

# PACKAGE OF PRACTICES FOR CULTIVATION OF VEGETABLES

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The **Package of Practices for Cultivation of Vegetables** contains the latest recommendations and readily-usable information provided by the specialists of vegetable crops of PAU through the coordination of the Director of Research. These improved farming techniques for stepping up productivity of vegetables have been discussed and finalised in the Research and Extension Specialists' Workshop for Vegetable, Fruit and Flower crops held on 22-23 January, 2013. It is purposely written in a simple and easy-to-understand language because these recommendations are intended for the use of field level extension workers and the farmers of Punjab.

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## **CAUTION**

Chemicals used to control insects, diseases and weeds are poisons for human beings. Farmers are cautioned to use these poisons carefully to avoid any effect on human health. For safe use of these chemicals see Appendix III given at the end of this book.

*Note :*

1. For proper presentation of information on pesticides, fungicides, etc., it is sometimes necessary to use the trade name of the product or equipment. No endorsement of the named product or equipment is intended nor criticism implied of a similar product or equipment not mentioned in this book.
2. Volume of spray material to be used for controlling different insects and diseases of various crops is based on the usage of shoulder-mounted knapsack sprayer having "fixed type hollow cone nozzle." Spray volume may vary when other types of sprayers/nozzles are used for this purpose.
3. It should, however, be ensured that the actual amount of insecticides recommended in the "Package of Practices" should not be reduced. For proper control of weeds, it is always necessary to use flood jet or flat fan spray nozzles.
4. The use of endosulfan 35 EC is not recommended till the decision of Hon'ble Apex Court.

## **CAUTION NOTICE**

**The information on the performance of recommendations given in this book holds good only when used under optimum conditions. Their performance may either change in due course of time due to several factors or can vary under different systems of management. Mishandling/negligence of the user can also result in damage/loss/non-reproducibility of results. All disputes are subject to Ludhiana jurisdiction only.**

# 1. VEGETABLES

## Introduction

In the Punjab state the vegetables are grown in an area of 1.92 lac hectares producing 37.34 lac tonnes with average productivity of 19.39 tonne per hectare. The area, production and yield of different vegetables during 2011-12 is as under :

### Area under Vegetable Crops during (2011-12)

	Area (000 ha)	Av. Yield (kg/ha)	Production (000 t)
Potato	84.11	25013	2103.97
Pea	19.70	10200	200.94
Root crops	18.73	20466	383.39
Cucurbits	13.40	14963	200.43
Chilli	10.56	1702	17.98
Cauliflower	8.86	17881	158.53
Onion	8.23	22182	182.69
Tomato	6.51	24669	160.74
Muskmelon	4.80	17348	83.41
Cabbage	4.50	17562	79.08
Garlic	3.76	11071	41.67
Brinjal	3.37	21229	71.65
Okra	2.66	10399	27.66
Watermelon	0.91	17660	16.02
Other vegetables	2.40	2499	6.01
Total	192.544	19394.00	3734.18

In the state, among vegetable crops, about half of the total area is covered under potato which is raised for fresh market and seed

potato. The state has established itself as a seed producing state of potato.

At present, production of vegetables is about 37.34 lac tonnes which does not include post harvest losses (20-40%), quantity procured and crop raised for seed production. It is estimated that per capita availability in the state is less than half. To feed the present population of the state, we have to double the total production of vegetables. Besides this, the state has to produce additionally to meet the requirement of the processing industry, exports and seed industry. Therefore, there is an immense scope of increasing area in the state. The vegetables are grown mostly in the vicinity of cities for commercial purpose. The supply of vegetables in the cities is uneven and uncertain which results into fluctuations in their prices. However, in the villages, the availability of vegetables is more disappointing than in the cities. On the contrary, the inclusion of vegetables in the daily diet is indispensable for the maintenance of good health. For the supply of fresh vegetables, the available area near and around the houses or near the tubewells at the farms can be utilized for growing vegetables.

## 2. MUSKMELON

### Climate and Soil:

Muskmelon plants flourish well under warm climate and cannot tolerate frost. The optimum temperature for germination of the seed is 27-30°C. With the increase in temperature, the plants complete their vegetative growth earlier. Stormy weather particularly dust storm during flowering reduces fruit setting. Dry weather with clear sunshine during ripening ensures a high sugar content, better flavour and a high percentage of marketable fruits. High humidity increases the incidence of diseases, particularly those affecting foliage. Cool nights and warm days are ideal for accumulation of sugars in the fruits.

A well drained loamy soil is preferred. Lighter soils which warm up quickly in spring are usually utilized for early yields and in heavier soils the vine growth will be more and fruit maturity will be delayed. Sandy river beds with alluvial substrata and subterranean moisture of river streams support its growth. In fact, the long tap root system is adapted to growth of this crop in river beds. The soil should not crack in summer and water should not stagnate. It is necessary that soil should be fertile well provided with organic matter. Muskmelon is sensitive to acidic soils. The crop can not be grown successfully below pH of 5.5. It prefers a soil pH between 6.0 and 7.0. Alkaline soils with high salt concentration are also not suitable.

Muskmelon is a warm season crop, but in the important muskmelon growing areas, it is sown during winter under proper protection against cold. It is also sown in February and March.

### Improved Hybrids/Varieties:

#### Hybrids

**Punjab Hybrid (1981):** Its vines are vigorous and dark green. The fruit setting takes place close to the base of the vine and it is early in maturity. The fruit is round, light yellow, sutured and netted. Flesh is thick, orange coloured, juicy and having excellent flavour with 12 per cent TSS. The fruits develop 'full slip' stage. Average

fruit weight is 800g. It is moderately resistant to powdery mildew and resistant to fruit fly. The yield is about 65 q/acre.

#### Varieties

**Punjab Sunehri (1974):** This variety has medium vine growth. The fruit weighs about 700-800g and is globular round with its rind intensely netted and light brown. It has thick orange flesh and is medium in juiciness. It is very sweet (TSS 11 per cent). The inside of the rind separating it from the orange flesh, is green. The fruits develop 'full slip' stage. The crop matures about 12 days earlier than *Hara Madhu*. This variety has good keeping quality. It is highly resistant to the attack of fruitfly. It yields about 65 q/acre.

**Hara Madhu (1967):** This variety is somewhat late in maturity. The fruit is large (average weight one kg.), round and slightly tapering towards the stalk end. It is very sweet (TSS 13 per cent). Its skin is light yellow with green sutures. Its flesh is thick, green and juicy. The seed cavity is small. The average yield is about 50 q/ acre. It is comparatively resistant to powdery mildew.

#### Agronomic Practices:

**Sowing Time :** The middle of February is the best sowing time. However, if the crop is raised by providing a suitable mulch or any other type of cover during winter, premium of early market can be captured. Early planting under cover would save crop from the attack of red pumpkin beetle also.

**Seed Rate :** With careful planting on hills by dibbling, 400g of seed is sufficient for one acre.

**Method of Sowing :** Prepare beds 4m wide for *Hara Madhu* and 3m for others. Sow two seeds per hill on both sides of beds at a distance of 60 cm between hills. Early crop raised from seedlings grown in polythene bags matures 15-20 days earlier than directly seeded crop. The polythene bags of 15 cm x 10 cm size and 100-gauge thickness punched at the base should be filled with a mixture of soil and well-rotten farmyard manure in equal proportions or with soil, well-rotten farm yard manure and silt in equal proportions when soil is sandy. Five to six kg. bags are required to raise seedlings for an acre. The seed should be sown in the bags in the last week of January or in the first week of February. Seedlings should be protected from cold winds. The bags should be placed near the wall facing the sun. The seeds should not be sown deeper than 1.5 cm. After sowing, water should be applied daily in the afternoon, preferably

with a sprinkling can. Transplanting should be done by the end of February or by the first week of March when the seedlings are 25-30 days old and have two true leaves.

Two days before transplanting, withhold watering the bags. At transplanting, a cut is given on the side of bag with a sharp knife and the bag is removed. The earth ball should not be allowed to break and placed in the hill very carefully. Irrigation is applied immediately after transplanting. With this method, the fruits mature by 2<sup>nd</sup> or 3<sup>rd</sup> week of May.

### **Manures and Fertilizers :**

Apply 10 to 15 tonnes of farmyard manure, 50 kg of N (110 kg of Urea), 25 kg of P<sub>2</sub>O<sub>5</sub> (155 kg of Single Superphosphate) and 25 kg. of K<sub>2</sub>O (40 kg of Muriate of Potash) per acre to the directly seeded crop. The farmyard manure should be added 10-15 days before sowing. Whole P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O alongwith one third of N should be applied in two parallel bands 45 cm apart and the channel should be prepared in between the fertilizer bands, before the sowing of seeds. The remaining dose of nitrogen should be applied to the vines near the base (but not touching it) and should be mixed with the soil during the early part of the growing season to ensure the maximum early growth, early fruit set and early maturity.

Under the transplanting technique, the row to row and the plant-to-plant distances are the same as in the above method. Locate the planting spots for the plants and dig 15-20 cm deep pits for receiving the plants. Fill each pit with a mixture of 1 kg of farmyard manure, 15g CAN or 7-8 g of Urea, 40g of Single Superphosphate or 158g DAP and 10g of Muriate of Potash before planting. About a month after; apply another dose of 15g CAN or 7-8g of Urea to each plant. In this way 5-7 tonnes of farmyard manure, 20 to 30 kg N(45 to 65 kg. Urea), 20-25 kg. P<sub>2</sub>O<sub>5</sub> (125 to 155 kg. Single Superphosphate or 55 kg DAP) and 20-25 kg. K<sub>2</sub>O (35-40 kg. Muriate of Potash) would be required per acre.

**Irrigation:** During summer, irrigate the crop every week. At the time of fruit maturity, water should be given when it is absolutely necessary. The over-flooding of the field should be avoided. In no case, water should be allowed to come in contact with fruits. Depending upon soil type and weather conditions, irrigate the fields 9-11 times.

### **Harvesting :**

The fruits of *Hara Madhu* should be harvested when it turns yellow. Other varieties should be picked at mature green stage for distant marketing and at 'half slip' stage for local market. To avoid fruit-rot during development and maturity, turn the fruits, particularly after rain or flooding when the soil is wet. Place dry grass below the fruits or place the fruits on the vines themselves.

### **Seed Production :**

Land should be free from volunteer plants of the same crop or other crossable species. A seed crop field must be isolated all around to a minimum distance of 1000 m and 500 m for foundation and certified seed, respectively. A muskmelon seed field should be isolated from snapmelon (Phut), longmelon (Tar), wanga and wild melon (Chibber). Systematic and timely field inspections at different stages of plant growth are essential to ensure the production of genetically pure seed. A minimum of 3 field inspections viz., before flowering, during flowering and fruiting, and finally at fruit maturity are required. In case of muskmelon, edible fruit should be examined for internal fruit characters and sweetness. Muskmelon fruit is ready for seed harvest at its peak of edibility. In most of the cultivars, a crack develops at the point of attachment of the fruit with the stem. The fruit gets easily detached from the vine.

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, wooden barrel or plastic bag. The muskmelon seed is left for fermentation for a day or two. After the fermentation is completed, the seed mixture is washed with water to float off the placental debris or pass it through the wire-mesh to get clean seed. Fermented seed is superior in germination to mechanically cleaned seed or the seed separated immediately after fruit harvest. The seed should be dried properly before packing.

### 3. WATERMELON

#### Climate and Soil :

It is a warm season crop mainly grown in tropical and subtropical regions. Generally, a long period of warm, preferably dry weather with abundant sunshine is required. It is susceptible to frost. Excess humidity will promote the attack of diseases and insect-pests. For good quality and sweetness, dry weather during the fruit development is necessary. It requires tropical climate and fairly high temperature (35-40°C) during fruit development. Cool nights and warm days are ideal for accumulation of sugars in the fruits. Maturity is hastened if nights are warm. The average temperature for growth should be around 30-35°C with maximum around 40°C and minimum between 20 and 25°C. The optimum moisture and temperature range of 18-25°C is required for germination.

A well drained loamy soil is preferred. Light soils that warm quickly in spring are usually used for early yield. In heavier soils, vine growth is high and fruits mature late. The long tap root system of watermelon has been adopted in riverbeds. The soil in which it is grown should not crack in summer and water log in rainy season. It prefers a soil pH of 6.0-7.0. It is slightly more tolerant to medium salt concentrations.

#### Improved Variety:

**Sugar Baby (Before 1962) :** This variety produces small to medium sized fruits with dark green skin. The flesh of the fruit is deep red and very sweet having 9-10% TSS. It yields 72 q/ acre.

#### Agronomic Practices:

**Sowing Time :** (i) Mid January to March

(ii) November to December (Under protection)

**Seed Rate :** For an area of one acre one and half kg for small seeded varieties and two kg for large seeded varieties.

**Spacing :** Two and a half to three metre wide beds should be

prepared for Sugar Baby. Seeds should be sown on both sides of the bed at a distance of 60 cm between the plants.

#### Manures and Fertilizers :

Apply 8-10 tonnes of farmyard manure along with 25 kg of N (55 kg. of Urea) 16 kg. of  $P_2O_5$  (100 kg of Single Superphosphate) and 15 kg. of  $K_2O$  (25 kg of Muriate of Potash) per acre in the same way as in the case of muskmelon.

**Irrigation :** During initial stages of growth irrigate weekly. Later the irrigation should be given at 9-13 days interval. Towards maturity irrigation should be given at longer interval. Total number of irrigations should be 7 to 9.

#### Harvesting :

The crop would be ready for harvest in 95-120 days after seed sowing depending on cultivar. The fruits should be harvested when fully developed and mature. Signs of maturity are drying of tendrils, change in colour of ground spots to yellow and thumping of matured fruits give dull sound.

#### Seed Production :

Land should be free from volunteer plants of the same crop or other crossable species. A seed crop field must be isolated from other varieties all around to a minimum distance of 1000 m and 500 m for foundation and certified seed, respectively. Systematic and timely field inspections at different stages of plant growth are essential to ensure the production of genetically pure seed. A minimum of 3 field inspections viz., before flowering, during flowering and fruiting and finally at fruit maturity are required. The edible fruit should be examined for internal fruit characters and sweetness.

Watermelon fruit is ready for seed harvest at its edible stage of maturity. Harvesting can be delayed for a few days after the fruit reaches edible stage. 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 may be harvested from the over-ripe fruits but in order to correctly inspect the interior fruit quality, it should be harvested at the time of its edible stage. The seeds are removed from the flesh, washed with water and dried in shade before packing.

## 4. SUMMER SQUASH

**Climate and soil :** It requires warm growing season with a temperature ranging between 18-30°C. It can be grown in various kinds of soils but sandy loam to loamy soils are ideal.

### Improved Variety :

**Punjab Chappan Kadoo-1 (1982):** It is an early maturing variety and is ready for first harvest in 60 days after sowing. Plants are bush type, with thick and erect foliage, leaves non lobed and green without white specks; petiole and leaves hairy; fruits attractive green; disc shaped, mildly ribbed with flat stem-end and attractive. This variety has field resistance to downy mildew and tolerant to virus, powdery mildew and red pumpkin beetle. It has a high female to male ratio. Average yield of fruits is 95 q/acre.

### Agronomic Practices:

- Sowing Time:** 1. Mid-January to March  
2. October to November (Under protection)

**Seed Rate :** Two kg of seed per acre.

**Spacing :** Prepare 1.25 m wide beds and sow two seeds/hill at a distance of 45 cm apart on both sides.

### Manures and Fertilizers :

Apply 15 tonnes of farm yard manure per acre before preparation of beds. Add 40 kg. of N (90 kg. of Urea), 20 kg. P<sub>2</sub>O<sub>5</sub> (125 kg. of Single Superphosphate) and 15 kg. K<sub>2</sub>O (25 kg. Muriate of Potash) per acre in two parallel bands at 45 cm apart and the channel should be prepared in between these fertilizer bands before sowing of the seed. Apply half of nitrogen alongwith whole of Single Superphosphate and Muriate of Potash at the time of land preparation. Rest half of the nitrogen should be applied as top dressing during early growth stage.

**Irrigation:** First irrigation should be given immediately after sowing to facilitate germination. Subsequent irrigations should be

given at 6-7 days interval depending upon season. Total number of irrigations should be 9-10.

### Harvesting:

The crop will be ready for first picking 60-80 days after sowing depending upon variety and season. Fruits become fit for harvesting after 7 days of fruit setting. The interval of pickings should be 2-3 days.

### Seed Production :

A seed crop field must be isolated all around to a minimum distance of 800 metre from other varieties of this crop. A minimum of three field inspections should be conducted to produce true to type seed. The first inspection should be done before flowering, second at flowering and fruiting and third before harvesting of the crop. The off type and diseased plants should be rogued off. The fruits turn bright yellow to orange at seed harvesting stage. The harvested fruits are cut into two halves and seed is scooped out by hand. The seed is washed in water and fruit flesh is poured off. The extracted seed is dried immediately. The seed yield is 2.0 to 2.5 q/acre.



## 5. PUMPKIN

### **Climate and soil :**

It is a warm season crop and requires dry weather with abundant sunshine. The soil should be well drained, loamy and rich in organic matter to get good yield. The soil pH of 6.0-7.0 is preferred.

### **Improved Variety :**

**Punjab Samrat (2008) :** Its vines are medium long, stems are angular and leaves are dark green. Its fruits are medium in size, nearly round, mottled-green and turn pale-brown at maturity. The fruit flesh is thick and golden-yellow. It is early in maturity, rich in vitamin-A and moderately resistant to mosaic virus. Its average yield is 165 q/acre.

### **Agronomic Practices :**

**Sowing time :** February-March

**Seed rate :** 1.0 kg per acre.

**Spacing :** Prepare 3.0 m wide beds and sow two seeds per hill at 60 cm spacing on both sides of the bed.

### **Manures and Fertilizers :**

Apply 8-10 tonnes of well rotten farm yard manure per acre before preparation of the beds. Add 20 kg of N (45 kg Urea) before sowing and another 20 kg of N (45 kg Urea) as top dressing with in one month.

**Irrigation :** First irrigation should be given immediately after sowing to facilitate seed germination. Subsequent irrigations should be given at 6-7 days interval depending upon the season. Total number of irrigations would be 8-10.

### **Harvesting :**

The fruits are ready for harvesting when skin turns pale-brown and flesh becomes golden-yellow. The mature fruits have good storage capacity and it is always better to reduce frequency of irrigation before fruit picking. The immature fruits can be harvested for sale also.

### **Seed Production :**

The isolation of pumpkin seed plot from other varieties should be 1000 metre for foundation and 500 metres for certified seed production. Off type and diseased plants are roughed out at vegetative, flowering and fruiting stages. When skin of the fruits turn hard and attain yellow brown colour are ready for harvesting and seed extraction. Then clean, grade and dry the seed to 8% moisture before storage.

## 6. BOTTLE GOURD

### Climate and Soil:

It requires warm growing season with a temperature ranging between 18-30°C. It can be grown in various kinds of soils but sandy loam to loamy soils are ideal.

### Improved Varieties:

**Punjab Long (1997):** The plants are vigorous, profusely branched bearing cylindrical light green and shinning fruits. It is suitable for packaging and long distance marketing. Average yield is 180 q/acre.

**Punjab Komal (1988) :** It is an early maturing variety. The first fruit attains marketable maturity in about 70 days after sowing. It bears oblong, medium sized, light green, pubescent, 10-12 fruits per vine. Fruits are tender and borne on medium, long, thin pedicel on 4<sup>th</sup> or 5<sup>th</sup> node onwards. It is tolerant to cucumber mosaic virus (CMV). Average yield is about 200 q/acre.

### Agronomic Practices :

There are three distinct sowing seasons :

- Sowing Time:** 1. February- March  
2. June-July  
3. November-December (Under protection).

**Seed Rate:** Use two kg. seed per acre.

**Spacing:** Prepare 2.0 to 2.5m wide beds and sow seed on both the sides of beds at a distance of 45-60 cm.

### Manures and Fertilizers:

Apply 20-25 tonnes of farmyard manure per acre before preparation of beds. Add 14 kg N (30 kg. Urea) before sowing and another 14 kg N (30 kg. Urea) at early picking stage.

**Irrigation:** First irrigation may be given just after sowing. Crop requires frequent irrigation. Summer season crop requires irrigation at 6-7 days interval whereas sparingly during rainy season. Total number of irrigations would be 8-9.

### Harvesting:

The crop is ready for harvesting in about 60-70 days after sowing depending upon variety and season. Harvest only tender and medium sized fruits which are still tender and shining in colour. In peak season, picking will have to be done every 3 or 4 days.

### Seed Production :

A 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 should be conducted to produce true to type seed. The first inspection before flowering, second at flowering and fruiting and third before harvesting of the fruits. The off type and diseased plants should be rogued off. The fruits turn green dull at seed harvest stage. The harvested fruits are dried and seed is extracted. The seed is graded and packed.

## 7. BITTER GOURD

### **Climate and Soil:**

Though it has a wide range of adaptability, yet it thrives best in warm humid regions. It cannot tolerate frost. Though it can be grown on all types of soils, yet well drained loam soil rich in organic matter is best suited for its cultivation. For getting early crop sandy or sandy loam soils are preferred but they should be manured well and good amount of artificial fertilizers should be added to soil.

### **Improved Varieties:**

**Punjab Kareli-1 (2009)** : Leaves are green, smooth and serrated. Vines are long. Its fruits are long thin, green and ridged. It takes 66 days for first fruit harvest. One fruit weighs about 50g and average yield is 70 q/acre.

**Punjab –14 (1985)**: It has small vines. Fruit weighs about 35g and is light green. Suitable for sowing during spring and rainy seasons. Average yield is about 50 q/acre.

### **Agronomic Practices:**

**Sowing Time:** 1. February-March  
2. June-July

**Seed Rate:** Two kg. seed per acre.

**Spacing:** Sowing should be done on both sides of 1.5m wide beds keeping plant to plant distance of 45 cm.

### **Manures and Fertilizers:**

Apply 10-15 tonnes farm yard manure 10-15 days before sowing and also apply 40 kg of N(90 kg of Urea), 20 kg of  $P_2O_5$  (125 kg of Single Superphosphate) and 20 kg of  $K_2O$  (35 kg of Muriate of Potash) per acre. Whole  $P_2O_5$  and  $K_2O$  along with one third of N should be applied in two parallel bands 45 cm apart and a channel should be prepared in between the fertilizer bands before sowing of seed. The remaining nitrogen should be applied one month after sowing.

**Irrigation:** First irrigation should be given after sowing. During summer season, crop may be irrigated after 6-7 days whereas during rainy season only when needed. Total number of irrigations should be 8-9.

### **Harvesting:**

The crop will be ready for harvesting in about 55-60 days after sowing depending upon variety and season. The picking should be done at 2-3 days interval.

### **Seed Production :**

For seed production the crop is grown just like market crop. To produce pure seed, genetic purity of the variety must be maintained and 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 turn 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.

## 8. SPONGE GOURD

### Climate and Soil :

Sponge gourd can be grown in tropical and sub-tropical climate. It grows well under warm and humid conditions. It is very sensitive to frost and low temperature. It can be grown in all types of soils, but sandy loam soil is ideal for its cultivation.

### Improved Varieties :

**PSG-9 (2005)** : The vines of this variety are medium long with dark green leaves. The fruits are smooth, long, tender and dark green. It takes 60 days from transplanting to first picking. Average fruit weight is 65 g and yield is 65 q/acre.

**Pusa Chikni:** The plants are medium sized with dark green leaves. The fruits are medium sized smooth 2.5 to 3.5 cm thick and tender. Average yield is 35-40 q/acre.

### Agronomic Practices:

**Sowing Time:** 1. Mid February to March  
2. Mid May to July.

**Seed Rate:** 2 kg seed per acre.

**Spacing:** Sow at least two seeds per hill on one side of 3 m wide beds at a spacing of 75-90 cm.

### Manures and Fertilizers:

Apply 40 kg of N (90 kg of Urea), 20 kg of  $P_2O_5$  (125 kg of Single Superphosphate) and 20 kg of  $K_2O$  (35 kg of Muriate of Potash ) per acre.

**Irrigation:** The first irrigation should be given just after seed sowing. During summer season irrigate at 7-10 days. The crop can be grown during rainy season with limited irrigation. Total number of irrigations would be 7-8.

### Harvesting:

The crop will be ready for harvest in about 70-80 days after sowing.

The picking should be done at an interval of 3-4 days. Harvest only tender and medium sized fruits.

### Seed Production :

The raising of seed crop is similar to that of crop grown for table purpose, except that of difference in harvesting stage of the fruit. The best time for raising the seed crop is Feb.-March rather than the rainy season, since harvesting and extraction of seed is convenient in the dry spell. The minimum isolation distance of 1000 m between two varieties of sponge gourd is required. The undesirable or off-type plants are removed before flowering, during flowering, fruiting and maturity stages. Fruits are allowed to mature physiologically on plant rather than harvesting at horticultural maturity. Seeds are extracted when fruits are dry and seeds rattle inside the shell. After cleaning, dry seed is packed and stored under low temperature and low humidity conditions.

## 9. ASH GOURD

### Climate and Soil :

Ash gourd is a warm season crop and grows well in temperature range of 22-35°C. It is sensitive to frost and low temperature conditions. It can be grown in all types of soils, but sandy loam soil is ideal for its growth. The pH range is 6.5-7.5.

### Improved Variety :

**PAG-3 (2003)** : The vines of this variety are medium long with green leaves. Fruits are attractive, globular and medium sized. It take 145 days from transplanting to harvesting. The average fruit weight is 10 kg. and average yield is 120 q/acre.

### Agronomic Practices:

**Sowing Time:** 1. February-March  
2. June-July

**Seed Rate:** Two kg per acre.

**Spacing:** Sow atleast two viable seeds per hill on one side of 3 m wide beds at a spacing of 75-90 cm.

### Manures and Fertilizers:

Apply 8-10 tonnes of FYM and 40 kg of N (90 kg Urea), 20 kg of  $P_2O_5$  (125 kg Single Superphosphate) and 20 kg of  $K_2O$  (35 kg Muriate of Potash) per acre. Apply FYM, half of N and whole of  $P_2O_5$  and  $K_2O$  in a band before preparation of beds. Apply rest half of the N at flowering stage.

**Irrigation:** Irrigate the crop at 7-10 days intervals.

### Harvesting:

The fruits are ready for picking after 120-150 days of sowing.

### Seed Production :

The raising of seed crop is similar to that of vegetable production of ash gourd. The best time for raising the seed crop is February-March. A minimum of 1000 m isolation distance between two varieties of ash gourd is required. The undesirable or off-type plants are removed before flowering, during flowering, fruiting, and maturity stages. Fruits are physiologically mature for seed harvesting, when white waxy surface appears on the fruits and stem surface. Seeds are separated from the pulp and washed with water before drying. After cleaning, dry seed is packed and stored under low temperature and low humidity conditions.

## 10. CUCUMBER

### Climate and Soil :

Cucumber is especially a warm season crop. This is very sensitive to frost. Excess humidity promotes diseases like powdery mildew and downy mildew. The optimum temperature for cucumber production is 26.4°C. Seed of cucumber germinates well at 25°C. A well drained loamy soil is preferred for cucumber production.

### Improved Variety :

**Punjab Naveen (2008)** : The plants have dark green leaves, having uniform cylindrical fruit shape and attractive light green colour with smooth surface. the fruits are bitter free, having soft seeds at edible maturity and are very crispy. It is better in quality having high dry matter and vitamin C. It takes 68 days from the transplanting to harvesting. The variety is excellent in taste, appearance, colour, size and texture and its average yield is 70 q/acre.

### Agronomic Practices :

**Sowing time :** February-March.

**Seed Rate :** One kg per acre.

**Spacing :** The seeds are sown on both sides of the beds of width 2.5 metre at a distance of 60 cm. Sow two seeds at one place to ensure good stand.

**Low tunnel technology :** To get early yield of cucumber, practice of low tunnel is helpful in raising crop in early summer. It helps to protect plants against cold from December to February. The beds of 2.50 m width are prepared in the month of December. The sowing is done on both sides of beds at a distance of 45 cm.

Before sowing the seeds, flexible iron rods of 2 meter length shaped into arches/hoops are fixed manually at the distance of 2 meter so as to have the height of 45-60 cm. It will cover the paired rows on the beds. Cover the hoops with transparent plastic sheet of 100 gauge thickness. Burry these sheets on both sides of the beds. Remove these sheets when temperature rises outside, in the month of February.

**Manure and Fertilizers :**

It requires 40 kg N (90 kg of Urea), 20 kg P<sub>2</sub>O<sub>5</sub> (125 kg of Single Superphosphate) and 20 kg K<sub>2</sub>O (35 kg Muriate of Potash). Apply one third of N alongwith P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O at the time of sowing in two parallel bands 15 cm away from the bed mark. Apply rest of the N during the early period of vine growth.

**Irrigation :** Sowing is done on the pre-irrigated furrows on top of the ridge on both sides of the beds. subsequently irrigation is applied second or third day of sowing. The crop is irrigated at 4-6 days interval. Total number of irrigations are 10-12.

**Harvesting :**

Fruits are picked when tender and young when seeds inside the fruit are still soft. Fruits must be picked before change in colour i.e. from green to yellow.

**Seed Production :**

For seed production the fruits should be picked when brown in colour. Three field inspections should be conducted. A minimum of 1000m isolation distance from different varieties of cucumber should be kept to produce true to type seed. First before flowering, second at flowering and fruiting and third before harvesting of the seed crop. All off type and diseased plants should be rogued off. For extraction of seed, 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.

## 11. LONG MELON

**Climate and Soil :**

Long melon is a warm season crop. It can also be grown under protected conditions to get early yield. The crop can be grown in wide range of soils ranging between sandy laom to heavy soil.

**Improved variety :**

**Punjab Longmelon-1 (1995) :** Its vines are long, stem pubescent, angled and light green. It is an early maturing variety. Its fruits are long, thin and light green. Average yield is 86 q/acre.

**Agronomic Practices :**

**Sowing time :** February-March.

**Seed Rate :** 1 kg per acre.

**Spacing :** Seeds are sown on both sides of the bed of width 2.5 m at a distance of 60 cm. Sow at least two seeds at one place to ensure good stand.

**Manure and Fertilizers :**

It requires 40 kg N (90 kg Urea), 20 kg of P<sub>2</sub>O<sub>5</sub> (125 kg of Superphosphate) and 20 kg of K<sub>2</sub>O (35 kg of Muriate of Potash). Apply one third of N alongwith whole of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O at the time of sowing in two parallel bands 15 cm away from the bed mark and prepare the ridges. Rest of the nitrogen is applied during the early period of vine growth.

**Irrigation :** Irrigate immediately after sowing the seeds on the beds. Irrigation may be given at 4-5 days interval in summer season. In the rainy season, apply irrigation whenever required.

**Harvesting :**

Long melon fruits are ready for picking in about 60-70 days. Fruits should be picked when attain the marketable size and are tender. In peak season harvest the fruits at 3-4 days interval.

**Seed Production :**

Long melon field should be minimum 1000m isolated from other

varieties of longmelon, muskmelon, snapmelon and *chibber*. The undesirable or off type plants are rogued out before flowering, during flowering and fruiting stages. Three field inspections should be conducted, first before flowering, second at flowering and fruiting and third before harvesting of the seed crop. The mature fruits are picked and pulp is taken out in fresh water. It is kept for one or two days for separation of seed from the pulp. The seed is rubbed with hands. Heavy seeds settle in water and are retained.

## 12. SQUASH MELON

### Climate and Soil :

It is a warm season crop but has a wide range of adaptability and can be grown at temperature between 25°C to 30°C. Growth is slow at low temperature. Tinda can be grown in soil ranging from sandy loam to silt loam.

### Improved Variety :

**Tinda 48** : Its vines are 75-100 cm long. Leaves are light green and deeply lobed. Fruits are medium sized with an average weight of 50 g each. Their shape is flat round, pubescent and shining light green in colour. Flesh is white. It yields 25 q/acre.

### Agronomic Practices :

**Sowing time** : 1. February-March  
2. June-July

**Seed rate** : 1.5 kg per acre

**Spacing** : The seeds are sown on both sides of the beds of width 1.5 m at a spacing of 45 cm. Seeds may be soaked over night in water to ensure proper germination. Sow at least two seeds at one spot.

### Manure and Fertilizers :

It requires 40 kg N (90 kg Urea), 20 kg of P<sub>2</sub>O<sub>5</sub> (125 kg of Single Superphosphate) and 20 kg of K<sub>2</sub>O (35 kg of Muriate of Potash). Apply one third of N alongwith full dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O at the time of sowing. Apply rest of the N during the early period of the growth.

**Irrigation** : The seeds are sown on the pre-irrigated furrows on the top of ridge on both sides of the beds. Subsequent irrigation is applied on second or third day after sowing. During summer, irrigate after 4.5 days. In rainy season, irrigation is applied depending on intensity of rains.

### Harvesting :

Fruits are ready for first picking after 60 days of sowing. First fruits should be picked as early as possible so as to facilitate further

fruit setting. The other pickings should be done when fruits are medium in size and tender. Picking is done at 3-4 days interval.

#### **Seed Production :**

For seed production, an isolation distance of 800 m is maintained from other varieties of squash melon. Three field inspections should be conducted, first before flowering, second at flowering and fruiting and third before harvesting of the seed crop. All off type and diseased plants should be rogued off. The mature fruits turn their colour into dull. These are picked and crushed with hands in fresh water so as to separate the seeds from the pulp. The heavier seeds settle at the bottom and are retained.

## **13. WANGA**

#### **Climate and Soil :**

Wanga can be grown in summer as well as in rainy season. It is a crop of dry area and can be successfully grown in Fazilka, Abohar and Faridkot areas. It is grown in sandy soils which are rich in organic matter.

#### **Improved variety :**

**Punjab Wanga No.-1 (1995) :** Its vines are medium long with angular and hairy stem. The leaves are serrated, dark green in colour. Male and bisexual flowers are borne on the same vine. Fruits are oval shaped, smooth and ready for picking after 88 days of sowing. Its average yield is 45 q/acre.

#### **Agronomic Practices :**

**Sowing time :** 1. February-March  
2. June-July

**Seed Rate :** One kg per acre

**Spacing :** The seeds are sown on both sides of the beds of width 2.5 m at a spacing of 60 cm. Sow at least two seeds at one place to ensure good stand.

#### **Manure and Fertilizers :**

It requires 40 kg Nitrogen (90 kg of Urea), 20 kg of  $P_2O_5$  (125 kg of Single Superphosphate) and 20 kg of  $K_2O$  (35 kg of Muriate of Potash). Apply one third N and whole of  $P_2O_5$  and  $K_2O$  at the time of sowing in two parallel bands 15 cm away from bed mark. Apply rest of the N during the early period of vine growth.

**Irrigation :** The seeds are sown on the pre-irrigated furrows on the top of the ridge on both sides of the beds. Subsequently the irrigation is given second or third day after sowing. During summer, irrigate after 5-6 days. In rainy season irrigation is applied as per the intensity of rains. Total number of irrigations are 8-10.

#### **Harvesting :**

Picking should be done when fruits are medium sized and tender. The first picking is done about 90 days after sowing. Picking is done at an interval of 3-4 days.



### Seed Production :

For seed production the fruits turn light green in colour and are soft to touch. A minimum of 1000 m isolation distance from different varieties of wanga, snapmelon, wildmelon and muskmelon should be kept to produce true to type seed. Three field inspections should be conducted, first before flowering, second at flowering and fruiting and third before harvesting of the seed crop. All off type and diseased plants should be rouged off. For seed extraction, the pulp of the fruit is kept in water for two days. Seed separates from the pulp and settle down in water and is retained.

### Plant Protection (Muskmelon, Watermelon and other Cucurbits)

#### A. Insect pests

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
<b>1. Red pumpkin beetle</b> ( <i>Aulacophora foveicollis</i> ) attacks the crops at the seedling stage. In case of a severe attack, the crop is totally destroyed.	Sow the crop in November to avoid the damage from this insect. Spray 75-150g of Sevin/Hexavin 50 WP (carbaryl) in 50-100 litres of water at 10 days interval or apply once, just after germination 2.75 kg of Furadan 3G(carbofuran)/acre 3-4cm deep in soil near the bases of the plants and apply irrigation.	
<b>2. Aphids</b> causes damage in Feb.-March by sucking the sap from the foliage. The aphids also spread virus diseases.	Spray 250 ml of Malathion 50 EC in 100 litres of water when this pest appears. Repeat the spray after 10 days.	
<b>3. Red spidermite</b> ( <i>Tetranychus</i> spp.) attacks the leaves and sucks the plant sap.	Spray 200 ml of Rogor 30 EC (dimethoate) or Metasystox 25 EC (oxydemeton methyl) in 100 litres of water per acre.	
<b>4. Fruit flies</b> ( <i>Bactrocera cucurbitae</i> ) puncture tender fruits and spoil them. Their attack is serious in longmelon, luffa, bitter	(i) Collect the infested fruits and destroy them by burying them deep in soil. (ii) Apply the bait spray containing 0.05% Malathion,	Spraying the bait on the lower surface of the leaves of maize plants grown in rows at distance of 8-10m as trap crop has been found to be

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
gourd,tinda, bottle gourd and muskmelon.	1% gur/sugar (20 ml Malathion 50 EC and 200g gur/sugar in 20 litres of water). Repeat the spray at weekly intervals when the attack is serious.	effective as the flies have the habit of resting on such tall plants.

#### B. Diseases

<i>Diseases</i>	<i>Causal Organisms</i>	<i>Symptoms</i>	<i>Control Measures</i>
<b>1. Powdery mildew</b>	<i>Sphaerotheca fulginea</i>	The fungus forms a white floury coating on leaves, stem and other succulent parts of the plant, develops in dry weather. Fruits remain poor in quality and flavour.	Spray the crop with Karathane 50-80 ml per acre with the 1st appearance of the disease. Repeat at 14-day interval.
<b>2. Downy mildew</b>	<i>Pseudo-peronospora cubensis</i>	On most of the host plants, the first visible symptoms are the appearance of small water soaked lesions on the leaves. These lesions appear yellow on the upper surface. Greyish downy growth of fungus develops on underside of the leaves. Lesions turn brown in the centre and veins are blighted.	1. Spray the crop with Indofil M.45/Kavach @ 300-600 g in 100-200 litres of water per acre depending upon growth stage. Apply first spray in second week of April before the appearance of the disease followed by six more sprays at weekly intervals. Give sprays promptly after rains. Under heavy disease risk situation, instead of 3 <sup>rd</sup> and 4 <sup>th</sup> spray of Indofil M-45/Kavach give two sprays of Ridomil MZ @ 500g or Aliette @ 600g per acre in 200 litres of water at 10 days interval, followed by one more spray of Indofil M-45/Kavach @ 600g/acre. 2. Destroy over wintering vines of cucurbits. 3. Avoid flood irrigations. Treat the seed with Thiram@ 3g/kg of seed before sowing
<b>3. Collar rot</b>	<i>Rhizoctonia solani</i>	At soil level, the stem shows brown to dark	

1	2	3	4	5
			brown lesions. The plant is eventually killed. Damping off of seedlings also takes place.	of seed.
4. Pythium rot	<i>Pythium butleri</i>	Water soaked lesions girdle the stem, later extending upwards and downwards. The affected tissues rot and even grown up plants collapse. This fungus also causes fruit rotting.		Treat the seed as in the case of collar-rot. Avoid flood irrigations.
5. Alternaria blight	<i>Alternaria cucumerina</i>	Yellow spots appear on the leaves which turn dark brown and finally black with age. They usually start from the margin & produce concentric rings; severely infected vines look like burnt charcoal. The disease is more severe on watermelon.		Spray with Indofil M-45 @ 300g in 100 litre of water per acre at an interval of 10-15 days.
6. Mosaic	Virus	The appearance of dark green and light green patches on the leaves; leaves become chlorotic, reduced in size and deformed into finger like structures in squash, bottle gourd and sponge gourd, at the end of season. The virus is transmitted through seeds and aphids.		1. Collect seeds from virus free plants. 2. Rogue out the virus affected plants. 3. Spray the crop with insecticides recommended for the control of aphids.
7. Root knot nematode	<i>Meloidogyne incognita</i>	Poor and patchy growth of crop. Leaves become yellow and reduced in size. Formation of knots on roots. Severely infected vines dry up and die earlier than healthy ones. Infected vines wilt easily during day. Disease is soil borne.		1. Give frequent cultivation in May-June to expose the soil to the Sun. 2. Follow rotations with rice, oat, wheat and taramira in nematode infested soils.

## 14. TOMATO

### Climate and Soil:

Tomato is a warm season crop and requires a relatively long growing season with plenty of sunshine and moderate day temperature of 20–28°C. It is sensitive to frost. Under low temperature, the plant growth is restricted and fruit setting is low. The critical factor in the setting of fruits is the night temperature, the optimum range being 15–20°C. The red pigment in the fruit will develop only when the temperature is between 15°C and 30°C. Above this range of temperature, only the yellow pigment formed. When the temperature exceeds 40°C, no pigment will be formed.

Tomato can be grown in all types of soils, but the soil should be friable. However, it grows best in light soils ranging from sandy loam to loam.

### Improved Hybrids/Varieties:

#### Hybrids

**TH-1 (2003)** : It is a determinate hybrid which is cross between W-321x1-181. Its foliage cover is dense that protects the fruits from sun scalding. Fruit colour is deep red, shape is round and average fruit weight is 85 g. Its fruits are firm, average TSS is 5% and is thus recommended both for fresh market and processing. It has better shelf life and can be transported to distant markets. TH-1 is moderately resistant to late blight. Average yield is 245 q/acre.

#### Varieties

**Punjab Ratta (2009)** : The plants are determinate, foliage cover is dense and dark green. It takes 125 days from transplanting to first picking when transplanted during the last week of November. The fruits are oval, medium sized, very firm and deep red (average lycopene content 8 mg/100g). It is suitable for processing and the average yield is 225 q/acre.

**Punjab Varkha Bahar-1 (2009)** : The plants are semi determinate, foliage cover is dense and dark green. Fruits are round and medium firm. It takes 90 days for maturity after transplanting. It

is moderately resistant to leaf curl virus. The variety is suitable for cultivation during the rainy season. Its average yield is 215 q/acre.

**Punjab Varkha Bahar-2 (2009)** : The plants are determinate, foliage cover is dense and light green. Fruits are round and medium firm. It takes 100 days for maturity after transplanting. It is moderately resistant to leaf curl virus. The variety is suitable for cultivation during the rainy season. Its average yield is 216 q/acre.

**Punjab Upma (2000)** : The plants are determinate, foliage cover is dense & leaflets are broad. The fruits are oval, medium in size, firm deep red in colour and is suitable for fresh market and processing. The average yield is 220 q/acre and yield is 300 g/q of fruits.

**Punjab NR- 7 (1985)** : Its plants are dwarf, foliage is medium dense, fruits are flat round, medium sized (70g), uniform red, multilocular and juicy. It is highly resistant to root knot nematodes (*Meloidogyne incognita* and *M. javanica*) and resistant to Fusarium wilt (*Fusarium oxysporum* f. *lycopersici*). Average yield is 175-180 q/acre.

**Punjab Chhuhara (1975)** : The plants are dwarf, being about 60 cm tall. Its dense foliage protects the fruits from sunburn. The fruit is pear shaped, small to medium with fewer seeds. Its fruits ripen uniformly. It yields about 320 q/acre.

### Agronomic Practices :

**Sowing time** : For winter planting, sowing should be done in October and transplanting in November-December. *Sarkanda* cover should invariably be provided during winter to protect the plants against frost. However, dwarf varieties can be successfully and economically covered with polythene bags of 35 cmx25 cm size and of 100- gauge thickness.

The transplanting of tomato can also be done in February. For February planting, sow seed in the end of November and protect seedlings from frost in the nursery beds by covering with polythene sheets or *sarkanda* thatch. However, the yield obtained would be comparatively lower from February planted crop than from November planted crop.

To ensure successful growing of healthy seedlings from costly hybrid seeds of tomato, grow nursery of this crop under polyhouse (size 24' x 13' x 6') made of UV stabilized low density polyethylene film of 200 microns (800 gauge) thickness.

<i>Time of sowing under polyhouse</i>	<i>Time of transplanting</i>
<b>Main season crop</b>	
a) 1st week of November	End of November
<b>Spring season crop</b>	
b) Last week of December	Mid February

The sowing of Punjab Varkha Bahar-1 and Punjab Varkha Bahar-2 can be done in second fortnight of July and their transplanting can be done in second fortnight of August. Transplant two seedlings per hill.

**Seed rate** : Seed rate is 100g/acre when sown in the nursery. Sow nursery in two marla (50 m<sup>2</sup>) area to transplant one acre.

**Nursery Raising** : Prepare 1.5m wide and 20 cm high beds in an area of about two marlas (50 m<sup>2</sup>) to raise seedlings for an acre. Mix 5 quintals of well rotten farmyard manure with the soil and water the beds at least 10 days before sowing. Drench the beds with 1.5 to 2.0% solution of Formalin by applying 4-5 litres of solution per square metre. Cover beds with a plastic sheet/tarpaulin for 48-72 hours. Turn the soil in beds once a day for 4 to 5 days to eliminate Formalin. Treat the seed with 3 g Captan/Thiram per kg of seed. Sow seeds 1 to 2 cm deep in lines with 5 cm spacing. Drench the nursery plants with 0.4% Captan/Thiram (4g/litre of water) after 5 to 7 days of germination. Repeat after 7 to 10 days. The seedlings become 15 to 20 cm tall in four to six weeks. After lifting the seedlings, wrap them in a wet paper for carrying to the transplanting site.

**Spacing** : Dwarf varieties require a close spacing of 75 cm x 30cm. Rainy season varieties should be planted at a spacing of 120-150x30 cm.

### Manures and Fertilizers :

Apply 10 tonnes of well rotten farmyard manure and plough it into the soil. Add 25kg of N (55kg of Urea) along with 25kg of P<sub>2</sub>O<sub>5</sub> (155 kg of Single Superphosphate) and 25 kg of K<sub>2</sub>O (45kg of Muriate of Potash) per acre in a band at 15 cm on one side of the bed mark and prepare the channels. After removing *sarkanda*/polythene bag cover by mid February, apply 35 kg of N (75kg of Urea) per acre in the rows, but not touching the base of the vines. Mix it with the soil and earth up. In the sandy soils, apply nitrogen in three split doses. The first part should be applied alongwith phosphorus and potash. The second dose should be applied just before the plants take up active growth and the third dose when the first flower clusters have

started setting fruits. Under high fertility conditions, the application of N should be reduced, as the blossoms may fail to set fruit due to the unfavourable carbohydrate nitrogen ratio within the plant.

**Weed Control** : For weed control in tomato, apply Stomp 30 EC (pendimethalin) one litre/acre or 750 ml/acre followed by one hoeing or Basalin 45 EC (fluchloralin) one litre/acre or 750 ml/acre followed by one hoeing or Sencor 70 WP (metribuzin) 300g/acre. These weedicides should be applied 3-4 days before transplanting on prepared beds and Basalin 45 EC (fluchloralin) need to be mixed into soil with light harrowing and planking.

**Growth Regulator** : To increase the yield of tomato, spray 'Vipul Booster' @ 1 ml/litre of water in the nursery beds at least a week before transplanting. Repeat the spray of @ 0.5 ml/litre of water five times at fortnightly intervals. The first foliar spray after transplanting should be started a week after transplanting. Each spray application requires 100 litres of water for which 50 ml of the chemical is needed. This growth regulator increases the yield by 16-18 per cent in November transplanted crop and about 12 per cent in the February transplanted crop.

**Irrigation** : First irrigation should be given immediately after transplanting. Subsequent irrigations may be given after 6-7 days during summer and 10-15 days during winter months. Total number of irrigations required are 14 to 15.

### Harvesting :

Harvesting should be done according to distance of markets. For long distance markets pick mature green fruits whereas for local market pick at turning red stage. For processing, pick when fruits are fully red. While packing for long distance markets remove rotten, over-ripe and borer-infested fruits. The fruit should be pre-cooled immediately after harvesting. Punjab Varkha Bahar-1 is ready for harvesting at the end of November whereas the harvesting of Punjab Varkha Bahar-2 should be started from first fortnight of December.

### Seed Production :

The tomato should be grown at the isolation distance of atleast 50 m from other varieties to avoid any chance of contamination. Minimum three field inspections should be made for getting the true

to type seed. The first inspection should be made at vegetative phase, second at flowering and fruiting and third before harvesting of fruits. Any off type and diseased plants should be removed. The extraction of seed from the ripe fruits is done by fermentation method and acid method. In fermentation method, the crushed fruits are allowed to ferment for 1 to 2 days and then put in water where pulp and skin float and the seeds settle down at the bottom. In Acid method, about 100 ml of commercial hydrochloric acid is thoroughly mixed to 14 kg of crushed tomato fruits. The seeds is separated out from the pulp within half an hour which may be cleaned, dried and packed.

## Plant Protection

### A. Insect Pests

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
1. <b>Aphid</b> ( <i>Aphis gossypii</i> ) and white-fly ( <i>Bemisia tabaci</i> )	Spray 400 ml of Malathion 50 EC in 100 litres of water before fruiting.	Ripe fruit should be picked before spray. Observe the waiting period of 3 days after spray of Fame.
2. <b>Fruit borer</b> ( <i>Helicoverpa armigera</i> ) The larva attacks the fruits and cause, holes and rotting afterwards	Give three sprays at 2 week intervals starting from the initiation of flowers with any of the following insecticides using 100 litres of water per acre.  1. Sevin/Hexavin 50WP (carbaryl) 800g. 2. Sumicidin 20 EC (fenvalerate) 100ml. 3. Ripcord 10 EC (cypermethrin) 200 ml. 4. Decis 2.8 EC (deltamethrin) 160 ml. 5. Carina 50 EC (profenophos) 600 ml 6. Fame 480 SL (flubendamide) 30 ml	

**Note:** For motorized knapsack sprayer, use the same quantity of pesticides per acre as mentioned above, but the quantity of water for dilution will be approximately 1/10<sup>th</sup>.

## B. Diseases

Diseases	Causal Organisms	Symptoms	Control Measures
1. Early blight	<i>Alternaria solani</i>	Concentric, dark brown spots appear on leaves and induce yellowing & shedding of leaves. The fruits are also affected and show dark circular areas followed by rotting.	i) Obtain the seed from healthy fruits only. ii) Treat the seed before sowing with Captan or Thiram @3g per kg of seed. iii) After transplanting, spray the crop with Indofil M45 @600g/acre at an interval of 7 days.
2. Late blight	<i>Phytophthora infestans</i>	Dark water-soaked patches appear on leaves and stem. The fruit is also affected. Crop is rapidly destroyed if rains occur during February.	i) Spray the crop as recommended under early blight during February-March just after rains. ii) When the disease risk is heavy, spray the crop in the middle of February with Ridomil MZ @500g per acre followed by 3 sprays of Indofil M-45 @600g/acre in 200 litres of water at 7 day intervals.
3. Damping off	<i>Pythium spp.</i> <i>Rhizoctonia sp.</i> <i>Fusarium sp.</i>	Cause pre and post emergence death of seedlings in nursery beds.	i) Treat the seed with Captan or Thiram @3g/kg of seed ii) Drench the nursery beds with 0.4% Captan or Thiram (400g in 100 litres of water) 5 to 7 days after germination. Repeat the drenching after 7-10 days, if necessary.
4. Leaf curl	Virus	Stunting of plants with downward rolling and crinckling of leaves, plants bear few flowers and fruits. Transmitted through white-fly.	i) Rogue out the affected plants. ii) Protect the crop in the nursery beds and fields from insect vector (white-fly) by spraying insecticides like Rogor or Metasystox @1ml/litre of water at 10 day intervals.
5. Mosaic	Virus	Leaves of the affected plants exhibit mottling with raised dark green areas. Distortion and malformation of leaves is common. Transmitted through seed/aphids.	i) Collect the seed from virus free plants. ii) Avoid unnecessary touching of plants. iii) Spray with insecticides viz. Rogor or Meta-systox @1ml/litres of water at 10 day interval.

Diseases	Causal Organisms	Symptoms	Control Measures
6. Root knot nematodes	<i>Meloidogyne incognita</i> and <i>M. javanica</i>	Yellowing of leaves patchy & unthrifty growth of plants, knot like swellings galls are formed in roots. Nematodes survive in soil for a long period.	i) Grow nematode resistant variety Punjab NR-7 in infested fields. ii) Solarize water saturated nursery bed using transparent polythene sheet (50 micron) for 40 days in the months of May-June for the control of root knot nematode in nursery beds. iii) Incorporate 40 days old Toria and Taramira crops into tomato nursery beds 10 days before sowing and turn the soil 3-4 times before sowing of tomato. iv) Dip the roots of the nursery plants in 0.03% dimethoate (10ml of Rogor 30 EC in 10 litres of water) for 6 hours before transplanting. v) Grow garlic in root knot nematode infested fields in rotation with other vegetable crops.

**Note:** Dip treatment should be conducted in shade and stems should not be immersed in solution.

## 15. BRINJAL

### Climate and Soil :

Brinjal requires a long and warm growing season. The plant is sensitive to frost injury. Chilling weather for a long time may also damage the crop. A well drained and fertile soil is desirable for growing brinjal. It is a hardy plant and can be grown on different kinds of soil but does best on silt loams and clay loams. However to raise an early crop sandy or sandy loam soil is preferred.

### Improved Varieties/Hybrids :

#### Round Fruited :

**Punjab Neelam (1998)** : It is ready for first picking in 65 days after transplanting. Plants are medium in height erect, thornless, foliage is green with purple tinge, fruits are oval-round, medium-sized and shining dark purple in colour. It is suitable for transplanting in February and August. Average yield is 140 q/acre.

#### Oblong Fruited :

**BH-2 (1994)** : Leaves of this hybrid are green and purplish. Plants are medium, erect, spreading and thornless. Its fruits are oblong and deep purple. Average weight per fruit is 300 g. It is highly suitable for cooking as 'bhartha'. It is tolerant to fruit borer. Average yield is 235 q/acre.

#### Long Fruited :

**Punjab Barsati (1987)** : This variety takes about 64 days from transplanting to the first harvesting. Its plants are dwarf, erect and thornless. The leaves are medium-long and shining purple. Its average yield is 140 q/acre. It is more tolerant to fruit-borer and is most suitable for transplanting in rainy season.

**Punjab Sada Bahar (1987)** : This variety takes about 76 days from transplanting to the first harvesting. Its plants are dwarf, erect and thornless. The leaves are green. The fruits are long, thin and deep purple. Its average yield is 125 q/acre. It is good for summer, autumn and also as ratoon crop. It is comparatively tolerant to fruit-borer.

#### Small Fruited :

**PBH-3 (2013)** : The plants of this hybrid are medium in height, compact and thornless. Foliage is green with purple tinge. Flowers are purple and borne in clusters. Fruits are shining purple of small size and oblong shape. It is comparatively tolerant to fruit borer. It is early in fruiting and gives 257 quintal per acre yield.

**Punjab Nagina (2007)** : Its plants are dwarf, semi-erect with dark green and spineless leaves. Its flowers are light-violet in colour with green calyx. Its fruits are shining, purple black, small, round and borne in clusters. This variety gives first picking in 55 days after transplanting. The average yield is 145 q/acre.

### Agronomic Practices

**Seed Rate** : To plant an acre 300 to 400 g of seed is grown in one marla (25m x 1m) on raised beds.

**Sowing Time** : The sowing time of four successive crops of brinjal is given below :

1. The nursery for the first crop is sown in October and seedlings are transplanted in November.
2. The nursery for the second crop is sown in November. It gives seedlings for transplanting in the first fortnight of February. The seedlings of this nursery are required to be protected against frost.
3. The seed for the third crop is sown in nursery beds in February-March. The seedlings are transplanted before the end of April.
4. The seed for the fourth crop is sown in the nursery beds in July and transplanting is done in August.

#### Low tunnel technology :

During winter protection of brinjal plants from low temperature with low tunnel technology gives early and high yield. For this nursery should be transplanted in first fortnight of November on raised beds at spacing of 90 cm between rows and 30 cm between plants. In first week of Dec., iron arches are fixed and covered with transparent non perforated plastic sheet of 50 micron thickness. When the temperature starts warming up, remove the polythene sheet in second fortnight of Feb.

**Spacing** : Rows are spaced 60 cm apart and plants are spaced 30-45cm apart in the row.

### Manures and Fertilizers :

Apply 10 tonnes of well rotten farmyard manure. Apply 25 kg of N (55 kg of Urea) 25 kg of P<sub>2</sub>O<sub>5</sub> (155 kg of Single Superphosphate) and 12 kg of K<sub>2</sub>O (20 kg of Muriate of Potash) per acre. Apply all the fertilizers at transplanting. After two pickings, again apply 25 kg of N (55 kg of Urea) per acre.

**Irrigation :** First irrigation should be given immediately after transplanting. During summer irrigate the crop at 4-6 days interval whereas during winter season irrigate at 10-14 days interval depending on soil type. It requires 10-16 irrigations.

### Harvesting :

Fruits should be harvested when fully developed but tender. Harvest every week in the peak season.

### Seed Production :

The brinjal variety should be grown at least 200 meter apart from other brinjal varieties. Minimum three field inspections should be made, first at vegetative phase, second at flowering and fruiting and third before harvesting of fruits. Any off type and diseased plants should be removed. For seed production, the ripe fruits which turned yellow are crushed and stored overnight and then the seeds are separated after washing with water is sieved and dried. The washing is usually done in the morning so that the seed is dried during the day. The dried seed is packed and labelled.

### Plant Protection

#### A. Insect Pests

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
1. Jassid ( <i>Amrasca biguttula</i> ), Hadda beetle ( <i>Elapilachna sp.</i> ) and brinjal shoot and fruit borer ( <i>Leucinodes orbonalis</i> ) cause damage during May to September. Plants attacked	Spray with 250 ml of Malathion 50 EC/acre at 10 day intervals as soon as the jassid and Hadda beetle appear. To control brinjal fruit and shoot borers, spray 3-4 times at 14-days interval using 100-125 litres of wa-	1. Pick regularly all ripe fruits before spraying. 2. All the infested fruits should be picked and destroyed. 3. Do not ratoon the brinjal crop. 4. For the control of brinjal fruit and shoot

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
by jassid become pale and finally bronze. A large number of greenish adults and nymphs are seen on the lower surface of leaves. Hadda adults and grubs feed on the leaves. Shoot infested with borer droop downwards and dry up. Infested fruits have a varying number of holes.	ter/acre with any one of the following insecticides as soon as the attack starts. A. Carbamate group i) 800g Sevin/Hexavin 50 WP ( <i>carbaryl</i> ) B. Synthetic Pyrethroids Group 1) 100 ml Sumicidin 20 EC ( <i>fenvalerate</i> ) 2) 200ml Ripcord 10E ( <i>cypermethrin</i> ) 3) 160ml Decis 2.8 EC ( <i>deltamethrin</i> ) C. Phosphatic Group i) 800 ml Ekalux 25 EC ( <i>quinalphos</i> ) 2) 500 ml Hostathion 40 EC ( <i>triazophos</i> )	borer, insecticides of the same group should not be used repeatedly in order to avoid the development of pesticide resistance and appearance of secondary pests. 5. A waiting period of 4 days in case of Ekalux and Hostathion should be observed after the spray.
2. Spider mites ( <i>Tetranychus urticae</i> ) attack during April-June and are very serious when the conditions are hot and dry. Initially yellowish-white specks appear on the leaves followed by scorching and leaf fall. Mite attacked leaves attract lot of dust particles.	Spray 300 ml Omite 57 EC or 300 ml of Kelthane 18.5 EC or 450 ml Fosmite 50 EC or 250 ml of Metasystox 25 EC per 150 litres of water per acre.	1. Do not keep brinjal as ratoon crop. 2. Do not delay or withhold irrigation during April-June. 3. Sprays of pyrethroid should be done only on need basis.

## B. Diseases

<i>Diseases</i>	<i>Causal Organisms</i>	<i>Symptoms</i>	<i>Control Measures</i>
<b>1. Phomopsis blight</b>	<i>Phomopsis vexans</i>	Straw-brown to deep brown spots develop on the leaves and fruits. The infected areas of the fruits begin to rot.	Collect seed from healthy fruits. Treat seed with Thiram or Captan @3g/kg. of seed before sowing. Spray Ziram or Zineb @200g in 100 litres of water per acre at weekly interval after transplanting.
<b>2. White rot</b>	<i>Sclerotinia sclerotiorum</i>	Disease appears as light pinkish brown water soaked irregular areas on leaves which become covered with white mycelium under humid and cool weather conditions. Hard black bodies (sclerotia) are formed intermingled with cottony growth on the leaves. The stem infection develops as pale or dark brown lesions. The sclerotia are formed either internally in the stem or intermingled with white mycelium on outside of stem. The fungus also causes wet rot on	i) Avoid growing of brinjal, after the susceptible crops like pea cauliflower, carrot and binjal, instead tomato and chilli can be grown. This will help in reducing the disease and spread of inoculum in the field. ii) The plant debris of crop should be collected and burnt. iii) Avoid growing of main season crop (July-February) in the disease prone fields.

<i>Diseases</i>	<i>Causal Organisms</i>	<i>Symptoms</i>	<i>Control Measures</i>
		fruits. The infected portion rots in the later stage of infection. Black sclerotia intermingled with white mycelium are formed on the infected portion. The disease is severe at flowering and fruiting stage of the crop.	
<b>3. Little leaf</b>	<i>Mycoplasma like organisms (MLO)</i>	Leaves are reduced in size. Affected plants give rosette appearance. Plants fail to produce flowers and fruits. Transmitted by jassid. It is more severe in ratoon crop.	1. Rogue out the affected plants. 2. Keep the jassid under check by spraying Malathion @250ml in 100 litres of water/acre in nursery and in the field.
<b>4. Root knot nematode</b>	<i>Meloidogyne incognita</i>	Yellowing of leaves, patchy and unthrifty plants, knot like swelling/galls are formed on roots.	1. Soak water saturated nursery bed using transparent polythene sheet (50 micron) for 40 days in the months of May-June for the control of root knot nematode in nursery beds. 2. Grow garlic in root knot nematode infested fields in rotation with other vegetable crops.



## 16. CHILLI

### Climate and soil :

Chilli performs well under humid climate. It is photo-insensitive and day length neither affects flowering nor fruit setting. A frost free period of about 130-150 days with temperature range of 15-35°C is optimum for chilli production. Generally chilli will not set fruit when night temperature is above 30°C. Temperature beyond 40°C result in poor fruit set and increased fruit drop. This is further aggravated if the relative humidity is low and is accompanied by dry winds.

Chilli can be grown on a wide range of soils but well drained loamy soil rich in organic matter is best suited for its cultivation. It can not withstand water-logged conditions for more than a day. Although chilli can be grown on soils with a pH range of 5.0 to 8.0 but it performs best at a soil pH of about 6.5.

### Improved Hybrids/Varieties :

#### Hybrids :

**CH-3 (2002)** : This hybrid has been developed by crossing MS-12 x S-2530. It is an early maturing hybrid with dark green foliage and pendent fruits. The fruits are long (8.2 cm). The colour of immature fruit is dark green and turns dark red at maturity. The fruits are mild in pungency with 0.51% capsaicin content, high dry matter (22.5%) and good Vit. 'C' (109.95 mg /100g ) content. The deep red coloured fruits make it specially suitable for making chilli paste for export purposes. The average yield of red ripe fruits is 110 q/acre.

**CH-1 (1992)** : It is a hybrid between MS12 x LLS. Its plants gain one metre height and more branching. Plants continue bearing fruits for a long time. Fruits are light green when immature and attain deep red colour at maturity. Fruits are of medium size (6.62 cm long) and weigh 2.7 g each. This hybrid is tolerant to viral and fungal diseases. Its fruits are highly suitable for drying and used as salad. Yield of red ripe chilli is 100 q/acre. Its fruits are used in processing industry. Fruits on an average have capsaicin content of 0.80%.

#### Varieties :

**Punjab Sindhuri (2013)** : Plants are dark green, compact and medium tall. It is an early maturing variety and first picking (red

fruits) is possible 75 days after transplanting. Fruits are long (7.14cm), thick skinned, dark green when immature and deep red when mature. Fruits are pungent (1% capsaicin content) and rich in Vitamin C content (155 mg/100g). Average yield of red ripe fruits is 76 q/acre. It is suitable for fresh market and distant transportation.

**Punjab Tej (2013)** : Plants are light green, spreading and medium tall. It is an early maturing variety and first picking (red fruits) is possible after 75 days of transplanting. Fruits are long (6.80 cm), thin skinned, light green when immature and deep red when mature. Fruits are highly pungent (1.32% capsaicin content) and rich in Vitamin C (115 mg/100g). Average yield of red ripe fruits is 56 q/acre. It is suitable for processing/powder making.

**Punjab Surkh (1995)** : Plants are medium tall, leaves dark green, fruits long (7cm), green when immature and dark red on maturity. It is a dual purpose variety which makes it suitable for salad and drying. It is tolerant to fruit rot and moderately resistant to mosaic virus. It is an early bearing variety which yields 80 q/acre of red ripe fruits. Fruits have capsaicin content of 0.80% on dry weight basis.

**Punjab Guchhedar (1995)** : It is a selection from material introduced from Indonesia. Plants are tall. Fruits are small (5cm), erect and borne in clusters of 5-16. Fruits have destalking habit which leave the stalk while picking. It is tolerant to fruit rot, highly resistant to mosaic and tolerant to leaf curl virus. Fruits are late bearing and yield 60 q/acre. Fruits are rich in capsaicin (0.98%) and deep red in colour.

### Agronomic Practices :

**Sowing Time** : The seed is sown in nursery during end October to mid November. Transplanting is generally done in February – March.

**Seed Rate** : Seed rate is 200 g per acre when sown in the nursery. Sow nursery in one marla (25m<sup>2</sup>) area to transplant one acre.

**Nursery Raising** : Seed of chilli is sown on raised seed beds. The beds should be 1.25 m. wide with height of 15 cm. The soil is loosened with the help of *khurpa* or spade. If farm yard manure application is required, it should be well decomposed and incorporated well into the soil. Then soil is sterilized with formaldehyde (1.5-2.0%). For this Formalin of commercial grade is taken and 15-20 ml of Formalin is added in one litre of water. This solution is added in the beds at the rate of 4-5 litres m<sup>2</sup>. so that it saturates upper 6 inches of the soil. The beds are then covered with polythene

for a period of 48-72 hours. Afterward the covers are removed and soil is loosened so that fumes of the chemicals escape into air and do not hinder the germination of the seed. After removal of the cover, the sowing of seed is done after 3-4 days. Sowing should be done in rows drawn widthwise at a distance of 5 cm.

To ensure successful growing of healthy seedlings from costly hybrid seed of chilli, nursery should be grown under polyhouse (size 24' x 13' x 6') made of UV stabilized low density polyethylene film of 200 microns (800 guage) thickness.

<b><i>Time of sowing under polyhouse</i></b>	<b><i>Time of transplanting</i></b>
a) Third week of November	Mid February
b) 1st week of February	End of April

**Spacing** : Thick and stout seedlings perform better than tall seedlings and should be planted on ridges at 75 cm apart with plant to plant spacing of 45 cm. In case of mechanized farming the wider spacing can also be done to facilitate weed control by the protected application of non selective herbicides between the rows.

#### **Manures and Fertilizers :**

Apply well –rotten farmyard manure (10-15 tonnes/acre). The recommended doses of fertilizers are 25 kg of N (55 kg of Urea) and 12 kg of P<sub>2</sub>O<sub>5</sub> (75 kg of Single Superphosphate) and 12 kg of K<sub>2</sub>O (20 kg of Muriate of Potash) per acre. All P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O together with one-half of N should be drilled at transplanting and the remaining N should be top dressed after first picking. Apply 30 kg N (65 kg urea) per acre to hybrid chilli.

**Growth Regulator** : Due to high temperature in May-June dropping of flowers take place. Two foliar sprays of naphthalene acetic acid (NAA) at 10 day interval @4g, 45 and 55 days after transplanting to increases the green and red ripe fruit yield of chilli.

Dissolve 4g NAA in 10-15 ml of ethyl alcohol and make the volume one litre. At the time of spray use this one litre in 100 litres of water.

#### **Irrigation :**

**1. Furrow Irrigation** : First irrigation should be given just after transplanting. Subsequent irrigations should be given at 7-10 days

intervals. Total number of irrigations required are 15-16. For saving of irrigation water, irrigate the crop in alternate furrow without affecting the crop productivity. With the use of paddy straw mulch @ 25 quintals per acre, the number of irrigations can be reduced to 9.

**2. Drip Irrigation** : Drip irrigation in chilli results not only increase in yield but also save 46% of water as compared to conventional method of irrigation. Under this system irrigation should be applied at an interval of two days. While irrigating with drip irrigation, transplant two rows of chilli on 80cm wide bed with row to row distance of 60cm and plant to plant distance of 45cm. Provide 40cm space between the two beds. The chilli crop should be irrigated with one lateral pipe per bed having drippers spaced at 30cm and discharge of 2.2 litres per hour as per the following schedule.

<b>Month</b>	<b>Time of irrigation (min)</b>
March	31
April	61
May	137
June	110
July	60
August	60

If discharge rate is less than 2.2 litres per hour, time of irrigation may be adjusted proportionally by the formula.

$$= \frac{2.2 \times \text{Time of irrigation}}{\text{Discharge of dripper}}$$

Fertigation saves 20% fertilizer. Apply 7.9 kg Urea, 3.2 kg Mono Ammonium Phosphate and 3.2 kg Muriate of Potash (white) per acre during first month of the transplanted crop in seven equal doses with every second irrigation (four days interval). The remaining amount of fertilizer 31.4 kg of Urea, 12.8 kg of Mono Ammonium Phosphate and 12.8 kg of Muriate of Potash (white) per acre should be applied in equal doses during the rest of crop season in 21 equal doses with every second irrigation.

#### **Harvesting :**

For dry powder chilli should be allowed to turn red. Six or seven pickings will be required. More pickings are possible for harvesting of green chillies. Dry the red ripe chillies in the sunshine.

**Seed Production :**

Chilli is an often crops pollinated crop so minimum isolation distance of 400 m between two varieties of chilli and sweet pepper should be maintained. A seed crop should be inspected at different stages of maturity to ensure the genetic purity. The first inspection should be done before flowering and off type/extra early plants should be removed. The second inspection should be conducted at full bloom and fruiting stage and the plants which do not conform to the varietal purity such as fruit shape, colour, position of the fruit, flower colour, plant spread and leaf characteristics like leaf colour and shape etc. should be removed. The third inspection should be done just before fruit picking and only true to type plants are retained for seed harvest. Red ripe fruits are harvested and dried under sun. The seeds are extracted manually on small scale. However on a large scale, the seed can be extracted with PAU Axial - Flow Vegetable Seed Extraction machine.

## 17. SWEET PEPPER

**Climate and Soil :**

Sweet pepper is more sensitive to unfavourable environment. The optimum night temperature for quality fruit production is 16-18°C. When the temperature falls below 16°C for extended periods, growth and yields usually decrease. It can tolerate day temperature over 30°C and night temperature 21-24°C. High temperature and dry winds result in flower and fruit drop. Sweet pepper is insensitive to photoperiod and humidity.

Sweet pepper grows better in a loam or sandy loam soil with good water holding capacity. They can be grown on all types of soils, as long as it is well drained. Soil pH should be between 5.5-6.8.

**Agronomic Practices :**

**Sowing Time :** Seeds are sown in the nursery beds in the end of October. The seedlings are protected from frost during December-January by covering with polythene sheet or *sarkanda* cover and transplanted in mid February. To raise early crop, the seed can also be sown in nursery in mid October and transplanted in end November. This crop is protected with polythene or *sarkanda* cover in the field during the period of frost.

**Seed rate :** Use 200 g seed per acre.

**Low tunnel technology :** To get early yield of sweet pepper the low tunnel technology can be practied. It helps to protect the plants against extreme low temperature from December to mid February. Nursery of the crop is sown in the first fortnight of October. Protect the seedlings against whitefly to check the spread of viruses by covering them with net in the area of nursery itself. Four to five week old seedling are planted on both sides of the raised beds maintaining a distance of 130 cm and 30 cm between rows and plants respectively.

In beginning of December, fix the iron arches manually at a distance of 2 meter so as to cover the paired rows and support the plastic tunnels. To prepare these arches, flexible iron rods of 2 meter length are shaped into hoops and fixed in a way so as to have the height of 45-60 cm above the bed level. Transparent non-perforated plastic sheet of 100 gauge thickness should be used to cover the plants. It helps to keep the temperature of low tunnel higher than outside. The sides of the sheet should be buried in to the soil on both sides. When the temperature rises in the month of February, remove the plastic sheet.

**Spacing :** The seedlings are planted on ridges 60 cm apart with a plant to plant distance of 30 cm.

#### **Manures and Fertilizers :**

This crop is a heavy feeder, therefore, loam to clay loam soils are preferred for higher yield. Farmyard manure at the rate of 20-25 tonnes/acre is applied at the time of preparation of the soil. The inorganic fertilizers at the rate of 50 kg N (110 kg of Urea), 25 kg P<sub>2</sub>O<sub>5</sub> (175 kg of Superphosphate) and 12 kg K<sub>2</sub>O (20 kg Muriate of Potash) should be applied per acre. The whole of superphosphate and muriate of potash and one-third of Urea are applied at the time of planting and rest of urea is supplied in two equal doses one and two months after transplanting.

**Irrigation :** First irrigation should be given immediately after transplanting. Afterwards irrigation is given at 4 to 5 days interval during hot weather and 7 to 8 days during cold weather.

#### **Harvesting :**

The crop is ready for harvest in about 3 months after transplanting. Pick the fruits when they are fully developed but still green and shining.

#### **Plant Protection :**

##### **A. Insect pests :**

**Thrips, mites, aphids and whitefly** are the serious pests of these crops. For their control, spray the crop with 400 ml of Malathion 50 EC in 100-125 litres of water at 15-20 days interval.

#### **B. Diseases**

<b>Diseases</b>	<b>Causal Organisms</b>	<b>Symptoms</b>	<b>Control Measures</b>
<b>1. Fruit rot and Die back</b>	<i>Colletotrichum capsici</i>	The tips of fruit bearing branches start drying soon after the fruits begin to ripe. Dark sunken spots covered with dark or pinkish fructifications scattered or arranged in concentric rings, appear, especially on the fruit.	1. Treat the seed before sowing with 2g. of Thiram per kg of seed. 2. Spray the crop with 750g of Indofil M-45 or Blitox in 250 litres of water/acre at 10 days interval. Givt first spray at the start of disease. (first week of July) followed by 3 more sprays)
<b>2. Wet rot</b>	<i>Choanephora cucurbitarum</i>	Young branches, flower and fruits are attacked, conspicuous black pin heads of the fungus are seen on rotten parts. This disease is severe after heavy rains.	Same as for fruit rot and die-back.
<b>3. Leaf curl</b>	Virus	Affected plants become stunted and have rosette appearance Leaves roll downwards. This virus is transmitted by whitefly.	1. Rogue out and destroy the virus infected plants. 2. Spray with 400ml. Malathion 50EC in 100-125 litres of water/ acre at 15-20 days interval.
<b>4. Mosaic</b>	Virus	Leaves show mottling and blistering. Plants become chlorotic and stunted. Transmitted by aphids.	1. Rogue out the infected plants. 2. Collect seed from virus free plants. 3. Avoid unnecessary touching of plants. 4. Spray with 400ml. Malathion 50 EC in 100-125 litres of water per acre.

## 18. OKRA

### Climate and Soil :

Okra is a crop of tropical and subtropical climate. It requires a long warm and humid growing season. The crop growth is vigorous during rainy season compared to spring summer. Seeds of okra fail to germinate below 20°C temperature and optimum temperature for seed germination is 29°C.

Okra can be grown on all types of soils, but the soil should be friable. However, it grows best in light soils ranging from sandy loam to loam. Okra can tolerate slightly acidic soil reaction (pH 6.8 to 6.0)

### Improved Varieties :

**Punjab-8 (1995)** : Plants are medium tall with splashes of purple pigmentation present on the stem. Leaves are deeply lobed and less serrated. Leaves, stem and petiole are less hairy. Fruits are thin, long, dark green and five ridged. It has resistance to yellow vein mosaic virus and tolerant to jassid and borer. It is suitable for processing. Average marketable yield is 55 q/acre. It is suitable for February-March as well as June-July sowings.

**Punjab-7 (1986)** : The plants are medium tall with splashes of purple pigmentation present on the stem. Leaves are deeply lobed up to the base of the petiole and the margins are less serrated. The basal portion of the petiole is deeply pigmented. Leaves, stem and petiole are sparsely hairy. Fruits are medium long, green tender and five ridged. Fruit tip is slightly furrowed and blunt. It carries resistance to yellow vein mosaic virus. Average marketable yield is 45 q/acre. It can be sown in February-March as well as in June-July.

**Punjab Padmini (1982)** : Plants are taller than those of Pusa Sawani and with purple tinge on the stem and petiole, leaves deeply lobed and hairy, fruits quick-growing, dark-green, thin, long, five ridged and remain tender for a longer period. It has field tolerance to yellow vein mosaic virus. Low intensity of virus symptoms appear only on the new shoot growth quite late in the season. It is ready for 1st picking in 60 days. It is high yielding with an average yield of 45 q/acre. It is suitable for sowing in spring and rainy season.

### Agronomic Practices :

**Sowing time** : In north Indian plains, spring/summer crop is sown in February-March whereas the rainy season crop is sown in the month of June-July throughout India. The seed crop is usually sown in rainy season. The optimum sowing time of seed crop is middle of June.

**Seed Rate** : Fifteen to eighteen kg of seed per acre is required for sowing up to 15<sup>th</sup> February, 8-10kg for March sowing and 4-6 kg for the June-July sowing. Soak the seed in water for 24 hours before sowing. Sowing should be done on ridges in February-March and on flat in June-July.

**Spacing** : The row to row spacing should be 45 cm and plant to plant 15 cm. Progressively wide spacing may be adopted for late sowing.

### Manures and Fertilizers :

15-20 tonnes of well rotten farmyard manure should be incorporated into the soil before sowing. Apply 36 kg of N (80 kg of Urea) per acre on soils of average fertility. Apply half of the N at sowing and the rest as top-dressing after first picking of fruits.

**Weed Control** : To keep weeds under control, give three to four hoeings. The first hoeing may be given when the seedlings are two weeks old and subsequent hoeings at fortnightly intervals. Besides this, use of Stomp 30 EC (pendimethalin) 1.0 litre/acre or 750 ml/acre followed by one hoeing can be practised. Stomp 30 EC (pendimethalin) should be applied at pre-emergence stage i.e. one day after sowing.

Alternatively, spray Basalin 45 EC (fluchloralin) @ 800 ml to 1 litre/acre as pre-plant application i.e. four days before sowing and incorporate it in to the soil by harrowing. Alternatively use Lasso 50 EC (alachlor) @ 2 litres/acre as pre-emergence spray i.e. one day after sowing. The spray may be followed by one hoeing after 60 days if the intensity of weeds is high.

**Irrigation** : Seed should be sown in proper soil moisture conditions. First irrigation should be given after 4-5 days of sowing. Further irrigations should be given after 10-12 days whereas during the rainy season, less irrigations are required. Total 10-12 irrigations are required.

## Harvesting :

The crop will be ready for harvest in about 45-50 days depending upon season and variety. Fruits should be picked tender (10 cm long). Frequent pickings would be required during peak season and 10-12 pickings are done.

## Seed Production :

For seed production of okra, minimum isolation distance of 200 meter between two cultivars is required. It requires a seed rate of 5-6 kg/acre which should be sown on flat soil maintaining a distance of 60 cm and 25 cm between rows and plants, respectively. A minimum of three field inspections should be conducted to produce true to type seed. The first inspection before flowering, second at flowering and fruiting and third before harvesting of the crop. The off type and diseased plants should be rogued off. 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. The average seed yield is 5-6 quintals per acre.

## Plant Protection

### A. Insect Pests

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
<b>1. Jassid (<i>Amrasca biguttula</i>) and Spotted bollworms (<i>Earias sp.</i>)</b> cause damage during May-September. Plants attacked by jassid show yellowing and curling along the margins, turn pale to bronze colour finally premature defoliation occurs. A large number of greenish adults and nymphs are seen under the leaves.	<b>(For vegetable crop only)</b> Spraying once or twice at fortnightly interval with 560ml Malathion 50 EC in 100-125 litres of water per acre will control sucking pests. As soon as flowering starts give three sprays at fortnightly interval with 70 g Proclaim 05SG (Emamectin benzoate or 500g of Sevin/Hexavin 50 WP (carbaryl) or 100ml of Sumicidin 20EC (fenvalerate) or 80ml of Cymbush 25EC	1. Pick all fruits before spraying or atleast 2-days after spraying. 2. Uproot hollyhock and the ratooned cotton, which are host plants for bollworms. 3. Remove regularly the attacked fruits and bury deep in the soil.

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
Shoots infected with borer droop downwards and dry up. Infested fruits have a varying number of holes.	(cypermethrin) in 100-125 litres of water/acre to control the jassid as well as spotted bollworms.	
<b>1. Jassid and Spotted bollworms :</b>	<b>(For seed crop only)</b> Apply 8kg Thimet 10G (phorate) at sowing in furrows or spray 250ml Rogor 30EC (dimethoate) or 20 g Pride 20 SP (acetamiprid) in 100-125 litres of water/acre. Repeat the spray after 15 days if necessary. Spray the crop when 20-30% shoots show borer damage with any of the following insecticides using 100-125 litres of water/acre. i. 100ml Sumicidin 20EC (fenvalerate) ii. 80ml Cymbush 25EC (cypermethrin) iii. 160ml Decis 2.8 EC (deltamethrin)	1. Do not apply these insecticides to the crop meant for use as vegetables. 2. Do not handle these granular insecticides with bare hands.
<b>2. Red spider mites:</b> attack the leaves, suck the cell sap and ultimately cause webbing, necrosis and defoliation.	Spray 250ml of Metasystox 25EC (oxydemeton methyl)/Rogor 30EC (dimethoate) in 100-125 litres of water.	

**Note :** To determine percentage of shoot infestations, regularly observe 20 plants from each of the 5 rows selected at random in field at 5-7 days interval.

## B. Diseases

<b>Diseases</b>	<b>Causal Organisms</b>	<b>Symptoms</b>	<b>Control Measures</b>
1. <b>Yellow vein mosaic</b>	Virus	First veins turn yellow and later on all the leaves show severe yellowing. Fruiting is reduced.	1. Sow resistant varieties, control whitefly (the virus vector) by spraying 560ml of Malathion in 100-125 litres of water/acre.
2. <b>Damping off</b>	<i>Pythium sp.</i> <i>Rhizoctonia sp.</i> <i>Fusarium sp.</i>	Both pre and post emergence mortality of plants occurs.	Treat the seed with 3g of Captan or Thiram/kg before sowing.
3. <b>Cercospora leaf spot</b>	<i>Cercospora hibisci</i>	Small, brown to sooty black, vein-limited spot appear on both the surfaces of leaves. The older spots may coalesce. The infection results into premature defoliation.	The disease appears in July-August and can be controlled by spraying Bavistin @200g in 200 litres of water/acre at 14 day intervals, starting from appearance of symptoms. Three sprays are enough.

## 19. COWPEA

### Climate and soil :

It is a warm season crop and can not withstand cold weather. Continuous rainfall is also harmful for its growth. It can withstand a considerable degree of drought. But under very dry conditions, it will produce a poor crop. Different varieties respond differently to temperature and day-length. The rainy season variety, if sown in summer, may give only vegetative growth. The germination is better at 12-15°C temperature and the crop thrives best between temperature of 21° and 35°C. It can tolerate partial shade.

It can be grown almost in all kinds of soils, provided there is no problem of bad drainage, but these should be rich in organic matter. Saline or alkaline soils are not good. The field should be well pulverized and well levelled by planking.

### Improved Variety :

**Cowpea 263 (1988)** : This variety is suitable for both spring and rainy seasons. Its pods are medium green, thick, meaty, tender and about 20 cm long. It is an early maturing variety. It is comparatively resistant to mosaic virus and free from golden mosaic virus. Average yield is 35 q/acre.

### Agronomic Practices :

**Seed Rate and Sowing** : Sow 8-10 kg of seeds per acre. For spring crop, sow in February and for rainy season crop in June-July.

**Spacing** : Keep distance of 45 cm between rows and 15 cm between plants.

### Manures and Fertilizers :

Apply 20 kg of N (45 kg of Urea) as a starter doze, 16kg P<sub>2</sub>O<sub>5</sub> (100 kg of Single Superphosphate) and 10 kg of K<sub>2</sub>O (16 kg. Muriate of Potash) per acre at sowing.

**Irrigation** : Irrigate the crop at 4-5 days interval in summer months and 10-12 days interval in rainy season. Adequate drainage results in a good yield.

### Harvesting :

Marketable pods are available after 45-50 days of sowing. Tender pods are harvested for marketing. Frequent pickings should be done

before the pods become fibrous or the seeds in the pods gain prominence.

### Seed Production :

There is no difference between the methods of raising crop for production of both green pods and seeds. In case of seed crop, land in which one cultivar of cowpea was grown in the previous year should not be used for growing another cultivar in the following year to avoid contamination with the self sown plants from the previous crop. Cowpea is a self-pollinated crop. An isolation distance of 10 m for the production of foundation seed and 5 m for the production of certified seed should be kept between fields of two cultivars. Ripe and dry pods harvested by hand picking or by cutting the plants in case of last flush. To avoid shattering of seeds, harvesting should be done when half to two-thirds of pods have matured. Threshing is done by a thresher. When cowpea is grown for seed, extreme care should be taken during threshing to prevent injury to the seed. For seed purpose, the harvested pods are dried for a few days before threshing. The threshed seeds are also dried sufficiently before storage in a cool and dry place. The seeds maintain viability for two years under normal storage conditions.

### Plant Protection

#### A. Insect Pests

<i>Pests</i>	<i>Control</i>
1. Jassids/aphids	Spraying at fortnightly intervals with 375 ml of Malathion 50 EC in 125 litres of water will control jassids/aphids.
2. Pod borer or Blue butter fly	Spraying at fortnightly intervals with 900g Hexavin 50 WP ( <i>carbaryl</i> ) in 125 litres of water control pod borer.

#### B. Diseases

<i>Diseases</i>	<i>Causal Organisms</i>	<i>Symptoms</i>	<i>Control Measures</i>
1. Seed and seedling rot	Seed and soil borne fungi e.g. <i>Pythium</i> spp. <i>Colletotrichum</i> spp. <i>Fusarium</i> spp.	Seeds rot in soil particularly in the rainy season. Seedlings are killed before they emerge out of soil	Treat the seed with Emisan or Bavistin @ 2.5 g or Thiram 3g per kg of seed.

<i>Diseases</i>	<i>Causal Organisms</i>	<i>Symptoms</i>	<i>Control Measures</i>
		and cause poor stand of the crop.	
2. Cercospora leaf spot	<i>Cercospora canescens</i> and <i>Cercospora cruenta</i>	The spots generally appear after flowering. Rough circular cherry red to dark red spots variable in size are formed by <i>C. canescens</i> . In case of <i>cruenta</i> , black mats due to mouldy growth of the fungus are formed. Defoliation occurs in both the cases. At maturity infected pods show black sporulation of the fungus.	The disease can be controlled by spray of 0.2% Indofil M-45.
3. Mosaic	Virus	Widespread mosaic mottling, interveinal chlorosis and vein bending takes place. Distortion of leaf lamina in certain cases also occurs.	Obtain seed from healthy plants.



## 20. ONION

### Climate and Soil :

Onion can be grown under wide range of climatic conditions, but it grows best under mild climate without extreme heat or cold, or excessive rainfall. Very low temperature at early stage results in bolting and sudden rise in temperature favour early maturity and small sized bulbs. The soil for onion cultivation should be rich in organic matter, free from diseases, weeds and should be well drained. Alkaline and low lying soils are not suitable for onion cultivation.

### *KHARIF* ONION

#### Improved Varieties :

**Agri Found Dark Red (AFDR)** : The bulbs are medium large, deep dark red with an average yield potential of 120 q/acre. It is suitable for sowing in *kharif* season.

#### Agronomic Practices :

**Sowing Time** : The best time for sowing *kharif* onion nursery is middle of June, whereas to produce bulb sets it is middle March.

**Nursery Raising** : Nursery beds should be raised 20 cm above the ground level and 1 to 1.5 metre wide area of the nursery beds depends upon the number of seedlings required. Keep nursery bed and field area ratio of 1:20. Nursery soil should be well prepared and mixed with well rotten 125 kg farmyard manure per marla (25 sq. m.). The plot should be leveled and the nursery beds should be prepared accordingly. Continuously sowing of nursery on the same site should be avoided. Treat the seed before sowing with 3g of Thiram/ Captan per kg of seed. Sow seed 1 to 2 cm. deep in lines with 5 cm. spacing. The seed should be sown uniformly in these lines and covered with a thin layer of well rotten farmyard manure. The seed should be sown in the proper moisture condition. First irrigation should be given just after sowing with the help of sprinkler. The nursery beds should be irrigated twice a day, i.e. in the morning and in the evening. The nursery bed should be protected from high temperature by covering it during day time. A shade structure of

straw or any other crop material should be placed at 1.5m. height over nursery beds of 1.5 cm. width preferably in North-South direction. Remove this structure after one month when the seedlings have established.

**Bulb Set Technique** : To grow *kharif* onion crop successfully and avoid failure of seedling during June, planting with bulb sets is economical. To raise bulb sets, sow 5 kg. seed in beds of 8 marla (200 sq.m.) in middle of March. Irrigate the seedlings twice a week. Medium sized bulb sets of 1.5-2.5 cm diameter give highest marketable yield. In the last week of June, uproot the bulb sets and store in a well ventilated dry room in baskets. Plant these bulb sets in the field in second fortnight of August. Bulb crop would be ready for harvesting by the end of November.

#### Manures and Fertilizers :

Add 20 tonnes of farmyard manure with 40 kg of N (90 kg of Urea), 20 kg of  $P_2O_5$  (125 kg of Single Superphosphate) and 20 kg of  $K_2O$  (35 kg of Muriate of Potash) per acre. Apply whole farmyard manure,  $P_2O_5$  and  $K_2O$  and  $\frac{1}{2}$  N before transplanting and remaining dose of nitrogen as top-dressing after 4 weeks of transplanting.

**Transplanting** : The nursery is ready for transplanting after 6 to 8 weeks of sowing. The seedlings should be transplanted in the first week of August. Planting at 15 cm between rows and 7.5 cm between plants in the rows is most conducive for high yield. The bed planting of sets improves the bulb size of *kharif* onion. Plant three rows on each bed of 60 cm size. This practice is highly suitable under conditions where drainage is a problem. The transplanting should always be done in the evening. Irrigation should be given immediately after transplanting and subsequent irrigations should be given as and when required.

**Weed Control** : Weed control is same as in *rabi* onion.

#### Harvesting :

The crop is ready for harvesting in December. There is no serious problem of pests or diseases in this crop.

### *RABI* ONION

#### Improved Varieties :

**PRO-6 (2003)** : The plants are medium tall, leaves are green, bulbs are deep red, medium to large, round with thin tight neck. It takes 120 days from the transplanting to harvesting. It has good keeping quality and less bolting. The average yield is 175 q/acre.

**Punjab White (1997)** : The bulbs are medium large, round white with tight neck. It has high TSS (15%) and is suitable for dehydration. Its average yield is 135 q/acre.

**Punjab Naroya (1995)** : Its plants are medium tall, green and bulbs are red, medium to large, round with close neck. It takes 145 days from transplanting to harvesting and average yield is 150 q/acre. It is tolerant to purple blotch disease both in seed and bulb crop production and is also tolerant to the attack of thrips and heliothis.

### **Agronomic Practices**

**Sowing and Transplanting Time** : Sow nursery from mid-October to mid-November and transplant from the middle of December to middle of January. Large (10 to 15 cm) and healthy seedlings are better to get higher yields.

**Seed Rate and Nursery Raising** : Sow 4 to 5 kg seed to raise seedlings for transplanting in an acre. Prepare 15 to 20 cm. high beds in 8 marlas (200 sq.m). Mix 125 kg well rotten farmyard manure per marla and irrigate atleast 10 days before sowing to allow complete germination of weeds. Sow seed thinly at one to two centimetre depth in 5 cm. apart lines. Transplant the seedlings in a *wattar* field soon after uprooting from the nursery beds.

**Spacing** : Close planting at 15 cm between rows and 7.5 cm between plants is most conducive for high yields.

### **Manures and Fertilizers:**

Add 20 tonnes of farmyard manure, together with 40 kg of N (90 kg of Urea), 20 kg of  $P_2O_5$  (125 kg of Superphosphate) and 20 kg of  $K_2O$  (35 kg of Muriate of Potash) per acre. Apply whole farmyard manure,  $P_2O_5$  and  $K_2O$  and half of N before transplanting and remaining dose of N 4-6 weeks later as top dressing.

**Weed Control** : Weeds are controlled by spraying Stomp 30 EC (pendimethalin) @ one litre/acre or Stomp 30 EC @ 750 ml/acre followed by one hoeing. The herbicide should be applied within a week after transplanting or after first irrigation. Alternatively, apply Goal 23.5 EC (oxyfluorfen) 380 ml/acre as early post-emergence (within 7 days after planting) using 200 litre of water followed by one hand weeding at 90-100 days after planting of onion nursery, for effective weed control.

**Irrigation** : Irrigate immediately after transplanting for proper establishment of seedlings. Depending upon the soil and weather

conditions irrigate the crop at 7-10 day intervals. Stop watering atleast a fortnight before harvesting to prolong storage life of bulbs. The total number of irrigations would be 10-15.

### **Harvesting and Storage :**

Harvest onion when tops dry up and fall. After harvesting cure the bulbs under shade and then cut the leaves 1-2 cm. above the bulb. Store in a well ventilated and dry place. Turn the bulbs once in a fortnight during storage and sort out and discard injured ones.

### **Seed Production :**

#### **1. Bulb to Seed method :**

Onion seed is raised from the bulbs produced during the previous year. 8-10 quintals of graded mother seed bulbs are required for an acre. The bulbs are planted at 60 cm x 45 cm in first fortnight of November. The isolation distance between different varieties of onion should be 1000 meter. Extra early and late bolter should be removed. Depending upon size and variety of onion each bulb produces 5-12 flowering stalks. A minimum of three field inspections should be conducted to produce true to type seed. The first inspection before flowering, second at flowering and fruiting and third before harvesting of the seed crop. The off type and diseased plants should be rogued off. All the flowering stalks do not mature at one time. The primary head generally matures first, followed by secondary and tertiary umbels. Therefore, when the seed turn black, harvesting is done in atleast 3 rounds.

#### **2. Seed to Seed Method :**

Seed to seed method can be followed for commercial seed production in onion. In this method, seeds should be sown in nursery beds during last week of Aug. to first week of Sept. and seedlings should be transplanted in last week of Oct. to first week of Nov. at a spacing of 15 cm between rows and 10 cm plants. It will save one year time of bulb production and cost involved in storage of onion bulbs.

## 21. GARLIC

### Climate and Soil :

Garlic is a cool season crop and it succeeds best in mild season without extremes of heat and cold. Short days are favourable for bulb formation. Sandy loam and silt loam soils are best suited for garlic.

### Improved Varieties :

**PG 17 (2005)** : Its plants have dark green leaves. The Bulbs are attractive and white. The Cloves are bold, white and vary from 25-30 per bulb. It takes 165-170 days for maturity. Its average yield is 50 q/acre.

### Agronomic Practices :

**Sowing Time:** The optimum time of sowing is from last week of September to the first week of October.

**Seed Rate:** For sowing an acre, 225-250 kg of healthy cloves are needed.

**Method of Sowing:** For kitchen gardening and small scale sowing, dibble the clove. In case of commercial planting, sow garlic by 'kera' method. Put the cloves at 3 to 5 cm depth. Sowing of garlic can also be done by manually operated garlic planter. Depth of planting with the machine should be maintained at about one inch. It covers about 0.5 acres per day with the help of 2-3 persons.

**Spacing:** Close planting at 15 cm between rows and 7.5 cm between plants in the row is most conducive.

### Manures and Fertilizers :

Twenty tonnes of farmyard manure/ compost per acre may be applied about 10 days before sowing. In addition, apply 50 kg N (110 kg. Urea) and 25 kg P<sub>2</sub>O<sub>5</sub> (155 kg Single Superphosphate). Whole P<sub>2</sub>O<sub>5</sub> should be applied before sowing. Apply N in three equal splits, 30, 45 and 60 days after sowing.

**Irrigation:** First irrigation should be given immediately after planting. Subsequent irrigations should be given at 10-15 days interval depending upon soil type and weather conditions. The total number of irrigations required are 10-12.

**Weed Control:** The weeds in garlic can be controlled with the application of Stomp 30 EC (pendimethalin) or Basalin 45 EC (fluchloralin) @ 1 litre per acre followed by one weeding at 90-100

days of planting. Stomp 30 EC should be applied within a day after planting and Basalin should be incorporated 3-4 days before planting of cloves. Alternatively, apply Goal 23.5 EC (oxyflorfen) @425 ml per acre as early post-emergence i.e. within 7 days after planting using 200 litre of water followed by one hand weeding after 90-100 days of planting for effective weed control.

### Harvesting and Storage:

At maturity the tops dry. Stop irrigation atleast a fortnight before harvesting to prolong storage life of bulbs. After harvesting cure the plants in a dry and shady place, for 5 to 7 days. Tie in small bundles and store in a well ventilated dry place. Sort out bulbs with dried cloves during storage.

### A. Insect Pests

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precaution</i>
<p><b>1. Onion thrips</b> (<i>Thrips tabaci</i>) Minute pale insects feed on foliage during Feb.-May and produce whitish spots followed by curling-a condition known as "silvertop". This pest is very injurious at the time of flowering and impairs seed production.</p>	<p>Spray 250ml of Malathion 50 EC in 80 litres of water/acre as soon the pest appears.</p>	<p>Do not spray during seven days before the harvest.</p>
<p><b>2. Onion maggot</b> (<i>Delia antiqua</i>) appears in a serious form in some fields during January-February. Infested plants and leaves turn brown from the tip downwards. The bulb and the base of leaves become flaccid and watery and contain about 1/2 cm long maggots which taper towards one end.</p>	<p>Apply 4kg of Sevin 4G (carbaryl) or Thimet 10G (phorate) to the soil followed by light irrigation.</p>	

## B. Diseases

<i>Diseases</i>	<i>Causal Organisms</i>	<i>Symptoms</i>	<i>Control Measures</i>
1. Purple blotch	<i>Alternaria porri</i>	The fungus causes purple spots on leaves and the seed stalks also infects the inflorescence and seeds.	1. Treat the seed before sowing with 3g of Thiram or Captan per kg. of seed. 2. Spray the crop with 600g of Indofil M-45 and 200 ml of Triton or linseed oil (as sticker) in 200 litres of water/acre as soon as first symptoms of the disease appear. This should be followed by 3 or more sprays at 10 day intervals.
2. Downy mildew	<i>Peronospora destructor</i>	Oval to cylindrical pale greenish lesions with white to purplish downy growth which turn into large elliptical dark brown depressed spots on umbel stalks. The infected weak stalks break and the crop gives a blighted appearance.	Same as in purple blotch

## 22. PEA

### Climate and soil :

Pea is a cool weather loving plant. It can germinate even at 4-5°C and can tolerate frost. However, under severe continuous frost, its flowers and young pods are likely to be damaged. Optimum germination takes place at 20-25°C. At temperature of 30°C and above, the germinating or emerging seedlings get killed. The high temperature conditions prevailing at the time of planting results in the build up of wilt and stem fly complex which results in considerable losses in yield. Hence pea attain an ideal growth and development in areas where there is a slow transition from cool to warm weather. It can be grown on all types of soils but well drained fertile loamy soils are best for the crop. Pea do best in soils having pH 6.0 to 7.5.

### Improved Varieties :

#### Early Maturing :

**Matar Ageta-6 (1989)** : Its plants are dwarf (40 cm), erect, vigorous and green. It can tolerate high temperature and can be sown early in the season. First picking is possible after 7 weeks of sowing. Each plant bears 12-15 pods. One or two pods are borne per bunch. Each pod contains up to 6 grains and shelling out turn is 44.6 per cent. Grains have high protein and dry matter content. On drying, percent seeds are light green, smooth with slight dimples. This variety gives 50 per cent of the total production in the first picking. Its green pod yield is 24 q/acre.

**Arkel (1985)**: Arkel is an early maturing variety and takes about 60-65 days from sowing to marketable green pod stage. It is suitable for sowing in the first week of October under the irrigated conditions. Plants are dwarf (30-45 cm). Pods are borne both in double and single and are attractive, dark green, well filled, 8-10 cm long and each contains 7 to 8 dark green grains with a shelling percentage of 40. Dry seeds are light green and wrinkled. It is good for dehydration. Its green pod yield is 18 to 20 q/acre and seed yield is 3.5 q/ acre.

#### Main Season :

**Punjab 89 (2007)** : The plants of this variety are medium dwarf, vigorous, having more number of well filled pods (28-30 per plant).

The pods borne in doubles and are dark green, long, very attractive having 9-10 grains per pod. It takes about 85-90 days for first picking. Shelled peas are very sweet and the shelling out turn is more than 55 per cent. Average green pod yield is 60 q/acre.

**Mithi Phali (1994):** It is an edible podded variety and its shelling is not required. Plants are tall (140 cm) with green foliage. The first picking takes place 90 days after sowing and subsequent pickings at 15 days interval. Pods are light green and 12-13 cm long. Its consumable yield is double than that of standard shelled pea varieties. It is rich in protein and total sugar. Average green pod yield is 47 q/acre.

### Agronomic Practices :

**Sowing and Seed Rate :** Since the incidence of wilt in September is very high, some what late sowing from mid-October to mid-November give the best crop in the plains. Seed rate is 45 kg for early maturing varieties and 30 kg for main season varieties per acre. Line x Plant spacing should be 30 x 7.5 cm for early and 30 x 10 cm for main season varieties.

The sowing of pea can also be done with Seed-cum- Fertilizer pea drill on ridges which are 60 cm wide. This drill sows two rows of pea which are 25 cm apart on each ridge. This drill can sow one acre per hour.

**Inoculation :** In areas where pea crop has not been sown earlier, it is advisable to treat the seed with bacterial culture (*Rhizobium leguminosarum*) to ensure nodule formation and quick growth. It increases the yield and quality of pods. The culture is available in the Department of Microbiology, Punjab Agricultural University, Ludhiana. One acre culture packet should be mixed with half litre of water. Rub the mixture thoroughly on seed to give a fine covering of the culture to every seed. Thereafter, spread the seed in shade for drying and plant it immediately afterwards.

### Manures and Fertilizers :

Apply 8 tonnes of farmyard manure and 20 kg of N (45 kg of Urea) and 25 kg of P<sub>2</sub>O<sub>5</sub> (155 kg of Superphosphate) per acre before sowing.

**Weed Control :** The field should be kept free from weeds by giving two hoeings after four and eight weeks of germination respectively. For chemical weed control use Stomp 30 EC (pendimethalin) @1.0 litre per acre or Afalon 50 WP (linuron) @500 g per acre as pre-emergence i.e. within 2 days of sowing. Dissolve

the herbicide in 150-200 litres of water and spray uniformly over the entire field. Application of these herbicides control many of the annual broad leaved and grass weeds, including *Phalaris minor*.

**Irrigation :** Seed should be sown in proper soil moisture condition. First irrigation should be given after 15 days of sowing. Next irrigation should be given at flowering and then at fruit set if necessary. Pea can be grown as rainfed crop with limited irrigations. The total number of irrigations required are 3-4 depending upon the soil type and weather conditions.

### Harvesting :

Harvest the crop at the proper edible maturity and do not allow the pods to over mature which impairs its quality. Harvesting is to be completed in number of pickings depending upon the maturity group of peas.

### 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.

### Plant Protection

#### A. Insect Pests

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
1. Pea thrip ( <i>Thrips indicus</i> ) cause severe damage to the young crop by sucking the cell sap.	Spray 400ml of Rogor 30 EC ( <i>dimethoate</i> ) in 80-100 litres of water/acre when the attack begins and repeat the spray at 15 days intervals.	Stop spraying the crop with these insecticides at least 20 days before the picking of pods.
2. Pea-leaf miner ( <i>Chrotomyia horticola</i> ) larvae feed by making tunnels in the leaves. These cause serious damage during December-March.	-do-	
3. Pea-aphid ( <i>Acrythosiphon pisum</i> )	-do-	Avoid direct contact with chemicals while treating the seed. Use rubber

<b>Pests and Symptoms</b>	<b>Control Measures</b>	<b>Precautions</b>
sucks the cell sap, owing to which the leaves turn pale and dry.		gloves for application of granules.
<b>4. Pea-stem fly</b> ( <i>Ophiomyia phaseoli</i> ) sometimes causes serious damage at the seedling stage.	i) Apply 3kg Thimet 10G ( <i>phorate</i> ) or 10kg Furadan 3G ( <i>carbofuran</i> ) granules per acre in furrows at sowing. ii) Sow the crop in the second fortnight of October to escape the damage by the pest.	

**Note :** For motorized knapsack sprayer, use the same quantity of pesticide per acre as mentioned above but the quantity of water dilution will be approximately 1/10<sup>th</sup>.

## B. Diseases

<b>Diseases</b>	<b>Causal Organisms</b>	<b>Symptoms</b>	<b>Control Measures</b>
1. Powdery mildew	<i>Erysiphe polygoni</i>	White floury patches covering large areas, appear on stem, branches, leaves and pods.	Spray the crop with Karathane 40 EC @80ml or Sulfex @600g in 200 litres of water per acre. Three sprays may be given at 10 days interval.
2. Wilt, root rot and collar rot	<i>Fusarium oxysporum</i> and <i>Rhizoctonia solani</i>	Root rotting and yellowing of lower leaves, followed by wilting. Reddish brown cankers may appear in the collar region.	i) Treat the seed with Bavistin @1g or Captan @ 2g or Talc based formulation of Pseudomonas fluorescens @15g+1g Captan per kg seed before sowing. ii) Avoid early sowing in badly infested areas.

<b>Diseases</b>	<b>Causal Organisms</b>	<b>Symptoms</b>	<b>Control Measures</b>
3. Rust	<i>Uromyces viciae fabae</i>	Yellowish, reddish-brown, spherical, raised pustules appear mainly on the lower side of leaves during December-January. This disease is more serious in the late sown crop.	i) Give first spray of 400g of Indofil M-45 in 200 litres of water by the end of December. Three subsequent sprays may be given at 10 days interval. ii) Keep the field free from Rewari weed which serves as a source of inoculum. iii) For controlling powdery mildew and rust together Karathane @80ml or Sulfex @600g. can be sprayed in combination with Indofil M-45 @400g per acre.
4. White rot	<i>Sclerotinia sclerotiorum</i>	Disease appears as irregular shaped water soaked spots on leaves, stem and pods; However, the disease is most frequently observed on pods which turn papery brown in colour in the later stage. White mycelial growth appears on the infected portion under wet and cool weather. Black hard sclerotial bodies embedded in mycelium are formed within the pods. The disease is high at flowering and pod formation stage.	i) Avoid growing of pea after the susceptible crops like brinjal, cauliflower, carrot and pea, instead tomato and chilli can be grown. This will help in reducing the disease and spread of inoculum in the field. ii) The plant debris of the crop should be collected and burnt.

## 23. CAULIFLOWER

### Climate and soil :

Cauliflower grows well on wide range of soils from sandy loam to clay. The optimum pH is between 6.0 and 7.0. Cauliflower is a thermo sensitive crop and temperature plays an important role influencing vegetative, curding and reproduction phases of plant. The optimum temperature of growth for young seedlings is around 23°C which at later growing stage drops to 17-20°C. The tropical cultivars grow even at 35°C, however, temperate cultivars grow well between 15°C to 20°C.

### Improved Varieties :

#### Late Season :

**Pusa Snowball-1 (1994)** : Outer leaves are upright and inner leaves cover the curd initially. Curd is compact, medium sized and snow white. Curd is ready for harvest in about 100 days after transplanting. Curd yield is 90 q/acre.

**Pusa Snowball K-1 (1994)** : Outer leaves are upright and inner leaves cover the curd tightly. Curd is compact, snow white and slightly raised in the centre. The maturity is late by one week than Pusa Snowball-1. Curd yield is 90 q/acre.

### Agronomics Practices :

**Sowing and Seed Rate** : The best transplanting time is June-July for the early varieties, August to mid-September for the main season varieties and October to first week of November for the late varieties. The seed rate for main and late season varieties is 250g per acre, whereas, for early season varieties 500 g seed is required.

To check bolting and buttoning, sow the recommended varieties at their proper time. To minimise mortality of early sown nursery and transplanted crop, apply heavy dose of well rotten farmyard manure and irrigate frequently. Protect seedlings in the nursery beds against sun stroke with *sarkanda* thatch. Transplant seedlings in a cool '*wattar*' field in the afternoon and irrigate immediately.

**Spacing** : The spacing for the main-season crop is 45 x 45 cm. and 45x30 cm for early and late-season crops.

### Manures and Fertilizers :

40 tonnes of farmyard manure, with 50kg of N (110kg of Urea), 25 kg of P<sub>2</sub>O<sub>5</sub> (155 kg of Single Superphosphate) and 25 kg of K<sub>2</sub>O (40kg of Muriate of Potash) per acre is the optimum fertilizer dose for all these varieties. Apply whole of farmyard manure, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O and half N before transplanting and the remaining half of N as top-dressing four weeks after transplanting.

**Weed Control** : Apply Basalin 45 EC (fluchloralin) @ 750 ml per acre 4 days before transplanting the seedlings. Herbicide should be thoroughly incorporated into the soil with the help of light harrowing. It should be supplemented by one hoeing after 30-40 days of transplanting. Stomp 30 EC (pendimethalin) 1 litre/acre or Stomp 30 EC 750 ml followed by one hoeing 35 days after transplanting can also be used. Stomp should be applied one day before transplanting of the seedlings in the moist soil conditions.

**Irrigation** : First irrigation should be given just after transplanting. Subsequent irrigations can be given at an interval of 7-8 days during summer and 10-15 days during winter depending upon soil type and weather. The total number of irrigations required are 8-12.

### Harvesting :

The curds should be harvested at the marketable stage. Delay in harvesting causes loosening of the curd. The curds should be sent to markets in baskets after proper grading and packing.

### Seed Production :

For seed production crop is grown just like market crop. After curd formation seed of early and main season varieties can be produced in the plains, however, the seed of late season varieties can only be produced in the hills because during flowering and seed setting stage moderate temperature is available in the 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. When pods turn brown they should be harvested two or three times. After curing they should be thrashed and cleaned.

## 24. CABBAGE

### **Climate and soil :**

It grows best in cool moist climate and is very hardy to frost even at head formation stage. In dry climate its quality becomes poor and much of its delicate flavour is lost. It is grown mainly as winter crop. It can tolerate high or low temperatures as compared to cauliflower.

It can be grown almost on all types of soils, Sandy loam soil is considered best for early crop but where high yield is the main criterion, clay loam or silt loam soils are preferred. Before transplanting the soil is prepared well to make it loose friable and retentive of moisture.

### **Agronomic Practices :**

September to October is the ideal planting time in the plains. Optimum seed rate is 200-250 g. per acre. A spacing of 45 x 45 cm. and 60 x 45 cm are optimum for the early and the late maturing varieties, respectively.

To get early yield of cabbage the direct sowing on ridges at 60 cm apart maintaining a distance of 15-20 cm between plants may be practiced. It yields about two week earlier than the transplanted one. A seed of 325 g/acre is sufficient for direct sowing.

Manurial requirements of this crop are the same as those of cauliflower.

**Weed Control :** For weed control in cabbage, apply Stomp 30 EC (pendimethalin) 1 litre/acre or 750 ml/acre followed by one hoeing. Alternatively use Basalin 45 EC (fluchloralin) 1 litre/acre or 750 ml/acre followed by one hoeing. These herbicides should be applied four days before transplanting. Basalin 45 EC should be well mixed with soil by light harrowing and planking.

**Irrigation :** First irrigation should be given immediately after transplanting. The subsequent irrigations should be given at 10-15 day intervals. The total number of irrigations required are 8-12.

### **Harvesting :**

Harvesting should be done as soon as heads reach marketable size and become hard. The heads should be properly packed and sent to market after cutting stumps.

## 25. BROCCOLI

### **Nutrition :**

It is most nutritious of the cole crops, especially in vitamins, iron and calcium content. It contains 3.3 per cent protein and high content of vitamin A & C and appreciable quantity of thiamine, niacin and riboflavin. Several flavouring compounds are found in broccoli. The glucosinolate content of purple-headed broccoli has been found in the range of 72-212 mg/100g. It also contains high concentration of carotenoids which are believed to be chemo-preventive and associated with a decreased risk of human cancers. Broccoli may play role in reducing levels of serum cholesterol. Besides, it is also rich source of sulphoraphane (singrin) compound associated with reducing risk of cancer. It is marketed as fresh, frozen and also used in salads.

### **Climate and soil :**

It thrives best in a cool and moist climate. It cannot tolerate very high temperature as it produces poor quality sprouts. The optimum temperature to grow is between 17-23°C. Temperature below optimum during growing time delays maturity and small sprouts may be formed.

It can be grown on a wide range of soils provided they are rich in nutrients, have adequate soil moisture and possess good drainage. The soil should contain plenty of organic matter. It must be thoroughly prepared so that it becomes loose, friable and retentive of moisture.

### **Improved Variety :**

**Punjab Broccoli –1 (1996) :** Leaves are smooth, wavy and dark green. Main as well as secondary sprouts are dark green. The leaves as well as sprouts have slightly bluish tinge. The sprouts are also compact, attractive and succulent. The main sprouts are ready for harvest in about 65 days after transplanting. This variety is suitable for both salad as well as cooking purposes. Its average yield is 70 q/acre.

### **Agronomic Practices :**

**Sowing and Seed Rate :** The best time for sowing seed in



nursery is mid August to mid September. When the seedlings are one month old, transplant them in the field. A seed rate of 250g is sufficient for one acre. To check bolting and buttoning sow the crop at proper time. Transplant the seedlings in proper 'Wattar' and irrigate the field immediately after transplanting.

**Spacing :** A spacing of 45 x 45 cm. should be followed between lines as well as plants.

**Manures and Fertilizers :**

40 tonnes of farmyard manure with 50 kg of N (110 kg Urea), 25 kg. of P<sub>2</sub>O<sub>5</sub> (155 kg. of Single Superphosphate) and 25 kg. of K<sub>2</sub>O (40 kg of Muriate of Potash) per acre make the optimum fertilizer dose. Apply whole of farmyard manure, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O and ½ N before transplanting and remaining half N as top dressing one month after transplanting.

**Weed Control and Irrigation :** Use the herbicides as have been recommended for cauliflower. Its irrigation requirement is also similar to those of cauliflower.

**Harvesting :**

As soon as sprouts are of marketable size they should be harvested. They should be marketed as soon as possible because they cannot be stored for a long time. After harvesting the central sprout, axillary sprouts become ready for harvest again in about 10-12 days.

**Seed Production :**

For seed production the crop is grown just like the market crop. After formation of sprouts the plants are left in situ for seed production. To produce genetically pure seed the off-type plants must be removed thrice during vegetative phase, sprout formation stage and flowering stage. Isolation of 1600 meter should be kept between different cole crops and different varieties of broccoli. When pods turn brown they should be harvested two or three times. After harvesting they should be thrashed and cleaned.

## 26. CHINESE CABBAGE

**Climate and soil :**

Chinese Cabbage is a winter season crop. It thrives best at temperature from 15-21°C. The crop can be grown on a wide range of soils ranging from sandy loam to heavy soils.

It is a non-heading strain of Chinese Cabbage which makes a high quality 'saag' due to its tender and succulent leaves. Its first cutting is ready by the middle of November.

**Improved Variety :**

**Chinese Sarson :** The plant is non-heading with semi-erect plant habit. It gives light green, broad, puckered and 12-15 leaves per plant. The leaf mid-rib is whitish, tender and succulent. It has quick growth habit and six to eight cuttings can be obtained. The first cutting can be had 30 days after transplanting. Average yield is 155 q/acre.

**Agronomics Practices :**

**Sowing and Seed Rate :** Sow the seed in raised nursery beds in mid September. Transplant the seedlings in the second fortnight of October. For sowing nursery, use 200g of seed and for direct sowing, 1 kg seed per acre.

**Spacing :** Row to row and plant to plant spacing should be kept at 30 cm.

**Manures and Fertilizers :**

15-20 tonnes of farmyard manure with 50 kg of N (110 kg of Urea) 25 kg of P<sub>2</sub>O<sub>5</sub> (155 kg of Single Superphosphate) and 25 kg of K<sub>2</sub>O (40 kg of Muriate of Potash) per acre is the optimum dose for this crop. Apply the whole of farm yard manure, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O and 1/3 N before transplanting or sowing and the remaining 2/3 N as top dressing in equal proportion after the second and fourth cuttings for the growth of plants.

**Harvesting :**

Harvest complete, fully developed leaves near the base without injuring the central bud point. Stop taking cutting by the end of

December to get seed. Bolting starts in the last week of January. Harvest the seed by the end of April or early May.

#### **Seed Production :**

A minimum isolation distance of 1000 meter should be maintained from other varieties of chinese cabbage, sarson and turnip. One month old seedlings should be transplanted at the spacing of 60cmx45cm. Minimum three field inspections should be made for getting the true to type seed. The first inspection should be made at vegetative phase, second at bolting stage and third before harvesting of the crop. Any off type and diseased plants should be removed. The plants showing variation in leaf characters as well as early and late bolters should be removed.

The crop should be harvested when most of the ripening seed stalks turn brown. Care should be taken to avoid shattering of seeds. After harvesting, the crop should left in the field for curing and drying for about a week before the seed threshing.

## **27. ROOT CROPS (CARROT, RADISH AND TURNIP)**

#### **Climate and soil :**

Carrot requires a relatively long growing season than the other root crops. The optimum temperature is 7.2.-23.9°C for germination and 18.3-23.9°C for growth. The best root colour develops at 15-20°C. Temperature higher than 30°C, particular in later stages of development, induces undesirable strong flavour and coarseness in the roots. Temperate types need low temperature of 5-8°C for 40-60 days before flowering to break dormancy.

Radish main season varieties develop best flavour, texture and root size when the temperature is between 10-15°C. In temperate types, maximum root growth occurs initially at 20-30°C and later at 10-14°C. More foliage growth is favoured at temperature above 20°C. In hot weather roots become pungent and tough before attaining marketable maturity.

Turnip roots develop best flavour, texture and size at 10-15°C. Long days and high temperature induce early bolting even without adequate development of roots. In hot weather, roots become fibrous, tough and pungent. The Asiatic types can tolerate fairly high temperature but flourish under cool weather.

**Soil Requirement:** Radish and turnip can be grown on all types of soil but a sandy loam, friable soil is considered best. These crops can be grown in fairly acidic soils having pH of 5.5-6.8. Sandy loam soil is ideal for quick growth of roots. Soils with high clay content are not desirable, as they tend to produce misshapen roots with numerous small laterals. Carrot needs a deep, loose loamy soil for best root development. Heavy soils check root development and promote forking. A soil pH of 6.5 is desirable for obtaining higher yield of better quality roots.

#### **Improved Variety :**

##### **Carrot:**

**Punjab Black Beauty (2013) :** It is a tropical variety and roots attain edible maturity after 93 days of sowing. Leaves are dark green

and petioles are purple in colour. Roots are purple-black, 26 cm long and 3.20 cm in diameter. Roots have ability to stay in the field over a fortnight after reaching edible maturity. This variety has high nutraceutical values and excellent quality characters. It is rich in anthocyanins (182 mg/100g) and phenols (73 mg/100g) which protect from cancers. It has high juice content (580 ml/kg), calcium (50mg/100g), iron (1.10mg/100g), TSS (7.5 per cent) and dry matter (11 per cent). Fresh carrots are suitable for salad, juice, pickle and *kanji*. Average root yield is 196 q/acre.

**PC-34 (2005)** : It takes on an average 90 days to mature after sowing. The leaves are dark green and the average plant height is 62 cm. The roots are red in colour. The average length of root is 25 cm with a small core i.e. 0.95 cm. The root diameter is about 3.15 cm. This variety has excellent quality characters. The dry matter is 13.3 per cent and juice yield is 480 ml/kg. The TSS is 8.8 per cent, total sugars 5.81 g/100g, reducing sugars 2.17 g/100g and alcohol insoluble solids are 60.8 g/100g. The  $\beta$ -carotene content is 8.86 mg/100g. Its average yield is 204 q/acre.

### Radish:

**Punjab Pasand (1997)** : It is an early maturing variety and roots attain edible maturity after 45 days of sowing. Roots are long, pure white, semi-stumped and free from hair. Its top is light, erect and leaves have complete lamina. It is suitable for sowing in main season and gives an average yield of 215 q/acre. During off season it gives 140 q/acre yield.

**Pusa Himani (1995)**: It is a temperate variety suitable for sowing in second fortnight of January. Roots are white, semi-stumped with green shoulder. Roots are fleshy, crisp, mildly pungent, 30-35 cm. in length and 10-12 cm in girth. Roots are ready for harvest 60-65 days after sowing. It yields 160 quintals of roots per acre.

**Pusa Chetki (1988)** : Roots snow-white, smooth, medium long (15.5 cm), thick (3.5 cm), stumpy and mildly pungent. Leaves medium sized (40.5 cm ) with complete lamina. Leaf root ratio is 1:1.5. An early maturing with good seed setting under Punjab conditions. This variety is most suitable for sowing from April to August. The average root yield is 105 q/acre and seed yield is 4.5 q/acre.

**Japanese White (1962)** : It is an introduction from Japan and is recommended for late sowing in the main season in north Indian plains and July to September in hills. Its top is medium and leaves have deep cuts. The roots are cylindrical, pure white with blunt end. Average yield is 160 q/acre.

### Turnip:

**L-1 (1974)** : The roots are round, pure white, smooth rat-tailed and crisp with mild flavour. It can be harvested between 45 to 60 days of sowing. It yields about 105 quintals of roots per acre.

### Agronomic Practices:

**Sowing Time and Seed Rate:** Although radish is a winter season crop but varieties have been developed that can be grown in summer and spring seasons. Except Pusa *Chetki*, other varieties do not tolerate high temperature if planted early in the season. Asiatic varieties if planted late in the season, start bolting without forming edible roots. With careful selection of varieties, radish can be grown almost throughout the year. The schedule of sowing radish varieties and their root availability is given as under:

Variety	Sowing time	Root availability
Pusa Himani	January-February	February-April
Punjab Pasand	Second fortnight of March	End April-May
Pusa <i>Chetki</i>	April-August	May-September
Punjab <i>Pasand</i> Japanese White	Mid September-Oct.	October-December
Japanese White	November-December	December-January

For desi varieties of carrot and turnip, August-September is the best time of sowing. European types should be sown in October-November. A seed rate of 4 to 5 kg. for carrot and radish and 2-3 kg. for turnip is sufficient for one acre. A spacing of 45 cm between ridges and 7.5 cm between plants in the row is common for these crops. The plant spacing is maintained by thinning at the time of true leaf formation. Thinning is very important for producing superior quality roots.

### Manures and Fertilizers:

15 tonnes of farmyard manure, with 25 kg. of N (55 kg of Urea) and 12 kg. of  $P_2O_5$  (75 kg. of Single Superphosphate) per acre is the common fertilizer dose. Carrot requires, in addition, 30 kg. of  $K_2O$  (50

kg of Muriate of Potash) per acre, as in the absence of potash, its root development is not good. Apply all fertilizers at sowing. Well rotten farmyard manure should be applied to root crops.

**Weeding and Earthing up:** Carrot normally grows slowly in the beginning and cannot compete with weeds. Removal of weeds is necessary especially in the early stages. In radish and turnip, one weeding about 2-3 weeks after sowing is sufficient. Weeding is immediately followed by earthing up especially in *desi* varieties of radish where roots have tendency to protrude above soil surface.

**Irrigation:** First irrigation should be given immediately after seed sowing. Subsequent irrigations should be given at 6-7 day intervals during summer and 10-12 days during winter, depending upon soil type. Radish requires 5-6 irrigations and carrot 3-4 irrigations. Excessive irrigation results in misshapen roots and numerous hair growth. Pre-harvest light irrigation is useful for summer crop of radish because this keeps the roots fresh and reduces pungency.

#### **Harvesting:**

Radish and turnip are harvested when roots are tender. A few days delay in harvesting particularly of European types, render the roots pithy and unfit for consumption. Punjab *Pasand*, a quick growing main season variety and Pusa *Chetki*, an early season variety attains marketable maturity 45 days after sowing. Other varieties of radish and turnip will be ready for harvest in about 45-60 days depending upon variety and season. Carrots will be ready for harvest in about 90-100 days depending upon variety. Harvest radish and turnip when they have attained marketable size but before becoming pithy. Carrot can be harvested when roots have developed marketable size and attractive deep orange colour.

#### **Processing :**

The fermentation process of LANC from Carrot and Amla with yeast *Clavispora lusitaniae* has been optimized. The beverage can be prepared at small and large scale with shelf life of 3 months. The technology can reduce the problem of carrot-amlu glut in market, making the availability of nutrients in the form of effervescent beverage for long period.

#### **Seed Production:**

**Carrot:** Follow the same practices as for table crop for raising roots. Roots raised in one acre are sufficient to plant four acres of seed crop. Transplant stecklings at 45 x 30 cm in the second fortnight

of December. Apply 30 kg. N (65 kg. Urea) and 8 kg. P<sub>2</sub>O<sub>5</sub> (50 kg. Superphosphate) per acre. Apply whole of P<sub>2</sub>O<sub>5</sub> and half of N before transplanting and the rest half of the N after 30 days.

**Radish:** Roots raised in one acre are sufficient to plant 4 to 5 acres of seed crop. Sow Pusa *Chetki* in August, Punjab *Pasand* in September and Japanese *White* in October for raising roots for seed production. Transplant steckling of Pusa *Chetki* in September and Punjab *Pasand* and Japanese *White* after middle of November. Transplant stecklings of  $\frac{3}{4}$  root length at 60 x 22 cm. spacings. Apply 30 kg N (65 kg Urea) and 8 kg P<sub>2</sub>O<sub>5</sub> (50 kg. Superphosphate) per acre. Add whole of P<sub>2</sub>O<sub>5</sub> and half of N before planting and the remaining half of nitrogen after 30 days.

**Turnip:** Roots raised in one acre are sufficient to plant 3 to 4 acres of seed crop. Seed of L-1 can be produced by sowing in mid September and transplanting in the first week of December. Select roots having diameter more than 5 cm for seed production. Keep rows 45 cm. and plants 15 cm apart. Fertilization is the same as in case of radish.

**Plant Protection  
(Cauliflower, Cabbage, Broccoli, Chinese Cabbage,  
Radish and Turnip)**

**A. Insect Pests**

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
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**A. Early-Season Crop (July-October)**

<b>1. Stem borer (<i>Hellula undalis</i>)</b> Serious during July-August. The larvae bore into the central shoots and the plant is unable to bear the flower head.	Since the attack is mostly on young plants in the nursery and the fields. Spray 150 g. of Sevin / Hexavin 50 WP ( <i>carbaryl</i> ) in 50 - 60 litres of water. Repeat the spray after 10 days if necessary.	Spray only when insects are present in damaging numbers. Pick all flowering heads before spraying and do observe the 7 days waiting period after each spraying for next picking.
<b>2. Diamond-back moth (<i>Plutella xylostella</i>)</b> . Serious during August-September. Larvae feed on the leaves, leaving intact the parchment like epidermis, sometimes they produce shot holes in leaves. The growth of young plants is greatly inhibited.	Give need based sprays of 300 ml of Dipel 8L ( <i>Bacillus thuringiensis</i> ssp. <i>kurstaki</i> ) or 300 g Halt WP ( <i>B. thuringiensis</i> ssp. <i>Kurstaki</i> ) at 7 days interval (spray in the evening) or 250 ml of Success 2.5 SC ( <i>spinosad</i> ) or 70g of Proclaim 05 SG ( <i>emamectin benzoate</i> ) or 130 ml of Avaunt 15.8 EC ( <i>indoxacarb</i> ) or Spray 200 g of Padan 50 SP ( <i>cartaphy-drochloride</i> ) or 200-400 ml Ekalux 25 EC ( <i>quinalphos</i> ) or 100 ml of Sumicidin 20 EC ( <i>fenvalerate</i> ) using 80-100 litres of water. Repeat the spray after 10 days, if necessary.	Preferred to used Dipel 8L or Halt WP in the initial sprays as these are safe to non target organisms. Follow the waiting period of 3 days for Avaunt 15.8 EC on both cabbage and cauliflower crops. For success 2.5 SC, follow 5 days waiting period for cabbage and 7 days for cauliflower crop. While, for Proclaim 05 SG, follow 3 days waiting period for cabbage and 5 days for cauliflower crop.
<b>3. Tobacco caterpillar (<i>Spodoptera litura</i>)</b> Serious during August-	1. Remove the egg masses and clusters of larvae and destroy them.	

<i>Pests and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
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October. It is a sporadic pest. If it is not controlled, it may completely damage the leaves. Young stages of the caterpillar feed gregariously.

2. Chemical sprays recommended above will also work against this pest, but in this case, spot application may be enough if the attack is not wide-spread in the field.

**B. Mid-Season Crop (September to December)**

The main-season crop is seldom severely attacked by any of the above mentioned insect pests. The incidence of tobacco caterpillar may sometimes become severe and extend upto October. Diamond back moth also attack the crop in October-November.

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**C. Late-Season Crop (December to March)**

Mainly attacked by aphids (*Lipaphis erysimi*). Serious during January to February They suck the sap from leaves and the growth of young plants is checked.

Spray 250-500 ml Malathion 50 EC in 80-100 litres of water per acre. Repeat the spray after 10 days, if necessary.

Besides aphids, the population of diamond back moth may sometimes build up during February-March.

Control measures are the same as given under early-season crop.

**Note :** For motorised knap-sack sprayer, use the same quantity of pesticides per acre, as mentioned above, but the quantity of water for dilution will be approximately 1/10th.

## B. Diseases

Diseases	Causal Organisms	Symptoms	Control Measures
1. <b>Damping off</b>	<i>Pythium sp.</i> <i>Rhizoctonia sp.</i> and <i>Fusarium sp.</i>	Both pre and post emergence death of seedlings occurs.	i) Treat the seed before sowing with 3g. of Captan or Thiram per kg seed. ii) Drench the soil around the seedlings with 200g of Captan per 100 litres of water twice, viz. on the 7th & 15th days after sowing.
2. <b>Crown rot of turnip</b>	<i>Alternaria brassicae</i>	Lesions appear in the collar region particularly in turnip on young seedlings. Lesions become black and corky with cracks on the root crown. Leaves, slowly dry up.	-do-
3. <b>Black rot</b>	<i>Xanthomonas campestris</i>	'V' shaped yellow lesions on margins of leaves, turn brown. The veins blacken, leaves malformed, dry up and die. Curds are also infected and become rotten.	i) Take seed from the bacterium-free areas of the plants free of disease. ii) Treat the seed before sowing with hot water at 50°C for 30 minutes and dry. Then treat with Thiram or Captan at 3g. per kg of seed. iii. Spray the crop with 40 g of Streptomycin with 200g. of copper oxychloride in 200 litres of water. Depending upon the in-

Diseases	Causal Organisms	Symptoms	Control Measures
4. <b>Alternaria blight</b>	<i>Alternaria brassicae</i> and <i>A. brassicicola</i>	Concentric spots on the lower leaves. The curd also gets infected and rots. Brown spots are formed on pods in the seed crop.	tensity of the disease, 2 or 3 sprays should be given. iv. Use sanitary measures. Destroy the diseased debris in the field after harvesting. i. Treat the seed before sowing with 3g. of Captan or Thiram per kg of seed. ii. Spray the crop with Indofil M-45 @500g in 200 litres of water per acre at 7 day intervals. iii. Destroy the affected plant debris. iv. If Black rot and Alternaria blight occur together, add 30g Agrimycin 100 to the solution of Indofil M-45 before spraying.
5. <b>Downy mildew</b>	<i>Peronospora parasitica</i>	The disease develops on leaves and curds. On leaves, the lesions are yellowish, irregular to angular with white 'downy' growth. The curd tops turn brown. The stems develop dark brown depressed irregular lesions/streaks with whitish 'downy' growth. The severely infected curds rot and fail to produce seeds.	Spray the crop with Indofil M-45 @ 500 g in 200 litres of water per acre at 7 day intervals.

<i>Diseases</i>	<i>Casual Organisms</i>	<i>Symptoms</i>	<i>Control Measures</i>
<b>6. Stalk rot of cauli flower seed crop</b>	<i>Sclerotinia sclerotiorum</i>	Stem and inflorescence twigs become straw coloured and dry during March. Pith of infected plant portion is filled with black, hard sclerotia of variable sizes.	In disease prone areas use of FYM decreases the disease incidence and the number of sclerotia of the fungus.

## 28. PALAK

**Climate and Soil :** It is a winter season crop but can be grown throughout the year. It can also tolerate frost. It can be grown almost on all soils but sandy loam with pH 7.0 is the best for its cultivation.

### Improved Variety :

**Punjab Green (1990) :** The plants are semi-erect, foliage is shining dark green, thick, long, sweet, succulent and free from sourness. There is mild purple pigmentation on stem. It is ready for first cutting after 30 days of sowing and yields on an average 125 q/acre. It is slow bolter. It has low oxalic acid which is desirable trait in greens.

### Agronomic Practices :

**Sowing Time and Seed Rate :** Winter crop is sown during September-October and spring/summer crop from mid-February to April. Normally palak is grown almost throughout the year. For winter crop, use 4-6 kg. and for summer crop 10-15 kg. of seed per acre.

**Spacing :** Seed should be sown 3-4 cm. deep in rows at 20 cm apart.

### Manures and Fertilizers :

Apply 10 tonnes of farmyard manure alongwith 35 kg of N (75 kg of Urea) and 12 kg of  $P_2O_5$  (75 kg of Superphosphate) per acre to harvest a good crop. Apply whole of farm yard manure,  $P_2O_5$  and half N before sowing and the remaining half may be applied in two splits after each cutting followed by irrigation.

**Irrigation :** First irrigation should be given immediately after sowing. Subsequent irrigations should be given at an interval of 4-6 days during summer and 10-12 days during winter.

### Harvesting :

The crop will be ready for harvest in about 3-4 weeks after sowing. Subsequent cutting should be done at an interval of 20 to 25 days depending upon the variety and season. During summer only one harvesting should be taken.

### Seed Production :

A minimum isolation distance of 1000 meter should be maintained all around palak seed field from other varieties. Row to row and plant to plant distance should be maintained at 50 cm x 30 cm. Skipping

of one row after every five rows is very essential for field inspection. The minimum three field inspections should be made for getting the true to type seed. The first inspection should be made at vegetative phase, second at bolting stage and third before harvesting of the crop. Any off type and diseased plants should be removed. The plants showing variation in leaf characters as well as early and late bolters should be removed.

The crop should be harvested when most of the late ripening seed stalks turn brown. After harvesting, the crop should be left in the field for curing and drying for about a week before the seed threshing.

## Plant Protection

### A. Insect Pests

<i>Pest and Symptoms</i>	<i>Control Measures</i>	<i>Precautions</i>
<b>Aphids</b> ( <i>Aphis sp.</i> ) Minute insects suck sap from the foliage resulting in twisting of leaves.	Spray 350 ml Malathion 50 EC in 80 litres of water per acre as and when the pest is noticed.	Harvest the crop 7 days after spray.

### B. Diseases

<i>Disease</i>	<i>Causal Organism</i>	<i>Symptoms</i>	<i>Control Measures</i>
<b>Cercospora leaf spot</b>	<i>Cercospora beticola</i>	Small circular to sub-circular spot with grey centres surrounded by red margins appear on leaves. This disease is more pronounced on seed crop.	On seed crop, disease can be controlled by spraying Bavistin @200g or Indofil M-45 600g in 200 litres of water/acre at 15 day intervals starting from appearance of symptoms. Three spray are enough.

## 29. LETTUCE

### Climate and soil :

Lettuce requires cool environment. The average mean temperature for growth and better taste is 13-16°C. High temperature promotes seed stalk and causes bitter taste of leaves. It performs well in sandy loam and silt loam soils.

### Improved Variety :

**Punjab Lettuce-I (1991)** : Its leaves are light green, shining and crispy. It is a non-heading type and bears loose leaves. It takes 45 days from sowing to first harvest of fully developed leaves and yield of green leaves is 35 q/acre. Harvesting of green leaves is possible from November to March.

### Agronomic Practices :

**Sowing Time and Seed Rate** : Sow the seed on 15-20 cm. raised nursery beds from mid September to mid November. Transplant 4-6 weeks old seedlings and irrigate at a weekly interval. To raise seedlings for an acre, sow 400g seed in 2 marla nursery beds.

**Spacing** : Keep the spacing between seedlings 30 cm. and rows 45 cm.

### Manures and Fertilizers :

Apply 15 tonnes of FYM, 25 kg N (55kg Urea) and 12 kg P<sub>2</sub>O<sub>5</sub> (75 kg of Single Superphosphate) per acre. Apply whole of superphosphate and 18 kg urea before transplanting and rest after six weeks.

**Irrigation** : First irrigation should be given immediately after transplanting. Subsequent irrigations should be given at an interval of 5-6 days on light soils but 8 to 10 days on heavy soils.

### Harvesting :

Harvest fully developed and tender leaves once a week regularly. Stop taking cuttings by the end of March or beginning of April when the plants attain milky stage. Bolting starts in the first week of April. Harvest seed crop in the middle of May. Seed yield per acre is 50 kg.

### Seed Production :

Lettuce is strictly self pollinated crop and require about 10 metre isolation to avoid mechanical mixture. Seed stalks should be harvested when seed is fully mature on the plants otherwise germination is affected.



## 30. CORIANDER

### Climate and Soil :

It requires cool climate in early stages and warm dry weather at maturity. Coriander can be sown on a wide variety of soil but it performs best in well-drained sandy loam to loamy soils.

### Improved variety :

**Punjab Sugandh (2008)** : Its green plants are semi-erect, and produce profuse tillers. Leaves are medium in size, green, tender and excellent in aroma. It is late in bolting and give four cuttings of green leaves. The average green leaves yield is 150 q, and of seed is 3.5 q/acre.

### Agronomic Practices:

**Preparatory Tillage** : Prepare a fine seed bed by giving two or three ploughings, each followed by planking.

**Seed Rate** : 8-10 kg/acre.

**Seed Preparation** : Use healthy and disease free capsules (seeds). Rub the capsules gently to break them into 2 to 4 parts. Unrubbed capsules give very poor germination. Treat the seed with Thiram @ 2.5 g per kg of seed.

**Time and Method of Sowing** : Optimum period of sowing for green leaves is first week of October and for seed last week of October to the first week of November. However, it can be continued up to last week of December. Sow by pora method in rows 30 cm apart.

**Weed Control** : The slow growth of coriander in the initial stages poses a serious weed problem. Give two weedings, preferably with improved wheel hand hoe, the first about 4 weeks after sowing and the second 5-6 weeks thereafter.

**Irrigation** : Give four or five irrigations depending upon the soil and rainfall. The first irrigation may be given about 3 weeks after sowing. Subsequent irrigations may be given as and when required taking care that there is no moisture stress, particularly at flowering and seed development stages.

### Manures and Fertilizers :

Apply 40 kg N (90 kg Urea) in three split doses, one third at sowing and remaining in two equal splits after first and second cutting of green leaves. However, for seed crop apply 30 kg N (65 kg urea) per acre in two splits, half at sowing and the remaining half at flower initiation. There is no need of applying phosphorus to soils testing medium to high in this nutrient.

### Harvesting and Threshing :

The green leaves are harvested on attaining 20-25 cm height. Therefore, 3-4 cuttings can be taken of green leaves. The crop is ready for harvest by the end of April. Harvest when the capsules are mature but green. The green coloured fetch a price premium over the brown coloured over-ripe capsules. Remove the harvested produce to a *pucca* threshing floor, allow it to dry and then thresh. Dry the capsules fully before storage.

### Plant Protection :

#### a) Insects

No serious insect-pests appear.

#### b) Diseases :

**Stem gall** : The disease forms tumor like swelling on leaf veins, petioles, peduncles, stems and capsules. The fruits in the umbels may become enlarged. Remove and burn the diseased plants.

Treat the seed as given under seed preparation.

## 31. POTATO

### Climate and Soil :

The crop is raised when maximum day temperature is below 30°C and night temperature is not above 20°C. Good crop growth is observed when days are sunny and nights are cool.

Potato thrives well in cool climate. The highest tuberization is obtained when day and night temperature is 20°C and 14°C, respectively. Potato can be grown on different types of soils. Well drained, loose, friable, non-saline and non-alkaline loamy sand to sandy loam soils are suitable for this crop. Soil pH should be in the range of 5.5 - 8.0.

### Improved Varieties :

#### Early Varieties

**Kufri Chandramukhi (1968)** : It is an early variety and matures in about 80-90 days. Its tuber is white, large, smooth, oval and flattened, with white skin, fleet eyes and white flesh. The tubers, though up-to-date type, are smoother, more uniform and more attractive. The variety is capable of yielding about 100 q/acre. It is susceptible to late blight.

**Kufri Ashoka (1996)** : Plants are tall, erect and medium compact with green foliage. It is an early bulking variety and matures in about 75-80 days under short day conditions. Its maturity is thus comparable with that of Kufri Chandramukhi. It is susceptible to late blight. However, it escapes late blight attack due to earliness. The tubers are large, smooth, oval long with white skin with fleet eyes. It has waxy texture and is easy to cook. It yields about 110 q/acre.

**Kufri Pukhraj (1998)** : Plants are tall, vigorous and erect. It is an early bulking variety which gives economic yield quite comparable with Kufri Chandramukhi in 70 days. It is susceptible to late blight but escapes due to earliness. Its tubers are large uniform, oval, white with fleet eyes. It has dry matter content of 17-18 per cent. It yields 130 q/acre in 70-90 days.

### Mid Season Varieties :

**Kufri Jyoti (1968)** : Plants are tall, erect, compact with light green foliage. It matures in about 90-110 days and yields about 80-120 q/acre. Tubers are large, oval, white with fleet eyes and white flesh. Tubers show variable degree of cracking. The variety possesses moderate degree of resistance to late blight and slow rate of degeneration. It is suitable for planting in spring season.

**Kufri Bahar (1980)** : The plants are medium compact and vigorous with grey-green foliage. The tubers are large, round-oval with white flesh with medium deep eyes. It is a late blight susceptible variety, but capable of yielding about 125 q/acre in about 100-110 days. It is not suitable for processing.

### Late Varieties :

**Kufri Sindhuri (1967)** : It is a medium late variety and takes 110-120 days to mature. The tuber is medium, smooth, round with light red skin, deep eyes and dull white flesh. The tubers have very good keeping quality. The variety yields about 120 q/acre. The tubers become hollow under very high fertility condition. It is not suitable for processing. It is moderately resistant to early blight and tolerant to leaf roll.

**Kufri Badshah (1979)** : The plants are vigorous with smooth leaves. The tubers are large, oval, white, smooth with fleet eyes and dull white flesh. Tubers tend to develop purple colour on exposure to light. It is a moderately resistant to late blight, resistant to PVX and matures in about 100-110 days, yielding on an average 130 q/acre. It is not suitable for processing.

**Seed Source** : Obtain the seed from a reliable source. It is better to replace the seed every 3-4 years. The yield is reduced progressively if the same seed is used year after year.

### Agronomic Practices :

**Green Manuring** : Sow 20 kg of sunhemp (*Crotalaria juncea*) or *Dhaincha* for green manuring from end of June to first week of July. Burry the crop after 7-8 weeks of sowing to allow proper decomposition before potato planting.

**Preparatory Tillage** : Plough with a mould board or disc-plough, followed by the disc-harrow or the tiller, depending upon the soil

type. In loamy sand soil, discing alone is sufficient. Apply farm yard manure after preparatory tillage just before planting as this practice is more beneficial than incorporating into the soil through cultivation. If weeds or stubbles of the previous crop are not a problem, potato can be grown with minimum tillage without loss in yield.

**Seed Rate :** For autumn sowing 12-18 q/acre seed tubers of 40-50 g weight should be used for planting. Good quality and disease free seed should be used. The seed should be produced by using the seed plot technique. If the seed raised from autumn crop is to be used for spring planting, its dormancy should be broken by dipping cut tubers in a solution of 1% Thiourea and 1 ppm (one ml per 100 litres of water) Gibberellic Acid for an hour followed by air drying the treated tuber pieces for 24 hours in thin layers in shade.

**Seed Potato Treatment and its Preparation :** To control black scurf and common scab, treat the tubers with Tafasan or Emisan @ 2.5 g per litre of water for 10 minutes after taking out of the cold storage.

The seed potatoes obtained from the cold store, cannot be planted immediately. It should first be dried with the help of blowers. Keep the treated tubers in a cool place/shade exposed in diffused sunlight for 8-10 days which initiates sprouting and helps the sprouts to become strong.

**Time of Sowing :** The best time for sowing is last week of September to mid-October for the autumn crop and the second fortnight of January for the spring crop. However, the date of sowing in September would much depend upon the temperature prevailing at that time.

**Method of Planting :** After the field has been prepared well, mark rows with a row marker. A ridger should be used for planting the crop manually. Semi-automatic or automatic planters are recommended where tractor power is available. The spacing between the rows should be 60 cm and between the tubers 20 cm. In south western districts, potato should be planted in two rows on 50-55 cm wide beds to get higher tuber yield and saving of water.

**Manures and Fertilizers :**

Twenty tonnes of farmyard manure or green manuring alongwith

75 kg of N (165 kg of Urea), 25 kg of P<sub>2</sub>O<sub>5</sub> (155kg of Single Superphosphate) and 25 kg of K<sub>2</sub>O (40 kg of Muriate of Potash) per acre should be used. Drill all P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O and half N at sowing and the remaining N at the time of earthing-up. Higher doses of these nutrients can be applied if the soil test shows low to very low status of these nutrients.

**Note:** Application of N fertilizer more than recommended is no substitute for farm yard manure or green manure.

**Earthing-up :** A double mould board plough or a ridger should be used for earthing up after 25-30 days of sowing.

**Weed Control :** Any one of the following herbicides can be used for controlling weeds.

<b>Herbicides</b>	<b>Dose per acre</b>	<b>Time of application</b>
Stomp 30 EC (pendimethalin)	1 litre	Pre-emergence application after the first irrigation but before the emergence of crop.
Arelon 70WP (isoproturon)	500g	-do-
Atrataf 50 WP (atrazine)	200 g	-do-
Sencor 70 WP (metribuzin)	200 g	-do-
Lasso 50 EC (alachlor)	2 litre	-do-
Lasso (alachlor)+atrataf (atrazine) 50 WP	1 litre + 100 g	-do-
Gramaxone 24 WSC (paraquat)	0.50 – 0.75 litre	Spray at 5-10 per cent emergence of the potato crop.

**Irrigation:**

**1) Furrow Irrigation :**

The first irrigation should be given immediately after planting as it ensures better germination. The potato crop responds well to light and repeated irrigations. While applying irrigation avoid the over flooding of the ridges and the subsequent hardening of the soil surface which interferes with emergence, growth and development of tubers. The total number of irrigations will be 7-8.

## 2) Drip Irrigation :

Drip irrigation in potato results not only in increase in yield but also saves 38% of water over conventional method of irrigation. Under this system, irrigation should be applied at two days interval. The potato crop should be irrigated with a lateral pipe having dripper discharge of 2.2 litre per hour and dripper placed at 30 cm apart the following schedule :-

Month	Time of irrigation (min)
October	20
November	25
December	45
January	20

\*If discharge rate is less than 2.2 litre/ hour, time of irrigation may be adjusted proportionally by the formula :-

$$= \frac{2.2 \times \text{Time of irrigation}}{\text{Discharge of dripper}}$$

Fertigation saves 20% fertilizer. Apply 24.50 kg Urea, 6.6 kg Mono ammonium Phosphate and 6.7 kg Muriate of Potash (white ) per acre during first month of the growing period of the crop in 7 equal doses with every second irrigation (4 days interval). The first fertigation should be started after germination of the crop. The remaining amount of fertilizer 97.5 kg Urea, 26.2 kg Mono ammonium Phosphate and 26.7 kg Muriate of Potash (white) should be applied in equal doses during rest of the crop season (before last irrigation) in 13 equal doses with every second irrigation (4 days interval).

## Harvesting :

Suitable tractor operated digger has been developed and is available in the market. There should be optimum moisture in the soil at the time of harvest. The clods affect the efficient functioning of potato digger. Bullock drawn diggers can also be used. Keep the produce in the field after harvesting for 10-15 days.

## Grading :

After harvesting the potato should be graded. Four grades may be made :

- (i) Small size (below 25 g weight)
- (ii) Medium size (25-50 g weight)
- (iii) Large size (50-75 g weight)
- (iv) Extra large size (above 75 g weight)

## Storage :

It should be stored in the cold storage where temperature is maintained at 2-4°C and relative humidity is 75-80%.

**Storage of Ware Potato :** Potato cultivars Kufri Chandramukhi, Kufri Jyoti and Kufri Chipsona-1 can be stored successfully for 5 months at 10±1°C and 90-95% RH with two consecutive foggings of CIPC at the rate of 40 ml per tonne. The first fogging is given at the initiation of sprouting (chitting) and second after 60 days of the first fogging. The stored potatoes maintain low reducing sugars (<0.25%) and are suitable for chipping and culinary purpose.

**Seed Plot Technique :** This technique aims at raising a healthy seed crop of potato in Punjab during the period of low aphid incidence. This pest is responsible for transmitting the viral diseases, like leaf-roll, PVX, PVY and PVA.

For the seed crop, healthy seed potato, free from viral infection should be obtained and planted in autumn i.e. in the first week of October. Sowing at a spacing of 50 x 15 cm would ensure the development of a large percentage of seed size tubers. An acre of the seed crop will produce enough seed for planting of 8 to 10 acres of the crop. Normal plant protection measures should be adopted to control aphids and other insect pests. Rogue out otherwise unhealthy plants noticed during the growing season to ensure the production for 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 transferred to cold storage for planting in the following autumn season.

## Plant Protection

### A. Insect Pests (Autumn crop)

<i>Pests and symptoms</i>	<i>Control measures</i>	<i>Precautions</i>
<p><b>1. Jassid and Aphid : (Autumn Crop)</b> Leaves curl, turn pale bronze and dry up as a result of Jassid attack (<i>Amrasca sp.</i>) the crop is stunted and has blighted appearance. Aphid (<i>Myzus persicae</i>) appears late in the crop season. Besides sucking the cell-sap, it transmits viruses and lowers the quality of the seed crop.</p>	<p>Spray the crop with 300ml of Rogor 30EC (dimethoate) or Metasystox 25 EC (oxydemeton methyl) in 80-100 litres of water per acre as soon as jassid appears. Give another spray after 10 days. In case of the crop meant for seed, apply 5kg of Thimet 10G (phorate) to the soil at the time of the first earthing up. No insecticidal spray will be required thereafter.</p>	<p>Do not spray Rogor or Metasystox within 3 weeks of harvest. Do not use Thimet granules in the crop meant for table purpose.</p>
<p><b>(Spring Crop)</b></p> <p><b>3. Cutworm (<i>Agrotis sp.</i>)</b> causes considerable damage from February to March by cutting the young plants at the ground level and later on by making holes into the tubers.</p>	<p>Drench the soil around the plant and the ridges with Chlorpyrifos 20EC @1 litre/acre in 400 litres of water, on the appearance of the pest in January-February.</p>	
<p><b>4. Aphids</b> suck the sap and transmit viral diseases. Besides these hadda beetle and jassid may also cause damage.</p>	<p>Spray the crop with 300ml Metasystox 25EC (oxydemeton methyl) or Rogor 30EC (dimethoate) in 80-100 litres of water per acre at 10-15 days interval beginning soon after emergence.</p>	

### B. Diseases

<i>Disease</i>	<i>Causal Organisms</i>	<i>Symptoms</i>	<i>Control Measures</i>
1. Late blight	<i>Phytophthora infestans</i>	<p>Infected tubers from cold stores serve as primary source of disease. On emergence the sprouts and leaves get infected. Water-soaked spots appear on margins of leaves which later turn into black patches with whitish fungus growth visible on lower surface in the morning hours. Black patches may extend and kill the foliage in a few days if moist weather prevails. Decaying leaves emit an offensive odour. Brown depressed patches appear on tubers which finally rot in the soil before harvesting.</p>	<p>i) Use selected healthy tubers for planting.                      ii) Infected/rejected tubers taken out of cold stores should be buried and not left in the open.                      iii) Follow high ridge culture to avoid tuber infection.                      Spray the crop with Antracol/ Indofil M-45/ Kavach @ 500-700g or Copper oxychloride 50 WP @ 750-1000g/acre in 250-350 litres of water in the first week of November before the appearance of disease followed by 5 more sprays at 7 days interval. Under heavy disease risk situation instead of 3rd and 4th spray of Indofil M-45/ Kavach/ Antracol, give two sprays of Ridomil Gold or Sectin 60 WG or Curzate M-</p>

1	2	3	4
			8 @ 700 g or Equation Pro @ 200 ml per acre at 10 days interval. Subsequently give one spray of Indofil M-45/ Kavach/ Antracol. In late/spring sown crop if the previous crop is infected and disease risk is heavy due to humid weather, give first spray of Ridomil Gold/ Sectin 60 WG/ Curzate M-8@ 500 g or Equation Pro@ 200ml per acre followed by three sprays of Indofil M-45/ Kavach/ Antracol @ 700g per acre at 7 days interval.
<b>2. Early blight</b>	<i>Alternaria solani</i>	The disease is inconspicuous and shows attack in light soils. Scattered brown spots appear on the leaves often at the top or on the margin. These spots later show concentric rings which give them a target board appearance.	Spray the crop with Indofil M-45 or Copper oxychloride as mentioned for late blight.

1	2	3	4
		Older spots become dark brown.	
<b>3. Black scurf</b>	<i>Rhizoctonia solani</i>	Diseased tubers have black rough incrustations. Plants raised from diseased tubers show wilting.	i) Use healthy seed ii) Disinfect the tubers with Moncoren 250 SL @2.50 ml or Emisan @2.5g per litre of water for ten minutes. or Dip potato seed tubers in 10g wet Trichoderma formulation and 20g mollasses per litre water for 10 minutes. Keep treated seed in shade for 24 hours before sowing.
<b>4. Mosaic and leaf roll</b>	Different viruses	Leaves show mottling varying from mild chlorosis to pronounced mosaic symptoms. In severe cases smalling, curling of leaves and dwarfing of plants occur.	i) Sow only certified and virus free seed tubers. ii) Raise virus free seed tubers by using the Seed Plot technique and use for 3-4 years. iii) Apply 5kg of Thimet 10G (Phorate) per acre to soil at the time of the earthing up. No insecticidal spray will be required thereafter.

1	2	3	4
5. Common scab	<i>Streptomyces scabies</i>	Affected tubers show deep, circular lesions about 0.5-1.0 cm in diameter.	i) Use disease free seed tubers. ii) Do green manuring before sowing of potatoes. iii) Treat the seed tubers with Emisan @2.5g/litre of water for 30 minutes. iv) Prevent drying of soil by regular irrigation from tuberization to maturity.
6. Leaf spot	<i>Cercospora solani tuberosi</i>	Small, circular to angular reddish brown spots of pin-head size appear first on lower and older leaves. Later they coalesce to form bigger irregular dark, brown to black spots with grey centre. Incidence is more on early sown crop.	Spray the crop as given under early blight.

## 32. ARUM

### Climate and Soil :

It is a warm season crop and requires rains ranging from 120-150 mm per annum. An assured irrigation is a pre requisite for the raising of successful crop.

*Arvi* can be cultivated in varied type of soils but it thrives best in sandy loam and loamy soils containing sufficient organic matter. Soil lacking in optimum fertility and moisture will result in low yield. The soils with poor drainage will produce corms of low quality. The land should be prepared thoroughly by 2-3 ploughings and plankings. Keep the field free from weeds and stubbles.

### Improved Variety :

**Punjab Arvi-1 (2009)** : The plants are tall, leaves are green, large and obliquely erect. Petiole is long and sheathing at the base. The corms are long and medium thick. The corm colour is brown and inner flesh is creamy. It takes 175 days for maturity. The average yield is 90q/acre.

### Agronomic Practices:

**Sowing and Seed Rate** : 300-400 kg of medium sized healthy corms are sufficient to plant one acre. The sowing of *arvi* can be done in first fortnight of February under Punjab conditions.

**Method of Sowing** : The corms are sown 6 to 7.5 cm deep by keeping 60x15 or 45x20 cm distance between rows.

### Manures and Fertilizers :

*Arvi* is a heavy feeder and requires 10-15 tonnes of well rotten farmyard manure which should be added in the field before sowing. In addition, 40 kg of Nitrogen (90 kg of Urea), 20 kg P<sub>2</sub>O<sub>5</sub> (125 kg Superphosphate) and 20 kg of K<sub>2</sub>O (35 kg of Muriate of Potash) per acre should be applied. Half nitrogen and whole of phosphorus and potash should be added at the time of sowing while remaining half of nitrogen should be applied 35-45 days after sowing at the time of hoeing, weeding and earthing up.

**Irrigation :** *Arvi* requires regular irrigation for uniform sprouting, therefore, irrigate the field immediately after sowing and keep the field wet till the completion of germination. Irrigate the field at 3-4 days interval during summer and as and when required, during rainy season.

**Hoeing :** Control weeds by giving one or two hoeings and earthing up should be done after each hoeing.

**Harvesting :**

The crop becomes ready for harvesting 180-200 days after sowing when the leaves start becoming yellow, which is the sign of maturity. The corms from early harvest are comparatively soft and are suitable for table purpose but can not be stored for long. The moisture in the field should be sufficient at the time of harvesting for easy lifting of corms which can be done by spades or other hand tools. The corms should be cleaned after harvesting and separate the primary corms from the other corms. It yields 200-250 q/acre.

**Storage :**

The secondary corms which have been separated from the primary ones are used as seed which are stored. The seed corms should be stored at cool and dry place to avoid rotting. The seed corms can be stored in the pits or in the cold store.

**Insect Pests :**

The insects which attack seed corms can be controlled by using 250 ml of Malathion 50 EC per acre.

### 33. TURMERIC

**Climate and Soil:**

This crop requires hot and moist climate. It is recommended for cultivation in irrigated areas. Turmeric grows in all types of soils, but it thrives well in well drained sandy loam to loamy soils with moderate organic matter content.

**Improved Varieties :**

**Punjab Haldi 1 (2008) :** Its plants are erect and medium in height. Leaves are green and medium in size. Rhizomes are long and medium-thick. Skin colour of rhizomes is brown and the flesh is dark yellow. It matures in 215 days and average yield is 108 q/acre.

**Punjab Haldi 2 (2008) :** Its plants are erect and tall. Leaves are light green and broad. Rhizomes are long and thick. Skin colour of rhizomes is brown and the flesh is yellow. It matures in 240 days and average yield is 122q/acre.

**Agronomic Practices :**

**Land Preparation :** To get fine seedbed, 2 or 3 ploughings followed by planking are necessary. The field should be free from stubble and weeds.

**Seed Rate :** Turmeric is propagated through mother and primary rhizomes. Fresh, healthy and uniform sized rhizomes weighing 6-8 quintals are sufficient to plant an acre.

**Sowing Time :** For getting higher yield, crop is to be sown directly in the field by the end of April. In submontaneous and northern districts, the sowing can be delayed for a week. It can also be raised by transplanting upto first fortnight of June without losing much in yield. For this, rhizomes should be sprouted in the nursery by planting them in close spacing and 35-45 days old seedlings should be transplanted in the field.

**Method of Sowing :** Ridge planting improves the size of turmeric rhizomes. It is planted in lines, keeping 45 cm row to row spacing for manual operations and 60 cm for mechanical, whereas, plant to plant spacing is maintained at 15 cm. After planting, apply straw



mulch @ 2.5 tonnes per acre. Keep the soil moist until the sprouting of rhizomes.

#### **Manures and Fertilizers :**

Turmeric responds favourably to organic manuring. Apply 10-12 tonnes of well-rotten farmyard manure per acre before planting. Turmeric does not need much nitrogen. A basal dose of 10 kg P<sub>2</sub>O<sub>5</sub> (60 Kg Single Superphosphate) and 10 Kg K<sub>2</sub>O (16 Kg Muriate of Potash) can be drilled at planting.

**Irrigation :** Turmeric takes a long time to sprout and needs frequent irrigation. Apply light and frequent irrigation.

**Weed Control :** In order to keep the crop free from weeds, 1 or 2 hoeings may be given.

Alternately, spray Stomp 30 EC (pendimethalin) @ 1300 ml or Sencor 70 WP (metribuzin) 400 g or Atrataf 50WP (atrazine) @ 600 g per acre by dissolving in 200 litres of water within 2 to 3 days of planting of turmeric. After the spray, spread uniformly paddy straw mulch @ 36 quintals per acre over the entire field.

#### **Harvesting and Yield :**

Maturity of turmeric is indicated by the complete yellowing and drying up of the plants. The crop is ready for harvesting in the month of November-December. After digging, clean the rhizomes by removing roots and soil.

#### **Seed Production :**

The fresh rhizomes are kept at a cool and dry place or preferably in cold storage for sowing in the next season. Alternatively, for field storage rhizomes are left in soil till late winter without giving the irrigation.

#### **Processing :**

Boil the cleaned rhizomes in a vessel having narrow mouth after adding water sufficient to cover the rhizomes in it. Boiling should be continued for an hour till the rhizomes become soft. If boiling is to be done under pressure (15 lb/sq.inch), then 20 minutes are sufficient. Boiled rhizomes are dried in the sun. On a small scale, dried rhizomes are polished by rubbing them against a hard surface whereas on commercial scale, special polishing drums are available.

## **34. SWEETPOTATO**

**Climate and Soil :** Sweet potato requires a long warm growing season. Plenty of sunshine and moderate rainfall with warm night and days for four months are best suited for it. It is drought resistant vegetable and can stand frost. Sweet potato can be grown on a wide range of soils but loamy sand soils are invariably regarded as suitable for sweet potato. The optimum pH range is 5.8 to 6.7.

#### **Improved Variety:**

**Punjab Sweetpotato –21 :** Vines are medium long in length. Leaves are dark green, broad, lobed with purple tinge. Stem is medium long and thick. Its internodal length is 4.5 cm and petiolar length is 9 cm. It matures in about 145 days. Tuber skin colour is deep red with white flesh. The tubers are 20cm long with 4 cm width. Average tuber weight is 75 g. It has 35% dry matter and 81 mg/g starch. It gives about 75 quintals tuber yield per acre.

#### **Agronomic Practices**

**Land Preparation :** The land should be well prepared and of good tilth for sowing sweet potato. The field should be ploughed 3-4 times followed by plankings. The field should be free from weeds.

**Seed Rate and Time of Planting :** 25,000 to 30,000 cuttings of vines are sufficient for one acre. Use 35-40 kg tubers in half a kanal area during January to February for raising vines in nursery beds for planting one acre. The optimum time of planting is from April to July.

**Spacing:** The vines are planted with line to line distance of 60 cm and plant to plant distance of 30 cm.

#### **Manures and Fertilizers :**

Apply 10 tonnes of farmyard manure with 125 kg CAN, 155 kg Single Superphosphate and 35 kg Muriate of Potash per acre.

**Earthing up :** Earthing up should be done after 40 days of planting.

**Irrigation :** Irrigation may be given at 14 days interval.

## 35. HYBRID SEED PRODUCTION OF VEGETABLES

PAU has released hybrid cultivars of four vegetable crops, namely Pb. Hybrid (Muskmelon), CH-1 and CH-3 (Chilli), TH-1 (Tomato) and BH-2 and PBH-3 (Brinjal). Hybrid seed requires seed replacement every season. Punjab Agricultural University encourages farmers to carry hybrid seed production of vegetables and supply the seed of parental lines to the farmers.

### Muskmelon

Sow two rows of seed parent (MS-1) alternating with one row of pollen parent (Hara Madhu) for hybrid seed production of Punjab Hybrid. Bed width is 3.0 m and planting is done on both side. The hills are spaced 30 cm for MS-1 and 60 cm for male parent. Two seeds/hills are sown. About 500 g seed of MS-1 and 100 g seed of male parent is required for one acre hybrid seed production plot. Seed plot should be isolated 1000 m from other muskmelon varieties, long melon, snap melon and wildmelon. Direct sowing is completed in the first week of March. Cultural practices are same as adopted for cultivation other muskmelon varieties for table purpose. Identification of male sterile plants during flowering is initiated every day between 5.30 to 9.30 in the morning. This is done by gently scrapping to external surface of anther lobe with the tip of needle. On the sterile plant, anther lacks pollen and remain poorly developed and gives full green appearance. Fertile plant produces yellow pollens. Male sterile plants are tagged and fertile plants are removed. The identification job is completed in 15-20 days. After identification work is completed, pinch off the already set fruits in male sterile plants. Place two beehives in the one acre seed plot. Harvest the fruits from female parents at maturity. It is possible to produce 30 kg hybrid seed from one acre plot.

### Chilli

Female parent for chilli hybrids CH-1 and CH-3 is MS-12 (male sterile line) and male parent is LSS and S-2530, respectively. For transplanting in the seed production plot, the ratio of rows of female to male parents is 2 : 1. Ridges are 60 cm apart and hills are 22.5 cm apart. Identification of male sterile plants is done at flowering. The sterile plants have blue coloured anthers and has no pollens

while fertile plants have green colour anthers and have plenty of pollens during do time. The sterile plants are retained and fertile plants are uprooted. This process should be completed in 8-10 days. After completing identification operation, all fruits from female parent are removed. Isolation distance is 400 m. The rouging of off-type plants from the rows of parental lines is necessary. Three to four beehives are required for one acre seed production plot. Fruits from female parent are harvested at red ripe stage and 30 kg hybrid seed is produced in one acre plot.

### Tomato

Female and male parents are planted in the ratio of 4-6 : 1. Hybrid seed production involves emasculation and pollination. Flower buds that are expected to open in the next morning (yellow colour) are emasculated in the evening and covered with butter paper bags. Emasculation is done with forceps. Next morning freshly opened flowers are collected from the male parent. Bags from the emasculated flower are removed and pollen from the anther of male flower are extracted with needle and placed in the tip of the stigma of emasculated flowers. A tag is put around the neck of the pollinated bud or 2-3 sepals are removed to keep identity of the crossed fruits from the selfed ones. Two to three buds are pollinated in each flower cluster. Seed is extracted from the red ripe fruits.

### Brinjal

Hybrids BH-2 is recommended for cultivation and the female parent of this hybrid is Punjab Neelam. Male parent for this hybrid is Punjab Barsati whereas, female parent of PBH-3 is P-67 and male is P-47. Seed required for female parent is 160 g and of male parent is 40 g for an acre hybrid seed production. The plant population ratio of female to male parent is 4:1. Hybrid seed is produced by emasculation and hand pollination. For emasculation, the buds of long and medium styled flowers which are expected to open in the next morning are selected and anthers are removed with forceps. Emasculated buds are covered with paper bags. Buds on male parent that are expected to open to next morning are also covered with paper bags. In the following morning emasculated flowers of female plants are cross-pollinated with the pollen collected from anthers of the male parent. The pollinated flowers are covered for 2-3 days with paper bags. The calyx crossed fruits are clipped for keeping identification mark. The fruits are harvested for seed extraction when one third of fruits turns yellow.

## 36. PROTECTED CULTIVATION OF VEGETABLES

In the present scenario of perpetual demand for better quality vegetables and continuously shrinking land holdings, protected cultivation is the best choice for quality produce and efficient use of land and other resources. Protected cultivation means some level of control over plant microclimate to alleviate one or more of abiotic stresses for optimum plant growth which can be achieved in naturally ventilated poly-house or net-/polynet-house. Crop yields can be several times higher than those under open field conditions, quality of produce is superior, higher input use efficiencies are achieved and vegetable export can be enhanced. In Punjab, extreme weather conditions under the open field conditions are the major limiting factors for achieving higher yield and better quality of vegetables. Under such circumstances, protected cultivation is best option. Keeping these points in view, net-house and naturally ventilated poly-house technology has been recommended for the cultivation of different vegetables.

### 1. Modified design of net-house - polynet-house

**Polynet-house** is a framed structure consisting of GI pipes covered with ultra violet (UV) stabilized plastic film of 200-micron thickness at the top and UV stabilized net of 40-mesh size on the sides. A relatively cost effective and stable structure of poly net house has been designed (Fig 1) and different pipe sizes to be used for its construction are given are shown in Fig 2.

#### Selection of site

1. The site for the net house should be well drained & fairly shadow free.
2. It should be away from the obstruction at least three times the height of the obstruction.
3. Windbreaks are desirable and at least 30 m away on all sides to minimize the adverse affect of wind.

#### Orientation

Polynet-house should be constructed in the East-West direction to get the maximum benefit of the sunlight throughout the year and

to minimize the adverse affect of wind. The detailed dimensions for its construction are given in table 1

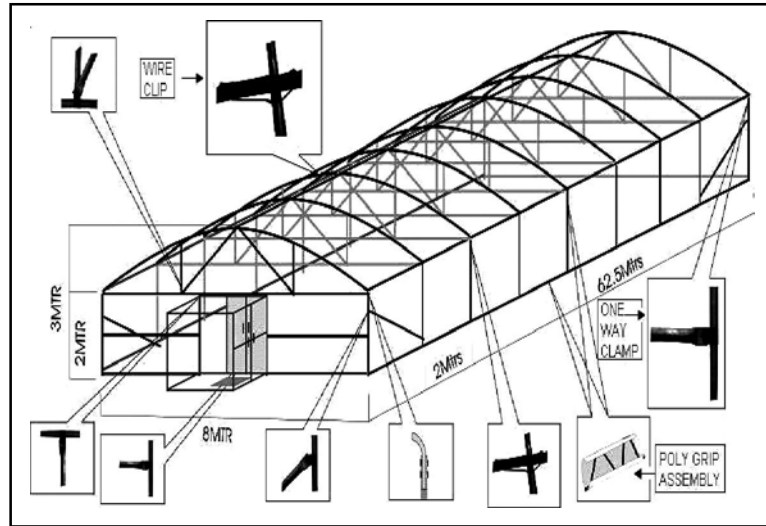
**Table 1. Detailed dimensions of polynet-house**

S. No.	Particulars	Dimensions
1	Area	500 m <sup>2</sup>
2	Length	62.5 m
3	Width	8.0 m
4	Height at the center	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

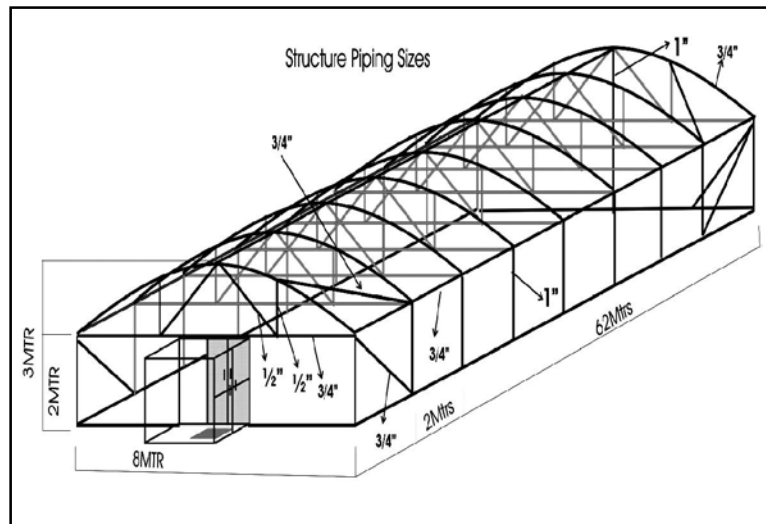
#### Salient features of the polynet-house

1. Stability has been increased by making the hoop as a truss and by increasing the depth of foundation.
2. **The modified design of net-house can withstand to wind speed of up to 100 km/ hr.**
3. Modified net-house has been installed using various types of assemblies so that it can be dismantle and can be put up at another place (every 3-4 years) to prevent the build up of inoculum of soil borne diseases ( Soil sickness, nematode etc) .
4. Poly grip assembly is used to fix the poly sheet at the top and net at the sides of the structure so that it is not blown away by the strong wind.
5. The same assembly can be used for fixing of shade net during the summer period.
6. Side height is about 7 ft and center height is about 10 ft. It can accommodate all crops.
7. Vertical stitching of the net is recommended instead of horizontal one. This reduces extra pressure on stitched section & avoids tearing of net.

8. The average life of structure and net is 25 and 3 years, respectively.



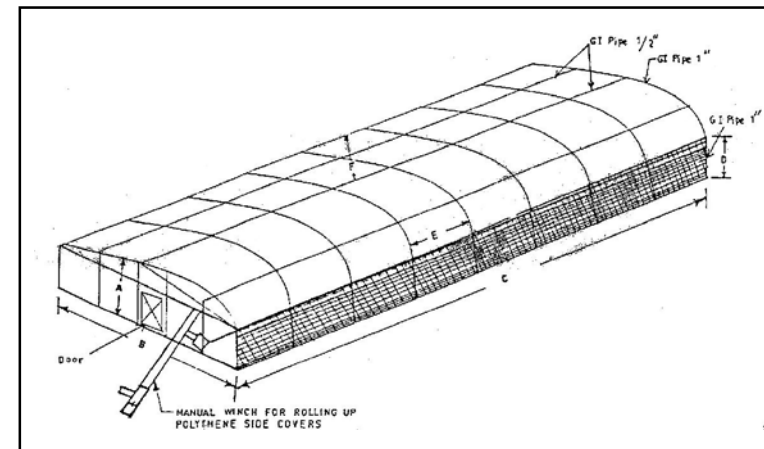
**Fig. 1 : Details of assemblies used in polynet-house (62.5mx8.0m)**



**Fig. 2 : Details of pipes used in polynet-house (62.5mx8.0m)**

## 2. Naturally ventilated poly-house technology

Poly-house (Fig-3) is a framed structure consisting of GI pipes covered with transparent UV stabilized polyethylene film and large enough to grow crops under protective cover. In a poly-house, environment is partially controlled by opening and closing of roof and sidewall ventilation. Although, poly-house is costlier than net house but it provides a controlled and favourable environment, which results in early harvest of superior quality fruits than that of the net-house. In poly-house, carbon di-oxide released by the plants during the night is consumed by the plants itself in the morning which increases the photosynthesis rate by nearly 15 times that helps in higher yield in comparison to net-house and open field conditions. It also gives additional protection to the crop from high or uneven rainfall and frost especially in winter. The poly-house can also be used for raising nursery during adverse weather conditions.



**A=3m; B=6.25m; C=16m; D=2m; E=2m**  
**Fig. 3: Details of the naturally ventilated poly-house (100sq.m.)**

## 3. CULTIVATION OF CAPSICUM IN NETHOUSE/ POLYNET-HOUSE AND NATURALLY VENTILATED POLYHOUSE OF 3m AND 6.5m HEIGHT

### Selection of Hybrid -

Green colored capsicum hybrids "Bharat and Indra" are recommended for cultivation under both nethouse/polynethouse and naturally ventilated poly-houses. Yellow colored "Orobelle" and red

colored “Bomby” capsicum hybrids are recommended for cultivation under naturally ventilated poly-houses only.

Based on the method of irrigation, cultivation of capsicum in net-house/polynet-house and naturally ventilated poly-house is given as under :

**(A) CAPSICUM CROP UNDER DRIP IRRIGATION -**

**Seed rate and nursery raising** – For an area of 1 acre, 12,000 seedlings are required. Sow capsicum nursery in the first week of August in pro-trays. Treat the seed with 3g of Captan per kg of seed before sowing. Before transplanting, drench pro-trays with Bavistin @ 2g/l of water.

**Land preparation and fertilizer application :**

Add 80 tonnes of well-decomposed farmyard manure per acre in the first year and 20 tonnes per acre in the subsequent years. Add DAP @ 100 kg and CaNO<sub>3</sub> @ 25 kg per acre every year and then prepare the land to a fine tilth.

**Bed Size :**

Mark the plot in nethouse/polynethouse and naturally ventilated poly-houses with rope at 1.5 m spacing, leaving at least 30 cm (1 foot) from all side walls. Then make beds of 1m width and 15 cm (1/2 foot) height with 50 cm row/path and slant from center of bed to both sides, rather than flat bed.

**Transplanting :**

Use 35-40 days old seedlings for transplanting in 2<sup>nd</sup>-3<sup>rd</sup> week of September. Transplant in early morning/ late evening. Plant at shallow depth of 2 - 2.5 cm.

(In case of absence of provision for polysheet on the roof of net-houses in rains and shade-net in both net-house/poly-house in summer, sowing and transplanting can be delayed but it will have direct effect on the yield of capsicum)

**Spacing :**

Seedlings should be transplanted in a paired row pattern with R-R and P-P @ 45 x 45 cm (1.5 x 1.5 foot) from the centre of bed, with zigzag transplanting i.e. in a triangle shape (means plants of second row should be placed in the centre and parallel of the plants of the first row) and the spacing between the paired rows should be 105 cm.

**Irrigation :**

If possible, it is advisable to install the drip irrigation system in

the net-/poly-house. One lateral per bed with drippers spaced at 30 cm having discharge of 2.25 l/hr should be used. Water the beds to field capacity up-to 15 days after transplanting and then operate drip daily as per the timings given in table – 1.

**Table – 1 :Daily drip timings (in minutes)**

Month	Net-house/Polynet-house	Poly-house
September	16	21
October	16	19
November	11	11
December	8	8
January	8	8
February	11	13
March	11	21
April	37	43
May	53	53
June	35	48

**Fertigation** – Give fertigation daily through drip as given in table – 2. Start fertigation 15 days after transplanting and stop one month before crop end.

**Table - 2**

S.No.	Time of application	* Liquid Fertilizer (N:P:K)	Daily dose (litre/acre)
A	Initial 15 days	12:61:0	2
		19:19:19	2
B	Next 30 days	13:40:13	1
		19:19:19	1
C	Next 30 days (flowering & fruiting)	13:5:26	4
D	Next 90 or 180 days (fruit development & picking)	13:5:26	2
		0:0:50	1
		CaNO <sub>3</sub>	1
		MgNO <sub>3</sub>	0.5

\* Different ratios of liquid fertilizers required can be made on-farm as per Table - 3.

**Table – 3: How to make 1 litre of required ratio of fertilizer (rounded-off figures)**

S.No.	Fertilizer	Urea (46%N)	Phosphoric acid (80% P)	* SOP (50%K)	*KNO <sub>3</sub> (38%K)	Water
1	12:61:0	260 g	760 ml	-	-	240ml
2	19:19:19	412g	238 ml	380 g	500g	762 ml
3	13:40:13	282 g	500 ml	260g	341g	500 ml
4	13:5:26	282 g	63 ml	520 g	639 g	937 ml
5	0:0:50	-	-	1000 g	1315 g	1000ml

\* Use either SOP or KNO<sub>3</sub>, not both

**Production measures :**

**Pruning and number of branches :** Do pinching after 5-6 pairs of leaves. It will give 5-6 branches after few days. Select 4 best branches, preferably in opposite direction. Remove all flowers for 1 month. Remove side shoots at weekly interval. Pruning starts 15-20 days after transplanting. Two steel strings per bed should be overhung at the gutter level of net-/poly-house, running parallel alongside the length of the bed. Twining (tying) of 4 branches should be done 30 days after transplanting with blue or green colored plastic twines, not gunny threads. Two branches of a plant should be tied to one steel string and the other two branches of a plant to the other string running parallel overhead. This will open up the plant and help in ventilation.

**Removal of lower older leaves :** As the plants grow up and fruit is harvested, remove lower and older leaves at least 1 feet or more from the ground.

**Micronutrient and Growth regulator foliar sprays :** Under **6.5 m structure height**, give foliar spray of Microsol B (micronutrient) @ 0.5 g/l water + Spic Cytozyme (growth regulator) @ 2 ml/l water at fortnightly intervals after transplanting. Spray growth regulators Lihocin/ Cycocel (chlormequat chloride) @ 300 ppm (3g/l of water) + NAA (Planofix) @ 25 ppm (0.25g/l of water) 2.5 months after transplanting, along with Microsol and Spic Cytozyme, at fortnightly interval..

**But under 3 m structure height**, start spraying Lihocin/ Cycocel along with Microsol and Spic Cytozyme, while spray of NAA should be started 2.5 months after transplanting.

**Shade net :** Use 50% white or red colored shade net placed at gutter level from September to mid-October and then April onwards till the end to protect the crop during hot months. Putting shade net over the roof from outside will give less reduction in heat.

**Ventilators opening/ closing :** In winter, all ventilators of poly-house should be closed at night to obtain maximum yield. Always open ventilators for at least 2-3 hours each day even in severe winters for exchange of air.

(\* Net-house should have provision of poly-sheet during rains and winter months. During summer, provide roof-top ventilation in case of polynet-house. Roof should not be fully closed with poly-sheet)

**Harvesting** : >60 g green colored fruits and >100 g yellow and red colored fruits are preferred in the market. In case of September transplanted crop, the green colored fruits are ready for harvest in mid-November and yellow and red colored fruits in mid-December. September transplanted crop gives 11 and 31 percent more and early yield advantage over October and November transplanted crop, respectively.

**Yield** : Yield of capsicum hybrids depend on the height of protected structure, time of transplanting, type of irrigation system and use of shade-net and poly-sheet.

September transplanted green colored Indra gives yield of 580 and 443 q/acre under 6.5m and 3m structure height, respectively, while Orobelle (yellow colored) give yield of 315 and 162 q/acre and Bomby (red colored) give yield of 322 and 167 q/acre under 6.5m and 3m structure height, respectively.

#### **(B) CAPSICUM CROP UNDER FURROW IRRIGATION :**

Sowing and transplanting time should be as given under drip irrigation. Seedlings should be transplanted on 15 cm high raised beds with a spacing of 90cm x 30 cm, accommodating 15,000 plants/acre. The fertilizer should be applied as per the recommendation mentioned in the package of practices for open field cultivation of capsicum. Cover the beds with a black polythene mulch of 25 micron thickness. Mulching increases early and total fruit yield, extends shelf life of fruits and improves fruit quality, especially colour of the fruits. The mulched crop produces maximum early and total fruit yield when seed is sown around 1st of October and seedlings are transplanted about a month later. Yield of November transplanted Bharat and Indra is 225 and 255 q/acre respectively, when white/red colored shade net is used from April onwards and 160 and 180 q/acre respectively without the use of shade net. If the net-house has the provision of both poly-sheet and shade-net, then September transplanted Indra gives yield of 310 q/acre.

### **4. CULTIVATION OF TOMATO**

#### **(A) Net-house**

Only indeterminate varieties/hybrids by virtue of their having long fruiting span can be grown successfully in net-house where fruit maturity is advanced by 20-25 days as compared to open field conditions. Cover the beds with a black polythene mulch of 25 micron thickness. Mulching increases early and total fruit yield, extends shelf life of fruits and improves fruit quality especially colour of the

fruits. The mulched crop produces maximum early and total fruit yield when seed is sown around 25th of September and seedlings are transplanted about a month later. Seedlings should be transplanted on 15 cm high raised beds keeping a spacing of 1.25 mx 30cm. Plants should be trained upright with the support of bamboos with nylon ropes. All cultural practices should be followed as mentioned in the package of practices for open field cultivation of tomato crop.

#### **(B) Naturally ventilated poly-house**

##### **Selection of cultivar:**

Naveen cultivar (indeterminate type hybrid) is recommended for the cultivation of tomato under polynet-house as it continues to flower for longer period, which results in higher yield.

##### **Seed rate and nursery raising:**

For an area of 100 m<sup>2</sup>, 1.5 g of seed is sufficient. Sow tomato nursery in the last week of September, which will be ready for transplanting in 25-30 days after sowing. Treat the seed with 3g Captan or Thiram per kg of seed before sowing. Nursery should be raised in the same polynet-house in which crop is to be grown to protect the seedling from white fly, a vector for viruses and other insect- pests.

##### **Land preparation and fertilizer application :**

Prepare the land to a fine tilth and apply well-decomposed farmyard manure @ 2.5 q/100 m<sup>2</sup> 15 days before transplanting. Apply urea 3.0 kg/100 m<sup>2</sup> in 4 equal splits (1/4, 3-4 days prior to transplanting, 1/4, 25 days after transplanting, 1/4, 45 days after transplanting and the remaining 1/4, 90 days after transplanting). For P and K, apply Single Super phosphate 4.0 kg/100 m<sup>2</sup> and 1.1 kg Muriate of Potash/ 100 m<sup>2</sup> as basal dose with first split dose of urea. If the crop is drip irrigated, than apply 3.0kg/100 m<sup>2</sup> of urea in 15 equal splits at 10 days interval along with irrigation.

##### **Spacing:**

To utilize the space efficiently, seedlings should be transplanted in the polynet-house in a paired rows pattern with plant-to-plant spacing of 30 cm. The spacing between two paired rows should be 90 cm and row-to-row spacing within the paired line should be 60 cm.

##### **Irrigation:**

If possible., it is advisable to install the drip irrigation system in the polynet-house as it reduces the humidity build up and weed

problem. First irrigation for surface irrigation is to be given just after transplanting. Initially for a few days, regular irrigation is to be applied for the establishment of the crop. Subsequent irrigation should be applied at 4 to 5 days interval depending upon the soil and climatic conditions. If the crop is drip irrigated then irrigation should be applied at 4-5 days interval in the month of November-February, 2-3 days interval in the month of March and 1-2 days interval in the month of April-May depending upon the climatic conditions. Application of urea along with irrigation (fertigation) helps in saving the quantity of fertilizer and labour besides improving the yield and quality of produce. The drip irrigation results in 48% saving of water as compared to surface irrigation. Don't allow the plants to wilt at any time. Fruit will be damaged if the plants do not get appropriate amount of water and fertilizer regularly.

#### **Earthing up and pruning:**

After 20-25 days of transplanting, earthing up is to be done. Prune the plants in a polynet-house to a single stem for better growth of fruits. All lateral branches must be removed when they are one to three inches long. This allows for maximum air circulation and reduces pest control problems. Pruning must be done regularly and plants should be checked at least once a week. Because of indeterminate nature of polynet-house tomato, the crop should be staked properly to get higher yields. The staking method involves the use of wooden stakes placed within the row of plants and running a number of parallel pieces of string or wire from stake to stake and trapping the new growth of plant between the strings. This keeps the plants in an upright position preventing the fruit from touching the ground.

#### **Harvesting :**

The fruits will be ready for harvesting in the last week of February, which will continue up to first fortnight of May. The average yield under naturally ventilated polynet-house condition is about 264 q/acre with surface irrigation and about 384 q/acre with drip irrigation and fertigation.

### **5. CULTIVATION OF BRINJAL IN NET-HOUSE**

Hybrid BH-2 has been recommended for net-house cultivation of brinjal. It gives 325, 270 and 132 q/acre yield by transplanting in 4<sup>th</sup> week of July, 1<sup>st</sup> week of Nov. and 4<sup>th</sup> week of Feb, respectively. Seedlings of 4 to 5 leaf stage are ideal for transplanting. For July transplanting, seed should be sown in mid June, for Nov. in mid Sept and for Feb. in end of Nov. November sown nursery should be

protected from low temperature with poly-thene sheet. Seedlings should be transplanted on raised beds at spacing of 90 cm between rows and 30 cm between plants. The fertilizer should be applied as per the recommendation mentioned in the package of practices for open field cultivation of brinjal. To get early and high yield from autumn transplanted crop mulching should be done with black polythene (25 micron thickness) from last week of Nov. to first week of March.

In net-house brinjal, supplementary pollination by tapping main stem with stick significantly increased the yield. This practice should be done during noon hours (12.00-3.00 P.M.) upon dehiscence of pollen from the flowers.

The rainy season crop of brinjal in net-house should be trained by keeping two main shoots. This practice helps in utilizing vertical space, avoid overshadowing of plants and facilitate in supplementary pollination.

### **PLANT PROTECTION**

#### **Soil-borne pathogens in net-house/polynet-house or naturally ventilated poly-house :**

Among the soil-borne pathogens, fungal pathogens (*Sclerotinia sclerotiorum* and *Fusarium solani*) and root-knot nematode cause maximum damage. Population of these pathogens build-up over a period of cultivation in net-/poly-houses. Straw colored symptoms seen externally and black colored sclerotia along with white colored cottony growth formed inside stem and branches are the typical symptoms of plants infected with *Sclerotinia*. Dark brown discoloration is seen externally on plants infected with *Fusarium*. *Sclerotinia* and *Fusarium* cause maximum damage near harvesting stage and result in complete loss of a plant. In root-knot nematode infected plants, aboveground symptoms include reduced growth, pale green or yellow foliage. Underground symptoms are most characteristic for the disease with root galls two to three times the diameter of healthy roots which give the root system a knobby appearance. Fungicides and nematicides effect also reduces with the build-up of these pathogens.

#### **Management of soil-borne pathogens :**

These sick soils in net-/poly-houses need to be managed by doing soil solarization.

#### **Methodology of soil solarization :**

First rotavate the soil (alongwith any recommended organic amendment ) to fine tilth followed by levelling and flooding. After 24 hours, cover the ground soil with 200 gauze (50 micron) clear or



transparent poly-sheet, leaving no gaps between sheets followed by covering the whole above ground structure also with 200 gauze clear poly-sheet in case of net-house or simply closing all vents of polynet-house and taping them for 4 weeks or 1 month. This will give effective soil solarization of protected structure against soil-borne fungal pathogens and nematodes. Period can be anywhere between 15 May to 30 June; but keeping in view the crop rotation in protected cultivation in Punjab, June is the most practical period.

**To prolong the benefits of soil solarization for 3 or more years, following disease management practices are necessary to be followed :**

**1. Proper site selection :**

Prefer net-/poly-house construction in rice fields. Avoid low lying and high clay fields.

**2. Pre-plant sanitation for disease control :**

(a) Previous crop debris removal – helps in reducing nematode population.

**3. Nursery raising :**

(a) Seed treatment

(b) To prevent insect-pest infestations, grow nursery under net of 40-mesh size.

**4. Production (crop raising) sanitation for pests, diseases and algae control :**

(a) Prefer raised beds and suitable planting time.

(b) Proper sunlight, ventilation and relative humidity in net-/poly-house can be ensured by selecting right combination of plant density (12,000 plants/acre under drip irrigation and 15,000 plants/acre with single row on a bed under furrow irrigation in case of capsicum), canopy management (pruning and tying of branches), enhance soil drying and aeration by using only required quantity of water through drip irrigation (follow given timing schedule), removing lower and older leaves by at least 1 feet, avoid growing crop all along borders/ walls inside net-/poly-house and prevent rain water entry from roof by having poly-sheet on roof in case of net-house and on lower one feet of side walls and proper spacing between two net-/poly-houses.

(c) Control weeds : Destroy weeds in and around the production area for managing diseases and proper crop growth.

- (d) Regular monitoring and correct diagnosis of disease symptoms, removal and disposing of diseased plant parts and timely and correct fungicidal sprays with proper spray technology – spray the plants in a row from both sides moving the lance up and down.
- (e) Use double door system in the net-/polynet-house. Always close the doors properly while entering.
- (f) Give preference to drip irrigation. Use under-ground water pipes for furrow irrigation.
- (g) Monitor the crop on alternate days to check the incidental entry of insect-pests. In case of infestation of brinjal shoot and fruit borer, tobacco caterpillar, hadda beetle or leaf miner, remove and destroy the infested leaves, shoots or fruits immediately. Destroy egg masses and tobacco caterpillars manually.
- (h) Remove dry and fallen leaves at frequent intervals to check insect-pests carry over.
- (i) All machinery and tools should be cleaned and disinfected before entering in the protected structures.
- (j) In winter, all ventilators should be closed at night to obtain maximum yield.
- (k) Always open the ventilator for sometime in each day for exchange of air/heat.
- (l) All ventilations must be provided with insect proof mesh/rambonet.
- (m) Inspect the net-/polynet-house regularly for wear and tear, plug all holes in doors and walls and fix the net or polysheet in the soil properly to prevent insect entry.
- (n) The entry door should be outside the main structure and preferably on the southern side covered fully with poly-sheet, so that it remains solarized throughout the year.
- (o) Provision of foot pond for potassium permanganate inside door the enclosure.

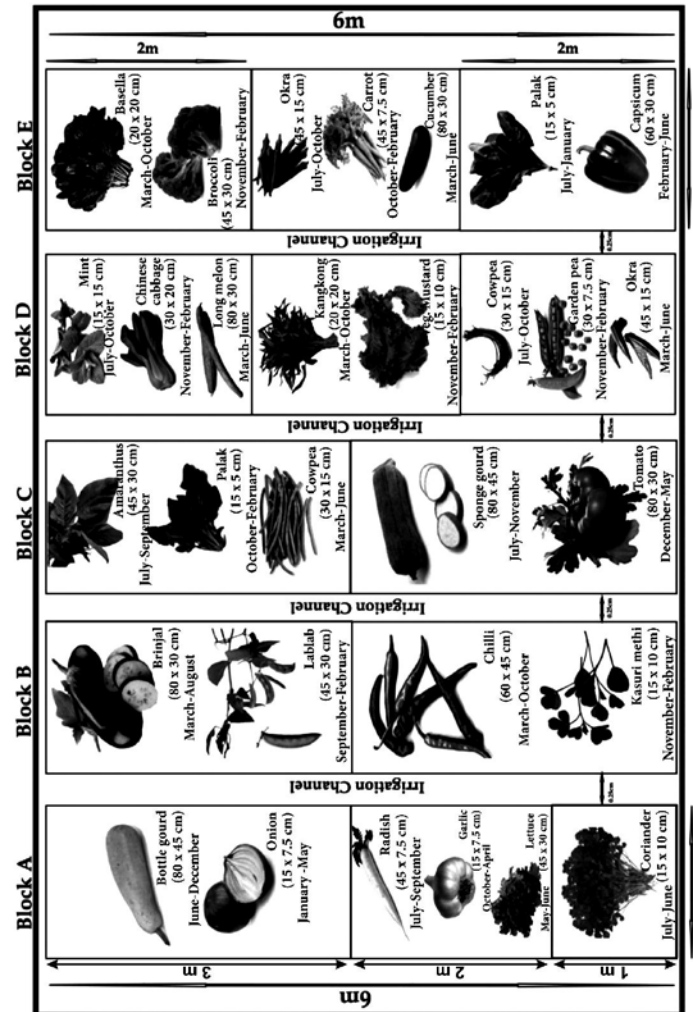
### 37. VEGETABLE NUTRITION GARDEN

Most of the vegetables reaching the market contain high amount of pesticide residues, it is of special interest of the consumers to grow vegetables themselves for their own use with minimum or no use of pesticides. In addition, micro-nutrient deficiencies affect the lives and health of a large number of people and three nutritional problems having serious consequences include deficiencies of iron, vitamin A and iodine. Vegetables help combat malnutrition and diversify diets. Dietary diversification balances the diet by enhancing the supply of essential micro-nutrients leading to improved health, enhanced thinking ability and increased efficiency. The improved model involves many annual crops that can be repeatedly harvested to meet a family's vegetable needs throughout the year. The crops and their varieties are scientifically selected to be highly nutritious with few pest and disease problems. The suggested model can produce 300 kg of vegetables each year. This will be sufficient to meet vitamins, minerals and protein requirement of a family comprising two adults and two children.

#### Important points to be kept in mind :

The cucurbitaceous vegetales like bottle gourd, sponge gourd, long melon, cucumber; and tomato are weak stemmed and were staked vertically with the help of nylon ropes tied to bamboo at a height of eight feet for production of good quality fruits.

Staggered sowing of coriander, carrot, radish, *methi* and okra at fortnightly intervals is recommended for continuous supply of these vegetables.



Vegetable Nutrition Garden Model

## 38. MULTIPLE CROPPING IN VEGETABLES

Most of the vegetable crops are of short duration and fit well in a number of sequences which result in greater production per unit area and time. The success of these vegetable rotations depends upon the selection of proper varieties, the adjustment of sowing time, adequate application of organic manures, fertilizers and irrigation, control of weeds, insect-pests and diseases and timely harvesting of the crops. The timeliness of these cultural operations becomes a highly critical factor in a successful multiple cropping programme in case of vegetables.

The following rotations may be practised :

### a) Vegetable farms located away from the main markets

- i) Potato-Onion - Green manuring  
(September-December)-(December-May)-(June-July)
- ii) Potato-Late Cauliflower-Chilli  
(October-December)-(December-March)-(March-October)
- iii) Potato-Okra-Early Cauliflower  
(November-February)-(March-July)-(July-October)
- iv) Potato (seed) - Carrot / Radish-(seed)-Okra (seed)  
(October-January)-(January-May)-(June-October)
- v) Pea-Chilli  
(October-February)-(March-September)

### b) Vegetable farms located near the main markets

- i) Brinjal (long) - Late Cauliflower - Bottle gourd  
(June-October)-(November-February)-(February-June)
- ii) Cauliflower - Tomato- Okra  
(September-November)-(December-May)-(May-September)
- iii) Potato - Muskmelon - Radish  
(October-January)-(February-May)-(June-August)
- iv) Spinach - Knolkhol - Chilli  
(August-October)-(October-February)-(February-August)

## 39. SEED EXTRACTION OF VEGETABLES

### “PAU” Axial-Flow Vegetable Seed Extracting Machine

Machine is recommended for extracting the seeds of tomato, brinjal, chillies, cucumber, watermelon, ashgourd and squashmelon. Freshly harvested ripe fruits of different crops are used for extracting the seed. Sufficient water should be available at the site of the machine and the machine preferably be installed near a tubewell/water source. Three persons are required to operate the machine. The efficiency of machine as compared to manual extraction is the highest in brinjal (12 times), cucumber (7 times) and tomato (5 times) whereas the efficiency is 3 times in watermelon and 2 times in chillies, ashgourd and squash melon. The cost of the machine excluding the cost of electric motor (2HP) is about Rs.20,000/-. Above all, the mechanical seed extraction is hygienic and the injury to the seed from traditional methods of seed extraction could be avoided.

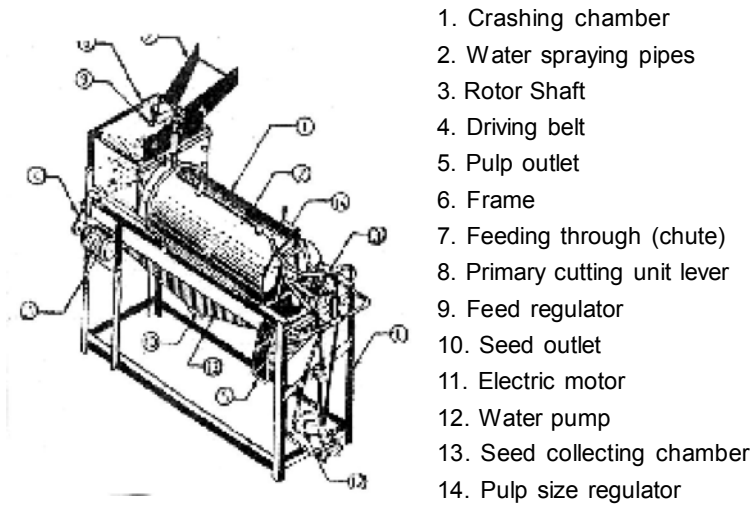
### Separation of the Seed :

Separation of the seed from the finally crushed seed material collected at the seed outlet is done by putting in a trough containing water. The seed being heavier settle down at the bottom of water and the fruit material floating over the water surface is easily removed by tilting of container. This process is repeated 2-3 times to obtain clear seed. The seed thus obtained should be sun dried in thin layers. However, since the tomato seed is surrounded by mucilaginous layer, the extracted seed should be treated with concentrated hydrochloric acid (commercial grade) at the rate of 8 to 10 ml per kg of seed material for 15 to 20 minutes. The mixture should be continuously stirred and thereafter the seed should be thoroughly washed with water and dried in thin layers under the sun.

### Vegetable Seed Thresher :

The vegetable seed thresher is used to thrash crops like radish, carrot and turnip. This thresher is of chaff-cutter type commonly used for wheat threshing, but differs from the conventional wheat thresher in the arrangement of separation and cleaning systems namely; location of the blower and size of sieve openings. The material after threshing passes through the concave and is allowed to flow on the sieves where the seeds are separated. The blower performs the winnowing action and it is located towards the rear end of the sieve.

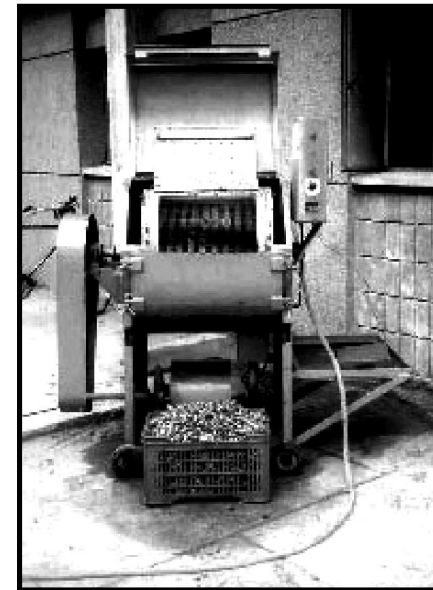
The blower is mounted on separate shaft from the threshing drum. The machine can be operated with an electric motor of 5 HP. Two persons are required to work on the machine. The machine can also thrash crop like soybean, arhar, moong, rapeseed and mustard etc. The output capacity per hour of this machine is 37 kg. for radish and 45 kg. for turnip.



**Fig :** Isometric view of axial flow vegetable seed extracting machine.

## 40. HORTICULTURAL PRODUCE WASHING MACHINE

A stainless steel, portable, 1 hp, electric power operated rotary drum type washing machine has been developed to wash a wide range of horticultural produce viz. carrots, potatoes, raddish, turnip, ginger, turmeric, okra, tomato, spinach, kinnow and pears. The inner rotary drum of the washer is made of stainless steel of 1.5 mm thickness, 760 mm long and 620 mm in diameter. Proper arrangements for feeding water into machine and draining out dirty water and silt is provided. Pressurized sprays of water with a water injection pump through the central, perforated inner shaft is provided for extensive washing. The machine when operated at optimum rotational speed for optimized time can wash 1-6 q/h of horticulture produce depending upon the crop as depicted in the following table. At optimum performance parameters, it does not cause any mechanical damage to the produce and gives a microbiological



**Fig. Horticultural produce washing machine**

washing efficiency of 90.2 - 95.5%. An electronic timer and a regulator has been provided in the machine to achieve optimum washing time and speed for various crops. Rotating parts and moving belts are covered with guard for operational safety.

**Table.** Optimum performance parameters of the washing machine.

<i>Horticultural Produce</i>	<i>Capacity (qph)</i>	<i>Optimum Speed (rpm)</i>	<i>Optimum Washing Time (min)</i>	<i>Microbiological Washing Efficiency (%)</i>
Carrot	3.5-4.0	40	8	95.5
Radish	1.5-2.0	50	5	94.0
Spinach	1.0-1.5	5	3	90.8
Ginger	3.5	40	6	90.2
Tomato	4.0	5	3	92.5
Potato	3.5-5.5	25	3	91.0
Turmeric	2.5-3.0	40	5	91.0
Okra	2.0-3.0	35	4	90.5
Turnip	2.5-3.5	25	4	92.2

## 41. EVAPORATIVELY COOLED STORE FOR STORAGE OF FRESH VEGETABLES AND FRUITS

It is a simple, low cost and zero energy store which can be used to extend the shelf life of fresh vegetables and fruits for short duration. The recommended store is a double walled structure with a cavity of 0.115 m (4.5") in between the walls which is filled with sand. Each wall is un-plastered single brick i.e. 0.115 m (4.5") thick. The outer dimensions of the store are 2.05x2.05x0.75 m and internal dimensions 1.36x1.36x0.75 m. A PVC pipe of 0.0125 m (0.5") diameter with 1 mm diameter holes at 0.150 m (6") interval, is placed above the sand filled cavity and is connected to a water tank placed at a height of 2.5 m from the ground for wetting the sand. The cover of the store should be made from wire mesh or bamboo sticks & should be covered with wet jute bags. To operate the store for storing fruits and vegetables, sand between the cavity of the walls and jute bags are kept wet thus reducing temperature and increasing relative humidity in the store which results in extension of shelf life of fruits and vegetables placed in plastic crates inside the store. Relative humidity inside the store remains more than 90% throughout the year whereas the average temperature drop inside the store is 12-18°C during April to June followed by 6-8°C drop in the months of September, October, February and March. Thus the store is suitable for extending shelf life of fruits and vegetables in general and particularly in hot and dry months (April to June). The store can be safely used to store a number of commodities such as pears, cabbage, tomatoes, ber for 15 days, kinnows for 20 days and lemons and potatoes for 30 days. The store should preferably be constructed at a shady and airy location on the field or backyard of the farm house. For further details, the information can be had from the Department of Processing and Food Engineering, Punjab Agricultural University, Ludhiana.

## 42. MANUALLY OPERATED GARLIC PLANTER

Machine is recommended for sowing garlic. The machine has a single row and it consists of a wheel hand hoe on which a planting mechanism is mounted. The seed metering mechanism consists of vertical disc with spoons. The spoons are fixed on the circular ring and this ring is mounted on the circular vertical plate in the planting hopper by means of three nuts and bolts. The capacity of hopper is about 3 kg and machine is operated by two persons. One person on the front pulls the machine with the help of a rope and another person steers it. Also, some time, third person is engaged for gap filling. It has also been provided with two depth adjusting wheels and markers to maintain the row spacing. Plant spacing can be varied by varying the number of spoons on the disc or by changing the sprockets. Also planting plates for different crops have been developed for sowing different crops like peas, moong/maize etc. Machine is operated in a prepared field and depth of sowing is maintained at about one inch. Since, the machine is light in weight about 12 kg thus operation of machine is very easy. At shallow depth of sowing, the germination after 20 days of sowing is about 95 percent which is close to manual planting. Also, it was observed that there was not much effect of position of garlic cloves on germination and yield. It can plant about 0.5 acres/day. Cost of planting with machine is only Rs. 350 per acre as compared to Rs. 2000 per acre manually.

## 43. VEGETABLE DIGGER FOR MECHANICAL DIGGING OF ONION, GARLIC, CARROT AND POTATO

A vegetable digger has been developed by the Department of Farm Machinery and Power Engineering, PAU, Ludhiana after modifying the existing potato digger. It is used for mechanical digging of different crops like onion and garlic grown on single bed of 1.1m width; carrot and potato on ridges at 67.5 cm ridge spacing. The machine consists of a digger blade having width of 1144 mm and thickness of 16 mm. The blade is mounted on the machine at an angle of 20° with the horizontal. An elevator chain conveyor is attached behind the blade. The spacing between the MS rods used for the fabrication of the elevator conveyor is 20 mm. Two oval agitators are provided in the conveying system for separation of soil particles from the bulbs. The power to the elevator conveyor is provided through a gear box. Two coulter discs are provided in front of the blade at the outer ends which helps in easy slicing and lifting of soil by the blade. Extension at the rear was also provided to increase the time for separation of soil.



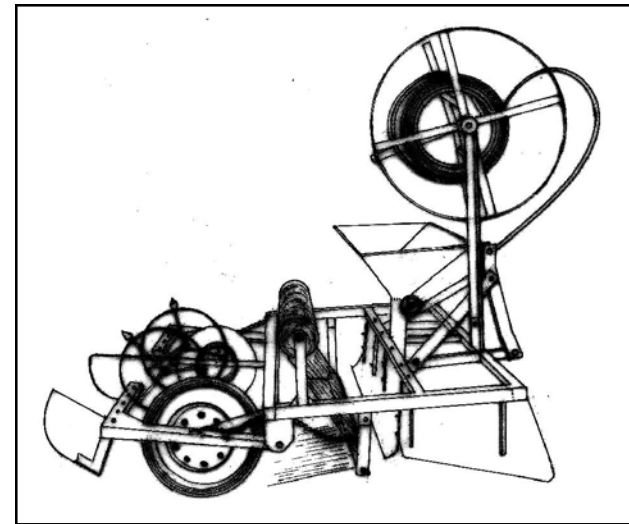
The field capacity of the machine is 0.20, 0.25 and 0.23 and 0.24 ha/h for digging onion, carrot, garlic and potato crop, respectively. Per cent exposed bulbs/roots were 99.0, 96.3, 98.6 and 96.4 per cent for onion, carrot, garlic and potato, respectively whereas respective damage to the crop was less than 1.0, 2.8, 1.1 and 1.92 per cent respectively for these crops. The performance of the machine was found satisfactory for digging these crops. Saving in labour was 69.0, 59.2 and 61.41 per cent respectively for onion, carrot and garlic as compared to manual harvesting and collection.



#### 44. TRACTOR DRAWN BED FORMER-CUM-PLASTIC MULCHING MACHINE

Plastic mulches have various beneficial effects on crop production, including an increase in soil temperature; the conservation of soil moisture, texture and fertility; and the control of weeds, pests and diseases. Besides, the volume of plastics material to be used per unit area is much lesser than that of traditional mulch material and, hence, plastic films are easy to handle, transport and lay in the field. Manual laying of plastic mulch is a laborious as well as time consuming process. A long time need was felt to mechanise this process.

Machine is being manufactured by Agribiz Corporation Gujarat. Machine's length is 2.2 meter, width 1.85 meter, height 2.2 meter. The tractor drawn bed former-cum-plastic mulch laying machine does four operations at a time i.e. bed forming, drip pipe laying, mulch laying and punching at the desired spacing. Tractor drawn bed former-cum-plastic mulching machine lays 75 cm, 90 cm, 105 cm, 120 cm,



*Fig. Tractor drawn bed former-cum-plastic mulching machine*

135 cm wide plastic mulch and requires a minimum of 30 hp tractor to operate. The height of the bed can also be adjusted from 15cm to 20 cm. This machine is very easy to operate and maintain and reduces the labour requirement by 92.5% and saves 30 man days per hectare per season.



## 45. MANAGEMENT OF RODENTS AND BIRDS

### 1. RATS AND MICE

Rats and mice usually live in burrows on the ground, possess acute senses of smell and taste, and are very selective in food choice. They are prolific breeders, extremely adaptable and intelligent pests and thus their control poses difficulties. Out of 8 species of rodents in fields, Indian mole rat, *Bandicota bengalensis* is most predominant under irrigated conditions and Indian Gerbil *Tatera indica* in dry and sandy soils.

The rats and mice attack seeds and seedlings in nurseries of fruits. Seedlings are also destroyed under heaps of soil made by rats. The Indian mole rat during burrowing, loosens the soil resulting in the felling down of fruit plants.

#### Methods of Control

The performance of different control methods vary in different situations and at different stages of the crop. Therefore, best control can only be achieved if these methods are adopted properly at appropriate timings.

#### A. Mechanical Control

- i) During irrigation of vacant harvested fields and orchards, rats coming out of flooded burrows should be killed with sticks.
- ii) Traps can be used to control rodents. Before use, wash the traps to remove odour from them. Place the traps at runways and activity sites of rodents. To enhance trapping, do pre-baiting with plain grains (cracked wheat or bajra) for 2 days and then trap the rats for 2 to 3 consecutive days. Kill the trapped rats by drowning.

#### B. Chemical Control

##### Baiting Technique

**Poison bait preparations:** The acceptance of poison baits by rodents depends upon the quality, texture, taste, odour etc. of the baiting materials. Therefore, the recommended baiting materials should be used for preparation of poison baits.



(i) **2% Zinc phosphide bait:** Smear 1 kg of bajra or sorghum or cracked wheat or their mixture with 20 g of groundnut or sunflower oil and mix it thoroughly with 25 g of zinc phosphide.

**Caution:** Never add water in zinc phosphide bait and always use freshly prepared bait.

(ii) **0.005% Bromadiolone bait:** Mix 20 g of 0.25% bromadiolone powder, 20 g of groundnut or sunflower oil and 20 g of powdered sugar in 1 kg of any cereal flour.

### Bait Placement

**Burrow baiting:** Rat burrows can be easily located in the fields, on bunds, water channels and surrounding waste lands. Close all the burrows in the evening and in the re-opened burrows on the next day insert a paper boat containing about 10 g of poison bait about 6 inches deep in each burrow. In case of burrows of the Indian mole rat, gently remove the fresh soil from the burrow opening to locate the tunnel and then put the poison bait deep inside it.

**Crop baiting :** Place about 10g of zinc phosphate or bromadiolone bait at 40 bait points per acre on dry sites and inside the crop throughout the field covering runways and activity sites of rats.

**Pre-baiting :** It is essential before zinc phosphide bait is to be alone. Place bajra & sorghum or cracked wheat or their mixture smeared with oil on pieces of paper 10g each at 40 bait points per acre for 2-3 days.

### Safety Measures

Since the rodenticides are very toxic to humans, domestic animals, pets and birds, the following safety measures must be adopted.

1. Keep the rodenticide and poison baits away from the reach of children, domestic animals, pets and birds.
2. Mixing of rodenticide in the baiting material should be done with a stick, spade or by wearing rubber gloves. Avoid the contact of poison with mouth. Wash exposed skin and hands after mixing.
3. Household utensils should never be used for preparation of the poison baits.
4. Use polythene bags for storage and carrying the poison bait. Bury them after use.

5. Collect and bury left over poison bait and dead rats from the field.
6. Zinc phosphide is toxic and there is no antidote for it. In case of its accidental ingestion, induce vomiting by inserting fingers in the throat and rush to doctor. Vitamin K is antidote for bromadiolone, it can be given to the patient under medical advice.

### C. Environmental Control

Weeds, grasses and bushes should be removed as these provide shelter and food to rodents. Highly infested bunds, water channels and field pavements should be periodically rebuilt to destroy permanent rat burrows.

Waste lands along roads, canals, railway lines, other uncultivated areas and forest strip serve as hiding places for rodents. So, to protect the adjoining crops, rat control operations must be carried out in these areas also.

### D. Biological Control

Owls, kites, eagles, falcons, cats, mongoose, jackals, snakes and lizards are the natural predators for rats and mice. These should be protected.

## 2. BIRDS

Birds, in general, are both useful and harmful to fruit crops. Even the same species may be beneficial or problematic in different situations. Only a few of about 304 species of birds of Punjab cause problems in orchards. The rose-ringed parakeet is the only bird that seems to be exclusively harmful to farmers' interests.

### Harmful Birds

Several fruits are damaged by birds at the bud stage and ripening stage. Parakeet is the major bird pest causing serious damage to guava, peach, pear, almond, grapes, mango and ber. House crows damage peach, plum and grapes. The major damage to grape is caused by mynas, especially the bank mynas.

### MANAGEMENT OF BIRD DAMAGE

#### A. Mechanical Control:

1. Make false gun-shots at different intervals to scare the birds.
2. Frequent beating of drums and use of *Gopia* at different points in the orchard is very effective against the birds.

3. Covering the vines of grapes and isolated fruit trees with nylon nets prevents the bird damage.
4. Fixing of scare crows i.e. a discarded earthen pot painted to stimulate human like head supported with wooden sticks and clothed in human dress to give a human like appearance is one of the most effective traditional techniques to keep the birds away. Position, direction and the dress of the scare crow should be changed atleast at 10 days interval. The height of the scare crow should be 1 metre above the plant height.
5. Use automatic bird scarer by shifting their position periodically and supplementing their noise with actual gunfire's. The other simplest method is the use of rope-crackers. It involves tying of sets of small fire crackers at a distance of 6-8 inches apart on a rope and igniting it from the lower end. The explosions caused by fire crackers on catching fire at different intervals scare the birds feeding on fruits. Fix the rope-crackers in the centre of the orchard.

### B. Cultural Practices

As far as possible sowing of maize and sunflower crops should be avoided in and around the orchards.

### C. Alarming Calls

Playing of cassettes (available at Communication Centre, PAU) of distress or flock calls of parakeets and crows respectively in a tape-recorder at peak volume for 1/2 hr. twice each in the morning between 7.00 to 9.00 a.m. and in the evening at 5.00 to 7.00 p.m. respectively, with a pause of 1 hour, scare the birds or halt their activities in orchards. Use of distress or flock calls remain effective for 15-20 days. Better results can be obtained by using this technique in sequence or in combination with other methods as an integrated pest management. For covering larger area use of amplifier or additional speakers (as per requirements) can be done.

### Conservation of Useful Birds

Predatory birds like owls, falcons, hawks, eagles, kites, etc. eat a large number of rats and mice. A single owl normally eats 4-5 rats a day. Insect eating birds like drongos, babblers, shrikes, lapwings, mynas, and many other small birds like sparrows and weaver birds feed a large number of insects to their young. A single pair of house sparrows feeds insects to their young about 250 times a day. Therefore, the useful birds should not be killed.

## APPENDIX - I

### Botanical names of vegetables

Sr. No.	English name	Botanical name
1.	Muskmelon	<i>Cucumis melo</i>
2.	Watermelon	<i>Citrullus lanatus</i>
3.	Summer squash	<i>Cucurbita pepo</i>
4.	Bottle gourd	<i>Lagenaria siceraria</i>
5.	Bitter gourd	<i>Momordica charantia</i>
6.	Sponge gourd	<i>Luffa cylindrica</i>
7.	Pumpkin	<i>Cucurbita moschata</i>
8.	Ash gourd	<i>Benincasa hispida</i>
9.	Cucumber	<i>Cucumis sativus</i>
10.	Long melon	<i>Cucumis melo var. utilissimus</i>
11.	Squash melon	<i>Citrullus vulgaris var. fistulosus</i>
12.	Wanga	<i>Cucumis melo sub sp melo</i>
13.	Tomato	<i>Solanum lycopersicon</i>
14.	Brinjal	<i>Solanum melongena</i>
15.	Chilli	<i>Capsicum annuum</i>
16.	Sweet pepper	<i>Capsicum annuum var. grossum</i>
17.	Okra	<i>Abelmoschus esculentus</i>
18.	Cowpea	<i>Vigna sinensis</i>
19.	Onion	<i>Allium cepa</i>
20.	Garlic	<i>Allium sativum</i>
21.	Pea	<i>Pisum sativum</i>
22.	Cauliflower	<i>Brassica oleracea var. botrytis</i>
23.	Cabbage	<i>Brassica oleracea var. capitata</i>
24.	Broccoli	<i>Brassica oleracea var. italica</i>
25.	Chinese Cabbage	<i>Brassica Oleracea var. pekinensis</i>
26.	Carrot	<i>Daucus carota</i>
27.	Radish	<i>Raphanus sativus</i>
28.	Tumip	<i>Brassica campestris var. rapa</i>
29.	Palak	<i>Beta vulgaris var bengalensis</i>
30.	Lettuce	<i>Lactuca sativa</i>
31.	Coriander	<i>Coriandrum sativum</i>
32.	Potato	<i>Solanum tuberosum</i>
33.	Arum	<i>Colocasia esculentum</i>
34.	Turmeric	<i>Curcuma longa</i>
35.	Sweetpotato	<i>Ipomea batatas</i>

## APPENDIX - II

### Fertilizer sources for the supply of nitrogen, phosphorus and potassium

#### (A) Nutrient contents of different fertilizers

Fertilizer	N (%)	P <sub>2</sub> O <sub>5</sub> (%)	K <sub>2</sub> 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	-	
Sulphated phosphate	13.0	33.0	-	15(s)
Urea-ammonium phosphate	28.0	28.0	-	-
Nitro phosphate	20.0	20.0	-	-
Sulphate of potash	-	-	48.0	
Muriate of potash	-	-	60.0	
Manganese sulphate	-	-	-	30 (Mn)
Zinc sulphate (Heptahydrate)	-	-	-	21 (Zn)
Zinc sulphate (Monohydrate)	-	-	-	33 (Zn)
Ferrous sulphate	-	-	-	19 (Fe)
Copper sulphate	-	-	-	24 (Cu)
Gypsum	-	-	-	16 (s)
FYM/Vermicompost (Dry)	0.5-1.5	1.2-1.8	1.2-2.0	Sufficient

#### (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 P<sub>2</sub>O<sub>5</sub>

Superphosphate	6.2 kg
Diammonium phosphate	2.2 kg
Urea-ammonium phosphate	3.6 kg
Nitrophosphate	5.0 kg

##### For 1 kg of K<sub>2</sub>O<sub>5</sub>

Muriate of potash	1.7 kg
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**Note:** Urea-ammonium phosphate (28-28), and diammonium phosphate (18-46) contain both nitrogen and phosphorus. By adding one kg of phosphorus (P<sub>2</sub>O<sub>5</sub>) through these fertilizers, one kg nitrogen (N) from urea ammonium phosphate and 400 g of N from ammonium phosphate is also added. This point must be taken into account while using two fertilizers.

## APPENDIX - III

### General recommendations regarding safe use of pesticides

1. Read the label carefully and follow the manufacturer's instructions.
2. Keep pesticides in labelled containers only.
3. Store pesticides in a safe and locked place, out of reach of children, irresponsible persons and pets.
4. Never store pesticides near foodstuffs or medicines.
5. In the handling of dangerous pesticides, the necessary protective clothing and devices must be used.
6. Do not tear open the pesticides bags, but cut them with a knife.
7. The preparations of spray solutions from concentrated dangerous pesticides should be done in drums using long sticks to protect the operator from splashing and to permit stirring from a standing position.
8. Wash hands thoroughly with soda and water (i) every time the sprayer/duster is filled with pesticides, (ii) before eating, drinking or smoking and (iii) at the end of the day's work.
9. Water contaminated, as a result of washing the equipment and drums, must be disposed off by scattering it over barren land.
10. Do not blow, suck or apply your mouth to any sprinkler, nozzle or other spraying equipment.
11. Operators should not work for more than 8 hours a day. Those engaged in handling dangerous pesticides should be checked by a physician periodically.
12. Separate working clothes should be used. They should be washed and changed as frequently as possible.
13. Do not use the empty containers of pesticides for any purpose. Destroy them by making holes and bury them afterwards.
14. Do not burn weedicide cartons, but bury them deep.
15. The worker should not smoke, chew, eat or drink in the spraying area or while spraying
16. A worker suffering from cold or cough should not be engaged for spraying.
17. Spray should always be done in direction of the blowing wind to avoid skin exposure and inhalation.

## FIRST AID PRECAUTIONS

In case of pesticide poisoning, call a physician immediately. Awaiting the physician's arrival, apply the FIRST AID.

### 1. Swallowed Poisons

a) Remove poison from the patient's stomach immediately by inducing vomiting. Give common salt one tea-spoonful (15 g) in a glass of warm water (emetic) and repeat until the vomit fluid is clear. Gentle stroking or touching the throat with a finger or placing the blunt end of a spoon will help induce vomiting when the stomach is full of fluid.

b) If the patient is already vomiting, do not give common salt in warm water and follow the specific directions as suggested.

### 2. Inhaled Poisons

- a) Carry the patient (do not let him walk) to fresh air immediately.
- b) Open all doors and windows.
- c) Loosen all tight clothing.
- d) Apply artificial respiration if breathing has stopped or is irregular. Avoid a vigorous application of pressure to the chest.
- e) Cover the patient with a blanket.
- f) Keep the patient as quiet as possible.
- g) If the patient is convulsing, keep him in bed in some dark room.
- h) Avoid any jarring noise.

### 3. Skin Contamination

- a) Drench the skin with water (giving a shower with a hose or pump).
- b) Apply a stream of water to the skin while removing the clothing.
- c) Clean the skin thoroughly with water.
- d) Rapid washing is most important for reducing the extent of injury.

### 4. Prevention of Collapse

- a) Cover the patient with a light blanket.
- b) Do not use a hot-water bottle.
- c) Raise the feet of the patient on the bed.
- d) Apply elastic bands to arms and legs.
- e) Give strong tea or coffee.

- f) Give hypodermic injection of stimulants, such as caffeine and epinephrine.
- g) Give fluid administration of dextrose 5% intravenously.
- h) Give blood or plasma transfusion.
- i) Do not exhaust the patient by too much or too vigorous treatment.

### 5. Eye Contamination

- a) Hold eyelids open.
- b) Wash the eyes gently with stream of running water immediately. A delay of even a few seconds greatly increases the extent of injury.
- c) Continue washing until the physician arrives.
- d) Do not use chemicals. They may increase the injury.

## Some other First Aid Measures

### 1. Cut Injury

- a) The first aid treatment of cut injury depends upon the date and extent of injury.
- b) But in first aid one should clean the wound with antiseptic lotion.
- c) If it is bleeding profusely tight bandage without ointment is to be given.
- d) The injured part should be kept raised or elevated.
- e) If there is any associated fracture, a proper splint or support should be given. But the patient, should be brought to the hospital at the earliest possible.

### 2. Snake Bite – Preventions

- a) In snake infested regions long trousers, high shoes or leggings and gloves should be worn. Most important is to look where to step while walking.

### First Aid

- a) Re-assure the complete rest to the victim to retard the absorption of venom. A wide tourniquet or any piece of cloth should be placed a few centimeters proximal or above the site of bite. It should be tight to an extent that a finger should pass below it with difficulty.

Suction of venom should be done by giving 1 cm linear and 1/2 cm deep incision at the mark of the fangs after applying an antiseptic lotion. Suction should preferably be done with rubber bulb, breast pump or with moth after ensuring that there is no oral lesion. It should continue for about an hour. If done promptly 50% of the venom can be removed.

### 3. Electric Injuries – Preventions

- a) Educate the electric hazards to everybody.
- b) Proper installation of electric appliances, grounding of telephone lines, radio and television arials, use of rubber gloves and dry shoes when working with electric circuit.

### First Aid

- a) Prompt switching off the current, if possible.
- b) Immediate removal of the victim from the contact with the current without directly touching him. Rescuer should use a rubber sheet, a leather belt, a wooden pole or any other non-conductive material to detach him.
- c) If the victim is not breathing, mouth respiration should be given.
- d) If no pulse is felt cardiac massage (pressure on left side chest) should be given.
- e) In mild cases local treatment of burnt part is required.

### 4. Honey bee Bite

- a) Cooling of the part with ice pads.
- b) Removal of stings.
- c) Cleaning with soap and water.
- d) Local and systematic anti allergies to be given.
- e) Perfumes and bright colours attract these insects and should be avoided.
- f) Sensitive person can have serve anaphyllatic shock with even a single bite.
- g) Every such patient must get the medical aid from a doctor.

## List of pesticides restricted or banned in the country

### a. Pesticides restricted for use

- |  |  |
|--|--|
| 1. Aluminium phosphide                   | It is to be sold only to government undertakings/ organisations and to be used under strict supervision of government experts or pest control operators. |
| 2. DDT                                   | Restricted for use in public health only.  |
| 3. Fenthion                              | Banned for use in agriculture except for locust control.   |
| 4. Lindane                               | Use of Lindane formulations generating smoke for indoor use is prohibited in India. It can be used for control of insect pests of field crops.           |
| 5. Methyl bromide                        | Restriction for its sale and use is similar to that of aluminium phosphide.  |
| 6. MEMC (methoxyethyl mercuric chloride) | –  |
| 7. Methyl parathion                      | Use is permitted only on those crops where honey bees are not acting as pollinators.   |
| 8. Monocrotophos                         | Banned for use in vegetables   |
| 9. Sodium cyanide                        | Use of sodium cyanide shall be restricted for fumigation of cotton bales by Plant Protection Advisor, Govt. of India.                                    |
| 10. Endosulphan                          | Banned for use in agriculture  |

**b. Pesticides banned for use in agriculture in India**

S. No. Name of pesticide	S. No. Name of pesticide
1. Aldicarb	17. Heptachlor
2. Aldrin	18. Maleic Hydrazide
3. BHC (HCH)	19. Menazon
4. Calcium cyanide	20. Metoxuron
5. Captafol	21. Nichotine sulphate
6. Chlorobenzilate	22. Nitrofen
7. Chlordane	23. Paraquat-di-methyl sulphate
8. Chlorofenvinphos	24. Pentachloro Nitrobenzene (PCNB)
9. Copper acetoarsenite	25. Pentachlorophenol (PCP)
10. Dibromochloropropane (DBCP)	26. Phenyl mercury acetate (PMA)
11. DDT	27. Sodium methane arsonate
12. Dieldrin	28. TCA (Trichloro acetic acid)
13. Endrin	29. Tetradifon
14. Ethylene dibromide	30. Toxaphene
15. Ethyl mercury chloride	
16. Ethyl parathion	

**c. Pesticide formulations banned for use**

1. Carbofuran	50% SP
2. Methomyl	24% L
3. Methomyl	12.5% L
4. Phosphamidan	85% L

**APPENDIX - IV**

**ANTIDOTES FOR PESTICIDES FOR HUMAN BEINGS**

**Signs and symptoms of toxicity:**

**Inhalation**

Usually appear within 1/2 hour of exposure, maximum after 6 hours. Nausea and vomiting, running nose, feeling of chest tightness, excessive salivation, difficulty in respiration, frothing from mouth, headache, giddiness, vertigo

**Oral intake**

Nausea and vomiting, abdominal cramps, diarrhoea, muscle twitching, confusion and disorientation, salivation and frothing, profused sweating, diminished vision, pin-point pupils, respiratory difficulty, convulsions, coma, death

**I. INSECTICIDES**

**Organochlorines**

(lindane etc)

No specific antidote. For convulsions : **Diazepam** 10 mg intravenous (IV). Could be repeated upto 30-40 mg. After that it should be mixed with drip.

**Phenobarbitone** 100-300 mg in drip.

**Organophosphates**

(monocrotophos, chlorpyrifos, methyl parathion acephate, triazophos malathion, quinphos, dimethoate etc)

**Atropine** : 2-4 mg intravenous as a test dose. If no effect double dose may be given every 10 minutes till atropinization. Maintain upto 24-48 hours. **2-PAM**: 1-2 g IV as 5% solution in dextrose to be given in 5-7 minutes or 150 ml of saline drip every 30 minute.

If required it may be repeated every hour if the muscle weakness and fasciculation persists. To be continued every 6-8 hours for 1-2 days or 5% solution as infusion @ 1/2 g/hr. **2-PAMCL**: dose same as above.

**Atropine+2PAM**: should be given together as 2 PAM acts as synergist to atropine

<b>Carbamates</b> (Carbaryl carbofuran etc.)	<b>Atropine</b> : 2-4 mg IV as a test dose. If no effect double dose may be given every 10 minute till atropinization. Maintain upto 24-48 hours. <b>Warning: Do not use oxime or morphine.</b>
<b>Pyrethroids</b> (cypermethrin, fenvalerate, deltamethrin etc).	Only symptomatic treatment, antihistamine are of value, if large amounts are ingested to cause nervous infestation, pentobarbitone (0.7g/day) should be used. For diarrhoea treat by <b>atropine</b> .
<b>Cartap hydrochloride</b> (Padan, Caldan etc)	<b>Dimercaprol (BAL)</b> 3-4 mg/kg body weight. (Comes as 3 ml, 10% solution alongwith benzyl benzoate in arachis oil). Given deep intramuscular every 4 hours for 2 days and then twice for another 10 days.
<b>Aluminium phosphide</b> (celphos. phostoxin etc)	No specific antidote, induce vomiting with 5% sodium bicarbonate. Give activated charcoal slurry with sorbitol 50-100 g orally, <b>diazepam</b> 5-10 mg IV slowly over 2-3 minutes. <b>Phenobarbitone</b> 600-1200 mg. diluted in 60 ml normal saline. Maximum dose 1-2 g. <b>Dimercaprol (BAL)</b> . <b>Dopamine</b> 4-6 ug/kg/min IV. Magnesium sulphate 3g IV bolus followed by 6 g in 12 hours for 5-7 days. Administering 5% glucose IV can minimize liver and kidney damage. <b>Warning : Do not give water or water based drinks</b>
<b>Naturalyte</b> (Spinoad)	No specific antidote. Treat symptomatically
<b>Oxadiazine</b> (Indoxacarb)	No specific antidote. Treat symptomatically
<b>Phenyl Parazole</b> (fipronil)	No specific antidote. Treat symptomatically
<b>IFUNGICIDES</b>	
<b>Carbendazim</b> (Bavistin, Agrozim, Parazim, Derosal etc.)	<b>Atropine</b> : 2-4 mg IV as a test dose. If no effect double dose may be given every 10 minute till atropinization. Maintain upto 24-48 hours.
<b>Streptocycline</b>	Injection of <b>adrenalin</b> , <b>antihistamine</b> and <b>cartisone</b> in case of acute anaphylactic shock, high or low blood pressure, profuse respiration and urticaria.

<b>Copper oxychloride</b> <b>Copper sulphate</b> (Blitox etc.) <b>Edifenphos</b> (Hinosan) <b>Iprobenphos</b> (Kitazin)	<b>Dimercaprol (BAL)</b> 3-4 mg/kg body weight. Comes as 3 ml, given deep intramuscular every 4 hours for 2 days and then twice for another 10 days. <b>Atropine</b> : 2-4 mg IV as a test dose. If no effect double dose may be given every 10 minutes till atropinization. Maintain upto 24-48 hours. <b>2-PAM</b> : 1-2g IV as 5% solution in dextrose to be given in 5-7 minutes or 150 ml of saline drip every 30 minutes. If required it may be repeated every hour if the muscle weakness and fasciculation persists. To be continued every 6-8 hours for 1-2 days or 5% solution as infusion @ 1/2g/hr. Activated charcoal, egg white or 5% sodium bicarbonate solution (gastric lavage). High colonic irritation : 5% <b>sodium formaldehyde sulfoxylate</b> (fresh 100-200 ml) intravenous. For faster treatment <b>sodium citrate</b> , oral 1-4 g every 4 hours. For spasms 100 ml (10%) <b>calcium gluconate</b> intravenous. <b>Ascorbic acid</b> (vitamin C) intravenous @ 0.2 g/min.
<b>Methoxy ethyl mercuric chloride</b> (MEMC), Agalol, Ceresan etc.	No specific antidote for metalaxyl. Antidote for mancozeb as given above may be recommended as this combination contains 64% mancozeb)
<b>Mancozeb</b> , Thiram, Zineb	No specific antidote, gastric lavage with 5% sodium bicarbonate.
<b>Ridomil MZ</b> (8% metalaxyl+64% mancozeb)	No specific antidote. Gastric lavage with 5% sodium bicarbonate and medicinal charcoal suspension. Then give 15-30 g sodium sulphate in half litre of water.
<b>Triadimifon</b> (Bayleton)	Treat symptomatically
<b>Dinocap</b> (Karathane)	If ingested, induce vomiting by administering a spoonful of salt in hot water.
<b>Carboxin</b> (Vitavax)	Treat symptomatically
<b>Captan</b> (Captaf)	Treat symptomatically
<b>Chlorothalonil</b> (Kavach)	Treat symptomatically
<b>Propiconazole</b> (Tilt)	Treat symptomatically

**Wettable sulphur** (Sultaf) If chemical has gotten into the victim's eyes, flush eyes with plenty of water for atleast 5 minutes

### III. HERBICIDES

**Anilophos** (Arozin, Libra, Anilguard, Anilfos Padigard etc.) **Atropine** : 2-4 mg IV as a test dose. If no effect double dose may be given every 10 minute till atropinization. Maintain upto 24-48 hours. **2-PAM** : 1-2 g intravenous as 5% solution in dextrose to be given in 5-7 minutes or 150 ml of saline drip every 30 minutes. If required it may be repeated every hour if the muscle weakness and fasciculation persists. To be continued every 6-8 hours for 1-2 days or 5% solution as infusion @ 1/2g/hr. **2-PAMCL**: dose same as above. Gastric lavage with 5% **sodium bicarbonate**.

**2,4-D** Ingestion: Gastric lavage with activated charcoal slurry. For muscle and cardiac irritability give **Lidocaine** 50-100 mg intravenous, followed by 1-4 mg/min as needed. Alkalize urine by sodium bicarbonate 10-15 g daily intravenously.

**Glyphosate** (Roundup) Ingestion : immediately dilute by swallowing milk or water.

**Isoproturon** Flush eyes with soap. Wash skin with soap and water.

(Arelon, Delron Milron etc.)

**Paraquat** (Grammoxone) Induce vomiting unless unconscious. Give gastric lavage with one litre of 30% aqueous suspension with Fuller's earth together with sodium sulphate. Repeat administration until Fuller's earth is seen in stool.

### M. RODENTICIDES

**Zinc phosphide** (Ratol, Zinc-Tox etc.) As under aluminium phosphide

**Coumatetralyl** (Racumin) Vitamin 'K' under medical supervision

**Bromadiolone** Vitamin 'K' under medical supervision

### Some common trade names of antidotes

Diazepam : Calmpose, Lori, Paciquil, Tenil, Valium

Phenobarbitone : Gardenal

Dimercaprol : Inj. BAL (Knoll Pharma)

PAM: Neopam, Pam, Pamplus, Pam-A-Korea

#### Atropinisation includes:

1. Drying up of secretions i.e. dry mouth, no frothing, loss of sweating.
2. Tachycardia : Pulse should be maintained at about 110/minute
3. Dilated pupils
4. Hyperthermia

#### Sources of Information :

- (a) Farm Chemicals Handbook, 1994
- (b) Health hazards of Pesticides and its management (1996) Voluntary Health Association of India
- (c) Essentials of Forensic Medicine and Toxicology (1999) by Narayan Reddy
- (d) National Poison Information Centre, AIIMS, New Delhi

**Caution:** Antidotes are to be used in case of poisoning only, for which a physician must be consulted immediately.

**Disclaimer:** The information given is only advisory. Actual selection of antidote, dose and manner of administration is to be decided by the qualified physician. **Punjab Agricultural University, Ludhiana accepts no legal responsibility.**



## APPENDIX - V

### Performa for referring sample to Plant Clinic, PAU, Ludhiana for diagnosis of disorders

1. Name and address of the farmer : \_\_\_\_\_
2. Crop : \_\_\_\_ Variety \_\_\_\_ Age of the crop \_\_\_\_\_
3. Problem noticed : \_\_\_\_\_  
(Approx. date)
4. Sowing date : \_\_\_\_\_
5. Area (under the crop) : \_\_\_\_\_ (acres)
6. Source of seed : \_\_\_\_\_
7. Is this problem related to weather ? : Yes/No
8. If yes, type of Weather : Rain/High temp./Storm/Frost/Hot dry Spell/Wet condition/Hail/Any other (Specify)
9. Suspected disorder : Insect damage/Disease/Nutritional/Input Phytotoxicity/Any other
10. Symptoms : Holes/Excreta/Rotting/Blight/Yellowing/Wilting/Mottling/Mosaic/Root swelling/Distortion/Any other
11. Extent of spread : Less than 25%/25-50%/50-75%/More than 75%
12. Spread pattern : Whole Crop/Patches/Isolated plants
13. Crop rotation : Wheat-Rice/Wheat-Cotton/Any other (Specify)
14. Soil type : Sandy/Loamy sand/Clay/Loam
15. Soil/Water analysis report : Copy attached/Not attached
16. Drainage system : Good/Moderate/Poor
17. Source of irrigation : Canal/Tubewell/Rainfed
18. Irrigation applied : 1/2/3/4/5/More than 5
19. Industrial plant in adjoining area : Yes/No  
If yes, : Distance in Mts. \_\_\_\_\_
20. Name the Inputs used : \_\_\_\_\_  
Dose \_\_\_\_\_ Timings \_\_\_\_\_
21. Diagnosis by field functionary (Extension Scientist) : \_\_\_\_\_  
**To be sent to** : **Director, Extension Education**  
**Punjab Agricultural University, Ludhiana.**

(Signature and Address of Extension Scientist)

## APPENDIX - VI

### IMPORTANT TELEPHONE NUMBERS OF THE PUNJAB AGRICULTURAL UNIVERSITY 0161-2401960 to 2401979

<i>Department/Discipline</i>	<i>Extension No. Office</i>
<b>Director of Extension Education</b>	<b>0161-2401644</b>
Addl. Director of Extension Education	0161-2400429
Addl. Director of Communication (CCL&C)	0161-2405731
Assoc. Director of Extension Education	0161-2401074
<b>FARMER'S HELP LINE</b>	
Plant Clinic	417
Agronomy & Agrometeriology	401
Farm Machinery & Power Engineering	402
Farm Management	461
Fruit Science	458
Vegetable Science	452
Soil Science	506
Plant Pathology	505
Entomology	504
Plant Breeding	435
Seed Shop	419
Farm Literature	475
Kairon Kisan Ghar	368
<b>Kisan Call Centre</b>	<b>1551 (Toll Free)</b>
<b>OTHER IMPORTANT TELEPHONE Nos. AT LUDHIANA</b>	
<b>Krishi Vigyan Kendras</b>	
Bathinda	0164-2215619
Ferozepur	01632-246517
Faridkot	01639-253142
Bahawal (Hoshiarpur)	01882-243647
Gurdaspur	01874-220743

Kheri (Sangrur)	01672-245320
Kapurthala	01822-233056
Langroya (Nawanshahr)	01823-250652
Rauni (Patiala)	0175-2225473
Ropar	01881-220406
Nag Kalan (Amritsar)	0183-2505672
Fatehgarh Sahib	01763-221217
Goneana (Mukatsar)	01633-210046
Moga	01636-235495
Samrala (Ludhiana)	01628-261597
Noormehal (Jalandhar)	98159-17643
<b>Farm Advisory Service Scheme</b>	
Amritsar	0183-2501989
Bathinda	0164-2212684
Ferozepur	01632-242136
Faridkot	01639-250143
Gurdaspur	01874-220673
Hoshiarpur	01882-222392
Jalandhar	0181-2225768
Kapurthala	01822-232543
Patiala	0175-2225473
Ropar	01881-222257
Sangrur	016732-234298
Chandigarh	0172-2775348
<b>Director of Research</b>	<b>0161-2401221</b>
Addl. Director of Research(Agri.)	0161-2407309
Director Seed	0161-2400898 0161-2401960-238
Director Farm	253
Deptt. of Fruit Science	303
Deptt. of Vegetable Science	370
Deptt. of Plant Breeding & Genetics	224

Deptt. of Food Science & Technology	305,328,384
Cotton Section	334
Maize Section	437
Oil Seed Section	433
Pulses Section	413
Fodder Section	443
Deptt. of Floriculture & Landscaping	440
Deptt. of Agronomy, Agrometeriology & Forestry & N.R.	308
Deptt. of Entomology	320
Deptt. of Plant Pathology	319
Deptt. of Soil Science	317
Deptt. of Extension Education	321
Deptt. of Farm Machinery & Power Engineering	257
Deptt. of Economics	301
Rodents & Birds	429
Deptt. of Microbiology	330
Deptt. of Zoology	382
Deptt. of Soil & Water Engineering	284
Deptt. of Clothing & Textile	337
Deptt. of Human Development	357
Deptt. of Family Resources Management	264
PAU Fax No.	0161-2400945
PAU Website	www.pau.edu.
<b>OUTSTATIONS</b>	
<b>Director Regional Stations</b>	
Bathinda	0164-2212159
Gurdaspur	01874-220703
Faridkot	01639-251244
Ballowal Saunkhri	01885-241601
Kapurthala	01822-265094
Usman (Tarn Taran)	01852-246487 81463-22553