

PACKAGE OF PRACTICES FOR VEGETABLE CROPS

2020



Directorate of Extension

**Sher-e-Kashmir
University of Agricultural Sciences & Technology of Jammu**

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FOREWORD

In global endeavor for food, nutritional and health security, vegetable crops have attained special significance. Vegetables contain good amount of carbohydrates, natural minerals, vitamins, proteins and natural health protective compounds. India is second largest producer of vegetable and contributes 14% share in world's total vegetable production. Vegetable production in country has significantly increased from 93.9 million tonnes during 2000-2001 to 184.4 million tonnes during 2017-18 (NHB, 2018). The productivity of vegetable crops has also shown an increase from 6.0 metric tonnes /acre to 7.18 metric tonnes /acre during the same period. Per capita consumption of vegetables in our country is more than the WHO standards (357g/day/capita against 300g/day/capita recommended by FAO). The demand for vegetables is likely to increase to 350 million tonnes by 2030.



Prof. J.P. Sharma
Vice Chancellor,
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In the erstwhile state of Jammu & Kashmir vegetables were grown over an area of 1.50 lakh acre with total production 13.37 lakh metric tonnes and productivity of 8.91 metric tonnes/acre during 2018-19. Vegetable sector has now assumed great significance in the UT where holding size of farming families is very small (1.65 acre) and majority of the farmers fall in small and marginal group. The JK UT is blessed with diverse agro-climatic zones with distinct seasons thereby making it possible to grow wide range of vegetables round the year. In order to keep pace with the needs of its growing population, there is an urgent need to address all the issues related to improving production and productivity at microclimate level.

Being highly specialized and technical job, vegetable production demands scientific know-how for enhancing vegetable production, productivity and returns. An updated ready reckoner of latest scientific recommendations on vegetable crops needs to be made available to various stakeholders.

It gives me immense pleasure to congratulate Prof. R.K.Gupta and associated scientists and Directorate of Extension for coming up with "Package of Practices for Vegetable crops 2020" that covers latest and useful information on all the aspects. I hope this publication will serve as useful source of information for farmers, field functionaries, students, scientists and others interested in vegetable production on scientific lines.

Place: Jammu
Date: 06.07.2020


(J.P. Sharma)
VICE CHANCELLOR

PREFACE

Directorate of Extension under the ambit of Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu is dedicated to the welfare of farmers in Jammu region. The publication of package of practices is a regular activity of the directorate to update the knowledge of extension functionaries and farmers in adoption of improved scientific practices.

Vegetables are cultivated in large scale on commercial level under different climatic zones: namely subtropical zone, intermediate zone and semi-temperate mid-hills areas in the Jammu region of Jammu and Kashmir Union Territory. In this sequence, the package of practices for vegetable crops is updated to provide latest research recommendations to the extension agencies for dissemination to the farming community. Vegetable production needs to be increased to meet the requirement of large population of Jammu region and for that knowledge of the vegetable growers of the region needs to be updated for profit maximization.

The major vegetable crops of *kharif* season are tomato, brinjal, chilli, cucumber, bottlegourd and bittergourd whereas in *rabi* season crops namely cauliflower, cabbage, knol-khol, carrot, radish, peas, spinach and fenugreek are cultivated by the maximum number of farmers of Jammu region. The diversity in climate necessitates location specific recommendations of vegetable crop production for all the *kharif* and *rabi* crops are crucial for doubling the income of farmers of Jammu region by adopting double or multiple cropping.

By the concerted efforts of SKUAST-Jammu, various new technologies have been developed for proper management of vegetable crops. It gives me an immense satisfaction that the Directorate of Extension is coming up with updated version of Package of Practices for vegetable crops. It is presumed that this publication will be highly useful for the field functionaries and farming community of the Jammu region.

S.K.Gupta
Director Extension

PREFACE

Jammu region of the Union Territory (UT) is bestowed with agro-climates ranging from subtropical plains with an altitude of about 300 m AMSL to intermediate lower and higher zones having altitude about 1500 m AMSL and above. In Jammu province, vegetables were grown on total area of 0.75 million acre (*kharif* 2017 and *rabi* 2017-18) with total production of 0.71 MT and average productivity 9.56 t/acre during 2017-18 (DOA, Jammu). Jammu district ranked 1st in area, production and productivity, followed by Udhampur and Doda districts during same period. Potato ranked 1st in area (12.45%) followed by okra (11.29%), knolkhol (7.45%), tomato (5.77%) and peas (5.64%). Among various vegetables, okra ranked 1st in terms of total production (20.19%) followed by potato (12.91%), knolkhol (6.27%), tomato (5.84%) and peas (3.19%).

Potential pockets for raising vegetables in main season and off season include Kalyanpur, Marhand Satwari blocks (Jammu) for cole crops, tuber crops, leafy vegetables, okra and cucurbits; Vijaypur block of Samba district for carrot, direct-sown cabbage, cauliflower and turmeric; Chenani block of Udhampur district for tomato, capsicum, brinjal and hill cucurbits; some blocks of Poonch district for garlic and root vegetables; Bhandarwah block of Doda district for beans and knolkhol and Marwah and Padder area of Kishtwar district for off-season peas and beans. There is also a great potential for seed production of temperate varieties of traditional vegetables and exotic vegetables (including broccoli, lettuce, kale, brussels sprouts and Chinese cabbage).

Vegetable growers of various niche areas in the region have positively responded to adoption of new varieties/hybrids, improved production technologies and environmental friendly practices (including organic manures, bio-fertilizers, bio-pesticides). Innovative technologies (including protected cultivation, safe vegetable production, INM, IPM, farmer level seed production and microtubers multiplication in potato) are being used by select progressive growers in niche areas for enhanced productivity and better returns. Efforts have been made to update existing information on latest knowhow relevant to region based work done in Division of Vegetable Science and elsewhere and field experience.

I put on record our gratitude to Director Extension, Director Research and Dean, Faculty of Agriculture for their active support in technology development/dissemination; and encouragement in bringing out this revised Compilation on production recommendations. The contribution made by Prof RK Samnotra, Prof Sandeep Chopra, Dr Satish Kumar, Dr Manoj Kumar, Dr Sanjeev Kumar and Dr Anil Bhushan and scientists from other disciplines; officers of line department and supporting staff is gratefully acknowledged.

It is hoped that this **Package of Practices for Vegetable crops** will serve as useful guide and reference to vegetable growers, students, teachers, field functionaries and kitchen gardeners

(RK GUPTA)
Professor and Head

CAUTION

Recommendations of varieties and production techniques given in this book holds good only when used under optimum growing conditions in respective agro-climatic situations. The performance of varieties may change in due course of time due several factors (including climatic variation or a-biotic and biotic stress reasons). The chemicals used to control insect-pests, diseases and weeds are poisons for human beings and should adopt eco-friendly methods as far as possible. Farmers are advised to use these poisons carefully to avoid any ill effect on human health and environment. Mishandling/negligence of the user may result in damage/ loss/ non-reproducibility of results.

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Agro-climatic Zones

The Union Territory of Jammu & Kashmir lies in the North of Indian Union and extends from 32°-17' to 37°-50' N Latitude, from 72°-40' to 8°-30' E Longitude and forms a transitional region of diverse physical features between the week monsoon zone of Punjab and cold arid dry zone of Tibet. Jammu Division is located between an altitude of 300 meter and 4200 meters above Mean Sea Level (MSL). This division has been divided in to three zones namely, 1) Sub-tropical zone, 2) Intermediate zone, and 3) Temperate zone.



1. Sub-tropical zone

It spreads between an altitude of 300 meters and 1000 meters above MSL and enshrines Jammu district as a whole and parts of Kathua, Udhampur, Samba and Rajouri districts. This zone is characterized by hot summer, heavy summer monsoon and relatively dry but pronounced winter with pre-ponderance of alluvial soils. Normal summer monsoon ranges between 1200 to 1500 mm from mid-June to mid-September. It includes irrigated and unirrigated areas of Kathua, Barnoti, Hiranagar, Ghagwal, Samba, Vijaypur, Purmandal, Satwari, Bishnah, R.S. Pura, Marh & Bhalwal, blocks on the right hand side of Jammu-Pathankot National Highway and Akhnoor, Khour blocks of Jammu district, Nowshera, and Sunderbani blocks of Rajouri district on the Jammu-Poonch Highway.

The major vegetable crop groups of this zone include 1) Solanaceous vegetables (Tomato, Brinjal, Chillies and Potato 2) Root crops (Radish, Carrot and Turnip); 3) Bulb crops (Onion and Garlic); 4) Legumes (Peas and Beans); 5) Cucurbits (Cucumber, Pumpkin, Bitter gourd, Watermelon, Muskmelon, Roundmelon, Ashgourd and Ridgegourd); 6) Leafy vegetables (Spinach, Methi, Hak sag and Amaranthus); 7) Okra; and 8) Colocasia.

2. Intermediate zone

This zone is located between an altitude of 1000 meters and 1500 meter above MSL. It consists of some parts of Basholi, Billawar, Ramnagar, Udampur, Reasi, Pouni, Chenani, Panchari, Ghordi, Mahore, Gool and large area of Kalakote, Budhal, Rajouri, Doda, Darhal, Thathri, Balakot, Ransoo, Assar, Bhagwah, Ramban, Mahore, Mendhar, Poonch, Ghordi, Panchari and Manjakote blocks within the said altitude. This zone has mild summers, fair monsoon during summer and relatively wet winter. Most of areas of Doda, Udampur, Ramban and Reasi districts (including Bhagwah, Baggar, Mahore, Gool and Pouni) are drought prone. The important vegetable crops that are being grown in these areas include Cucumber, potato, beans, tomato, garlic, bottlegourd, chillies, capsicum, onion, peas as single crop or intercrop with maize or okra. The farmers in areas like Assar, Baggar of Doda district, Basht, and Sudh Mahadev of Udampur district grow lots of off-season vegetables which fetch very remunerative prices. Similarly, beans and garlic are grown in potential pockets in Rajouri and Poonch.

3. Temperate zone

This zone includes all other areas of hill regions of Jammu Division which are located above 1500 meters altitude. Of special mention are the blocks of Warwan, Marwah, Dachhan, Chhatru, Paddar, Kishtwar, Thathri, Bhaderwah, Banihal, Mendhar, Manjakot, Bani, Basohli and some parts of Bhagwah, Assar, Gool-Gulabgarh, Mahore, Dudu-Basantgarh and Darhal. This zone is characterized by relatively mild but dry summer with little monsoon and fairly cold-wet winter. Most of areas are mono-cropped zone with low production and productivity. The potential pockets in this zone serve as natural green house for producing vegetables particularly peas, tomato, beans, cabbage, cauliflower, capsicum, cucumber at such a time when their availability is almost over.

Importance of Vegetables

Any part of herbaceous plant which can be used as culinary purpose is known as vegetable. Vegetables comprises of large number of plants mostly annuals besides some biennials and perennials of which different parts (seeds, roots and fruits) and immature parts (stems, leaves, flowers and succulent bulbs) are eaten. Vegetables cultivation assumes great significance because of various factors:

1. Most of the vegetables are short duration and fast growing and therefore, more crops can be raised from the same unit of land.
2. The yield potential and productivity of vegetables is very high (5 to 10 times more than many cereals).
3. Vegetables fit well in crop rotations, inter-cropping, multiple cropping, mixed and companion cropping.
4. They can be grown on small and marginal holdings.
5. Kitchen gardening of vegetables have been proved to be the most efficient system of utilizing the home wastes like organic residues and used water.
6. They can also be grown in neglected places where other crops may not be grown successfully like a backyard, roofs, corridors, verandahs, windows and partial shady places. Thus make a substantial contribution in meeting daily requirements and improving aesthetic values.
7. Vegetables growing make effective use of land and labour resources.
8. Vegetable growing provides opportunity for employment to rural poor since most of the operations are labour intensive and time bound.
9. Vegetables have vital role to play in economy and wellbeing of human beings
10. Vegetables provide vitamins, proteins, carbohydrates, minerals etc when consumed along with some cereals and thus to make a balance diet.

Vegetables are component of a balance diet. Vegetables are protective food and natural source of carbohydrates, proteins, fats, minerals, vitamins and fibre. Vegetables increase palatability of foods, eliminate acidity, provide valuable roughages and serve as cheapest source of protective elements. Every diet to be considered balanced should include at least 300g of different vegetables. They are important source of natural nutrients.

Nutritive constituents and source of vegetables

Constituent	Source
Carbohydrates	Tapioca, sweet potato, yams, colocasia, potato
Proteins	Peas and beans
Minerals	All green leafy vegetables, drumstick fruits
Vitamin A	Tomato, carrot, turnip, leafy vegetables, root vegetables like sweet potato, colocasia and pumpkin-yellow
Vitamin B	Peas and beans, garlic, colocasia, tomato, asparagus
Vitamin C	Green chillies, tomato, turnip, brussel's sprouts, drumstick leaves, cauliflower, cabbage, knol-khol, bitter-gourd, radish leaves and leafy vegetables
Chemical compounds having medicinal properties	Brassicac, onion, garlic etc

1. Tomato (*Solanum lycopersicum* L.)

Tomato is widely grown in all agroclimates of Jammu region. It is considered beneficial for health due to medicinal properties and role in reducing risk of cancer, particularly prostate and mouth cancer due to the presence of lycopene and carotene pigments that gives red colour to tomato.

Climate and soil

It is a warm season crop and highly susceptible to frost. A warm and sunny weather is most suited for its proper ripening, colour development and better quality. Fruit set and ripening are adversely affected in most of cultivars and hybrids when temperature is below 14°C or exceeds 32°C. Proper colour formation takes place at 26°C-32°C. It can be grown on all types of soils ranging from light sandy to heavy clay. But well-drained light soils (sandy loam to loam with pH 6.0 to 7.0) rich in organic matter are considered ideal.

Varieties

Pusa Ruby: Indeterminate, early to medium maturing variety (60-85 days) with attractive uniform ripening. Fruits are flattish round, small-medium, uniform red, slightly lobed (4-5 locules) and acidic. Yield potential: 120 q/acre.

Pusa-120: Semi - determinate, late maturing variety (130 days) with uniform ripening. Fruits are medium to large sized, flattish round and less acidic. It is tolerant to nematodes. Yield potential: 120-128 q/ acre.

Pusa Sheetal: Semi – determinate variety with light green foliage and medium maturity (90 days). Fruits are flattish round with yellow stem end, smooth, attractive, medium sized, red colour and uniform ripening. Plants are capable of fruit setting under low night temperature (around 8°C). It is suitable for early spring season. Average yield: 140 q/acre.

Pusa Early Dwarf: Determinate, early maturing variety (70-80 days) with good foliage. It bears medium sized flattish round fruits of uniform colour. Yield: 120 q/acre.

Arka Vikas: Fruits are medium large (80-90g), oblate with light green shoulder, which develop deep red color on ripening. It is suitable for fresh market. Adapted to both rain fed and irrigated conditions. Average yield is 140 q/ acre.

Arka Abha: Fruits are oblate with light green shoulder. It develops deep red colour on ripening. Average fruit weight is 75g. It is resistant to bacterial wilt caused by *Ralstonia solanacearum*. It is suitable for fresh market. Average yield is 172 q/ acre.

Arka Saurabh: Fruits are medium large (70-80 g), round with light green shoulder, deep red in colour, firm with nipple tip, Suitable for both fresh market and processing. Average yield is 120-128 q/ acre.

Arka Alok: Fruits are square round on lower cluster, large in size, firm with green shoulder, resistant to bacterial wilt. It is Suitable for fresh market. Average yield is 184 q/ acre.

Kashi Vishesh (DVRT-2): Determinate variety with dark green foliage. Fruits are medium to large sized, spherical and red. It is ready for first harvest at 70-75 days after transplanting and tolerant to TLCV. Average yield: 160-180 q/ acre.

Kashi Sharad: Plants are indeterminate, leaves are broad, fruits are attractive red, slightly oval, firm with thick pericarp, longer shelf life and avg. fruit weight is 90-95 g. Average yield is 160-200q/ acre.

HS-101: Plants are determinate, multi branched, fruits develop in clusters of 2-3, round, small to medium sized, red at ripening and suitable for winter season cultivation. Average yield is 100-110 q/ acre.

Pant Bahar: The plants are bushy and profusely branched. Fruits are flattish round, medium in size with 5-6 locules, slightly ridged and uniform red at maturity. First picking starts in 75-80 days after transplanting. Average yield is 100 q/ acre.

Pant T-3: The fruit weight is about 70 g. Fruits become uniform red at maturity. It is suitable for processing purpose. Average yield is 120 q/ acre.

Hisar Arun (Sel-7): Plants are determinate dwarf, erect, with cut leaf and synchronized clustered flowers, bear 15-20 fruits. Fruits are round, red, medium size (65-70 g), 4-6 locules with deep red flesh. First picking starts in 60-65 days after transplanting; gives an average of 60q/ acre and 114.8 q/ acre early and total yield respectively in 80-85 days of crop duration.

Hisar Lalit: It is a nematode resistant variety developed by CCSHAU, Hisar. It is derived from the cross HS101 x Resistant Bangalore. Plants are determinate and early maturing. Fruits are round and medium to large in size. It is suitable for cultivation in nematode infested areas.

Punjab Chhuhara: The plants are dwarf with dense foliage that protects fruit from sunburn. Fruits are pear shaped, small to medium sized, firm fleshy, less seedy and uniformly red at maturity. Yield potential: 140-160 q/ acre.

Sowing time

Zone/Areas	Nursery sowing time	Transplanting time
Sub-tropical zone	Mid December	End January to mid February
Intermediate (Mid hills) zone	February- March	March-April
Temperate (high hills) zone	March-April	April-May

Around 5 marla nursery is sufficient for transplanting in one hectare. Raise nursery of hybrids in Portrays only. In frost prone areas in sub-tropical zone, two crops can be taken. In irrigated plains/low hill regions, first transplanting is done

in January (after the frost is over) while in rain-fed areas transplanting is done around July (when the rains have set in). About 4-5 week old seedlings at 3- 4 leaf stage are considered ideal for transplanting.

Seed Rate

Open pollinated varieties: 200g/ acre

Spacing: 60 cm x 45 cm

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP)kg/acre	K ₂ O (MOP) kg/acre
10	48 (100)	24 (52.8)	24 (40.5)

Apply 10 tonnes of well rotten FYM and plough it into soil at least 20-30 days before transplanting. Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at 30 days interval after transplanting.

Irrigation

It should be so arranged that the soil remains evenly or moderately moist. Excessive irrigation is harmful since it induces wilting and dropping off the flowers. Irrigation needs to be given at every 3 to 4 days interval during summer season and 8-10 days interval during winter or as per need of the crop. Adequate moisture at flowering and fruiting stage is good for higher yields.

Interculture and weed control

Shallow hoeing should be done at regular intervals so as to keep the field free of weeds, facilitate soil aeration and ensure proper root development. The early stage of the crop is the critical period for weed competition. Two hoeings one each at 1st and 3rd fortnight after transplanting normally keep down the weeds that include *Trianthema portulacastrum* (Itsit), *Digeria arvensis* (Takla), *Amaranthus viridis* (Cholai) and *Portulaca oleracea* (Kulfa). Alternatively apply pendimethalin @ 1litre/acre or 0.75 litre/acre followed by one hoeing or metribuzin @ 0.3 kg/acre. These weedicides should be applied 3-4 days before transplanting on prepared beds.

Mulching

It can be done when the plants are 30-40 cm high in order to conserve soil moisture and keep fruits away from touching the soil so as to reduce losses due to fruit rot. It also helps in checking growth of weeds and reducing the incidence of blossom-end-rot and cracking.

Pruning and staking

All the side shoots are removed by pinching so that plant may use all its food and energy to develop its fruits. Plants can be loosely tied on horizontal staked 3-4 weeks after transplanting. Staking can also be done with any local material.

Harvesting

Tomato fruits may be harvested at various stages depending on distance of market. Pre-cooling of fruits to about 13°C to 15°C immediately after harvesting increases shelf life

Green stage: Suitable for distant markets when fruits are fully developed but are green.

Pink stage: Suitable for local markets when fruit is not fully ripe (some portion red or pink).

Ripe stage: Most suitable for home or table use when major portion of the fruit is red.

Full ripe stage: It is suited for processing when fruit develops red colour and turns soft.

Grading, packing and storage

After removing green, over ripe, rotten, injured and defective fruits, grading can be done into four grades Super A, Super, Fancy and Commercial. Packing should be done in bamboo baskets, plastic crates and polythene bags as per need and availability of packing material. Plastic crates and wooden boxes of various sizes are used for packing and long distance transportation. Mature green fruits can be stored at 10°C to 15°C for 30 days and ripe tomatoes at 4.5°C for 10 days under 85-90 per cent relative humidity.

Seed production

Tomato is a self pollinated crop and requires an isolation distance of 50 m for foundation seed and 25 m for certified /truthfully labeled seed production between two varieties. Field inspection and rouging for off types and diseased plants should be carried out at least 3 times, 1) Before flowering, 2) during lowering and fruit formation and 3) before harvesting. Common seed extraction methods include:

Fermentation method: The ripe fruits are crushed well by hand or by any mechanical method to make slurry in a non-metallic container (wooden or earthen pots) for 2-3 days at 24°C to 27°C. The entire material is kept as such till it ferments. When fermentation is completed it shows profuse foam formation on the upper surface of material and tomato flesh gets separated from seeds completely. The material should be stirred every morning and evening to avoid any fungal growth. The liquid is decanted off and seeds are washed at least 8 to 10 times with clean water. Seeds are spread thinly in the sun for drying.

Acid treatment method: Commercial grade hydrochloric acid @ 10 ml/1.4 kg of fruit pulp is sufficient to disintegrate mucilaginous material surrounding the seed. The seeds separate out from the pulp within half an hour. The pulp is then again stirred and washed thoroughly with clean water and seeds are allowed to dry in the sun.

Subsequently, drying of seeds can be done in the sun where 10-12 per cent moisture can be obtained easily. Drying can also be done with Drier where 7 or 8

per cent moisture content. Tomato seeds with 8-10 per cent moisture after treatment with suitable fungicide can be stored in appropriate moisture-vapor proof containers. Such seeds remain viable for about 2 years.

Physiological disorders

Blossom end rot: Water soaked spot or brown discoloration appears at the blossom-end or point of attachment. The spots enlarge and cover up to the considerable area of the fruit. It is due to reduced soil moisture. Due to water deficit conditions or damaged roots, cells at the blossom-end of the fruit fail to get adequate water which results in breakdown of the tissues and ultimately rotting of fruits. It can also occur due to calcium deficiency. It can be controlled by cultural operations that conserve soil moisture, frequent light irrigation and spraying Calcium ammonium nitrate can be used as the source of nitrogen in calcium deficient soils.

Fruit cracking: It is commonly observed in mature green and fully ripe fruits during rainy season. Fruits develop either radial or concentric type cracks and former is more damaging. Probable reasons include genetic factors, poor water management, and exposure to sun after pruning and boron deficiency. In order to reduce the incidence of radial cracking, use relatively less susceptible varieties (Sioux, Punjab Chuhara, Roma and Pusa Ruby), maintain sufficient soil moisture and harvest the fruits before full ripe stage. In case of boron deficiency, give 1st spray of borax (0.3 to 0.4 per cent) in nursery, 2nd at spray after 3 -4 weeks and 3rd after 5 -6 weeks of transplanting.

Flower drop and poor fruit-set: It is a commonly caused due to imbalanced nutrition and incorrect method or time of application; poor water management; temperature extremes (Night temperature below 13°C and day temperature above 32° C ; hot dry winds; and high light intensity during summer. Poor fruit set caused due to failure of pollination or fertilization, can be overcome by spraying 2, 4-D (@ 1 to 2 ppm) and urea (1 %) at flowering stage. Poor fruit set (if due to inadequate soil moisture) can be averted with regulated moisture supply.

Sun scalding: It is caused due to the exposure of fruits to the intense sunlight. Affected fruits show yellow patches which enlarge; and tissues get damaged//shrinkled. The affected fruits show burning effect. For control, avoid wider spacing and select varieties with dense foliage. .

Pocket or puffiness: The affected fruits are light in weight and feel soft. Sometimes, surface of fruit is flattened and locular cavities are large and partially filled with pulp and seeds. This disorder is sometimes due to high soil moisture or excess use of nitrogen. For control, avoid overwatering and use lower dose of nitrogen.

2. Brinjal (*Solanum melongena* L.)

It is the most common vegetable crop grown widely for its varied shape, size and colour of fruits. Because of wide adaptation, ease of cultivation and high yield, it is considered poor man's crop. Fruits are good source of minerals (calcium, phosphorus, iron) and vitamins (B group). Fruits possess cholesterol reducing properties due to the presence of higher amount of poly-unsaturated fatty acids in pulp and seeds.

Climate and soil

It is a warm season crop and requires a relatively long growing season with plenty of sunshine and moderate day temperature (21°-27°C). Extreme temperature (below 10°C and above 30°C) adversely affects fruit set. Warm and humid climate favours luxurious growth and cool climate restricts the growth. It can be grown in all types of soils. The soils that are well drained, fertile, organic matter rich, silt or clay loam soils are considered ideal.

Varieties

Long fruited

Pusa Purple Long: Early fruiting with purple colour, 20-25 cm long fruits, first picking 75-80 days after transplanting, average yield is 120q/acre.

Pant Samrat: It is a long fruited variety which produces dark purple medium to long fruits in clusters. Plants are tall (80-100 cm). Young leaves are purplish green. This variety possesses field resistance to bacterial wilt and phomopsis blight. First picking starts in 70 days after transplanting. Average yield is 120q/acre

Punjab Sadabahar: Fruits are long (20-25cm), black coloured with average yield of 120q/acre.

Pusa Kranti: Fruits are stocky, oblong, dark purple colour, first picking 80-85 days after sowing. Average yield is 140q/acre

Round fruited

Pusa Ankur: Fruits are small, round glossy purple and gives picking within 45-55 days under Jammu conditions.

Pusa Purple Round: Fruits are round, purple colour weighing about 400-500g. Resistant to little leaf, fruits are ready for harvesting after 80-90 days and average yield is 100-120q/ acre.

Pant Rituraj: It is a round fruited variety which produces purple coloured fruits slightly tapering towards the bottom. Young leaves are purplish green. It is suitable for planting both in winter and summer season. First picking starts in 60 days after transplanting. Average yield is 120 q/acre.

BR-112: Plants are bushy, fruits are round, bright purple in colour and fleshy. Average yield is 100 q/acre.

Hisar Shyamal: Fruits are round, bright and dark purple in colour. Average yield is 120-130q/ acre.

Small fruited

Pusa Purple Cluster: Purple pigmentation on stem and leaves. Fruits are 10-12 cm long, borne in clusters of 4-9. This variety possesses field resistance to bacterial wilt. First picking starts in 60-65 days after transplanting. Average yield is 100 q/a.

Sowing time

Zone	Seed sowing	Transplanting
Sub-tropical		
I st Crop	January	February
II nd Crop	February-March	March-April
III rd Crop	May	June
Intermediate (Low)	March-April	April-May
Intermediate (High)	March-April	April-May

Seed rate: 160-180 g/acre

Spacing

Round fruited cultivars: 90 x 90 cm

Long fruited cultivars: 60 x 45 cm

Manure and fertilizers

Prepare the land well in advance with 4-5 ploughings. Add well rotten FYM or compost @ 8-10t/ acre and level the field properly.

FYM (t/acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
8-10	40 (82.4)	24 (52.8)	12 (20.4)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses after taking two pickings.

Irrigation

It is a shallow rooted crop and needs irrigation at frequent interval. During summer, apply irrigation at 4-5 days interval and during winter at 10-15 days interval. Furrow method of irrigation is the most common method.

Interculture and weed control

Shallow hoeing should be done after first irrigation to remove weeds and conserve moisture. A total of 3-4 hoeings are needed to check weeds. Earthing up after top dressing of nitrogen is quite beneficial.

Harvesting and storage

Harvest fruits every week when they develop full size but still glossy and tender. For long distance transport, fruits should be harvested in evening hours

and thereafter cooled by sprinkling water. Normally, storage life of 2-3 weeks can be achieved when fruits are kept at 8°-10°C temperature and 85-90% RH. Packaging of fruits in paper molded trays followed by wrapping with cling film or perforated polythene bags improves shelf life and maintains quality for about one week.

Seed production

The cultural requirement of market and seed crop is same. Maintain an isolation distance of at least 200 meters between different varieties. Three inspections are done to rogue out disease and off type plants, 1) vegetative stage 2) flowering and fruiting and 3) before harvesting. Fruits are ready for harvesting when at least one third of the fruit part turns yellow in colour. The mature fruits are cut or crushed into small pieces. The seed along with fruit flesh is extracted with fingers. The seed is washed to free of food material (if any) by washing in tub filled with water. The fruit flesh floats over the surface of water and are removed by hand. The clean seed can be obtained by repeated washing in water. Seed should be dried immediately after washing.

3. Chilli (*Capsicum frutescens* L.)

Chilli or hot pepper is one of the most valuable cash crops. Its unripe pungent fruits are as table vegetable in salads and dry fruits as spice for pungency and red colour. Its pungency is due to capsaicin and oleoresin while red colour due to pigment capsanthin. Its fruits contain fair amount of vitamin (A & C), phosphorus and crude fibre.

Climate and soil

It performs well in warm and humid climate in tropical and subtropical regions. Ideal temperature for successful plant growth and fruit development is 20-35°C. Low temperature at fruit ripening stage delays colour development and frost is injurious. It can be grown in almost all types of soils ranging from sandy loam that are well drained to heavy clays rich in organic matter. The pH should be around 6.5-7.5. It can also tolerate salinity to a considerable extent.

Varieties

Pusa Jawala: Plant are dwarf, bushy, light green, fruits 9-10 cm long, light green, ripe fruits are light red, highly pungent, fairly tolerant to thrips and mites, Average yield is 34 q/acre (green) and 7.2 q/acre (dry).

Pusa Sadabahar: Plant are erect, perennial, 60-80 cm tall bushy, fruits 6-8 cm long, borne in clusters with 6-14 fruits per cluster, ripe fruits are dark red, highly pungent, resistant to CMV, TMV and leaf curl complex, First picking starts in 75-80 days after transplanting. Average yield is 38q/acre (green) and 8q/acre (dry).

Pant C-1: Fruits highly pungent, small in size, broader at the base, moderately resistant to mosaic and leaf curl virus. Average yield is 30q/acre (green) and 6q/acre (dry).

Punjab Lal: Plants are determinate, fruits are compact, dark green and pungent, suitable for long distance transport and requires 120-180 days for maturity. Average yield is 40-48 q/acre for fresh and 3.6-4.0 q/acre for dry fruits.

Sowing time

Zone		Seed sowing	Transplanting
Sub-tropical	I st Crop	November	January
	II nd Crop	February -March	March-April
	III rd Crop	May-June	June - July
Intermediate (Low)		March-April	April-May
Intermediate (High)		April-May	May-June.

Seed rate: 280-320 g/acre

Spacing: 45 x 30 cm

Manure and fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
10	40 (82.4)	24 (52.8)	12 (20.4)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at 21 and 42 days after transplanting.

Irrigation

Frequency depends upon soil conditions. First irrigation is given immediately after transplanting and subsequent after weekly interval during summer and 10-12 days interval during winter. Furrow method is the most common method of irrigation. Drip irrigation increases yield and saves about 40 % water.

Interculture and weed control

Hoing and weeding should be done at 1-2 week intervals to remove weeds and conserve moisture. A total of 3-4 hoeings are needed to check weeds. Earthing up after top dressing of nitrogen is quite beneficial. Alternatively, pre plant application of fluchoralin @ 0.4-0.6 kg a.i/acre followed by one hand weeding 30 days after transplanting is effective.

Harvesting

Harvesting of chillies depends upon the purpose for which crop is grown. More pickings should be done for green chillies. For dry chillies, one harvest of green chillies should be taken to stimulate further flush of flowering. Subsequently, ripe fruits are picked at an interval of 1-2 weeks. Harvesting continues depending upon variety and season for period of about 3 months. Keep the harvested fruits in heaps either indoor or in shade away from direct sunlight for 2-3 days to develop uniform red colour. Red ripe fruits are then dried in sun for 8-15 days.

Storage

Green chillies can be stored in the cold storage up to 40 days at 0°C and 95-98% relative humidity. The moisture content of the dry pods is to be kept at 8-10%.

Yield: 28-40 q/acre (Green) 6-10 q/acre (Dry)

Seed production

Chilli is an often cross pollinated crop and requires so minimum isolation distance of 400 m. between two varieties for seed production. The seed crop should be inspected at different stages to ensure the genetic purity. The 1st inspection should be done before flowering to remove off type and extra early plants; 2nd inspection at full bloom and fruiting stage to confirm the varietal purity such as fruit shape, colour, position of fruit, flower colour, plant spread and leaf characteristics like leaf colour and shape and 3rd just before fruit picking

for retaining only true to type plants for seed harvest. Red ripe fruits are harvested and dried under sun. The seeds are extracted manually on small scale and with axial-flow seed extractor on commercial scale.

Physiological disorder

Flower/Fruit drop: It may be caused due to low humidity, high temperature; low light intensity and short day conditions during early flowering stages. Irrigation at flowering and fruit set stage reduces blossom/fruit drop. Foliar application of 50 ppm NAA at full bloom stage is also effective.

4. Sweet Pepper (*Capsicum annuum* L.)

Sweet pepper or bell pepper is mostly consumed both in green matured and ripe form raw, in salads, cooked, mixed and stuffed vegetable. It is particularly rich in vitamin A and C thus acts as potential antioxidant.

Climate and Soil

It requires relatively cooler climate for growth and fruiting. A temperature ranging from 26-28°C during day time and 16-18°C at night is considered ideal. It is quite susceptible to frost. Extreme temperature (below 15°C and above 30°C) reduces growth and fruit set. Its cultivation under poly-tunnels or poly-houses is preferred. A well drained red loamy and alluvial soil with slightly acidic pH is considered ideal for sweet pepper cultivation. On sandy loam soils, it can be grown successfully with proper manuring and timely irrigation. The pH should be around 5.5-6.8.

Varieties

California Wonder: Plant are upright, fine flavoured with 3-4 distinct lobes, smooth, thick flesh, deep green, turns bright crimson at maturity, first picking occurs in 90-100 days after transplanting. Average yield is 68 q/acre.

Arka Mohini: Thick fleshed, 3-4 lobed dark green blocky fruits. Avg. fruit weight is 180-200g. Fruits are pendant which turn red at ripening. Average yield is 80 q/acre.

Arka Gaurav: Thick fleshed, 3-4 lobed dark green blocky fruits. Avg. fruit weight is 130-150 g. Fruits are erect which turn orange yellow at ripening. Average yield is 64 q/ acre.

Arka Basant: Thick fleshed, 2-3 lobed conical fruits. Avg. fruit weight is 50-80 g. Fruits are erect cream coloured which turn orange red at ripening. Average yield is 60 q/ acre.

Planting time

Zone	Seed sowing	Transplanting
Sub-tropical	End of October	Mid February

Seed rate: 120 g/acre

Spacing: 45 x 45 cm.

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10	48 (104)	28 (61.6)	12 (20.4)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses, at 21 and 42 days after transplanting.

Irrigation

Capsicum needs judicious irrigation for proper growth and yield. Frequent and heavy irrigations induce lanky growth and cause flower shedding and reduce yield. Critical stages of irrigation are flowering, fruiting and after periodical harvests. In winter season irrigation is applied at 12-15 days interval. Average consumptive use is 446 mm. Most adopted method of irrigation is furrow method and under poly house condition drip irrigation is beneficial.

Interculture and weed control

Around 3-4 shallow hoeings are needed to check the weeds growth. Earthing up after 25 days of transplanting (first top dressing of nitrogen) is quite beneficial. Alternatively, a pre plant application of fluchoralin @ 0.4-0.6 kg a.i/ acre followed by one hand weeding 30 days after transplanting can be used for weed control. Judicious pinching of flowers produces 8-10 big fruits of 90-100 g weight per plant. Also provide stake to plants to produce fruits free from blemishes.

Harvesting and Storage

The crop becomes ready for harvest in 2-3 months depending on variety, season and region. It can be done once in 10-12 days with 5-8 pickings. Pick up large sized fruits with an upward twist when they are still green, firm and crisp. Red and yellow varieties can be harvested at the onset of colour change. Keep fruits in shade and then cool. The fruits are wiped, cleaned, graded and packed in paper moulded or plastic trays and wrap with heat shrinkable or cling film. Alternatively, fruits are packed in wooden boxes, paper cartons or plastic crates. Fruits can be stored up to 14-21 days at 7°-10°C with high RH and for 40 days at 0°C and RH of 95-98% with minimum shrinkage.

Seed Production

Capsicum is an often cross pollinated crop and require so minimum isolation distance of 400 m. between two varieties for seed production. Field inspection and rouging for off types and diseased plants should be done at least three times, 1) before flowering 2) at flowering and 3) at mature fruit stage. Red ripe fruits are harvested and dried under sun. The seeds are extracted manually on small scale and with axial-flow seed extractor on commercial scale.

Physiological disorder

Flower/Fruit drop: It may be caused due to low humidity, high temperature; low light intensity and short day conditions during early flowering stages. Irrigation at flowering and fruit set stage reduces blossom/fruit drop. Foliar application of 50 ppm NAA at full bloom stage is also effective.

Skin cracking: Cracking occurs around the shoulder of the fruits. Fluctuations in temperature and humidity are responsible for this disorder. High day temperature and average relative humidity increase the incidence of cracking.

Sun scald: Soft, light coloured area appears on the fruit which becomes slightly

wrinkled, slightly sunken and papery later on. It occurs when the fruits are exposed to scorching sun light.

Blossom end rot: Water soaked spots appear at the blossom end which becomes light brown and papery as the lesions dry out. Heavy irrigation after a period of low soil moisture condition and heavy application of nitrogenous fertilizers causes this disorder. Judicious irrigation and nutrient management along with two foliar sprays of 0.2% calcium chloride at the time of fruit development is useful.

5. Potato (*Solanum tuberosum* L.)

Potato is a major source of carbohydrate. It is often used as a substitute for cereals and is grown in almost every country. It also contains essential nutrients like protein, minerals (Ca, P and Fe) vitamins (B1, B2, B6 & C) and amino acids like leucine, tryptophane and isoleucine.

Climate and soil

Potato is a cool season crop. At low temperature vegetative growth is restricted and at freezing point temperature irrecoverable frost injury occurs. Long days coupled with high temperature conditions promote vegetative growth without formation of tubers while short day with low temperature induce tuberization. It should be grown when maximum day temperatures are below 34°C and night temperatures are not above 20°C. Optimum temperature for good plant growth is 15-20°C. Most of the cultivars do not tuberize when the prevailing night temperature is above 21°C. It can be grown in all types of soils like alluvial, black, red and laterite having pH range of 6.5-7.5 and electrical conductivity (EC) below 0.5%. Alkaline or saline soils are not suitable for its cultivation.

Varieties

Early Maturing Group: (70-90 days)

Kufri Chandermukhi: Tubers are creamish white ovoid with shallow eyes. The variety is susceptible to major diseases; however it is suitable for processing also. Average yield is 80-100 q/ acre.

Kufri Lauvkar: Tubers are round, creamish white with medium deep eyes. This variety is suitable for processing when grown in warmer areas of central plains. This variety is tolerant to heat and susceptible to major diseases. Average yield is 8-100 q/ acre.

Kufri Pukhraj: Tubers are ovoid, yellow with medium deep eyes and develop faint purple colour on exposure to sun. This variety is resistant to early blight, moderately resistant to late blight and immune to wart. Early bulker and suitable for low input ecosystem. Average yield is 140-160 q/acre.

Kufri Ashoka: Tubers are ovoid, creamish white with medium deep eyes. This variety is susceptible to major potato diseases. Average yield is 100-120 q/acre.

Kufri Khyati: Tubers are ovoid, creamish white with medium deep eyes. This variety is moderately resistant to early and late blight. Early bulking variety suitable for high cropping intensity. Average yield is 100-120 q/acre.

Kufri Surya: Tubers are oblong, creamish white with shallow eyes. This variety is heat tolerant and can be grown in areas having night temperature above 20°C. Suitable for early planting in plains. Average yield is 80-120 q/acre.

Medium Maturing Group: (90-100 days)

Kufri Jyoti: Tubers are round, creamish white with shallow eyes. This variety is suitable for processing when grown in warmer areas of central plains. The variety carries moderate resistance to early and late blight. It is immune to wart, has wider adaptability and slow rate of degeneration. Average yield is 80-100 q/acre in hills and 120q/acre in plains.

Kufri Bahar: Tubers are ovoid creamish white with medium deep eyes. The variety is early bulking, immune to wart, tolerant to Gemini viruses and has a slow rate of degeneration. Average yield is 120-140 q/ acre.

Kufri Chipsona-1: Tubers are ovoid, creamish white with shallow eyes. The variety possesses resistance to late blight and is suitable for preparation of chips and French fries. Average yield is 120-140 q/ acre.

Kufri Arun: Tubers are ovoid, red with medium deep eyes. The variety possesses moderate resistance to late blight. Average yield is 120-140 q/ acre.

Kufri Pushkar: Tubers are ovoid, yellow with medium deep eyes. The variety possesses moderate resistance to late blight, resistance to early blight and immunity to wart. Average yield is 120-140 q/ acre.

Kufri Shailja: Tubers are ovoid, creamish white with medium deep eyes. The variety possesses moderate resistance to late blight. Average yield is 120-140 q/ acre.

Kufri Chipsona -3: Tubers are ovoid, creamish white with shallow eyes. The variety possesses resistance to late blight. The tubers have high dry matter, low reducing sugars and low phenols. Variety is highly suitable for making chips and French fries. Average yield is 120-140 q/ acre.

Kufri Himalini: Tubers are ovoid, creamish white with medium deep eyes. The variety possesses moderate resistance to late blight. Average yield is 120-140 q/acre.

Kufri Frysona: Tubers are oblong, creamish white with shallow eyes. The variety possesses field resistance to late blight and immunity to wart. The tubers have high dry matter, low reducing sugars and low phenols. First Indian variety suitable for making french fries. Average yield is 120-140 q/acre.

Kufri Girdhari: Tubers are ovoid, creamish white with shallow eyes. The variety possesses field resistance to late blight in foliage and tubers. Average yield is 120-140 q/ acre.

Late Maturing Group: (110-130 days)

Kufri Sindhuri: Tubers are medium in size, round in shape, red in colour with deep eyes. It is moderately resistant to early blight, tolerant to PLRV and has slow rate of degeneration. Suitable economic yield even under low fertility conditions. Average yield is 120-140 q/ acre.

Kufri Badshah: Tubers are ovoid, creamish white with shallow eyes. It is moderately resistant to early blight, late blight and resistant to potato virus X. Average yield is 120-140 q/ acre.

Sowing time:

Zone	Sowing time	Harvesting time
Sub-tropical		
Autumn crop	September- October	January- February
Spring crop	2 nd fort night of January	April –May
Intermediate (Low)	September	December-January
Intermediate (High)	April-May	September- October

Take out the whole tubers from cold storage 10-15 days before planting and keep in shady place under diffused light condition in thin layer on the floor to facilitate sprouting. Treat the seed tuber with mancozeb @ 4-5 g/ litre of water for 10 minutes. For treating one quintal of seed tubers, 50 litres solution is required and same solution can be used for 3-4 times after which fresh solution is to be prepared.

Seed rate

For Autumn Crop: 8-10 q/ acre

For Spring Crop: 6.5-8.0 q/ acre

Size: 30-35 g, 3-5 cm. diameter and with 2-3 sprouts.

Spacings

Spacing (cm)	Size (g)	Plant population/ha
60x15	35-40	1, 11, 000
60x20	40-50	83,000
60x25	50-55	67,000

Manure and fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
20	48 (100)	24 (52.8)	48 (81.6)

Apply whole of phosphorus and potash along with half of nitrogen at the time of planting. Rest of nitrogen should be top dressed in two split doses at 25-30 days after planting and 40 days after planting followed by earthing up.

In case of micro-nutrient deficiency, apply zinc sulphate @ 10 kg/ acre, sulphur @ 3.2 kg/ acre and borax @ 4.0 kg/ acre at the time of final land preparation.

Irrigation

Adequate irrigation is essential for proper growth and yield of potato. Stolon formation, tuber initiation and tuber development stages are the critical stages for irrigation. Give one light irrigation if necessary, before planting to ensure uniform germination. Irrigate the crop at an interval of 7-10 days after earthing

up. The level of irrigation water must not exceed 3/4th part of ridges. Total water requirement for the crop varies between 350-550 mm. Stop irrigation 10-15 days before harvesting the crop to allow the tuber skin to become firm.

Interculture and weed control

Earthing up is necessary in potato because proper development of tubers depends upon aeration, moisture availability and proper soil temperature. It also prevents greening of tubers. First earthing up is done 25-30 days after planting and second after 10 days of the first one. A double mould board plough or a ridger should be used for earthing up.

Pre-emergence application of pendimethalin @ 1.0 litre or isoproturon @ 0.5 kg or alachlor @ 2.0 litre per acre after the first irrigation but before the emergence of the crop is recommended for effective weed control.

Harvesting and storage

Harvest the crop when haulms start yellowing and falling on the ground. It is better to cut the haulms 10-15 days before harvesting when irrigation has been stopped. Apply chlorothalonil @ 2.5 g/litre of water on the cut portion of haulms. Harvest the crop manually with spade or mechanically with the help of 1-4 row potato diggers. Cure the harvested tubers under shade for 10-12 days for hardening. Discard cut, rotten, insect damaged and bruised tubers after harvest. As per market demand, grade the tubers into small (<25 g), medium (25-50 g), large (50-75 g) and extra large (>75 g) on the basis of their size. After grading pack them in gunny bags and keep in cool places till the produce is sent to market or cold stores. Store the table varieties in cold storage at a temperature of 2°-4°C and at 80-85% relative humidity. Store the processing varieties in cold storage at temperature of 10°-12°C and 80-85% relative humidity.

Seed tuber production

Healthy seed tubers, free from viral infection should be obtained and planted in autumn i.e. first week of October at a spacing of 50 x 15 cm. Rogue out unhealthy plants noticed during the growing season to ensure the production of better quality seed. Towards mid-December, irrigation may be restricted and later withheld completely so that the haulms wilt and fall down. As soon as there are 20 aphids per 100 leaves, cut the haulms. Allow the tubers to mature in soil for about 15 days. The harvested crop may be graded and moved to cold storage for planting in the following autumn season. A hectare of seed crop will produce enough seed for planting 8 hectares of the crop.

Physiological disorders

Uneven sprouting in field: This disorder happens due to: planting immediately after their removal from cold storage, soil moisture deficiency and untreated cut tuber pieces if infected by the fungus.

Control measures:

1. Held tubers in storage till end of dormancy period.
2. Treat the cut tuber pieces with 0.375% copper oxychloride M-45 for 10 min.
3. Place tubers somewhat deep, particularly in light soil with the cut surface facing downwards.

Dormancy: Dormant or even semi-dormant tubers do not sprout readily after planting causing delayed and erratic crop stand. This disorder becomes problem when two potatoes are taken in rotation and tubers produced in the hills are used as seed immediately after the harvest.

Control measures:

1. In advanced stage of dormancy, cutting of tubers may terminate dormancy.
2. Cut tuber pieces are immersed immediately in 1% thiourea solution for one hour and then plant them as soon as possible.

Greening: In field, tubers exposed to sunlight become green due to formation of chlorophyll pigment. Such tubers contain higher amount of glycoalkaloids like solanine and chaconine. The tubers become bitter in taste and non-edible.

Control measures:

1. Cover the exposed tubers with the field soil especially after severe rains.
2. Follow high ridge planting.
3. Choose varieties with profuse foliage.

Black or hollow heart: Insufficient availability of oxygen to the tubers is said to be one of the important factors causing black/ hollow heart disorder. The affected tubers have black discoloration in their central tissues, which later on get dried and form the cavities as hollow heart. Large sized tuber varieties are prone to this disorder.

Control measures:

1. Avoid excessive use of fertilizers, irrigations and planting at wider spacing because all these factors are favourable for the production of large sized tubers which are susceptible to hollow heart.
2. Apply irrigation at short interval so that the soil temperature may not exceed 32°C during tuber development and maturity.
3. Avoid raising temperature above 32°C during transit and storage of potato by avoiding piling and stacking too high and maintaining proper ventilation in the stores.

Insect-pest management in solanaceous vegetables (Tomato, brinjal, chilli, capsicum and potato)

Cutworm (<i>Agrostis</i> spp.)	
The damage is caused by caterpillars by cutting the plants in the nursery and during early stage of transplanting. Damage is caused during night. The caterpillars cut more plants than they actually feed.	<ol style="list-style-type: none"> 1. Irrigate the vegetable beds, collect the caterpillars from the standing water and destroy them. 2. Soil treatment before sowing by dusting of chlorpyrifos 1.5%D @ 8kg/acre or broadcasting of quinalphos 5G @ 8-10 kg/acre or cartap hydrochloride 4G @ 8-10 kg/acre.
Mealy bugs, <i>Phenacoccus solenopsis</i>	
Mealybugs are emerging insect pests found infesting on leaves, stems and fruits of tomato, brinjal and okra in Jammu region. They are covered with white wax, which makes them difficult to control. Both nymphs and adults suck the sap from leaves causing withering and yellowing of leaves. Heavy infestation can cause defoliation and even death of the plants.	<ol style="list-style-type: none"> 1. The crop residues in earlier infested fields should be removed and burnt. 2. Soil raking and field sanitation (free from weeds and debris) should be followed. 3. Spray chlorpyrifos 20 EC @ 2.5 ml/litre, oxydemeton methyl 25 EC @ 1 ml/litre, imidacloprid 17.8SL @ 0.3 ml/litre of water (in case of severe infestation) or malathion @ 2 ml/litre of water at 15 days intervals.
Whiteflies, <i>Bemesia tabaci</i>	
The adults and nymphs suck sap from the leaves of the host plants and reduce the vitality of crops. They often congregate on the underside of leaves act like vector for transmitting the tomato leaf curl virus in tomato. Severe stunting of plant with downward rolling, crinkling of leaves and severe chlorosis of newly formed leaves takes place. Older leaves become leathery and brittle in severe infestation of white flies.	<ol style="list-style-type: none"> 1. Seed treatment with imidacloprid 70 WG @ 5g per kg of seed to protect the crop from infestation up to 30-35 days. 2. Nursery crops should be covered with nylon net (200 mesh size) for 30 days. 3. Removal of weed hosts. 4. Use of delta traps or sticky traps @ 4/acre for effective catching of whiteflies. 5. Foliar spray of imidacloprid 17.8 SL (0.3 ml per litre) during the vegetative stage of the crop (before flowering) or root dip of tomato seedlings in imidacloprid @ 0.3 ml per litre of water for half an hour 6. Need based application of methyl demeton 25 EC @ 1ml or dimethoate (2ml/litre) after flowering.
Jassids (<i>Amrassca devastans</i>)	
Both nymphs and adults suck the sap from the leaves and cause shriveling of leaves. It is also a vector of virus diseases.	<ol style="list-style-type: none"> 1. Seed treatment with thiamethoxam 70 WS @ 5g/kg seed or imidacloprid 70 WG @ 5g @ /kg seed before sowing. 2. Use of delta traps or sticky traps @ 4/acre. 3. Foliar spray of imidacloprid 17.8 SL @ (0.3 ml/litre) during the vegetative stage of the

	<p>crop (before flowering)</p> <p>4. Spraying of methyl demeton 25EC @ 1 ml/litre or dimethoate 30 EC @ 2ml/litre or malathion 50 EC @ 2ml/litre after flowering.</p>
Aphids (<i>Aphis spp.</i>)	
<p>The damage is caused both by nymphs and adults, which suck the sap from leaves and the plants become sick.</p>	<ol style="list-style-type: none"> 1. Use yellow sticky traps @ 4/acre. 2. Spray 2 ml of malathion 50 EC per lit of water or imidacloprid 17.8 SL @ 0.3 ml /litre or of water or methyl demeton 25 EC@ 1 ml/litre or dimethoate 30 EC @ 2 ml/litre as and when the pest is noticed. If necessary, repeat the spray after 10-12 days.
Tomato leaf miner	
<p>Leaf miners cause heavy leaf mining on upper or lower side of the leaves.</p> <p>Mines starts From the margins of leaves and progress towards the base/centre of leaf. Severe leaf mining slows down the plant growth & accelerates the leaf drop.</p>	<ol style="list-style-type: none"> 1. Judicious application of nitrogenous fertilizers 2. Removal and destruction of infected leaves 3. Spraying with imidacloprid 17.8 SL @ 0.3 ml/lit of water during early stage of crop before flowering. 4. After flowering or in full bloom, spray dimethoate @ 2 ml per litre of water in case of severe infestation are found to be effective against leaf miner.
Fruit Borer (<i>Helicoverpa armigera</i>)	
<p>The caterpillars initially feed on leaves and later bore into the fruits making them unfit for consumption.</p>	<ol style="list-style-type: none"> 1. Deep summer ploughing to expose the hibernating pupa for sunlight and predation by birds 2. Planting one row of African marigold (40 days old) after 16 rows of tomato as a trap crop for luring the adults to oviposite 3. Installation of pheromone traps @ 2-3/acre for early detection and 5-6/acre for trapping and mass mating disruption. 4. Spraying of <i>Bacillus thuringiensis</i> powder @ 200g /acre in 240 litre of water. 5. Foliar spray Ha-NPV 100-200 LE/acre (1 ml/litre) freshly procured and mixed with 10 g/litre gur or jaggary and tinopal blue (1ml/litre) for 2-3 times at 12 days interval at evening hours. 6. Need based and alternative application of fenvalerate 20EC @ 1 ml/litre or deltamethrin 2.8EC @ 1 ml/litre of water followed by dimethoate (2 ml/litre of water).
Root knot nematode (<i>Meloidogyne spp.</i>)	
<p>Pest of brinjal, tomato, potato and other solanaceous plants. Due to</p>	<ol style="list-style-type: none"> 1. Follow crop rotation and grow marigold in nematode infested area.

the attack of nematodes the leaves turn yellow patchy. On roots knot like galls are formed.	2. Broadcast quinalphos 5G @ 8-10kg/acre or cartap hydrochloride 4G @ 8-10kg/acre at the time of last ploughing.
Snails	
The snails feed on leaves and stem, lives in cool moist shady and dampy places. Serious pest of vegetables in Batote area during summer and rainy seasons.	1. When sufficient number of snails are observed in the fields 2. Dusting of 1.5% metaldehyde or 20% metaldehyde liquid or 5% metaldehyde pellet or methiocarb 4% bait.
Slugs	
The slugs make irregular holes on the leaves and ripe fruits. They cause heavy damage when they attack the young plants.	1. When sufficient number of slugs are observed in the fields. Place 2-3% metaldehyde @ 0.6 kg/acre mixed with bran in small heaps when the soil is moist
Hadda Beetle (<i>Epilachna vigintioctopunctata</i> .) Both grubs and adults cause damage which feed on the epidermis of leaves. The leaves turn papery as the chlorophyll is destroyed.	1. Collection and destruction of eggs, grubs, and pupae from leaf surfaces 2. Spraying of acetamiprid 20 SP@ 0.3 ml/litre or malathion 5D @ 8-10 kg/acre.
Brinjal shoot and fruit borer (<i>Leucinodes orbonails</i>) The Cater pillers bore into shoots and fruits. The holes remain plugged with black excreta. The affected shoots drop and wither away. The attack is more severe during rainy seasons.	1. Regular clipping of the infested shoots and fruits and destroy them or buried in a pit 2. The moths can be mass trapped by installation of pheromone traps (Leucinlure) /Wota or water traps @ 40/acre at 10 m spacing after 15 days of transplantation. 3. Plant two lines of border row of soumf (Anise) /coriander for encouragement of natural enemy fauna for natural control 4. Spraying the crops alternatively with profenophos 50 EC @ 2 ml /litre of water and flubendiamide (0.2 ml or g/litre of water) or carbosulfan 25 EC@ 1ml/litre or methomyl 40 SP @ 2 g/litre at 15 days interval starting from 20 days after transplantation to control the brinjal shoot and fruit borer.
Brinjal stem borer (<i>Euzophera perticella</i>) (<i>Euzophera perticella</i>) Damage ic; done by newly hatched caterpillar. They feed on exposed parts of the plants for few minutes, later on they bore into the stem and moves down wards and feed on the pith hand make longitudinal tunnels as a result of which plants droop down and finally die.	1. Infested plants should be pulled out and destroyed by burning. 2. Avoid ratoon cropping 3. Application of neem cake @ 200 kg/acre or cartap hydrochloride 4G @ 8-10 kg/acre at the time of transplantation around the base of the plant.

Spider mite (<i>Tetranychus</i> spp.)	
Spider mites attack the leaves suck the cell sap and ultimately cause defoliation.	1. Acaricides like dicofol 18.5EC (2.5 ml/litre) and wettable sulphur (2 g/lit) or propargite 57EC @ 1.5-2 ml/litre of water gives effective control of red mites in brinjal.
Termites <i>Microterrnacs</i> spp.	
The worker class of the termite cause damage by feeding on the roots and the stem. The plants do not grow properly, wilt and soon dry up.	1. If attack is noticed in standing crop, apply chlorpyriphos 20EC @ 1.6 litres/acre with irrigation water
Thrips (<i>Scirtothrips dorsalis</i>)	
Both nymphs and adults scrap the tissues and suck the sap from leaves resulting into curling of leaves and stunted growth	1. Seed treatment with imidacloprid 70 WG @ 3-5g per kg seed. 2. In the field, foliar spray with imidacloprid 17.8 SL @ @ 0.3 ml/litre of water or fipronil 5FS @ 1.5 ml per liter or thiomethoxam @ 0.3 ml/litre of water before flowering. 3. Spraying of methyl demeton 25 EC @ 1.0 ml/litre or dimethoate 30 EC @ 2 ml/litre or malathion 50 EC @ 2.0 ml/litre during flowering and fruiting.
Chilli Yellow Mites	
Mites attack the leaves suck cell sap and cause ultimately defoliation.	1. Spraying of dicofol 18.5 EC @ 3 ml/litre or wettable sulphur @ 2 ml/litre or propargite 57 EC @ 4.0 ml/litre or vertimac 1.8 EC @ 0.3 ml/litre of water alternatively at an interval of 15 days. 2. Choose any two and spray alternatively.
Potato aphids (<i>Myzus persicae</i>)	1. Early sowing of crops (September and October beginning). 2. If 20 or more aphids have been observed on 100 compound leaves, spray dimethoate 30 EC @ 2 ml or methyl demeton 25 EC @ 1.0 ml/litre or malathion 50 EC @ 2 ml or imidacloprid 17.8 SL @ 0.3 ml/litre of water at 15 days interval.
Potato leaf hopper	1. Seed treatment with thiamethoxam 70 WS @ 5g/kg seed or imidacloprid 70 WG @ 5g/kg seed before sowing. 2. Use of delta traps or sticky traps @ 4/acre. 3. Foliar spray of imidacloprid 17.8 SL (0.3 ml/lit) during the vegetative stage of the crop (before flowering) 4. Spraying of methyl demeton 25 EC @ 1 ml/litre or dimethoate 30 EC @ 2 ml/litre or malathion 50 EC @ 2 ml/litre.

Potato tuber moth (<i>Gnorimoschema operculella</i>)	<ol style="list-style-type: none"> 1. Don't leave potato tubers exposed in the field. 2. Store potato in the godowns with 5-7mm thick layer of sand/ wheat/ paddy straw. 3. Keep the godown clean and fumigate with Methyl bromide @ 800g/1000cft. (Use under strict supervision only)
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Disease Management in Solanaceous Vegetables (Tomato, brinjal, chilli, capsicum and potato)

<p>Damping off (<i>Pythium Phytophthora, Fusarium, Rhizoctonia spp.</i>) Seedlings are killed at the pre and post emergence stages and diseased seedlings topple.</p>	<ol style="list-style-type: none"> 1. Partial sterilization of the soil may be done by burning 10-12 inch thick stack of farm trash on the nursery bed. 2. Treat well prepared nursery beds after adding manure with formalin (1 part formalin: 7 parts of water) and cover the treated beds with alkathene for 15-20 days before sowing. The seeds should be sown only when the soil becomes free from formalin vapours. About 5 litres of formaline solution is sufficient to drench 1 sq. mt. area. 3. Use the seeds treated with copper oxychloride (3g/kg seed) or <i>Trichoderma viride</i> @4g/kg of seed 4. Drench the nursery beds with metalaxyl (0.2%) at the initiation of damping off symptoms
Tomato	
Buck eye rot: (<i>Phytophthora nictianae var. parasitica.</i>)	
Brown spots with light and dark concentric zonations appear on green fruits.	<ol style="list-style-type: none"> 1. Adopt field sanitation, and crop rotation. 2. Use the treated seed 3. Give staking to tomato plants and prune out lower leaves upto 30 cm height just before onset of monsoon and apply one prophylactic spray with the metalaxyl (0.2%) 4. Collect rotten fruits and destroy them. Spray the crop with copper oxychloride (0.3%) at 10-15 days.
Septoria leaf blight: (<i>Septoria lycopersici</i>)	
Attack is earliest on older leaves. Small, circular and water soaked spots appear on the surface. On upper surface minute fungal fruiting bodies are seen. Disease spread from lower to upper leaves	<ol style="list-style-type: none"> 1. Seed treatment with copper oxychloride (3g/kg of seed) 2. Field sanitation 3. Crop rotation may be adopted

Early Blight: (<i>Alternaria solani</i>)	
In case of <i>Alternaria</i> diseases concentric or brown spots appear on leaves which induce yellowing. Fruits also show similar symptoms. While different types of small to medium light brown to dark spots appear on foliage, with other defoliating diseases resulting into premature leaf fall & exposure of fruits to sun burn.	<ol style="list-style-type: none"> 1. Get seed from healthy plants 2. Treat the seed with copper oxychloride (3g/kg of seed) or azoxystrobin @1g/kg of seed. 3. Spray the crop with copper oxychloride (0.3%) or azoxystrobin (0.1%) on appearance of diseases.
Bacterial wilt: (<i>Pseudomonas solanacearum</i>)	
Wilting, stunting, yellowing of foliage and finally the entire plant collapses. Vascular system becomes brown but roots are healthy.	<ol style="list-style-type: none"> 1. Follow 3 year crop rotation in infested field by including non-host crop. 2. Always transplant disease free seedlings.
Bacterial canker: (<i>Corynebacterium michiganensis</i>)	
Lower leaves wilt, on stem brown streaks and canker develop and small brown scabby lesions surrounded by white appear on fruit.	<ol style="list-style-type: none"> 1. Use disease free seed. 2. Follow 3 year crop rotation in infested field by including non host crop. 3. Remove diseased plants and destroy them.
Viral diseases (leaf curl, mosaic and tomato spotted wilt virus) Symptoms are self explanatory as per nomenclature terms used. In case of tomato spotted wilt, brown coloured markings on upper side of young leaflet and tender stem, followed by curling, stiffening. In severe cases, the plants wilt and wither.	<ol style="list-style-type: none"> 1. Always use virus free seedlings. Rogue out infected plants in early stages of infection and destroy them. 2. Remove reservoir hosts (weeds such as <i>Datura stramonium</i>). 3. Spray imidacloprid (0.3ml/litre) or thiomethoxom (0.03%) for vector control from nursery growing to pre-flowering stage in infested areal season. Use healthy seed for the control of mosaic. 4. Growing tomato nursery under insect proof net houses.
Brinjal	
Phomopsis blight (<i>Diaporthe vexans</i>): Brown lesions phomopsis vexan develop on leaves and shoots. Infected fruits show brown discoloration.	<ol style="list-style-type: none"> 1. Seed treatment with copper oxychloride (3g/kg seed) or azoxystrobin @1g/kg of seed. 2. Spraying with copper oxychloride (0.3%) or chlorothalonil @ 0.2%.
Phytophthora fruit rot (<i>Phytophthora parastica</i>): Fruit start rotting from the apical portion.	<ol style="list-style-type: none"> 1. Treat the seed before sowing with copper oxychloride (3g/kg seed) 2. Spray the crop with copper oxychloride (0.3%) 3. Collect and burn plant debris.
Little leaf (<i>Phytoplasma</i>)	
In infected plants, leaves are reduced to very small size resulting	<ol style="list-style-type: none"> 1. Eradication of infected crop plants 2. Spray malathion (2 ml/litre of water) starting

in stunted growth and bushy appearance; plants fail to bear any fruit. The disease is transmitted by leafhopper (<i>Hishimonus phycitis</i>)	with the appearance of leaf hopper to control their population
Chilli	
Die-back and fruit rot (<i>Colletotrichum capsici</i>)	
Necrosis of twigs from tip to backward. Black spots (fungal accrvali) are seen all over the affected surface. Circular spots on the fruit appear which become elliptical in shape. Rotting of the fruit starts in the field and may continue after harvesting in transit and storage.	Give a prophylactic spray of metalaxyl 0.2% (200g per 100 litre of water), Just before the onset of monsoon followed by spray with copper oxychloride @ 0.3% at 10-15 days interval.
Chilli wilt complex (<i>Fusarium, Phytophthora, Pseudomonas</i>)	
Disease is favoured by high soil moisture and poor drainage conditions. The wilt complex includes root rot, collar rot and true wilt symptoms with sudden death. The disease is in alarming proportions in certain season in traditionally chilli growing belts in temperate, intermediate as well as sub-tropical areas and results into complete failure of crops in certain belts. The wilt complex usually appears severe with the onset of monsoon when plants are in bearing state, indicating high sensitivity to high soil moisture. The chill wilt complex is usually confused with attack of foliar blights at later stages by the growers.	<ol style="list-style-type: none"> 1. Plant resistant/ tolerant varieties. 2. Give seed treatment with metalaxyl (2g/kg of seed) or copper oxychloride @ 3g/kg of seed. Raise the seedling in the nursery as discussed under tomato damping off. 3. Apparently healthy seedlings are dipped in solution of chlorothalonil 0.2 % + streptomycin (100 ppm) for 30 minutes before transplanting. 4. Transplant the seeding in well drained field and provide need based irrigation without allowing water stagnation. 5. In disease prone areas, the field/plot should be rotated with non solanaceous crops.
Leaf curl (chilli leaf curl virus)	
Curling and yellowing of leaves are the main symptoms of the disease stunting of the plants is observed.	It can be managed by spraying with any systemic insecticide.
Potato	
Early blight (<i>Alternaria solani</i>)	
Concentric rings appear on leaves resulting into necrosis of tissue and its defoliation. In severe infection, stems and tubers may also get infected.	<ol style="list-style-type: none"> 1. Tubers should be free from disease. Treat the tubers with copper oxychloride (3g/kg of seed) before sowing or azoxystrobin @ 1g/kg of seed. 2. Spray crop with copper oxychloride at 10-15 days interval or azoxystrobin @ 1ml/litre of

	seed.
	3. Follow high ridging to avoid tuber infection.
Late blight (<i>Phytophthora infestans</i>)	
Symptoms first appears on margin leaves as small brown patches which kill foliage in few days. Decaying crop under cloudy and wet Weather conditions often emits an offensive odour. In severe incidence whole of the field gives burnt appearance. The tubers are also infected.	<ol style="list-style-type: none"> 1. Collect potato tubers from disease free areal field and treat them. 2. Use disease resistant varieties. 3. Give one prophylactic spray 30-40 days after sowing with copper oxychloride @ 0.3%. Give at least one spray of 0.25% metalaxyl or iprovalicarb+propineb@4gm/litre of water on appearance of disease. Sprays may be given at 10 days interval depending upon weather conditions. 4. Follow high ridging and avoid over flooding/ irrigation during infection. 5. Trace out primary infection in field and try to remove infected leaves/plants in early stages to reduce primary inoculum before giving spray.
Leaf roll and mosaic	
Symptoms are evident on leaves of potato. Rolling of leaves, puckering, stunted growth are the main symptoms.	<ol style="list-style-type: none"> 1. Rouging out of infected plants from field should be done as soon as disease is detected 2. Dehaulm (removal of haulm) in third or fourth week of December when infestation starts. 3. Spraying of imidacloprid (0.3 ml/litre) to control insect vector (aphid).

6. Cucumber (*Cucumis sativus* L.)

Cucumber is one of the most popular cash vegetable crops and is widely cultivated in the Union Territory of J&K. It is a trailing or climbing annual, bearing elongated, thick cylindrical fruits of varying sizes and forms. The fruits and seeds have cooling effect and prevent constipation. The seed oil is also used as antipyretic.

Climate and soil

It is basically a warm season crop but is successfully grown in tropical, subtropical and temperate regions. Optimum temperature range for growth and development is 18-24°C. Seed germinate well at 25°C day temperature. Low temperature causes stunting of growth and poor germination of seeds. Long days and high temperature above 30°C increases the number of staminate flowers and reduce the number of female flowers in the vine. Cucumber thrives best in the soils ranging from sandy to heavy clays with good drainage system. For attaining early yields sandy loam soils are preferred where as heavy yields can be obtained from loam, silt loam and clay loam soils. It prefers a soil pH ranges between 6-7 and below 5.5 the cucumber cannot be grown.

Varieties

Japanese Long Green: It is an early yielding variety requiring 40-45 days only. The fruits are long (30-40 cm) and green skinned. The flesh is light green and crispy. Average yield is 46-50 q/ acre.

Straight Eight: It is also an early and short season variety with white skinned fruit which are medium long, thick straight and cylindrical with round ends. Average yield is 50-60 q/acre.

Poinsette: This variety is quite tolerant to downy mildew, anthracnose and angular leaf spot and mildly tolerant to Fusarium wilt. The fruit are dark green with blunt ends and matures in 50-60 days. Average yield is 50-60 q/acre.

Kheera Local: It matures in 40-50 days. The fruits are 20-25 cm long. Skin greenish yellow turns brown on maturity. The flesh is light green and crispy. Average yield is 40-50 q/acre.

Above varieties are most suited for subtropical and intermediate low zone areas only

Sowing time

Subtropical zone	Sowing time
Spring-Summer Crop	January (under protection), February-March (Open)
Rainy season Crop	June-July
Intermediate (low) zone	March
Intermediate (High) zone	April-May

Seed rate: 0.8-1.2 kg/ acre

Spacing:

Spring-Summer Crop	1.0-1.5 m x 60-90 cm
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Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10	16 (34.8)	10 (22.0)	10 (16.8)

Apply half nitrogen along with full P and K and farm yard manure as basal dressing and the remaining nitrogen should be top dressed in two split doses i.e. 25-30 days after sowing and 50-55 days after sowing.

Irrigation

Irrigation at regular intervals of 4-5 days is very important for spring summer crop. Irrigate the field subsequently at 5-6 days interval during summer season and as and when required during the rainy season. The crop must be irrigated during the critical stages i.e., flower bud development and early fruit development stages. Over irrigation during vegetative and early flowering stages may cause excessive vine growth resulting in more staminate flowers in the plant. Ridge and furrow method of irrigation is the best method.

Interculture and weed control

Pre-emergence application of fluchoralin @ 0.5 kg a.i/ acre followed by manual hoeing and weeding of young vine at regular intervals promote healthy growth and quality fruits and checks weed population effectively. When the vine start spreading, weeding may not be needed in between the rows or ridges, since the vine growth can smother the weeds.

Harvesting and storage

Fruits should be harvested at tender stage (8-12 cm). If the harvesting is delayed, dark green skin colour turns to brownish yellow. The cucumbers cannot withstand long duration transportation. They can be stored for two weeks at 10-11°C temperature with 92% relative humidity. It is better to consume the fruits fresh and immediately after removal from the storage.

Seed Production

Cucumber is highly cross pollinated crop and requires a minimum of 1000 meters from different varieties for producing true to type seed. Three inspections for rouging out off type and diseased plants are 1st before flowering, 2nd at flowering and fruiting and 3rd before harvesting. For seed crop, fruits should be picked when brown in colour. For extraction of seeds, the pulp of the fruit is taken out in fresh water. It is kept for one to two days to allow the seed to separate from the pulp. The seed is rubbed with hand. Heavy seeds settle down in water and are retained.

Physiological disorders

Preponderance of staminate flowers: The plants are monoecious in sex form hence staminate and pistillate flowers are borne separately in the same plant and the fruit yield depends upon the number of pistillate flowers. Preponderance of staminate flowers is caused due to Excessive nitrogen application; high temperature conditions; long day length; and over irrigation

Control measures

1. Avoid excess use of fertilizers and irrigation.
2. Apply nitrogenous fertilizer at proper dose.

7. Muskmelon (*Cucumis melo* L.)

Dessert types of muskmelons are consumed as fruits. Flesh inside varies from white to cream-yellow, orange or green. Most of the commercial types of musk melon contains significant amount of dietary fibres and potassium useful in lowering constipation and blood pressure. It is a good source of vitamin A and folic acid. It has refreshing effect during hot summer months. Good characteristics of muskmelon are thick skin, thick flesh with good consistency and flavour.

Climate and soil

It is predominantly a warm season crop but can resist the mild frosts. High temperature, sunlight and dry winds at the ripening stage result in better quality fruits. High humidity and rains lower the sugar content and facilitate the incidence of downy mildew. It requires an optimum temperature range of 70°-80°F with minimum of 65°F and maximum of 90°F. It grows well in soils ranging from sandy loam to clay loam which are friable and well drained. The crop is very susceptible to acidic soils where leaves develop yellowish green colour.

Varieties

Hara Madhu: The plant has vigorous growth. Fruits are large sized light yellow in colour with distinct green ribs and very sweet with 12-15% TSS. The variety is late in maturity (120-130 days) and lacks the slip stage. It has small seed cavity when ripe. Average yield is 50-60 q/ acre.

Pusa Madhuras: The fruits are somewhat flattened with green stripes, yellowish and smooth skinned. Flesh is orange, juicy and highly flavoured with TSS between 12-14%. Maturity is 100 days. Average yield is 48-64 q/ acre.

Punjab Sunehri: The vines are prolific, foliage dark green and average fruit weight is 700-800 g. Skin is brown in colour with intense tinge towards the rind. The crop matures in 90 days. Average yield is about 80-88 q/ acre.

Above varieties are most suited for subtropical and intermediate low zone areas only

Sowing time

Subtropical plains January-February

Spacing

Spring-summer crop: 2-2.5 m x 60-70 cm

River bed cultivation: 2-3 m x 1.0-1.5 m

Seed rate: 1.2- 2.0 kg/acre

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10-12	48 (104)	24 (52)	24 (39.8)

Whole of farm yard manure, phosphorus and potassium and $\frac{1}{3}$ rd of nitrogen should be applied in two parallel bands 45 cm apart on both the sides of the bed. Prepare channels in between the fertilizer bands. Rest of the nitrogen should be applied to the vines 3-4 weeks after germination prior to earthing-up.

Irrigation

During summer, irrigate the crop every week. The irrigation should be as light as possible. At the time of fruit maturity water should be given when it is very necessary. Over flooding should be avoided as the fruit on coming contact with moist soil gets spoiled.

Interculture and weed control

Hoeing and weeding keeps the soil loose and free from the weeds. In the beginning, cultivation can be fairly close of the plants and shallow (5-10 cm). When the vines cover the ground cultivation should be stopped and weeds should be pulled out by hands only. Pre emergence application of butachlor @ 0.8 kg *a.i./* acre and trifluralin @ 0.4-0.8 kg *a.i./*acre are effective to check weeds.

Harvesting and storage

Fruits should be harvested at slip stage (*i.e.* separation of fruits from vine) except in case of Hara Madhu where the fruits should be picked when it turns yellow, as it lacks the usual slip stage. During rains or wet period, the fruit should be provided with proper cushioning, to avoid fruit rot. Musk melon keeps well for one week at 1.5-3.0°C and 85-90% relative humidity.

Seed Production

Melons are highly cross pollinated crops and a minimum of 1000 m for foundation and 500 m for certified seed production is required to isolate them from different varieties of muskmelon and other crops like snapmelon (*Phoot*), longmelon (*Tar*) and other wild melons. Three inspections for rouging out off type and diseased, 1st before flowering, 2nd at flowering and fruiting and 3rd before harvesting of the seed crop, are required. The fruit gets easily detached from the vine at mature fruit stage (peak edibility) and must be examined for internal fruit characters and sweetness. The muskmelon fruits are cut into half and the seed is scooped out of the fruit and placed in non-corrosive metallic trough, earthen pot or plastic bag. The muskmelon seed is left for fermentation for 1-2 days. The seed mixture is washed with water to float off the placental debris and to get clean seed.

8. Watermelon (*Citrullus lanatus* Thanb.)

It is common man’s fruit, delicious, nourishing and exerts a cooling effect in hot summer months. It is a rich source of lycopene and beta carotene, the powerful antioxidants.

Climate and Soil

Watermelon requires a relatively hot dry climate and long growing season preferably with warmer days and cooler nights. It cannot withstand frost or very low temperatures. For seed germination optimum moisture and soil temperature between 25-30°C is needed. The plant growth is optimum under 28-30°C while the fruiting is better at 24-27°C. Higher temperatures are beneficial during ripening. Watermelon grows best and gives early yield in a well-drained sandy loam soil. Alluvial river beds are good for its cultivation. Heavier soils do not permit easy root growth and hence only short duration varieties with smaller fruits are suitable. A soil pH of 6.5-7 is ideal.

Varieties

Sugar Baby: It is a mid-season variety. Fruit weight is 3-4 kg with dark green strips. The flesh is deep red very small and matures in 95-100 days. It gives an average yield of 100-120 q/ acre.

Asahi Yamato: It is mid-season variety. The vines are medium with deeply cut lobed leaves. Fruits medium in size, 6-7 kg, round, pale green, smooth, non-stripped skin, flesh is deep red in colour, sweet, matures in 95-100 days. Average yield is 80 q/ acre.

Arka Manik: Fruits are oval with light green to green stripes with average fruit weight of 6.0 kg, excellent granular texture with TSS of 12-15%. Deep crimson flesh. The variety has triple resistance to anthracnose, powdery mildew and downy mildew. Average yield is 240q/ acre.

Above varieties are most suited for subtropical and intermediate low zone areas only

Sowing time

Sub-tropical zone Mid-January (Under protection) or Feb-March (open)

Intermediate low/ high zone March-April

Seed rate: 1.2-1.4 kg/ acre

Spacing: 2-25m x 60-75cm

Manure and fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P₂O₅ (DAP) kg/ acre	K₂O (MOP) kg/ acre
10-12	24(52.0)	16 (34.8)	16 (26.4)

Whole of farm yard manure, phosphorus and potassium and 1/2 of nitrogen should be given as basal dose and rest nitrogen should be top dressed in two split doses at the time of vining (20-30 DAS) and at blooming (45-50 DAS).

Irrigation

Watermelon responds very much to irrigation but it cannot with stand water logged conditions. Soil moisture stress during pre-flowering, flowering and fruit development stages drastically reduces the yield. The crop should be irrigated at 10-15 days interval during summers. Irrigation should be stopped during ripening as it adversely affects the fruit quality and promotes fruit cracking.

Interculture and weed control

In early stages, the beds and ridges should be kept weed free. 2-3 weedings are required and need to be started 20-25 days after sowing. In the beginning, cultivation can be fairly close of the plants and shallow (5-10 cm). When the vines cover the ground cultivation should be stopped and weeds should be pulled out by hands only. Pre emergence application of fluchoralin @0.8 kg a.i/acre or trifluralin @0.4-0.8 kg a.i/acre is effective to check weeds.

Harvesting and storage

Watermelon should be harvested at proper stage of maturity. The crop is ready for harvesting in 90-120 days after sowing depending up on the cultivar and the season. Average yield is 100-120q/acre. The fruit should be separated from the vine with the help of knife. Watermelons keep well for 1-3 weeks at 2.2-4°C and 80% relative humidity.

Seed Production

It is highly cross pollinated crops and a minimum of 1000 m for foundation and 500 m for certified seed production is required to isolate them from different varieties of muskmelon, volunteer plants of same crop and other crossable cultivated and wild species. Three inspections for rouging out off-type and diseased, 1st at vegetative stage, 2nd at flowering and fruiting and 3rd at fruit maturity are required. Watermelon seed is ready at its edible stage of maturity. Dryness of the tendrils at the point of attachment of fruit to the vine and change of belly colour from green to yellow are the other important criteria for judging the fruit maturity. The seeds are removed from the flesh, washed with water and dried in shade before packing.

9. Round Gourd/Indian Squash (TINDA) (*Citrullus vulgaris* var. *fistulosus* L.)

Climate and soil

Round gourd requires a warm weather, good sunshine, cloudless days and frost free area. It can be grown at a temperature between 25-30°C. It has relatively shorter growing season than the watermelon. It grows best and gives early yield in well drained loamy soils and properly drained heavy soils.

Varieties

Arka Tinda: It is an early season cultivar; the fruits are round, with light green skin, and soft hairs. The crop yields 8-10 picking and matures in 90-100 days. Average yield is 40q/ acre.

Tinda 48: Its vines are 75-100 cm long leaves are light green and deeply lobed, fruits are medium sized with average weight of 50 g each. Flesh is white. Average yield is 24-26 q/ acre.

Punjab Tinda-1: Early maturing variety suitable for sowing in spring season. Average fruit weight is 60 g. First picking starts 54 days after sowing. Average yield is 72q/ acre.

Above varieties are most suited for subtropical and intermediate low zone areas only

Sowing time

Sub tropical Zone	Sowing time	
Spring-Summer Crop	January (Under protection) or Feb-March (open)	
Intermediate Low & High	March-April	

Seed rate: 2.0-2.4 kg/ acre

Spacing: 1.5 m x 45 cm

Manure and Fertilizers

FYM (t/acre)	N (Urea)kg/acre	P ₂ O ₅ (DAP)kg/acre	K ₂ O (MOP) kg/acre
10	24 (52.0)	12 (26.4)	12 (20.0)

Apply whole of FYM, P₂O₅ and K₂O along with 1/2 N at the time of sowing. Remaining half dose of N may be applied 30 days after sowing.

Irrigation

The seeds are sown on the pre irrigated furrows on the top of the ridge on both sides of the bed. Subsequent irrigation is applied on the second or third day after sowing. During summer season irrigate the field after 4-5 days interval.

Interculture and weed control

Round gourd do not require much attention on inter culture. In early stages the beds and ridges should be kept weed free. Inter culture operation need to be started 15-20 days after sowing. In general 2-3 weedings are required.

Harvesting

Fruits are ready for first picking after 60 days of sowing. First fruits should be picked up as early as possible so as to facilitate further fruit setting. The other picking should be done when the fruits are medium in size and tender. Picking is done at 3-4 days interval.

10. Bottle Gourd (*Lagenaria siceraria* L.)

Climate and Soil

It is summer and rainy season crop. It can withstand cold climate but not the frost. Optimum temperature range for growth and development is 24°-27°C. A soil temperature of 18-22°C promotes good growth and ensures better yield. Short days, comparatively low night temperature and high relative humidity increase the intensity of pistillate flowers in the vine. It can be grown in all type of soils. But best growth occurs in soil having pH range of 6-7. Soil moisture is important for rapid growth and it should be at least 10-15% above the permanent wilting point.

Varieties

Pusa Summer Prolific Long: The fruits are long (40- 50cm) with medium girth (20-25cm). The skin colour is yellowish green. This variety is suitable for spring and summer seasons. Average Yield is 80-100 q/ acre.

Punjab Long: Tolerant to cucumber mosaic virus, vines vigorous, profusely branched, first picking starts 70-80 days after sowing, and average yield is 160 q / acre.

Punjab Komal: Tolerant to cucumber mosaic virus, early maturing, fruits light green, first picking starts 70 days after sowing, average yield is 200 q/ acre.

Pusa Summer Prolific Round: The fruits are green, round and 15-18 cm in girth. It is also suitable for summer and spring planting. Average yield is 80-100 q/ acre.

Punjab Round: The fruits are round and smaller in size and are born on the side branches. This variety responds well to fertilization. Average yield is 70-80 q/ acre.

Pant Loki 4: This is a medium duration and high yielding variety of bottle gourd. Fruits are green in colour with light stripes, having hairs, 40 cm long. Yield potential is 120 q/ acre.

Above varieties are most suited for subtropical and intermediate low zone areas only

Sowing time

Sub tropical zone: Mid February, June-July

Intermediate (low zone): March

Intermediate (High zone): April - May

Seed rate: 2.0 kg/ acre

Spacing: 2-2.5 x 75-90 cm

Manure and Fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
10	40 (80.0)	20 (44.0)	20 (34.0)

Full dose of FYM, P₂O₅, K₂O and 1/2 N should be applied at the time of sowing and the remaining N should be applied in two split doses at the time of vining (25-30 DAS) and at full blooming (50-60 DAS). Bottle gourd is comparatively shallow rooted crops hence responds well to top dressing. High nitrogen under high temperature conditions promotes staminate flowers resulting in low fruit set and yield. So fertilizer dose should be adjusted according to the season of cultivation.

Irrigation

During summer season the crop should be irrigated at 3-4 days intervals but in rainy season, one irrigation per week is sufficient, depending upon the occurrence of rain. The crop must be irrigated during the critical stages i.e., flowering and fruit setting. Over irrigation during vegetative and early flowering stages may cause excessive vine growth resulting in more staminate flowers in the vine.

Interculture and weed control

Weeds are quite competitive with crop especially in early stages. Frequent hoeing and weeding of young plants promote healthy growth and heavy fruiting. It should continue till the vines interfere with the normal field operations.

Harvesting and storage

The fruits generally take 12-15 days after fruit set to reach the marketable stage when the fruits are tender. These are harvested with knife by cutting the peduncle. Under normal cool and shady conditions fruits can be kept for 3-5 days. Proper stages of harvesting can be judged from fruit size, gentle press of finger penetrates the epidermis, plugging the fruit which shows fine tender flesh and quite immature seed and presence of hairs on the fruit. Under cold storage conditions, the fruits can be stored for 2-3 weeks at a temperature of 8-10°C.

Seed Production

The seed crop field must be isolated all around to a minimum distance of 800 metre from fields of other varieties of his crop. A minimum of three field inspections are required to produce true to type seed. The first inspection at vegetative stage, second at flowering and fruiting and third before harvesting of the fruits should be done to rogue out off type and diseased plants. The fruits turn green dull at seed harvest stage. The harvested fruits are dried and seed extracted, graded and packed in suitable containers.

11. Bitter Gourd (*Momordica charantia* L.)

Climate and soil

It is a warm season crop and can withstand cold better than the other cucurbits, but it is quite susceptible to extreme frost. Bitter gourd thrives best in warm humid regions. Temperature below 18°C causes poor germination of seeds, stunting of growth resulting in poor yield. Optimum temperature range for seed germination and growth and development is 25-30°C. Temperature above 36°C causes poor development of pistillate flowers leading to poor yield. Long days and high temperature increases the number of staminate flowers and reduces the number of pistillate flowers. The crop can be raised in almost all types of soils but sandy loam and silt loam soils are most preferred. Proper drainage of soil is quite essential. A pH range of 6.5-7 is ideal.

Varieties

Pusa Domausmi: The fruits are long 7-8 cm and green in colour. It is quite suitable for both summer and rainy season. It is prolific bearer and average yield is 40-52 q/ acre.

Punjab-14: Suitable for rainy and summer season, plant bushy and bear light green fruits weighing 35g, average yield 56 q/ acre.

Pusa Vishesh: Fruits are glossy green, thick, long in size, average fruit weight 120g first picking starts 55-60 days after sowing, gives an average yield of 60 q/ acre.

Kalyanpur Baramasi: Plants are vigorous, fruits are long (30-50cm), light green, thin, tapering, gives an average yield of 80 q/ acre in about 120 days of crop duration, tolerant to fruit fly and mosaic, suitable for *kharif* season.

Punjab Jhaar Karela-1: Fruits are attractive, green, tender, spindle shaped suitable for cooking by chopping. It is resistant to root knot nematode and viruses. Average yield is 34 q/ acre.

Above varieties are most suited for subtropical and intermediate low zone areas only

Sowing time

Sub Tropical zone January (Under protection), Mid- February, June-July (Open)

Intermediate (low zone) March

Intermediate (High zone) April-May

Seed rate: 2.0-2.2 kg/ acre

Spacing: 1.0-2.0 m x 75-90 cm

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10	40 (87.0)	20 (43.5)	20 (33.2)

Full dose of FYM, P₂O₅, K₂O and 1/2 N should be applied at the time of sowing and the remaining N should be applied in two split doses at the time of vining (25-30 DAS) and at full blooming (50-60 DAS). Bitter gourd is comparatively shallow rooted crops hence respond well to top dressing. High nitrogen under high temperature conditions promotes staminate flowers resulting in low fruit set and yield. So fertilizer dose should be adjusted according to the season of cultivation

Irrigation

It is shallow rooted crops and roots are mostly concentrated at the top 60 cm soil layer. First irrigation is given immediately after sowing. Critical stages of irrigation are flower bud development and early fruit development when irrigation is necessary. During summer, the crop should be irrigated at 3-4 days interval but during rainy season, one irrigation in a week is sufficient.

Interculture and weed control

Weeds are quite competitive with crop especially in early stages. Frequent hoeing and weeding of young plants promote healthy growth and heavy fruiting.

Harvesting and storage

The marketable fruits are bright green in colour during immature stage and with the passage of time the green colour fades to a slight whitish yellow or whitish green. First picking starts 65-70 days after sowing depending upon the variety, sowing time, soil type and management practices. Regular harvesting at shorter intervals increases the number of fruits in the vine and irregular harvesting may delay the successive fruit production. The harvested fruits cannot be kept for longer time in ambient conditions so needs to be sent to market as soon as possible. Sprinkle water over the fruits to maintain the freshness for sometime at initial stages. The fruits can be kept in poly propylene bags for extending the shelf life. The fruits can be stored in cold storage at 1-2°C and 85-90% relative humidity for four weeks.

Seed Production

To produce pure seed, off-type plants must be removed. The rouging should be done thrice i.e. at vegetative phase, at flowering stage and at fruiting stage. Isolation distance of 1000 m should be kept between different varieties. Keep one honey bee colony per acre to produce good seed yield. When the colour of the fruits turns dark yellow to orange, they should be harvested. The seed should be separated from fruits and pulp and should be cleaned and dried in shade.

12. Pumpkin (*Cucurbita moschata* L.)

Climate and soil

Pumpkin requires much longer growing season which is about 80 -100 days. It grows best at an optimum temperature of 20°C-25°C with minimum of 18°C and maximum of 30°C. The crop requires warm, frost free period of 120-140 days and can also withstand the cold. High temperature and long days help to increase the number of staminate flowers and reduce the number of pistillate flowers. Deep well drained loamy soils with pH range 6.0-7.0 are ideal for its cultivation. Ideal range of soil temperature for seed germination is 20°C-25°C. Seed germination is hampered at a soil temperature below 10°C and above 30°C. Soil moisture should be at least 10-15% above the permanent wilting point for proper growth and yield.

Varieties

Pusa Vishwas: Fruits are brown and spherical shaped weighing about 4 -5 kg with thick and golden yellow flesh. Mature in 120 days. Average Yield is 160-170q/ acre.

Azad Pumpkin-1: Fruits are green with medium broken white pattern and spherical shape. Average Yield is 180-200 q/ acre.

Arka Suryamukhi: The fruits are small, round with flat ends and rind colours deep orange yellow. It has excellent flavour, firm texture and bright orange flesh colour. Average yield is 120-136q/ acre.

Arka Chandan: The fruits are round, medium sized and rind colour is light brown. It has excellent flavor, firm texture and bright orange flesh colour. Average fruit weight is 2-3 kg. Average yield is 140-160q/ acre.

Punjab Samrat: Fruits are medium in size, nearly round. Flesh is thick and golden yellow. It is early in maturity. Average yield is 165q/ acre.

Above varieties are most suited for subtropical and intermediate low zone areas only

Sowing time

Sub Tropical zone: January (Under protection);
February-March (open)
June-July (Dry Land)

Intermediate (low zone): March

Intermediate (High zone): April - May

Seed rate: 2 kg/ acre

Spacing: 2-2.5 x 75-90 cm

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10	40 (80.0)	20 (44.0)	10 (17.2)

Full dose of FYM, P₂O₅, K₂O and 1/2 N should be applied at the time of sowing and the remaining N should be applied in two split doses at the time of vining (25-30 DAS) and at full blooming (55-60 DAS). High nitrogen under high temperature conditions promotes staminate flowers resulting in low fruit set and yield. So fertilizer dose should be adjusted according to the season of cultivation.

Irrigation

The crop must be irrigated during the critical stages *i.e.* flowering and fruit setting stages. In summer season irrigation can be applied at an interval of 5-6 days and in rainy season one irrigation per week is sufficient. Excessive irrigation at fruit maturity stage adversely affects the storage of fruits.

Interculture and weed control

Two shallow hoeings and weedings of young vines promote healthy growth and heavy fruit formation. Pre-emergence application of alachlor @ 1.0 kg a.i / acre is done to check weed population.

Harvesting and Storage

At full maturity rind colour of the fruits turn brown or reddish brown from green and peduncle either dries up or separates from the fruits. It matures in 160-220 days after sowing depending upon the variety and season of cultivation. Fruits can be kept for 2-4 months without any damage at room temperature. However, the fruits should not be kept in heaps. The fruits can be kept for 6 months at 10-12°C temperature with 70-75% relative humidity conditions.

Seed Production

Pumpkin is highly cross pollinated crop. Maintain isolation distance of 1000 metre for foundation and 500 metres from other varieties for certified seed production. Off type and diseased plants should be roughed out at vegetative, flowering and fruiting stages. When skin of the fruits turn hard and attain yellow brown colour fruits become ready for harvesting and seed extraction done. Then clean, grade and dry the seed to 8% moisture before storage.

13. Sponge Gourd and Ridge Gourd (*Luffa cylindrica* L. and *Luffa acutangula* L.)

Climate and soil

Both these gourds are warm season crops but can also withstand the cold. The fruits of sponge gourd are smooth whereas the fruits of ridge gourd possess sharp ridges. These grow best at a temperature of 25-30°C. Well drained loamy soil with good amount of organic matter is preferred. Soil having pH of 6-7.5 is ideal.

Varieties

Sponge gourd

Pusa Chikni: It is an early variety and flowers in about 45 days both in spring and summer seasons. Average yield is 40-48 q/ acre.

Pusa Supriya: Fruits are pale green, non-hairy, suitable for spring, summer and rainy seasons; first picking on 50-53 days during summer and 45 days during rainy season gives an average yield of 56-60q/ acre.

Ridge gourd

Pusa Nasadar: It is an early variety and flowers in about 65 days both in spring and summer. The fruits are ridged and light green, the flesh is yellow with firm texture and good flavour. Average yield is 40-44 q/ acre.

Swarna Manjari: Fruits are highly ridged, green and soft, pulps contain less fibre, tolerant to powdery mildew; first picking starts on 65-70 days after sowing; gives an average yield of 72-80q/ acre in 140-150 days of crop duration.

Swarn Uphar: Fruits are medium sized (200g) weak ridge with soft pulp and less fibre, first picking starts on 65-70 days sowing; gives yield of 80-120q/ acre in 140-150 days of crop duration.

Pant Tori-I: Vines are 5.0m long bearing 5 cm long & club shaped fruits, first picking after 65 days of sowing; average yield 40q/ acre; more suitable for rainy season cultivation.

Above varieties are most suited for subtropical and intermediate low zone areas only

Sowing time

Sub Tropical zone	January (Under protection); February-March (Open) June-July (Dry Land)
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Intermediate (low zone)	March
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Intermediate (High zone)	April - May
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Seed rate: 2.0 kg/ acre

Spacing: 1.5-2.5 x 75-90 cm

Manure and Fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
10	16 (34.8)	12 (26.0)	12 (20.0)

Apply full dose of FYM along with, P₂O₅, K₂O and ½ N at the time of sowing and remaining N should be applied in 2 split doses at 30 and 60 days after planting.

Irrigation

In summer season irrigation can be applied at an interval of 5-6 days and in rainy season one irrigation per week is sufficient.

Interculture and weed control

Hand weeding should be done 15-20 days after sowing and later on second weeding may be done 25-30 days after the first.

Harvesting and storage

The crops should be harvested when the fruits are still immature and after harvesting fruits should be kept at cool places. Gourds are of highly perishable nature and cannot be transferred to distant markets under ordinary packing. Fruit harvested at the marketable stage can stand 3-4 days in a cool place without any adverse effects. The fruits can be stored for 1-2 weeks at 7-10°C with 90-95% relative humidity.

Seed Production

The minimum isolation distance of 1000 m between two varieties of sponge gourd or that of ridge gourd is required. The undesirable or off-type plants are removed at vegetative stage, during flowering, fruiting and maturity stages. For seed crop, fruits are allowed to mature physiologically on plant itself. Seeds are extracted when fruits are dry and seeds rattle inside the shell. Subsequently, seeds are cleaned, cleaned and stored

14. Pointed Gourd and Ivy Gourd (*Trichosanthes dioica* Roxb. and *Coccinia indica* L.)

Climate and Soil

Both these gourds prefer warm and humid climate. They remain dormant during winter. They grow best in sandy loam and are not adapted to heavy soils. Both require good drainage and are susceptible to water logging

Varieties

Only local cultivars or farmer varieties can be grown.

Planting method

Both are propagated by stem cuttings. In case of pointed gourd (parwal), 60cm long stem cutting from one year fruiting vines of both male and female plants are prepared in the month of October and placed in sand medium for root development. The cuttings are ready for transplanting in two-three months and planted either by straight vine method or by ring method. Only 800-1000 cuttings are required per acre. In ivy gourd (kundru), 12-15 cm stem cuttings of pencil thickness with 5-6 leaves are taken and planted in basins of 60cm diameter, dug 175 cm apart. About 2-3 stem cuttings are transplanted 3 cm deep in each basin. Planting is done between July-February. Vines are trailed on bowers. About 10 percent male cuttings are sufficient to pollinate female plants in one hectare and about 3200 cuttings are planted in one acre.

Manure and Fertilizers

Pointed Gourd (Parwal)

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
6-8	8(18.0)	16(18.0)	8(12.0)

Ivy Gourd (Kundru)

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
8	8(18.0)	16(18.0)	8(12.0)

Interculture and weed control

Manual hoeing and weeding should be done during initial stages carefully. Later-on, pulling of big weeds from the trailing vines is possible.

Training

Plants should be trained on bowers for effective growth and development of the plant as well as easiness in harvesting of the fruits.

Harvesting

Pointed gourd: 40-48q/ acre

Ivy Gourd: 28-32q/ acre

Insect pest management in cucurbits

Red Pumpkin beetle	Spraying of acetamiprid 20 WP @ 0.2 g/litre of water
Jassids and Aphids	Spray dimethoate 30 EC @ 2 ml or methyl demeton 25 EC @ 1.0 ml/litre or malathion 50 EC @ 2 ml or imidacloprid 17.8 SL @ 0.3 ml/ lit of water at 15 days interval.
Fruit flies (<i>Bactrocera cucurbitae</i> , <i>B. tau</i> and others <i>Bactrocera</i> spp.)	1. Installation of methyl eugenol traps @ 2-4/acre or increase its number as required. 2. Spray malathion @ 1ml + 10g gur/litre of water at evening hours when fruit flies are congregated on leaf surface

Disease Management in cucurbits

Powdery mildew: (<i>Sphaerotheca fuliginea</i> and <i>Erysiphe cichoracearum</i>)	
Disease can be identified by appearance of small white patches on the leaves which later on spread to cover whole plant with white floury mass on stem, tendril and even fruits resulting into low yield and poor quality and sun burnt fruits.	1. Spray triadimefon (1g/litre) of water) or wettable sulphur @ 0.2% in morning and evening to avoid sulphur injury. Repeat the spray at 7-10 days interval if disease incidence is high.
Downy mildew (<i>Pseudoperonospora cubensis</i>)	
The disease is more destructive on muskmelon and cucumber during April- May in the irrigated plain and river bed areas. The disease is recognized by presence of yellow spots on upper surface of leaves and purple to brown on the corresponding lower sides with white downy growth. Leaves wither off prematurely resulting into low, poor quality and sun-burnt fruits.	1. On the appearance of disease spray the crop with copper fungicide 0.3% (300g/100 litre of water) or chlorothalonil (2g/litre of water) or combination of iprovalicarb + propineb @ 3g/litre of water. Repeat at weekly interval keeping in view the wet weather condition. Thorough spraying is needed in ensuring coverage of the under surface of leaves as well. Collect seed from diseased free fruit.
Anthracoise (<i>Collectotrichum lagenarium</i>)	
It causes dark brown lesions on leaves, fruit stem and fruit in some cucurbits like bottle gourd and melons.	1. Clean Cultivation 2. Early sowing of the crop 3. Spray the crop with copper oxychloride @ 0.3% or azoxystrobin @0.1%.
Fruit rot (<i>Pythium</i> sp., <i>Fusarium</i> sp., <i>Phytophthora</i> sp. or <i>Rhizoctonia</i>): Fruits in contact with wet soil develop soft rot.	1. Avoid contact of fruit with soil. 2. Don't delay harvesting of first ripened fruit 3. Irrigation may be given in trenches around the root zone only

15. Bhindi/Okra (*Abelmoschus esculentus* *Moench*)

Ookra is an important annual vegetable crop in tropical and subtropical parts of the world. It is mainly used for its tender green fruits as vegetable. It is a rich source of iodine, calcium, sulfur and sodium. Its tender fruits also contains vitamin-A, C, thiamine and riboflavin. Besides it also has dietary fibres, proteins and carbohydrates.

Climate and Soil

It is basically a hot weather crop and thrives well during hot and humid climatic condition. It can be successfully grown under the temperature ranging between 25-30°C. It is susceptible to draught, frost and low night temperature. Day temperature more than 42°C causes flower drop. Optimum temperature range for seed germination is 25-35°C and seed do not germinate below 17°C. Adequate sun shine is very important for growth and yield of the crop. It can be grown in wide range of soil, sandy to clay loam with enough organic matter and having good drainage facility however, loose, friable, well manured loamy soils with a pH range of 6.0-6.8 are best for its cultivation. Water logging is harmful for the crop.

Varieties

Jammu Okra-05: The variety is developed by SKUAST-Jammu during 2017. The variety is medium in height (80-90cm) with small intermodal distance. Fruits are dark green having 5 ridges, 8-12cm long. Plants bear 25-30 fruits with average fruit weight of 10-15g. The variety shows field resistant against YVMV and fruit borer and recommended for sowing under spring-summer and rainy season under Jammu conditions. Average yield is 48-60q/ acre.

Pusa Sawani: Fruits are smooth with 5 ridges, dark green and 18-20 cm long when fully developed. It is distinguished by the presence of a purple patch at the base of the yellow petal on both the sides. It is suitable for cultivation in spring - summer season in plains. Average yield is 60-70q / acre.

Pusa A-4: Fruits are smooth, dark green and 12-15 cm. long when fully developed. It is tolerant to YVM and aphids. First picking starts in 45 days. Average yield is 56q/ acre.

Arka Anamika: Fruits are lush dark green, tender and long, free from spines, having 5-6 ridges with delicate aroma. Possesses good keeping and cooking qualities. Field tolerant to YVMV. Average yield is 80q/ acre.

Varsha Uphar: Plants are medium tall, suitable for rainy season cultivation, fruiting starts on third/fourth node, resistant to YVMV. Average yield is 36-40q/ acre.

Hisar Unnat: Suitable for rainy season cultivation, fruiting starts on third/fourth node, resistant to YVMV. Average yield is 40-44q/ acre.

Hisar Naveen: Suitable for rainy season cultivation, high yielding variety, tolerant to YVMV. Average yield is 44-48q/ acre.

Sowing

Zone	Sowing time
Sub-tropical	February- March (Spring-summer crop) June - July (Rainy season crop)
Intermediate (low)	March - May
Intermediate (high)	April - May

Seed sowing

Soak the seed overnight in water for better germination. Soaking the seed in 0.3% copper oxychloride overnight protect the seedlings from wilt.

Seed rate

For Spring- Summer Crop: 8-10 kg/ acre
For Rainy Season Crop: 4.8-6.0 kg/ acre

Spacing

Spring - summer Crop: 45 x 30 cm
Rainy season Crop: 60 x 45 cm

Manure and fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
10	40 (82.0)	24 (52.8)	24 (40.8)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses, at 30 days after sowing and at flowering.

For the ratoon crop, same nutrient schedule is followed and basal dressing should be done immediately after pruning followed by irrigation and plant protection measures.

In spring summer season, application of N in splits after every 3-4 pickings increases the crop duration and yield.

Irrigation

Seed should be sown in optimum moisture conditions. Apply water at the initiation of first true leaf during spring-summer and at its expansion during rainy season. Irrigate the field subsequently at 5-6 days intervals during summer and as and when required in rainy season crop. The crop must be irrigated during its most critical stages i.e. flowering and fruit setting stages. However, over irrigation should be avoided as it causes wilting.

Intercultural operations

3-4 hoeings/weedings are required. The first hoeing may be given when the seedlings are two weeks are old and subsequent hoeing at fortnightly intervals.

Weed control

Apply fluchoralin 48 EC @ 0.6 kg a.i/ acre as pre-sowing soil incorporation or pendimelhalin @ 0.3 kg a.i/ acre as post sowing and pre-emergence soil surface spray. The surface application of these herbicides is effective for 4-5 weeks.

Harvesting and storage

First harvesting is generally done 40-50 days after sowing depending on the variety. Harvest the tender fruits by bending the pedicel with a jerk or with the help of a knife at every alternate day. Use cotton cloth gloves to protect fingers and harvest in the morning for local market and in late evening for distant markets. For local markets pre-cool the fruits by dipping in cold water and fill in jute bags or baskets and sprinkle water on them. For distant markets the pre-cooled fruits of graded size are packed in perforated paper cartons. The fruits can be stored at 7-9°C temperature and 80-90% relative humidity for 7-10 days.

Seed Production

Okra is often cross pollinated crop and requires a minimum isolation distance of 200 meter between two cultivars for seed production purpose. To have true to type seed, first inspection is done before flowering, second at flowering and fruiting and third before harvesting of the crop for removing off type and diseased plants. The seed crop matures in 90-100 days. The pods are picked 3-4 times due to uneven maturity. The harvested pods are dried in the sun threshed and the seeds are cleaned.

Insect-pest management in bhindi/okra

Maggots and White grubs	1. Broadcasting of quinalphos 5G @ 8-10kg/acre at the time of sowing or cartap hydrochloride 4G @ 8-10 kg/acre at the time of land preparation.
Jassids	1. Seed treatment with thiamethoxam 70WS @ 3g/kg seed or imidacloprid 70WG @ 5g/kg seed before sowing. 2. Use of delta traps or sticky traps @ 4 /acre 3. Foliar Spray of imidacloprid 17.8SL (0.3ml/litre) during the vegetative stage of the crop (before flowering) 4. Spraying of methyl demeton 25 EC @ 1 ml/litre or dimethoate 30 EC@ 2 ml/lit or malathion 50 EC @ 2 ml/litre of water after flowering.
Aphids	1. Use Yellow sticky traps @ 4/acre 2. Spray 2 ml of malathion 50 EC per litre of water or imidacloprid 17.8 SL @ 0.3 ml/litre or of water or methyl demeton 25 EC@ 1 ml/litre or dimethoate 30 EC @ 2ml/litre as and when the pest is noticed. If necessary, repeat the spray after 10-12 days.
Shoot and Fruit borer (<i>Earias</i> spp.)	1. Installation of Erviture @ 5-6 /acre for mass trapping of spotted bollworm on bhendi. 2. Cypermethrin @ 1 ml/litre or malathion 50 EC@ 2 ml/litre of water or methomyl 40 SP@ 2 g/litre of water or spinosad 45SC @0.2ml/litre of water.

	3. All the consumable fruits should be picked before spraying.
Red cotton bug	Spraying of acetamiprid 20 SP @ 0.2 g/litre of water or imidacloprid 17.8 SL@ 0.3 ml/litre of water or thiamethoxam 25 WG @ 0.25 g/litre of water.
White flies (<i>Aleurolobus spp.</i>)	<ol style="list-style-type: none"> 1. Seed treatment with imidacloprid 70 WG @ 3g/kg of seed to protect the crop from infestation up to 30-35 days. 2. Nursery crops should be covered with nylon net (200 mesh size) for 30 days. 3. Removal of weed hosts. 4. Use of delta traps or sticky traps @ 4/acre for effective catching of whiteflies 5. Foliar spray of imidacloprid 17.8 SL@ (0.3 ml/litre of water) during the vegetative stage of the crop (before flowering) or root dip of tomato seedlings in imidacloprid 70 WG@ 3 g per lit of water for half an hour. 6. Need based application of methyl demeton 25 EC@ 1ml or dimethoate 30 EC (2ml/litre of water) after flowering.
Blister beetle (<i>Mylabris postulate</i>)	<ol style="list-style-type: none"> 1. Hand picking and destruction 2. Spray quinalphos 25 EC@(0.03%) at evening hours

Disease Management in bhindi/okra

<p>Seed/Seedling rot: (<i>Fusarium spp.</i>, <i>Rhizoctonia spp.</i> and <i>Phytophthora spp.</i>) Rotting of seeds result into failure of germination or pre-emergence death. Emerged seedlings exhibit dark brown rotting of roots and collar portion with sudden or protracted death or decline.</p>	<ol style="list-style-type: none"> 1. Use of healthy and disease free seeds. 2. Management as mentioned in damping off of tomato.
<p>Yellow Vein Mosaic: (<i>Leaf vein mosaic</i>) Leaf veins turn yellow, with leaf lamina light green. Later on, the whole leaf may turn yellow resulting into stunted growth and reduced setting of fruits which are usually yellowish white in colour. The virus is transmitted by white fly (<i>Bemisia tabaci</i>). The disease is more severe in rainy season crop than summer crop.</p>	<ol style="list-style-type: none"> 1. Use resistant/tolerant Varieties especially for the rainy season. 2. Spray the crop if needed. With imidacloprid Spraying of acetamiprid 20 SP @ 0.2 g/litre of water or imidacloprid 17.8 SL @ 0.03%, especially before fruiting starts in order to check the vector population and rogue out infected plants in early stages.

16. Cauliflower (*Brassica oleracea* var. botrytis)

It is the most important vegetable crop of the UT of J&K grown for its white and tender head or curd formed by the shortened flower parts. It is not a rich source of nutrient, however substantial amount of protein, carbohydrates, phosphorus, calcium, iron and ascorbic acid is present. The edible part of cauliflower is curd.

Climate and Soil

It thrives best in cool, moist climate. Dry weather and low humidity are not suitable for it. High temperature produces poor quality curds. Temperature below the optimum during growing period delays maturity and undersized small unmarketable curds or buttons may be formed. Dry hot weather may also give rise to small hard curds. It can grow on a wide range of soils provided they are rich in nutrients. Light soils are good for early crop while the clay loam soils are well suited for high yields. Ideal pH is 6-7.

Varieties

Early group

Pusa Katki: This variety is suitable for early sowing. Curds are yellowish white and compact.

Pusa Deepali: Early season crop. Plants are medium tall with erect waxy green short leaves, curd compact white and medium in size. Ready for harvesting in 100-120 days. Yield about 80 q/ acre.

Medium group

Giant Snow Ball: It is a main season variety. Curds are snow white in colour and large sized. Average yield is 100q/ acre.

Pusa Synthetic: Plants erect, frame narrow medium, curds somewhat creamy white to white and compact.

Pant Shubra: This is a mid season variety. This variety is characterized by semi erect outer leaves. Inner leaves partially cover the curds which are compact, slightly conical, non ricey and creamish white in colour. This variety produces marketable curds by December-January. It takes about 120 days to produce marketable curds from nursery sowing. The yield potential of this variety is 100 q/ acre.

Pant Gobhi-2: The marketable curd of this variety is available in October in the plains. The curds are yellowish and medium compact. Average yield is about 40 q/ acre.

Pant Gobhi-3: This is a synthetic variety. This is classified as September maturity group variety. The curds are creamish white and non ricey. The yield potential of this variety is about 60 q/ acre.

Late group

Snow Ball-16: This is a late variety. The plants are of shortened stem. Curds snow white, self blanched, compact and uniform in maturity. Yield 100-120 q/ acre.

Pusa Snow Ball-1: Leaves straight, upright, inner leaves tightly cover the curds. Curds are compact, medium in size and snow white in colour. Yield 100-120 q/ acre.

Pusa Snow Ball K-1: Self blanched, snow white curds and resistant to black rot under field conditions. Last to mature in Snow Ball group. Yield 100-120 q/ acre.

Kt-25: This is a late maturing variety. Leaves are waxy, upright, slightly bending towards inner side with puckered margins. Curds are very solid, medium sized white with good keeping quality. Suitable for transplanting from October to early November and can yield edible curd between end of January to end of March, tolerant to *Sclerotinia* rot and black rot diseases, gives yield up to 80-120q/ acre.

Pusa Him Jyoti: Plants are erect, leaves bluish green with waxy coating, self blanched, white curd, average curd weight 500-600 g. It takes 60-65 days from planting to harvesting. This variety is suitable for April to July sowing in the hills above 1000 m height. Average yield is 64q/ acre.

Hisar-1: Suitable for mid late season, curds are medium to large and white in colour. Average yield is 100 q/ acre.

Sowing time

Zone	Sowing time
Sub-tropical	
Early Group	May- June
Medium Group	August
Late Group	September-October
Intermediate (Lower)	
1 st Crop	May
2 nd Crop	August-September
Intermediate (Higher)	April-May

Seed rate: 160-200g/ acre

Spacing

Early group: 60 cm x 30 cm

Mid and late group: 60 cm x 45 cm

Manure and fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
10	48 (100.0)	24 (52.8)	24 (40.8)

Apply 1/2 N along with other fertilizers as basal application and the remaining N should be top dressed 35 days after transplanting. Mid late and late varieties need comparatively more nutrients than early and mid early varieties

Irrigation

Cauliflower is a shallow rooted crop and requires proper soil moisture throughout the cropping period. Early crop may need irrigation twice in a week after transplanting and late crop once a week. During the later stage of the early crop and early stage of the mid season crop, irrigation is only given if there is a long gap in the rains. At the time of curd formation, there should be enough moisture in the field. Irrigation is generally required at 10-12 days interval during the cool season. Total water requirement is about 350 mm.

Interculture and weed control

Cauliflower being a shallow rooted crop, deep cultivation should be avoided. The crop needs at least 4 weeks weed free period after transplanting to prevent the yield loss. Earthing up operation, along with one split dose of nitrogen, should be done after 30-35 days of transplanting.

Pre-plant application of fluchoralin@ 0.8-1.0 litre/ acre or pendimethalin @ 1.32 litre/acre in the finally prepared field followed by one hand weeding after 40-45 days of transplanting is the best.

Harvesting and storage

Harvesting should be done during morning or evening so that the products may remain fresh for the market. At the time of harvesting, the head should be compact. Large leaves are trimmed away leaving only sufficient jacket leaves packed tightly to protect the curd from bruising. Storage at 0-2.0°C with 85-90% relative humidity can keep cauliflower in good quality for 30 days.

Seed Production

The cultural requirements of market and seed crop up to curd formation stage are same. The seed production can be done by two methods viz., *in situ* and *ex situ* methods. The seed of early and main season varieties can be produced at farmer's level in the plains, however, the seed of late season varieties can only be produced in the mid/high hills. To produce genetically pure seed, the off-type plants must be removed thrice during vegetative phase, curd formation stage and flowering stage. Isolation distance of 1600 meter should be kept between different cole crops and different varieties of cauliflower and a minimum population of at least 100 true to type and disease free plants should be maintained for random pollination in isolation. Care should be taken to see that sufficient insect pollinators are available at the flowering time. When pods turn brown they should be harvested two or three times. The harvested branches should be staked, turned upside down and allowed to cure for 4-5 days more. After curing they should be thrashed and cleaned.

Physiological disorders

Browning

It is caused due to boron deficiency. The water soaked lesions first appear in the stem, leaves and on the surface of the curd, which later on turns rusty brown

in colour. The browning of curd is sometimes associated with hollow stem symptoms. The affected curds are bitter in taste.

Control measures:

- Correct the soil reaction and salinity
- Soil application of borax @ 4-6 kg/ acre.
- Three sprays of 0.25-0.5% borax solution (0.4-0.8 kg/ acre) along with a sticker 20, 35 and 90 days after transplanting.

Whip tail

It is caused due to molybdenum deficiency and occurs in the soils with the pH below 5.5. The plants become chlorotic and may turn white particularly along the leaf margins and finally become cup shaped and wither. Leaf blade of the older plants does not develop fully, becomes strap like and hence the name whip tail. In extreme cases the growing point is deformed and no marketable curds are formed.

Control measures

- Raising of soil pH to 6.5 by proper liming.
- Soil application of 0.6 kg/acre sodium or ammonium molybdate mixed with fertilizer or irrigation water after transplanting.
- Three sprays of 0.1% ammonium molybdate solution along with sticker 15, 30 and 45 days after transplanting.

Buttoning

This disorder is characterized by the development of small curds or buttons which cannot be developed to full size of the curd. It is caused due to

- Nitrogen deficiency
- Over aged seedlings.
- Out of season planting.
- Exposure of seedlings to poor light conditions.

Control measures

- Plant varieties according to maturity group.
- Provide recommended dose of nutrition.

Blindness

The plants lack terminal buds and curds and only large dark green thick and leathery leaves develop in these plants and is caused due to

- Injury to terminal bud due to mechanical means or insect attack.
- Out of season planting.
- Exposure of seedlings to very low temperature.

Control measures

- Careful handling of the plants against insect pest and diseases.
- Avoid low temperature exposure.

Riceyness

It is marked by velvety or granular appearance on the curd surface and premature initiation of the flower buds and is caused due to

- Exposure to temperature higher or lower than the optimum required for particular variety in curd development stage.
- Temperature fluctuations during curd development
- Poor seed stock.

Control measures

- Plant varieties according to the maturity group.
- Good seed stock and provide favorable weather conditions.

17. Cabbage (*Brassica oleracea* var. *capitata*)

It is the second most important cole crop of the Union Territory of J&K after cauliflower. It is grown for its leafy head which is highly nutritious.

Climate and Soil

This is a cool season crop and thrives well in a relatively cool & moist climate. It is grown mainly as a winter crop in sub-tropical plains.

Produces marketable heads at temperature range of 15-30°C but the day temperature should not be above 35°C. For early crop sandy or sandy loam soils are preferred. For late crop lay loam and silty soils are preferred.

Varieties

Golden Acre: The plant is small, head is round, cover leaves are dark green, cup shaped with prominent veins. It becomes ready in 60-75 days after transplanting. It yields about 90-100 q/ acre and gets ready for the market in 60 days.

Pride of India: Head round, solid and medium large sized weighing about 1-1.5 kg, very good for marketing. It yields about 100-120 q/ acre.

Pusa Drum Head: Heads are large, 3-4 kg, flat, cover leaves are light green, field resistance to black leg disease. Ready for harvesting in 80-90 days after transplanting. Yield is 100 q/ acre.

Pusa Mukta: Bacterial rot resistant variety, plants have short stalk, medium frame and light green wavy puckered leaves. Heads are compact, flattish round with loose wrapper leaf at the top, 1.5-2.0 kg of weight, gives an average yield of 80-120 q/a.

Sowing time

Zone

Sub-tropical

Intermediate (Lower)

Intermediate (High)

Sowing time

August-September

July-August

May-June

Seed rate

Early varieties: 200 g/ acre

Late varieties: 160 g/ acre

Spacing

Early varieties: 45cm x 45cm

Late varieties: 50cm x 50cm

Manure and fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
10	48 (100.0)	24 (52.8)	24 (40.8)

Apply 1/3 N along with other fertilizers as basal application and the remaining N should be top dressed in two split doses at 30 days interval after transplanting.

Irrigation

Cabbage requires a continuous supply of moisture for proper development. It may be irrigated after every 10 days. This interval may be shortened for late varieties and in hot season. It should not be irrigated when the heads are fully developed and quite firm, otherwise many of them will burst or split within 24 hours.

Interculture and weed control

Three hoeing are sufficient for cabbage. Earthing-up of plants after 5-6 week is essential to produce solid heads. Apply pendimethalin @ 1.0 litre/acre one day before transplanting in moist soil conditions.

Harvesting and storage

Cabbage heads are harvested when they attain full size and are hard. The best time for harvesting is in after noon or early morning. The heads when mature should be cut with a long knife. Storage at 0-2.0°C with 85-90% relative humidity can keep cauliflower in good quality for 30 days.

Seed production

The seed production of cabbage is only possible under temperate conditions of Jammu where chilling requirements ranging from 0-4°C for a period of 8-10 week after head formation prevails. The off-types and undesirables not conforming to the varietal characteristics are rogued out during vegetative phase, head formation stage and flowering stages. In areas, where winters are not very severe, the heads may be allowed to over winter in the field either in the open field or by covering; it is preferable that these are stored in trenches of 2 x 1x1 m. size, because of the risk of theft of heads. The outer leaves of selected plant are removed and the plants are arranged in single layer and then covered, leaving holes on both sides for aeration. The plants are replanted in the field in March-April before the head start bursting. The seed production fields should be isolated by 1600 m in all directions from other cabbage varieties, cauliflower, knol-khol, brussels sprouts and kale. Harvesting of branches has to be done as the pod matures. The harvested branches should be staked for curing for 4-5 days.

18. Broccoli (*Brassica oleracea* var. *italica*)

Climate and soil

Broccoli is an important cole crop after cabbage, cauliflower and knol-khol in this region. It is a cool season crop. The temperature of 20-25°C is optimum for its proper growth and 15-20°C for heading stage. High temperature leads to formation of loose heads and bolting thereof. Deep loamy soil is best suited but it can be grown in a wide range of soils. The pH of 5.0-6.5 is optimum.

Varieties

Jammu Broccoli-07: Developed by SKUAST-J in the year 2017, the variety is medium in height, maturing in 75-80 days. Leaves are dark green with wavy margins. Curds are dark green of the size of 120-140 g and average yield is 72-80 q/ acre.

Palam Kanchan: It is a late maturing variety. It has long, broad, bluish-green upright entire margin leaves with prominent white midrib and veins. The head is large, compact, attractive and yellowish-green in colour. The heads matures 140-145 days after transplanting. The average yield potential is about 100-110 q/acre.

KTS-1: It is a medium-tall (65-70cm) variety. Foliage is waxy and dark green with slightly wavy margins. Heads are solid green with small heads slightly raised at the centre. The main head weight is 350-450g. It matures in 90-105 days after transplanting under temperate climate, while 5-10 days earlier in the tropical plains. Average yield is 88-100 q/acre.

Palam Samridhi: This is a high-yielding variety. Its large terminal head weight about 300-400g each. Average yield is 100-110 q/acre.

Palam Vichitra: It has a medium open, dark green leaves with reddish tinge. The head is medium, compact and purple coloured. The heads matures 115-125 days after transplanting. The main head weight is 400-500g. The average yield potential is about 90-100 q/acre.

Seed rate: 120-160 g/acre.

Sowing time

Zone	Sowing time	Transplanting
Subtropical	September-October	October-November
Intermediate (low)	August-September	September-October
Intermediate (high)	March-April	April-May

Spacing: 60 cm x 45 cm

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10	48(104.0)	24 (52.8)	24 (40.8)

The full dose of P and K and half N are applied at the time of transplanting and remaining half of N be applied as band dressing in two split doses, first one month after transplanting and second at the time of head initiation as band dressing. For micronutrient requirement, soil application of 200 g ammonium molybdate and 4-6 kg borax/a helps in controlling the molybdenum and boron deficiency respectively. Three foliar sprays of 0.3% borax after 20, 35 and 50 days after transplanting is beneficial in increasing the yield and checking the browning disorder.

Irrigation

Watering is done immediately after transplanting. Broccoli needs sufficient moisture in the soil for uniform and continuous growth of plants. Frequent irrigations at 10-15 days are given depending upon weather conditions. Dry condition adversely affects the quality and yield of shoots.

Interculture and weed control

2-3 hand hoeing and weeding is recommended to break the surface crust for better aeration and water absorption. Earthing up the crops 35 days after transplanting and immediately 2nd hoeing/weeding and application of 2nd dose of nitrogen should be applied. Regarding chemical weed control, apply pendimethalin @ 1.0 litre/acre one day before transplanting in moist soil conditions.

Harvesting and storage

Heads having 10-15 cm stems should be harvested with a sharp sickle/knife when its bud clusters are green and compact with central head weight about 300-600g. If harvesting is delayed the bud clusters become loose. After harvesting the heads are sorted, graded packed in baskets and sent to market. They should be cooled at 4°C and then packed with ice in crates. They can be stored well for 7-10 days at 4°C.

Seed production

The field selected for seed production should be fertile, loam or clay loam having good drainage. For certified seed production *in situ* method is preferred whereas for breeder seed production, the *ex situ* method of seed production is recommended. Only healthy curds, true to type and free from diseases are allowed to remain in the field for raising seed. Another rouging should be done at bolting stage to remove early and extremely late bolters. Seed crop of broccoli should be isolated by 1600 m distance from other varieties of broccoli and other cole crops like cabbage, knol-khol, brussels sprout etc. grown for seed production. The flowering appears after 30-35 days of replanting of the selected knobs and there after pod setting takes place. Care should be taken to see that sufficient insect pollinators are available at the flowering time. Harvesting of branches has to be done as the pod matures. The harvested branches should be staked for curing for 4-5 days. The crop is turned upside down and allowed to cure for 4-5 days more.

19. Knol Khol (*Brassica oleracea* var. *gongyloides*)

K nol-khol is one of the important cole crops of the UT of J&K. Both the leaves and knobs are used as culinary and pickle purposes.

Climate and Soil

This is a cool season crop and thrives well in a relatively cool and moist climate. It is grown mainly as a winter crop in sub-tropical plains. For early crop sandy or sandy loam soils are preferred. For late crop clay loam and silty soils are preferred.

Varieties

G-40: It is an early maturing variety. Marketable knobs mature in 35-40 days. It has globular flat knobs, short stalk length with erect and smooth leaves. The variety is tolerant to alternaria blight, stalk rot, downy mildew, cabbage butterfly and semi loopers. Yield potential is 120-140 q/ acre.

White Vienna: An early variety maturing in 70 days, leaves and stems medium dwarf; knob globular, light green and smooth, fleshy creamy white and tender.

Purple Vienna: Matures about a week later. The knobs are purplish and fleshy greenish white.

King of Market: An early variety maturing in 70 days, knob flattened fleshy, light green with profuse foliage. Leaves are more in number than White Vienna.

Sowing time

Knol-khol can be grown all the year round under sub-tropical zone of Jammu Division.

Zone	Sowing time	Transplanting time
Subtropical		
1 st crop	Mid-September	Mid-October
2 nd crop	Mid-October	2 nd week of December
3 rd crop	Mid February	Last week of March
4 th crop	Last week of March	Mid April
5 th crop	Last week of August	Direct sowing

Note: Direct sowing of the crop in lines 30 cm apart by kera method can also be done by the end of August. Thin the crop by keeping 20 cm distance between the plants after one month. The plants obtained by thinning can further be transplanted in the field in the month of October.

Seed rate:

Transplanted crop: 0.5-0.6 kg/acre

Direct sown crop: 1.2-1.6 kg/acre

Spacing: 30cm x 20cm

Manure and fertilizers

FYM (t/ acre)	N (Urea) kg/ acre	P ₂ O ₅ (DAP) kg/ acre	K ₂ O (MOP) kg/ acre
10	40 (80.0)	20 (44.0)	20 (34.0)

Interculture and weed control

Frequent shallow inter culture should be done in the soil to kill the weeds and to provide the soil mulch. Cauliflower being a shallow rooted crop, deep cultivation should be avoided. Weeding should be done as the plants are well set in the field.

Harvesting

The crop may be harvested when the swollen stem is 5-7.5 cm in diameter, soft and non fibrous. For its marketing cut off the main roots and then tie leaves with enlarged stem in bunches.

Seed production

For certified and truthfully labeled seed production, *in situ* method is preferred while for breeder seed production, the *ex situ* method in plains and low/mid hill region are adopted. Healthy and true to type knobs that are free from diseases are allowed to remain in the field for raising seed while allowing isolation of 1600m distance from other varieties of knol-khol and other cole crops. In later, the flowering appears after 30-35 days of replanting of the selected knobs and there after pod setting takes place. Care should be taken to see that sufficient insect pollinators are available at the flowering time. Harvesting of branches has to be done as the pod matures. The harvested branches should be staked for curing for 4-5 days. The crop is turned upside down and allowed to cure for 4-5 days more.

Seed yield: 320-400 Kg/ acre.

Insect-pest management in cole crops(Cauliflower, cabbage, knolkhol and broccoli)

Cutworm (<i>Agrotis Spp.</i>)	<ol style="list-style-type: none"> 1. Deep ploughing of fields before planting. 2. Use chlorpyrifos 1.5%D @ 8 kg/ acre as soil treatment before sowing. 3. Broadcasting of quinalphos 5G @ 8-10 kg/ acre.
Cabbage butterfly (<i>Pieris brassicae</i>)	<ol style="list-style-type: none"> 1. Release of <i>Trichogramma chilonis</i> @ 20,000 adults / acre per release (6 times) at weekly interval in Mid January 2. Promotion of <i>Cotesia glomeratus</i>, potential parasitoids against cabbage butterfly larva can be encouraged by planting border row of mustard and coriander as flowering plants. 3. Foliar spray of <i>Bacillus thuringiensis dipel</i> formulations @ 200 g/acre or 2g/lit of water along with sticker (0.5 ml/lit of water) or spinosad 45 SC@ 0.2 ml/litre is found promising to control all lepidopteran insect pests in cole crops.

	4. Don't spray the crop near harvesting.
Cabbage semilooper (<i>Plusia orichalcea</i>)	Spraying of cypermethrin 10 EC or fenvalerate 20 EC @ 1 ml/litre of water.
Cabbage aphid (<i>Brevicoryne brassicae</i>)	Spraying of cypermethrin 10 EC or fenvalerate 20 EC @ 1 ml/litre of water or methyl demeton 25 EC @ 1ml/litre of water.
White grubs (<i>Melolontha fuscicollis</i>)	1. Deep ploughing of fields before planting 2. Use Chloropyrifos 1.5%D @ 8 kg/ acre as soil treatment before sowing 3. Broadcasting of quinalphos 5G @ 8-10 kg/ acre.
Mustard Sawfly (<i>Athalia lugans proxima</i>)	1. Malathion 5 D @ 8kg/acre 2. Spraying of cypermethrin @ 1 ml/litre of water at evening hours.
Stem borer (<i>Hellula undulalis</i>)	1. Spraying of cypermethrin 10 EC or fenvalerate 20 EC @ 1 ml/litre of water when the damage is observed in the late stage.
Tobacco caterpillar (<i>Spodoptera litura</i>)	1. Installation of spodolure pheromone traps @ 5-6/acre for mass destruction of adult moths. 2. Spraying of cypermethrin 10 EC @ 1 ml/litre of water at evening hours. 3. Spray the NPV solution for <i>Spodoptera</i> caterpillar, SpltNPV @ 1 ml/litre of water at evening hours.

Disease management in cole crops (Cauliflower, cabbage, knolkhol and broccoli)

Black rot (*Xanthomonas campestris* pv. *campestris*.)

'V' shaped yellow lesions on the edges of the leaves which turn dark brown later on. The veins may show black or brown discoloration. In severe cases, the curd formation may not be proper.

Control measures

- Collect seeds from disease free area/plants.
- Soak seeds in plain tap water for 30 minutes, thereafter, treat the seeds with hot water 50°C, mixed with streptomycin 100 ppm (1g/10 liter) for 30 minutes. Dry the seeds in shade before sowing.
- Spray the crop with streptomycin 100 ppm or copper oxychloride fungicides (0.3%) particularly the crop meant for seed production in diseased prone area.
- Destroy the diseased debris after harvest.

Damping off (*Phytophthora*, *Pythium*, *Rhizoctonia* spp.)

Both pre and post emergence death of seedlings.

Control measures

- Treat nursery beds with formalin (1 part formalin 7 parts water) 3-4 days before sowing.
- Get healthy seeds.

- Seed treatment as in damping off of tomato.
- Always transplant diseased free seedlings

Downy mildew (*Peronospora parasitica*)

Characteristic water soaked round lesions on under surface of the leaves and also cause curd rot. Rotten tissues become brown and are surrounded with black discoloration at the base of the curd stalk.

Control measures

- Spray the crop with metalaxyl 0.25% or chlorothalonil @ 2g/litre of water or iprovalicarb+propineb@ 4gm/litre of water at 10-15 days interval starting from just appearance of disease in problematic area.

Stalk rot (*Sclerotinia sclerotium*, *Alternaria*, *Botrytis spp.*, *Erwinia caratovora* and *baccillius polymixa*.)

Leaves droop down, stalk rots from inside and becomes hollow and filled with black sclerotia, curds if formed develops white rot.

Control measures

- Follow cauliflower- paddy rotation.
- Uproot diseased plant and destroy. Spray copper oxychloride (0.3%) or streptomycin 100 ppm (1g/10 liter) from earthing up stage at 10-15 days interval till bolting in diseased prone areas/field.

20. Radish (*Raphanus sativus* L.)

Radish is one of the common root crops eaten either raw as salad or cooked in many ways. It has a cooling effect and increases the appetite. There are two types of radish-the Asiatic varieties produce edible roots in the first season and seed in the second season whereas European varieties produce roots in subtropical and intermediate low zone and seeds in the intermediate high zone.

Climate and soil

Radish is a cool season crop but the Asiatic varieties can resist heat more than the European varieties. It attains best flavour, texture and size at 10-15°C. During hot weather the roots produced are small and fibrous, later on becomes tough or ill shaped and extremely pungent. High temperature leads to bolting without adequate root formation. It may be grown on all kinds of soils. However, best radish is produced on sandy loam soils which are friable and contains high amount of humus. Heavy soils produce rough ill shaped roots with a number of small fibrous and branched roots. Ideal soil pH ranges between 5.5-6.8.

Varieties

Japanese White: It is an Asiatic variety. The roots are 25-30cm long cylindrical in shape with stump end, skin is white and smooth. Flesh is snow white, crisp, solid and mildly pungent. It matures in 65-70 days. Average yield is 60-120 q/acre.

Minowase: The roots are 30-35 cm in length, cylindrical in shape, smooth and white. The tops are medium and less pungent than Japanese White.

Pusa Chetki: A hot season variety suitable for extreme early and late sowing. Roots are medium long, pure white, stumpy and soft in texture. Ready for harvest in 40-45 days.

Pusa Himani: European type variety, the roots are 30-35cm long, pure white with whitish green shoulder. The roots are mildly pungent with green tops. Roots medium long, white and soft. Good size roots are ready in 50-60days. It is suitable for December-February sowing in plants.

Pusa Reshmi: Root white with green tinge on top of roots are 30-40 cm in length, suitable for early sowing in cooler months. Tolerate slightly higher temperature. Good size roots are ready in 50-60 days.

White Icicle: European type variety and the plant top is medium short, root pure white, thin, tender and solid. Flesh is icy white, crispy, mildly pungent and flavoured.

Pusa Desi: Roots are white with green shoulders, 30-35 cm long, medium thick, tapering, pungent, leaves dark green. Suitable for sowing between mid August-September in northern plains. It matures in 50-55 days. Average yield is 120 q/acre.

Arka Nishant: Roots are long, marble white in colour, with crisp texture and mild pungency. Resistant to pithiness, premature bolting, root branching and forking. Average yield is 140-160 q/acre.

Sowing time

Zone	Sowing time	Variety
Sub-tropical	March-May	Pusa Chetki
	September-October	Pusa Reshmi and Minowase
	End November-January	Japanese White, Arka Nishant and Minowase, Pusa Desi, Pusa Himani
Intermediate (Low)	Mid August- November	Japanese White and Minowase
Intermediate (High)	March-June	Pusa Himani
	August-September	Pusa Reshmi, Japanese White and Minowase

Radish is sown on ridges which are 45cm apart. L.5-2.0 cm deep furrow is drawn on the top of each ridge with a pointed stick. The seed is sown in the furrow with proper moisture by using kera method and then furrow is closed. Before the second irrigation, the plants should be thinned out properly.

Seed rate

- 4-4.8 kg/acre (Asiatic types): Kera Method
- 6-7.2 kg/acre(European types): Kera Method
- 1.6-2.0 kg/acre(Dibbling Method)

Spacing

- Asiatic types: 30-45 cm x 8-10 cm
- European types: 20-25 cm x 5-6 cm

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
12	24 (48.0)	12 (26.4)	20 (34.0)

Apply whole of FYM together with P₂O₅ and K₂O and half of N at the time of field preparation. Remaining half N should be applied at the time of earthing up.

Irrigation

Irrigation immediately after sowing is the best to good seed germination and establishment of the crop. Next irrigation should be on the third day and subsequently once in 5-7 days. During summer months frequent irrigation is necessary otherwise the growth will be checked and the root becomes pungent and tough. The total irrigation requirements for radish are found to be about 210-250 mm.

Interculture and weed control

Before the second irrigation, the thinning of thickly sown plants should be

done to keep them at 2 cm apart (European varieties) and 5-6cm apart (Asiatic varieties). Weeds are removed and open roots are earthed up twice in the case of Asiatic varieties and only one weeding and earthing up is sufficient in case of European Varieties. Timely thinning is also very important.

Harvesting and storage

There should be sufficient moisture in the soil at the time of pulling out the roots by hand. Tender, crisp and large roots are pulled along with leaves and smaller ones are left on the ridges. This will help to get more yield per unit area as the smaller roots will have better chance to develop. Asiatic varieties can yield 100-120q/acre and the European varieties 24-32q/acre. Roots can be stored for about two months at 0°-1.0°C and 90-95% relative humidity.

Seed Production

The cultural requirement of radish raised for market and seed crop are same. Roots raised in two kanals are sufficient to plant one acre of seed crop. Seed crop of radish should be isolated by 1600m distance from other varieties of radish. Sow seeds of Asiatic varieties in September / October in plains and low/mid hill regions for raising roots for seed production. Transplant seedlings of $\frac{3}{4}$ root and $\frac{1}{4}$ shoot length at 60 x 60 cm spacings. Three rougings one each at vegetative, flowering and maturity should be done to remove off type. Plants show flowering in the month of March-April and pods are ready to harvest in the month of May-June.

Physiological disorders

Hollow root: High temperature during 16-30 days of sowing inhibits the formation of secondary meristem in the center of roots leading to development of intercellular spaces which would otherwise have been filled with parenchyma cells. The environmental conditions and boron deficiency resulted in hollow root formation.

Wart: It is the physiological disorder which is a white protrusion of white inner root tissue through the splits in the skin mainly occurs due to soil moisture deficiency.

Pithiness: It occurs more in the summers than in spring or autumn crop. Excess application of fertilizers, soil moisture stress and high temperature conditions three weeks before harvest results in pithiness.

Control measures

- Keep proper moisture conditions in the field.
- Avoid growing sensitive varieties during summer season.
- Excess application of the fertilizers should be avoided.
- Spray 0.3% borax 25 and 40 days after sowing.

21. Carrot (*Daucus carota* L.)

Climate and Soil

It is a cool season crop and require relatively long growing season, though some of the tropical types tolerate quite high temperatures. The seed germinate under temperature in range of 7.2-23.9°C. The optimum temperature for growth is 16-18°C and colour development in 20-22°C. Asiatic varieties produce edible roots in the first season and seed in the second season whereas European varieties produce roots in subtropical and intermediate low zone and seeds in the intermediate high zone and are orange coloured. Carrots can be grown on all types of soil. It thrives best on a deep, loose and loamy soil. The pH of 6.7 is ideal and yield is extremely low at low pH.

Varieties

Pusa Kesar: An improved Asiatic type of carrot with reduced foliage. Roots are deep red coloured with narrow central core. It is rich in carotene (30 mg per 100g of edible portion). It can stay in field for about a month longer than other varieties without bolting. It matures in 80-90 days. Average yield is 120q/acre.

Nantes: It is a European type with stump root, 13-15cm long. Its skin, flesh and core are orange. Roots are smooth, attractive and get ready in 90-100 days after planting. Suitable for sowing from mid October-early December. Average yield is 48q/acre.

Chaman: European variety, plants dark green and semi-erect foliage; roots long, cylindrical, tolerant to cracking and forking. Average yield is 100-108 q/acre.

Pusa Yamdagini: European variety. Roots are 15-16 cm long, orange with self coloured core, slightly tapered, rich in carotene, gives an average yield of 36-40 q/acre in 90-100 days of crop duration.

Sowing time

Zone	Sowing time	Variety
Sub-tropical	September-October	Pusa Kesar
	November-December	Nantes, Pusa Yamdagini
Intermediate (Low)	August-September	Pusa Kesar
	October-November	Nantes, Pusa Yamdagini
Intermediate (High)	April-August	Nantes

Seeds are soaked in water for 12-24 hours prior to sowing to improve germination.

Seed rate	Asiatic type	2.4-3.2 kg/acre
	European type	2.0-2.4 kg/acre
Spacing	Asiatic type	30-45 cm x 22-25 cm
	European type	30 cm x 22-25 cm

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
12	24 (48.0)	12 (26.4)	20(34.0)

Apply whole of FYM together with P₂O₅, K₂O and half N at the time of field preparation. Remaining half of nitrogen should be applied after the first hoeing and weeding i.e.20-25 days of sowing.

Irrigation

The sowing should be done when moisture is sufficient. The first irrigation should be given 5 days after sowing and the second 3-4 days thereafter. The furrows should be kept moist till the seed has germinated. Subsequent irrigations are given before any wilting appears. The crop should be irrigated after a week if the soil is sandy and after 10-14 days, if it is loam. Avoid heavy irrigation.

Interculture and weed control

In the early stages carrot grows slowly and normally cannot compete with weeds. Weeding at this stage is very necessary but very little hoeing is needed after the plants are 8-10 cm high. Weeding and hoeing should not be done during dry weather. The exposure of roots to the dry winds causes loss of moisture, arrested growth and damage to the roots. The crown should not be exposed since it causes green discoloration and lowers the quality of the roots.

When the plants are well established, thin them to 3-4 cm apart to ensure proper development. If the roots are over-crowded, their shape and size are affected adversely. Thinning should be done in moist soil.

Harvesting and storage

Start digging when the roots are 2.5-3.0 cm in diameter at the upper end. Light irrigation is given a few days before harvest. Tops are removed and roots are dug with a spade. The soil may be loosened with a plough to reduce the cost of large scale harvesting. At temperature of 0.0-4.5°C with 93-98% relative humidity carrots can be stored for 6 months.

Seed production

The seed of Asiatic varieties can be produced successfully under sub-tropical low and mid hill conditions of Jammu region. Seed crop should be isolated by 1000m distance from other varieties/crops of Apiaceae family. Follow the same practices for market crop and seed crop upto root formation. Roots raised in two kanals are sufficient to plant one acre of seed crop. Transplant true to type stecklings of ¾ root and ¼ shoot length at 60 x 40 cm spacings. Premature bolters should be removed before flowering. The harvesting should be done in the month of April-May, when the secondary umbels becomes fully ripe and the third order umbel begins to turn brown.

Physiological disorders

Splitting or cracking of roots: Roots show vertical as well as longitudinal cracks. Apply recommended dose of nitrogen and well decomposed FYM. Follow proper irrigation scheduling.

Cavity spot: This disorder appears as a cavity/pitted lesion on the root surface and mainly caused due to deficiency of calcium and increased accumulation of potassium. For control, apply lime at the rate of 6-8 kg/acre.

Root forking: Roots get misshapen due to un-decomposed organic matter or heavy texture of the soil. For control, prepare land finely and use well decomposed FYM.

22. Turnip (*Brassica rapa* L.)

Climate and soil

It is a cool weather crop. If sown in hot weather, the root becomes woody, bitter, mishappen and small. Turnips develop best flavour, texture and size 10-16°C. Long days and high temperature induce early bolting and poor root development. Turnip can be grown on all kinds of soils but best turnips are produced on sandy loam soils.

Sowing time

Zone	Sowing time
Sub-tropical	October-November
Intermediate (Low)	September-October
Intermediate (High)	April-August

Seed rate: 1.6-2.0 kg/acre (Kera Method)
0.8-1.2 kg/acre (Dibbling Method)

Spacing 30x15cm

Varieties

Purple Top White Globe: It is high yielding, medium to late variety with round shape purple top, flesh white, firm, crisp and mildly sweet flavoured. Top is small with cut leaves. It gets ready in 60-65 days and average yield is 100-120 q/acre.

Pusa Sweti: Roots are white, round and slightly flat with rat tail habit. Flesh white, sweet and mildly flavoured. Leaves are green and small to medium in size. Suitable for sowing from early August-September. Maturity in 45-50 days. Average yield is 100-120 q/acre.

Pusa Swarnima: Roots are large, flattish round, rich in carotene content and sweet in taste. Leaves medium and green. Suitable for sowing from October-December. It matures in 65-70 days. Average yield is 140-150 q/acre.

Pusa Chandrima: Roots medium to large, smooth, pure white, sweet in taste. Leaves medium and green. Suitable for sowing from October- November. Maturity in 60-65 days. Average yield is 140 q/acre.

Pusa Kanchan: The roots stay longer in the fields. Leaf top is shorter. Produce seed satisfactorily in the plains. Excellent flavor and taste. Average yield is 100-120q/acre.

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
8	24 (48.0)	12 (26.4)	20 (34.0)

Whole of FYM along with P₂O₅, K₂O and half dose of N should be given at the time of field preparation and remaining half be given at the time of earthing up i.e., 30-35 days after sowing.

Irrigation

Light irrigation should be given immediately after germination. Subsequent irrigations are given as per the available soil moisture.

Interculture and weed control

Thinning is one of the most important operations in the successful cultivation of this crop. The plants are thinned to stand 8-10 cm apart in rows. After thinning, application of fertilizer, watering and then light earthing up is done. Only 2-3 cm of the upper part of the plant is covered with soil. At least, one such light earthing up is essential.

Harvesting and storage

The turnip roots are harvested when they are tender and attain the marketable size depending on the variety. The size ranges from 5-8 cm in diameter. They soon become fibrous and hard if they are allowed to grow beyond the marketable stage. The edible roots could be stored for 2-3 days at room conditions, whereas they can be stored for a longer period under cold storage at temperature 0°C and 90-95% relative humidity. It can be stored up to 8-16 weeks.

Seed production

The seed of turnip can successfully be produced both in plains and hills. Seed crop of turnip should be isolated by 1600m distance from other varieties of the same crop. In plains of Jammu, roots are fully mature during November-December. These are uprooted and true to type ones are selected. Under developed, deformed, diseased and off type roots are discarded. Plants show flowering in the month of March and seed is harvested in the month of April-May.

Insect-pest management in root crops (radish, carrot and turnip)

Flea Beetles (<i>Phyllotreta cruciferae</i>)	1. Spraying of acetamiprid 20 SP@ 0.2 g/litre of water.
Mustard saw fly (<i>Athalia proxima</i>)	1. Chlorpyrifos 1.5 D or malathion 5 D @ 8kg/acre 2. Spraying of cypermethrin 10 EC@ 1ml/litre of water at evening hours.
Cabbage butter fly (<i>Pieris brassicae</i>)	1. Release of <i>Trichogramma chilonis</i> @ 20,000 adults/acre per release (6 times) at weekly interval in mid-January. 2. Promotion of <i>Cotesia glomeratus</i> , potential parasitoids against cabbage butterfly larva can be encouraged by planting border row of mustard and coriander as flowering plants. 3. Foliar spray of <i>Bacillus thuringiensis</i> or <i>dipel</i> formulations @ 200 g/acre or 2g/lit of water along with sticker (0.5 ml/litre of water) or spinosad @ 0.3 ml/ lit is found promising to control all lepidopteran insect pests in cole crops. 4. Don't spray the crop near harvesting.

Mustard aphid (<i>Lipaphis erysimi</i>)	1. Spraying of dimethoate 30 EC @ 1.5 ml/l or oxydemeton methyl 25 EC @ 1 ml/l of water strictly at evening hours to protect the natural enemies and pollinators visiting at day time.
Diamond back Moth (<i>Plutella maculepennis</i>)	1. Planting border row of mustard and coriander 2. Foliar spray of <i>Bacillus thuringiensis</i> or <i>dipel</i> formulations @ 200g/acre or 2g/lit of water along with sticker (0.5 ml/lit of water) or spinosad 45 SC@ 0.2 ml/ liter is found promising to control all lepidopteran insect pests in cole crops. 3. Don't spray the crop near harvesting

Disease management in root crops (radish, carrot and turnip)

Alternaria blight

Brown circular spots on older leaves of the plant. These spots later show concentric rings with black colour. The disease becomes more serious in crops meant for seed production where lesions develop on stem and pods with more severity.

1. Collect seed from disease free crop.
2. Treat the seed with copper oxychloride (3g/kg of seed).
3. Spray the crop with copper oxychloride fungicide 0.3% (300g in 100 litres) or azoxystrobin @ 0.1% at 15 days interval starting from first appearance of disease on flowering branches.

23. Onion (*Allium cepa* L.)

The onion is a hardy cool-season biennial, but usually grown as annual crop. The onion has narrow, hollow leaves and a base which enlarges to form a bulb. The bulb can be white, yellow, or red and require 80 to 150 days to reach harvest.

Climate and soil

Onions are temperature sensitive. They require cool weather to produce their tops and warm weather to produce their bulbs. However, crop can be grown well under mild climate. Temperature ranging from 12.8°C-23°C before bulbing and 20°C -25°C for bulb development is considered ideal. Deep friable loam and alluvial soils are best for successful cultivation. The optimum range of soil pH is between 5.8 and 6.5.

Varieties

N-53: Bulbs are shiny red, globular in shape less pungent, TSS 11-12% poor storage capacity, gives yield of 60-80 q/acre, suitable for *kharif* season.

Agrifound Dark Red: Bulbs are dark red, globular 4-6cm size moderately pungent with 12-13% TSS, average keeping quality, gives 120q/acre bulb yield in 95-110 days of transplanting.

Agrifound Light Red: Bulbs are light red, globular, tight skinned 4-6cm in size, 12-13%TSS, good keeping quality, bulb yield of 120-130 q/ acre. Bulb yield in 110-120 days of transplanting.

Pusa Ratnar: Plants are 30cm tall and dark green leaves with waxy bloom. Bulbs are bronze deep red, obovate to flat globular, less pungent with 12% TSS and good keeping quality. This variety has yield potential of 130-140 q/ acre with crop duration of 150 days.

Pusa Red: Plants 55-65cm tall with 6-9 leaves/plant, bulb yield of 100-160 q/ acre in 125-140 days of transplanting.

Bhima Super: A red onion variety from DOGR has been identified for release for *kharif* season. It is reported to have an average yield of 80-88q/acre in *kharif* and 160-180q/acre in late *kharif*. Bulbs attain maturity within 100-105 days after transplanting (DAT) in *kharif* and 110 -120 DAT in late *kharif*.

Bhima Red: This variety already recommended for *rabi* season. Maturity is in 105-110 DAT during *kharif* and 110-120 DAT during late *kharif* and *rabi* seasons. The average marketable yield in *kharif* season is 76-84 q/acre and it is 120-128 q/acre in *rabi* season. It can be stored up to 3 months in *rabi*.

Sowing time

Zone	Sowing	Transplanting
Sub-tropical	Oct- Nov	Dec.-Jan
Intermediate	August	October

Seed rate: 4.0-4.8 kg/acre
Spacing 15x7.5cm

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
8	40 (86.8)	20 (43.6)	20 (34.0)

Full dose of well rotten farmyard manure should be well applied to the field, one month before transplanting. Full dose of phosphorous and potash and half dose of nitrogen should be applied before transplanting and remaining dose of nitrogen is top dressed after about a month after transplanting (i.e., before initiation of bulbs)

Irrigation

Light irrigation is given immediately after transplanting. Subsequent irrigations should be provided at 7-10 days interval. In all, 10-15 irrigations are required.

Interculture and weed control

Onion is shallow rooted crop and requires 3-4 hoeings and weedings for good growth and bulb development.

Weed Control

Application of pendimethalin @ 1.0 litres/acre or fluchoralin @ 0.4 litre/acre immediately after transplanting or after first irrigation followed by one hand weeding after 45 days can check the weeds effectively.

Harvesting and Storage

In onion, neck fall is the indication of maturity. Onion becomes ready for harvesting in 5-6 months after transplanting for dry onion (after 25-50% neck fall). In *rabi* season, keep bulbs in the field for 3-5 days and then cut the pseudo stem 2-5cm above the bulb and dry them in shade for 7-10 days. It will remove the excess moisture from the outer skin and neck. Onions are considered cured when neck is tight and the outer scales are dried.

Bulbs can be stored under well ventilated storage structures with low temperature (20.0°C to 25.0°C) and dry condition for 5-6 months without sprouting and without excessive loss of weight.

Seed production

Onion requires two seasons to complete its cycle. In first year, bulbs are raised from seed and in second year, these mother bulbs are planted at 45 x 20 cm distance in October and crop is ready in April/May. Land should be free from volunteer plants. In seed production, minimum isolation distance of 1000 must be maintained between different varieties. A minimum of four inspections, first before flowering, second and third during flowering and fourth at maturity should be done to rogue out diseased and off type plants. The viability of seed is just one year.

24. Garlic (*Allium sativum* L.)

It is second important allium crop. It is highly demanded as flavouring and seasoning agent and has immense medicinal properties

Climate and Soil

It requires cool and moist period during growth and relatively dry period during maturity. Garlic requires medium black, fertile, well drained loamy soils rich in humus and potash content. The soils with pH range of 6-7 are ideal for crop growth.

Varieties

Agrifound Parvati-2 (G-408): Bulbs are bigger in size 5.0-6.0cm in diameter, creamy white colour, 10-16 cloves with average diameter of 1.5-1.8cm, TSS 37%, dry matter 38% cloves are suitable for export, tolerant to common diseases, gives an average yield of 70-80 q/acre.

Yamuna Safed (G-1): Bulbs are silvery white skin with creamy flesh, 4.0-4.5 cm diameter, 25-30 cloves, TSS 38%, dry matter 39.5%, suitable for export. Average yield 60-70 q/acre.

Planting Time

Zone	Planting Time
Sub Tropical	September- October
Intermediate (low)	August -September
Intermediate (High)	March-April

Garlic is propagated by cloves which are detached individually from the bulb and are planted. The cloves are planted in small plots, convenient for irrigation and Intercultural operations, by dibbling method.

Seed rate: 2.0-2.4 q/acre (Cloves)

Spacing 15 cm x 7.5 cm

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
8	40 (86.8)	20 (43.6)	20 (34.0)

Full dose of well rotten farmyard manure should be well applied to the field, one month before transplanting. Full doses of phosphorus and potash are drilled at the time of sowing. Nitrogen is applied in three splits 30, 45 and 60 days after sowing.

Irrigation

Garlic requires light irrigation. First irrigation is given 1-2 days after planting. Subsequent irrigations are given after every 10-15 days depending on the soil type and weather conditions. Irrigation should be stopped at maturity at least 15 days before harvesting.

Interculture and weed control

Garlic is poor competitor of weeds and should be controlled at initial stage. First weeding is done one month after planting and second after two months. Hoeing just before the formation of bulb loosens the soil and helps in settings of bigger neck bulbs. The weeds in garlic can be initially controlled by the application of pendimethalin @ 0.8-1.0 litres in 250 litres of water or 1.2-1.6ml/litre of water for one acre followed by one hand weeding after 45 days of planting. The weeds can also be controlled by the pre-emergence application of oxadiargyl @ 36g/acre followed by post-emergence application of quizalofop-ethyl @ 20 g/acre, applied at 2-3 leaf stage of the weeds.

Harvesting and storage

Garlic is a crop of 4-5months duration. When the leaves start turning yellow or brownish and show signs of drying up, the crop is ready for harvest. The plants are pulled out and tied into small bundles. They are kept in shade for 5-7 days for curing and drying so that the bulbs become hard and their shelf life is prolonged. It is important to store bulbs in well ventilated rooms.

Insect pest management in bulb crops

Thrips	1. Spraying of methyl demeton 25 EC @ 1.0 ml/litre or dimethoate 30 EC @ 2 ml/litre of water or malathion 50 EC @ 2.0 ml/litre of water.
Maggots	1. Apply quinalphos 5G or carbofuran 3G @ 8-10 kg/acre at the time of land preparation. 2. Set up of poison bait having 0.05 ml malathion + 5 g gur solution in 100 ml of water in a hard plastic pan 20-25 days after sowing.

Disease management in bulb crops**Damping-off** (*Rhizoctonia solani*, *Fusarium spp.*, *Pythium spp*)

Seedlings are killed at pre and post emergence stage.

- Treat the beds (after adding manure) with formalin in 1:7 ratio with water and cover the treated beds with polythene sheet for 15-20 days before sowing. The seeds should be sown when the soil becomes free from formalin vapours.
- Treat seed with copper oxychloride (3g/kg of seed before sowing) or *Trichoderma viride* @ 4g/kg of seed.
- Drench nursery beds with copper oxychloride (0.3%) or iprovalicarb+propineb@ 4gm/litre of water at the initiation of damping off symptoms.

Downy mildew (*Peronospora destructa*)

Light yellow spot on root and downy growth on leaves and flowering stalks followed by necrotic lesions.

- Collect seeds from disease free crop.

- Spray the crop with metalaxyl (1g/litre of water) or chlorothalonil @ 2g/litre or iprovalicarb+propineb@ 4gm/litre of water at the time of disease appearance.

Purple blotch (*Alternaria porri*)

Purple zonated spots appear on leaves and flowering stalks which usually break at the point of attack.

- Immerse bulbs before sowing in chlorothalonil @ 2g/litre or azoxystrobin@ 1ml/litre of water and spray the crop at fortnightly interval starting from appearance of the disease.

Stemphylium blight (*Stemphylium vesicarium*)

Small yellow to orange spots or streaks appear in middle of leaves and on flower stalks on one side.

- Spray copper oxychloride @ 3g/litre of water at 15 days interval.

Black mould (*Aspergillus niger*)

Black powdery masses of spores are borne on exterior.

- Protect bulbs from moisture after harvest and store them properly.

25. Pea (*Pisum sativum* L.)

Climate and Soil

Pea is winter season crop and can tolerate frost. High temperature conditions at time of germination results in susceptibility to pea stem fly and wilt attack. The optimum temperature for its growth and development is 10°C to 18°C. Hot and dry weather interferes with the filling of pods. It grows on a variety of soils ranging from light sandy loam to clay. But well drained friable loamy soils are considered ideal. It does not perform well on acidic soils with pH below 5.5.

Varieties

Early season

Arkel: Plants are dwarf and pods borne in double on lower nodes. Pods are attractive dark green, about 8.5 cm long, incurved towards the sutures with pointed distal end and filled with 7-8 seeds. It is suitable both for fresh market and dehydration. Pods are ready for harvest in 55-60 days.

Azad P-3: Pods are medium sized, thick, straight with green bold seeds; gives an average yield of 32 q/acre.

Matar Ageta-7: Plants are vigorous with 15-18 well filled pods having 7-9 grains per pod. Shelling percentage is 48%. Average pod yield is 32 q/acre.

Main season

Arka Karthik: Pods are medium to long 8-9 cm. Seed are medium bold green and sweet. It is resistant to powdery mildew and rust. First picking starts 80 days after sowing. Average yield is 40 q/acre.

Azad P-1: This is a high yielding mid-season variety matures in 90-95 days with 40q /acre yield.

P-89: Mid-season variety, plants medium dwarf, vigorous with long green well filled pods, 9-10 grains/pod, crop ready in 85-90 days for first picking and heavy yielder. Seed is wrinkled, Average yield 60-70 q/acre.

Bonneville: Mid-season variety, plants medium tall, with long green well filled pods, sweet and bold grains, crop ready in 85 days and heavy yielder. Seed wrinkled. Average yield is 70 q/acre.

Sowing time

Zone	Sowing time
Sub-tropical	Last week of October Early crop
	Mid October- Mid November Main crop
Intermediate (Low)	Mid September-October
Intermediate (High)	1 st Crop- October-November
	2 nd Crop- May

Seed rate

Main crop: 24 kg/acre
 Early crop: 48 kg/acre

Spacing

Main crop: 20 x 10 cm
 Early crop: 20 x 5 cm

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
8	20 (40.0)	24 (52.8)	20 (34.0)

Apply whole of FYM along with N, P₂O₅ and K₂O at the time of field preparation.

Irrigation

During dry season apply light irrigation at an interval of 10-15 days. One or two irrigation at the time of flowering and fruit set are essential.

Interculture and weed control

The field should be kept free from weeds by giving two weedings and hoeings after four and eight weeks of germination. Usually two hand weedings are sufficient. In case of tall varieties it is advisable to provide stakes to plants to harvest better quality pods. Application of pre-emergence herbicides like linuron @ 0.5 kg/acre @ or pendimelhalin @ 1 litre/acre can control the weeds effectively.

Harvesting and storage

Harvesting of green pods must be done at proper maturity stage. Green pods of the early, mid and late varieties are ready for harvest in 50-55, 60-65 and 70-75 days after sowing respectively. Only 2-3 pickings in early crop and 3-4 in mid-season/late crop should be done. Proper storage at low temperature (0°C) and relative humidity (88-92%) may prolong the availability duration of green peas for 2-3 weeks and reduce the losses due to fungal diseases.

Seed Production

For seed production, seed rate and spacing are same as for table crop. Sow seed crop in second fortnight of November. An isolation distance of 5 meters is kept between two varieties grown for seed production.

26. French Bean (*Phaseolus vulgaris* L.)

French bean or Rajmash is grown for tender vegetable, shelled green beans and dry beans. There are large numbers of cultivated cultivars i.e snap beans (for pods), green shelled beans and dry shelled beans. Each cultivar is divided into climbing (Pole) and dwarf types.

Climate and Soil

French bean is a cool weather crop. The plants drop their blossoms or pods in very hot weather. The best quality pods are obtained at 15.6°C to 21.1°C temperature.

It can be grown on all types of soils ranging from low to heavy clays. Sandy and loam soils are preferred for an early crop but heavier soils are good for the mid-season crop. The optimum soil pH is 5.5-6.8. Liming is needed if soil pH is less than 5.5.

Varieties

Contender: It is bushy type with light green, fleshy, thick and slightly curved pods without fibres and green color. It is tolerant to mosaic and powdery mildew. Yield: 44-46 q/acre.

Pusa Parvati: Prolific bearer, pods mature in 40-45 days. It is tolerant to mosaic and powdery mildew. Average yield is 40-44 q/acre.

Arka Komal: Plant erect and bushy. Pods are straight, flat, tender and green. It is very good for transport as keeping quality is good. Yield 80-100 q/acre and requires 65-70 days for maturity.

Arka Anoop: Plants are bushy, resistant to both bacterial blight and rust. Pods are 17-18 cm long, flat and straight. Average yield is 80q/acre.

Kashi Param: Bush type, average yield is 48-56 q/acre.

Kentucky Wonder: Pole type, round and slightly curved pods, first picking starts in 60-65 days. Average yield is 40-48 q/acre.

Sowing time:

Zone	Sowing time	Varieties
Sub-tropical	last week of January	Contender, Arka Komal
	1 st fortnight of February	Pusa Parvati
Intermediate (Mid)	March-April	Contender, Arka Komal,
Temperate (High)		Pusa Parvati
1 st Crop	March April	Contender, Arka Komal
2 nd Crop	May-June	Pusa Parvati

Seed rate: Bush type: 34.0 kg/acre
Pole type: 18.0 kg/acre

Spacing: Bush type: 30-45 cm x 10-15 cm
Pole type: 90-100 cm x 15-20 cm

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
6-8	20(44.0)	40(86.8)	20(33.2)

Apply whole of FYM along with 1/2 N, P₂O₅ and K₂O at the time of field preparation and rest half-N during earthing up after 3rd week of sowing.

Interculture and weed control

Field should be kept weed free for proper growth of the plant. Beans are shallow rooted and sensitive to excessive moisture. However, optimum soil moisture should be made available at the time of fruit set and pod development. Two hoeings at 25 and 40 days after sowing are recommended.

Harvesting and storage

The pods are ready for harvest, two to three weeks after the first blossom or in about 50-60 days after sowing. Picking is usually done by hand. The pods can be stored for about 15-20 days at 2-4°C with 60-70% relative humidity.

Seed Production

For seed production, seed rate and spacing are same as for market crop. Sow seed crop in second fortnight of November. An isolation distance of 5 metres is kept between two varieties grown for seed production.

27. Broad Bean (*Vicia faba*)

Climate and soil

The broad bean (faba bean or horse bean or bakla bean) is hardy plant. It is grown mainly at higher altitudes where the climate is relatively cool. It is the only bean which can withstand cold temperature up to 4°C and therefore, it is grown as winter crop.

Soil

Broad beans do well in a rich heavy loam soils free from water logging. Acidic soils are not good for broad bean. Liming may improve the soil reaction. It can tolerate salinity up to some extent. Land should be prepared thoroughly by digging the soil deeply.

Varieties: Local

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
4	8 (14.0)	20 (43.2)	16 (27.2)

Sowing time:

Plains: September-October

Hills: March-April

Spacing: 45cm x 10-15 cm

Seed rate: 28-40 kg/acre

Irrigation

Broad bean cannot withstand drought. Therefore, light irrigations should be given at regular intervals of 12-15 days.

Interculture and weed control

Regular hoeing should be done around the plants for keeping down the weeds besides providing good environment for plant growth.

Harvesting

The pods are ready for harvesting in 3-4 months for spring sowing; 6-7 months for autumn sowing. Very young pods are preferred by most people. The beans are harvested at the plant are used as dry-shell beans. Pods are picked by a quick downward movement of the hand.

Yield: 28-40 quintals of green pods per acre.

Seed Production

For seed production, seed rate and spacing are same as for table crop. Sow seed crop in second fortnight of November. An isolation distance of 5 metres is kept between two varieties grown for seed production. On an average, from one acre of seed crop, 280-320 kg of seed can be obtained.

28. Cowpea (*Vigna unguiculata*)

Climate and soil

It is warm season crop and cannot withstand cold weather. It can be grown both in spring and in rainy season in plains but cannot tolerate heavy rainfall. It can be grown practically on all types of soils.

Varieties

Pusa Phalguni: It is bushy and dwarf variety, best suited for spring (February-March) sowing in the northern plains. The pods are dark green, about 12.5 long and appear in two flushes. The pod gets ready in about 60 days and the yield about 20-40 q/acre.

Pusa Barsati: It is early variety suitable for the rainy season. The pods are about 25-27 cm long and appear in 2-3 flushes. The pods get ready in about 45 days and the yield is about 36-38 q /acre.

Pusa Komal (Sel-1552): Plants are bushy and flowers at 45 days after sowing; pods are light green, 25-30 cm long; suitable for both spring summer and rainy season cultivation; resistant to bacterial blight; gives an average yield of 40 q/acre.

Arka Garima (Sel-61-B): Plants are tall, bushy, purple flowers, pods round fleshy and stringless; tolerant to heat and drought; gives an average yield of 72 q/acre in 90 days of crop duration.

Sel-263: Early maturing, plants are dwarf and can be grown in both spring and rainy season, pods are green, tender and medium (20 cm long); resistant to mosaic, golden mosaic viruses; gives average pod yield of 88q/acre.

Pusa Dofasli: It is a bushy variety, suited for both spring and rainy seasons. The pod is about 10cm long and gives the first picking about a week later than Pusa Phalguni. It gives about 15 picking in two months and produces about 30-32 q/acre.

Sowing time

Zone	Sowing time
Sub-tropical	February-March (Spring season crop)
	June-July (Rainy season crop)
Intermediate (low)	March (Spring season crop)
	June (Rainy season crop)

Spacing: 45-60 cm x 10-15 cm

Seed rate: 8-10 kg/acre (Spring season crop)

4.8-6.8 kg/acre (Rainy season crop)

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
6-8	20(43.4)	24(48.0)	20 (33.3)

Apply whole of FYM along with full dose of P₂O₅ and K₂O and ½ N at the time of field preparation and rest N should be top dressed 25-30 days after sowing.

Irrigation operation

In spring season crop 5-6 irrigations are required whereas in rainy season crop as per the requirement irrigation must be given.

Interculture and weed control

For effective control of weeds two hand weedings and hoeing are required. Alternatively, fluchlorin @ 0.4 kg a.i./ acre in 400 litres of water as pre-planting application is effective.

Harvesting

The marketable pods are available from 45 days in case of early varieties and 100 days in late varieties. Harvesting should be done at proper edible state.

Seed Production

For seed production, seed rate and spacing are same as for table crop. Sow seed crop in second fortnight of November. An isolation distance of 5 metres is kept between two varieties grown for seed production.

Insect-pest management in legume crops (peas, french beans, broad bean, cowpea)

Pea maggot (<i>Melanagromyza phaseoli</i>)	<ol style="list-style-type: none"> 1. Broadcasting of quinalphos 5G @ 8-10 kg/acre at the time of land preparation. 2. Set up of poison bait having 0.05 ml malathion 50 EC + 5 g gur solution in 100 ml of water in a hard plastic pan 20-25 days after sowing.
Pea leaf miner (<i>Chromatimyia horticola</i>)	<ol style="list-style-type: none"> 1. Broadcasting of quinalphos 5G @ 8-10 kg/acre at the time of land preparation. 2. Set up of poison bait having 0.05 ml malathion 50 EC + 5 g gur solution in 100 ml of water in a hard plastic pan 20-25 days after sowing.
Pea pod borer (<i>Maruca testulalis</i>) and (<i>Helicoverpa armigera</i>)	<ol style="list-style-type: none"> 1. Spray malathion 50 EC @ 2 ml/litre of water at evening hours. 2. All matured fruits should be picked before spraying.
Pea thrips (<i>Thrips</i> spp.)	<ol style="list-style-type: none"> 1. Spray malathion 50 EC @ 2 ml/litre of water at evening hours or dimethoate @ 2ml/litre of water. 2. All matured fruits should be picked before spraying.
Pea aphid (<i>Acyrtosiphum pisum</i>)	<ol style="list-style-type: none"> 1. Spray malathion 50 EC @ 2 ml/litre of water at evening hours or methyl demeton @ 1ml/litre of water. 2. All matured fruits should be picked before spraying.

Flea beetles (<i>Phyllotreta sp.</i>)	1. Spraying of acetamiprid 20 SP@ 0.2 g/litre of water
Jassids	1. Seed treatment with thiamethoxam 70 WS @ 3g/kg seed or imidacloprid 70 WG @ 5g /kg seed before sowing. 2. Use of delta traps or sticky traps @ 4 /acre. 3. Foliar spray of imidacloprid 17.8 SL (0.3 ml/litre) during the vegetative stage of the crop (before flowering). 4. Spraying of methyl demeton 25 EC @ 1 ml/litre or dimethoate 30 EC @ 2 ml/litre or malathion 50 EC @ 2 ml/litre of water after flowering.
Aphids	1. Use Yellow sticky traps @ 4/acre 2. Spray 2 ml of malathion 50 EC per lit of water or imidacloprid 17.8 SL@ 0.3 ml/litre or of water or methyl demeton 25 EC@ 0.4 ml/litre or dimethoate 30 EC @ 0.4 litre/acre as and when the pest is noticed. If necessary, repeat the spray after 10-12 days.
Pod borer (<i>Maruca testulalis</i>)	1. Spray malathion 50 EC@ 2 ml/litre of water at evening hours. All matured fruits should be picked before spraying.
Hairy caterpillars (<i>Amsacta moorei</i>)	1. Collection and destruction of 1 st and 2 nd instar larvae in gregarious phase. 2. Spray with quinalphos 25 EC @ 2ml/litre of water or cypermethrin @ 1 ml/litre of water.
Bean gall weevil (<i>Alcidodes signatus</i>)s	1. Broadcast cartap hydrochloride 4G @ 8-10 kg/acre. 2. Proper staking of rajmash plants. 3. Two spray of malathion 50EC @ 0.05% at 15 days interval at evening hours. 4. Spray acetamiprid 20 SP @ 0.2 g/litre of water or imidacloprid 17.8 SL@ 0.3 ml/litre of water or thiamethoxam 25 WG @ 0.25g/litre of water.

Disease management in legume crops (peas, french beans, broad bean, cowpea)

Powdery mildew (*Erysiphe polygoni*)

White floury appearance on stem, branches, leaves and pods. Severe infection results into stunted growth and reduced yield.

- Spray azoxystrobin @ 0.1% or triadimefon @ 0.1% or wettable sulphur 0.2% (200g/100l water) just on the appearance of disease at 10 days interval depending upon disease severity.

Ascochyta blight (*Ascochyta pinodes*, *A. pinodella*, *A. pise*)

Brown spots appear on foliage and stems of infected plants. The roots of

such plants turn brown.

- Use healthy seed for sowing.
- Treat the seeds with copper oxychloride (3g/kg seed) before sowing.
- Spray affected plants with copper oxychloride @ 0.3% (100g/100 litre of water) or azoxystrobin @ 1ml/litre of water.

Wilt and root rot (*Fusarium oxysporium*, *F. pisi* and *F. solani*, *Rhizoctonia*, sp., *Phoma* sp.)

Control measures:

- In true wilt, the plants wilt without yellowing while in root/ collar rot, rotting of roots and collar region starts with yellowing of lower most leaves followed by wilting.
- Treat the seed with copper oxychloride (3g/kg seed) in problematic field.
- Avoid early sowing in badly infested area.
- Follow 3 year crop rotation with cereals.

29. Beet Leaf (*Beta vulgaris* var. *bengalensis*)

Climate and Soil

It is a cool season crop. It can withstand frost better than other vegetables crops. High temperature (35-40°C) and long days cause bolting thus reduce its market value. Higher yields are obtained under short day and mild temperature conditions. It can be grown on a wide range of soils. It thrives best on well drained loam soils. A pH range of 6-6.5 is desirable.

Sowing time

Zone	Sowing Time
Sub-Tropical	August to December
Intermediate (Mid)	June to September
Intermediate (High)	March-June

Spacing: 20 x 5 cm

Seed rate: 14-16 kg/acre

Varieties

Jammu Spinach Beet-07: Developed by SKUAST-J in 2017, the variety is a multicut type and first cut comes after 35 days of sowing. Leaves are dark green, tender and average yield is 120-140q/acre.

All Green: Uniformly green tender leaves, heavy yielder, very early and ready for first cutting in four weeks. 6-7 cuttings can be taken and average yield is 50q/acre.

Pusa Bharati: Leaves are smooth, tender, green, without any red pigmentation, leaves ready for first picking in 30-40 days after sowing. Average yield is 200q/acre.

Pusa Jyoti: Leaves thick, dark green, fleshy, wavy margins, suitable for September sowing. Average yield is 170q/acre.

Pusa Harit: Plants are erect, leaves upright, thick, dark green, quick rejuvenation after cutting. Average yield is 104q/acre.

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10	32 (64.0)	10 (22.0)	10 (17.2)

Apply whole of FYM, P₂O₅ and K₂O and 1/4 nitrogen before sowing. Rest of nitrogen should be applied in splits after each cutting followed by irrigation.

Irrigation

First irrigation should be given immediately after sowing and subsequent at weekly interval for better growth of foliage.

Interculture and weed control

2-3 hoeing cum weeding are required to keep away the weeds from the field. Hand weeding is advocated in the earlier stage. After every cutting, weeding and hoeing should be done.

Harvesting and storage

The crop is ready for harvesting is about 4 weeks. Harvesting should be done at frequent intervals when the foliage is tender and at edible stages. One crop of prickly seeded variety in season gives 3-4 cuttings with total yield of about 20-24q/acre whereas round seed varieties give comparatively more number of cuttings with a total yield of 40-50q/acre. Under low temperature (0.0°C) and high relative humidity (90-95%) leaves can be stored for 10-14 days.

Seed production

The crop of beet leaf is raised for seed production in the same way as for green leaves production. Isolation distance of 1000 m should be provided in all the direction from any other beet leaf crop. Extreme male and vegetative male plants should be removed because these plants do not bear seed. Only hermaphrodite and female plants should be allowed to produce seed. Seed of beet leaf matures at different times. So, three harvestings be done and then threshed properly. An average yield of 3.2-4.0q/acre of seed can be obtained.

30. Spinach (*Spinacia oleracea*)

Climate and Soil

It is a cool season crop. It can withstand frost better than other vegetables crops. High temperature (35-40°C) and long days cause bolting thus reduce its market value. Higher yields are obtained under short day and mild temperature conditions. It can be grown on a wide range of soils. It thrives best on well drained loam soils. A pH range of 6-6.5 is desirable.

Sowing time

Zone	Sowing Time
Sub-Tropical	August to December
Intermediate (Mid)	June to September
Intermediate (High)	March-June

Spacing: 30 x 7.5 cm

Seed rate: 14-16 kg/acre

Varieties

Prickly Seeded: It is a variety with narrow and pointed leaves. Plants are upright and vigorous, leaves blistered, thick and good yielder.

Virginia Savoy: Smooth seeded plants upright and vigorous. Leaves with round tips, blistered, crumpled and thick. Average yield is 40-50q/acre. Suitable for mid and temperate zone.

Banerjee Giant: Plants robust, leaves large and fleshy, double the size of ordinary spinach, suitable to subtropical and mid hill zone of the province. Average yield 60-80q/acre.

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10	32 (64.0)	10 (22.0)	10 (17.2)

Apply whole of FYM, P₂O₅ and K₂O and 1/4 nitrogen before sowing. Rest of nitrogen should be applied in splits after each.

Irrigation

First irrigation should be given immediately after sowing and subsequent at weekly interval for better growth of foliage.

Interculture and weed control

2-3 hoeing cum weeding are required to keep away the weeds from the field. Hand weeding is advocated in the earlier stage. After every cutting, weeding and hoeing should be done.

Harvesting and storage

The crop is ready for harvesting is about 4 weeks. Harvesting should be done at frequent intervals when the foliage is tender and at appropriate edible stages.

One crop of prickly seeded variety in season gives 3-4 cuttings with total yield of about 20-24q/acre whereas round seed varieties give comparatively more number of cuttings with a total yield of 40-50q/acre. Under low temperature (0.0°C) and high relative humidity (90-95%) leaves can be stored for 10-14 days.

Seed production

The crop of spinach is raised for seed production in the same way as for green leaves production. Isolation distance of 1000 m should be provided in all the direction from any other spinach crop. Extreme male and vegetative male plants should be removed because these plants do not bear seed. Only hermaphrodite and female plants should be allowed to produce seed. Seed of spinach matures at different times. So, three harvestings should be done and then threshed properly.

31. Kasuri Methi (*Trigonella corniculata*)

Climate and soil

Kasuri methi requires a relatively cooler climate. It can tolerate frost and freezing weather. The areas where rains are heavy and continuous, growing of methi should be avoided. Kasuri Methi can be grown on a wide range of soils. The ideal soil is clay loam. The favorable soil pH is 6-7.

Sowing time

Zone	Sowing Time
Sub-Tropical	September - November
Intermediate (Mid)	August - September
Intermediate (High)	March- April, May-June
Seed rate:	12-14kg/acre

Varieties

Jammu Fenugreek-07: Developed by SKUAST-J in 2017, the variety is a multicut type and first cut comes after 30-35 days of sowing and subsequent cuts at 20-25 days interval. Leaves are dark green, fragrant and average yield is 60-80q/acre.

Kasuri Methi: It is a late cultivar. Plants are small statured and erect. It takes about 150-160 days from seed to seed. Leaves are small and scented and pods are sickle shaped. 4-5 cuttings can be taken as green.

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
6	24 (48.0)	8 (17.6)	8 (13.6)

Apply whole FYM, phosphorus, potash and 1/4th N at the time of sowing and remaining nitrogen @8kg/acre after every cutting to get green, tender and succulent leaves.

Interculture and weed control

Two hoeing and weedings are enough to control the weeds. Alternatively, pre plant application of trifluralin @ 0.03 kg/acre along with one hand weeding keeps weed under check.

Irrigation

The first irrigation is given immediately after sowing and subsequently after every 8-10 days. Avoid water stress at pod and seed development stage.

Harvesting

The crop is meant for flavor and aroma. It is dried as spice crop. The green leaf yields of Kasuri type vary from 36-40q/acre while the common type produces yield of 28-32q/acre.

Seed production

The methi is raised for seed production in the same way as for green leaves production. After one month of sowing one-two cutting of green leaves should be taken and then crop is left for raising seed. After one cutting 8 kg N/acre and then irrigate the field. Methi is predominantly a self-pollinated and an isolation distance of 10 and 5 m should be maintained for foundation and certified seed production. Crop is ready for seed harvest when pods turn brown and leaves get dry.

32. Common Methi (*Trigonella foenum gracum*)

Climate and soil

It is cool season crop and can tolerate frost and freezing weather. Avoid growing methi in areas where rains are heavy and continuous. It can be grown on a wide range of soils. The ideal soil for methi is clay loam. The favorable soil pH is 6-7.

Sowing time

Zone	Sowing Time
Sub-Tropical	September- November
Intermediate (Mid)	August - September
Intermediate (High)	March- April, May-June

Seed rate 16-18kg/acre

Varieties

Pusa Early Bunching: It is an early cultivar commonly known as methi. It takes about 125 days from seed to seed.

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
6	24 (48.0)	8 (17.6)	8 (13.6)

Apply whole FYM, phosphorus, potash and 1/4th N at the time of sowing and remaining nitrogen@8 kg/a after every cutting to get green, tender and succulent leaves.

Interculture and weed control

Two hoeing and weeding are enough to control the weeds. Pre-plant application of trifluralin @ 0.30kg/acre along with one hand weeding keeps weeds under check.

Irrigation

The first irrigation is given immediately after sowing and subsequently after every 8-10 days. Avoid water stress at pod and seed development stage.

Harvesting

When common methi is used as leafy vegetable, the young shoots are nipped off in about one month after sowing. The picking of leaves is done by nipping 2cm above ground level leaving the stubs which produces new shoots. Average yield is 28-32q/acre.

Seed production

The crop is raised for seed production in the same way as for green leaves production. After one month of sowing one-two cutting of green leaves should be taken and then crop is left for raising seed. After one cutting 8kgN/acre and then irrigate the field. It is predominantly self-pollinated and an isolation distance of 10 and 5 m should be maintained for foundation and certified seed production. Crop is ready for seed harvest when pods turn brown and leaves get dry.

33. Coriander (*Coriandrum sativum*)

Climate and soil

It is a tropical plant cultivated in *rabi* season. It requires frost free climate at the time of flowering and seed formation. Dry and moderately cool weather is congenial for increasing the seed yield. Heavy rains are harmful to the crop. It can be grown on wide range of soils. However well drained sandy loam soils rich in organic matter are quiet ideal.

Varieties

Jammu Coriander-07: Developed by SKUAST-J in 2017, the variety is semi spreading multicut type, dual purpose, highly aromatic and average yield is 60-64q/acre.

Other varieties are:

Pant Haritma

Narnaul Selection

Hissar Surbhi

Sowing time: Last week of October.

Seed rate: 4-6 kg/acre (irrigated conditions)
10-12 kg/acre (un- irrigated conditions)

Spacing: 30 x 10 cm

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
6	24 (48.0)	12 (26.4)	8 (13.6)

Apply whole FYM, phosphorus, potash and 1/3rd N at the time of sowing and remaining nitrogen should be applied 30 and 75 days after sowing.

Irrigation

Depending upon the climatic conditions, soil type and variety, 4-5 post sowing irrigations are given. The first irrigation is given 35-40 days after sowing and the second one 60-70 days after sowing.

Interculture and weed control

Two weedings and hoeing one each after 30 and 60 days of sowing are recommended.

Harvesting

The crop is raised for green leaves and seed purpose. For green leaves fully developed succulent leaves are nipped off along with stem after 75 days of growth. For seed purpose the crop is harvested when 50% seeds turn yellow. After drying the seeds are separated by beating with sticks and winnowing.

Yield: 10q/acre (irrigated)
2.8-3.2 q/acre (rainfed crop)

Seed production

The coriander is raised for seed production in the same way as for green leaves production. After one month of sowing one-two cutting of green leaves should be taken and then crop is left for raising seed. After one cutting 8 kg N/acre and then irrigate the field. Coriander is predominantly a cross pollinated and an isolation distance of 1000m should be maintained. Crop is ready for seed harvest when pods turn brown and leaves get dry.

34. Amaranthus (*Amaranthus tricolor*)

Climate and Soil

Amaranthus (choulai, badi choulai) is a very popular leafy vegetable. It is grown in temperate as well as tropical climatic conditions. In India, it is grown throughout the year. However, it is mainly grown in summer and rainy season. Severe winters are not desirable for its cultivation and drought conditions may not affect much the grain types. It can be grown on a wide range of soil. However leafy types require fertile soils of sandy loam nature with well drained and slightly acidic. It does not perform well on heavy, poorly drained or sandy soils.

Cultivars

Pusa Chhoti Choulai: Plants are dwarf, leaves small suitable for greens, responds well to cutting. Flowers are borne in clusters in leaf axils suitable for both summer and rainy season cultivation.

Pusa Badi Choulai: Plant is tall, stem is thick, tender and green in colour; leaves large and green in colour, responds well to cutting and can be grown for longer period of time. It is suitable for summer and crop may prolong up to the end of rainy season.

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
8-12	16(34.0)	20(44.0)	20(34)

Seed rate: 0.8 kg /acre (Badi Choulai) and 1.2 kg/acre (Chhoti Choulai)

Sowing

The seeds are sown thinly in lines. The distance between plant to plant is 10 to 15 cm and row to row distance is 45 cm. The distance between plant to plant is maintained by thinning particularly when it is grown for grain purposes. For vegetable purpose if thinning is not done, will not affect the yield adversely.

As far as possible, sowing of the seeds should be done at the depth 1 to 2 cm. It will ensure uniform and rapid germination. The seeds are very small (thousand grain weights 0.4-1.2 g) therefore some quantity of sand or fine powder of leaf mold or soil is mixed to get uniform distribution. It will also help in maintaining seed rate per unit area.

Irrigation

Since the seeds are very small, if irrigation is done after sowing there is risk for soil crust formation which will result in slow and poor emergence of seedlings. Therefore, it is advisable to do pre-irrigation so that sufficient moisture is made available for rapid and uniform germination. The leaf types require irrigation at frequent interval, better if irrigation is followed by each cutting. The grain type of amaranthus is drought resistant and hence crop can easily taken as rain-fed crops.

Interculture and weed control

Hoeing at early stage of crop growth will ensure good aeration and weed free crop. Being a short duration crop, weeds do not pose a problem.

Harvesting

Usually, after 25 to 30 days plants are pulled as a whole and washed properly. The root portion along with hard portion of stem is removed. Instead of uprooting whole plants, clipping of full grown side leaves is done; many times tops of the plants may also be cut. The first cutting is done 25 to 30 days after planting and thereafter at 6 to 8 days interval. Crop is over in 6 to 8 cuttings or so.

Yield

The average yield of greens is about 24-32 quintals per acre depending upon cultivars, climatic condition and management of the crop.

Storage

Its leaves are very perishable in nature. They cannot store for more than few hours under ordinary conditions.

Insect-pests

Amaranthus is not harmed by any insect pest seriously, common insects viz. leaf webber, leaf hopper, stem weevil, caterpillars and ants are seen in the crop. On leaf type of amaranthus where cutting of the leaves is a regular practice and hence, insects may not be a problem. Only at initial stage, one spray of malathion at the rate of 1.5 to 2 ml per litre of water may be done. It is not advisable to use insecticide in amaranthus because leaves are cooked as vegetable.

Diseases

Leaf spot (*Cercospora* spp.): Small brown spots appear on the leaves. Spots are roundish with concentric rings in the beginning which later increase in size and may coalesce.

Control measures

- Remove affected leaves.
- Spray bordeaux mixture (5:5:50) or copper oxychloride (0.3%) three times at an interval of 15 days.

White rust (*Albugo bliti*): White blisters appear on the lower surface of the leaf and opposite to each blister on the upper surface a yellow patch develops. Leaves may wilt and die when incidence becomes severe.

Control measures

- Follow crop rotation.
- Spray metalaxyl (0.2%)

35. Basella (*Basella alba*)

Climate and soil

Basella is popularly known as Poi. Basella is a climbing plant. It can be grown on a wide range of climatic conditions. Frost is harmful and so also extremes of hot climate. However, it thrives best under warm and moist climate. It can be grown successfully under partial shade with the advantage of getting broad succulent leaves. Basella can be grown on a wide range of soils. However, heavy soils are not suitable. The best soil which is sandy loam type containing or has been supplied with adequate amount of well rotten farmyard manure or compost. The soil should be well drained.

Cultivars

Generally, two types of cultivars are grown which are used for vegetable purpose.

1. Cultivar with reddish petioles and stems.
2. Cultivar with green leaves, petioles and stems.

Both the types of cultivars are grown in Assam, West Bengal and South India whereas green-leaved cultivars are preferably grown in Uttar Pradesh and Punjab.

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
8-12	32 (68.0)	32 (68.0)	20 (34.0)

Sowing

Basella is raised mainly by seeds. It can also be raised by stem or root cuttings. The sowing is usually done in March to May in the northern and eastern plains of India whereas sowing time in south India is June and October to November. In the hills, basella is sown in March to April. When it is raised by stem or root cutting, planting is restricted to only monsoon season or early summer when success is high. Basella can be raised by directly sowing the seeds in the main field or by raising seedlings in nursery and then transplanting them in the main field

Seed rate 4.8-6.0 kg/acre

Spacing

Distance of planting is 45 x 35m or 60 x 60m, when plants are allowed to grow on the ground. When plants are trained on machans made up of bamboo sticks and joined with jute string or trained on trellises. In such cases, distance of planting can be reduced to 20 to 30 cm between plant to plant.

Irrigation

Basella is a foliage plant the leaves and soft portion of stems are used as vegetable. It requires adequate quantity of water at frequent interval. Inadequate

watering will lead to poor development of leaves. The succulence of leaves, their colour, weight of leaves, attractive appearance will be affected if water is not available in time. The spring-summer crop requires watering at narrow interval compared to winter season crop. However, rainy season crop does not require irrigation except when there is long spell of drought.

Interculture and weed control

In order to provide good environment for plant growth, light cultivation is essential. Besides, it will also help in keeping down the weeds. Moreover, cultivation acts as mulch. Hoeing is best. It is done with khurpi. It is advisable to put some soil very near to the base of the plant which will prevent plants from the direct contact with water. Water stagnation should always be avoided, and aeration in the root zone helps better growth of vines.

Harvesting

The leaves become ready for harvesting 60 to 75 days after sowing the seeds. The crop become ready for harvesting earlier also when it is raised by stem or root cuttings, it takes about 45 days.

Yield

The yield is low in the first cuttings, which increased in subsequent cuttings when plants are fully developed and spread well. The total yield of 60 to 80 quintals per acre is obtained depending upon the management practices followed for growing the crop.

Insect-pests and diseases

Basella plant is more or less free from any serious insect-pests infestation.

36. Asparagus (*Asparagus officinalis* L)

Asparagus (Shatavar) is a dioecious plant, appears early in the spring and when once established will produce for over many years. It is cultivated for its tender shoots, commonly known as spears. These spears are considered as a delicacy in preparation of soups, and other vegetable products. It starts yielding a sizeable crop after about three years and with good care given an economic yield for about 10-15 years and the yield goes on increasing for 6-7 years, then remains uniform up to about 12 years, after which it gradually declines.

Climate and soil

Asparagus grows well in cool regions, where the day temperature ranges between 24.0-30.0°C during the entire growing season accompanied by adequate moisture supply. Asparagus spears are hardy and are seldom injured by cold winters. Asparagus can be grown on nearly all kinds of soils, but deep soils, well drained and friable are considered best.

Varieties

Mary Washington: It is a well-established variety, tolerant to rust, with good productivity and has wide adaptability and good market quality. It is the most widely planted variety.

Martha Washington: It is a later variety very similar to Mary Washington.

Early Argenteuil: It is said to be earliest and under favorable conditions it may give cut from the beginning of April onwards.

Conover's Colossal: It is originally an American variety and is later, having slender pointed buds which on exposure to the full light soon lose their reddish colour and becomes a lighter green than other kinds.

Manure and fertilizers

FYM (q/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
6-8	30 (64.0)	14 (30.8)	14 (24.0)

Sowing: Two methods are mostly used:

1. Through seeds.
2. Through 1-2 year old crowns for kitchen gardening.

Seed Rate: 0.8-1.0 kg/acre

Spacing: 150 x 60cm

Irrigation

Watering is done immediately after transplanting. Asparagus needs sufficient moisture in the soil for uniform and continuous growth of plants. Frequent irrigation at 10-15 days is given in summers depending upon weather conditions.

Interculture and weed control

2-3 hand hoeing and weeding is recommended to break the surface crust for better aeration and water absorption.

Harvesting and storage

The first cutting of spears usually starts from third season or after the completion of two full growing seasons. The green asparagus which is the greater portion of the crop, cut 2.5-5 cm below the surface of the soil. Asparagus is usually harvested every day during the main season, but if the weather is cold, every other day or even every third day and if it is very hot twice a day.

Spears can be stored at 0-2°C in 90-95% RH for 2-3 weeks.

37. Lettuce (*Lactuca sativa* L.)

Lettuce is most often used for salads, although it is also seen in other kinds of food, such as soups, sandwiches and wraps and can also be grilled.

Climate and Soil

High temperature induce bolting with most varieties growing poorly above 24°C, cool temperatures prompt better performance, with 16 to 18°C being preferred and as low as 7°C being tolerated. Lettuce grows best in loose, nitrogen rich soils with a pH of between 6.0 and 6.8.

Varieties

There are several types of lettuce, but three (leaf, head and cos or romaine) are the most common. There are seven main cultivar groups of lettuce, each including many varieties:

Great Lakes: It is crisp head type. The head is large, firm with green leaves and outer leaves blistered. Resistant to tip burn but susceptible to powdery mildew.

White Boston: It is butter head type with a loose arrangement of leaves, known for its sweet flavor and tender texture.

Alamo-1: It is heading type variety. Heads are compact weighing 500g. Leaves are dark green, curly and crisp. Maturity 90-100 days after sowing and yield about 80-100kg/acre.

Summer Crisp: Also called Batavian or French Crisp, this lettuce is midway between the crisp head and leaf types. These lettuces tend to be larger, bolt-resistant and well-flavored.

Seed rate: 160-200g/acre

Sowing: Sowing is done during September-November in subtropical Jammu and February to June in intermediate high zone. Sowing is done in nursery beds and seedlings are transplanted when 4-6 week old.

Spacing: 25 x 45cm

Manure and fertilizers

FYM (q/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
4-6	20(44.0)	24(52.0)	20(34.0)

Irrigation

Watering is done immediately after transplanting. It needs sufficient moisture in the soil for uniform and continuous growth of plants. Excess irrigation in heavy soils cause rotting and burning of leaves.

Interculture and weed control

Being shallow rooted crop, it requires 2-3 hand hoeing and weeding is recommended to break the surface crust for better aeration and water absorption.

Harvesting and storage

The heading types are harvested in 60-70 days after transplanted whereas leafy types are harvested in 50-60 days when leaves are tender, immature but large enough to use. After harvest, lettuce can be stored for 7-10 days when kept at 0°C and 90-95 percent humidity.

38. Swiss Chard (*Beta vulgaris* subsp *cicla*)

Swiss chard is a leafy green vegetable, green or reddish in colour. It is considered to be one of the healthiest vegetables available, and is a valuable addition to a healthy diet.

Climate and Soil

It is a cool season crop grows well at 16 to 18°C temperature. High temperature induces bolting with most varieties growing poorly above 25°C. Lettuce grows best in loose, nitrogen rich soils with a pH of between 6.0 and 6.5.

Varieties

Green forms

1. Lucullus
2. Fordhook Giant

Red-ribbed forms

1. Ruby Chard
2. Rhubarb Chard

Sowing time

Clusters of chard seeds are usually sown during September-October under subtropical conditions of Jammu

Seed Rate: 16-18kg/acre

Spacing: 40 x 20cm

Manure and Fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
8-10	32 (64.0)	10 (22.0)	10 (17.2)

Apply whole of FYM, P₂O₅ and K₂O and 1/4 nitrogen before sowing. Rest of nitrogen should be applied in splits after each cutting followed by irrigation.

Irrigation

First irrigation should be given immediately after sowing and subsequent at weekly interval for better growth of foliage.

Interculture and weed control

2-3 hoeing cum weeding are required to keep away the weeds from the field. Hand weeding is advocated in the earlier stage. After every cutting, weeding and hoeing should be done.

Harvesting and storage

Chard can be harvested while the leaves are young and tender. Leaf petioles are tied in small bunches for marketing. 3-4 pickings can be taken in a season. Average yield ranges from 100-120q/acre. After harvest, chard can be stored for 7-10 days, when kept at 0°C and 90 percent humidity.

39. Colocasia (*Colocasia esculenta* L.)

Colocasia (Arvi or Ghuiyan) is a popular vegetable and its all the parts (tubers, leaves and petioles) are used as vegetable. Chips are also prepared from the tubers. Tubers are rich in starch content. It is good source of carbohydrates, proteins, vitamins (A&B) and minerals (calcium and phosphorus).

Climate and soil

It is primarily a warm season crop and can be grown in both summer and rainy season. However, too hot and dry weather adversely affect its growth. It can be grown in almost all types of soil except the clayey soils. However, well drained sandy loam soils are considered ideal.

Varieties

Punjab Arvi 1: It matures in 175-190 days. Average yield is 80q/acre.

Planting Time

It varies from region to region. In northern India, the planting is done in February-March (summer crop) and June-July (rainy season crop).

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
4-6	40 (82.0)	28 (61.6)	36 (61.2)

The field should be prepared well by one deep ploughing and harrowing. Planking should be done to make the soil friable and to conserve the moisture. Whole of FYM, Phosphorus and Potash along with $\frac{3}{4}$ of nitrogen should be applied at the time of planting. Remaining $\frac{1}{4}$ dose of nitrogen should be applied as top dressing at the time of earthing up.

Seed rate and spacing

About 3.2-4.8 quintal medium sized prouted corms/cormlets are required for one acre. These are planted 6-8 cm deep during February in plains/low hill regions while maintaining row to row spacing of 45-60 cm and plant to plant spacing of 20-30 cm.

Irrigation

During summer season crop should be irrigated at weekly interval. There is no need of any irrigation in rainy season. If the crop is raised for tubers/corms, no irrigation is needed after monsoon because at that time tubers harden, and foliage dries up.

Interculture and weed control

Two shallow hoeings are sufficient followed by earthing up. At the time of earthing up, additional shoots should be pruned off, leaving one or two main shoots in order to increase more number of cormels.

Harvesting and Storage

It is common practice to take out some side cormels during early harvesting for table purpose. This practice gives good remuneration to the growers and help in increasing the growth and bulking of central corms. The final harvesting is done 120-150 days after planting when the foliage becomes yellow and dries. After harvest, corms are spread under shade, cleaned, graded and stored for market supply.

Seed

The secondary corms are separated from main corm are stored and used for seed in next year.

Insect-pest management of colocasia

1. Flea beetle (*Monolepta signata* Oliver) or white spotted flea beetle: This is polyphagous in habit. The vegetable crops like beet root, cabbage, cauliflower, chillies and radish act as host plants. The beetles feed on leaves and make holes resulting in slow growth of the plants and ultimately affecting both the leaf and the tuber yields.

Control measures: Spray the crop with acetamilaprid 20 WP @ 0.2 g/litre of water.

Leaf eating caterpillars: Larve or a number of lepidopterous pests feed on young leaves which become unfit for human consumption. The common species which damage the colocasia crop are *Pericallia ricini* Fabr., *Agrius convolvuli* L., *Theretra* spp.

Control measure

1. Hand-picking of the caterpillars and destroying them.
2. Spray the crop with cypermethrim 10 EC @ 1 ml/litre of water

Diseases management of colocasia

Colocasia blight (*Phytophthora colocasiae* Racib): The disease first appears in the form of small, dark and roundish spots on the leaves and petioles. Later, these increase in size becoming circular, oval or irregular. The corms and cormels may also get damaged.

Control measures

1. Planting of healthy corms and cormels.
2. Spraying of copper oxychloride (0.3%) or iprovalicarb + propineb @ 4gm/litre of water.
3. Grow resistant varieties.
4. Avoiding cultivation of colocasia more than once in the same field.

40. Ginger (*Zingiber officinale*)

Ginger is one of the most important spice crops of the region. Its characteristic pungency, aroma and flavor are due to the presence of oleoresins and volatile oils. Ginger rhizomes have immense medicinal properties. It warms and softens stomach, cures pains, cough and chest disorders. It acts as analgesic, anti-arthritis, anti-helminthic, anti-ulcer and potential antioxidant.

Climate and soil

It is grown successfully in irrigated areas with good drainage and rain fed conditions in low/ mid hill regions with well distributed annual rainfall. The favorable temperature range is 19-28°C. The temperature lower than 13°C induces dormancy while higher than 32°C causes sunburns. The foliage and rhizomes are also destroyed by frost resulting in poor storability. Cold climate during resting period does not affect the crop. It thrives well under partial shade in plains and low/mid hills. It can be grown as an intercrop with maize or in orchards.

It can be grown in all types of soils. The sandy loam, light, loose, friable, well drained soils rich in organic matter with pH between 6.0-6.5 are considered ideal. It is grown as rainfed crop in low/mid hills but irrigation is useful. It is very sensitive to water logging, frost and salinity.

Varieties

Varda: The crop duration is 200 days. This variety has 6.7% oleoresin and 1.7% essential oil. Crop duration is 200 days. Fresh mean yield is 88-92 q/acre and dry recovery is 19.5%.

Mahima: This variety possesses 3.3% crude fibre, 4.5% oleoresin and 1.7% essential oil. Duration is 200 days. Fresh mean yield is 92-96 q/acre and dry recovery is 23.0%.

Hingiri: Duration is 210 days. Fresh mean yield is 92-96 q/acre. Other local varieties grown in mid hill region includes Tanda local and Ghordi local.

Planting time

Irrigated conditions: March-April

Rain fed areas: April-May

Mid and high hills: May-June

Seed rate

The ginger seed is very costly input and involves about 50% of the total cost of production. Seed rate vary with the size or weight of the seed bits and may be 6-8 q/acre. Bit size may be 15-150 g or 3-10 cm in length or with 2-8 eyes. Seed bits of 20-25 g having 2-3 eyes are generally recommended. Before sowing treat

the seed with a mixture of diathane M-45 +copper oxychloride or chlorpyriphos 10 EC (0.2%) for one hour and dry in shade for 24 hrs. as a safeguard against soft rot and to induce early sprouting. Rhizomes for seed are also treated in hot water at 48°C for 20 minutes before planting. Soaking seed rhizomes in water for 24 hours 10 days prior to planting results in good sprouting.

Spacing

Ginger can be sown on ridges or furrows or flat beds, however flat sowing on raised beds is preferred. Depending on the seed rhizome size and weight, agro-ecological situation etc. the spacing of 20 x 25 cm is recommended. Seed bits is placed 3-5 cm deep in the soil.

Manure and fertilizers

Ginger is very exhaustive and long duration crop thus requires considerable amount of manure and fertilizers. The recommended schedule is as follows:

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
10-12	30(60.0)	20 (44.0)	30 (50.8)

The FYM should be applied by broadcasting during land preparation. Full dose of phosphorus and potash along with 1/3 N should be applied as basal dose. Remaining N should be splitted in two equal doses i.e. one month after germination and rest one month after the second split. The beds are to be earthed up after each top dressing with the fertilizers. Application of neem cake @ 0.8 t/acre at the time of planting helps in reducing the incidence of rhizome rot and increases the yield. Overdoses of nitrogen should be avoided as it induces more tenderness leading to proneness to rhizome rot.

Mulching

It is an essential operation in ginger to enhance sprouting, conserves soil moisture, maintains optimum temperature and prevents weeds, evaporation, and runoff of soil due to heavy rains. Preferably locally available material like green or dry grass/leaves, paddy straw, cane trash, sarkanda etc. can be used. Generally 8-10 t/acre is recommended. The first mulching is done at the time of planting or just after planting. It is to be repeated at 40 and 90 days after planting, immediately after weeding, hoeing, earthing up and application of fertilizers. Under low shade mulching may be reduced without affecting the yield.

Harvesting and Storage

The crop is ready for harvesting after 8-9 months. For seed purpose, fully mature and disease free rhizomes are stored above ground or in pits. In former method, healthy rhizomes are treated with copper oxychloride 0.3% or chlorothalonil 0.2% solution for 30 min. and shade dried for 2 days. These are heaped over a layer of 5-10 cm. sand under shade of the tree or shed or ventilated room, covered with turmeric leaves and then plastered with earth mixed with cow dung. In below ground storage, pits of 1x1x1 m or convenient

size as per requirement are made under shade/shed. The walls of the pit are plastered with cow dung while keeping a layer of sand at the base of pit. Healthy and disease free rhizomes are treated with copper oxychloride or chlorothalonil and dried as explained. These seed rhizomes are then placed loosely in pits and filling done by leaving 10-15 cm. space from the top and covered with dry grass. The pits are then closed with wooden plank and plastering done. Perforated PVC pipe of 2 inches diameter is kept in the centre of the pit for removal of gases. The seed rhizomes can be stored for 3-4 months before next planting. The seed rhizomes can also be stored in saw dust and sand. The rhizomes can be removed 20-25 days before planting.

41. Turmeric (*Curcuma longa*)

Turmeric is widely used as spice and food colorant. It has long been used in ayurvedic and Chinese medicines for various ailments. The active ingredient in turmeric is curcumin.

Climate and soil

The crop can be successfully grown in irrigated areas and rainfed plains/low hill region regions as single or mixed/intercrop. It can be grown on various types of soils but thrives best in well drained, friable, sandy or clay soils rich in organic matter. The crop cannot withstand water logging and alkalinity. Loamy soils are best suited for the development of rhizomes.

Varieties

PH-1: Plants are erect and leaves are green and medium in size. Rhizomes are long and medium thick. Skin colour is brown and flesh is dark yellow. Duration is 215 days; fresh average yield is 108 q/acre.

PH-2: Plants are erect and leaves are green and broad. Rhizomes are long and thick. Skin colour is brown and flesh is yellow. Duration is 240 days, fresh average yield is 120 q/acre.

Pant Peethabh: Long attractive fingers, curcumin: 7.5%, Fresh average yield is 80q/acre and dry recovery is 18.5%.

Prabha: Duration is 205 days, curcumin: 6.5%, Fresh average yield is 148 q/acre and dry recovery is 19.5%.

Pratibha: Duration is 225 days, curcumin: 6.2%, Fresh average yield is 156 q/acre and dry recovery is 19.0%.

Sowing/ Planting time

The optimum time of planting is April-May depending upon the availability of irrigation facility. However it can be delayed till fall of first monsoon showers under the rain-fed conditions, but yield is reduced under late planting.

Seed rate and spacing

Seed rate varies between 8-10 q/acre. The seed rhizomes bits of 30g. with 2 to 3 eyes are planted 10-12 cm deep in the soil. Rhizomes are treated with copper oxychloride (0.3%) for 30 minutes before planting. These seed rhizomes are planted in three ways namely

1. Raised bed method: Each bed is 1m wide, 15 cm. in height and of any convenient length with spacing of 30x20 cm between plants.
2. Ridge and Furrow method: Protects crop from water logging in rainy season with spacing of 45x22.5 cm
3. Flat system: Followed in sandy loam or well pulverized soils with a spacing of 50x15cm.

Manure and fertilizers

FYM (t/acre)	N (Urea) kg/acre	P ₂ O ₅ (DAP) kg/acre	K ₂ O (MOP) kg/acre
12-16	24 (48.0)	12(26.4)	36 (61.2)

Whole of phosphorus and potash and half nitrogen should be applied as basal dressing. The remaining nitrogen should be given in two split doses after 45 and 90 days after planting.

Irrigation

First irrigation is given immediately after planting and then as per need. The number of irrigations may vary with the soil types. During the period of rhizome development and maturity, frequent irrigations are necessary.

Interculture and weed control

The initial growth of turmeric is slow and 1-2 hoeings during this period are must. Mulching is an essential operation in turmeric. It can be done with green or dry grass/leaves, paddy straw, cane trash or sarkanda. The first mulching is done at the time of planting and repeated again after 3 months. It can be grown as inter crop with chillies, colocasia, and onion and so as to get maximum returns per unit area. Earthing up should be done 3-4 times one each after 40 -50 days after planting (DAP), 90-105 DAP and 120-135 DAP.

Harvesting & Storage

Depending upon the varieties, the crop matures in 8-9 months after planting. Maturity is indicated by complete yellowing and drying up of plants somewhere in January. The rhizomes are harvested by digging and cleaned. Mother rhizomes are separated from the fingers before they are cured. For seed purpose, fully mature and disease free rhizomes are stored conventionally on above ground or below ground (or pits). Method followed is same as explained for Ginger.

Insect-pest management in ginger and turmeric

Shoot borer (<i>Conogethes punctiferalis</i>)	1. Spraying of malathion 50 EC@ 2 ml/litre of water or <i>Bacillus thuringiensis</i> dipel @ 200g/acre or 2g/litre of water. 2. Applied as soon as the 5% dead hearts are observed.
Rhizome scale (<i>Aspidiella hartii</i>)	1. Discard the severely infested rhizomes. 2. Soaking of rhizomes in quinalphos 25EC @ 1 ml/litre of water prior to storage and sowing.

Disease management in ginger and turmeric

Rhizome rot: Caused by *Pythium myriotylum*, *P. graminicolum* & *P. aphanidermatum*. The pathogen is soil and seed borne in nature.

Symptoms: The disease is characterized by the appearance of water soaked lesions at the base of pseudo stem and yellowing of lower leaves. The root infection is visible as browning and rotting of roots which advances to rhizomes changing its colour from bright orange to different shades of brown. The

rhizomes finally becomes soft & rotten. The infected plants show gradual drying up of leaves along the margins and later entire leaf dries.

Management: Rhizome treatment with copper oxychloride (0.3%), metalaxyl (0.1%) and iprovalicarb + propineb @ 4gm/litre of water. Soil drenching with metalaxyl (0.2%) at 15-20 day interval twice with the first appearance of symptoms is effective in managing the disease.

Storage rot: Caused by *Macrophomina phaseolina* and *Cladosporium cladosporioides* other species viz. *Aspergillus*, *Fusarium*, *Rhizoctonia* and *Sclerotium* are also reported to be associated with rot.

Symptoms: It is a serious problem in turmeric. Improper storage as well as heaping harvested rhizomes under sun results in rotting of rhizomes. The rot is caused by a complex of fungus species. Favorable incubation temperature and relative humidity at 60% leads to maximum spoilage. But no rotting occurs at 15°C even when the RH varied from 30-90%. The rot is maximum in September and minimum in May in north Indian conditions.

Management: Storage rot can be controlled by treating the rhizomes with copper oxychloride @ 0.3% or chlorothalonil @ 0.2%. After seed treatment, the rhizomes should be well air dried before storage.

42. Nursery Production in Vegetables

Site selection

- Area selected should be well drained, and free from water logging
- There should be proper sunlight,
- The nursery should be near the water supply so that irrigation can be easy.
- The area should be well protected from pet and wild animals

Nursery bed preparation

- Prepare 1-1.5m raised nursery beds of convenient length
- Mix 3 kg well rotten and fine Farm yard manure/compost or leaf compost or 500 g vermicompost per square meter and mix in the soil. If the soil is heavy mix 2-3 kg sand per square meter so that the seed emergence may not be hampered. Add 20g Urea, 20g DAP and 15g MOP in one square meter area.
- Soil solarization may be done during May-June when temperature is between 30-40°C in plains and low/mid hills. Wet the soil with water and cover the whole nursery area with white polythene of 200 gauges for about 5-6 weeks. The margin of the polythene should be covered by wet soil (compressed mud) to check the entry of air.
- Alternatively, fumigation can be done with formalin solution (1.5 to 2%). Add 15-20 ml /litre of water in one container and drench the soil @ 4-5 litre of water per square meter soil surface to saturate it up to a depth of 15-20 cm. Cover the drench area with polythene sheet of 200 gauge. Put the wet soil on the margin of the covered polythene sheet so as it does not allow the polythene film blown away by the wind. Remove the cover (polythene) after 15 days. Prepare the beds for seed sowing.
- Drenching of beds with fungicides copper oxychloride @ 0.3% (5-6 g/m²) can also be done for sterilization of nursery area.
- For controlling soil borne insects, chlorpyrifos @ 2 ml/ litre of water can be used
- Pre emergence herbicides like pendimethlin @ 2.5 ml/litre of water can be sprayed on the nursery beds to check weeds.

Sowing

- Seed should be sown in lines at a distance of 5.0 cm and covered with straw mulch.
Remove the mulch after seed germination and provide light irrigation with the help of rose can.

Weed control

- Timely weeding in nursery is very important to get healthy seedling. If there are some weeds in the seed bed, remove them manually either by hand or by hand hoe (thin forked khurpi).

Transplanting

The seedlings are ready for transplanting after 4-6 weeks of sowing. Light irrigation may be given before harvesting.

43. Hybrid Vegetable Cultivation

Hybrids have demonstrated supremacy for enhancing productivity in various vegetables. Both public/private sector hybrids are now available in various vegetable crops including crops tomato, brinjal, chilli, capsicum, cucumber, water melon and bottle gourd. Hybrids have also demonstrated higher productivity per unit area in farmer's field under protected cultivation. They are now becoming popular for kitchen and container gardening in urban/periurban areas. Important features of hybrids include higher yield, uniformity, early maturity, resistance/ tolerance to insect-pests and diseases, better quality and wider adaptability. The important considerations for growing hybrids are as under:

1. Recommended hybrids may be grown.
2. High yielding and multi disease resistant hybrids that are adapted to various micro climates should be preferred.
3. Obtain seeds from authentic/reliable source.
4. Grow hybrids in situations where irrigation is assured and plant protection measures within reach of farmers and affordable.

Institutional and popular hybrids in vegetable crops

Sl. No.	Crop	Hybrids
1	Tomato	Arka Rakshak, Arka Vardan, Pusa Hybrid-2, Rupali, NS-815, NS-2530, Pusa Hybrid-2, Naveen, Rashmi, BSS 488, Meenakshi and Tolstoi.
2	Brinjal	PBH-3, Navkiran, Pusa Hybrid-5, Pusa Hybrid-6, Arka Navneet, Kashi Komal, Klashi Sandesh, NHB-10, Nisha Improved, Shamali, PBH-5, PBHR-41, PBHR-42 and PPL-74
3	Chilli	CH-1, CH-3, Tejaswani and NS-101.
4	Capsicum	Nishat, Pusa Deepti, Bharath, Indira and Lerio.
5	Cucumber	Malini, Pusa Sanyog, Pant Sankar Khira-1
6	Bottle gourd	Pusa Hybrid-1, Pusa Hybrid-3 and Warad
7	Bitter Gourd	Palee, Chaman and Pusa Hybrid-1
8	Water Melon	Arka Jyoti, Arka Manik and NS-2895.
9	Musk Melon	Punjab Hybrid, MH-27, MH-51
10	Cauliflower	PPH-1 and PPH-2
11	Cabbage	Punam, Pusa Hybrid-2, Priya, Ageti Himlata, NS-60, NS-66 and Summer King

Tips for hybrid cultivation in subtropical plains/low hills

Name of the vegetable	Time of sowing	Row Spacing (cm)	Plant spacing (cm)	Seed Rate (kg/ acre)	N (kg/ acre)	P (kg/ acre)	K (kg/ acre)	Harvesting (days)
Tomato	Feb-March	90	60	0.1	80	40	40	60-70
Brinjal	Feb-March	90	90	0.1	80	40	32	80-90
Chillies	Feb-March	75	60	0.14	60	32	32	70-80
Capsicum	Feb-March	80	45	0.1	80	60	40	70-80
Okra	March-April (Summer crop)	60	60	6.0	80	40	40	50-60
	June-July (Rainy Crop)	90	90	4.8				
Onion	Nov (Nursery) Jan (Planting)	20	10	2.0	80	40	40	150-160
Cauliflower	Sept-Oct	60	60	0.12	80	40	40	70-80
Cabbage	Sept-Oct	50	50	0.12	80	40	40	60-65
Cucumber	Feb-March	150	60	0.4 0.1 (Polybag)	24	16	16	70-75
Bottlegourd	Feb-March	250	90	0.28 0.12(Polybag)	80	40	40	70-80
Bittergourd	Feb-March	200	90	1.2 0.16 (Polybag)	80	40	40	80-85

44. Vegetable Based Cropping System

Most of the vegetable crops are of short duration and fit in with a number of sequences which results in greater production per unit area and time. Adoption of multiple cropping in vegetables enhances the income of the farmer. It also helps in weed control measures. The success of these vegetable rotations depends upon the selection of proper crops and varieties, adjustment of sowing time, adequate application of organic Manure and fertilizers; irrigation; Control of diseases, insect-pests, nematodes and weeds; and timely cultural operations.

Vegetable based cropping systems for different zones

Sub-tropical zone

1	Tomato (End Jan.-End May)	Brinjal (June- November)	Cole crops (December-January)
2.	Brinjal	Sweet corn (May- September)	Potato (Oct- End Jan)
3.	Onion	Brinjal	Radish
4.	Cucumber	Brinjal	Knol Khol
5.	Gourds	Okra	Potato
6.	Potato	Sweet Corn/Okra	Radish
7.	Pumpkins/Squashes	Brinjal	Cauliflower
8.	Okra (End Jan- June)	Cucumber (July-Oct)	Potato (Oct- Jan)
9.	Beans (Mid Jan-May)	Okra(June- Oct)	Leafy vegetables (Nov- Jan)

Tomato & Spring Potato based cropping systems are highly vulnerable to temperature fluctuations. Adherence to the recommended planting dates and stable varieties is strictly recommended to meet the vagaries of climate change for potential harvests.

Intermediate higher Zone

1.	Tomato, potato, capsicum spp. brinjal, beans, cabbage, cauliflower, knol khol, kale, cucurbits and beans (April – July)	Leafy Vegetables, radish, turnip and beans (August – October)	garlic, peas, potato (October – May)
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45. Protected Cultivation

Protected (Poly house or net house) cultivation is emerging as additional option for efficient use of land/water resources and quality vegetable production. Protected cultivation provides congenial environment at microclimate level for enhanced production both in main and offseason. A few crops (including cucumber, capsicum and tomato) under protected cultivation have recorded 2-4 times higher yield depending upon type of structure and agro-climatic conditions. Protected cultivation provides opportunities for vegetable cultivation in extreme weather conditions and making available produce during extended period. Net house / poly house and trench cultivation technology hold potential to supplement income of farmers.

Types of Protected structures

1. Hi-Tech Poly/Net House

These are high cost structures constructed to achieve higher degree of climate control (light, temperature and humidity) to enhance the growing period of the crop. These automatically controlled structures require uninterrupted power supply. These are mostly used for nursery production of hybrids at commercial level; and cultivation of cucumber, tomato and coloured capsicum and other high value crops for higher yield, better quality and availability over extended period.

2. Poly/Net House (Partial climate Control)

These are partial climate control medium cost structures. These are made up of galvanized iron pipes with provision of exhaust fans and cooling pads structures. These are for maintaining temperature and humidity. These are suitable for cultivation of cucumber, tomato and coloured capsicum and other high value crops

3. Naturally ventilated Poly/Net House

These are relatively simple low cost structures. The frame could be made with galvanized iron pipes, bamboos, wooden logs or steel pipes or other local material with no provision for heating or cooling system. These are suitable for cultivation of cucumber, tomato, coloured capsicum and other high value crops.

4. Plastic low tunnels

These are simple and low cost structures used for nursery production and cultivation of vegetables in mid/ high hill regions where damage from hail, winter cold injury, frost and strong winds is reduced.

Nursery production under protection

Nursery raising technology has been developed for raising healthy, disease free and off-season nursery using beds, polythene bags and plug trays. Two growing media are commonly used.

- 1. Coco-peat:** Coco peat also known as coir pith, coir fiber pith and coir dust, is relatively new growing medium being used for growing vegetables and ornamentals in hydroponics and soil less culture.
- 2. Perlite:** Perlite is a siliceous mineral of volcanic origin. The light powdery substance is neutral in reaction and provides no nutrients to the mix except for small amounts of sodium and aluminum.

Seedlings production under protection

The raising of cucurbits seedlings in polythene bags and their transplantation give mature fruits 20-25 days earlier than the normal sowing. The polythene bags of 15 x 10 cm size and 100 gauge thickness are punched at the base and are filled with a mixture of soil, sand and well rotten farm yard manure in ratio of 2:1:1. For raising nursery for 1 acre, 5.0-6.0 kg of polythene bags are required. The seed should be sown in bags in the last week of December or in the first week of January. The bags should be placed near the wall facing the sun in order to give them maximum solar heat. Two seeds should be sown per bag at a depth of 1.0-1.5 cm. Watering can be done with rose can just after the seed sowing. Transplanting should be done when the seedlings are 25-30 days old and should be completed latest by 1st fortnight of February

At the time of transplanting a cut is given on the side of the bag with a sharp knife and the bag is removed. The seedlings are transplanted along with the earth ball and the irrigation is given immediately. Other benefits of this method is early yield, less seed rate (i.e. 100 g/acre) and minimum attack of red pumpkin beetle as the crop grows 15-20 days early.

Detailed dimensions of Polynet-house structure *Source: PAU, Ludhiana*

Sl.No.	Particulars	Dimensions
1	Area	250 m ²
2	Length	32.0 m
3	Width	8.0 m
4	Height at the centre	3.0 m
5	Height at the side	2.0 m
6	Depth of the foundation	0.90 m
7	Distance between two side poles	2.0 m
8	Door size	2.0 x 1.0 m
9	GI pipes for foundation post	25.0 mm dia
10	GI pipes for hoops, perlins and other support	19.0 mm dia
11	GI pipes for making hoops and truss	12.5 mm dia

** Structures suited for early nursery raising and cultivation during winters for plains and low/mid hills.*

Detailed dimensions of Polyhouse structure *Source: PAU, Ludhiana*

S.No.	Particulars	Dimensions
1	Area	100 m ²
2	Length	16.0 m
3	Width	6.25 m
4	Height at the centre	3.0 m
5	Height at the side	2.0 m
6	Depth of the foundation	0.90 m
7	Distance between two side poles	2.0 m
8	Door size	2.0 x 1.0 m
9	GI pipes for foundation post	25.0 mm dia
10	GI pipes for hoops, perlins and other support	19.0 mm dia
11	GI pipes for making hoops and truss	12.5 mm dia

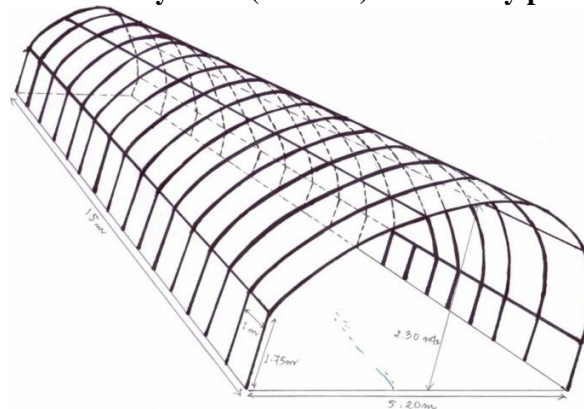
** Structures suited for early nursery raising and cultivation during winters for plains and low/mid hills.*

List of hybrids suitable for growing under poly house conditions

S No.	Crop	Hybrids
1.	Tomato	Pant Poly House Tomato-1,Pant Poly House Tomato-2,Palam Hybrid-1,Naveen,Surya and Rakshita Cherry Tomato: Punjab Red Cherry, Punjab Kesar Cherry
2.	Cucumber	Kian, Nun-9729, Nun-9729,Nun 3019,Mansaur,Satis
3.	Capsicum	Red: Indira, Heera, Bombay Yellow: Orebelle,US-26,Tanvi,Nun-3020 Green: California Wonder(OP),Indra,Bharat,Mekong
4.	Lettuce	Iceberg, Garishma, Dublin and Red Butter Head

**Recommended for cultivation in plains and low/mid hills*

Detailed dimensions of Polyhouse (low cost) for nursery production



Length: 15.0 m; Width: 5.20 m; Central height: 2.30 m; Side height: 1.75 m;
Distance between 2 poles: 1.0 m

Source: Division of Vegetable Science and Floriculture, SKUAST-Jammu

46. River Bed Cultivation

It is a specialized technique of growing off season summer vegetables under intense cold conditions. Mostly cucurbits and solanaceous vegetables are sown from mid-September-December in trenches for production of peri urban summer vegetables. Land is demarcated for the digging of trenches after the rains are over (1st week of September). Trenches of convenient size (Length 30-35 m, width 1.0-1.25m and depth 1.75-2.0m) are dug in moist soil manually in East-West direction. These trenches are usually dug up to the level from where the ground water starts oozing. It is principle of river bed / trench cultivation in the areas where irrigation facilities are not available but crop meets its water requirement during summer months from the ground by capillary action. In irrigated areas trenches are dug up to the depth of 0.75-1.00m below the ground level. Trenches are generally spaced 2.0- 3.0 meters apart depending upon the variety and type of crop to be raised.

Trench filling and trench geometry at sowing

Trenches are filled with mixture of soil, sand, well rotten FYM and organic manures up to 0.5 feet below ground level to act as hot beds in such a way that these may go down to the root zone for better growth of the crop during intense cold conditions. After filling the trenches are left for few days to settle various layers of soil. Sometimes pre sowing irrigation is also managed which not only settle the soil layers but also facilitates better germination of seed.

Manure and fertilizers

Fertilizers are applied in each trench at the following rates:

FYM (kg)	Urea(kg/trench)	DAP(kg/trench)	MOP (kg/trench)
250	2.0	3.0	1.0

FYM is incorporated in trenches a few weeks earlier to sowing and plantings. *Azotobacter* and *Azospirillum* @ 5g/m² and *Trichoderma* @ 2-3 kg/ trench are applied to control soil borne pathogens (collar rot, damping off and wilt).

Pre- sprouting of seeds

Seeds are dipped in a water container for 4-6 hours. Wrap the moist seeds in a bundle of straw and leaves in a piece of cloth and keep bundles in a heap of FYM or at a warmer place for two days to fasten its sprouting. Keep the sprouted seeds in a tightly packed polythene bag for it further use till the sowing is completed in the field.

Sowing/ transplanting time

Two pre sprouted seeds of cucurbits per hill are sown under optimum soil moisture at a depth of 3-4 cm and spacing of 60 cm. Trenches are covered immediately after sowing with low density polythene sheets of convenient length

and width to conserve heat in order to facilitate periodical sowings of cucurbits at an interval of 7 days to regulate the supply of fruits in the market is recommended as per the schedule mentioned below:

Bitter gourd	:	I st fortnight of September
Pumpkin	:	I st fortnight of October
Bottle gourd	:	I st fortnight of November
Round Gourd	:	I st fortnight of November
Summer Squash	:	I st fortnight of November
Cucumber	:	I st fortnight of January
Muskmelon	:	I st fortnight of January
Watermelon	:	I st fortnight of January
Watermelon (autumn)	:	Last week of October

Transplanting of seedlings raised in poly-bags/ low cost poly arc tunnels can also done to save time for raising early crop for fetching remunerative returns. After few weeks, root system develops and top dressing of urea @ 2.0 kg per trench is done followed by hoeing and weeding. Care should be taken that the urea should not come in direct contact with the plants particularly under un-irrigated conditions where damage to the spreading vines has often noticed.

At the same time, 40 days old seedlings of tomato, brinjal and capsicum raised under low cost poly arc tunnels/ thatch houses during intense cold conditions of December can also be transplanted in the month of January in trenches for production of early crops.

Irrigation

Initially the young seedlings are watered with fountain bucket and thereafter roots absorb nutrients and moisture from the trenches through capillary action when there is no surface water. Under irrigated conditions irrigation is applied as per the requirement of the crop. Always give light irrigation to the trench grown crops to avoid damage to the crops by anoxia or hypoxia conditions

Use of Wind breaks

In Northern India where winter temperature dips down to 1°C during December and January, the young plants are to be protected against frost and cold wind by erecting sarkanda grass (*Saccharum munja*) wind breaks at an angle of about 60° to the trench. The wind breaks have advantages 1) check sand drifting on the dug up trenches and covering the hills sown with seed; 2) help training of vines when spread over the sand; 3) prevent the sand being blown off with vines especially in May when too hot summer winds sweep the areas; and 4) protect fruits from heat and fruit rot.

Training of vines

After proper hoeing, weeding, top-dressing and earthing up, training and spreading of spreading vines is done on sarkanda grass (wind break) spread on sand wind breakers. .

Harvesting

The harvesting of crop is done at proper maturity stage. The crop fetches lucrative returns because of its early entry in market. Yield is variable depending upon the location.

Annexure I

Fertilizer sources for the supply of nitrogen, phosphorus and potassium

(A) Nutrient contents of different fertilizers

Fertilizer	N (%)	P ₂ O ₅ (%)	K ₂ O (%)	Other
Ammonium Sulphate	20.5	-		-
Ammonium Chloride	25.0	-		-
Calcium Ammonium Nitrate	25.0	-		-
Urea	46.0	-		-
Superphosphate (single)	-	16.0		-
Diammonium Phosphate	18.0	46.0		-
Urea-ammonium Phosphate	28.0	28.0		-
Sulphate of Potash	-	-	48.0	-
Muriate of Potash	-	-	60.0	-
Manganese Sulphate	-	-	-	30 (Mn)
Zinc Sulphate	-	-	-	21 (Zn)
Ferrous Sulphate 7 H ₂ O	-	-	-	19 (Fe)
Copper Sulphate S1 H ₂ O	-	-	-	24 (Cu)
Gypsum	-	-	-	16 (G)

(B) Quantity of the fertilizer to give 1 kg of nutrient

For 1 Kg of N				
Calcium Ammonium Nitrate		4 kg		
Ammonium Chloride		4 kg		
Ammonium Sulphate		5 kg		
Urea		2.2 kg		
For 1 kg of P₂O₅				
Superphosphate		6.2 kg		
Diammonium Phosphate		2.2 kg		
Urea-ammonium Phosphate		3.6 kg		
For 1 kg of K₂O				
Muriate of Potash		1.7 kg		

Annexure II**Nutrient contents of different fertilizers**

Fertilizer	N (%)	P ₂ O ₅ (%)	K ₂ O (%)	Other
Ammonium Sulphate	20.5	-	-	-
Ammonium Chloride	25.0	-	-	-
Calcium Ammonium Nitrate	25.0	-	-	-
Urea	46.0	-	-	-
Super Phosphate (Single)	-	16.0	-	-
Diammonium Phosphate	18.0	46.0	-	-
Urea Ammonium Phosphate	28.0	28.0	-	-
Sulphate of Potash	-	-	48.0	-
Murate of Potash	-	-	60.0	-
Manganese Sulphate	-	-	-	30.0 (Mn)
Zinc Sulphate	"-	-	-	21.0 (Zn)
Ferrous Sulphate	-	-	-	19.0 (Fe)
Copper Sulphate	-	-	-	24.0 (Cu)
Gypsum	-	-	-	16.0 (G)

Quantity of the fertilizer to give 1 kg of nutrient**For 1 Kg of N**

Calcium ammonium nitrate	4 kg
Ammonium Chloride	4 kg
Ammonium sulphate	5 kg

Urea	2.2 kg
For 1 kg of P₂O₅	
Superphosphate	6.2 kg
Diammonium Phosphate	2.2 kg
Urea-ammonium Phosphate	3.6 kg
For 1 kg of K₂O₅	
Muriate of Potash	1.7 kg

Annexure III

New molecules of insecticides/ biopesticides/ pheromones in vegetable crops

Common name and formulations	Trade name	Recommendations		Target pests
		Per cent	ml/lit or g/lit	
Abamectin 1.8 EC	Vertimec	0.0009	0.5	Mites, thrips
Acetamiprid 20 SP	Pride	0.004	0.2	Sucking insect pests
Beta cyfluthrin 2.5 EC	Bulldock	0.0035	1.5	Fruit and shoot borers
Fipronil 5 SC	Regent	0.01	2.0	Borers, soil drenching for soil dwelling insects
Imidacloprid 17.8 SL, 200 SL	Confidor, Sensor	0.0045	0.25	Sucking insect pests which are responsible for transmitting viral diseases
Indoxacarb 14.5 SC	Avaunt	0.0145	1.0	Borers
Methomyl 40 SP	Lannate	0.06	1.5	Borers
Propargite 57 EC	Omite	0.142	3.0	Mites
Spinosad 45 SC	Tracer	0.018	0.4	DBM, lepidopteran borers
Thiomethoxam 25 WG	Actara	0.005	0.2	Seed treatments for sucking pests
<i>Bacillusthurin giensis</i> (Bacteria)	halt, biolep,dipel, thuricide, <i>Bt kurstaki</i> , <i>Bt aizawai</i>	-	0.5 to 1.0	Lepidopteran insect pests
NPV (virus)	<i>HaNPV</i>	-	1.0	<i>Helicoverpa armigera</i>
NPV	<i>SpltNPV</i>	-	1.0	<i>Spodoptera litura</i>
GV (virus)	Granulosis virus	-	1.0	<i>Plutella xylostella</i>
<i>Beauveria bassiana</i> (fungus)	Boverin, biotrol	-	3g	Caterpillars, white grubs
<i>Verticilium lecanii</i> (fungus)	Verticel, mycotal	-	3g	Aphids, thrips, whiteflies scale insects
Azadirachtin <i>Pongamia</i> (Karanz)	Various neem based products <i>Pongamia</i> soap	-	3-5ml	Caterpillars, leafhopper, white flies, aphids caterpillars
Pheromones devices	Heli-lure		12-15	<i>Tomato fruit borer</i> , <i>Helicoverpa armigera</i> (<i>Polyphagous pests</i>)

	Spodo-lure		12-15	<i>Spodoptera litura</i> (<i>Polyphagous pests</i>)
	Leuci-lure		100	<i>Leucinodes orbonalis</i> <i>Ibrinjal fruit and shoot borer</i>)
	Ervin lure		12-15	<i>Earias vitella</i> (<i>okra fruit borer</i>)
	Nomate-DBM		30	<i>Plutella xylostella</i> (<i>crucifers dreaded pests</i>)
	Cue lure or methyl eugenol traps		15-20	<i>Bactrocera cucurbitae</i> (<i>fruit fly traps</i>)

Annexure-IV

**Pesticides which are Banned, Refused Registration and
Restricted in Use**

(29.02.2020)

I. PESTICIDES / FORMULATIONS BANNED IN INDIA

A.	Pesticides Banned for manufacture, import and use.
1.	Aldicarb (vide S.O. 682 (E) dated 17 th July 2001)
2.	Aldrin
3.	Benzene Hexachloride
4.	Benomyl (vide S.O 3951(E) dated 8th August, 2018)
5.	Calcium Cyanide
6.	Carbaryl (vide S.O 3951(E) dated 8th August, 2018)
7.	Chlorbenzilate (vide S.O. 682 (E) dated 17 th July 2001)
8.	Chlordane
9.	Chlorofenvinphos
10.	Copper Acetoarsenite
11.	Diazinon (vide S.O 3951(E) dated 8th August, 2018)
12.	Dibromochloropropane (DBCP) (vide S.O. 569 (E) dated 25 th July 1989)
13.	Dieldrin (vide S.O. 682 (E) dated 17 th July 2001)
14.	Endosulfron (vide ad-Interim order of the Supreme Court of India in the Writ Petition (Civil) No. 213 of 2011 dated 13th May, 2011 and finally disposed of dated 10th January, 2017)
15.	Endrin
16.	Ethyl Mercury Chloride
17.	Ethyl Parathion
18.	Ethylene Dibromide (EDB) (vide S.O. 682 (E) dated 17 th July 2001)
19.	Fenarimol (vide S.O 3951(E) dated 8th August, 2018)
20.	Fenthion (vide S.O 3951(E) dated 8th August, 2018)
21.	Heptachlor
22.	Lindane (Gamma-HCH)
23.	Linuron (vide S.O 3951(E) dated 8th August, 2018)
24.	Maleic Hydrazide (vide S.O. 682 (E) dated 17 th July 2001)
25.	Menazon
26.	Methoxy Ethyl Mercury Chloride (vide S.O 3951(E) dated 8th August, 2018)
27.	Methyl Parathion (vide S.O 3951(E) dated 8th August, 2018)
28.	Metoxuron
29.	Nitrofen
30.	Paraquat Dimethyl Sulphate
31.	Pentachloro Nitrobenzene (PCNB) (vide S.O. 569 (E) dated 25 th July 1989)
32.	Pentachlorophenol
33.	Phenyl Mercury Acetate
34.	Sodium Cyanide (banned for Insecticidal purpose only vide S.O 3951(E) dated 8th August, 2018)*
35.	Sodium Methane Arsonate
36.	Tetradifon

	37.	Thiometon (vide S.O 3951(E) dated 8th August, 2018)
	38.	Toxaphene(Camphechlor) (vide S.O. 569 (E) dated 25 th July 1989)
	39.	Tridemorph (vide S.O 3951(E) dated 8th August, 2018)
	40.	Trichloro acetic acid (TCA) (vide S.O. 682 (E) dated 17 th July 2001)
B.	Pesticide formulations banned for import, manufacture and use	
	1.	Carbofuron 50% SP (vide S.O. 678 (E) dated 17 th July 2001)
	2.	Methomyl 12.5% L
	3.	Methomyl 24% formulation
	4.	Phosphamidon 85% SL
C.	Pesticide/ Pesticide formulations banned for use but continued to manufacture for export	
	1.	Captafol 80% Powder (vide S.O. 679 (E) dated 17 th July 2001)
	2.	Nicotin Sulfate
D.	Pesticides Withdrawn (Withdrawal may become inoperative as soon as required complete data as per the guidelines is generated and submitted by the Pesticides Industry to the Government and accepted by the Registration Committee. (S.O 915(E) dated 15th Jun, 2006)	
	1.	Dalapon
	2.	Ferbam
	3.	Formothion
	4.	Nickel Chloride
	5.	Paradichlorobenzene (PDCB)
	6.	Simazine
	7.	Sirmate (S.O. 2485 (E) dated 24 th September 2014)
	8.	Warfarin (vide S.O. 915 (E) dated 15 th June 2006)

- Regulation to be continued in the extant manner for non-insecticidal uses.

II. PESTICIDES REFUSED REGISTRATION

Sl.No.	Name of Pesticides
1.	2,4, 5-T
2.	Ammonium Sulphamate
3.	Azinphos Ethyl
4.	Azinphos Methyl
5.	Binapacryl
6.	Calcium Arsenate
7.	Carbophenothion
8.	Chinomethionate (Morestan)
9.	Dicrotophos
10.	EPN
11.	Fentin Acetate
12.	Fentin Hydroxide
13.	Lead Arsenate
14.	Leptophos (Phosvel)
15.	Mephosfolan
16.	Mevinphos (Phosdrin)
17.	Thiodemeton/ Disulfoton
18.	Vamidothion

III. PESTICIDES RESTRICTED FOR USE IN THE COUNTRY

Sl.No.	Name of Pesticides	Details of Restrictions
1.	Aluminium Phosphide	<p>The Pest Control Operations with Aluminium Phosphide may be undertaken only by Govt./ Govt. undertakings/ Govt. Organizations/ pest control operators under the strict supervision of Govt. Experts or experts whose expertise is approved by the Plant Protection Advisor to Govt. of India except ¹Aluminium Phosphide 15% 12 g tablet and ²Aluminum Phosphide 6% tablet.</p> <p>[RC decision circular F No. 14-11(2)-CIR-II (Vol. II) dated 21-09-1984 and G.S.R. 371(E) dated 20th may 1999]. ¹Decision of 282nd RC held on 02-11-2007 and, ²Decision of 326th RC held on 15-02-2012.</p> <p>The production, marketing and use of Aluminium Phosphide tube packs with a capacity of 10 and 20 tablets of 3 g each of Aluminium Phosphide are banned completely. (S.O.677 (E) dated 17th July, 2001)</p>
2.	Captafol	<p>The use of Captafol as foliar spray is banned. Captafol shall be used only as seed dresser. (S.O.569 (E) dated 25th July, 1989)</p> <p>The manufacture of Captafol 80% powder for dry seed treatment (DS) is banned for use in the country except manufacture for export. (S.O.679 (E) dated 17th July, 2001)</p>
3.	Cypermethrin	<p>Cypermethrin 3% Smoke generator, is to be used only through Pest Control Operators and not allowed to be used by the General Public. [Order of Hon'ble High Court of Delhi in WP(C) 10052 of 2009 dated 14-07-2009 and LPA-429/2009 dated 08-09-2009]</p>
4.	Dazomet	<p>The use of Dazomet is not permitted on Tea. (S.O.3006 (E) dated 31st Dec, 2008)</p>
5.	Dichloro Diphenyl Trichloroethane (DDT)	<p>The use of DDT for the domestic Public Health Programme is restricted up to 10,000 Metric Tonnes per annum, except in case of any major outbreak of epidemic. M/s Hindustan Insecticides Ltd., the sole manufacturer of DDT in the country may manufacture DDT for export to other countries for use in vector control for public health purpose. The export of DDT to Parties and State non-Parties shall be strictly in accordance with the paragraph 2(b) article 3 of the Stockholm Convention on Persistent Organic Pollutants (POPs). (S.O.295 (E) dated 8th March, 2006)</p> <p>Use of DDT in Agriculture is withdrawn. In very special circumstances warranting the use of DDT for plant protection work, the state or central Govt. may purchase it directly from M/s Hindustan Insecticides Ltd. to be used under expert Governmental supervision. (S.O.378 (E) dated 26th May, 1989)</p>

6.	Fenitrothion	The use of Fenitrothion is banned in Agriculture except for locust control in scheduled desert area and public health. (S.O.706 (E) dated 03 rd May, 2007)
7.	Methyl Bromide	Methyl Bromide may be used only by Govt./ Govt. undertakings/ Govt. Organizations/ Pest control operators under the strict supervision of Govt. Experts or Experts whose expertise is approved by the Plant Protection Advisor to Govt. of India. [G.S.R.371 (E) dated 20 th May, 1999 and earlier RC decision]
8.	Monocrotophos	Monocrotophos is banned for use on vegetables. (S.O.1482 (E) dated 10 th Oct, 2005)
9.	Trifluralin	(vide S.O 3951(E) dated 8th August, 2018) (i) The Registration, import, manufacture, formulation, transport, sell and its all uses except use in wheat shall be prohibited and completely banned from date of publication of this Order. (ii) A cautionary statement has to be incorporated in the label and leaflet that it is toxic to aquatic organism, hence should not be used near water bodies, aquaculture or pisciculture area.

Endosulfan*: Endosulfan has been banned by the supreme Court of India w.e.f. 13-05-2011 for production, use & sale all over India till further orders vide ad-Interim order in the Writ Petition (Civil) No. 213 of 2011

IV. PESTICIDES WHICH SHALL BE PHASED OUT VIDE GAZETTE NOTIFICATION NO. S.O. 3951 (E).

Sl.No	Name of the pesticide	Insecticides to be phase out by 31st December, 2020
1	Alachlor	(i) No new certificate of registration to manufacture shall be issued after publication of this Order. (ii) No person shall import, manufacture or formulate Alachlor with effect from the 1st January, 2019. (iii) The use of Alachlor shall be completely banned with effect from the 31st December, 2020. (iv) It is toxic to aquatic organism, hence a cautionary statement should be incorporated on label and leaflets “toxic to aquatic organism hence should not be used near water bodies, aquaculture or pisciculture area.
2	Dichlorvos	(i) No new certificate of registration to manufacture shall be issued after publication of this Order. (ii) No person shall import, manufacture or formulate dichlorvos with effect from the January, 2019. (ii) The use of dichlorvos shall be completely banned with effect from the 31st December, 2020. (iv) It is very toxic to aquatic organism, hence a cautionary statement should be incorporated on label

		<p>and leaflets that it is toxic to aquatic organism, hence should not be used near water bodies, aquaculture or pisciculture area.</p> <p>(v) A warning may be incorporated in the label and leaflet stating that this product is toxic to honey bees so do not spray during active honey bees foraging period of the day.</p>
3	Phorate	<p>(i) No new certificate of registration to manufacture shall be issued after publication of this Order.</p> <p>(ii) No person shall import, manufacture or formulate Phorate with effect from the 1st January, 2019.</p> <p>(iii) The use of Phorate shall be completely banned with effect from the 31st December, 2020.</p> <p>(iv) It is very toxic to aquatic organism, hence a cautionary statement should be incorporated on label and leaflets that it is toxic to aquatic organism, hence should not be used near water bodies, aquaculture or pisciculture area.</p> <p>(v) A warning may be incorporated in the label and leaflet stating that this product is toxic to honey bees so do not spray during active honey bees foraging period of the day. (vi) A cautionary statement should incorporate in label and leaflet that this product is toxic to birds.</p>
4	Phosphamidon	<p>(i) No new certificate of registration to manufacture shall be issued after publication of this Order.</p> <p>(ii) No person shall import, manufacture or formulate Phosphamidon with effect from the 1st January, 2019.</p> <p>(iii) The use of Phosphamidon shall be completely banned with effect from the 31st December, 2020.</p> <p>(iv) It is very toxic to aquatic organism, hence a cautionary statement should be incorporated on label and leaflets that it is toxic to aquatic organism, hence should not be used near water bodies, aquaculture or pisciculture area.</p> <p>(v) A warning may be incorporated in the label and leaflet stating that this product is toxic to honey bees so do not spray during active honey bees foraging period of the day.</p> <p>(vi) A cautionary statement should incorporate in label and leaflet that this product is toxic to birds.</p>
5	Triazophos	<p>(i) No new certificate of registration to manufacture shall be issued after publication of this Order.</p> <p>(ii) No person shall import, manufacture or formulate Triazophos with effect from the 1 st January, 2019.</p> <p>(iii) The use of Triazophos shall be completely banned with effect from the 31st December, 2020.</p>

		<p>(iv) It is very toxic to aquatic organism, hence a cautionary statement should be incorporated on label and leaflets that it is toxic to aquatic organism, hence should not be used near water bodies, aquaculture or pisciculture area.</p> <p>(v) A warning may be incorporated in the label and leaflet stating that this product is toxic to honey bees so do not spray during active honey bees foraging period of the day</p> <p>(vi) A cautionary statement should incorporate in label and leaflet that this product is toxic to birds</p>
6	Trichlorfon	<p>(i) No new certificate of registration to manufacture shall be issued after publication of this Order.</p> <p>(ii) No person shall import, manufacture or formulate Trichlorfon with effect from the 1 st January, 2019.</p> <p>(iii) The use Trichlorfon shall be completely banned with effect from the 31st December, 2020.</p> <p>(iv) It is very toxic to aquatic organism, hence a cautionary statement should be incorporated on label and leaflets that it is toxic to aquatic organism, hence should not be used near water bodies, aquaculture or pisciculture area.</p> <p>(v) A cautionary statement should incorporate in label and leaflet that this product is toxic to birds.</p>

Annexure V

Waiting / Safe periods of insecticides

Sl. No.	Insecticides	Crops	Waiting Period (Days)
1.	Malathion 50% EC	Brinjal	1-4
		Toria, Okra, Longmelon, Cabbage	3-4
		Tomato	5
		Onion	6
2.	Quinalphos 25% EC	Cabbage	10
		Cauliflower	1-6
		Mustard	15
3.	Dimethoate (Rogor) 30% EC	Toria, Rough surface Fruits & Vegetable	10
		Smooth surface vegetable and fruits	5-7
4.	Fenitrothion 50% EC	Cowpea, Pea	10
		Cabbage	7
		Pigeon pea	15
		Cauliflower	8
		Mustard	3-5
5.	Metasystox	Mustard	15-18
6.	Phosalone 35 EC	Pea	5
		Cabbage	10
		Green gram	16
7.	Cypermethrin 10% EC	Okra	4
		Cabbage	6
8.	Fenvalerate 20 EC	Okra, cabbage	9
9.	Decamethrin 2.8 EC	Okra	1
		Cabbage	2

Annexure VI

**Nutrient composition of important vegetables
(per 100g edible portion)**

Crop	Energy (kcal)	Moisture (g)	Macronutrients				Vitamins				Minerals		
			Protein (g)	Fat (g)	CHO (g)	A (iu)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic Acid (mg)	Ca (mg)	P (mg)	Fe (mg)
Amaranath	45	85.7	4.0	0.5	6.1	9108	0.03	0.30	1.2	99	397	83	25.5
Bitter ground	25	92.4	1.6	0.2	4.2	208	0.07	0.09	0.5	88	20	70	1.8
Bottle Ground	12	96.1	0.2	0.1	2.5	0	0.03	0.01	0.2	0	20	10	07
Brinjal	24	927	1.4	0.3	4.0	122	0.04	0.11	0.9	12	18	47	0.9
Broad bean	48	85.4	4.5	0.1	7.2	15	0.08		0.8	12	50	64	1.4
Cowpea	48	85.3	3.5	0.2	8.1	930	0.07	0.09	0.9	14	72	59	2.5
Cucumber	13	96.3	0.4	0.1	2.5	0	0.03	0	0.2	7	10	25	1.5
French bean	32	90.0	1.9	0.2	7.1	600	0.08	0.11	0.5	19	56	44	0.8
Indian Squash	21	19.3	1.4	0.2	3.4	21	0.04	0.08	0.3	18	25	24	0.9
Muskmelon	17	95.2	0.3	0.2	3.5	279	0.11	0.08	0.3	26	32	14	1.4
Okra (Bindi)	35	89.6	1.9	0.2	6.4	86	0.07	0.10	0.6	13	66	56	1.5
Ridge Gourd	17	95.2	0.5	0.1	3.4	54		0.01	0.2	5	18	26	0.5
Pointed Gourd	20	92	2.0	0.3	2.2	652	0.05	0.06	0.5	29	30	40	1.7
Pumpkin	25	92.6	1.4	0.1	4.6	82	0.06	0.04	0.5	2	10	30	0.7
Sponge gourd	18	93.2	1.2	0.2	2.9	396	0.02	0.06	0.4	0	36	19	1.1
Tomato	22	93.5	1.1	0.2	4.7	900	0.06	0.04	0.7	23	13	27	0.5
Watermelon	26	92.6	0.5	0.2	6.4	590	0.03	0.03	0.2	7	7	10	0.5