate change also playing crucial role in vegetable cultivation since climate change *per se* is not necessarily harmful. The problems arise from extreme events that are difficult to predict. Climate change has forced the hill farmers to re-synergize the cropping pattern. As a consequence of this climate change, the orchard line is gradually shifting to the higher mountainous regions of the state. *e.g.* Earlier, the apple of Shimla district was considered as the best quality apple in the international market which was later on replaced by the Kinnauri apple. Now, Lahaul and Spiti apple is taking the place of best quality Kinnauri apple. The area under apple orchards in the Shimla and Kinnaur districts has been taken over by vegetables. Now, vegetables are generating more revenue than fruits by contributing more than Rs. 3000 crores leaving behind the fruits which contribute only Rs. 2200 crores annually.
- Highest per hectare yield of vegetables has been reported in Lahaul & Spiti followed by Kinnaur areas of Himachal Pradesh.
- In HP there are many in un-exploited potential pockets to grow off-season vegetables. Cultivation of green peas in dry temperate zone has brought a revolution in changing economic status of hill farmers. Cultivation of tomato, beans and bell pepper in Solan and Sirmour areas has been a successful venture.
- In Mandi and Chamba Districts, cultivation of European vegetables particularly broccoli, Chinese cabbage, lettuce *etc.* has been taken up on commercial scale. These days, farmers have established direct contact with distant markets to harness better returns.
- In the past decade, the Department of Vegetable Science of both the universities have developed number of varieties and production technologies which are available to the vegetable growers through KVKs and State Department of Agriculture and Horticulture.

India has the largest number of poor and malnourished people in the world where vegetables can combat this alarming situation by promoting this cheaper and easily accessible source of nutrients. Vegetables can be supplemented in mid day meal of government schools to overcome malnutrition among younger generation. To further boost the vegetable cultivation to meet out the set target of 350 million tonnes by 2030 we need to explore new areas having potential in the state.

- Himachal is a treasure house of traditional locally adapted indigenous vegetables. It is imperative to promote such vegetables for poverty alleviation and nutrition improvement of rural households. By adding diversity to production systems and diets,

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indigenous vegetables help to ensure year-round availability and balanced nutrition. Different locally adapted indigenous vegetables in Himachal Pradesh which are consumed traditionally based on age old indigenous knowledge of their nutritive and medicinal value in different areas are leafy vegetables (*Amaranth*, *Chenopodium*, *Colocasia* leaves and stems, curry leaves, *Fagopyrum* sp. etc.), flower buds and fruits (*Bauhinia*(Kachnar), *Cordia* (lasora), chayote (launku) etc.), fern (*Diplazium*) and legumes (broad bean, sword bean etc). These vegetables are rich in Beta-carotene, quality protein, calcium, iron, phosphorus, vitamin C and dietary fibre. Thus, they play a greater role in tackling malnutrition.

- In Himachal Pradesh many semi domesticated and semi-edible tuber crops are being grown where systematic research work is required. The crops like ginger, turmeric, colocasia, elephant foot yam require more attention in the state where monkey menace has become a serious problem and these crops can serve as viable alternative especially where the farmers have bunged/abandoned their productive land.
- These indigenous and tuber vegetables are growing organically by default in the state and need more attention. Organic vegetables fetch a premium price of 10%- 50% over conventional products. Market of organic products is growing at faster rate (20%) as compared to conventional ones (5%). Organic Farming has the twin objective of system sustainability and environmental safety.
- Today majority of vegetable growers are procuring hybrid seeds of private sector from local vendors. In general, the performance of these hybrids is not up to the mark as they are not evaluated in the varied agro-climatic conditions and lack recommendations of the reliable agencies. In vegetables, the scenario is different as compared to cereals *e.g.* in our state we recommend only those tested hybrids of maize to the farmers which are thoroughly tested by our university and their DNA profiling is done and rechecked by taking random samples from the open market. Such mechanism and facility is strongly required in vegetables to check the purity of hybrid seed.
- In the present scenario of globalization we need to conserve locally available genetic resources for future crop improvement.
- Alongwith offseason vegetable cultivation, Himachal is also known for quality seed production of various vegetables. The seed produced in hills has longer viability, more vigour and is disease free.
- The pace of developing new genotypes for specific purpose can be geared up by involving various biotechnological tools like marker aided selection. Gene pyramiding and development of varieties with multiple resistance and quality.

To increase vegetable production, a number of production constraints must be alleviated to enhance productivity of vegetable crops, their nutrient quality, post harvest management and value addition.

☞ RESEARCH ACHIEVEMENTS

➤ Vegetable improvement

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Varieties Developed and Released

During the period under report the University has developed following three varieties of different crops, which have been approved by the H.P. State Seed Sub Committee in its meeting held on 10-01-2012 for general cultivation in different agro-climatic conditions of the State:

Crop	Name of Varieties
Garden pea	DPPA8-E (Palam Triloki) and DPPM-64 (Palam Sumool)
French bean	Palam Mridula.

Other Research Achievements

- New high yielding and yellow vein mosaic (YVM) resistant okra line ‘Palam Komal’ has been developed for release in the state. The fruits are attractive, slender, dark green and five ridged. Fruits remain tender on the plants for longer duration as compared to the check P-8. Average fruit yield is 215-230 q/ha.
- Elephant foot yam (Zimikand) variety “Palam Zimikand-1” has been identified for release in the zone I and II of Himachal Pradesh. It is the first varietal recommendation for the state. It has white fleshed corms, solid, round, densely spotted pseudo stem. It is ready to harvest in 170-180 days. Yield from 100 g cormlets raised crop is 200-250 q/ha and from 100-500 g corm is 450-550 q/ha.
- Asparagus bean line ‘DPASB-1(Palam Long Bean)’ has been identified for release in the state based on its good performance in the station trials and on-farm trials conducted in farmers’ fields. The line has indeterminate growth habit and requires staking. It is early maturing and ready for first harvest in 55 days. It has profuse pod bearing. The pods are very long, attractive, green, fleshy, tender, juicy and stringless. Average pod yield potential is 110 q/ha.
- Three bacterial wilt resistant recombinants of capsicum *viz.*, DPWRCap-14-11, DPWRCap-49-11 and DPWRCap-49-11 have been identified with bell shape fruits and shining green colour for further evaluation in station trials and also in farmer’s field.
- In cauliflower, two superior genotypes namely, DPCaY-7 (early maturing in 60-65 days) and DPCa-1(late maturity group) have been developed. These genotypes have been included in IET varietal trials under AICRP (vegetable crops).
- A new cabbage hybrid ‘H-702’ has been developed involving self-incompatible line. The seeds of this hybrid could be produced successfully in a net house by planting the S-allele line I-4-6 and the pollen parent GA(P) in 2:1 ratio and pollination through honey bees.
- In chilli, three bacterial wilt resistant recombinant lines *viz.*, Plp-CH-VVG-11, Plp-CH-34-11 and Plp-CH-CH-15-11 have been identified with superior horticultural traits and high yield.

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- Chilli variety 'Palam Yellow' has been developed with low pungency for salad.
- White onion variety 'Palam White' has been developed which showed high yield performance in station trials.
- In cucumber, two high yielding hybrids namely, Plp × KL-1 and G-1 × Summer Green have been developed using gynocious lines. The performance of these hybrids is at par with private sector hybrids namely, Hyb No. 005(Dhanya) and Damini(Century).
- Cytoplasmic male sterile gene is being transferred into four genetic backgrounds to develop CMS lines in chilli along with their maintainers for their utilization in hybrid development.
- The cytoplasmic male sterile (CMS) and self incompatible (SI) lines are being utilized in cabbage, cauliflower and broccoli for hybrid development.
- In garden pea, three lines 2011/PMPM/2, 2012/PMVAR/5 and 2012/PMVAR/4 were found to be high yielding and resistant to powdery mildew. Recombinant inbred lines, Line No. 13 and Line No.14 were found to be promising with respect to earliness and high yield.
- Kale genotype "Siberian Sel-1" was observed to possess high green leaf yield (43.48 q/ha.).
- In brinjal lines viz., 10/BRBWRES-5, 0/BRBWRES-2, Arka Nidhi and SM-6-6 were found to be bacterial wilt resistant.

➤ **Vegetable Production**

- Change in the seed rate of garlic varieties with large clove size (GHC-1 and Agrifound Parvati) has been proposed @15-20 q/ha instead of 5-6q/ha.
- Revised fertilization schedule for onion cultivation has been proposed. There is no recommendation for application of sulfur in onion. With the existing recommendation of 475 kg SSP, 57 kg S ha⁻¹ is added. Application of S above 25 kg ha⁻¹ has deleterious effect on bulb yield. So, by reducing sulfur dose to 25 kg ha⁻¹ through Gypsum along with application of recommended NPK through 12:32:16, urea and MOP resulted in an increase of 50-60 quintals of bulbs ha⁻¹ over the existing recommendation of CAN, SSP and MOP.
- *Kharif* onion production technology has been standardized. The most appropriate sowing time of nursery was found during second fort night of March and planting of sets in second fortnight of August along with seed rate 10-12 kg/ha.

➤ **Protected cultivation**

- Portable low tunnels (305 m × 1.2 m × 1 m) were found to be promising for quality nursery production of different vegetables rather than traditional/polyhouse nursery production.
- An ideal model of modified naturally ventilated polyhouse having double door, side ventilation, top ventilation, drip system of irrigation, overhead fogging/misting system

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and top covered with rollable 40-50% UV stabilized green shade nets is being advocated in low and mid hills for efficient and cost effective commercial production of capsicum, tomato and parthenocarpic cucumber.

- Tomato hybrid “Palam Tomato Hybrid-1 (BWR-5 × Palam Pride)” has been approved by the Research Evaluation Committee of CSKHPKV for release under protected conditions. In addition, two more hybrids of tomato namely, 1-2×16-B and BWR-5 × Hawaii-7998 were also found superior for fruit yield and resistance to bacterial wilt disease.
- Three hybrids of tomato, two of capsicum and three of parthenocarpic cucumber from private companies were identified for protected cultivation and have been approved by the Research Evaluation Committee of CSKHPKV for release.
- Coriander can be successfully grown under portable low tunnels of size 3.5 m × 1.20 m × 1.0 m covered with transparent polythene sheet of 120 GSM during summer and rainy season (Sowing –June-July). Three to four cuttings of green leaves can be obtained during rainy/autumn season.
- Lettuce can be used as a filler crop in the polyhouses to incur more income. Two hybrids Dublin (heading) and Green Romaine (Leafy) were found suitable to be grown as filler crop under polyhouse conditions in mid hills of HP
- Carotene rich tomato ‘Palam Yellow’ with semi-indeterminate growth and resistant to bacterial wilt has been found promising for table purposes.
- Successful grafting on bacterial wilt resistant rootstocks of capsicum, tomato and chilli has been done using scions of commercial hybrids of capsicum, tomato and chilli.

➤ **Crop Protection**

Disease management

- Management of Rhizome Rot of ginger by cutting seed rhizome with sterilized surgical blade dipped in rectified spirit.
- Two new emerging diseases *i.e* gray leaf spot of tomato caused by *Stemphylium* sp. and root rot of capsicum by *Phytophthora capsici* were recorded under protected cultivation in HP.
- Under protected condition, hexaconazole (0.1%) and difenoconazole (0.05%) were found effective in the management of capsicum and tomato powdery mildew.
- *Pepper mild mottle virus* (PMMoV) is of wide prevalence in capsicum and is a potential threat for its cultivation under polyhouse conditions.
- Seedling dip with Bavistin @ 0.10% at the time of transplanting accompanied by one foliar spray of Dithane Z-78 at the time of diseases appearance followed by two sprays of Ridomil MZ 72 WP @ 0.25% were found highly effective in controlling early blight, buck-eye rot, Septoria leaf spot and late blight of tomato.
- Sectin 60 WG (Fenamidone 10% + mancozeb 50%) @ 0.20% and Melody Duo 66.75 WP (Iprovalicarb 5.5%+Propineb 61.25%) @ 0.25% were found highly effective against late blight of tomato.

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- Spray of Indofil M-45(10 days interval) followed by two sprays of Ridomil MZ 72 WP (15 days interval) @ 0.25% is effective in controlling *Phytophthora* blight of brinjal.
- Module comprising of alternate spray of Indofil-M 45 (at 10 days interval) and Ridomil MZ 72 WP (at 15 days interval) @ 0.25% is effective to control downy mildew of cucumber.
- Under protected condition, Ridomil Gold (0.25%) was found effective against downy mildew of cucumber
- For pea root rot/wilt complex, seed dressing with Vitavax (2.5g/kg) was the most effective as compared to Bavistin (2.5g/kg).
- Palam Trichoform has been developed in the biological control unit of Plant Pathology against soil borne pathogens.
- Three up scaled bioformulations namely, SMA-5, DMA-8 and JMA-11 strains of *Trichoderma* have been developed against soil borne pathogens.

Insect-pest management

- In organic tomato (hybrid 7730) cultivation, *Bacillus thuringiensis* sub sp. *kurstaki* (Lipel) @ 1.0 kg/ha in 3 sprays at 10 days interval, initiating at 40 days after transplanting, was found to be the most effective and economical against fruit borer. In this treatment, fruit infestation and yield losses due to borer were 3.66 and 3.31 per cent, respectively as compared to 19.06 and 14.51 per cent in the control.
- In tomato, for the management of fruit borer and foliar and fruit rot diseases at Bajaura, amongst the the six modules evaluated, a module comprising use of pheromone (Helilure) traps @12 traps /ha just after transplanting followed by three sprays at 15 days interval initiating spraying after 40 days of transplanting. First foliar spray consisted of lambda- cyhalothrin 5EC @ 0.004% + Dithane-Z 78 (Zineb) @ 0.25% followed by 2nd spray with Helicide (Ha NPV) 100 LE @ 0.5ml/l + Indofil M-45 (0.25%) and 3rd spray with lambda- cyhalothrin 5EC @ 0.8ml/l (0.004%) and Amoximate (cymoxanil+ mancozeb)@ 0.25% was found superior.
- In brinjal, studies on integrated management of shoot and fruit borer and fruit rot disease (Phomopsis fruit rot) in Kullu valley revealed a module consisting of use of pheromone traps (@12 traps /ha); mechanical destruction of infested shoots and fruits.; application of Neem cake @ 250 kg/ha (20-25 grams/ pit) at the time of transplanting and followed by 4 foliar sprays (Emamectin benzoate 5 SG @ 2g/5L, Agrospray oil @ 2.5 ml/L + Indofil M-45 (0.25%, Neemban @ 5 ml/L + Ridomil @ 0.25% , L-cyhalothrin 5 EC @ 0.004% + Ridomil @ 0.25%) at 15 days interval, initiating spraying at 45 days after transplanting was found to be the most effective and economical.
- In cucumber, Module comprising installation of fruit fly traps @ 25 traps/ ha from crop germination till harvest followed by first spray with Neemban 1500 ppm @ 50 ml/ 10L with the appearance of pest; second spray with Malathion 50EC 10 ml+ gur 100 g + Indofil M-45 (25g) in 10 litres of water 10 days of first spray; third spray with Malathion 50EC 10 ml+ gur 100 g + Ridomil MZ 72 WP @ 0.25% after 15 days of 2nd spray and fourth spray with Indofil M-45 (0.25%) only after 15 days of 3rd spray) has been

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found to be most economical module with net additional return of Rs. 1,7,901 and Rs. 24.85 net returns per rupee invested.

- In garden pea, studies undertaken on the integrated management of leaf miner, fungal root rot & wilt complex and *Ascochyta* blight showed that a module consisting of seed treatment with Bavistin 50 WP @ 2.5 g/kg seed followed by foliar application of lambda-cyhalothrin @ 0.004% and carbendazim @ 0.1% (Bavistin 50 WP) at 50% flowering (2nd week of March) followed by 2nd application of acetamiprid @ 0.005% and hexaconazol @ 0.05% (Sitara 5 SC) after 15 days of the 1st spray was found to be the most effective and economical treatment.
- In cauliflower, five modules were evaluated against cutworms, cabbage butterfly and diamondback moth in Lahaul valley. The module comprising foliar spray after transplanting with cypermethrin 10 EC @ 1.0 ml/l followed by alternate application of lambda cyhalothrin @ 0.8 ml/l and malathion @ 1.0 ml/l with appearance of insect pests repeating after 15 days was found to be the best.
- In polyhouses, red spider mite, yellow mite, aphid and *Spodoptera litura* were of major significance in zone 1.1 and 1.2. In zone 2.1 and 2.2 major pests in the order of abundance are greenhouse whitefly, aphid, *S. litura* and red spider mite. *Polyphagotarsonemus latus* and *Aculops lycopersici* were recorded as new mite pests on capsicum and tomato in H.P. During 2012-13, mealy bug, *Phenacoccus solenopsis* was recorded for the first time from Himachal Pradesh in low hills on tomato and capsicum. Abundance of yellow mite, *Polyphagotarsonemus latus* on capsicum has also increased in mid-hill.
 - For mass trapping of greenhouses whitefly, economical yellow sticky traps have been designed and popularised.
 - Against aphids in capsicum, acetamiprid 20SP (0.02%) proved most efficacious followed by imidacloprid 17.8 SL and L-cyhalothrin 5EC.
 - For the management of yellow mite and thrips in capsicum, spiromesifen proved efficacious.
 - For the management of red spider mite in cucumber, spiromesifen 240SC @ 120 and 144 g a.i. per hectare was found promising.
- Application of Hamla (chlorpyrifos 50% + cypermethrin 5%) @ 2.0 kg + 200 g a.i./ha has been found to be the best treatment in controlling whitegrubs (*Melolontha* sp.) in cabbage. Against *Phyllognathus dionysius* in capsicum, chlorpyrifos 20EC @ 2.0 kg a.i./ha has been found to be the best treatment.
- Bio-efficacy of *Melia and Eupatorium* formulation evaluated against different vegetable crop pests revealed the waiting period of 0 days. Mammalian toxicological data revealed them to be safe for mammals.
- Out of 95 lines/varieties of sponge gourd screened for their resistance/susceptibility reaction to *M. incognita*, none was rated to be either highly resistant or resistant. Fifteen lines were rated as moderately resistant, 73 as susceptible and 7 as highly susceptible. In ridge gourd, 76 lines/varieties were screened for their resistance to this nematode species. No line was rated to be highly resistant whereas 2 were rated as resistant, 9 as moderately resistant, 51 as susceptible and 14 as highly susceptible. Three cakes

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namely, Neem, castor and jatropa evaluated @ 30 g/plant in bottle gourd revealed ICBR of 3.33, 4.76, and 3.24, respectively.

- Three bioagents, namely, Neem cake @ 200g/m² before transplanting(T₁), *Trichoderma harzianum* @ 50 g/ m²(T₂), *Paecilomyces lilacinus* @ 50 g/m²(T₃), combined application of T₁ +T₂ and combined application of T₁ +T₃ were evaluated for their efficacy against *M. incognita* in polyhouse tomato. The yield was increased in all the treatments, compared to the untreated control but ICBR was found to be favourable only in Neem cake (3.77).
- Soil sterilants formalin (40% formaldehyde) @ 225 ml/m² and metham sodium @ 30 ml/m² evaluated alone and also with additional application of neem cake @ 200 g/m² enriched with either *Paecilomyces lilacinus* @ 50 g/m² (2 x 10⁶ cfu/g) or *Pseudomonas fluorescens* @ 50 g/m² (1 x 10⁹cfu/g), mixed 15 days prior to sowing in polyhouses revealed that both root knot index (RKI) as well as soil population of the nematode in tomato was recorded to be low as compared to the control. Highest ICBR was calculated when metham sodium was applied alone.

New Recommendations

Programme Area	Variety/ Recommendation
Crop Improvement	Release proposal of Asparagus bean variety DPASB-1 (Palam Long Bean)
-do-	Release proposal of Okra variety DPO-P20 (Palam Komal)
-do-	Release proposal of Elephant foot (Zimikand) variety Palam Zimikand-1
Crop Production	Proposal for change in the recommendation of seed rate of garlic (1500-2000 kg/ha) for varieties with large clover size (GHC-1)
-do-	Revised fertilization schedule of onion for inclusion in the package of practices (POP).
Crop Protection	Additional recommendation for the control of Powdery mildew of pea caused by <i>Erysiphe pisi</i> .
-do-	Refined technology proposal for the control of rhizome rot of ginger
Protected cultivation	Proposal for inclusion of new tomato hybrid “ Palam Tomato Hybrid-1” (15-2xPalam Pride) for cultivation under protected conditions.
-do-	Adhoc recommendation of new hybrids of cucumber, tomato and capsicum for inclusion in the package of practices (POP)
-do-	Management of russet mite in tomato grown under naturally ventilated polyhouses.

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-do-	Management of yellow mite in capsicum grown under naturally ventilated polyhouses
-do-	Management of green peach aphid, <i>Myzus persicae</i> on capsicum grown under naturally ventilated polyhouses
-do-	Adhoc recommendation of capsicum hybrids for protected cultivation for inclusion in the package of practices on vegetable crops
-do-	Adhoc recommendation on “Lettuce production under protected conditions” for inclusion in the package of practices on vegetable crops.
-do-	Low cost yellow sticky traps for the management of green house whitefly under naturally ventilated polyhouses
-do-	Adhoc recommendation on “Off season coriander production under portable low tunnels” for inclusion in the package of practices on vegetable crops