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Pusa Golden Cherry Tomato-2
**Tridax procumbens: A medicinally valuable weed**

*Tridax procumbens* Linn. is a typical medicinal plant that belongs to the family Asteraceae which is used in Ayurveda as medicine due to the presence of pharmacological activities. It is an annual or perennial plant, native to Central and South America and occurs throughout India as a weed, commonly known as ‘Coat buttons’ and Tridax daisy in English. Its leaves have antiseptic, insecticidal and antiparastic properties. Therefore, it could be used in organic farming for sustainable agriculture in the future.

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*Tridax procumbens* Linn. (2n=36), is an annual or perennial plant from the Asteraceae family, native to Central and South America and naturalized in tropical Africa, Asia, Australia and India. It is found all over in India, especially in Rajasthan, Uttar Pradesh, Maharashtra, Madhya Pradesh, Jharkhand and Chhattisgarh regions. It is commonly known as a widespread weed and pest plant. It is also known as Coat buttons in English, Jayanti veda in Sanskrit, Kansari in Hindi, Ghamara (in local language) etc. *T. procumbens* is found along roadsides, waste grounds, dikes, railroads, riverbanks, meadows, and dunes. Its widespread distribution and importance as a weed are due to its spreading stems and abundant seed production. Leaves are simple, opposite, stipulate, lanceolate or ovate, toothed margin, shortly and petiole, hairy on both surfaces. Flowers are tubular shape, yellow composite, bisexual flowers with basal placenta and inflorescence capitulum. The plant has two flower, types ray florets and disc florets. Flowering occurs in *T. procumbens* throughout the year. The herb is tolerant to drought, humidity, pollution, seashore, slope and wind. Traditionally, whole aerial parts of *T. procumbens* are useful medicinally, it has been in use for wound healing, hypotensive action, anticoagulant, antifungal, insect repellent and treatment for infectious skin diseases in India. A study was carried out to verify the claims wherein tribal inhabitants of Udaipur district, Rajasthan were using the plant for treatment of diabetes.

**Phytochemical constituents**

Phytochemical screening revealed the existence of flavonoids, alkaloids, carotenoids, β-sitisterol, n-hexane, fumaric acid, luteolin, glucoluteolin, quercetin, isoquercetin, dexamethasone, lauric acid, rutin, palmitic, myristic, linoleic acid, arachidic, tannins and oxoester. A novel flavonoid named ‘procumbenetin’ has been extracted from the leaf of the plant. Mineral composition of *T. procumbens* leaves is
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Horticulture Sector: Opening up new avenues

HORTICULTURE production in India has almost doubled from 146 million tonnes in 2001-02 to 320.77 million tonnes in 2019-20. Whereas, the production of food grain has increased from 213 million tonnes to 297.5 million tonnes only during the same period. Keeping in view the immense potential of the horticulture in enhancing farmers’ income, the Government of India allocated ₹ 2,250 crore for this sector during 2021-22. Horticulture is the science, art and business of cultivating vegetables, fruits, flowers, ornamental plants, and herbs. In the last some decades, the horticulture sector in India has emerged as one of the most significant and dominant sectors not only in India but in many other countries across the globe.

Around 700,000 families are somehow involved with the horticulture sector in India. The horticulture sector helps majority of the population to eat a different and balanced diet to enjoy a healthy life. Horticultural crops are advantageous for the ecological balance as they clean up harmful gases from the environment. The horticulture sector in India provides more opportunities in the realm of employment across primary, secondary as well as tertiary sectors of agriculture. This sector has proved its mettle and has come out as one of the rapidly expanding area of advancement as it turned out to be more beneficial and productive in the agricultural sector (food grains). Horticulture crops and fruits are more resilient in ungracious and unfavourable weather conditions, and the vegetables exponentially uplift the income of small and marginal farmers. The demand for water usage is at low level, which drastically lessens the crop failure risk.

The government has not fixed any Minimum Support Price for horticultural products comprising fruits such as mangoes, bananas, cucumber, pomegranate, custard apple, etc. These fruits come under the category of perishable items. As there is a lack of proper transport system and paucity of good cold chain storage, increasing the shelf-life of perishables has become a challenge. The research and development-led management along with planning strategies related to the utilization of resources in the field of horticulture would bring astounding transformation in the horticulture sector. Value-addition in horticultural products is the need of the day. Value-addition is the process that meets the requirements of nutritional security. It enhances the economic value of horticultural products and unlocks new markets as well. The sector requires latest developed machinery for effective, efficient and elegant management of the horticultural crops. Many horticultural crops like aonla, pomegranate, phalsa, jamun or black plum, citrus, fig, ber, khejri, bael, field beans, cucurbits, and more need insect pollinators for effective and value-rich pollination to reap better outcomes. The horticulture sector displays huge potential due to diversification factor and gives high returns compared to agricultural sector. In recent time, the government is bringing up several schemes and drafting strategies to exhilarate this sector.

Wish you a Happy and Prosperous New Year 2022.

(Ravindra Verma)
Pusa Hybrid-4: First gynoecious based high yielding hybrid of bitter gourd for commercial cultivation

Bitter gourd is an economically important multipurpose vegetable and highly valuable for its nutritional contents like carbohydrate, proteins, vitamins, minerals (mainly high concentrations of ascorbic acid and iron) and numerous medicinal uses including treatment for diabetes and also possess anti-microbial, anti-oxidant, and anti-viral activities. Pusa Hybrid-4, the first gynoecious based early and high yielding hybrid, has been released and recommended by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Horticultural Crops for cultivation in National Capital Region of Delhi including Delhi and its adjoining areas of Haryana, Rajasthan and Uttar Pradesh.

Pusa Hybrid-4 has been developed by using gynoecious as female parent and monoecious line as male parent. It is highly suitable for growing during spring summer under north Indian plains. It is a predominately gynoecious hybrid with high female: male flower ratio (2:1) compared to commercial variety, Pusa Do Mausami (1:9). Fruits are dark green, medium long (average fruit length 16 cm and fruit diameter 5.5-6.5 cm) and medium thick. Fruits have 5-6 discontinuous narrow ridges and first harvest after 45-50 days of sowing. The average fruit weight is 60 g. Its average yield is 22.26 t/ha at 5 centres (4 in northern zone) of all Indian Coordinated Research Project on Vegetable Crops which is 25.7% higher than the national check Private Hybrid ‘Vivek’.

The fruits have high iron content (18.20 mg/100 g) as compared to Vivek (6.77 mg/100 g).

The hybrid will be highly accepted by the farmers since there is no hybrid in bitter gourd available with higher female: male ratio available for commercial cultivation under north Indian plains.

Cultivation practices

Pusa Hybrid-4 can be grown in all types of soil ranging from sandy loam to clay soil. However, well drained, fertile, rich in organic matter, silt or clay loam soils with a pH of 6-7 are ideal for successful cultivation. It requires a long and warm growing season with an average temperature ranging between 24-30°C for better growth, flowering and higher production. Production of female flowers, fruit set and growth of plant are affected above 40°C temperature. About 4 to 5 kg seed is sufficient for sowing of 1 hectare of land. Seed should be treated with Thiram (2.5 g/kg of seed). Sowing is done during February-March for summer crop. The crop is sown in a channel of 1.5 m apart with spacing of 60 cm between the plants. Generally 2-3 seeds are sown in a hill at 2.5 to 3.0 cm depth. The channels should be kept weed-free by frequent hand weeding, hoeing and light earthing up along with application of fertilizers.

Irrigation

The crop cannot tolerate drought or water stagnation. Irrigate the channels two days before dibbling the seeds. Frequent irrigation at 3-5 days interval especially at flowering stage and at alternate days...
during fruiting is necessary. Regularly shallow intercultivation is done after 4-5 days of irrigation to remove weeds and to facilitate soil aeration for proper root development.

**Manures and fertilizer management**
About 20-25 t/ha of farmyard manure, 70 kg N, 40 kg P₂O₅, and 30 kg K₂O/ha is sufficient for 1 hectare of land. The farmyard manure should be mixed in soil at the time of field preparation. Apply 1/3rd N and full dose of P and half dose of K just before sowing. The additional dose of N (Urea 40 kg), P and K can be applied in several split doses (5-6) at fortnightly intervals. Since bitter gourd is harvested frequently, fertilizer also should be applied in several split doses.

**Plant protection**
Sulphur fungicides are cheaper to use for powdery mildew control. Wettable sulphur has been used for many years for powdery mildew control. Myclobutanil, tebuconazole, and chlorothalonil, are registered for use on bitter melon for powdery mildew disease. Chlorothalonil can also be used for gummy stem blight. *Fusarium* wilt can be managed by long crop rotations of 4–5 years or more with non-host crops. Drenching root zone with Carbendazim 12% + Mancozeb 63% WP is also effective in management of this disease. Downy mildew can be managed by spraying Ridomil @ 2g/litre of water. Plants affected with complex viruses should be uprooted in the early stages as well as spraying with acetamiprid 20% SP @ 100 g/ha for controlling the vectors like aphid and white fly. Fruit fly is the most harmful pest of bitter gourd which can be managed by collection and destruction of dropped fruits and infested fruits on plants, raking the soil around the plants to expose fruit fly pupae for natural enemies and placing of cue-lure traps helps in both monitoring and management of fruit fly. Spraying of spinosad @ 5 ml/10 litre of water is also effective. Collection and destruction of beetles in early stage of infestation controls red pumpkin beetle in bitter gourd.

**Harvesting and yield**
Fruits are ready for first harvesting after 45-50 days of sowing when they become dark green, medium long (16 cm) and attains fruit diameter of 5.5-6.5 cm. The average yield is 22.26 tonnes/ha.

**Seed production**
Seed production of Pusa Hybrid-4 can be done both under protected structures and open field condition. Generally, spring summer season is preferred for open field hybrid seed production whereas under protected structures, it can be done both during summer and *kharif* season. It is a highly cross pollinated crop, therefore, under open field, the proper isolation distance should be maintained from other varieties. If it is difficult to maintain the isolation distance, the female and male buds should be protected by covering with butter paper bag and cotton one day prior to anthesis and hand pollination is done during early morning (7:30 to 9:00 AM). Gynoecious as female parent in Pusa Hybrid-4 allows the natural crossing between gynoecious line (Female parent) and monoecious line (Male parent). The planting ratio of 4:1 for female and male parent is ideal for proper pollination. Under protected structures, hand pollination is done for hybrid seed production. Silver thiosulphate (400 ppm) is used for the maintenance of gynoecious bitter gourd lines (Female parent) which induces hermaphrodite flowers for selfing and sieving. The diseased and infected plants should be removed from the seed production field. The fully matured and ripened fruits should be harvested when the fruit colour has turned orange yellow. The fruits are crushed to separate seeds from the pulp followed by sun drying for 2-3 days till the moisture content of the seeds reaches 8% or below. The average seed yield is 2.5-3.0 q/ha. The seeds should be stored in moisture proof bags.

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Mateera – An underutilized cucurbit vegetable of Indian desert

Mateera is an under-utilized, drought tolerant and native form of watermelon. It is grown in rainfed areas and its fruits are liked by desert dwellers. Nutritionally rich tender fruits are used for vegetable and ripened for dessert. Fruits and seed-kernel are sold at premium price. From 1994, ICAR-CIAH has undertaken intensive research for germplasm conservation and utilization in varietal development. On evaluation of wide range of *Citrullus* germplasm, watermelon genotypes failed to express their potential under the high temperature conditions. Therefore, promotion of varieties from native germplasm is beneficial and recommended for commercial cultivation under resource constrained arid region. The developed varieties such as AHW-19 and Thar Manak are early to harvest, producing better quality fruits suitable for multiple-use.

**Native** and drought tolerating cucurbits such as kachri, kakadia, mateera, tinda and tumba are components of traditional mixed cropping and play a significant role in providing nutritious food and income to inhabitants of desert eco-system. Non-availability of crop-specific genotypes suited to environmentally stressed production sites is a major limiting factor in vegetable promotion under hot arid climate of Rajasthan. Mateera is of multiple-use and CIAH technology is much useful to the farmers for getting benefits as loiya, seed, as well as rainfed, off-season, organic, low-input and less-water cultivation of this crop-commodity.

**Drought tolerant mateera**

Mateera is an indigenous form and drought tolerating watermelon (*Citrullus lanatus*). It is widely grown in north-western part of India particularly in arid region of Rajasthan during *kharif*. Mouth appeal of mateera fruit is attributed to sweet taste, aroma and refreshing edible pulp. Ripen fruits are consumed fresh as dessert-salad and have juicy and cooling pulp. Tender fruits weighing 100 g (loiya) are used extensively for vegetable culinary and *raita*. Loiya is rich in nutrition and 100 g fresh weight contains 96.3% moisture and 3.7% dry matter. On percent basis, dry matter contains carbohydrate (35.71), protein (12.15), fat (18.25), crude fibre (25.4), calcium (5.8), phosphorus (0.18) and trace elements (3.3). Seed are protein rich (25–32%), roasted and eaten as snacks. Seed also yield nutritive oil (30–40%). Seed kernels (magaz) is extracted on large-scale and used in sweets, bakery and ice-creams. Rind of ripen...
fruits is pickled or turned into sugar-candy (tuty-fruity), and used as animal feed too.

**Why mateera cultivation in arid region?**

For production of mateera, farmer’s broadcast its seeds with mixed cropping of bajra or arid legumes. With good monsoon rains, farmer’s collected mateera fruits during October-November and it is the period of harvesting kharif crops and fruits ensure some income as bonus. In recent years, its cultivation is also popular as sole or inter-crop of orchards. Now, it is grown as irrigated crop in particular for loiya production under extremes of high temperature conditions.

Due to the non-availability of drought tolerant mateera varieties in the recent past, farmers of the region used heterogeneous and mixed seed collected from cross-pollinated crop and it is based on sweetness of fruit. Intensive study on flesh characters of open-pollinated mateera crop was done at farmers’ fields, and it was concluded that hardly 10% fruits are of marketable quality. With such seeds, there is no guarantee of fruit quality before it is used. Thus, absence of varieties in native mateera, productivity and quality is much variable and poor. Consequently, it fetches low market price and marginal returns to the growers.

Likewise, commercial watermelon varieties and hybrids (Durgapur Meetha, Arka Manik, Sugar Baby, Charleston, Mahobobi, Arka Jyoti, etc) need high and frequent irrigation, have poor yield and suffer from fruit cracking under high temperature conditions in summers. In rainy season, these genotypes exhibit poor fruit quality and high level of viral complex in plants, and cannot grow under rainfed situation.

**Breeding for marketable quality fruits in mateera**

Realizing the importance of drought tolerant and multiple-use mateera in the Indian desert and potentialities to extend its period of fruit availability (April to November) time called for concerted research. Looking at this, systematic work-plan on mateera improvement was taken since 1994 with objective to develop standard varieties for uniform and quality fruit production including dessert-salad, loiya and high seed content. To fulfill this, intensive surveys were conducted from 1994 to 2002 in arid and semi-arid areas of Rajasthan and wide range of genetic variability was collected in *Citrullus* species at CIAH. The collected germplasm was characterized, evaluated and utilized in improvement programme over the years (1995 to 2010) and also conserved at national gene-bank.
A wide range of variability was recorded with respect to growth, flowering, fruiting, maturity, quality and seediness besides tolerance towards biotic and abiotic factors. During characterization, Citrullus germplasm was categorized based on economical traits and promising type such as AHW-18, AHW-19, AHW-65, AHW-108, AHW-140, AHW-RSS-1 and AHW-BSM-1 were identified. Besides, two high yielding selections namely AHW-19 and AHW-65 were developed and released in 1998 for immediate gains and growers accepted them for uniform harvest under rainfed conditions.

However, two essential traits of commercial watermelon i.e. eye-appealing flesh quality and sweetness were not materialized in mateera varieties developed by the institute. Therefore, intensive breeding work was done involving AHW-19, AHW-65, Sugar Baby, Durgapura Meetha, Charleston and Mahobobi. A large number of progenies were generated using selected parents in combinations (F1, F2, BC1, BC2 and bi-parental) and evaluated. Four prioritized traits such as flesh quality, earliness, tolerant to cracking and yield behaviour under high temperature (>40°C) situations were kept to screen the progenies. In F6 generation, few progenies of cross combination of AHW-19 × Sugar Baby exhibited desirable trend for fruit flesh (colour, firmness, content and Tss) and yield.

Fruit quality and yield potential of advanced family F6/a/10 was much superior and highly acceptable depicting internally as good as sugar Baby and rind characters as mateera. This was further advanced under isolation and open pollinated progeny designated as F6/a (Thar Manak) and released during 2007. The developed variety is devoid of cracking and suitable for summer and rainy season cultivation under hot arid climate.

AHW–19
It is multiple-use and rainfed growing selection. Female flowers start at 45 days and tender fruits (loiya) are available from 58 days of sowing. Ripen fruits are ready for first harvesting at 75-77 DAS, and 3.8-4.1 kg in weight, 30-33 cm in length and 60-65 cm in girth. Oblong shape fruits have dark green in clear stripes on smooth rind. It bears 3.1-3.4 ripen fruits/plant and yield is 192–386 q/ha. Flesh is pink, firm having good taste and 8.0-8.4% sweetness. High in seeds, 489-527 number/fruit and weight of 100 seeds is 9.12-9.27 g. Seed is bold and khaki in colour.

Thar Manak
It is widely acceptable fruit quality selection and tolerant to drought, high temperature and abiotic stressed conditions. It is through hybridization from cross combination of AHW-19 × Sugar Baby. It is early in first harvesting (75 DAS) and high yielding (185–355 q/ha). Ripen fruits are oblong-round with dark green-green stripes on smooth rind. Fruits weigh 2.65-4.21 kg and are 20-22 cm in length and 58-62 cm in girth, and free from cracking. Flesh is attractive, reddish, firm, granular and have 9.5-11.2% TSS. Seeds are very big, bold, black and low (160-266 number/fruit). It is suitable for summer and rainy season irrigated crop and also rainfed cultivation during kharif.

AHW-RSS–1
It is trait specific selection from native germplasm and high seed yielding under rainfed conditions. It is a short duration selection, fruit harvesting starts from 80 days and vine bears approximately 3.2 mature fruits. Fruit is big and oblong shape with no stripes, light green and smooth rind. Ripen fruits are 7.9 kg in weight, 32 cm in length and 68 cm in girth. Edible flesh firm but white in colour. Fruits are very high in seeds (950-1120 number) and weight of 100 seeds is 9.8 g. Seed is big, bold and reddish in colour.

Production technology
Now, drought tolerant mateera varieties are in attraction for loiya, seed-kernels and ripen fruits too. These can be successfully grown by sowing in June-July and February-March. Onset of monsoon rains is the best for sowing rainfed crop in arid area. Selected field should be prepared as per topography of sand-dune landscape at the production site. Deep-furrow, channel and drip technology as standardized at CIAH is simple for mateera cultivation. In thoroughly developed and lay-out plot, 1.5–2.0 m apart and 50 cm wide channels or deep-furrows are prepared, or laterals also laid-down for drip technology, which are 25 m in length on one-side of water delivery-line. Prior to sowing, furrows or channels of...
1 hectare area is manured and fertilized with FYM (50 q), vermin-compost (5 q), DAP (100 kg), SSP (100 kg), urea (50 kg), MOP (50 kg) and 10 kg neem-leaf powder and mixed thoroughly. For drip, furrows / channels are converted into seed-bed and lateral-pipes fixed in centre.

About 2 kg seed is enough for sowing 1 hectare area. Prior to sowing, seed should be soaked in water for 5–6 hours and also treated with fungicide. Seed should be sown at 50 cm distance at inner-down slope of the channel, centre-line of furrow or near to drippers of lateral-line. At each sowing point, 3–4 seeds should be sown and 1–2 healthy plants are allowed. Thinning of seedling is done at 18–21 days from sowing or when they attain 2–4 true-leaf stage. The crop should be irrigated at 6-8 days intervals by flood method only in the channels or at 2–3 days for 1.5–2.0 hours with drip (lateral 16 mm and 4 lph in-line emitters) under sandy soil. Manual hoeing and weeding is done at 18-21, 28-30 and 40-45 days from sowing and at this time, urea @ 50 kg/ha is applied in 2-3 split-doses. Spraying of insecticide such as imidachloropid (0.3 ml/l), di-methoate and malathion (1.5 ml/l) to manage aphid, thrips, jassid, white-fly and minor insect-pests is recommended at very early plant-growth, flowering and fruit setting stages. For genetically pure seed production, isolation distance of about 500 m is sufficient between the varieties of mateera, watermelon and tumba. Integration of inter-culture operations, spraying, roughing and monitoring is beneficial. Protection measure from birds and wild animals is also required.

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The Handbook of Agriculture is one of the most popular publication of the ICAR with a wider readership. The present edition presents science-led developments in Indian agriculture, the ongoing research efforts at the national level and with some ideas on the shape of future agriculture. While information in some chapters such as Soil and water, Land utilization, field and forage crops has been updated with latest developments, many new topics such as the Environment, agrobiodiversity, Resource conservation technologies, IPM, Pesticides residues, Seed production technologies, Energy in agriculture, informatics, Biotechnology, Intellectual Property Rights, Agricultural marketing and trading and Indigenous Technical Knowledge have been included in the present edition. For those who take intelligent interest in agriculture – and their number is increasing fast – the present edition would serve as a useful book.

TECHNICAL SPECIFICATIONS

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**Litchi stink bug in Bihar: Status, threats and management strategy**

Generally, low incidence of litchi stink bug had been recorded from different regions of India. But its incidence has increased in recent years especially in Jharkhand and the North-Eastern states. In 2018, this pest was seen in litchi orchards of Bihar for the first time. During last two years, damage in the orchards of Bihar was up to 100% where this pest attacked. The threats from this pest are so serious that it has the potential to completely eliminate litchi cultivation. Management of this pest requires an immediate action plan as well as long-term strategy which are being done by National Research Centre on Litchi in coordination with Horticulture Department, Government of Bihar. A detailed discussion of the current status, threats and management strategy of the stink bug is provided in this article.

Litchi stink bug (LSB) (*Tessaratoma javanica*) recently invaded the litchi orchards of Bihar where it has potential to completely wipe out litchi cultivation from the state. Pest found its way to get introduced in Bihar in 2018 when it was observed in some orchards in Damodarpur and Mirzapur village of Mehsi block in East Champaran district of Bihar. From few orchards in the beginning years, the area of infestation increased nearly 3 km in 2021 during litchi season (February-June 2021). In the month of August-September, litchi is in vegetative phase and stink bug infestation is discernible in orchards in adjoining area like Chakiya, Madhuban and Kalyanpur blocks of East Champaran.

Litchi stink bug possibly got entry in Bihar from neighboring state Jharkhand, most likely carried through logwood transported in Lowry or some private vehicles coming from Jharkhand. Jharkhand has kusum trees (*Schleicheria oleosa*; Family Sapindaceae; the same family to which litchi belongs) which is a natural host of the stink bug and is abundantly found in Ranchi and adjoining districts of Jharkhand where LSB is reported to be the major pest of litchi.

Litchi stink bug

Though a regular pest of litchi in North Eastern states, usually a low incidence is reported from different regions of India. However in recent years, incidence of *T. javanica* has increased particularly in Jharkhand and the north eastern states. The peak incidence of the pest was 1.21-4.09 bugs [nymphs and adults] per shoot during 2008 in north-western India. An outbreak of *T. javanica* in the Chhotanagpur plateau region of Jharkhand during February-March 2012 was also reported, causing severe losses (up to 80%) to litchi fruits. Pest found its way to get introduced in Bihar (2018). It has been reported on Mahua (*Maduca indica*) tree from Chhattisgarh and on longan (*Dimocarpus longan*; Sapindaceae) and rambutan (*Nephelium lappaceum*; Sapindaceae) by various workers from China, Thailand and other countries.

Both adults and nymph feed mostly on tender plant parts such as growing buds, leaf petioles, fruit stalks and tender branches of litchi tree. Excessive feeding causes drying of growing buds, tender shoots and ultimately fruit drop off. In the north-western part of India, infestation of *T. javanica* occurs on litchi from the last week of April to the last week of August after which it undergoes hibernation in adult stages on litchi trees. The bug lays globular and off pink eggs, mostly in bunch of fourteen on lower surface of leaves. The insect passes through five instars, which are sub-rectangular and dark brick red.
except first instar. Newly emerged adult is dirty white and soft bodied insect but colour changes to yellow red after few days. The average duration of male and female adults is 43.2±7.7 and 47.2±9.5 days, respectively. Life cycle is completed in about 80 days. Both adults and nymphs are able to expel offensive odours when disturbed. The head, pronotum, scutellum and elytra of the adult bug are light brown in colour. The underside of the body is white. The size of the bug is close to 15-20 mm, plus it has small triangular head. When people find a stink bug, their first instinct is to squish them. However, when disturbed or crushed, stink bugs have a tendency to release a bad-odour chemical from pores on the sides of their bodies. This is how the pest earned its name. This causes the problem of blisters on the body.

**Invasiveness and threats of the pest**

Invasive species are organisms that are introduced to an area where they are not known to occur. When a non-native organism is released into a new area, it will arrive without its natural enemies and the population can explode without anything standing in the way. This is the reason of worry about litchi stink bug. Some of the points that should be considered in favour of threats include: Longer life cycle and high fecundity of pest; quick buildup of pest population which coinciding flowering and fruit set in litchi and continuing till fruit matures; contiguous and abundant availability of host tree to a introduced invasive pest; though insecticidal spray has a quick ‘knock down’ effect, but even if a few insects escapes/ avoid insecticidal spray (say 5%) on a single tree, it will be sufficient to build up its population to a level enabling infestation of complete orchard.

**Management strategy**

Current management strategies rely on insecticide sprays. Two sprays of any of the following insecticide combinations are recommended by the National Research Center for Litchi, Muzaffarpur:

- Triazophos 40% E.C (1.5 ml/L) + Thiacloprid 21.7% SC (0.5 ml/L)
- Thiacloprid 21.7% SC (0.5 ml/L) + Lambda Cyhalothrin 5% E.C (1.0 ml/L)

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1. Litchi stink bug sucking sap from a soft twig, 2. Close-up view of bug on fruits, 3. Adult bug, 4-5. Bug infested panicles and fruits, and 6. Signs of damage on fruits due to feeding of bugs
We need to have immediate action plan as well as a long-term strategy for quick knock-down. Though insecticidal spray has a quick knock-down effect, some individual may escape (say 2-5%) and from the small population can again build up population in large numbers because of high fecundity of female and longer life cycle, that are capable of infesting whole orchard. There are no natural enemies of the pest because of being an introduced pest in the region. During flowering and fruit-set, population builds up very fast and no insecticidal spray can be done during this time. Hence, farmer just have to wait and watch their litchi crop being damaged by this dreaded pest. Another dimension is that the pest emits bad odour from its body fluid are toxic causing blisters on skin of human being. Even if there are fruits on tree, it becomes difficult to harvest fruits as skin of the body gets blisters. In background of the threats explained, an action plan similar to managing ‘COVID-19’ pandemic is required for stink bug to save litchi orchards in Bihar and livelihood of litchi farmers. Like ‘mass vaccination’ against COVID-19, we need to have wide area management through ‘mass insecticidal spray’ or ‘community spay’ for all the orchards in the identified containment zone. We need to have an immediate action plan as well as a long-term strategy too for this pest. Immediate action plan includes quarantine and mass insecticidal spray as the pest needs to be quarantined in its current area of infestation by any means. This will involve continuous survey and surveillance in the current area of infestation and the adjoining areas as well, on a war-footing basis and containment zone may be declared. In this containment zone, immediate action plan will be to undertake two insecticidal sprays at 15 days interval in September-October i.e. before the pest undergo winter hibernation on litchi trees. Not a single orchard should be missed for insecticidal spray. An organophosphate group of insecticide such as Triazophos (Triazophos 40% EC @1.5 ml/L), Profenphos (Profenphos 50 EC @ 2.0 ml/L water) or quinalphos (Quinalphos 25% EC @ 2.0 ml/L) will be appropriate at this phase. Further at the time of panicle initiation (but before flower opening), two insecticidal sprays (mass spray) need to be undertaken. At that time, combination of insecticides rather than single (as given under management strategy) may be undertaken. All these need to be done by the Department of Agriculture, Government of Bihar as individual farmer neither will be able to afford it nor the objective of community spray be fulfilled if left to farmers. An additional fund by the government may be earmarked to implement the action plan.

The long term strategy to manage the pest will involve research on eco-biology of the pest and alternative management options involving use of proven parasitoid like Anastatus bangalorensis and Anastatus acherontiae. Mass rearing and release of parasitoid of the pest is to be undertaken at local level. This parasitoid and the technology for mass rearing is available with ‘National Bureau of Agricultural Insect Resources’, Bengaluru. Funding of the the project for mass rearing and release of this parasitoid at local level can be made under Rashtriya Krishi Vikas Yojana (RKVY) or under State Horticulture Mission.

Complexities involved in adopting the management strategy for quick know-down

- This pest is so sensitive to disturbances and sound that once a spraying operation is going to start, it flies away to another trees and after sometime when effect of insecticidal spray lessens, it again settle down on sprayed trees.
- The female lay eggs in batches that hatches on different time so one spray is not sufficient to kill the population of nymphs.
- Though insecticidal spray has a quick knock down effect, some individual may escape (say 2-5%) and from the small population can again build up population in large numbers because of high fecundity of female and longer life cycle, that are capable of infesting whole orchard.
- There are no natural enemies of the pest because of being an introduced pest in the region.
- During flowering and fruit-set, population builds up very fast and no insecticidal spray can be done during this time. Hence, farmer just have to wait and watch their litchi crop being damaged by this dreaded pest.
- Another dimension is that the pest emits bad odour and the body fluid are toxic causing blisters on skin of human being. Even if there are fruits on tree, it becomes difficult to harvest fruits as skin of the body of labourers get blisters once the insect come in their contact that is inevitable to happen during the process.

For further interaction, please write to:
Vinod Kumar (Principal Scientist), ICAR-National Research Center on Litchi, Muzzafarpur, Bihar 842 002. *Corresponding author’s email: vinod3kiari@yahoo.co.in
Pusa Golden Cherry Tomato-2: New promising yellow cherry tomato for protected cultivation

Cherry tomatoes are a different group of tomato. This tomato is mostly used raw in salad. The fruit bearing habit is in bunches i.e. called truss and fruit shape varies from round, oblong and pear shape. Fruit size varies from 2–15 g. Fruits are of different colours varying from dark red, red, pink, yellow, golden yellow to orange. Golden yellow cherry tomatoes look very fascinating. Pusa Golden Cherry Tomato-2 is the first indigenous golden yellow cherry tomato variety suitable and proposed for naturally ventilated polyhouse/low cost protected cultivation from ICAR-Indian Agricultural Research Institute, New Delhi. It will cater to the needs of the people who are looking for protective food.

This unique nutrient rich variety has been developed by Center for Protected Cultivation Technology and Division of Vegetable Science, ICAR-IARI, Pusa, New Delhi for cultivation under protected conditions/structure. It is indeterminate in growth habit and first harvesting starts at 75-80 days after transplanting and continues up to 270-300 days depending upon the climatic condition of the area. Fruits are round, born in truss (9-10 average flower truss per plant), golden yellow in colour, thin pericarp having smooth surface and uniform ripening. It is rich in vitamin A and vitamin C and acts as protective food. The fruits contain 13.02 mg/100 g fresh weight carotene, 18.3 mg/100 g fresh weight ascorbic acid, 0.33% acidity and TSS 9° brix and carotene content (13.02 mg/100 g).
The average fruit weight is about 7-8 g with approximate average fruit yield of 3-4.5 kg/plant with yield potential of 9-11 t/1000 m².

Seed should be sown in insect proof nursery/in multi-celled plug tray by using soil-less medium in July-August and 25-30 days old seedlings should be transplanted. In greenhouse, crop should be vertically trained and regularly pruned for better growth and yield. Variety is responsive to normal soil fertility status. Added pollination is required in greenhouse during winter season and done by using electric vibrator or by air blower in morning hours on alternative days. Seed (10 g) is sufficient for growing a commercial crop in 1000 m² green house.

Cultivation

Climate
It requires relatively warm season for its growth and development. The ideal night and day temperature for fruit set and colour development is 20-25°C.

Soil
Well drained sandy loam soil is ideal for growing good crop. It prefers a pH of 6-7.

Sowing time
Under fully controlled environment polyhouse, it can be grown round the year, while under naturally ventilated polyhouse / low cost polyhouse structures, transplanting is done in September and crop may last up to May.

Seed rate
The seed rate for the variety is 125 g/ha.

Nursery raising
For nursery raising, seed should be sown in insect proof nursery/in multi-celled plug tray using soil less medium (cocopeat, perlite and vermiculite mixture) in July-August to produce disease free and healthy seedlings. The prootrays should be kept inside the polyhouse/insect proof nethouse. One seed should be sown in each holes of portrait during second week of July to August after treating them with thiram @ 3 g/kg seed. Immediately after sowing the seed, light irrigation should be given by watering can containing Captaf @ 2 g/litre of water. After that, portraits are piled on each other and the upper one is covered with an empty portrait. In four-five days after sowing, seed starts germinating and then portraits are spread over benches or floor. In soilless medium, nutrients are applied in the form of water soluble fertilizers N:P:K (1:1:1) 16:16:16 grade @ 2 g/litre once a week through the fine sprinkler to maintain the uniformity in application of nutrients. After 22-25 days of sowing, when the seedlings become 10-12 cm long and four true leaves had emerged, it should be kept for 2-3 days for hardening by holding irrigation for two days. Hardening of seedlings before transplanting is very effective in reducing transplanting shock and result in better crop stand.

Transplanting
Transplanting should be done on both sides of 10 cm raisedbed of 0.75 m width. There should be 30 cm distance between two beds. The seedlings should be transplanted at 0.60 m distance within row on both sides of the raised bed. It should be planted under drip irrigation system for efficient use of water and fertilizers.

Manure and fertilizers
Soil testing must be done to determine the soil fertility of protected environment and the deficiency of nutrients must be supplemented as and when required. In general, about 25-30 metric tonnes per hectare of well rotten farmyard manure should be added at the time of preparation of land. In addition, 80 kg phosphorus and 90 kg potash is added at the time of land preparation before
transplanting. Nitrogen (150 kg) is applied in split doses, one-third at the time of transplanting and other two-thirds in the form of four top dressings, first at 25-30 days after transplanting, second after 50-60 days after transplanting or flowering, third after first picking and after every picking later on. Mixture of micronutrients (especially calcium and boron) should also be applied at the time of flowering @ 0.5% water solution.

Irrigation
It is necessary to maintain even moisture supply, as overwatering is harmful. Water is essential at the time of flowering and fruiting. Adequate moisture also helps in better colour development. Irrigation is applied at 8-10 days interval in winter season whereas during summer months, irrigation is applied at 3-4 days interval depending upon weather conditions. If possible, drip facility should be installed for efficient irrigation and fertigation. Mulching with black polythene mulch helps in conservation of soil moisture and weed management.

Interculture
Weeds are often a limiting factor in tomato production as they share light, water, nutrients and space, harbor insect pest and diseases. Frequent hoeing should be done as often as necessary to control weeds. Tomato bed before mulching and transplanting should be drenched with Stomp @ 2 ml/litre solution for controlling pre-emergence weeds.

Training, pruning and trellising
Staking is an important operation for tomato under protected condition. Staking should be done 20 to 25 days after transplanting. The plant should be loosely tied on vertical stakes. The timely staked plants produce more and better quality fruits. All the side branches should be removed/pinched at early stage to maintain single stem. Plants are supported by plastic wire or blinder twine loosely anchored with plastic clip at base of plant to overhead support wires running to the length of row of bed. Overhead wires running over the row of the bed are fitted 8 to 10 feet above and firmly supported with structure. Stem / vine of plant is either fitted in round plastic clip of 1 inch diameter with hanging twine or twine is wrapped around a stem below the leaves clockwise leaving top 15 cm shoot of the growing plant. Regular pruning of side shoot should be done for entire crop duration. After first harvest, the leaves touching the ground (up to one feet from ground) should be removed which improves air circulation and reduce disease incidence.

Improved varieties of tomato

**VL Cherry Tomato 1 (VT 95):** It has been identified and recommended for cultivation in Zone I, III and VII. It has fruit yield of 250–300 q/ha in open and 400–450 q/ha in polyhouse. Fruits are smooth, oval, attractive red, firm (15 to 25 g), rich in Vitamin C (86 mg/100 g).

**Hybrid CTH 1:** Fruits are flat, round, thick pericarp (5.84 mm) with extended shelf life (10 days at room temperature). Fruits are borne in clusters of 5–6, with an average fruit weight of 75.3 g. The hybrid has long harvesting period (20–22 harvests) in 150 days with a yield of 2.94 kg/plant (92.3 t/ha) and moderately resistant to leaf curl virus.

*Source: ICAR Annual Report (2020)*
Pollination

Since tomato is a self-pollinated crop having bisexual flower, therefore normal flowering and fruiting takes place in sunny weather, however for better fruit setting in foggy or cloudy weather, electric vibrators or air blowers or manual shaking can be used for effective pollination during 10 to 11 AM and 2 to 3 PM in the day.

Harvesting

Harvesting starts 80-85 days after transplanting and depends upon purpose for which they are harvested and distance over which they are to be transported. Tomato is harvested at mature green stage for long distance transportation. For short distance transportation, fruits are harvested at pink stage and for processing, fully ripe red colour tomato should be harvested.

Average yield

Yield depends on climatic factor and cultural practices. On an average, it gives fruit yield around 90-100 q/1000 m² area of polyhouse.

Plant protection

The warm humid condition and availability of abundant food under protected condition provide an excellent stable environment for pest development. Sanitation, soil solarization, mulching and fumigation are done to manage pest in protected condition. Major pest of tomato under polyhouse are whiteflies, mites and nematodes, which come inside with the workers due to frequent entry in the polyhouse. The polythene used as cladding material should have 200 micron thickness and UV stabilized. Similarly, insect proof net should be of 40 mesh. Building a screen foyer to create a double door entry partially solve the problem of wind career insects. Our major emphasis should be on prevention of entry of pest inside the protected structure. The seedling should be raised in protected environment for transplanting. The lower or damaged leaves should be removed to make ground clear for proper ventilation and also to avoid spread of pest. For whiteflies, aphids and leaf miner adults, yellow sticky cards (8 “× 12”) should be placed @ 5 card / 100 sq. m. area for control of pests in protected environment. Hang the yellow sticky cards /traps in the crop with the help of string about 4 “ to 6 “ above the plant canopy. As the crop grows, card can be moved up. The card is changed when more than 60 to 70% of the area is covered by trapped insect. For effective management of pest and disease, integrated pest management (IPM) strategies should be followed. If required, Dicofol @ 2 ml per litre of water should be applied to control mites and trizophos @1 ml /3 litres of water to control whiteflies. For fungal diseases, mixture of 1 g carbendazim and 1 g mancozeb per litre water solution can be applied.

Market value

Pusa Golden Cherry Tomato-2 is the first indigenously developed golden yellow cherry tomato variety which is suitable for low cost protected cultivation. It looks very fascinating and appealing. Its unique selling point is that this cherry tomato variety is sweet and rich in nutrients, antioxidants, vitamin A and C. It is of a premium market segment, so farmers can get returns from the crop. It will cater to the needs of the people who are health cautious and looking for nutritious food. This variety can be dried as tomato resins which could be another market segment for post-harvest researchers and industry people. Golden yellow cherry tomatoes can be marketed @ ₹ 500-600 per kg in premium markets.

For further interaction, please write to:

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Prospects

Winged bean – A nutritionally rich underutilized vegetable crop

Winged bean (*Psophocarpus tetragonolobus* (L.) DC) is a protein rich, underexploited leguminous vegetable of the tropics. Winged bean grows abundantly in hot and humid equatorial countries. In Asia, the major producing countries are India, Burma, Sri Lanka, Indonesia, Malaysia, Thailand, Philippines, Indo-China, China and is also extending to Papua & New Guinea. It has high nitrogen fixing capacity with multiple nodules present in the root system and the leaves contains superior quality of protein. This underutilized vegetable has an ability to fight malnutrition and provide dietary supplementation. A considerable amount of diversity exists in the germplasm lines of winged bean, thus providing scope for the plant breeders to seek for improvement of the seed, vegetable, tuber yield and quality aspects. This promising vegetable offers resistance towards the adverse impact of abiotic stresses and can withstand marginal upland conditions. It can be introduced in the marginal upland areas as a source of income, especially for resource-poor households in these regions. It has been observed that proteins present in legumes have low nutritive value, which is mainly attributed to low amounts of sulphur-containing amino acids, less digestible proteins and anti-nutritional factors. Thus, winged bean is recommended for commercial cultivation to enhance diversity in field conditions and improve soil health. When it reaches the plate of hungry people, it leads to improvement in human health and consequently helps in solving the malnutrition problems.

The winged bean is popularly known as ‘One Species Supermarket’ because of its high nutritionally rich green pods, tuberous roots, leaves, immature and mature seeds. Leaves are eaten like spinach, flowers as salad, tubers as raw or processed food and seeds are used in different forms of processed food. Owing to its vining nature and nitrogen fixation ability, it used as a cover crop and also incorporated into rotation or intercropping systems. As such, winged bean could be a good candidate for diversifying diets to improve nutritional security, based on complex and more sustainable agricultural systems. Besides nutritional qualities, winged bean is a potential climatic resilient crop for adaptation in suboptimal weather conditions, like drought, flood, heat and biotic stresses as compared to other major staple crops.

Increasing awareness about the role of agro-biodiversity in sustainability, socio-economic resilience and human health has resulted in re-diversifying agro-biodiversity through utilization of neglected and underutilised crop species. Realizing the importance of such crops, the US National Academy of Sciences (NAS) constituted a committee in 1974 to carry out ‘an extensive survey of underexploited tropical plants’ as possible crops for the future and winged bean was identified for promotion among agricultural research communities with exceptional merits. Despite the good qualities and international attention, winged bean cultivation could not be extended to the non-traditional areas in our country.

Recognising the importance of the crop amid changing climatic conditions and increasing health awareness among the human society, winged bean is considered as one of the future crops which is likely
to play crucial role in world food and nutritional security. Recent technologies like genomics and phenomics tools along with precision agriculture practices can play very important role in enhancing the crop productivity.

Winged bean belongs to the genus *Psophocarpus*, legume family Fabaceae and sub-family of Papilionoideae. The plants are herbaceous perennial but mainly grown as annual. It is a vine crop with climbing nature and a wiry stem, which attains a height of 4 m and above, if the stacking provided is tall enough. The stem is usually green but certain varieties have stem with a shade of purple, pink or brown. Leaves are trifoliate, alternate, subtended by a stipule oval to ovate on the entire margin. The inflorescence is axillary, raceme and bearing many flowers. The calyx tube is long, inflorescence is axillary and 4-10 flowered raceme. The height of the vines varies between 3 and 4 meters. The colour of flower varies from white to deep purple, basically, blue, bluish white etc. Maximum flower opening is between 10 AM to 12 noon. The plant bear pods of different length and shape. Based on the shape, pods are of four types namely, rectangular, semi-flat, and flat on sides, flat on suture. The pods are 4 angled, 15-22 cm long, 2-3 cm broad with each angle continued into a much crisped and papery wing. Pod wings may be undulated, dented or serrate. An individual pod contains 5-20 seeds; the seeds are smooth, shiny and globular in shape with an average weight of 250 mg. They burst out from ripe pods and the colour of seed changes to brownish at the time of ripening. Seeds are round in shape that emits an aroma which is similar to asparagus.

The diversity of this crop has been observed in Papua, New Guinea, Mauritius and India, but maximum variation occurs in Papua and New Guinea. In India, it is grown mainly in eight states, including Assam, Manipur, Mizoram, Kerala, Tamil Nadu and Karnataka by the tribals as a backyard crop. The encouraging results of trials provide a ray of hope for its successful cultivation in North Indian plains also.

### Nutritional significance
Winged bean has been recognized as a crop having much promise for nutritional security in the coming decades. Winged bean tubers are notably rich sources of starch, protein, and B-complex vitamins. Winged beans provide adequate amounts of proteins, minerals and vitamins. In addition, thiamine, pyridoxine (Vitamin B-6), niacin, and riboflavin are some of the nutrients found in winged beans. The crop is also a source of vitamins A, C, B-1, B-2, and B-3.

### Table 1. List of winged bean varieties

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Economic part</th>
<th>Seed yield (q/ha)</th>
<th>Specific features</th>
</tr>
</thead>
<tbody>
<tr>
<td>AKWB-1</td>
<td>Green pods and Seeds</td>
<td>10-12</td>
<td>It is dual purpose variety used as vegetable and pulse.</td>
</tr>
<tr>
<td>IWB-1</td>
<td>Seeds</td>
<td>11-13</td>
<td>High yielding, medium duration variety and test weight is 36-38 g.</td>
</tr>
<tr>
<td>IWB-2</td>
<td>Green pods and Seeds</td>
<td>13-14</td>
<td>This variety is amenable for seeds, green pods and fodder.</td>
</tr>
<tr>
<td>Chhattisgarh Pankhya Sem-2</td>
<td>Green pods and Seeds</td>
<td>10-12</td>
<td>It is a dual purpose variety performing well under backyard (badi situation) at tribal people of Chhattisgarh.</td>
</tr>
</tbody>
</table>

### Table 2. Nutritive value of winged bean (*Psophocarpus tetragonolobus*) per 100 g

<table>
<thead>
<tr>
<th>Principle</th>
<th>Nutrient value</th>
<th>Percentage of RDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>49 Kcal</td>
<td>2.5%</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>4.31 g</td>
<td>3%</td>
</tr>
<tr>
<td>Protein</td>
<td>6.95 g</td>
<td>12%</td>
</tr>
<tr>
<td>Total fat</td>
<td>0.87 g</td>
<td>3%</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0 mg</td>
<td>0%</td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Folate</td>
<td>66 µg</td>
<td>16.5%</td>
</tr>
<tr>
<td>Niacin</td>
<td>0.900 mg</td>
<td>6%</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>0.059 mg</td>
<td>1%</td>
</tr>
<tr>
<td>Pyridoxine</td>
<td>0.113 mg</td>
<td>9%</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.100 mg</td>
<td>8%</td>
</tr>
<tr>
<td>Thiamin</td>
<td>0.140 mg</td>
<td>12%</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>128 IU</td>
<td>4%</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>18.3 mg</td>
<td>30%</td>
</tr>
<tr>
<td>Electrolytes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>4 mg</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Potassium</td>
<td>240 mg</td>
<td>5%</td>
</tr>
<tr>
<td>Minerals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>84 mg</td>
<td>8%</td>
</tr>
<tr>
<td>Copper</td>
<td>0.051 µg</td>
<td>5.5%</td>
</tr>
<tr>
<td>Iron</td>
<td>1.5 mg</td>
<td>19%</td>
</tr>
<tr>
<td>Magnesium</td>
<td>34 mg</td>
<td>8%</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.218 mg</td>
<td>9%</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>37 mg</td>
<td>5%</td>
</tr>
<tr>
<td>Selenium</td>
<td>1.5 µg</td>
<td>3%</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.39 mg</td>
<td>3%</td>
</tr>
</tbody>
</table>

(Source: USDA National Nutrient Database)
B-complex vitamins embedded in these beans. Some of the essential minerals such as iron, copper, manganese, calcium, phosphorus, magnesium is concentrated in them. Manganese is utilized in the human body as a co-factor for the powerful antioxidant enzyme, superoxide dismutase. Winged bean green leaves, are an excellent source of fibre, vitamin A, C and minerals. Hundred grams of fresh leaves provide 45 mg of vitamin C (75% of recommended daily value) and 8090 IU of Vitamin A (270% of RDA).

Fresh, young winged bean pods are one of the finest sources of folates. Hundred grams beans provide 66 µg or 16.5% of daily requirement of folates. Folate, along with vitamin B-12, is one of the essential components of DNA synthesis and cell division. Adequate folate in the diet around conception and during pregnancy may help prevent neural-tube defects in the new-born baby. Fresh winged beans contain quite a good amount of vitamin-c as 18.3 mg/100g, or 31%. Vitamin C is a powerful water-soluble antioxidant, and helps in building immunity against infections, maintaining blood vessel elasticity, and offers some protection against cancers when adequately provided in the diet. Tender, immature pods of winged beans are one of the very low-calorie vegetables as 100g beans carry just 49 calories.

**Adaptation amid changing climatic conditions**

Winged bean can tolerate drought, flood, extreme temperatures, pests and diseases to a greater extent than other major staple crops. The diversification of global food systems with this vegetable can prove to be an effective instrument in addressing the extreme weather patterns or the effects of long-term climate change while tackling the problem of dietary imbalances being faced by the world in present era. It is estimated that food supply must be doubled by 2050 to cope with the adverse impacts of climate change and population pressure on global food systems. The diversification of staple crops and the systems in which they grow is essential to make future agriculture sustainable, resilient, and suitable for local environments and soils. A recent analysis conjures up a worrying picture of global food consumption patterns and urges people to consume a broader range of food sources to combat malnutrition and global food insecurity, which is expected to grow further. That implies humans should consume more of the world's underutilized crops, also known as ‘potential’ or ‘minor’ crops.

One notable feature of the winged bean is the potential for almost all parts of the plant to be eaten, including leaves, flowers, tuberous roots, pods and seeds, whereas stems and leaves are used as fodder. It also serves well in crop rotation, because of the nitrogen fixation capability.

As with several underutilized crops, however, there are anti-nutritional factors in winged bean (specifically trypsin inhibitors), requiring thorough soaking, rinsing, and cooking of the dried beans, which may deter more widespread acceptance of winged bean in human diet. It is also relatively high in vitamins A and C, calcium, and iron. In countries where protein deficiency is high, or access to meat protein is low, winged bean is a candidate crop, which can enable diversification of human diet and improve nutrition.

The winged bean is largely a self-pollinated crop but up to 7.6% cross pollination is reported. It is a short-day plant and maximum flower-bud opening is between 10 AM to 12 noon. The exclusion of pollinating agents by
caging winged bean plants resulted in significant yield reduction and delayed fruit maturity. This indicated that insect pollination is beneficial for fruit-setting in winged bean. The stigma remains receptive up to 34 hours after flower opening. Anther dehiscence occurs even before flower opening. Considering above facts, winged bean is considered largely as self-pollinated with a level of cross pollination ranging from 0 to 7.6%. Flowers are hermaphrodite and light blue coloured.

Cultivation

Soil and climatic requirements

The land is ploughed at a depth of 3-4 cm and a very fine tilth is maintained. The purpose of land preparation is to provide the necessary soil conditions which enhance the plant and root growth. The sandy to heavy clays soils, well-drained sandy loam, rich in organic matter having a \( \text{pH} \) of 4.3-7.5 is preferred. Hot and humid climate is ideal for the cultivation of winged bean. It can tolerate temperature range of 15.4–27.5°C and annual rainfall between 700–4100 mm. Flowering is observed from mid-September to October under short day conditions. Despite prevalence of short day conditions, temperature above 32°C or below 18°C inhibits flowering. The crop grows well up to an elevation of 2,000 m.

Method of sowing and seed rate

Winged bean is mainly propagated through seeds, but stem cuttings can also be used under specific circumstances. The recommended seed rate is 15-20 kg/ha. However, seeds have a hard seed coat and should be pre-soaked for 1 - 2 days. The seeds are sown at a depth around 3 – 4 cm, which germinate within 5-7 days after sowing. Optimum mean temperature for the growth of crop is 25°C and North-South orientation of trellis is best for proper exposure to sunlight. The optimum spacing is 90 cm × 90 cm for commercial crop and 45 cm × 45 cm for seed crop. A spacing of 30 cm × 20 cm can be followed in case of dwarf types.

Time of sowing

Normally, the winged beans are sown with the onset of monsoon in June-July. The crop grown for tubers should be sown in August-September, since early sowing results in profuse vegetative growth and may inhibit tubulisation.

Integrated nutrient management

Being a leguminous crop, winged bean holds prolific nodulation capacity. This legume crop does not need inoculation with nitrogen fixing bacteria for its vigorous growth, as it has ability to grow quickly and enriches the soil with nitrogen especially under ploughed conditions. Tropical soils are generally deficit in nitrogen but winged bean thrives well even in poor soils reflecting its ability to fix the atmospheric nitrogen. In acidic soils, winged bean reflects the symptoms of aluminium toxicity similar to other legumes. The crop requires 20 tonnes/ha FYM and application of fertilizer dose of N:P:K at 50:80:50 kg/ha. Full dose of P and K and split dose of nitrogen is applied at the time of sowing while remaining dose of nitrogen is top dressed at 40 to 60 DAS.

Weed control

Winged bean is a fast growing crop and provides plant cover within one month of sowing. However, one hand weeding at 15-20 DAS is required to control weeds during early growth period.

Staking is a very important practice to obtain good and quality yield in winged bean due to indeterminate stem growth. Several methods of stalking are in practice, depending on the uses of crop and availability of resources. For instance, plants grown for tuber yield are allowed to trail across the ground but if the legume is grown exclusively for the pods, short stalks are used for continuous picking of green tender pods. The support of the vine is also essential for higher seed production.

Plant protection

There are no major reports of insect-pest and disease incidence on winged bean in India. However, false rust (Synchytrium psophocarpri), leaf spot (Pseudocercospora psophocarpri) are the important fungal diseases. Similarly, Maruca testulalis and Hormocheplaca signatipennis and root knot nematodes may affect the crop. Therefore, suitable plant protection measures may be taken to minimize yield losses.

Harvesting and Post-harvest management

Harvesting the shoots and leaves is done while they are still tender. Green pods can be harvested from about 10 weeks after sowing. Fresh pod and tuberous root yield 5-10 t/ha each, whereas seed yield ranges from 1-1.5 t/ha. Winged bean can be stored in plastic bags, tightly tied at the neck to keep them fresh. The shelf life of the pods can be increased to 4 weeks under storage temperature of 10°C and 90% relative humidity.

Future thrust and Prospects

The exceptional nutritional quality along with tropical adaptation makes winged bean a potential candidate for cultivation in the tropical areas of the world. Past research efforts were hampered by a lack of genetic resources and knowledge upon which to build, critical infrastructure that can spur research efforts. More importantly, efforts must be made to collect, conserve and utilize the largely eroding genetic resources and promote awareness among the local people, particularly the young generation, of its existence thus, enhancing its utilization. The establishment of an enabling policy and financial assistance by government agencies and support of non-governmental organizations will be critical to push forward research and development efforts. Yet, the nutritional potential of this legume demands such efforts. There is no doubt that renewed research efforts will thrust winged bean forward and transform this orphan legume crop into one of worldwide impact.

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calcium, magnesium, potassium, sodium and selenium. Leaf of *T. procumbens* mainly contains crude proteins 26%, crude fibre 17% soluble, carbohydrates 39%, calcium oxide 5%. Quercetin, isoquercetin, luteolin, and glucoluteolin have been reported from its flowers. Oleanolic acid was obtained in good amounts from *T. procumbens* and found to be a potential antidiabetic agent when tested against aglucosidase. *T. procumbens* can be used as a prospective source of provitamin A (carotenoid).

**Medicinal properties**

Each and every part of *T. procumbens* is useful, having pharmacological properties. The plant product over synthetic compound is the need in the treatment of diseases as it does not have any deleterious effect on higher animals including humans. India is home to a variety of traditional medicinal systems that rely to a very large extent on native plant species for their raw drug material. The work done till date on various pharmacological activities like wound healing activity, antimicrobial, anti-inflammatory, hepatoprotective effect, immunomodulating property, antidiabetic, and antioxidant, bronchial catarrh, diarrhea, dysentery and hair treatment give immense importance to the herb. The qualitative analysis revealed the presence of the biomolecules such as flavonoids, tannins, phenolic compounds, anthraquinone, catachol, saponins, steroids, and terpenoids.

**Summary**

*Tridax procumbens* is found throughout India and have various pharmacological active compounds which allow its use as folk medicine in variety of ailments. It has been widely used in the Ayurveda due to the presence of medicinal properties for wound healing, malaria, diarrhea, dysentery, bronchial catarrh, stomach-ache and reducing blood pressure. It also prevents hair loss and haemorrhage from cuts and bruises. Its flowers and leaves possess antiseptic, insecticidal and parasiticidal properties. *T. procumbens* also shows various pharmacological activities. Therefore, there is a broad area of research in direction of more pharmacological activities of plant and use their properties like antimicrobial and insect repellent properties in organic farming to reducing the input cost in agriculture.

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Untimely snowfalls – An emerging concern for temperate fruit growers in Kashmir valley

The horticulture sector is perceived as the backbone of the Jammu and Kashmir economy as it significantly contributes to Gross State Domestic Production. Around 7 lakh families, comprising 33 lakh people, are directly or indirectly associated with the horticulture sector. During the last few years, the Kashmir fruit growers have suffered a major setback mostly due to climatic variability in particular to the unseasonal heavy snowfall. Based on the time of occurrence, untimely snowfall affect flower parts, pollination process, fruit set, harvesting of late-season varieties, on-farm activities like sorting, grading, packaging, storage, and marketing of produce. In addition, it results in mechanical damage to trees. Furthermore, it can have a significant effect on return bloom by reducing fruit-producing areas on trees. We have no control over the occurrence of pre-and post-winter snowfall but still with the help of some management practices, we can minimize the losses due to untimely snowfall.

THE agro-climatic conditions of the Himalayan region in the country offer tremendous possibility for the production of temperate fruit crops. Accordingly, the area under the temperate fruit crops is growing rapidly and contributing to economic, nutritional, and employment security. Kashmir valley is most suitable for temperate fruit production in particular apple, almond and walnut due to its plain and fertile land, and productivity data also show the same. As per the available data, Jammu and Kashmir is way ahead in productivity of apple (11.43 MT/ha) compared to other major apple-growing states i.e. Himachal Pradesh (3.96 MT/ha), Uttarakhand (2.32 MT/ha). Further, Kashmir enjoys a monopoly in the production of almonds (94.4%), walnut (91.9%), and cherry in India. However, the large portion of temperate fruits crops area of Kashmir is under rainfed conditions. Unlike other temperate regions, Kashmir is devoid of monsoon rains (June-September) and January to May is the rainy season, but a large proportion of precipitation is received in winter in the form of snow. Thus, snowfall plays a crucial role in the successful production of temperate fruit crops. But in the last few years, fruit orchards were hit by heavy and untimely snowfall. Pre-and post-winter snowfall considerably affected the temperate fruit industry of Kashmir.

Post-winter snowfall

March snowfall-2015: During 2015, heavy snowfall happened twice during March (8th and 16th) which resulted in blossom damage in the almond crop. Low temperature followed by snowfall reduced bee activity and consequently resulted in low fruit set.

April snowfall-2017: Untimely snowfall during 6th April 2017 badly affected stone fruits including apricot, peach, plum, and cherry which were in full bloom. Snowfall resulted in a considerable dip in temperature on snowfall days i.e. average temperate was 2°C, compared to 12°C during 2015 and 2016. Moreover, the effect of snowfall on temperature remained for a week. The mean weekly higher, average and low temperature after snowfall during 2017 was 14.71, 8.86 and 2.86 which were respectively 20.57, 13.86, 7.29°C during 2015 and 2016. Usually in mid-December heavy snowfall is witnessed in the entire Kashmir valley and the snow kept the pace until late February. Though moderate to heavy rains are usually in the early spring season in Kashmir, but the snowfall witnessed on 6th April 2017 is a rare happening. The last time it snowed in April in Kashmir was on 28th April 1978. Due to low temperature, the pollinating agent like bees remained inactive for a week, as their flight stops below 12°C. The pollen grains were washed away as a result of heavy rain on April 5 and snowfall on April 6. The pollen grains that were transferred prior to the snowfall also did not germinate since pollen grains do not germinate below 5°C, and the stigma became non-receptive as a result of the low temperature. In those flowers that were pollinated before the snowfall, the growth of the pollen tube also slowed down because the temperature was below 10°C. All these factors adversely affected the fruit setting. However almond and apple escaped as most of the almond orchards blooming were over or some late varieties bloom was near to completion, whereas apple orchards were at tight cluster to pink bud stage, the two budding stages before

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Cherry, peach, plum and late blooming cultivars of almond were badly affected by 6th April 2017 snowfall whereas, apple crop escaped at ICAR-CITH, Srinagar.

The apple trees witness full bloom. However, fruit set may have been affected to some extent in apples as cold periods just before flower opening can injure ovule. The cross-pollinating temperate fruit trees like pear and cherry were more severely affected compared to self-pollinating like plum and apricot due to unexpected snowfall and the accompanying chilly conditions. Further, the north Kashmir region was affected more severely as compared to central and south Kashmir as the north Kashmir region witnessed more snow.

**Pre-winter snowfall**

**November snowfall-2018 and 2019:** During 2018 (2nd to 4th November) and during 2019 (7th November), the early and unprecedented snowfall caused extensive damage to orchards in particular apples across the Kashmir valley, thousands of trees observed mechanical damage in nearly entire Kashmir. The damage was more severe where fruits in some varieties were not completely harvested from trees. This damage was not confined to 2019 only but has hit apple production in the forthcoming years as well. This is the fifth time since 2000 (2004, 2008, 2009, 2018, and 2019), when Kashmir valley recorded snowfall in the month of November. However, during 2019, Kashmir registered its heaviest snow in November in about 40 years. Snowfall records of the past four decades-monitored by the Meteorological Department showed that 9.6 cm (4 inches) equivalent snowfall was recorded between 6 and 7 November 2019 in Srinagar which is the heaviest 24-hour snowfall recorded in November since 1980. In Kashmir valley, around 1,58,150 hectares of land is under apple cultivation and most of the orchards are on seedling rootstocks and it takes around 10-15 years of investment of a grower to come to full production potential. About 10-40 and 20-50% damage to orchards was seen in a different part of the valley due to November snowfall during 2018 and 2019 respectively. The damage was higher in the southern district i.e. Kulgam, Shopian, Pulwama, and Anantnag during 2018.

**Why untimely snowfall is harmful to trees or how it affect fruit growers?**

**Mechanical damage:** Leaves were still on trees at the time of snowfall during the first week of November as in apple, pear, peach, cherry, plum, apricot, etc. Leaf senescence process starts in the second half of November and by the first week of December, trees shed their leaves. With leaves still on trees, every snowflake accumulate on leaves and put weight on branches-thus severely damaging them. Furthermore, this unexpected snowfall was heavier than normal snowfall which resulted in more destruction. Trees were uprooted, developed major cracks in stem and several trees suffered broken branches. Being an evergreen fruit crop, olive suffered the most drastic damage whereas, the leaf senescence process was already started in almond and walnut and most of the trees had shedded around 60% of leaves. But because of the brittle nature of wood and dense canopy (pruning not started), almond observed severe damage next to olive in ICAR-CITH, Srinagar. However, due to the strong nature of wood and spare canopy, walnut escaped from any major mechanical damage. The two-year-old feathered nursery plants of apple were also severely damaged/uprooted due to untimely November snowfall.

**Loss of fruit:** The fruit of some apple varieties was still on trees at the time of snowfall. Snowfall not only damaged apples that were on trees but led to severe fruit drop. Most of the apple growers lost crop of late cultivars ‘Maharaji’, Granny Smith and Golden Delicious and Red Delicious. Over-mature fruits on the trees developed watercore disorder.

**Loss of harvested apple:** Most of the apple growers deserted their harvested fruit in orchards, lying on the floor, and there was also damage to the packed fruits.
boxes in piles, which led to bruising and injury to the packaged fruit.

**Transport:** This untimely snowfall affected transportation of fruit from the valley to different mandis of the country, and the fruit from these mandis to neighbouring countries as well. Thousands of apple-laden trunks got stranded on the Srinagar-Jammu highway due to the closure of the NH-44 by the heavy snowfall. The fruit boxes in stranded trucks on the highway caused massive losses to apple growers as well as traders due to the rotting of fruit inside boxes.

**Effect on production in forthcoming years**

*Loss of trees in orchards:* Direct loss to the temperate fruit industry.

*Loss of branches on trees:* In apple trees, fruit is borne on spurs. Spurs are short, strong, stubby, compressed stems and are produced on more than two years old wood and maybe grow a quarter inch each year and produce quality fruit for 5-6 years and remain productive for 8-10 years. Like apples, most temperate fruit crops produce fruits on spur. The fruiting area was also reduced on the tree due to mechanical damage. In trees, lots of fruiting spurs are damaged and loss of spur ultimately means loss of fruit. Loss of branches and complete trees will affect temperate fruit production during the coming years.
Suggestions to mitigate the effect of untimely snowfall

Flowering time
- After the snowfall, induce more bee colonies in the orchard to ensure sufficient pollination in the remaining flowers.
- Spray of plant growth regulators and micronutrients in particular GA₃, B, Zn, etc. can improve fruit set under adverse climatic conditions.

November snowfall

Before snowfall
- If snowfall is predicted in November, complete of harvesting of late-maturing apple cultivars and spray of 5-10% urea on the tree to accelerate the leaf senescence process should be done.
- Some minimal pruning can also be done to remove overcrowded, intermingled weak branches. The old plants should be preferably pruned on priority.

During snowfall
- Do not allow snow to accumulate on the tree. Manually remove accumulating snow from trees recurrently to minimize damage (Fig. A).
- Remove large limbs from the tilted tree and give proper support with the bamboo sticks or other convenient material to prevent them from falling/uprooting.
- If possible, harvest fruits from trees.

After snowfall
- Harvest fruit as soon as possible.
- Remove accumulated snow from trees manually by shaking branches or by a wooden stick. Do not shake the tree (Fig. B).
• Severely prune uprooted/fallen tree on the ground itself and upright it. Use some dry soil and compact the soil around the crown. Finally, give proper support to the tree with the bamboo sticks or other convenient material (Fig. C). The tree will get re-establish in the next season (Fig. D).

• If damage to the limb is severe, then remove the limb with a smooth and clean-cut and apply chaubattia or any other copper containing paste on the cut surface (Fig. E).

• If damage to limb or major branches is not severe, then tie it properly by joining the cambium layer by tying with other branches on trees and wrap with wide grafting/budding polythene (Fig. F). Healing will take place in the next season (Fig. G).

• Management of broken primary or secondary branches on a mature tree: Reduce load from the branch by pruning. Clean the broken area and join the cambium layer by tying the branch with other branches on the tree with the use of sutali or other convenient material. Use nails/nut bolt (size depends on branch diameter) to fix the joint and wrap properly with wide grafting/budding polythene then support the branch from the lower side (Fig. H). Healing will take place in the next season (Fig. I).
Management of broken branches

- Remove small broken branches with a smooth cut to outward-facing bud or branch and apply chaubattia or any other cupper containing paste on cut surface (Fig. J).

- Provide proper drainage in orchards to drain excess water accumulated by the melting of snow.

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Pusa Raunak – A high yielding round melon variety for spring summer season

Round melon [*Praecitrullus fistulosus* (Stocks) Pangalo] is also known squash melon/ Indian squash/ Tinda. The tender, green, non-fibrous immature fruits are cooked as vegetable. India is believed to be its centre of origin. In round melon improvement programme, attention should be focussed on development of early, green, shiny, uniform, flattish round high yielding genotypes having white, tender, less-seeded flesh. Keeping these facts in view, a round melon variety Pusa Raunak was developed by Division of Vegetable Science, ICAR-Indian Agricultural Research Institute, New Delhi.

In north Indian plains, generally two crops of round melon are taken in a year, viz. spring-summer and kharif crops. The consumer preference in India is early maturing variety having medium sized flattish round fruits with tender flesh and high yielding ability. The National check variety Punjab Tinda is an old variety and shy bearer, and significantly lower in yield as compared to the new variety Pusa Raunak which has been released and recommended by Delhi State Seed Sub-committee for commercial cultivation in National Capital Territory of Delhi during spring summer season. It was subsequently notified by Central sub-committee on Crop standards, Notification and Release of Varieties of Horticultural Crops during 2019.

**Pusa Raunak (DRM-26)**

Pusa Raunak is developed from highly heterozygous local material collected from Sonipat, Haryana. Selfing and individual plant selections were carried out to purify the material and develop the variety.

Vine length of this variety is 1.0-1.5 m. Leaves are alternate, dark green, deeply lobed, and hirsute. Plants are monoecious. The staminate and pistillate flowers are solitary, axillary and yellow in colour. The ovary of female flower is hairy. Young fruits at marketable stage are green, shiny, uniform, flattish round in shape, 5 cm in diameter, medium in size with an average weight of 60 g each and covered with soft hair. Flesh is white, tender, less-seeded and has good cooking quality. Fruits turn flattish round towards seed maturity and the fruit colour fades and becomes pale green. The seeds are flattish round in shape, medium in size and black in colour with ridged border. Fruits become ready for first harvesting in 55-60 days after sowing during spring-summer season. Average yield under normal conditions is 7.5 t/ha.

**Cultivation**

It can be grown successfully on all type of soils but prefers well-drained loam and sandy loam soils rich in organic matter. The seed rate is 4-5 kg per hectare. As a spring-summer crop, it is sown from mid-February to first week of March. The seeds are sown in the hills 45 cm apart on the slope of channels prepared at a distance of 1.5 m. The spacing between channels is increased to 2.5 m when sowing is done on both the sides. Two to three seeds are sown 2 cm deep in each hill. About 15-20 tonnes of well-rotten organic manure per hectare before field preparation and 50 kg urea, 120 kg single super phosphate and 60 kg muriate of potash at the time of last ploughing should be applied. Another dose of 50 kg urea should be top-dressed in two equal split doses, 30 and 45 days after sowing. Foliar application of urea (1%) may be done during early growth and at the time of fruit development. When seedlings become 8-10 cm tall, thinning should be done to keep 1 or 2 seedlings per hill.

**Performance of Pusa Raunak**

Pusa Raunak (DRM-26) has been tested in yield trial at several locations from 2011 to 2015 along with check Punjab Tinda. The results indicated that Pusa Raunak
Table 1. Mean performance of DRM-26 and Punjab Tinda at IARI, New Delhi during spring summer season from 2011 to 2015

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Yield (t/ha)</th>
<th>Average yield (t/ha)</th>
<th>% increase over check</th>
<th>No. of days to first harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRM-26</td>
<td>7.38</td>
<td>7.59</td>
<td>64.29</td>
<td>55-60</td>
</tr>
<tr>
<td>DRM-44</td>
<td>7.02</td>
<td>6.80</td>
<td>47.19</td>
<td>55-60</td>
</tr>
<tr>
<td>DRM-3</td>
<td>5.77</td>
<td>5.67</td>
<td>22.73</td>
<td>55-60</td>
</tr>
<tr>
<td>DRM-12</td>
<td>5.59</td>
<td>5.48</td>
<td>18.61</td>
<td>55-60</td>
</tr>
<tr>
<td>Punjab Tinda (C)</td>
<td>4.94</td>
<td>4.62</td>
<td>60-65</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Performance of DRM-26 round melon during spring-summer season 2015 at IARI Regional Station, Karnal

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Average yield (t/ha)</th>
<th>% increase over check</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRM-27</td>
<td>6.71</td>
<td>40.97</td>
</tr>
<tr>
<td>Punjab Tinda (C)</td>
<td>4.76</td>
<td></td>
</tr>
<tr>
<td>CD 5%</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>CV (%)</td>
<td>10.63</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Performance of DRM-26 round melon during spring-summer season 2015 at KVK, Shikohpur, Gurgaon

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Days to first fruit harvest</th>
<th>No. of fruits/ plant</th>
<th>Average fruit weight (g)</th>
<th>Average yield (t/ha)</th>
<th>% increase over check</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRM-26</td>
<td>54-60</td>
<td>10.30</td>
<td>58.80</td>
<td>8.48</td>
<td>75.21</td>
</tr>
<tr>
<td>Punjab Tinda (C)</td>
<td>60-67</td>
<td>6.0</td>
<td>51.70</td>
<td>4.84</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Performance of DRM-26 round melon during spring-summer season 2015 at KVK, Ujwa, New Delhi

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Days to first fruit harvest</th>
<th>No. of fruits per plant</th>
<th>Average fruit weight (g)</th>
<th>Average yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRM-26</td>
<td>53-58</td>
<td>6.9</td>
<td>47.1</td>
<td>5.85</td>
</tr>
<tr>
<td>Punjab Tinda (C)</td>
<td>55-60</td>
<td>5.7</td>
<td>38.2</td>
<td>3.62</td>
</tr>
</tbody>
</table>

Yielded 7.59 t/ha which was 64.3% higher than check Punjab Tinda (Table 1). In multi-location testing, Pusa Raunak has average yield of 6.71, 8.48 and 5.85 t/ha at IARI Regional Station, Karnal; KVK, Shikohpur; and KVK, Ujwa, respectively (Tables 2, 3, 4).

Disease and pest management

Red pumpkin beetle attacks the plant and feeds away the leaves. It can be controlled by spraying of Carbosulfan 20 EC @ 2 g/litre of water. The adult of fruit fly insect punctures the skin of young fruit and lay eggs. The maggot starts feeding the flesh of the fruit and infected fruit become deformed. The affected fruit should be picked and destroyed. Fruit fly can be effectively controlled by spraying of Malathion @ 2 ml/litre of water and use of poison bait and pheromone trap to trap and kill the adult flies. A need based spray of Imidachloprid @ 0.3 ml/l or acetamiprid @ 0.3 g/litre of water followed by Dimecron @ 2ml/litre of water at two weeks interval should be applied judiciously to prevent the crop from important sucking pests like aphid and whitefly.

High summer rainfall and high humidity is conducive for the spread of downy mildew disease. Symptoms appear as reddish brown spot on the upper surface and greyish black spot on the lower surface of leaves. It can be controlled by spraying of Dithane M-45 @ 2 g/litre of water twice at 10 days interval. Fusarium wilt is a soil borne disease in which the young seedlings, cotyledons droop and wither. In older plant, leaves wilt suddenly and collar region become yellow or brown. The disease can be checked by drenching the soil and root zone of the crop by Captan @ 2 g/litre of water. This should be repeated at 10 days interval.

SUMMARY

Pusa Raunak is an early improved variety of round melon for spring-summer season cultivation developed by IARI for National Capital Territory of Delhi. Apart from superior quality characters, it showed 64% higher yield over the National check variety Punjab Tinda.

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Offshoot preparation in Date palm: Methods, maintenance and care

Date palm (Phoenix dactylifera L.) is one of the oldest cultivated fruit crops in the world and belongs to the family Arecales. It is believed to be originated in Mesopotamia (Current-day Iraq) during 4000 BC. From its origin, the cultivation has spread and has become a major crop in Arabian Peninsula, North Africa and the Middle Eastern countries. In India, date palm cultivation is believed to be 450-500 years old with the major cultivation concentrated in Kachchh district of Gujarat accounting for more than 85% of India’s total area and cultivation. The crop is dioecious, monocotyledon plants and can grow in very hot and dry climate. It can relatively tolerate saline and alkaline soils. Being a dioecious crop, high heterozygosity is observed in its population and to maintain its quality characters, they are asexually propagated through offshoots. Since, one palm produces only 10-20 offshoots in initial duration of 10-15 years; mass production of the planting material becomes very difficult and thus needs special care.

The commercial cultivation of date palm, Phoenix dactylifera L. is concentrated in the western border states of India where Kachchh district of Gujarat contributes the largest area and production but most of the cultivated area is still of seedling origin. The crop can be propagated through seeds, offshoots and tissue cultured plant. Being a dioecious and highly cross pollinated crop, great variability exist in colour, size, shape, taste of the fruits if propagated through seeds. Moreover, the seed never assure the true-to-type nature of mother palm and 50-60% turned to be male and it also leads to variability, hence not recommended for commercial plantation. Tissue culture plants are currently not very easily available in bulk in India; hence the best way to maintain and increase production of quality date palm is propagation through the offshoots.

Offshoots are auxiliary buds developed between leaf base and the trunk during the juvenile phase of the palm. The number of offshoots developed per palm is dependent on the variety/clones which are limited to a short vegetative phase of the palms and in initial 10-15 years of age, the palm produces an average of 10-20 offshoots. The offshoot development process is very slow, which retard the fast multiplication process. Currently, no tool or technique is available to increase as well as speed up the production of offshoot and also to reduce time gap. Furthermore, the survival rate of the offshoots is very low (20-30%) under field conditions, and there are chances of enhancement and spread of pests and diseases. The preparation and removal of offshoot is a skilled and laborious work, and needs proper care. The propagation of the offshoot can be divided into two parts, first is the preparation of the offshoots by allowing them to root and second is the removal of the offshoots and transplanting them into the field. Each of these events are discussed in the later section.
Selection of mother plants and offshoots

Mother plant should be healthy, high yielding with desirable qualities and bear good quality fruits. The same method can be followed for both male and female plants. Plants should be preferably disease or pest free. For proper development of the plant along with good harvest of offshoot, it is better to maintain average of 3-5 offshoots per plant.

Offshoots that emerges from the base of the plants are called as ‘ground offshoot’ and the offshoots emerging from the trunk are called as ‘aerial offshoot’. Since the ground offshoots touch the soil, natural rooting from the ground is observed which allows higher success rate during propagation. For effective propagation of the offshoots, it is best to select 2-3 years old ground offshoots which weigh about 10-15 kg.

Preparation of offshoots

The offshoots are prepared by cleaning the base of the offshoots by removing the surrounding soil and peeling the outer area using sickle. The exposed area is treated with IBA@2000 mg/L. The base of the offshoot is then covered with the plastic bag, long enough to cover the surface, they are tied and media is filled and tighten. For higher rooting, mixture of soil + FYM or soil + vermicompost (1:1 ratio) is beneficial. Offshoots are allowed to root for 4-6 months before planting in the field. If natural moisture is not available, make arrangements by using drip to regularly wet the surface. While removing the outer surface of offshoots, care should be taken that the cut should not be too deep to damage the offshoots and the mother palm. Media should be devoid of stones and moisture must be maintained in prepared offshoot for better root initiation.

Transplanting of offshoots

When the offshoots are rooted, they are ready to be detached from the main plant. Before removing, tie the leaves of the offshoot and clean the base of the offshoot by removing excess soil. Detach the offshoot using a chisel.
1. Offshoots are ready for transplanting

2. Tie the leaves of the offshoots

3. Remove the soil around the offshoot

4. Remove the offshoot from the mother plant using chisel and hammer

5. Dip the cut portion in IBA solution (2000 mg/L)

6. Smear the cut portion with fungicide

7. Plant the offshoot with maximum girth at the ground level

8. Cover the offshoot with dates leaves or gunny bags

9. Irrigate the planting

Newly planted offshoots of date palm
and a hammer. Dip the offshoot in IBA solution (2000 mg/L) for a minute. Smear the cut portion with systemic fungicide. Plant the offshoot in a 1 m × 1 m × 1 m pit and care must be taken that the maximum girth of the offshoot’s bole remains at the ground level. Planting the offshoot too deep may result in entry of water at terminal portion resulting in death. Cover the offshoot with the dates leaves or gunny bags to reduce its transpiration and respiration loss as most of the offshoots are planted in the summer months. Irrigate after planting and keep the soil moist until the plants are set.

Care should be taken to keep the cut clean and it should not be deep enough that it damages the mother plant. The cut section of mother plant should be treated with systemic fungicide and covered with the soil to avoid pest/disease attack. One-third of the leaves of the offshoot are cut during transportation and planting to reduce the transpiration and respiration rate. Transplanting in the month of March-April is preferable and must not be done in winter as it increases the chances of mortality. Preferable distance of planting in date palm is 8 m × 8 m and 9 m × 9 m in a pit of 1 m × 1 m.

Post care after transplanting
Transplanted offshoots should not be disturbed to prevent any root damage. It should be protected from extreme heat, cold and wind (by covering with date leaves or green net). Mild irrigation should be provided daily up to 5-6 weeks of transplanting. Spray of systemic fungicide on the new emerging leaves after one month of plantation reduces changes of spoilage of terminal leaves.

Success story
The most important impact of this technique was the selection of elite palm by the farmers and its further multiplication through offshoots which led the production of quality fruits in bulk. Before adopting this technique, there were hardly one or two orchards with same type of clones in large numbers, however the scenario has changed tremendously as now many orchard having elite clones with sufficient numbers are available. In Dhrub village of Kachchh, more than 95% farmers are propagating through offshoots.

For further interaction, please write to:
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**SUSTAINABLE DEVELOPMENT GOALS RELATED TO FRUITS AND VEGETABLES**

<table>
<thead>
<tr>
<th>SDGs</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health benefits of fruit and vegetables&lt;br&gt; Harness the goodness&lt;br&gt; Fruit and vegetables have multiple health benefits. They strengthen the immune system, combat malnutrition and help prevent non-communicable diseases.</td>
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<table>
<thead>
<tr>
<th>SDGs</th>
<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>Diversified diet and a healthy lifestyle&lt;br&gt; Live by it, a diverse diet&lt;br&gt; Adequate amounts of fruit and vegetables should be consumed daily as part of a diversified and healthy diet.</td>
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<thead>
<tr>
<th>SDGs</th>
<th>2</th>
<th>8</th>
<th>12</th>
<th>15</th>
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</thead>
<tbody>
<tr>
<td>Food loss and waste&lt;br&gt; Respect food from farm to table&lt;br&gt; Fruit and vegetables are worth more than their price. Maintaining their quality and assuring their safety across the supply chain, from production to consumption, reduces losses and waste and increases their availability for consumption.</td>
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**SDGs 1 2 12 15**

Sustainable value chains<br> Foster sustainability<br> Sustainable and inclusive value chains can help increase production, and help to enhance the availability, safety, affordability and equitable access to fruit and vegetables to foster economic, social, and environmental sustainability.

**SDGs 1 2 3 4 5 8 11 12 15**

Highlighting the role of family farmers<br> Growing prosperity<br> Cultivating fruit and vegetables contributes to a better quality of life for family farmers and their communities. It generates income, creates livelihoods, improves food security and nutrition, and enhances resilience through sustainably managed local resources and increased agrobiodiversity.

*Source: Fruit and vegetables – your dietary essentials, FAO background paper, FAO, Rome*
Orchids are one of the largest families of flowering plants and are globally distributed. With a delicate, sculptural beauty and historical rarity, these exotic blooms carry an unrivalled symbol of refinement, luxury and mystery. There are more than 25,000 different types of orchids existing naturally among which 99% are accessible and available for cultivation, while 1% of tropical varieties still grow in virtually inaccessible habitats and have only been seen a handful of times.

Cultural ornamental uses

Chiefly orchids cultivation has come in vogue for the enjoyment of flowers. Along with all tropical and subtropical orchids, some of the temperate species like Ophrys apifera (bee orchid), Gymnadenia conopsea (fragrant orchid), Anacamptis pyramidals (pyramidal orchid) and Dactylorhiza fuchsii (common spotted orchid) are also available in the market. Orchid flowers admiration both for ornamental value and cultural, religious ceremonies too is evinced since time immemorial. For example, flowers of Dendrobium maccarthiae Thwaites are used as special temple offerings in Sri Lanka, and flowers and pseudobulbs of species of Laelia Lindl. are used in Mexican Day of the Dead ceremonies. Owing to augmented trend of growing unusual small-flowered orchids often referred as ‘Botanical orchids’ in parallel with common ‘Florist’ orchid, enormous species (around 1700-2000 species) of Pleurothallis and Bulbophyllum are now added in the wishlist of orchid hobbyists to nourish their aesthetic sense.

Cultural symbolism

Orchids have many associations with symbolic values. For example, the orchid is the City flower of Shaoxing, China. Cattleya yamossiae is the National Venezuelan flower, while Cattleya trianae is the National flower of Colombia. Vanda var. Miss Joaquim is the National flower of Singapore, Guarian theskinneri is the National flower of Costa Rica and Rhyncholaelia digbyana is the National flower of Honduras. Prosthechea cochleata is the National flower of Belize, where it is known as the ‘black orchid’. Lycaste skinneri variety ‘alba’ is the National flower of Guatemala, commonly known as ‘Monja Blanca’ (White Nun). Panama’s National flower is the ‘Holy Ghost orchid’ (Peristeria elata). Rhynchostylis retusa is the State flower of the Indian state of Assam where it is known as Kopou Phul. Furthermore, Bulbophyllum auricolum Lindl. is the National flower of Myanmar while its similar species, B. sukhakulii Seidenf. is often used for hair adornment purpose.

Medicinal uses

The orchid family is probably the most vital plant families from a horticultural point of view. Other than its horticultural contribution, this family is notably lacking in species from which products are derived. Once an expensive and highly demanded commodity, orchids were believed to have healing, disease-fighting and protective properties. The reconnaissance and ethnobotanical survey made in Kasungu and Mzimba districts of Africa during 2009 revealed that 61% orchids are used for treating a number of diseases. For instance, tubers of Dendrobium maccarthiae Thwaites are used as special temple offerings in Sri Lanka, and flowers and pseudobulbs of species of Laelia Lindl. are used in Mexican Day of the Dead ceremonies. Owing to augmented trend of growing unusual small-flowered orchids often referred as ‘Botanical orchids’ in parallel with common ‘Florist’ orchid, enormous species (around 1700-2000 species) of Pleurothallis and Bulbophyllum are now added in the wishlist of orchid hobbyists to nourish their aesthetic sense.

Various other orchids are used for a variety of folk medicines and cures. In the West Indies, the bulbs of Bletia purpurea are boiled, and the liquid is thought to cure poisoning from fish. In Malaysia, women take a drink made from the boiled leaves of Nerolilia aragana to prevent sickness after childbirth. In Melaka, a state in western Malaysia, boils are treated with a poultice made from the entire plant of Oberonia anceps. In Chile, Spiranthes diuretica is known to be a strong diuretic. In
certain parts of Ecuador, the mucilage from *Catasetum* is thought to be good for broken bones. Various *Dendrobium* spp. received attention in Chinese traditional medicine particularly *D. catenatum* Lindl. (including *D. officinale* Kimura & Migo), *D. loddigesii* Rolfe, *D. moniliforme* (L.) Sw. and *D. nobile* (Lindl.). Other than the above, tubers of *Gastrodia elata* Blume (from which tian-ma is prepared), rhizomes of *Bletilla striata* (Thunb.) Rchb.f. (from which bai-ji is derived), the rhizomes and stems of *Anoectochilus* spp. (jin-xian-lian) and the corms of *Cremasra appendiculata* (D.Don) Makino, *Pleione bulbocodioides* (Franch.) Rolfe and *P. yunnanensis* (Rolfe) Rolfe (from which shan-ci-gu is prepared) too have some potential clinical significance.

Around 94 species of orchids counting *Crepidium acuminatum* (D.Don) Szlach., *Habenaria intermedia* D.Don, *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti & Lu Q.Huang and *Malaxis muscifera* (Lindl.) Kuntze have significant role in ayurvedic medicines. *Eulophia* spp. (*E. dabaia* (D.Don) Hochr. & *E. spectabilis*) and *D. hatagirea* are medicinally valuable in various parts of India, and is used to treat a range of ailments. The latter one is abundantly available in north-eastern Himalayan region of Sikkim while *Paphiopedilum druryi* endemic to South India become critically endangered for its relentless harvesting to meet the medicinal demand.

**Edible orchids**

Apart from its medicinal uses, orchids could also be utilized as source of foods for the nutrient rich content (Table 1) having global importance such as vanilla flavourings (extracts of *Vanilla Plum. ex Mill.*). The dried seed pods of *Vanilla* (especially *Vanilla planifolia*), are commercially important as a flavouring in baking, for perfume manufacture and aromatherapy. Except this species, the hybrid *Vanilla × tahitensis* J W Moore is the second most cultivated one. The principal vanilla-growing areas are Madagascar, Mexico, French Polynesia, Réunion, Dominica, Indonesia, the West Indies, Seychelles, and Puerto Rico.
Some other edible products are used on national and regional scales. Processed orchids are eaten either as relish or just as a snack. In south-eastern part of Africa, edible orchids are popular as ‘Chinaka’, a delicacy which shields from several diseases, and furnishes energy. The most preferred orchid species resides to 3 genera namely Disa sp. P J Bergius, Habenaria sp. and Satyrium cursonii L., but Brachycorythis Lindl., Eulophia R.Br. & Rosteroscharis Rech.f. could also be used to feed. In general, female orchids are preferred over male. Mixing of female and male orchids improve quality (texture and colour) and taste. The quality of ‘Chinaka’ is also influenced by expertise and experience in cooking. It involves cleaning the tubers and pounding them in a mortar using a pestle. The pounded tubers are then cooked together with a locally made baking powder (NaHCO₃) for a few minutes until a hard-starchy substance is produced. Upon cooling, the starchy substance becomes thick and viscous followed by cut into small pieces and cooked with groundnut sauce, or tomatoes. The cooked pieces can also be simply eaten as a snack. On the other hand, few species of Habenaria Willd., called ‘Nappiè’ also employed for preparing similar dish by Bayam people in Cameroon.

The underground tubers of terrestrial orchids [mainly Orchis mascula (early purple orchid)] are ground to a powder and used for cooking, such as in the polysaccharide-rich hot beverage ‘Salep’ or in the Turkish frozen treat ‘Dondurma’. The name salep has been claimed to come from the Arabic expression ‘asyu al-tha’lab’, ‘fox testicles’, but it appears more likely the name comes directly from the Arabic name ‘sa lab’. The similarity in appearance to testes naturally accounts for salep being considered an aphrodisiac. To prepare salep, tubers are treated with water, milk or ayran (a yoghurt-based drink) to make it enzymatically inactive followed by drying and pounding them into powder. It could be also used as ice cream called ‘mara dondurma’. At least 35 species of orchids are used to make salep, including species from the genera Anacamptis Rich., Dactylorhiza Neck. Ex Nevski, Himantoglossum Spreng., Ophrys L., Seraptas L. and SteveniellaSchlr.

Some saprophytic orchid species of the group Gastrodia produce potato-like tubers and are consumed as food by native people in Australia and can be successfully cultivated, notably Gastrodia sesamoides. Wild stands of these plants can still be found in the same areas as early aboriginal settlements, such as Ku-ring-gai Chase National Park in Australia. Aboriginal people located the plants in habitat by observing where bandicoots had scratched in search of the tubers after detecting the plants underground by scent. The dried, aromatic leaves of Jumellea fragrans and J. Rossi Senghas are used to flavour rum (trades as Faham) on Reunion Island and Mauritius. Leaves are also used for the production of ‘Bourbon tea’ (thé de Bourbon) or ‘Madagascan tea’ (thé de Madagascar).

Apart from this, in various parts of the world, certain orchids are also used for food or food supplements. In Malaysia, the leaves of one species of Anoectochilus are sold as a vegetable, and the leaves of Dendrobium salaceense are cooked as a seasoning with rice. In certain parts of the Asian tropics, the tubers of some species of Gastrodia are eaten like potatoes. Throughout the world, only few species of orchids are used as a glue substitute. In most cases, the glue is derived from the pseudobulbs. As for example, the mucilage extracted from pseudo-bulbs of Prosthechea cocklebrel (commonly known as ‘Black Orchid’), is used as glue for repairing wooden objects, ‘Zauadhli’ is a type of glue extracted from the pseudo-bulb of Laelia autumnalis, an epiphytic orchid used as adhesive for feather mosaics.

**Novel fragrance genes of orchids**

Orchids are devoid of any fragrance but still they are admired by the consumers owing to their unusual floral structure. But definitely the floral scent will be a supplemental component to enhance consumers’ preference and attract pollinators (like bees, wasps, humming birds etc.). Very recently, researchers found that TF PbHLH4 regulates the geranyl diphosphate synthase gene for monoterpoid synthesis in *Phalaenopsis bellina* while MYB1 has been identified as phenylprotonid gene regulator in *Cymbidium* species. Both these genes are responsible for floral scent profiles.

**Future prospects**

Versatility and diversity of orchid plants have clinched the attention to explore this unique group of plant in diversified arena. Despite having broad-array of socio economical and ethno-botanical importance, its secured position is yet to be made in mainstream commercial trade. But illegal harvesting and non-sustainable use of majority of orchid species has noticeably put their existence in question. In this backdrop, to reap the utmost benefit of this taxonomically unique group of plants, appropriate conservation is mandatory. Their horticultural, nutritional, pharmaceutical and cultural importance may open several promising vistas to enrich the national economy. Hence, some stringent legal-regulatory action could strengthen orchid conservation which consequently will facilitate to unveil the potential of orchids at different scales.

For further interaction, please write to:

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**Table 1. Food composition of raw edible orchids**

<table>
<thead>
<tr>
<th>Food component</th>
<th>Composition (in terms of 100 g of edible portion)</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food energy</td>
<td>115</td>
<td>Calories</td>
</tr>
<tr>
<td>Moisture</td>
<td>70</td>
<td>Per cent</td>
</tr>
<tr>
<td>Protein</td>
<td>1.3</td>
<td>Grams</td>
</tr>
<tr>
<td>Fat</td>
<td>0</td>
<td>Grams</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>27.6</td>
<td>Grams</td>
</tr>
<tr>
<td>Ash</td>
<td>1.1</td>
<td>Grams</td>
</tr>
<tr>
<td>Calcium</td>
<td>48</td>
<td>Milligrams</td>
</tr>
<tr>
<td>Iron</td>
<td>7.8</td>
<td>Milligrams</td>
</tr>
</tbody>
</table>
During summer and winter season in northern India in general and Bundelkhand in particular, it is extremely difficult to grow vegetables in open field conditions; however, with the creation of false micro-climate through modified protected structures, some high-value crops and vegetables could easily be grown continuously. In northern India particularly at semi-arid region like Bundelkhand, the summer (April to July), the rainy (July to October) and the winter (November to February) are the major hot-spot seasons. However, in protected cultivation, growing season can easily be extended and one or two more short duration crops could easily be taken which further adds to increased crop yield per unit per day as compared to open field conditions. Moreover, the cultivation of high value crops/vegetables in protected condition can play a better role in improving quality and advancing maturity as well as increasing fruiting span.

In Uttar Pradesh, at poor resourced farmers’ level, the popularity of protected cultivation has not been encouraging. This could be due to unawareness about its significance, unavailability of working capital for developing infrastructure, illiteracy of farmers’, deprived communication channels and tormented glitches in transportation and lack of sound resources. In Uttar Pradesh, the Bundelkhand region comprising of two mandals i.e. Chitrakootdham mandal (Banda, Chitrakoot, Hamirpur and Mahoba districts) and Jhansi mandal (Jalaun, Jhansi, Lalitpur districts) lags behind than other regions of the state in general and country in particular with respect to all socio-economic indicators.

Bundelkhand with its wide variability of climate and soil type is highly favourable for growing a large number of vegetables crops. The economy of Bundelkhand is primarily and largely dependent on agriculture and its allied sectors owing to its predominantly rural inhabitants. Regional inhabitants’ livelihood is mainly based on subsistence, rainfed, and single/mixed farming system. To overcome with long-lasting agricultural problems of this region, the Government of Uttar Pradesh has established Banda University of Agriculture and Technology (BUAT), Banda (UP). The university has formed 8 different protected structures such as natural ventilated polyhouse, insect proof net, green shade net and mist chamber with hardening chamber under the project ‘Centre of Excellence on Dryland Agriculture’ for cultivation of high value crops/vegetables in protected condition.
value vegetable crops (Table 1). Simultaneously, BUAT Banda organizes trainings, conducts field day on low cost protected cultivation, and creates awareness among the farmers to adopt low cost protected cultivation technology at their fields and gradually progressive farmers of the Banda District have been showing their interest and started creating low cost protected infrastructure at their field for commercial cultivation and large dissemination. With this limited effort, some of the farmers are ensuring better yields, greater price and are saving their input resources (water, labour and fertilizer costs) year after year that helped them to uplift their socio-economic livelihood in the region.

### Advantages of protected cultivation
- It provides conducive micro-climatic conditions for production of high-quality vegetables and allows to grow multiple crops on the same piece of land in a year.
- It gives opportunity to fetch a better price of the produce by growing them in off-season.
- It supports well to easily raise nurseries of different

<table>
<thead>
<tr>
<th>Protected structure</th>
<th>Suitable crops</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturally ventilated polyhouse (NVPH)</td>
<td>Cucumber, Tomato, Capsicum etc.</td>
<td>August to April</td>
</tr>
<tr>
<td>Green shade net-house</td>
<td>Cucumber, leafy and root vegetables</td>
<td>Last August to November and February to May (Cucumber) and April to August (leafy and root vegetables)</td>
</tr>
<tr>
<td>Insect proof net-houses (IPNH)</td>
<td>Capsicum, Cucumber, Tomato, Brinjal and cucurbits, etc.</td>
<td>Round the year</td>
</tr>
<tr>
<td>Plastic low tunnels</td>
<td>Cucurbits</td>
<td>Mid November to February</td>
</tr>
<tr>
<td>Plastic mulch</td>
<td>All vegetable crops</td>
<td>Round the year</td>
</tr>
</tbody>
</table>

Table 1. Different vegetable crops for Bundelkhand region in protected structures
vegetable crops, hybrid seed production and also protects them.
• It increases the yield productivity with better quality and attracts enhanced return per unit resource invested.
• It provides alternative venture to cultivate the vegetables in non-growing areas such as high altitudes and deserts.
• It gives shelters from the wind, rain, snow, birds, hail etc.
• It promotes advanced agriculture techniques (hydroponics, aeroponics, vertical cultivation of vegetables).
• It also fulfils the demand of producing nutritionally rich and hygienically healthy vegetables due to lesser use of toxic pesticides.
• Required less irrigation due to moisture conservation.
• It facilitates effective control to pests and diseases and becomes easier to produce disease and insects’ free seeds of costly vegetables.
• It enables to develop propagation of elite planting material of different horticultural crops.
• Low cost protected structures are ideally suited for progressive farmers having small holdings.
• It is a labour-intensive technology and generates labour-employability at the source for educated youth.
• It improves better acclimatization of developed plantlets through tissue culture techniques.
• It helps to maintain the stock plants, grafted plantlets and micro-propagated plant.

Protected structures at BUAT, Banda

Natural ventilated polyhouse

It is manually operated and comes under mid-range cost. Naturally ventilated polyhouse are the protected structures where no heating or cooling devices are provided for climate control. Cost of these structures is less than hi-tech structure but higher than others (Table 2). These greenhouses can efficiently be used year-round for growing parthenocarpic slicing cucumber, off-season muskmelon, tomato and sweet pepper for 8–9 months duration. This structure is made up of stainless steel and wall and roof with plastic walls. Polythene sheet (150 gm thick) used in construction further prevents entry of ultraviolet light, conserves CO₂ and enhances plant growth and development. Temperature and moisture inside the polyhouse are comparatively higher than the outside condition, which improves photosynthesis and uniform plant growth.

But now, the time has come when unemployed educated youths should be motivated and trained in Bundelkhand of Uttar Pradesh to use naturally ventilated greenhouse technology for cultivation of high value vegetables for higher profits. The basic prerequisite of implementing the technology is the selection of appropriate design based on the climatic conditions, available market and the type of vegetables. Under extreme hot periods (May–July), rooftops of the greenhouses should be covered with shade nets (preferably with black colour) allowing a space between the shade net and roof surface for air movement.

Shade net-house

The Bundelkhand region encounters high solar radiation and high temperature that adversely affect crop production. Therefore, the use of shade net-houses is essentially required. In general, shade net-house comes with different shading intensity shade-nets (40-75% shading intensity depending upon different crops) of different colours, i.e. black, green and white that can easily allow us to grow vegetable and ornamental crops. Shade net-house
is considered as one of the real innovations to provide development of healthy seedlings for various horticultural crops irrespective of climatic conditions. These structures are less costly than above structures. It not only protects the crops from harmful ultraviolet and infrared radiation but also protects from the extreme temperatures and helps to maintain air and soil moisture. Large-scale use of shade net-houses during harsh summer months is advised for cultivation of different horticultural crops. Black colour shade nets are most efficient in reduction of temperature compared to other colours like green, white or silver, etc. as the black colour absorbs the maximum amount of heat. Mostly leafy vegetables like beet leaf and green coriander are preferred to be grown under shade-nets, but it is also suitable for growing early cauliflower and radish cultivation during June to September months.

**Insect proof net-houses**

It is used to minimize the use of pesticides in crop production. It also enables us to produce healthy and hygienic vegetables and good quality seeds. Insect proof net-houses are preferred structure for several vegetables (brinjal, capsicum, cauliflower, tomato, okra and cucurbits etc.) and some fruit crops like papaya etc. which have more problems of pest or viruses. Insect management by use of these structures will reduce the load of pesticides in the crop and will increase the demand in market as consumer prefer no/low pesticide exposed crop specifically vegetables and fruits. Nets of 40 and higher mesh are effective means of controlling most of the flying insects. Pests and other vectors population can effectively be checked by using insect proof net-houses that creates a physical barrier between crop and open environment. These insect proof net-houses can be erected by providing an aluminium coated shade-nets (aluminet) approximately 1.0 m above the roof top of the net-houses with movable facility and with two door waiting area facility. The structures can be fabricated with a cost of 700–800/m² having 40–50% shading net covering during critical summer months (April–June) and with transparent plastic covering during critical winter months (December–February) under arid and semi-arid climatic conditions. High value vegetables like tomato, cherry tomato (crop duration 7–8 months), two crops of parthenocarpic cucumber (summer and post rainy season) and capsicum (crop duration 7–8 months) can be produced.

**Walk-in tunnels**

These are simple, temporary and low-cost structures erected on half-inch GI pipes covered with transparent plastic with 200-micron thickness and the height of the tunnel is around 2.0-2.5 m with a width of around 4 m and accommodate almost 2 to 3 beds. This structure is covered with UV film, suitable for all types of crops, flowers and vegetables. These structures are small in size and low in cost therefore are generally acceptable by farmers. Basically, these are temporary and really low-cost structures since the fixed investment made on plastic can last for 5–6 years and the investment made on GI pipes can last for more than 20 years if proper care is taken. The ideal size has been standardized for optimum cross ventilation, to have a single piece coverage of above sized structure with plastic commonly manufactured by firms of dimension 7 × 30 m or 7 × 36 m and a length of nearly 25–30 m is very suitable for honey bees to fly from one end to other for pollination. Walk-in tunnels can be used for off-season cultivation of vegetables by protecting them against extreme low temperature during the peak winter months. Mainly, cucurbitaceous vegetables are grown under these structures, but these structures can also be used for other crops which will have erect and compact canopy like capsicum, lettuce, bush type beans, etc. They are also suitable for nursery raising.

**Plastic low tunnels**

Low temperature is causing significant loss to rabi or late rabi crops in the region. A physical barrier in way of the air flow and use of plastic sheet can reduce the
extent of loss to the crop. These structures are laid in open fields to cover rows of plants with transparent plastic film stretched over steel hoops of about 50 cm height and about 1 m width. Low tunnels are supported above the plants by using hoops of GI wire and a clear or transparent plastic sheet of 20–30 micron is covered/stretched over the hoops and the sides are secured by placing in soil. These are also called miniature greenhouses. The concept of using plastic low tunnel is very effective in early crop stage when the crop is having low strength to face low temperature stress. It protects plants from harsh climatic conditions such as rain, wind, hailstorm and snow etc. These are mainly used for raising nursery and also helps in early seed germination. The farmers can grow different varieties of summer squash (round fruited, long fruited), which is an emerging crop along with cultivation of netted muskmelon varieties in place of traditional varieties. Bitter gourd and round melon are two other crops with increasing demand and which usually fetches very high price during off-season and can be grown successfully by using the plastic low tunnel technology. This technology is highly suitable and profitable for the farmers living in northern plains of India.

Plastic mulching

Plastic mulching technology, also called surface covered cultivation, largely involves mulching with polythene sheets for addressing three major issues, viz. soil and water conservation, leaching of nutrients as well as reduction of weeds and to some extent insect pest damage. Drip irrigation is an integral part of mulching technology. Mulching involves covering the soil around the plant base with an organic or inorganic material which makes condition more favourable for plant growth and development. Organic mulches, like leaves, straw, sawdust etc. add nutrients and humus to the soil as they decompose, improving its tilth and moisture holding capacity. Synthetic or plastic mulches have various beneficial effects on crop production. Plastic mulch accelerates plant growth by increasing soil temperature, conserving soil moisture, weed control, production of quality produce and reduction in leaching of nutrients. The plastic mulch is available in different colours and each colour has its own significance. Transparent polyethylene mulch raises the soil temperature by soil solarization used mainly for managing soil-borne diseases and nematodes. This effect derives mostly from the suppression of latent heat loss through evaporation. Black polyethylene film also gives effective weed control by cutting down solar radiation by more than 90%, resulting in etiolated growth and the eventual death of weeds under the film. The yellow plastic mulch attracts insects so it can be used to attract and kill insects. The silver-reflective type of plastic mulch associated with higher reflectance causes insect disorientation and repels aphids. The different types of mulches are reflective plastic mulches, infra-red transmitting mulches and biodegradable plastic mulches. Suitable horticultural crops that can take advantage of mulching include plants growing vertically by nature and not the creeping types e.g. solanaceous crops and cole crops. This technology is again useful for areas with water scarcity or rainfall ecosystems, and can conserve moisture to the extent of 50% water saving and 30% nutrient saving. Thus, we can conserve resources, economise input use and efficiency and harvest 25-30% higher yields as also the quality, playing a significant role in increase in income and overall upliftment of livelihood of farming families.

Vegetable nursery raising

Growing of off-season vegetable nurseries under protected structure has become profitable to the farmers. The cost of hybrid seeds of different vegetable crops is very high so, it is necessary that every seed must be germinated with maximum germination and it requires controlled conditions. The main purpose of raising nursery in the controlled condition is to get higher profit and disease-free seedlings in off-season to bring the early crop. Raising of vegetable nursery in protected structures has manifold
benefits such as easy management, early nursery and protection from biotic and abiotic stresses. Cucurbits are warm season crops and they are sown in last week of March to April when night temperature is around 18-20°C. But in controlled conditions, their seedlings can be raised during December and January in polythene bags and planted, during end of February and 1st week of March in the field and fruits obtained in 1.0-1.5 months in advance than the normal method of direct sowing. It results in the bonus price due to marketing of produce in the off-season. Similarly, the seedlings of tomato, chilli, capsicum, brinjal, cucumber, cabbage, cauliflower and broccoli can be grown under plastic cover protecting structure. Income generated through the production of vegetable seedlings in polyhouse was more, followed by shade net-house and open field units of the same area. Nursery growing under polyhouse showed a significant result. In the polyhouse technique, a greater number of plants per unit area and the crop growth from it gave higher early and total fruit yields.

Challenges

- High temperature being the major challenge allows to grow only limited crops in summer months and the grown crops withstand scorching heat of sun with heat storms.
- High level of radiations encounters the sudden increase in temperature and encourage water deficit stress and both reduces the adaptability of newly introduced crops.
- The quantity and quality of underground water is limited for irrigation however, the quality of water deteriorate due to presence of salts (saline and brackish).
- This region possesses rugged and undulated topography and the soils are poorly fertile being very low in organic carbon (i.e. 0.1-0.4% only), nitrogen, phosphorus and zinc and has high degree of erodibility. Therefore, surface and sub-surface runoff is very common during rainy season.
- Low and scattered vegetation cover in these regions are very common which favours frequent dust storms ultimately causing significant loss to the crops.
- This region commonly has erratic and uneven rainfall (750-1020 mm), however, recurrent monsoon failure makes this region a drought prone area. Scarcity of water gives cause to the need for its more efficient use. Therefore, in situ and ex situ rain water harvesting and afforestation is the only key to manage challenged environment.
- Protected cultivation technology requires very careful planning, maintenance and management about timing of production and further, harvest time to coincide with the shortage period of availability of vegetables and high market prices, choice of varieties adopted to off season environments, and able to produce higher and economical yields of high-quality produce, etc.

Opportunities

- The escalating population and economy has resulted in a continuous increasing demand for vegetables and high valued crops.
- Creation of huge self-employments for unemployed educated youths.
- Raising the national economy by sale of high-quality produce in domestic and international markets.
- Unproductive lands can be converted for good quality production of horticultural crops.
- Protected cultivation possesses high potential for enhancing the income of farmers opting for quality and off-season vegetable and cut flower cultivation.
- An increased water efficiency is possible solely with protected cultivation.
- Developing climate-resilient vegetables suitable for protected cultivation.
- Focusing on local values, indigenous knowledge and uses: such an approach will strengthen the link between diversity and sustainable uses and is important in considering marketability.

Strategies

- Standardizing proper designing of low-medium cost polyhouse including cladding and glazing material.
- Developing cost effective agro-techniques for growing different vegetables and reducing input costs of the greenhouse management.
- Revalidating the developed agro-techniques under harsh climatic condition and refining the technologies developed as per need and demand.
- Developing young professional and skilled polyhouse manufacturers.
- Creating awareness among farmers pertaining to the potential of protected vegetable production.

Constraints/Limitations in protected cultivation

- Higher initial investment cost, short life of polysheet and non-availability of cladding materials is one the major constraint to adoption of this technology by the farmers for commercial cultivation.
- Lack of minimum support price, high price fluctuations and lack of market information were the major
of marketing constraints in the way of protected cultivation.

- The components of polyhouse such as fibre glass, cooling pads, fans, etc have to be imported at high costs including freight and custom duty.
- Greenhouse and other structures design for different agro-climatic of the region is not standardized.
- Lengthy loan procedure, a high cost of production, and non-availability of quality seedlings.
- Lack of technical guidance, high cost of pesticides and fertilizers create the low production.
- In marketing channel of produce, the major constraints faced by the farmers include non-payment of prices by commission agents in time and the high cost of transportation also.
- Lack of appropriate tools and machinery one of the constraints for quality production of horticultural crops.
- Lack of awareness among farmers, relating to potentials of protected vegetable production and also lack of significant research programme for protected cultivation.
- The initial cost of structure looks unaffordable to the farmers, because he has zero risk affordability so do not come forward to adopt this technology.
- The protected growers face the attack of minute insects like mites, whiteflies, especially the white fly menace, nematode infestation, frequent occurrence of windstorms, hailstorms, lack of cold storage facilities in villages, high cost of refrigerated vehicle are the serious constraints.

Suggestions

- Use of local materials such as bamboo/wood instead of expensive steel pipes to reduce the initial cost of greenhouse installation.
- To regulate the temperature and humidity in such low-cost greenhouses, open the polyethylene sheet on one side manually when the temperature increases inside and irrigate or sprinkle the beds to increase the humidity and reduce the temperature.
- Subsidy rate on polyhouse already given to the farmers should be increased for popularization of greenhouses in these areas.
- Farmers should form their own co-operative societies to make best use of greenhouse in arranging materials jointly at cheap rates for their installation and further taking the produce to the market to get good returns.
- Regular training programmes should be organized to transfer the appropriate technology to the farmers.

Crop performance at BUAT, Banda in protected structure

The Banda University of Agriculture and Technology (BUAT), Banda, Uttar Pradesh has formed the different protected structures for cultivation of high value vegetable crop. At Banda, under natural ventilated playhouse (NVPH), red and yellow capsicum var. Natasha and Swarna, respectively were sown in first week of August and further transplanted in second week of September and crop is harvested up to April. The average weight of harvested green fruits was 245 g and 330 g, respectively. At present, in Banda, the sale rate of marketable green fruit of capsicum is around ₹40/kg and red and yellow capsicum can easily be sold off at 20-25% higher price i.e. ₹50-60/kg. The average fruits per square meter were 7-10 kg, 7.50-11 kg and 8.50-12 kg in capsicum hybrid Indira, Natasha and Swarna, respectively. Likewise, hybrid tomato (NS-4266) also transplanted in the second week of September and harvested up to April, the matured fruits are pulpy with tight pericarp and highly suitable for long transportation. It can simply be stored for 10-15 days at normal room temperature and can easily be sold off in local market at a price of ₹20-25/kg. The per square meter average yield was 20-26 kg. Similarly, the parthenocarpy cucumber was sown in the 2nd fortnight of September in green shade net which later fruited well at each and every node, the harvested fruits was dark green in colour and the market acceptance was excellent as it was seedless and was sold off in local market at a price of ₹40/kg in November.

For further interaction, please write to:
R K Singh (Professor), Department of Vegetable Science, Banda University of Agriculture and Technology, Banda, Uttar Pradesh 210 001. *Corresponding author’s email: singhrrknbpgr@gmail.com
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**Cardamom at a Glance**

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<th>Cardamom - Appangala-1</th>
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<th>Cardamom - Vijetha</th>
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**Cardamom**

Cardamom is one of the oldest known spices in the world popularly called as ‘Queen of spices’. It is commercially cultivated for its dried fruits (capsules), which is also referred as cardamom of commerce.

**Botanical name and chromosome number**

_Elettaria cardamomum_ (L.) Maton; 2n = 48 and 2n = 52

**Family and origin**

Zingiberaceae. Evergreen forests of Western Ghats of South India

**Economic part and uses**

Dried fruits (capsules). Used as flavoring agent and drug in traditional medicine

**Growth form and habit**

Herbaceous perennial plant. It has clumpy growth with 10 and 20 leafy shoots arising from the rhizome. The shoots are pseudostems composed of overlapping leaf sheaths. Plant reaches a height of 5 m and has an economic life span of 10-15 years.

**Types/cultivars**

Based on adaptability, nature of panicle, shape and size of capsules, the cultivars are categorized into Malabar, Mysore and Vazhukka. IIISR-Vijetha-1 (Malabar type), IIISR-Avinash (RR1) (Malabar type), Kodagu Cardamom-Susvassini (Malabar type), and Appangala-2 (Malabar type) are some of the improved varieties of small cardamom developed by ICAR-Indian Institute of Spice Research (IIISR).

**Inflorescence type**

Long panicle with Racemose clusters arising from the underground stem

**Pollen agents**

Bees

**Anthesis and stigma receptivity**

Takes place at 3.30 AM which continues up to 7.30 AM. Receptivity is at maximum between 8 AM and 10 AM

**Climate and soil**

Crop thrives well in regions which receive a well-distributed annual rainfall of 1500-2500 mm with a mean temperature of 15°C to 35°C and 600-1200 m above MSL. Cardamom grows luxuriantly in forest loam soils, which are generally acidic in nature with a pH range of 5.5-6.5.

**Propagation technique**

Suckers, seed, and tissue culture

**Planting and management**

Old seedlings (18-10 months) are preferred for planting. Shade regulation, terracing and preparation of planting pits should be done during summer months in the areas identified for fresh planting. A spacing of 1.8 x 1.8 to 3 x 3 m is recommended based on cultivar type. Pits of 45 cm³ to 90 cm³ are taken for planting. The pits are filled to one-third with topsoil, FYM or leaf litter and 100 g of rock phosphate. Planting is normally done during June-July with the commencement of monsoon.

**Shade regulation**

It is undertaken during the summer months by pruning shade tree branches to provide 40 to 60% filtered light. To ensure a balanced canopy, lopping of branches is carried out on all sides of the shade trees.

**Irrigation**

It is essential to irrigate the crop during January to May at an interval of 10-15 days till the onset of monsoon, by adopting a convenient method of irrigation by hose/sprinkler/minisprinkler/drip.

**Weeding**

Cardamom being a surface feeder, in the first year of planting, weeding at frequent intervals is necessary. Later, depending on the intensity of weed growth, 2-3 rounds of hand weeding at the plant base during May, September and December/January are recommended.

**Mulching and trashing**

Entire plantation and particularly the plant bases should be mulched at 3-10 cm thickness using fallen leaves of the shade trees, except during periods of heavy monsoon (June-September). Trashing may be carried out once in a year with the onset of monsoon under rainfed conditions and 2-3 times in high-density plantation provided with irrigation facilities.

**Pruning**

Pruning may be done during January and September which coincides with peak thrips population. Earthing up of the plant base and root zone with top soil is recommended during October-December. In valleys and high rainfall areas with medium slopes, suitable drains (45 cm depth and 30 cm width) have to be provided in between two rows of cardamom.

**Manuring**

Recommended nutrient dosages for cardamom are 75:75:150 kg/ha (rainfed - two splits) and 125:125:250 kg/ha (irrigated- three splits). One-third dosage should be applied during 1st year, which is increased to 2/3rd during 2nd year, and full dose is given from 3rd year onwards.

Organic manures like cow dung/compost @ 5 kg/plant may be applied during May/June along with rock phosphate and muriate of potash. Under irrigated condition, manuring can be done in two splits (May and September). Application of neem cake, bone meal or vermicompost @1 kg/plant improves root proliferation and plant growth.

**Yield**

Cardamom starts yielding at 2-3 years after planting. The yield stabilizes after the fourth year. During second year, it yields at an average of 50 kg per acre; at third year, it yields 145 kg per acre and in the fourth year, it yields 200 kg per acre.

**Pests and diseases**

Cardamom thrips, shoot and capsule borer, root grub are major pests that infest cardamom. Root or rhizome borer, capsule borer, hairy caterpillars, shoot fly and nematodes are minor pests observed in cardamom.

Diseases such as leaf spot, leaf rot and damping off diseases are common in cardamom nursery. Whereas in plantation, ‘Azhukal’ or capsule rot, rhizome rot, leaf blight diseases appear in severe form.

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For further details, please contact or write to:

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Lijo Thomas, ICAR-Indian Institute of Spices Research, Calicut, Kerala 673 012.
The Indian Council of Agricultural Research has brought out the Second enlarged and revised edition of the Handbook of Horticulture. Horticultural crops are gaining more and more importance as they have been instrumental in improving the economic condition of the farmer and contributing significantly to the national GDP. This new revised edition has been divided into 2 volumes – Volume 1 contains General Horticulture and Production Technologies (Fruit, Vegetable and Tubercrops) and Volume 2 has Production Technologies (Flower, Plantation, Spices crops and Medicinal and aromatic plants), Plant Protection and Post-harvest Management. The earlier chapters have been thoroughly revised and new chapters have been added. It is hoped that the readers will find this Second edition more useful and informative.

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