PACKAGE OF PRACTICES FOR CULTIVATION OF FRUITS

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The **'Package of Practices for Cultivation of Fruits-2021'** contains the latest recommendations and readily-usable information provided by the PAU specialists on fruits through the coordination of the Director of Research. These improved farming techniques for stepping up productivity of fruits have been discussed and finalised in **'Virtual Research & Extension Specilist's Workshops on Horticultural Crops' held on 7 January, 2021 (Winter) and 6 July, 2021 (Summer)**. 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 fruit growers of Punjab.

ISBN : 978-93-86267-00-9

Price per copy : Rs. 50.00

Printed and Published by Additional Director of Communication for Punjab Agricultural University.

Printed at PAU Printing Press, Ludhiana (July, 2021)

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IMPORTANT NOTICE

The information on 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. In this regard, The Punjab Agricultural University accepts no legal responsibilities.

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.

NEW RECOMMENDATIONS

FRUIT VARIETIES

Strawberry

Chandler (2021): It is mid-season cultivar giving fruits from first week of February to first week of April. Fruits are medium sized, conical to sometimes long flat glossy with attractive skin. Flesh colour is deep red. Average fruit weight is 17.2 g, TSS 8.7 %, acidity 0.83 % and TSS/acid ratio 10.48. Average yield is about 260 g/plant.

Winter Dawn (2021): It is early maturing cultivar giving fruits from mid January to end of March. Fruits are large, medium conical to wedge shaped with deep red and glossy skin. Flesh color is dark red. Average fruit weight is 20.2 g, TSS 9.1 %, acidity 0.82 % and TSS/acid ratio 11.2. Average yield is about 290 g/plant.

PRODUCTION TECHNOLOGY

Leaf sampling of Litchi orchard for nutrient status: For leaf analysis collect 50 leaves having 4-5 months age from middle of 2nd and 3rd pair leaflets from terminal apex of shoot of litchi plant.

Soil application of potash in Kinnow mandarin for sub-mountain and central zones of Punjab: Soil application of of muriate of potash 185g per tree per year of age upto 7years and 1465 g every year per tree after 8 years of tree age can be made along with farm yard manure.

Bagging of Litchi bunches for quality production: The bagging of litchi fruit bunches with white and pink polypropylene non-woven bags at 25-30 days after fruit set provide physical protection against fruit nut borer and also improves fruit quality.

Strawberry cultivation: Complete Package of Practices for cultivation of strawberry in Punjab including varieties, propagation, time of planting, irrigation, fertigation, harvesting and marketing have been standardized.

PLANT PROTECTION

Management of Citrus foot rot with *Trichoderma asperellum*: Apply 100 g Talc based bio-formulation of *Trichoderma asperellum* mixed with 2.5 kg FYM per plant one week after the spray of Sodium hyphoclorite at foot and basin region of the plant during Feb-March and July–August.

Control of Mango powdery mildew with Contaf 5 EC: The disease can be managed by giving three sprays of Contaf 5 EC (hexaconazole) @ 1 ml/litre water before flowering, during flowering and after fruit set.

Integrated management of Grape Chafer beetle or white grub: Clean cultivation, ploughing around the trees during winter, irrigation of orchard as per recommended schedule and fixing Anisole based PAU Chafer Beetle Trap @12 traps/acre at ground level during last week of April helps in managing the chafer beetles.

POST HARVEST MANAGEMENT

Harvesting and marketing of Strawberry: Harvest strawberry fruits at entirely red (ripe) stage and pack them in 200 g punnets which should be further packed in corrugated fiber trays or ventilated cardboard boxes. Strawberries can be stored at 5±10C; 90-95 % RH for 6-9 days and at ambient conditions up to 2 days.

Lacto-fermented Indian Gooseberry/Amla beverage: The bioprocess was optimized by fermenting the blend of Indian Gooseberry juice (Indian gooseberry juice (2): Ginger (1): Guava juice (2)) water 1:3 and salt (condiment) @ 1.0% followed by pasteurization at 55ºC for 15 seconds with functional starter culture (consortia of ten allochthonous lactic acid bacteria @ 5.0% (w/v)) by incubating at 37ºC for 24 hrs.

Indian Gooseberry/Amla pickle: The bioprocess for the fermentation of Indian Gooseberry pickle; dip the 1 inch aseptically chopped Indian Gooseberry pieces in 5% brine solution followed by the addition of actively grown functional starter culture (consortia of ten LAB strains @ 5% w/v) and fermenting till 48 hrs at 37°C in tightly stoppered sterilized glass jar.

1. INTRODUCTION

Presently, total area under fruit crop is 93616 ha and total production is 2027177 MT in Punjab. Kinnow, Guava, Mango, Pear, Sweet Orange, Litchi, Peach and Ber are major fruits; while Limes/Lemons, Amla, Grapes, Plum, Banana, Pomegranate, Phalsa, Sapota, Papaya etc. are the minor fruits grown in the region. There is a good scope for expansion of area under fruits due to their high production per unit area.

Area, yield and production of major fruits in Punjab (2020-21)

Sr. No.	Fruit crop	Area (ha)	Yield/ha (kg)	Production (MT)
1.	**Citrus**			
	Kinnow	44752	26313	1177544
	Sweet orange	2788	8672	24179
	Lime & Lemons	2655	8023	21304
2.	Guava	9730	22596	219850
3.	Mango	7987	17188	137281
4.	Pear	3336	23454	78236
5.	Litchi	3142	16394	51504
6.	Peach	1801	17900	32232
7.	Ber	1278	17276	22083
8.	Amla	640	14916	9540
9.	Plum	399	17657	7041
10.	Grapes	230	30371	6980
11.	Banana	147	61376	9053
12.	Others	14731	15637	230350
	Total	**93616**		**2027177**

Fruit crops are labour and capital intensive and require technical knowledge to achieve the production potential. Effort has been made through these package of practices to make available the required knowledge and information for the benefit of fruit growers.

GENERAL RECOMMENDATIONS

Zone	Fruit trees recommended
Submontane Zone: The districts of Roopnagar, Hoshiarpur, Pathankot, SBS Nagar with Balachaur Tehsil, Gurdaspur (except Batala tehsil) SAS Nagar, Mohali, Bassi Pathana block of Fatehgarh Sahib and union territory of Chandigarh.	Mango, Litchi, Kinnow and other Mandarins, Pear, Sapota, Amla, Guava, Peach, Plum are main fruits. Lemon and Loquat can also be cultivated in this region.
Central Zone : The districts of Shri Amritsar, Tarntaran, Kapurthala, Jalandhar, Ludhiana, Barnala, SBS Nagar (except Balachaur Tehsil), Sangrur (except Sunam tehsil), Fatehgarh Sahib (except Bassi Pathana block), Patiala, Moga, Batala tehsil of Gurdaspur and Zira tehsil of Ferozepur.	Pear, Guava, Peach, Plum are main fruits. Kinnow and other Mango, Ber, Grape, Sweet Orange , Amla and Lemon can also be cultivated in this region. Banana except Amritsar, Tarntaran, Gurdaspur, Jalandhar and Kapurthala.
3. Arid-irrigated Zone : The districts of Bathinda, Faridkot, Sri Muktsar Sahib, Ferozepur (except Zira tehsil) Fazilka, Sunam of Sangrur district and Mansa.	Kinnow and other Mandarins, Sweet orange, Guava, Grape, Ber are main fruits. Grapefruit, Pear, Peach, Plum, Amla, Date palm, Pomegranate, Lime and Lemon can also be cultivated in this region. Banana except Sri Mukatsar Sahib and Faridkot with pH less than 8.5.
4. Special Areas :	
(i) *Kandi* Area	Guava, Ber, Amla, Mango and Galgal are important fruits of the region, while Kinnow and other Mandarins, and Lemon can also be cultivated in this region.
ii) *Bet* Area	Pear, Guava, Banana, Ber, Phalsa and Plum are important fruits of this region.

Suitable Soil for an Orchard

Soil for an orchard should be deep, well drained, loamy, fertile and free from hard pan upto depth of two meters. Water table should be below three metres and not fluctuating. Water logged, marshy and salt affected soils should be avoided for fruit growing.

- **Select the fruit plants according to their suitability to different climatic zones.**
- **Avoid growing fruit plant in water logged and salt affected soils.**
- **Always test soil and water before orchard plantation.**
- **Level the land before planting to save water and restrict soil borne diseases.**

The nutritional status and other conditions of the sub- soil are also important for the growth of fruit trees. Analysis of soil for orchard plantation should be done to the depth of two metres as follows:

1. Collect 500 g soil samples separately from each soil layer i.e. for top 15 cm, 15 to 30 cm, 30 to 60 cm, 60 to 90 cm, 90 to 120 cm, 120 to 150 cm and 150 to 200 cm either by soil auger or by digging a pit.
2. If a hard pan or concrete layer is present, note its depth and thickness and collect its sample separately.
3. Put different soil samples in separate clean cloth bags, avoiding contamination. Label each bag indicating the depth of the layer from which sample has been taken. Send the sample to the Soil Testing Laboratory or hand over the same to the University Extension Specialist of your district.

Suitability Limits of Soil for Orchard Plantation

*Character	Citrus and Peach	Other fruit plants
Conductivity (mmhos/cm)	< 0.5	< 1.0
Calcium carbonate (%)	< 5	< 10
Lime concretion (%)	< 10	< 20
pH	< 8.5	Upto 8.7
		Upto a depth of 60 cm only in the lower layers however, the pH may go upto 9.0

*Concern all soil-horizons upto a depth of two metres.

Leaf Sampling Procedures in Fruit Crops

In order to diagnose or confirm nutrient deficiencies or toxicities and to determine nutrient status of fruit trees, following leaf sampling procedures should be adopted :

Fruit	Leaf age (month)	Sample size*	Season	Remarks
Citrus	4-8	100	July-October	Immediately behind fruit
Peach	3-5	100	Mid May to Mid July	Mid shoot leaves from current season's growth
Pear	4-6	50	July-Sept.	-do-
Plum	3-4	100	May-July	-do-
Guava	5-7	50	August-October	Mid shoot leaves from non-fruiting terminals
Mango	5-7	30	March-April	Non-flushing and non-fruiting twigs
Ber	5-7	70	November-January	From middle of shoot.
Litchi	4-5	50	Feburary-March	Middle of 2nd and 3rd pair of leaflets from terminal apex of shoot.

***Number of leaves**

Sampling Instructions : Collect 4-8 leaves per tree from each direction (North, East, South and West) at working height of 1-2 m by taking one leaf per shoot. Sample along diagonals (X pattern) from about 10-20 per cent trees from selected blocks in the orchard.

Collect leaf samples in polythene bags. Keep the bags in ice-box and immediately send to Leaf Analysis Laboratory of the Department of Fruit Science, PAU, Ludhiana and Regional Station, Abohar, Bathinda and Gurdaspur. For leaf analysis, farmers can also contact Citrus Estate, Badal and Hoshiarpur, Department of Horticulture, Punjab.

PLANTING OF ORCHARD

Planting Time

Evergreen fruit plants: There are two planting times for

evergreen fruit plants, viz. February-March and September-October. Planting of Citrus, Mango and Litchi should preferably be done during September-October.

Deciduous fruit plants: These are planted in dormant stage preferably during December-mid January before the start of new growth e.g. Peach and Plum. However, grapes and pear can be transplanted upto mid February, before emergence of new sprouts.

Planting Distance (Square System) and Number of Plants Per Acre

Fruit Plant	Distance		(Rows × Plants in rows)	Number of plants/ acre
	(Feet)	(Metres)		
Mango and Sapota	30	9.0	7×7	49
Citrus/Guava/Soft Pear/ Plum/Fig	20	6.0	11×10	110
Pomegranate				
Kandhari	13	4	16×15	240
Ganesh	10	3	22×20	440
Peach/Loquat	22	6.5	10×9	90
Sand Pear/Ber/Litchi/Amla	25	7.5	9×8	72
Papaya/Phalsa	5	1.5	44×40	1760
Banana/Papaya (Red Lady 786)	6	1.8	41×30	1230
Grapes (Bower)	10	3.0	22×20	440

Note:

1. In case of Mango, Litchi and Pear which bear late and are planted comparatively at wider spacing, additional fillers (temporary plants such as Peach, Plum, Papaya or Phalsa etc.) to the extent of about 80 per cent of the original plants can be accommodated to make use of the vacant space. The fillers should be removed when the permanent plants start commercial bearing.
2. Purchase 10 to 20 per cent more plants than those mentioned above. These plants should be kept in nursery to fill up gaps after the death of plants.

High Density Planting

Fruit Plant	Distance		Rows×Plants in Rows	Number of plants/acre
	Feet	Metres		
Kinnow	20×10	6×3	11×20	220
Guava	20×17	6×5	11×12	132
Grapes	13×5	4×1.5	15×44	660
Peach and Plum	20×4.7	6×1.5	11×40	440
Patharnakh*	26×13	8×4	8×15	120

- High Density plantation (20×10 ft.) is recommended in Kinnow mandarin for better economic returns. These are widened by uprooting alternate trees (20×20 ft.) at 15th year of the tree age to prolong the life expectancy of Kinnow plants.
- Train the Grapes on Y-system of training.
- Peach and Plum should be pruned and trained to build Y-shaped frame work.
- "In Patharnakh plant should be trained by bending of main scaffolds and two secondaries".

Pit Making

The orchard site should be properly laid out by keeping roads, water channels and paths within the orchard before planting. The land should be properly cleaned and leveled with the help of Laser Land Leveler well in advance to save the irrigation water and restrict the soil borne diseases. One metre deep and one metre wide round pits should be dug for each plant. Refill the pits with a mixture of top soil and farmyard manure in equal parts. To each pit, add 15 ml of Chlorpyriphos 20 EC mixed in about 2 kg soil against white ants. The refilled pits should be watered a few days before planting the trees.

- **Purchase healthy plants of known pedigree from certified nurseries.**
- **Dig the pits (1m × 1m) and fill with mixture of top soil and farmyard manure in equal parts before planting.**
- **Plant evergreen fruit plants in February – March and September – October and deciduous plants up to mid-January.**

Selection of Nursery Plants

Healthy fruit plants, free from diseases and insect-pests and of known pedigree should be obtained from the reliable nursery and preferbly near to the orchard site. The plants should be of medium height budded or grafted on the recommended rootstock. The bud union should be smooth. Evergreen plants should be lifted with well sized earthen balls whereas deciduous plants should be taken out with major part of root system intact. Tying material should be removed from the bud/ graft union before transplanting.

Name of fruit plant nurseries of PAU, alongwith the plants available :

Name and Address	Available Fruit Plants
Department of Fruit Science, PAU Ludhiana-141004 0161-2401421	Kinnow, Lemon, Lime, Grapefruit, Peach, Pear, Plum, Grape, Guava, Ber, Papaya, Fig, Amla and Pomegranate etc.
Dr J.C. Bakshi Regional Research Station, Abohar (Fazilka) 01634-225326	Kinnow, Sweet Orange, Lemon, Lime, Grapefruit, Grape, Ber, Peach, Plum Guava, Amla, Pomegranate and Date palm.
Regional Research Station, Bathinda 0164-2212159	Kinnow, Sweet Orange, Lime, Lemon, Guava, Grapes, Ber and Peach.
Fruit Research Sub-Station, Bahadurgarh (Patiala) 0175-2381473	Guava, Ber, Mango, Peach, Plum, Amla, Sapota, Bael, Lemon and Lime.
Dr M.S. Randhawa Fruit Research Sub-Station, Gangian (Hoshiarpur) 01883-285073	Mango, Litchi, Peach, Plum, Kinnow, Amla, Lemon and Lime.
Regional Research Station, Gurdaspur 01874-220825	Mango, Litchi, Guava, Pear, Peach and Plum.
Regional Research Station, Ballowal Saunkhri (Shaheed Bhagat Singh Nagar) 01885-241601	Amla, Galgal, Lemon and Guava
Fruit Research Sub-Station, Jalowal-Lesriwal (Jalandhar) 98141-37547	Kinnow, Lime, Galgal, Sweet Orange, Grapefruit and Pomegranate

Handling and Transportation of Nursery Plants

Plants should be carefully handled during transportation to avoid breakage of earth balls,as the plants with broken earth balls are likely to dry up. Before loading the plants (with earth ball) in the vehicle, a layer of cushioning material such as *parali*,dried grass or sand should be spread at the bottom. Then place/pack the plants carefully in the vehicle. During long transportation sprinkle water on the foliage to keep these plants turgid.

Bare rooted plants may be packed in small bundles. The root portion of these bundles should be given mud coating and then wrapped with moist material such as wet gunny bags, parali or polythene sheet to avoid dehydration of feeder roots during transit.

Planting and Care of Young Plants

Bore holes of suitable size in the centre of the filled pits with the help of planting board. The tree should be planted in this marked holes in such a way that bud union remains about 9 inches above the ground level. The soil around the plants should be pressed firmly with feet followed by light irrigation. After irrigation, if plant is tilted, it should be stalked when the soil become in vattar condition.

- **Protect the fruit plants from hot/ cold winds by growing *Jamun*, seedling Mango, Mulberry, *Eucalyptus* and *Arjuna* around the orchard as wind breaks.**
- **Always keep recommended plant spacing between fruit plants.**
- **For higher returns, high density planting can be adopted.**
- **Train the fruit plants from the first year of planting. Do not allow suckers to grow below the bud union.**

After planting, provide supports to the plants. Remove dead and diseased portions by careful pruning. Provide adequate protection against vagaries of summer and winter season. Against white ant attack, apply Chlorpyriphos @ half litre per acre followed by light irrigation. Keep examining the young plants regularly and remove stock sprouts.

Weed Management

Weed can be managed by giving 2-3 hoeings. Tractor operated offset rotavator having automatic side shifting mechanism can be used for tillage and inter-culture in orchards especially under the tree canopy.

Eco-friendly Management of Termites through Earthen Pot Based Traps

Termites are the important soil borne insect-pests of pear, ber, peach, grape and amla under Punjab in nursery and grown up trees in the orchards. They feed on cellulose, particularly the wood. They are social polyphagous and polymorphic insect, living in large colonies comprising of queen, king, soldiers and workers nests called termitaria. These nests are constructed both above and below the ground. The workers class causes all the damage by feeding on roots and above ground parts of the trees. Peak activity period of termities in Punjab is April to June and September to October.

Management

Eco-friendly management of termites in pear, ber, peach, grape and amla can be carried out by burying maize cobs without grains (*Gul*) filled 24-holed earthen pots of diameter 13 inch, with lid @ 14 per acre in termite infested orchards during first week of April and again during first week of September. These earthen pots are buried in the soil keeping their neck outside the soil surface. The pots should be removed from soil after 20 days of installation and collected termites should be destroyed by dipping in water containing a few drops of diesel oil.

Windbreaks and Hedges

A good windbreak should be provided on the windward side of orchard well before the orchard is established. *Eucalyptus*, Arjuna, *Jamun*, seedling Mango, Mulbery etc. are good windbreak plants. In the spaces between windbreak trees, a hedge may also be planted. Bougainvillea, *Jati Khatti, Galgal, Karonda,* etc. form good hedges. Hedges of citrus species should not be planted around a citrus orchard.

SOME HINTS/ PRECAUTIONS IN PLANT PROTECTION

Methods of Preparing Various Fungicides

a) Wound Disinfectant Solution

Mercuric chloride	1 g
Methylated spirit	250 ml
Water	750 ml

The solution should not be placed in metal container. Glass vessels or porcelain jar may be used to hold it. The disinfectant solution should be applied with a large swap of cotton. Allow the disinfectant to evaporate and cover the wounded surface with Bordeaux paste which is applied with a brush.

b) Bordeaux Paste

Dissolve 2 kg of copper sulphate in 15 litres of water. Take 15 litres of water in another vessel. With a small portion of the second lot of water, slake slowly 3 kg of quick lime. Add the remaining portion of water to it. Mix the two concentrated solutions and stir. Apply the paste thus formed, to the cut ends with a brush.

c) Bordeaux Paint

Monohydrated copper sulphate	1 kg
Hydrated lime dust	2 kg
Boiled linseed oil	3 Litre

Monohydrated copper sulphate can be made by heating the copper sulphate crystals over fire. Place the crystals on a sheet of iron or on a frying pan *(tawi)* till they crumble into a white amorphous powder. Lime dust and copper sulphate powder are then mixed thoroughly and linseed oil is added. All the three constituents are then homogenized. Bordeaux paint is now ready for application. Apply it with a brush. It may be stored in a vessel for future use or made fresh, when needed. Bordeaux paint makes the covered surface impervious to water. It is very useful in places subject to abundant rains and protects the wounds from the wood-rotting fungi. It lasts for a year or so.

d) Bordeaux Mixture 2:2:250

Copper sulphate	2 kg
Quick lime (unslaked lime)	2 kg
Water	250 litres

The raw material should be of good quality. Copper sulphate of guaranteed 98 per cent purity should be obtained. Only the freshly burnt limestone (quick lime) should be used. It should be free from earth and sand. Solution of copper sulphate and lime should be made separately. For preparing 2:2:250 Bordeaux mixture, dissolve 2 kg of copper sulphate in 125 litres of water. Copper sulphate dissolves very slowly in cold water. Hence, in winter use hot water or suspend copper sulphate in gunny sac into a wooden barrel or an earthen pitcher, so that the material remains immersed.

Note: Do not dissolve copper sulphate in a metallic vessel.

Slake 2 kg of quick lime in another vessel and add water slowly, when the lime is completely slaked, add enough water to bring it up to 125 litres.

Then mix the two solutions either by pouring the copper sulphate solution into the lime solution slowly or the two solutions together into a third vessel. Pour the lime solution through a strainer to keep back all lumps. Stir the mixture all the time while pouring. Stir and strain the mixture again when pouring into the sprayers.

How to test Bordeaux mixture :

i) Bordeaux mixture as prepared above, is alkaline containing excess of lime. It turns the red litmus paper blue. An excess of copper compound in the mixture is dangerous to the foliage of many plants and is indicated by the solution turning the blue litmus paper red.

ii) Another way of determining whether the mixture contains excess of copper is to immerse a bright surface, such as knife blade or a nail in the upper layer of the liquid. A deposit of copper will form on the metal if the mixture is unsafe.

iii) A more accurate test can be made with ferrocyanide of potassium. Add a few drops of the Bordeaux mixture to little

ferrocyanide in a small saucer. If no change occurs, the mixture is safe but if it becomes reddish brown, too much copper is present.

More lime solution must be added, if the tests indicate that copper is present in excess.

Bordeaux mixture should not be applied, when it is raining or on exceptional hot day when the plants are showing sign of temporary wilting.

e) White Wash Mixture

Lime slaked	25 kg
Copper sulphate	500 g
Gum or Suresh	500 g
Water	100 litre

Note:

1. The quantity of water (500 litres) given in various spray schedules is for full grown fruit trees for one acre sprayed with foot sprayer. For young trees, the quantity of water will vary according to the size of plants.
2. For motorized knapsack sprayer, use the same quantity of insecticides/ fungicides as mentioned in the text, but the quantity of water for dilution will be approximately 1/10th.
3. Dissolve the suresh in hot water before putting in the mixture.

2. CITRUS

The Citrus fruits comprising of Mandarins (mainly Kinnow), Sweet oranges, Limes, Lemons and Grapefruit are of major economic significance in Punjab. Kinnow ranks first with respect to area and production, followed by Sweet orange and Limes and Lemons. The districts of Fazilka, Hoshiarpur, Sri Muktsar Sahib and Bathinda occupy maximum area of Kinnow in the State. Sweet orange is grown particularly in the arid irrigated region of Punjab i.e. districts of Fazilka, Hoshiarpur, Sri Muktsar Sahib and Bathinda. The Citrus fruits are rich source of vitamin C (25-60 mg of vitamin C per 100 g of juice). The rind of fruit is rich in pectin and essential oils.

Climate and Soil

Citrus plants, being of tropical origin, cannot withstand extended cold periods. Temperatures of $-2^{o}C$ to $0^{o}C$ are injurious to the Citrus plants, if such low temperatures prevail for long periods. Extremely high temperatures are also not conducive to the production of the high quality citrus fruits. Under such conditions, the foliage is killed and much of the fruit drops. In areas, which have more total heat units available during the growing season, Oranges mature early with a higher amount of total soluble solids. Citrus fruits are successfully grown in comparatively dry areas of Punjab provided adequate irrigation facilities are available. Citrus plants can be grown almost all over the Punjab state.

Citrus thrives well in deep, fertile, well-drained soils devoid of any hard pan and layer of calcium carbonate in root zone. Citrus trees are susceptible to salt injury and cannot thrive well in saline/alkaline soil. Presence of excessive free lime leads to deficiency of phosphorous, manganese, zinc and lime induces chlorosis. The soils, which are water-logged or have a high and fluctuating water-table should not be put under Citrus. Soils having electrical conductivity upto 0.5 mmhos/cm, calcium carbonate upto 5 per cent, lime concentration upto 10 per cent and pH upto 8.5 are suitable for successful cultivation of Citrus. The optimum pH range for Citrus cultivation is between 5.5 to 7.5.

Recommended Cultivars

1. Mandarins *(santra)*

PAU Kinnow-1 (2016): It is mid-season variety and mature in January. The fruits are low seeded as compared to Kinnow with 0-9 seeds per fruit. The flesh is orange colour and juicy, with a rich and sweet flavor, having TSS of 10.5% and 0.81% acidity. Yield of five year old plant is 45 kg.

- **Citrus fruits are rich source of vitamin C, A, and B and protein, phosphorus, calcium iron and essential oils.**
- **Plant PAU Kinnow-1 as low seeded variety.**
- **For early harvesting and premium pricing, Daisy should be planted.**
- **For better productivity, use Carrizo rootstock for Daisy and W. Murcott. Daisy mandarin fruits must be harvested upto 20th November to avoid granulation.**

Daisy (2013): Daisy is a cross between Fortune and Fremont mandarin. It is an early maturing variety and mature before mid-November. It produces a medium-large, fruit with an attractive dark orange rind. It peels and sections moderately well. Daisy is moderately seedy with 10-15 seeds per fruit. The average fruit weight is 210 g; TSS 11.5%; acidity 0.54% and juice content 41.8%. The average yield is 57 kg per plant at 5th year of age. Complete fruit harvesting upto 20th November.

W. Murcott (2013): The tree is moderate in size and vigour. The fruit is usually flattened with a thin, smooth, orange rind that is easy to peel. The flesh is orange-coloured and juicy, with a rich and sweet flavour. It is mid-season variety and mature in January-February. Average fruit weight is 201 g; seed number 10, TSS 11.5%; acidity 0.68% and juice content 39.0%, its average yield is 57 kg per tree at 5th year of age. It is suitable for the area having soil pH less than 8.0 when raised on Carrizo rootstock.

Kinnow (1968) : It is a prime fruit of the State. Fruit medium globose to oblate; skin golden orange when fully mature; acidity moderate with fine sugar/acid blend; flavour very rich and seeds 12 to 25. It matures in January and can produce 125-150 kg fruit/tree.

Local (1968) : It may be planted in some pockets of Gurdaspur, Hoshiarpur and Roopnagar districts of Punjab. Fruit small to medium in size, oblate to subglobose; skin cadmium yellow, base short necked and furrowed; flavour fair, juice abundant, slightly acidic; seeds 3-7; matures in December-January.

2. Sweet oranges (*malta*)

Early Gold (2018) : Trees of this variety are semi-vigorous. Fruit size is medium to large, shape sub-globose and rind texture slightly rough. Rind colour changes from green-yellow to orange at maturity. Fruit ripen during last week of October to mid of November. It is low seeded variety (2 - 6 seed per fruit) with high juice content (47.23%) having attractive golden yellow colour and good blend of sugar and acidity. Its average fruit yield is 45 kg/ tree. It is recommended for arid-irrigated zone of Punjab.

Valencia (1968) : Fruit medium, slightly oval; skin deep golden yellow; juice abundant, subacid in taste, rich in flavour, seeds 2-7; ripens during February-March and produce about 38.9 kg fruit/tree.

Musambi (1962) : Fruit small to medium, subglobose, surface smooth with longitudinal furrows, apex marked with circular ring, flesh pale yellow or whitish; juice has low acidity; seeds 20-25;ripens in November. The average yield is 41.3 kg fruit/tree. Plants budded on Pectinifera rootstock do better than others.

Jaffa (1962) : Fruit medium to large,round to oblate; skin orange red; acidity and sweetness well blended; flavour rich; seeds 8-10; ripens in December. The average fruit yield per plant is 50-55 kg.

Blood Red (1962) : Fruit medium to large; roundish to slightly oblong, rind thin, deep orange, tight and glossy; flesh fully red when ripe; rich flavour with sweetness and acidity well blended; seeds 8-10; ripens in December-January. Plants budded on Cleopatra rootstock do better than other rootstocks. The tree can yield 42.3 kg fruit/tree.

3. Grapefruit

Star Ruby (2009) : Trees medium in size, fruit size small to medium, shape oblate-roundish. Peel smooth, glossy yellow

having distinctly bright red blush. Flesh colour is deep red, fruits seedless (1-2 seeds), juicy, rich in vitamin C and have high TSS well blended with acidity. It is an early variety which ripens during last week of November and have yield of 53 kg fruit/tree.

Red Blush (1995) : Fruit small to medium, oblate, peel smooth, glossy and deep yellow having crimson colour in patches at maturity. Deep bright crimson blush in juice vesicles. Mildly acidic and high in TSS, seeds 0-8, mostly aborted; ripens during last week of November. Average yield is 76.5 kg fruit/tree.

Marsh Seedless (1968): Fruit medium to large; oblate-roundish; skin light yellow, smooth; acidity and sweetness medium; seeds 0-6; ripens in December-January. The average yield of this variety is 92.8 kg fruit/tree.

Duncan (1968): Fruit large; oblate; skin pale light yellow or creamy; acidity and sweetness good but bitterness well marked, seeds about 50. It matures late in January and yield 84 kg fruit/tree.

Foster (1968): Fruit medium to large; oblate; skin pale yellow, flesh pink, acidity and sweetness well-blended, bitterness well-marked; seeds 40-50; ripens in November-December. It yields 51.4 kg fruit/tree.

4. Lemon

Punjab Baramasi Lemon (2008) : Tree spreading and vigorous, fruit medium to large, spherical in shape, peel smooth, fruit very juicy with low seed content and matures in the first week of July. Average yield is 84 kg fruit/tree.

Punjab Galgal (1994) : Its trees are vigorous. Fruit is medium in size, oval in shape, peel is smooth, glossy, medium thick and yellow at maturity. Its juice has 5.2 per cent acidity and 5-8 seeds per fruit. It matures in last week of November and gives 80-100 kg fruit per tree.

PAU Baramasi Lemon-1 (1990): The fruit is lemon yellow, round, tapering towards the base and apex is rounded. The skin is smooth and thin. Fruit is very juicy, seedless and contains about 7 per cent acidity.

Eureka (1968) : Fruit medium oblong, apex nippled; skin lemon yellow, smooth, juice abundant, clear, strongly acidic with excellent flavour; seeds rarely present, ripens in August-September.

5. Lime *(Nimboo)*

Kagzi (1968): Fruit small, round and thin skinned, pulp greenish white, juice strongly acidic.

6. Sweet Lime *(Mitha)*

Local (1968): Fruit medium, globose to ellipsoid, rind smooth with distinctive aroma. Juice abundant, lacking in acidity and insipid, seeds 5-6 ripens in the beginning of September.

Propagation

The propagation of quality plants need utmost attention because of susceptibility of citrus to viruses and mutation. The quality of nursery plants has a major contribution in the productivity of Citrus orchards vis-à-vis the decline problem.

Recommended Rootstocks

Jatti Khatti is suitable rootstocks for Kinnow, Daisy, Jaffa, grapefruit, lime and lemon. If pH of orchard soil is less than 8.0 then Kinnow, Daisy and W. Murcott can also be planted on Carrizo rootstock. Kinnow plants on Carrizo are tolerant to *Phytophthora* and fruits produced are of better quality. Sweet orange variety Blood Red should be propagated on Cleopatra and Mosambi on Pectinifera rootstock.

Rootstock Raising

Rootstock seeds should be obtained from healthy fruits harvested from vigorous trees. Preferably the fruits which are too close to the ground should not be used for seed extraction because of high chance of *Phytophthora* infection. The Jatti Khati seeds are extracted in August-September. Immerse the seeds in hot water at 52^{o}C for about 10 minutes to check *Phytophthora* infection. Pectinifera seeds should be sown during August-September. Seeds of Carrizo and Cleopatra should be sown in the first week of February for raising the rootstock seedlings.

Citrus seeds should be sown in nursery soon after extracting from fruits, as they loose viability rapidly. The seeds are sown in

nursery beds of 2 m×1 m size and in rows 15 cm apart. The seeds should never be sown more than 2.5 cm deep.

The seedlings are transplanted to nursery field when seedlings are 10-12 cm in height. The seedlings of uniform vigour and height should be selected for transplanting. Dwarf and exceptionally vigorous seedlings and those with badly crooked roots should be removed. Discard approximately 25 per cent of total seedlings. This would ensure the uniformity of stock and selection of nucellar seedlings. At the time of transplanting, care should be taken to prevent doubling up of the roots. If necessary, the roots may be pruned back slightly before planting.

Spray of 1.5% urea (15 g/litre of water) on Rough lemon seedlings at monthly interval (March to December) increases number of buddable plants, improves budding success and produces healthy Kinnow plants.

Maintenance of Mother Trees of Kinnow for Enhanced Bud Wood Supply

For the induction of more bud wood required for the nursery production, the mother trees of Kinnow should be pruned at 8 feet height from ground level along with topping of side branches during last week of January to first week of February. Bordeaux paste should be applied on cuts after pruning. The fruits should also be removed from the Kinnow mother trees after fruit set in the month of April.

Budding

Pencil thickness seedlings are budded by inserting shield shaped bud into the slot cut in the bark of the seedling at 15-20 cm from the ground level. This slot is usually 'T'-shaped. It can be made by first making a horizontal cut about 1.5-2.0 cm long according to the thickness of the stock. Another vertical cut, about 2.5 cm long, is made downwards from the middle of the horizontal cut to receive the bud shield. After the 'T'-cut has been made in the stocks, the bud is removed from the budstick and inserted into the slot and wrapped up with the plastic tape keeping the bud eye uncovered. The wrapping should be fairly tight, but not so tight as to girdle the stock. The sprouts of the stock seedlings below and above the bud union should be removed regularly.

Shield or 'T'-budding is done in Sweet orange, Mandarins Grapefruit etc. during mid February-March and again during August-September, when the sap flows in the seedlings. In Lemons and Limes, the plants can be propagated by air layering (*gootee*) or by cuttings. Moss grass or roots of water hyacinth can be used as a rooting media.

The cuttings are planted in well prepared nursery beds or in polythene bags about 5×7 cm size during February or September.

Care should be taken in the nursery that the attack of any insect-pests and diseases should not be allowed by adopting recommended practices.

Containerized Nursery Production of Kinnow under Protected Conditions

Preparation and sterilization of potting mixture

The potting mixture consisting two parts of soil, one part of farmyard manure and one part cocopeat (2:1:1 v/v) should be prepared on a concrete floor and spread as a flat bed of 45 cm height. These beds should be drenched with water and covered with 100µ UV stabilized transparent polythene sheet during the months of May-June.

- **Always take bud wood from true to type and diseases free mother plant for nursery production.**
- **Use soil, FYM and cocopeat potting mixture (2:1:1) in polybags for containerized nursery production of Kinnow under protected conditions.**
- **Budding should be performed at 15-20cm above the ground level.**
- **Containerized nursery prodution helps in propagating Kinnow plants in shorter time and reduces the incidence of insect-pest and diseases.**

Raising of rootstock and budding

The rough lemon seeds (2 seeds per bag) should be sown directly in black polythene bags (size 12"×7", 250 gauge) filled with sterilized potting mixture in the second fortnight of August under screen house/ polycarbonate roof screen/ shade net house. The seeds start germinating in about 3 weeks and when the seedlings become 10 cm tall retain only one nucellar seedling per bag by uprooting all other seedlings. Then the seedlings should be sprayed with 1.5% urea at monthly interval. The polythene bags

containing seedlings should be shifted in glasshouse/ polyhouse during winter (mid-November till end of February) which should again be transferred to screen house/ shade net house (50% shade) during first week of March. More than 75 per cent seedlings will become buddable in the first fortnight of May. The budding operation can be started from May onwards under shade net house which will become saleable during September-October and remaining plants will become saleable in next March. This technology will help in propagating Kinnow plants in less time for fulfilling the increasing demand for quality planting material. It requires smaller nursery area and there is no need to change nursery site every year. It will reduce the transplanting shock and lead to higher survival, continuous and quick growth of plants in field. The containerized nursery production under protected conditions reduces the incidence of insect pest & diseases and eliminates the spread of soil borne diseases, insect and nematodes.

- **Prune the dead/diseased branches and twigs after harvesting, followed by spray of Bordeaux mixture.**
- **Thin out the fruit of young Kinnow plants in 3rd and 4th year to maintain the proper health of plant.**
- **Correct the zinc and manganese deficiency by spraying zinc sulphate and manganese sulphate in end April and mid August. Keep one week gap while spraying Bordeaux mixture.**
- **Drip irrigation saves water, improves yield and reduces the incidence of *Phytophthora* disease.**

Planting

There are two planting seasons for citrus plants in Punjab i.e. the spring and the monsoon. The spring planting starts from Mid February and continues upto Mid March. The monsoon season starts from the middle of August and continues upto the end of October. Citrus is, however, commonly planted when rains have set in and the weather has sufficiently cooled down. Kinnow and Baramasi lemon plants can be successfully transplanted bare-rooted during December-February. After digging the plants from nursery, remove the one-fourth foliage and cover the rest with moist wrapping material.

Training and Pruning

Citrus trees may be pruned at any time, but it is better to avoid those periods when trees are in active growth. The best time for prunning the bearing trees is after the harvest of the fruits during late winter or early spring. For getting better yield of high quality fruit, pruning of such branches is necessary to open up the tree for proper ventilation and provide more chances for innerwood to bear fruit. Removal of dead and dried wood is necessary to check the further spread of diseases.

Manure and Fertilizers

Fertilizer schedule for Kinnow plants

Age of Tree (year)	Farmyard Manure (kg/plant)	Dose per tree (g)					
		Nitro-gen	Phos-porus	Urea	Single Super phosphate	*Pota-ssium	*Muriate of Potash
1-3	10-30	110-330	240-730	-	-	110-330	185-550
4-7	40-70	440-770	970-1690	220-385	1370-2400	440-770	735-1285
8 & above	80	880	1940	440	2730	880	1465

*Soil application of potash can be done for Sub-mountain and Central zones of Punjab along with farm yard manure.

Fertilizer schedule for citrus plants other than Kinnow

Age of the Tree (year)	Farmyard manure (kg/plant)	Dose per tree (g)	
		Nitrogen	Urea
1-3	5-20	50-150	110-330
4-6	25-50	200-250	440-550
7-9	60-90	300-400	660-880
10 and above	100	400-800	880-1760

These nutrients can also be supplied from other fertilizers available in the market (Appendix-I).

In Kinnow and other citrus fruits, entire farmyard manure should be applied during December. Split the N dose into two parts and apply the first half in February and the second half in

April-May after fruit set. Apply phosphorus alongwith the first dose of nitrogen.

Fertigation schedule for Kinnow orchards

The following fertigation schedule should be followed for high density Kinnow mandarin for higher nutrient use efficiency. The fertilizer dose (g/tree) should be divided equally among the number of splits and applied at weekly intervals during February-April (15 splits) and July-mid September (12 splits). It will same 20% fertilizers and also gives higher fruit yield and better fruit quality.

Fertigation schedule for Kinnow plants

	February- April (15 splits)			July-Mid September (12 splits)		
	(g/plant)					
Age of plants	Urea	Urea Phosphate	MOP	Urea	Urea Phosphate	MOP
01	115	-	-	77	-	-
02	230	-	-	154	-	-
03	346	-	-	230	-	-
04	370	240	80	247	160	120
05	466	300	80	310	200	120
06	558	360	80	373	240	120
07	647	420	80	431	280	120
08 and above	742	480	240	494	320	160

Zinc and Manganese Deficiency : The symptoms of zinc deficiency appear on fully mature new leaves as irregular interveinal chlorosis commonly known as “mottled leaf”. The terminal leaves become small and narrow referred to as ‘little leaf’. Fruit bud formation is severely reduced and twigs die-back. To control zinc deficiency, spray zinc sulphate solution 0.47% (4.7 g/litre of water) without addition of lime on spring flush in end April and on late summer flush in mid August. Foliar application should be given to the fully developed flushes. To correct zinc and manganese deficiency, spray the plant with zinc sulphate (470g) + manganese sulphate (330g) in 100 litres of water in end April and mid August. A gap of one week should be kept between the

foliar application of Bordeaux mixture and zinc sulphate and manganese sulphate solution.

Irrigation

The young plants upto the age of 3-4 years, should be irrigated at weekly intervals, whereas, older trees be irrigated after 2-3 weeks interval, depending upon the climate, rainfall and type of soil. Irrigation is crucial before sprouting in February, after fruit set in April and in the hot weather, otherwise the growth of trees may be adversely affected resulting in the excessive shedding of flowers/ fruits.

Drip irrigation in Kinnow orchards

In the beginning, 1-2 drippers per plant or tree are required which may be increased to 4-5 depending on the soil type and age of the plant or tree. For efficient use of water sub lateral loops of the drippers should be used around each plant or tree.

The drip irrigation system enables efficient and judicious use of water along with improvement in yield. The requirement of water during different months according to age of the tree is given as below :

Drip irrigation schedule for Kinnow plants of normal spacing (6m×6m)

Month	Age of plants (Yrs)				
	0-2	3-4	5-6	7-8	9 and more
Jan	3	6	9	12	15
Feb	6	12	18	24	30
March	9	18	27	36	45
April	13	25	39	52	65
May	16	32	48	64	80
June	17	34	51	68	85
July	13	26	39	52	65
Aug	12	24	36	48	60
Sept	11	22	33	44	55
Oct	8	16	24	32	40
Nov	5	10	15	20	25
Dec	3	6	9	12	15

Irrigation schedule for high density (6m×3m) Kinnow orchards

The following irrigation schedule should be followed for Kinnow mandarin for higher water use efficiency. The amount of water is given in liters of water per day per plant in different months. It will save 40% irrigation water and also improves yield and fruit quality.

	Age of tree (years)				
Months	**1**	**2**	**3**	**4**	**5**
	Amount of water (litre/plant/day)				
January	0.6	0.5	2.0	2.9	7.5
February	0.8	1.5	3.8	5.9	13.6
March	1.7	2.2	6.3	10.2	22.5
April	3.3	5.4	13.6	33.1	40.9
May	4.1	9.6	16.3	39.2	53.3
June	4.4	8.4	15.8	38.1	54.3
July	3.2	6.5	10.1	27.8	35.8
August	2.6	4.4	9.8	21.4	29.3
September	1.9	4.9	7.8	19.6	26.1
October	1.7	3.5	6.4	15.2	18.8
November	1.1	1.9	4.0	5.7	12.5
December	0.6	1.4	.5	7.0	7.5

Note :

1. Follow the instructions for use of drip irrigation system given in Appendix-II.
2. Amount of irrigation water may vary by 10-15 percent depending upon the prevailing weather conditions.
3. For lifting water from canal storage tank, a booster pump with solar/electric motor of 2 HP will be sufficient for 10 acre Kinnow orchard. However, for 15 and 25 acres a booster pump with electric motor of 3 and 5 HP respectively, will be required for lifting water.
4. The Kinnow mandarin trees can be occasionally irrigated with mixture of fresh and saline water (EC around 2 mmhos/ cm) only through drip irrigation as life-saving irrigations during canal closure or scarcity of canal water.

Intercropping

Intercropping should not be done in bearing orchards. But in young and non-bearing orchards, intercropping upto four years with leguminous crops such as *Guara, Moong, Mash*, Cowpea, Gram and Pea may be done. The *Guara*-Wheat rotation with *Guara* as a green manure can be taken in Sweet orange for 5-6 years. Sufficient space should, however, be left unsown to permit the young trees to make unrestricted growth. Recommended fertilizers should be added to meet the requirements of intercrops separately. The fruit trees and the intercrops should be provided with independent irrigation system.

Caution : Tall and exhaustive crops like Cotton, *Chari, Bajra*, Maize, *Berseem, Bhindi* and Creeper type vegetables should not be grown in the orchards.

Weed Control

Light cultivation of the field should be done to manage the different kinds of weed flora.

Integrated management of fruit drop in Kinnow

- Prune citrus trees to remove diseased and dead twigs during January to February after the fruit set and spray Bordeaux Mixture (2:2:250) or Copper oxycholoride 50 WP (3g/litre of water).
- Repeat spray in March, July and September to reduce die-back of twigs.
- Collect and destroy all the pruned wood by burning.

- **Adopt integrated strategies for management of drop in Kinnow.**
- **Use ventilated Corrugated Fibre Board (CFB) boxes for fruit packing and long distance transportation.**
- **Use eco-friendly approaches such as PAU fruit fly trap for fruit fly and HMO oil for psylla control.**
- **Avoid flood irrigation in orchards, as it increases the attack and spread of *Phytophthora* disease.**

- Spray GA_3 (10 mg/litre of water) in mid April, August and September.
- Collect and destroy the mummified fruits on the trees as well as the fallen fruits by deep burying.

- Apply the recommended fertilizers to maintain the health of the trees.
- Give irrigation according to the requirement. Avoid stagnation of water for longer period in tree basin.

Fruit Thinning

Kinnow tends to bear too heavily in the third and fourth year of its age. Sometimes there may be 400-500 fruits on young plants of this age. Due to such a heavy load, health of plants suffers badly and some of them may even die. Thus, the fruit on young Kinnow trees must be thinned out judiciously soon after setting in May.

Quality Improvement

To improve fruit size and increase yield in Kinnow mandarin, three foliar sprays of 1.0% potassium nitrate (10g/litre) at the end of May, June and July should be applied.

Fruit Maturity and Harvesting

Kinnow fruits should be harvested when they have attained proper size, attractive colour and acceptable total soluble solids : acid ratio. The fruit from the periphery should be picked when they attain TSS/acid ratio of 12:1, whereas the fruits from the interior of the trees can be harvested somewhat later when they have a ratio of 14:1. The best time for picking Kinnow fruits is from mid-January to mid-February with a little variation depending upon locality, season, etc. The fruits should not be pulled from the branches during harvesting as the skin from stem end can be ruptured. Harvest with the clipper retaining a non-protruding short fruit stalk (button).

Post-harvest Handling and Marketing

After harvesting, the fruit should be properly cleaned and suitably graded. The fruits can be packed in boxes in 3 or 4 layers in such a way that they do not get pressed while in transit.

The proper stage of maturity is the prime factor for harvesting mandarins fruit for storage. Fruits harvested too early or late in the season do not keep well in the storage. Harvesting during early hours of the day when there is dew on fruits or immediately after rains should be avoided.

Freshly harvested fruits of Kinnow, Daisy and Star Ruby should be washed in clean water followed by dip in 0.01% chlorinated water (Sodium hypochlorite 4% @2.5 ml/litre water). The fruits should be partially dried under shade and Citrashine wax should be applied with foam. Waxed fruits should be again dried under shade before packing. Citrashine treated fruits retain shape and flavour upto two weeks. The healthy unbruised Kinnow harvested during first week of February can be stored for 8 weeks at prevailing room temperature by individually seal packing with electric sealer or rubber band in 10 micron thick high density polythene bags.

Pack Kinnow, Daisy, W. Murcott and Star Ruby fruits in paper moulded trays and wrap with heat shrinkable film. It improves the shelf life and maintains the quality of Kinow for 14 days, Daisy for 10-15 days, W. Murcott for 10 days and Star Ruby for 14 days at room temperature. The Kinnow fruits harvested at optimum maturity, packed in ventilated corrugated fibre board boxes should be stored at 5-6^{o}C and 90-95% RH. The quality remains acceptable for 45 days.

The Kinnow fruits can be safely packed in two kg capacity 3 ply CFB boxes of internal size (335 mm×215 mm×95 mm), four kg capacity 3 ply CFB boxes (335 mm×215 mm×185 mm) for retail marketing. For distant marketing of Kinnow, 10 kg capacity, jumbo pack of 5 ply (450 mm×240 mm×180 mm) can be used.

The non-alcoholic naturally carbonated lemon beverage can be shelf stabilized with optimized concentration of clarifying agents and optimized heat treatment with a shelf life of four months.

Citrus Decline

It may be due to several causes, such as unhealthy planting material carrying viruses and similar diseases, improper rootstock, defective soil, poor drainage, mismanagement of the orchard, malnutrition, insects, nematodes and diseases.

For the Rejuvenation of Declining Citrus Orchards, the following Schedule is Recommended:

(1) Remove dead wood during January-February before the new growth starts. Spray 2:2:250 Bordeaux mixture immediately and apply Bordeaux paste to the cut surface and the trunk of

the trees. Apply Bordeaux paint to the trunk after a week. The methods of preparing Bordeaux mixture, paste and paint are given in Chapter-1.

(2) Add fertilizers, as recommended under 'Manures and Fertilizers'.

(3) Spray 1.5 kg of zinc sulphate in 500 litres of water after one week of Bordeaux mixture in end April and mid August or on new growth flushes when the leaves have attained two-third of their size.

(4) Follow the recommended spray schedule.

Plant Protection Measures

A. Insect pests

Pests and symptoms of attack	Control
1. Citrus psylla (*Diaphorina citri*) is active throughout the year with its peak period of infestation from March to mid October. The population density is more in arid zone. The adult psyllid is grey coloured and fly actively. It rests on the leaves with closed wings and hind end is raised upwards. The nymphs are orange yellow. Both nymphs and adults suck the cell sap from buds, leaves and young shoots and as a consequence, the leaves get curled and shoots start drying. It also acts as a vector of greening disease.	(i) Spray 200 ml Crocodile/ Confidor 17.8 SL (imidacloprid) or 160 g Actara/Dotara 25 WG (thiamethoxam) or 6.25 litre MAK HMO (Horticulture Mineral Oil) in 500 litres of water per acre during March and again in the first week of September. **Note: (i)** There should not be any water stress in the orchard at the time of spray of MAK HMO. (ii) Time of application may be adjusted with the appearance of the pest.
2. Citrus leaf miner (*Phyllocnistis citrella*) : Leaf miner is a serious pest in the nursery and young plantations during flushing seasons. The larvae attack the tender leaves/shoots epidermis by making serpentine mines which are silvery in colour. The affected leaves become distorted and crumpled. Severe infestation causes defoliation. The pest is active from end March to November with its maximum infestation during April-May and September-October. Its attack encourages the development of citrus canker.	Spray 200 ml Crocodile/Confidor 17.8 SL (imidacloprid) in 500 litres of water during April-May and August-September.

3. Citrus whitefly (*Dialeurodes citri*) and **Citrus blackfly** (*Aleurocanthus woglumi*) are the serious pests of Citrus in the state. Both nymphs and adults suck the cell sap from tender leaves and shoots and reduce the vigour of plant. Severely infested foliage turns yellowish green, becomes curled and finally shed. Sooty mould developed on honey dew excreted by the whitefly gives black appearance to the foliage. Affected trees have less chlorophyll, nitrogen and crude protein and produce few flowers which may shed. The fruits are insipid. Nymphs of whitefly are small pale yellow with red eyes. **Citrus blackfly** lays eggs in spiral rings on the lower side of new leaves and nymphs are black in colour. Freshly emerged adults are reddish but later on get covered with a heavy pulverulence of salty bluish look. Both the species are active from March to November with their peak period of infestation during April-May and September-October.	---
4. Aphids (*Toxoptera aurantii, Aphis gossypii and Myzus persicae*) : These aphids are regular pest of Citrus. *Toxoptera aurantii* and *Myzus persicae* are active from first week of February to first week of May with their critical period of infestation from first week of March to first week of April. These two species along with *A. gossypii* also cause damage to Citrus plants from last week of August to second week of November with their critical period of infestation from second week of September to first week of October. The nymphs and adults suck the cell sap from young leaves and tender twigs. This impairs the vitality of the tree and causes severe curling and deformation of young leaves resulting into stunted growth. The honeydew excreted by the aphids also provides a good substrate for the growth of sooty mould, which affects the photosynthetic activity of the plant.	Same as for citrus psylla

5. Mites (*Eutetranychus orientalis*) **:** Mites damage the leaves, flowers and fruits. Their incidence is maximum during dry and hot period (May-June) or sometimes become serious in August-September. The leaves have minute specks left by the feeding of mites. Leaves generally give dusty look.	---
6. Leaf folder (*Psorosticha zizyphi*): The pest is active in the nursery and young plantations from May to October. The larvae feed inside the leaves by webbing them together and start feeding from top to downwards. The plants become stunted.	---
7. Bark-eating caterpillar (*Indarbela quadrinotata*): This pest causes damage by boring holes into the stem and branches and feeds on the bark under the cover of its excreta. The pest is active in neglected orchards.	Remove the webbing and inject kerosene oil into the holes during September-October and again in January-February. Treat all the alternate host plants in the vicinity.
8. Citrus thrips (*Scirtothrips citri*): The pest starts appearing in first week of March with the initiation of flowering and causes damage to petals, stamens and subsequently the basal part of the ovary. The attacked flowers dry up and shrivel. Thrips attack occurs upto third week of April. As soon as the petals start drying, adults and nymphs within the floral parts start lacerating the developing fruits. At the initial stage, the damage on the rind/skin of the fruits appears as light silvery white abrasion but with the increase in size of fruit, the scarring becomes prominent and deep on the rind of fruits.	---
9. Mealybugs : Four species, viz. *Planococcus citri, Planococcus lilacinus, Nipaecoccus viridis and Maconellicoccus hirsutus* are active in citrus orchards during July-October, but *Planococcus citri* is a major pest. These species cause damage to leaves, tender shoots, twigs, branches and fruits. The nymphs and females of these mealybugs suck cell sap and reduce the vigour of plant.	(i) Monitor regularly the infestation of trees by observing the underside of leaves, young shoots, fruits and branches. (ii) Keep the orchards neat and clean. (iii) Do not allow the branches of trees to touch the ground. (iv) Prune or remove the infested branches and destroy them.

The severe feeding causes drying of tender shoots and growing point. Heavy infestation also encourages the growth of sooty mould due to which the leaves, shoots and fruits become black in colour. All these mealybugs, hibernate on the twigs and branches of trees.	(v) Destroy the ant nests in the orchards.
10. Fruit flies (*Bactrocera dorsalis and Bactrocera zonata*): The fruit flies punctures the fruit at colour break stage and deposits its eggs below the epicarp. On hatching, the maggots feed on the soft pulp. The punctured fruit portion start rotting and fruit fall down. On pressing, the juice comes out from the punctured portion of the fruit.	(i) Regularly collect and bury the infested fruits. (ii) Fix PAU fruit fly traps @16 traps/ acre in the second week of August and recharge the same if required.

B. Snails

Insect and symptoms	Control
Brown snail (*Macrochlamys indica*) **in citrus nursery :** The peak activity period of snail in Punjab is during rainy season. For its management in citrus nursery integrated practices should be adopted.	(i) Cleaning up debris in/around nursery will remove breeding and hiding places for snails. (ii) Spread papaya leaves in/around nursery area to attract snails. Then, collect the snails and put into a bucket containing common salt water to kill them. (iii) Hand picking and manual killing. (iv) Keep wet gunny bags in the nursery area as snails try to hide under gunny bags. Then, collect the snails and put into a bucket containing common salt water to kill them. (v) Do bait application of Metaldehyde (2.5% dust) bait when population of snails started appearing in nursery plants or nursery plots. Bait immediately following an irrigation or rainy period when the soil is wet and snails are active. Do not irrigate after bait application. For 1 kg bait, add Jaggery (250 grams) in Wheat bran 750 grams and Metaldehyde (2.5% dust) 25 grams. **Caution:** Metaldehyde bait is highly toxic and should be stored way from reach of children and pets.

C. Diseases

Disease and symptoms	Control
1. Canker: (*Xanthomonas axonopodis pv. citri.*) : Disease appears on leaves, twigs and fruits. On leaves it appears as yellowish spots, which gradually enlarge, turn rough and brownish and become raised on both sides of the leaf. The spots are surrounded by a yellow halo. Fruit lesions become rough and corky confined only to the rind. Kagzi lime and Grapefruit are highly susceptible.	Give three sprays of 50g Streptocycline + 25 g Copper sulphate in 500 litres of water one each in October, December and February. Bordeaux mixture (2:2:250) or 50% Copper oxychloride (0.3%) can also be sprayed. Also spray nursery plants particularly during July-August.
2. Scab (*Elsinoe fawcetti*): It appears as small, dark brown, rough, irregular, raised lesions mostly on under-side of the leaves. Twigs and fruits are also infected.	Clipping of infected leaves in July and apply three sprays of Bordeaux mixture (2:2:250) or 50% Copper oxychloride (0.3%) during last week of June to August at 20 days interval.
3. Gummosis/Foot Rot (*Phytophthora parasitica.*) : Affected trees show symptoms of foot rot with profuse gumming, trunk girdling, pale green foliage, stunted growth flushes and twig die-back. The gummy lesions may extend downwards as well as upwards on the tree trunk and may also appear on branches/limbs.	(i) Avoid flood irrigation. Do not allow irrigation water to stay in direct contact with the tree trunk. (ii) Avoid deep hoeing. Avoid injuries to the trunk bark and roots. (iii) Decorticate and disinfect wounds on trunk either with (a) disinfectant solution and cover the wounds with, (b) Bordeaux paste, which when dries up apply (c) Bordeaux paint followed by spray preferably (d) Bordeaux mixture (2:2:250). (for different preparation see at chapter-1 at page 10. OR (iv) Give two applications of Curzate M8 as paint (2 g/100 ml of Linseed oil) to the infected trunk portion and drench (25 g/10 litres of water/ tree) the soil at the base of the tree in February-March and again in July-August. OR (v) Spray sodium hypochlorite 5% @50ml per tree by diluting it in 10 litres of water. Spray should be given in the foot and basin region of the trees during February-March and again during July-August. OR

	(vi) Apply 100 g Talc based bio-formulation of *Trichoderma asperellum* mixed with 2.5 kg FYM per plant one week after the spray of Sodium hyphoclorite at foot and basin region of the plant during Feb-March and again during July–August.
4. Wither tip / Die-back / Anthracnose (*Colletotrichum gloeosporioides*) : Symptoms include drying of tips and branches and even of large limbs; necrotic circular areas on leaves; fruit-rot.	Remove the infected twigs during February and then spray with Bordeaux mixture (2:2:250) or 50% Copper oxychloride (0.3%) during March, July and September.
5. Melanose or Stem end fruit rot (*Phomopsis citri*): It manifests as dark circular depressions and yellowish margins on leaves, branches and fruits. Later the spots become raised, rough and light brown and yellow margins disappear. Sand paper texture develops on the surface of leaves and fruits.	Spray Bordeaux mixture (2:2:250) or 50% Copper oxychloride (0.3%) during July-August and September.
6. Sooty mould : (*Capnodium citri*): It develops on the honey-dew excreted by the whiteflies. The disease produces black velvety superficial coating on leaves, twigs, stems and fruits. The affected leaves exhibit curling and shriveling symptoms. Heavy infestation leads to poor growth flushes, less flowers and fruits in next cropping season. The incidence of the disease is more on shaded and closely spaced trees The mould deposited on the fruit rind may delay the fruit colouring and also become difficult to remove resulting in poor market acceptability	Keep the population of sucking pests under check.
7. Citrus greening (*Candidatus Liberibacter asiaticus*) : It is caused by a bacterium and manifests as stiff, upright multiple twigs and buds; small chlorotic or mottled leaves; pre-mature defoliation, die-back of branches and greening of fruits.	(i) Use disease free bud wood. (ii) Since it spreads through an insect vector, citrus psylla (*Diaphorina citri*) keep the same rigorously under check through recommended insecticidal sprays.

8. Virus and Virus-like Diseases	
a) Tristeza (*Citrus tristeza virus*): It causes veinlet clearing in young leaves, necrosis of cells at bud union, honey combing of main stem, inverse pits on bark.	(i) Use disease free bud wood and only tolerant rootstocks such as *Jatti Khatti*. (ii) Control the insect vector (aphid) that causes its spread through recommended insecticidal sprays.
b) Exocortis (*Citrus exocortis viroid*): It is not common on Kinnow and sweet orange budded on Jatti Khatti. In some species like Lime, it causes yellow blotches and cracks on shoots with stunting of trees.	(i) Use disease free bud wood. (ii) Use only resistant rootstocks like *Jatti Khatti*. (iii) It spreads through the cutting tools. Sterilize them after each contact with infected plants to avoid spread to healthy trees.
c) Ring Spot (*Citrus ring spot virus*): The disease appears as yellow rings on mature leaves. The ring number varies from one to several per leaf with variable diameter. These rings may coalesce to form bigger patches by covering the entire leaf. The severely infected plant shows die-back and decline symptoms with low fruit yield. The virus is transmitted through the infected bud wood.	Use virus free plants for raising the citrus orchard.

3. GUAVA

Guava is an important fruit crop of Punjab and ranks second after kinnow. Guava grows well in almost all the districts of the state. It is highly nutritious fruit and contains vitamin C from 150-200 mg/100 g of pulp. Guava fruit pulp have antioxidant factors and is also known to control the systolic blood pressure.

Climate and Soil

Guava is successfully grown under tropical and sub-tropical climatic conditions owing to its wider adaptability. It is a hardy and prolific bearing fruit plant. It bears twice in a year i.e. during rainy and winter season. However, the areas having distinct winter season are considered best for increasing yield and improving fruit quality. It can also be grown in arid and rainfed areas like Kandi.

Being a hardy fruit crop, it can be grown in poor, alkaline and poorly drained soils. Preferably it should be grown on soils with pH ranging from 6.5 to 7.5, however, it can withstand soil pH upto 8.7. For successful cultivation, the soils for guava should be deep, well drained, friable, sandy loam to clay loam. Guava is a shallow rooted plant, therefore, the surface soil should be rich in mineral nutrients.

Recommended Cultivars

Punjab Apple Guava (2019) : Trees are semi-vigorous with round crown and drooping branches. The fruits are medium in size, round, dark red coloured peel having creamy flesh with medium sized seeds. Fruits have 11.83 % TSS and 0.45 % acidity. For better colour development and high quality fruit production of only winter season crop should be taken. Its average fruit yield is about 100 kg/tree.

Punjab Kiran (2018) : The trees are semi-vigorous with round crown and drooping branches. Fruits medium in size, round to oblong, pink fleshed with small and soft seeds. Fruits have 12.3% TSS and 0.44 % acidity. Its average fruit yield is 100-125 kg/tree.

Punjab Safeda (2018) : The trees are vigorous with spreading branches. Fruits medium to large in size, round with

smooth creamy-white skin, white flesh and firm texture. Fruits have 13.4 % TSS and 0.62% acidity. Its average fruit yield is 125-150 kg/ tree.

- **Guava is rich source of vitamin C and antioxidants.**
- **Punjab Apple Guava fetches higher price due to its attractive colour.**
- **Portogal or L-49 should be used as rootstocks for propagation.**
- **Wedge grafting can be done in the month of February for plant propagation.**
- **High density planting (6 m×5 m) of guava gives more yields per unit area.**

Shweta (2013): It is a selection from the open pollinated seedlings of Apple colour guava. Trees of this variety are semi-vigorous, with round crown and spreading branching habit. The fruits are sub-globose, smooth with creamy white flesh, having TSS 10.5-11.0 % with semi-hard seeds. Average fruit yield is 150 kg per tree.

Punjab Pink (2009) : It is a hybrid between Portugal×L 49=F_1×Apple colour. The trees of this variety are vigorous with drooping branches. The fruit is medium to large in size with attractive golden yellow colour. The flesh is red having pleasant flavour. TSS range from 10.5 to 12.0 per cent. It is a prolific bearer and suitable for processing. Average yield of this cultivar is 150-160 kg per tree.

Arka Amulya (2003) : It is a hybrid of Seedless× Allahabad Sufeda. The trees are some what dwarf with compact, round crown and drooping branches with dense foliage. The fruit is medium, round, glossy with white flesh containing semi-soft seeds. The total soluble solids in fruit range from 9.3 to 10.1 per cent and acidity from 0.25 to 0.34 per cent. The average yield of rainy and winter seasons crop is 140-150 kg per tree.

Sardar (1967) : It is a selection from Allahabad Safeda. This cultivar is also known as L-49. The tree is dwarf with open rounded but flattened crown and spreading branches. The leaves are medium in size with dense foliage. The fruit is large, with rough surface due to ribs on shoulders, having creamy white, smooth juicy flesh with excellent taste and 10-12 percent TSS. In full grown trees, the fruit yield may vary from 125 to 150 kg per tree.

Allahabad Safeda (1967) : The trees of this variety are somewhat dwarf with compact sub-globose, round crown, spreading branches and the leaves are large in size with less dense foliage than Sardar guava The fruit is round and smooth with white flesh having pleasant flavour and 10-12 per cent TSS. In full grown trees, the fruit yield may vary from 120-140 kg per tree.

Propagation

Guava is commercially propagated by improved patch (retaining 2 buds on a patch) budding.

Rootstock Portugal : Portugal rootstock of guava is most suitable for Sardar and Allahabad Sufeda varieties, as it improves fruit yield and weight. It also imparts vigour and wilt tolerance to these scion varieties.

Rootstock Raising: Guava seeds of cv. Sardar or Purtugal are sown on raised seed beds of 2m×1m size in August. The seedlings become ready for transplanting after six months and budding is done when these seedlings attain a diameter of 1.0 to 1.2 cm at about 15 cm height. Sometimes, the guava seedlings show signs of wilting due to damping-off. To control this, drench the seed beds with 0.3% (3g in 1 litre water) Captan.

Budding : The best time for patch budding is May and June when it gives 75-80 per cent success. Freshly cut, angular budwood from current season's growth is used for budding. A semi-circular or a rectangular patch of bark (2.5×1.0 cm) with two buds is removed from the scion stick taking care that the bark does not split. It is then fixed on the exposed portion of the rootstock and tied immediately with the polythene strip leaving both the buds uncovered. The polythene is removed after a week or so when the bud-take has occurred. When the shoots developing from the buds have attained a length of 15-20 cm, retain the vigorously grown shoot and remove the weaker ones.

The guava can also be propagated by wedge grafting in February, on rootstock seedlings 2.5-3.0 cm thick, raised from seeds directly sown in polythene bags. The scion stick should be

defoliated 8-10 days prior to grafting. To maintain humidity, the graft should be immediately covered with white polythene tube (25 cm×6 cm) which should be removed after bud sprouting.

Planting

Guava may be planted in February-March or August-September with earthballs Guava plants can be planted at a spacing of 6m×5m. With this planting plan, 132 plants can be accomodated in one acre.

Training and Pruning

Modified leader system of training is generally followed in guava. The main objective of training guava trees is to provide a strong framework and branches suitable for bearing a heavy remunerative crop without breakage of the branches. The flowers and fruits in guava are borne on current season's growth, hence, a light annual pruning upto 10 cm tip removal may prove useful to encourage new shoots after the harvest. Dead, diseased, intercrossing branches and suckers coming up from the base and sides of the framework should be removed.

- **Avoid rainy season crop by adoption of recommended crop regulation practices. This ensures better winter crop and higher returns.**
- **The old unproductive guava trees can be rejuvenated by heading back at 1.5 m from ground in March, leaving 2-3 primary scaffolds.**
- **Use integrated practices for management of fruit fly. Fix PAU fruit fly traps in the first week of July, to reduce fruit fly incidence in rainy season crop.**

Rejuvenation of Senile Guava Trees

Head back the old unproductive guava trees at 1.5 m from the ground level in the month of March leaving 2-3 primary scaffolds and apply Bordeaux paste on the cut ends. In August-September, thin out the crowded and intermingled shoots and prune 50 percent portion of the newly emerged remaining shoots from the top to develop proper frame work of rejuvenated trees. The rejuvenated trees start giving good yield during third year of rejuvenation.

Manures and Fertilizers

Age of tree (years)	Farmyard manure (kg/tree)	Dose per tree (g)		
		Urea	Super phosphate	Muriate of Potash
1-3	10-20	150-200	500-1500	100-400
4-6	25-40	300-600	1500-2000	600-1000
7-10	40-50	750-1000	2000-2500	1100-1500
Above 10	50	1000	2500	1500

Farmyard manure should be applied in May. Application of 20 kg Paddy straw manure can be used as a subsititue of Farm Yard Manure to full grown guava plants. Half of the inorganic fertilizers should be applied in May-June and the remaining half in September-October.

Fertigation schedule for guava orchards

The fertigation schedule for guava orchards planted at 6mx5m has been recommended. The fertilizer through drip irrigation can be applied from July-September (12 splits) and March-May (12 splits) at weekly interval. With this technology, 20% fertilizers can be saved. It produces higher yield of better quality fruits.

Fertigation schedule for guava plants at 6m×5m spacing

Age of plants (year)	July-September (12 splits)			March-May (12 splits)		
	Doses of fertilizers at weekly interval in equal splits (g/plant)					
1	33	72	40	33	72	40
2	16	145	100	16	145	100
3	-	218	160	-	218	160
4	40	218	240	40	218	240
5	88	256	320	88	256	320
6	132	292	400	132	292	400
7	192	292	440	192	292	440
8	226	328	520	226	328	520
9	248	346	560	248	346	560

Zinc Deficiency: The affected plants having small leaves with yellowing or chlorosis in between the veins. The plant growth

is suppressed and the branches start dieing back. Correct this deficiency by spraying the trees with 1% solution of zinc sulphate (1 kg of zinc sulphate + 1/2 kg of unslaked lime in 100 litres of water). Give 2 or 3 such sprays at fortnightly interval between June to September.

Irrigation

The young guava plants need irrigation at weekly interval during summer months and 2-3 irrigations during winter months. Bearing trees require, irrigation for flowering and better fruit set at an interval of 2-3 weeks during summer months and at monthly intervals during winter months. Heavy irrigation at peak flowering should be avoided as it may cause excessive flower drop.

Drip irrigation schedule for guava orchards : The drip irrigation schedule for guava planted at 6×5 m spacing has been recommended with this technology, 35-40% irrigation of water can be saved by improving fruit yield and quality.

Drip irrigation schedule for guava plants at 6m×5m spacing

	Age of plants (Year)								
Months	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	Irrigation Water (litres/day/plant)								
January	0.5	0.8	2.3	2.8	5.3	5.7	7.0	8.0	8.4
February	0.6	2.3	4.5	5.7	9.6	10.2	11.4	12.5	13.2
March	1.2	3.4	7.5	9.9	15.9	17.0	18.4	19.2	19.8
April	2.4	8.5	16.0	17.9	28.8	30.5	32.5	33.6	34.5
May	3.0	14.9	19.2	23.0	37.5	39.5	41.5	43.4	44.0
June	3.3	13.1	18.6	27.0	47.8	49.2	51.4	52.6	53.0
July	2.4	10.0	11.9	19.7	28.1	30.5	32.4	33.5	33.8
August	1.9	6.9	11.6	14.9	20.6	22.5	24.3	24.8	25.0
September	1.4	7.6	9.7	14.0	18.4	20.2	21.5	22.7	23.0
October	1.3	5.4	8.5	10.8	13.2	13.8	15.0	16.2	16.8
November	0.8	3.0	5.4	4.0	8.8	9.2	10.4	11.1	12.1
December	0.4	2.1	3.3	5.0	5.2	6.0	6.8	7.2	7.8

Intercropping

During initial 3-4 years, the leguminous crops like cowpea, guara, gram, beans etc. should be sown as safe intercrops.

Vegetables like radish, carrot, okra and brinjal can be interplanted in the vacant land.

Weed Control

Light cultivation of the field should be done to manage the different kind of weed flora. Weeds can also be managed with application of paddy straw @4.0 tons per acre as mulch after application of recommended dose of organic manure and inorganic fertilizers in May under the tree canopy. Incorporate the degraded mulch in October in the field, along with the second dose of recommended fertilizers. In addition to management of weeds, the fruit size and yield also increases with paddy straw mulch. In case of attack of white ants, manage it with recommended practices.

Crop Regulation

Guava gives two crops in a year. Winter season crop is superior in quality than rainy season crop, as rainy crop may get infested with fruit flies. In order to get only winter season crop, the following methods may be adopted.

(i) Spray urea 10 per cent or naphthalene acetic acid (NAA) @ of 600 mg/litre during May, when maximum flowers have opened. Each tree needs about 10-12 litres of solution i.e. about 1000 litres per acre. For making this concentration of NAA, dissolve 600g of NAA in 1500-2000 ml alcohol, then make the final volume of 1000 litres.

(ii) Pruning of terminal portions of the shoots upto 20 or 30 cm between 20th to 30th April avoids completely the rainy season crop.

(iii) Withhold irrigation during April-May.

(iv) Apply fertilizers during June to encourage growth in July-August for getting maximum flowering during August-September for winter season crop.

Bagging technique for rainy season fruits

Good quality mature green hard fruits of rainy season guava can be produced by covering with white non-woven bags at the end of June to middle of July. Harvesting the bagged fruits at colour break stage. It also improves the fruit size and quality. On tree,

fruit bagging protect the fruits from fruit fly attack and eliminates the use of pesticides.

Fruit Maturity and Harvesting

Guava fruit is climacteric in nature and should be picked when it is mature but firm. When picked at this stage, it ripens to give excellent taste and flavour. The fruits change their colour from dark green to greenish yellow at maturity. The fruits should not be allowed to over ripe on the trees as they deteriorate in quality and are more liable to be damaged by birds. It is a common practice that farmers retain a few leaves or small branches with the fruit to make it attractive. But this practice rather leads to higher moisture loss from the fruit and may injure the adjoining fruits and aggravate spoilage.

Post-Harvest Handling

Guava is highly perishable fruit and should be marketed immediately after harvest. Harvested fruits are cleaned, graded and packed preferably in CFB cartons of sizes ranging from 4-10 kg. The guava fruits when picked at proper maturity can be kept at room temperature for one week in perforated polythene bags and for three weeks in CFB cartons in commercial cold storage at 0-3.3^{o}C and RH of 85-90%. Guava cv. Shweta can be stored for one week at ambient temperature (15-20^{o}C) and for two weeks in cold storage at 6-8^{o}C and 85-90% RH. Fruits of winter guava cv. Sardar harvested at physiological mature stage can be ripened at 20^{o}C in 72 hrs and these fruit can be kept for 48-72 hours at ambient conditions in winter. Squash, nectar and leather can be prepared from Punjab Kiran and Punjab Pink, coloured guava varieties.

Plant Protection Measures

A. Insect Pests

Pests and symptoms of attack	Control
1. Fruit flies (*Bactrocera dorsalis and Bactrocera zonata*): They are the most common and serious pests of guava. Being polyphagous, they damage and multiply profusely on various fruit crops. The fruit fly lay the eggs at colour break stage of fruits in the soft epicarp.	(i) Cover the rainy season mature green guava fruit on tree with white non-woven bags at the end of June to middle of July.

On hatching, the maggots bore further into fruits and feed on soft pulp. The infested fruits show depressions with dark green punctures and when cut open the wriggling white maggots are seen inside. The infested fruits rot and fall down. Pupation takes place in the soil under trees. Isolated orchards are less infested by the fruit flies.	(ii) Avoid taking rainy season crop only in orchards with history of severe fruit fly infestations. (iii) Harvest the ripening fruits and do not allow the ripe fruits on the tree. (iv) Regular removal of fallen fruits from the ground and bury the infested fruits atleast at 60 cm depth. (v) Shallow ploughing with cultivator immediately after harvest is effective in exposing and killing the pupating larvae/pupae which are mostly present at 4-6 cm depth. (vi) Fix PAU fruit fly traps @16 traps/acre in the first week of July and recharge the same if required.
2. Guava shoot borer (*Microcolona technographa*): It is serious under nursery conditions. It damages the tender shoots of nursery plants of guava. Side sprouting of the vegetative buds just below the larval gallery impairs the quality of the seedlings as the buds below the damaged portion produce lateral shoots and plants give bushy look. Secondly, infested shoots dry up which can be located from a distance by the presence of fine black frass on the leaves/shoot parts beneath the site of infestation.	---
3. Mealybugs : *Ferrisia virgata, Planococcus lilacinus and Nipaecoccus viridis* cause damage to guava trees. *Ferrisia virgata* is active in orchards during June-October, while other species cause damage during July-October. *Ferrisia virgata* is the major species as compared to other mealybugs. The nymphs of these mealybugs suck cell sap from the different parts of the plant like leaves, tender shoots, twigs, branches and fruits. Heavy infestation encourages the growth of sooty mould due to which the trees become black in colour. All these mealybugs hibernate on the twigs, branches and shoots of trees.	Same as under citrus

B. Diseases

Disease and symptoms	Control
1. Wilt (*Fusarium* sp., *Cephalosporium* sp. *Rhizoctonia* sp.): Symptoms appear on the infected trees many months after their roots are attacked by the fungi. Sparse foliage, denuded branches, yellowing of leaves and wilting are the important symptoms. In the root, the cambium in between the bark and the wood, shows discoloration. Replanted trees bear fruit for a number of years before ultimately wilting due to the disease.	(i) Use Sardar or Purtugal seedlings as a rootstock for budding plants. (ii) Plant guava in a well drained field. Avoid too heavy soils. (iii) Uproot and burn the wilted trees alongwith all the roots. (iv) Drench the soil in the pit with 2 per cent Formalin solution and cover with *Sarkanda* and old wetted gunny bags. Expose the soil for 14 days and replant healthy guava plants.
2. Fruit rot/Anthracnose or Die-back (*Gloeosporium psidii* and *Phytophthora parasitica; Rhizopus* sp., *Aspergillus* sp.) : Fully mature fruits are more prone to attack of the fungus. Circular, slightly sunken, brown spots with definite margins appear on the fruits. The centre of a lesion has a pink sticky spore-mass, characteristic of the anthracnose disease. Fruits rot completely within 2 to 3 days. The fungus also atttacks young trees, twigs and branches during the rainy season resulting in the die back of the shoot from the distal end.	(i) Rain or irrigation water should not be allowed to stand in the basin around the tree. (ii) After pruning, spray the trees with Bordeaux mixture (2:2::250) or 300 gm Blitox in 100 litres of water. (iii) The rotten and mumified fruits which fall on the ground should be burried deep into the soil. (iv) Avoid bruising of the fruits.

4. MANGO

The Mango is the choicest fruit of most of the people in India and; fruit contains 0.6% protein, carbohydrates (11.8%), minerals like calcium, phosphorus & iron (0.3%) and rich source of vitamin A (4800 units) B_1 & B_2 90mg and vitamin C 13 mg per 100g of pulp. The fruit is consumed at all its developmental stages.

Climate and Soil

Mango can be grown in a wide variety of soils provided the soil is deep without any hard pan or compact *Kankar* in atleast top 6 feet soil. The electrical conductivity of the soil should be less than 1.0 mmhos. whereas calcium carbonate and lime concretion should be less than 10 and 20 per cent, respectively. Soil should have a pH less than 8.5 upto the depth of 60 cm and the water table should be below 3 metres.

Mango is essentially a tropical crop and the ideal temperature for mango cultivation is 24–27°C during the growing season alongwith high humidity. Young trees and actively growing shoots get killed at temperature falling below –1°C and small developing fruits are damaged if the temperature suddenly falls below 4.5°C.

Rainfall during flowering adversely affects final fruit set. Winds may also cause great damage to the crop by way of fruit drop, breakage of limbs or even uprooting of the plants. High velocity winds also affect the process of pollination. Hot summer wind (*loo*) damages the fruit by causing severe fruit drop.

Recommended Cultivars

Alphonso (2000) : Fruit matures in the first week of July. Fruit medium in size, oval with prominent ventral shoulder, fruit colour greenish light yellow with light pinkish blush towards the proximal end, skin thin and smooth, flesh cadmium yellow and firm, fibreless, superb taste, captivating flavour, juice abundant, TSS 17.5%, acidity 0.35% and stone is small. Average fruit yield is 70 kg per tree.

Dusehri (1967) : Fruits mature in the first week of July. Fruits are small to medium, skin medium-thick, smooth and yellow;

flesh firm, fibreless, pleasantly sweet, acidity 0.2%, stone small and thin; keeping quality good. Average fruit yield is 150 kg per tree.

Langra (1967) : Fruit maturity occurs in the second week of July. Fruit medium to large, skin medium thick, smooth, green, flesh fibreless, lemon yellow, fine taste and flavour with TSS 15.7%, acidity 0.3%, stone medium in thickness. Average fruit yield is 100 kg per tree.

Sucking Mangoes

Out of collections made from a survey undertaken in and outside Punjab, the following collections were considered ideal and recommended for cultivation.

Gangian Sandhuri (GN-19) (2006) : Fruit matures in end of July. Fruit large, ovate oblong, peel thick, tough, *Sindhuri* blush at shoulders with yellow base, pulp orange in colour, very good taste with pleasant flavour, juice abundant, stone and fibre. Average fruit yield is 83.7 kg per tree.

GN_1 (1981) : Its trees bear regularly and yield a medium crop. Fruits mature in the second week of July. Fruit is medium in size, ovate, basal sinus shallow, beak and apex pointed. Peel smooth, green at maturity, pulp orange colour, juice thin but abundant with TSS 19%, stone small and fibre absent.

GN_2 (1981) : Fruit matures in the third week of July. Fruits medium to large in size, oval-oblong, skin thick, pulp yellow, TSS 25%, stone small and fibrous all over.

GN_3 (1981) : Fruit matures in the second week of July. Fruits medium in size, ovate, peel thick, surface smooth, spinach green with sparce glands. Pulp yellow, juice abudant, TSS 22%, stone medium in size.

GN_4 (1981) : Fruits mature in the third week of July. Fruit extra large, ovate oblong. Peel yellowish green with sparse glands. Juice abundant, slightly thick with 21% TSS, stone large and sparsely fibrous.

GN_5 (1981) : Fruit matures late in the season. Fruit medium in size, ovate, peel thick and smooth. Juice slightly thick, TSS 22%. Stone medium in size, fibre absent.

GN_6 (1981) : Fruit matures in mid July. Fruit large, peel colour yellow with red blush at the basal end. Popularly known as Punjab Beauty. Pulp yellow, juice abundant with pleasant flavour, TSS 17%. Stone medium, oblong and fibrous all over.

GN_7 (1981) : Fruit maturity occurs in the middle of July. Fruit medium in size, peel smooth with numerous glands, pulp orange in colour, juice plenty and tasty, stone large in size and fibrous all over the stone.

Propagation

Although there are several methods of propagation but side grafting has been found to be more efficient and cheaper than inarching under Punjab conditions.

Rootstock Raising: Stones of selected healthy seedling mango trees are sown in August. Germination takes place in 2-3 weeks depending upon the medium. These seedlings alongwith stones are transplanted to the nursery beds when their leaves are still brown in colour and expanded to one fourth of their normal size. During transplanting their tap roots be pruned suitably retaining most of the fibrous roots. The seed beds are regularly watered so that no transplanted stone dies till properly established. The seedlings need to be protected from frost during the cold months. Seedlings resume growth in the end of February or the beginning of March and become graftable from March onwards.

Grafting : For grafting select healthy scion shoots with plump, terminal buds from the last mature flush. Reject scion shoots with swollen, protruded auxillary buds as they are known to produce malformed plants. Remove the leaf blades from the selected scion shoots leaving the petioles intact. In about 7-10 days the petioles drop and the terminal buds become swollen and ready for grafting. One horizontal cut (1.25 cm) and two vertical cuts (4.0 cm each) are made on the stock at a height of about 15 cm from the ground and the bark of the demarcated portion is lifted away from the rootstock. An appropriate slanting cut is also made on the base of the scion stick to expose cambium. The length of the scion stick should not be more than 7.5 cm otherwise considerable breakage of the grafted plants in the nursery occurs. The prepared scion stick is inserted under the bark flap of the rootstock. The bark flap of the rootstock is restored in its position and the graft joint is tied

securely with a polythene strip of 150-200 gauge thickness. After the completion of grafting a part of the top of rootstock is lopped to encourage growth of the scion. In Punjab, July to September is the best time for mango propagation.

Mango can also be propagated through wedge grafting from end-July to end-August on rootstocks on the same or higher thickness than scion stick under open field and protected conditions. Select 3 to 4 months old healthy scion sticks and defoliated it nearly 7-10 days prior to grafting. Rootstock should be cut off just above the active growing point by retaining 3-4 leaves and make a 3-4 cm deep cut on the top of the rootstock. Prepare wedge shape cut on the bottom of scion stick, so that it can fit properly in the cut made on the rootstock. Insert scion stick into the cut portion of the rootstock and wrap the graft union firmly with plastic strip. Remove the new sprouts emerging below the graft union, regularly.

Planting

Mango being an evergreen fruit plant can be planted during February-March and August-September in the pits (1×1×1 m) prepared about a month earlier. The best planting time is August-September when the weather relatively cools down.

The planting is done at 9×9 metre distance for the grafted varieties and 10×10 metres for the sucking type mangoes in the square system. However, planting can also be done according to Hexagonal system as this system accommodates 15 per cent more plants per unit area.

Training and Pruning

Mango hardly needs any training or pruning. Normally, a young graft is allowed to grow unhampered for 3-4 years. The main scaffold branches should be selected on the grafted plants in such a way that these are spaced 20-25 cm apart on the main stem. No further training is required for giving a proper shape to the plant. Branches crossing in the centre should be removed and there should be no branch too close to the ground.

Rejuvenation of Senile Mango Trees

After attaining the age of about 30 years, mango trees produce less fruits of inferior quality. The production potential of such

trees can be revived by rejuvenation. Trees should be headed back at the height of 2 m from the crotch angle (approximately at 3.0 m from the ground level) in first week of January by retaining about four to five outward growing branches and rest should be thinned out. Apply Bordeaux paste on the cut ends and exposed branches should be white washed. The new shoots will emerge around the headed limbs. In June, retain 3-4 healthy outward growing shoots oriented at the proper distance on each stub. Trees will start bearing fruits after three years of rejuvenation.

- **Mango is rich source of vitamin A, B_1 & B_2 and vitamin C**
- **Side grafting is best method for propagation in Mango.**
- **The productive potential of old mango trees can be revived by head backing at 3 meters from ground level in first week of January.**
- **Intercropping of vegetables like onion, tomato, radish, cauliflower, cabbage, leafy vegetables and leguminous crops like moong, mash, gram and lentil are recommended during pre-bearing period to get good returns.**

Note: Proper monitoring and management practices to control the attack of stem and shoot borer should be followed. Remove the pruned wood immediately from the orchard.

Manures and Fertilizers

The following fertilizer schedule is recommended for 'off' year.

Dose per tree (g)				
Age of Tree (Years)	**FYM (kg/tree)**	**Urea**	**Superphosphate**	**Muriate of Potash**
1-3	5-20	100-200	250-500	175-350
4-6	25-50	200-400	500-750	350-700
7-9	60-90	400-500	750-1000	700-1000
10 and above	100	500	1000	1000

During the 'on' year apply half kg additional urea in June. Apply the whole of FYM and the phosphatic fertilizer in December and N and K in February. It is advisable to use CAN @ 1.00 kg instead of urea, as the use of urea induces soft nose disorder in mango fruits. It is a case of ammonium induced calcium deficiency leading to this disorder.

Irrigation

Frequency of irrigation to mango orchards depends upon the type of soil, climatic conditions especially the rainfall and its distribution and the age of the tree. Generally, the young plants with shallow root system require frequent irrigation during the dry period. However, bearing trees usually require irrigation during fruit development period between April to end June at an interval of 10-12 days depending upon the evapotranspiration. One irrigation should be given at the time of addition of fertilizers in the month of February. No irrigation should be given for a period of 2-3 months during October-December.

Intercropping/Interplanting

Mango tree has a juvenile period of 3-7 years depending upon the variety.Therefore the vacant space between the trees can be profitably utilized by growing intercrops. Intercrops also reduce weed growth and nutrient losses through leaching and surface run off, besides, giving good returns. Vegetables like Onion, Tomato, Radish, Beans, Cauliflower, Cabbage, Leafy vegetables and Leguminous crops like *Moong*, *Mash, Gram* and *Lentil* can be grown. Crops like Maize, Sugarcane and *Bajra* should not be grown.

- **Spray 2,4-D in last week of April or first week of May to control fruit drop.**
- **Remove the malformed shoots and spray NAA in October for the management of mango malformation disease.**
- **For mango mealy bug control, use slippery bands at the base of trunk in mid- December.**
- **The physiological mature fruits can be ripened by dipping in ethephon solution.**

Papaya, Peach and Plum can be grown as fillers in Mango orchards till the bearing starts. Separate arrangements for manures, fertilizers, irrigation and interculture should be made for the interplants and intercrops.

Fruit Drop and its Control

A spray of 10 g sodium salt 2,4-D in 500 litres of water in the last week of April or in the first week of May controls the preharvest fruit drop in Dusehri and Langra cultivars. 2,4-D should be dissolved in a small quantity of alcohol or spirit and then the

required volume of water be added. It must be ensured that the spray pump is washed throughly with washing soda before and after the spray. **Do not repeat the spray of the 2,4-D solution.**

Fruit Maturity and Harvesting

Tapka, the natural fall of mature fruit is considered to be the first indication of fruit maturity in Mango. It usually takes 15-16 weeks after fruit set. In case of coloured varieties change in the skin colour is also indicative of the fruit maturity. The maturity of Mango fruit is also indicated when specific gravity is around 1.0.

The harvesting should be done individually with the help of a ladder or a bamboo attached sharp knife and a net for collecting the harvested fruits. In no case the fruit should be allowed to drop on the ground as it damages the post-harvest life and cause rotting of the fruit.

Fully mature but still hard green fruits should be picked individually with the help of a picker attached at the end of a long bamboo stick. The harvested fruits be sorted and graded for size and maturity before being packed in the boxes.

Post-harvest Handling

The harvested fruits must be placed on a polynet upside down so that the milky ooz flows out and does not stick to the fruit. The fruit is then washed in warm water at 45-50^{o}C and dried.

The fruit is graded according to the size ; Grade A : 200-350 g., Grade B : 351-550g and Grade C:551-800g. and should be waxed with paraffin emulsion or StaFresh. The fruit after this treatment is then cold stored at a temperature of 7-9^{o}C with relative humidity of 85-90% in two to three layers in the cardboard boxes of the size of 45×25×25 cm of five ply for 35-45 days which are used for packing the fruit.

The fruits of 'Alphonso' harvested in the last week of June or first week of July can be ripened after 4 days by dipping in 600 ppm ethephon (1.5 ml/litre water) solution for 4 minutes and packing in wooden boxes lined and covered with newspaper.

The physiological mature fruits of mango cvs Dusehri and Langra packed in CFB boxes with paper lining can be ripened at 25^{o}C in 5 and 4 days after harvesting, respectively. The fruits should

be washed in chlorinated water 0.01% (sodium hypochloride 4% @ 2.5 ml/litre) and dried under shade before packing in CFB boxes.

Plant Protection Measures

A. Insect Pests

Pests and symptoms of attack	Control
1. Mango mealybug (*Drosicha mangiferae***) :** Both nymphs and female bugs cause lot of damage by sucking the cell sap from inflorescence, panicles, tender leaves, shoots and fruit pedicle from January to April. The affected panicles shrivel and get dried. Infested plants are covered with sooty mould. First instar nymphs after hatching from eggs in soil migrate and crawl up the mango trees and congregate on the growing shoots and panicles. Fertilized female bugs start migrating to soil when temperature starts rising. They hide in cracks and crevices and lay eggs in ovisacs. There are three nymphal instars in the soil.	(i) Dig or plough around mango trees during summer to kill the eggs. (ii) Nymphs should be prevented from crawling up the trunk by applying a slippery band at the base by mid December which consists of 15-20 cm wide alkathene sheet. It is applied to the basal end of the stem and secure both its upper and lower edges with 1-3 nails (2 cm). It is desirable to cover the lower end with compacted soil around the lower edge of the alkalthene sheet so that nymphs are prevented from climbing up from under the slippery band. Occasional wiping of the band during rains is also desirable.
2. Mango hoppers (*Amritodus atkinsoni* and *Idioscopus* sp.)**:** Mango hoppers are very active during February-March at the time of flowering. Enormous number of nymphs and adults are found clustering on the tender leaves and inflorescence and suck the cell sap. The infested flowers become sticky and sooty, shrivel, turn brown and ultimately fall off as the summer winds blow. The hoppers love damp and shady places during summer and their population is high in the old neglected and dense orchards.	(i) In case of old dense orchards, prune some of the branches during winter to have better light interception. (ii) Do not go for high density planting. (iii) **Spray two times**, one in the end of February and second in the end of March with 800 ml Malathion 50 EC in 500 litres of water.
3. Mango scales : Scale sometimes appears as a serious pest in certain localities. It inflicts damage by sucking the cell sap from leaves.	---

4.Stem borer(*Batocera rufomaculata*): Stem borer sometimes destroy the trees by tunnelling into the stem. On hatching, the grubs make zig-zag burrows beneath the bark and tunnel into the trunks or main stems, moving upward, feeding on the internal tissues. When the grubs reach sapwood, the stems die and wither away. Normally, the attack goes unnoticed till a branch or leaves start drying up. Sometimes sap and masses of frass are seen exuding from bored holes.	Kill the grubs by inserting iron wire into the hole created by the grub.
5. Mango shoot borer *(Chlumetia transversa)* : Eggs are laid on tender leaves. Freshly hatched caterpillars bore into mid-ribs of tender leaves and come out after a couple of days to bore into tender shoots near the growing point, tunnelling downwards and throwing their excreta out of entrance hole. When full grown, these caterpillars come out and enter into the slits and cracks in the bark of the tree, dried malformed inflorescences or cracks and crevices in the soil, for pupation. Leaves of affected shoots wither and droop down. Young grafted seedlings are severely affected and may even get killed. Young caterpillars are yellowish orange in colour with characteristics dark brown prothoracic shield. Full grown caterpillars are dark pink, with dirty spots.	---
6. Fruit flies (*Bactrocera dorsalis* and *Bactrocera zonata*) are polyphagous fruit fly pests of fruit crops. The female adult fruit fly punctures the ripening mango fruit by penetrating its needle like ovipositor and lays the eggs inside. On hatching, the maggots feed on pulp. Sticky fluid oozes out of punctures. Brown patch appear around the place of oviposition and the infested fruit start rotting. These affected fruits drop prematurely. Activity of the fruit flies on mango fruits is during last week of May to last week of July.	Fix PAU fruit fly trap @ 16 per acre in the 3rd week of May. Recharge the trap after 30 days, if needed.

B. Diseases

Disease and symptoms	Control
1. Mango malformation: Its cause could be environmental factors, mites, virus and/or fungus, *Fusarium moniliforme.* On seedlings that are over three months old, swelling appears in the axis of leaves. Small clustered leafy shoots are produced at the apex on the main shoots or laterals. In the case of bearing trees, the panicles are affected. The peduncles become thickened and fleshy with heavy numerous branches. Profuse development of numerous small leafy structure occurs in place of flowers, resulting in a "witch's broom" appearance; i.e. all the floral structures are crowded in the form of a broom. Fertile flowers are rare. The whole mass turns greyish brown and then black. Witch's broom is also formed in young and even nursery plants. A few or all the inflorescences produced by a tree may be malformed.	(i) Remove the affected shoots every month and destroy them. (ii) Spray Naphthalene Acetic Acid (NAA) in October. Dissolve 100 g NAA in 100-150 ml alcohol and make the volume upto 500 litres.
2. Powdery mildew (*Microsphaera mangiferae*) : A whitish powdery growth appears on the inflorescence and the floral axis. The infected floral parts show necrotic streaks and eventually drop. Small fruits, branchlets and the floral axis show die back symptoms and may eventually drop leaving the main axis naked.	Spray 500 ml Contaf 5 EC (hexaconazole) or 500 ml Karathane or 1.25 kg Wettable sulphur in 500 litres of water before flowering, during flowering and after fruit set. If needed, give one more spray after 10-15 days.
3. Anthracnose and Twig die-back (*Colletotrichum gloeosporioides*): It causes dark brown to brownish black spots on shoots wither owing to infection on the bark. Fruit may also show small, raised, dark brown or black areas. Twig dieback appear as minute, light brown spots on large and green twigs.	Prune the shoots showing spots of canker, anthracnose and dead branches. Immediately after pruning, apply the disinfectant solution to the cut ends followed by Bordeaux paint. Thereafter, spray with Bordeaux mixture (2:2:250).

These spots enlarge and cover more than half of the leaf surface. The inner margins of the lesions is dark brown. The severely affected twigs dieback. Dark brown lesions appear on young and ripening fruits followed by rotting.	
4. Stem canker : (*Schizophyllum commune*) : It causes discoloration and drying of foliage of one or more branches and exudation of gum from the affected bark. Branches may be killed in due course. Small shell like dirty white fruiting bodies of the fungus, with gills in the lower side, appear in rows on the dead main branches.	Spray Bordeaux mixture (2:2:250) or 1.5 kg Copper oxychloride in 500 litres of water at fortnightly intervals.
5. Black tip: It is associated with toxic gases from brick-kilns *chimneys*; fruits become abnormally long at the tips, causing pre-mature ripening. Black tip may cover half of the fruit.	Spray three times with Borax (6 g/litre of water) before flowering, during flowering and along with Bordeaux mixture (2:2:250) or 1.5 kg of Copper oxychloride in 500 litres of water after fruit set.

5. PEAR

Pear is one of the important fruit crops of temperate regions. Its fruits are rich source of protein (0.69 g), vitamins (vitamin A 0.06 mg, vitamin B 0.03 mg) and minerals like calcium (8mg), phosphorus (15mg) and iron (0.5mg) per 100g of pulp. *Patharnakh* fruits are well known for their keeping quality and ability to withstand transportation.

Climate and Soil

The sub-tropical pears which are recommended for cultivation in Punjab require 200 to 300 chilling hours. The soft pear cultivars grown in higher hills of Himachal Pradesh and Jammu and Kashmir require 900 to 1000 chilling hours which are not available under the sub-tropical conditions of Northern India. For this reason these are not cultivated in these areas.

Pear can be grown successfully on a variety of soils from sandy loam to clay loam provided it is deep, well drained, fertile, without the presence of hard pans of any type in the top 2 metres and does not have a pH value more than 8.7. The electrical conductivity should be less than 1.5 mmhos/cm, calcium carbonate less than 10% and lime concretion less than 20%. In high pH soils deficiencies of iron and zinc always pose a problem.

- **Pear fruit contains protein, vitamins A, B and minerals like calcium, phosphorus and iron which are good for health.**
- **Patharnakh is suitable variety for storage and long transportation.**
- **Nijisseiki is suitable for processing, where as Punjab Soft is very juicy and soft variety.**

Recommended Cultivars

Hard Pear

Punjab Nakh (2008) : It is a selection from Patharnakh. Tree spreading and vigorous. Fruit weight 155 g, ovate, light yellowish green with prominent dots. The flesh is gritty, crisp and juicy. Keeping quality good. Fruits mature in fourth week of July. The average yield is 190 kg per plant.

Patharnakh (1967) : Tree spreading and vigorous, fruit medium, round, green with prominent dots. Flesh gritty, crisp and juicy. Keeping quality good, stands transportation well. Matures in the last week of July. Average yield is 150 kg per tree.

Semi Soft Pear

Punjab Gold (2004): Tree upright and medium in vigour. Fruit large with average weight of 166g ground colour golden yellow, white fleshed. Total soluble solids 13.3 per cent with acidity 0.22 per cent. Mature fruit less gritty, mellow when ripe. Matures in end of July. Yield 80 kg per tree. Suitable for processing and table purposes.

Punjab Nectar (2004): Tree upright and medium in vigour, precocious, fruit medium to large, ground colour yellow green, white fleshed, average fruit weight 138g. Total soluble solids 13.6 per cent, acidity 0.21 per cent, mature fruits less gritty, mellow when ripe and very juicy. Fruit matures in fourth week of July. The average yield is 80 kg per tree. Suitable for table and processing purposes.

Punjab Beauty (1999) : The trees are upright, medium in vigour and regular in bearing. The fruit is medium,yellow with red blush. Total soluble solids 14.0 per cent with acidity 0.3 per cent. Fruits mature in third week of July. The average yield is 80 kg per plant.

Baggugosha (1967) : Tree upright and vigorous, fruit greenish yellow, stem end tapering. Flesh white or cream-coloured, sweet, somewhat gritty. Matures in the first week of August and stands transportation well. Average yield is 60 kg per tree.

Soft Pear

Nijisseiki (2010) : Tree spreading, medium in vigour, leaf colour green, fruit size medium, ground colour golden brown, flesh whitish. TSS 12.9%, acidity 0.21%, mature fruits very soft, fruit firmness (11.17 lbf), very juicy (74.6% juice), matures in end June to first week of July, fruit ripen on tree, yields 80.2 kg per tree. Suitable for processing like RTS, nectar and squash. Fruits have good storage potential and can be stored for 4 weeks at 0-1^0 C and 90-95% RH.

Punjab Soft (2007) : Tree upright, spreading and medium in vigour. The fruit is medium, ground colour yellow green. The

flesh is white and mature fruit is soft and very juicy. Total soluble solids 11.3 per cent with acidity 0.135 per cent. Matures in first week of July. The average yield is 85 kg per plant. It is suitable for processing.

Propagation

Pear can be propagated on Kainth (*Pyrus pashia*) rootstock.It reduces precocity and does not produce rootsuckers.

Collection of Kainth (*Pyrus pashia*) Seed: Fully mature fruits of *Kainth* are collected from end of September to first week of October. Seeds extracted from the softened fruits are stratified for promoting germination during December by placing them in alternate layers of moist sand in wooden boxes for a period of 30 days. The stratified seeds are sown in nursery beds in January. The seeds start germinating within 10 days. One month old seedlings are planted in nursery at a distance of 10×60 cm. These seedlings become graftable in January next year.

Raising of Kainth rootstock without stratification : The seeds extracted from mature fruits in last week of September or first week of October can be sown directly. Freshly extracted seeds should be placed in moist sand in wooden boxes for germination. The seeds germinate in 10-12 days. These seedlings are planted in the field in lines at 10 cm apart leaving 60 cm space after every four lines at 2 to 4 leaves stage. These seedlings become buddable in May-June or can be grafted in December-January.

Budding/Grafting : The pear is T-budded or tongue grafted on *Kainth* seedling. Tongue grafting is done in December January.

Planting

The planting of pear is done in winter while plants are still dormant. Planting may preferably be completed within January. Generally one year old plants are used but 2 to 3 years old nursery trained plants can also be planted.

Closer planting

The pear cv. Patharnakh can be planted at 8 m×4 m distance and the trees are trained by bending of main scaffolds and two secondaries. This also helps in reducing juvenility by two years.

Training and Pruning

Training at planting time : To develop a strong scaffold

system pear trees should be trained according to modified leader system. The plants should be headed back at a height of 90 cm at the time of planting. The buds start sprouting in February-March. No branch should be allowed to develop up to the height of 45 cm from the ground level.

Training in Second Year : The top most shoot in the centre is kept as the leader but it is cut back where immature portion starts. Three to five laterals which are properly spaced at a distance of 15 to 20 cm from each other in different directions should be selected. It is advantageous if these laterals are bent downward by tying with rope or thick thread to the ground. The tying of these laterals will encourage the development of secondaries.

Training in Third year : The laterals left at the end of second season's growth should be headed back to encourage the sprouting of buds to develop tertiary branches.

Training in Fourth and Fifth year : The unwanted secondary/ tertiary branches should be removed. The leader should be cut back to a well placed, out growing lateral.

Pruning : The pear trees bear on spurs which remain productive for about 8 years. Therefore, pear trees do not need pruning every year. In case of old and bearing trees, pruning of dead wood and old non-bearing spurs should be done during January. Thinning out and heading back of laterals may also be done to encourage the formation of more fruiting spurs.

The Patharnakh pear trees should be pruned at the height of 2.5m for better quality and fruit production. For this closer spacing of

- **Use Kainth as rootstock for pear propagation.**
- **For more profit, Patharnakh can be planted at 8m×4 m distance under high density planting.**
- **Complete planting of Pear within January when plants are still dormant for better establishment.**
- **The production of old trees can be restored by heading back of 3 to 4 main scaffolds about 15 cm in December to January.**
- **Three foliar sprays of potassium nitrate @ 1.5 % at 15, 30, 45 days after full bloom improve the yield and fruit size of Patharnakh and semi-soft pear.**

4m×4m is recommended. Bordeaux paste should be applied after pruning of plants.

Rejuvenation of Old Pear Orchards

Pear trees tend to become less productive when they become very old. Production on such trees can be restored by rejuvenating them. It can be achieved by heading back 3 to 4 main scaffolds to about 15 cm during December-January. The rest scaffolds should be completely removed. Paint the cut ends with Bordeaux paint. Mainy sprouts shall emerge on these stubs in March. In May, retain only one to two out going-shoots on each stub with a total of 6 to 8 shoots per tree. Rejuvenated trees start fruiting in third year and bear commercial crop in the fifth year.

Weed Control

Light cultivation of the field should be done to manage the different kinds of weed flora. In pear orchards, 10 cm thick layer of paddy straw mulch (5.5 ton/acre) can be applied during second week of April mulching under the canopies of trees to supress weeds.

Manures and Fertilizers

Age of tree (years)	Farmyard manure (kg/tree)	Dose per tree* (g)		
		Urea	Superphosphate	Muriate of Potash
1-3	10-20	100-300	200-600	150-450
4-6	25-35	400-600	800-1200	600-900
7-9	40-50	700-900	1400-1800	1050-1350
10 and above	50	1000	2000	1500

* These nutrients can also be supplied from other fertilizers available in the market. Apply supplemental dose of Urea @ 500g to the full grown plants of Punjab Beauty in the month of September in addition to recommended fertilizer doses to get higher yield and fruit size.

Note: All the farmyard manure, superphosphate and muriate of potash should be added in December. Half of urea should be added in early February before flowering and the other half in April after the fruit set.

Zinc deficiency : It appears on younger leaves as difuse interveinal chlorosis, reduction in leaf size and tendency of the

leaf edges to curl upward. To correct its deficiency, spray the plants with 3 kg zinc sulphate + 1.5 kg unslaked lime in 500 litres of water.

Iron deficiency : Iron deficiency appears on apical leaves which develop characteristic symptoms of dark green veins on a pale green background. Its deficiency may be corrected by spraying 0.3 per cent ferous sulphate (300g in 100 litres of water).

Irrigation

Pear trees need frequent irrigation after transplanting. The interval of irrigation may be 5 to 7 days during summer months and 15 days in July-August. Irrigation should be restricted after fruit harvest. No irrigation should be given in the month of January. Bearing trees should be irrigated through flood method during summer months at an interval of 5 to 7 days so that fruit size may be increased.

Intercropping

Intercrops like moong and mash can be grown during kharif while peas, gram and senji may be grown during rabi season in young and rejuvenated pear orchards to get some income during the non-bearing period. Additional dose of fertilizers should be given for intercrops. Berseem should not be grown as intercrop in pear because of its higher demand for irrigation during winter when the pear plants are in dormant condition and do not require any irrigation.

Crop Regulation

Pear tree tend to overbear, resulting in smaller fruits. To avoid this, one fruit per cluster may be retained after thinning. This operation should be performed soon after the occurrence of the natural fruit drop in the middle of April.

To improve the fruit size and increase the yield in Patharnakh and semi soft pear, three foliar sprays of potassium nitrate@ 1.5% (15 g per litre of water) at 15,30 and 45 days after full bloom should be applied.

Fruit Maturity and Harvesting

Harvesting of fruits should be done at proper stage of maturity. The fruits of Patharnakh mature 145 days after fruit set whereas

fruits of Baggugosha and Punjab Beauty take 135 days and Punjab Nectar and Punjab Gold take 140 days to reach maturity. The fruits should be picked by giving an upward twist to the fruit so that the spurs are not damaged.

Post-harvest Management and Processing

Handling : The fruit should be harvested at proper maturity. The bruised and damaged fruits should be sorted-out and only graded and healthy fruits be packed in corrugated fibre board (CFB) boxes for ripening, storage and marketing.

Ripening : For improving ripening and eating quality of pear varieties, Punjab Beauty fruits should be chilled at 0°C and ripened at 20°C for 3 days, while that of Patharnakh fruits should be chilled for 3 days at 0°C and ripen at 20°C for 4 days.

For proper ripening and improving quality of pear, fruits should be treated with 1000 ppm Ethephon (2.5 ml/litre of water) for three to four minutes or exposed to 100 ppm ethylene gas for 24 hrs and stored at 20^0C. The Patharnakh fruits would be ready in 8 days while Punjab Beauty takes 4 days to ripen.

Storage : Fruits of Patharnakh, Punjab Nakh and Punjab Beauty can be stored for 60 days at 0-1°C with RH of 90-95%. After storage, fruits of Punjab Beauty have post-harvest life of 1-2 days at room temperature and 4 days in refrigerator, while, Patharnakh fruits have post-harvest life of 2 days at room temperature and 4-6 days in refrigerator. Similarly fruits of Punjab Soft can be stored at 0-1°C and 90-95% RH for 2 months after dipping in 2.0% calcium chloride solution for 5 minutes.

Fruits of Punjab Soft can be stored at 0-1^0C with RH of 90-95% for 4 weeks with dipping of fruits in 2% calcium chloride solution for 5 minutes, the storage period can be extended to 60 days at similar conditions. Similarly, the fruits of Punjab Nakh can be cold stored for 60 days at 0-1^0C with RH of 90-95%.

Processing : For value addition, the fruits of Punjab Nectar, Punjab Soft and Punjab Gold are suitable for the preparation of Ready to Serve (RTS), Nectar and Shelf Stable Squash products.

Plant Protection Measures

A. Insect Pests

Pests and symptoms of attack	Control
1. Hairy caterpillar (*Euproctis* sp.) are sporadic pests. Females lay eggs in clusters on ventral surface of leaves covered with yellow hair. On hatching, the young caterpillars feed gregariously on leaf lamina, skeletonzing the same completely. Later, the caterpillars segregate and gnaw the leaves. In case of severe infestation, the entire tree may be defoliated. Young caterpillars have whitish hair, while full grown caterpillars have red head, darkish brown body with white hair on the head and a tuft of long hair at anal end. Adults are yellow moths with pale lines on forewings.	---
2. Spider mites (*Eutetranychus orientalis* and *Tetranychus urticae*) attack during April-June. Initially yellowish-white specks appear on the leaves followed by leaf scorching and premature leaf fall. Infested leaves gather dust.	(i) Frequent irrigations during April-June. (ii) Removal of Castor and *Bhang*, as they act as alternate sources of mites.
3. Leaf-hoppers : Sometimes cause serious damage to the plants by sucking the cell-sap from the leaves and tender fruits.	---.
4. Bark eating caterpillar (*Indarbela quadrinotata*) : This pest causes damage by boring holes into the stem and branches and feeds on the bark under the cover of its excreta. The pest is active in neglected orchards.	Remove webbing and apply Kerosene oil into the holes during September-October and again in January-February. Treat all the alternate host plants in the vicinity.
5. Fruit flies (*Bactrocera dorsalis* and *Bactrocera zonata*) They are serious pests of pear fruits. Fruits nearing maturity are punctured by the fruit flies for egg laying and the maggots after hatching bore into the fruits thus render the fruits unfit for consumption. Isolated orchands are less infested by fruit flies.	(i) Harvest the ripening fruits and do not allow the ripe fruits on the tree. (ii) Regular removal of fallen fruits from the ground and bury the infested fruits atleast at 60 cm depth. (iii) Shallow ploughing with cultivator immediately after harvest is effective in exposing and killing the pupating maggots/ pupae which are mostly present at 4-6 cm depth.

	(iv) Fix PAU fruit fly traps @16 traps/acre in the first week of June and recharge the same if required.
6. Aphids : Two aphid species (*Schizaphis* sp. and *Toxoptera* sp.) cause damage to the vegetative and flower buds, leaves, flowers and developing fruits from February to mid-April. The attack is more severe on semi-soft pear than on hard pear.	---

B. Diseases

Disease and symptoms	Control
1. Shoot/Fruit-blight and Bark canker (*Botryodiplodia theobromae* and *Phoma glomerata*) : Cankers appear on bud scars, wounds, twig stubs or in crotches. Cankers are elliptical. Small circular brown spots appear around a leaf-scar or superficial wound. As the canker enlarges the centres become sunken with the surrounding healthy bark. The fungus perpetuates itself on the trees in bark cankers.	Decorticated the dead bark along with 2 cm of the healthy bark. All the dead wood and pruned wood should be destroyed. Cover the wounds with a disinfectant solution and after this, apply Bordeaux paste. After a week cover the dried paste with Bordeaux paint. Spray Bordeaux mixture in January, March and June.
2. Root-rot and Sapwood rot (*Polyporus palustris, Ganoderma lucidum* and *Schizophyllum commune.*) : Gummosis of main trunk, limbs and secondary branches. The bark and wood of the roots rot and turn brown, with white mycelial mat in the crevices. The affected trees begin to show symptoms of wilt, early leaf fall and increase in fruitset before collapsing. Rotting of roots leads to toppling over the trees, especially those with bulky tops.	(i) Locate the affected trees (showing distress signs) by examining their roots and give irrigation seperately. (ii) Avoid deep hoeing to avoid injuries to the roots, through which the fungus attacks. (iii) Also avoid growing intercrops which require excessive irrigation during winter. (iv) Avoid piling up of the soil around the trunk of the tree.

6. BER

The *ber* is one of the ancient and common fruit of Punjab. The districts of Sangrur, Patiala, Mansa, Bathinda, Fazilka and Barnala are most famous for *ber* cultivation. *Ber* is one of the nutritious fruits. It is a rich source of vitamin C (120 mg/100g), protein (1.0%) and minerals like calcium (0.03%), phosphorus (0.036%) and iron (1.14%). Umran variety is most suitable for the preparation of candy, sundrying and dehydration. Fully mature unripe fruits of ber can be used for the preparation of *murabba*, pickle and *chutney*. The juicy varieties can be converted into pulp to serve as base material for squash, nectar and ready-to-serve (RTS) beverage. The fully mature fruits of *ber* can be canned in sugar syrup.

Climate and Soil

The *ber* is a hardy fruit tree and can grow successfully even under unfavourable climatic conditions where most other fruit trees fail to grow. It can be grown in sub-tropical and tropical climate. Ber trees relish hot and dry climate for successful cultivation but need adequate watering during the fruiting season. Excessive atmospheric humidity is a limiting factor for satisfactory fruiting. It can withstand hot and dry weather during summer months of May and June as tree enters into dormancy by shedding its leaves. New growth starts in July with the advent of rains and growth period continues till the middle of November when it stops with the onset of cold weather.

Although ber grows and yields the best on deep sandy loam soils with neutral or slightly alkaline reaction having good drainage, it can be grown on marginal lands or even those which are considered unsuitable for growing other crops. It develops a deep tap-root system and as such adapts itself to a wide variety of soils. It is known for its ability to thrive under adverse conditions of salinity, drought, alkanity and water-logging. It can flourish even in soils with pH upto 9.2.

Recommended Cultivars

Wallaiti (2000): Tree semi-erect to erect and vigorous. Fruit medium to large, oval in shape, skin smooth and light golden yellow to golden yellow at maturity. Pulp soft, sweet with 13.8 to 15.0% TSS. It is an early variety and ripens during first fortnight of March. Average yield is 110-120 kg fruit per tree. Moderately susceptible to powdery mildew disease.

- **Ber fruit are rich source of vitamin C, protein and minerals like calcium, iron and phosphorus. .**
- **Plant are hardy and can be grown in all types of soil and climatic conditions.**
- **Grow Umran variety for higher yield.**
- **Regular annual pruning in second fortnight of May gives higher fruiting and yield.**

Umran (1968) : Tree spreading and vigorous. Fruit large, oval with a round apex. Skin smooth and glossy, golden yellow, turning to chocolate brown at maturity. Pulp sweet with a pleasant flavour and 16% TSS. Ripens from end-March to mid-April. Yield upto 150-200 kg of fruit per tree. Susceptible to powdery mildew disease.

Sanaur-2 (1968): Tree spreading and semi-vigorous. Fruit large, oblong, smooth and golden yellow. Pulp sweet with a typical flavour and 16% TSS. Ripens in the second fortnight of March. Average yield is 150 kg per tree. It is resistant to powdery mildew disease. Most suitable for *Kandi* area.

Propagation

Rootstock Raising : The ber plants should be budded on *desi* ber. However, Katha ber is generally used for raising rootstock seedlings.

The germination of *ber* seed is quite difficult process on account of the stony nature of the shell (endocarp) which contain the seed. Seeds should be dipped in 17-18% salt solution for 24 hours before sowing. The stones are sown during April after fresh extraction in well prepared nursery beds at a distance of 15 cm in rows spaced 30 cm apart. Germination starts in about 3-4 weeks and seedlings become buddable in August.

Budding : The propagation of ber by budding is the most successful method. Shield budding (T) is done during June-September.

Planting

The budded plants are usually transplanted during February-March or August-September at 7.5×7.5 m in square system. Dig out the plants from the nursery with a good-sized earth ball so that minimum roots are lost. Pack the plants properly and carefully to keep earthball intact. The ber plants can also be transplanted bare-rooted with equal success. For this, lift the plants from nursery in usual manner from mid-January to mid-February. Defoliate the plants just before lifting them from the nursery.

On sandy land, it is advisable to sow seeds and bud in situ as transplantation of budded plants has a poor success.

Training and Pruning

The *ber* fruits are trained according to modified leader system. After transplanting head back the main stem at 75 cm from the ground level. Out of the new lateral growth produced on the main stem select four to five laterals which are most favourably located around the main stem. As the ber tree bears fruit on the current season's growth, regular annual pruning is necessary. Prune the lower branches to prevent them from spreading on the ground. Also remove thin, dry, broken and diseased branches of the previous season. Pruning is done during second fortnight of May when the trees are dormant. Pruning in Sanaur-2 cv. should be done during the thrid week of April. Pruning by heading back to 8 buds of previous year's growth gives higher yield of better quality fruits. Severe pruning after four-five years is recommended.

Rejuvenation of Old Ber Trees

Ber trees need to be rejuvenated after the age of about 25 years. This can be done by heading back the main limbs to about 30 cm during second fortnight of May. The trees start giving commercial crop with higher yield of excellent fruit quality during the third fruiting season.

Manures and Fertilizers

Age of tree (Years)	Farmyard manure (kg/tree)	Urea (g / tree)
1	20	200
2	40	400
3	60	600
4	80	800
5 or more	100	1000

Apply the whole quantity of farmyard manure in May-June. Urea may be split up in two parts – one part to be applied during the rainy season in July-August and the other soon after the fruit set.

Irrigation

Irrigation is essential during the development of fruit i.e. from October to February. It may be given at intervals of 3 or 4 weeks depending upon the weather. The fruit becomes large, quality improved and fruit shedding is minimized by irrigating the trees during fruit development period. Irrigation should be stopped in second fortnight of March, as fruits on the branches lying on the ground get damaged and their ripening is delayed.

Weed Control

Light cultivation of the field should be done to manage the different kinds of weed flora. Apply paddy straw mulch @ 5.0 ton per acre under the canopies of trees to supress weeds. Application of mulch should be done in the month of October after application of second split of inorganic fertilizers.

Intercropping

Intercropping can be successfully done on the vacant land in the young orchard during the first three-four years. Only the leguminous crops of short stature like gram, *moong* and *mash* should be grown to get some income from the land. These crops also enrich the soil by fixing atmospheric nitrogen. The exhaustive and tall-growing crops should not be grown in the orchard as they deplete the soil of its nutrients to a greater extent and compete for light with the trees.

In the established ber orchards the short duration groundnut var. TG 37A can be grown as an intercrop immediately after pruning of trees in the middle of May. TG 37A matures in about 100 days after sowing. It gives an additional income without having adverse effect on ber plant.

Management of Physiological Fruit Drop in Ber

For the management of physiological fruit drop in "Umran" ber, give two sprays of 15g NAA (Naphthalene Acetic Acid) in 500 litres of water per acre once in 2nd fortnight of October and again in the 2nd fortnight of November. NAA should be dissolved in a small quantity of alcohol or spirit and then the required volume of water should be added. Wash the spray pump thoroughly with washing soda before and after the spray.

- **In young orchards, intercrops like gram, moong and mash can be grown successfully to get some income from fellow land.**
- **Physiological fruit drop can be managed by giving two sprays of NAA in 2nd fortnight of October and November.**
- **The old unproductive Ber trees can be revived by heading back in 2nd fortnight of May at dormant stage.**
- **Spray the recommended fungicides for controlling powdery mildew and black fruit spot diseases.**

Quality improvement in ber

Two foliar sprays of potassium nitrate @1.5% (15 g per litre of water) during mid November and again in mid January increase the fruit size and yield.

Fruit Maturity and Harvesting

The *ber* tree grows quickly and the first crop ca n be harvested within 2-3 years of planting. The peak season for harvesting is mid-March to mid-April. During this period, ber sells readily at remunerative prices. The fruit should always be picked at the right stage of maturity, i.e. when it is neither under-ripe nor over-ripe. It should be picked when it has acquired normal size and characteristic colour of the variety e.g. deep golden yellow colour in Umran. All the ber fruits on the tree do not ripen at the same time and picked 4-5 times from mid-March to mid-April In

no case, the fruits should be allowed to become over-ripe on the tree as they deteriorate in taste and quality and thus fetch lower price.

Post-Harvest Handling

Grading and Packing of Fruits : The grading should be done before the fruit is marketed. Sorting should be done to remove culled, undersized, under-ripe, over-ripe, mis-shapened, cankered and bird-damaged fruits. The fruits should be graded into four grades namely, A grade – large sized; B grade – medium-sized; C grade- small-sized and D grade – under-ripe, over-ripe, deformed, mis-shapened and cankered fruits. Highest distribution of fruits is found in grade B (33%), which is closely followed by grade A (27%). The extent of C and D grade fruits is 21% and 19% respectively. The fruits of Umran belonging to A and B grades which accounted for 60 per cent of the total crop have deep golden yellow colour are more acceptable to the consumers and considered the best for marketing.

The fruits should be packed properly in Corrugated Fibre Board (CFB) cartons, wooden crates, polynets, wooden baskets and gunny bags of convenient sizes on the basis of grades.

Storage : The ber fruits of cultivar Umran, harvested at colour break stage can be stored at 7.5 ± 1^0C and 90-95% RH for two weeks with acceptable colour and quality.

Plant Protection Measures

A. Insect Pests

Pests and symptoms of attack	Control
1. Fruit fly (*Carpomyia vesuviana*) is one of the specific and serious pest of ber. Fruit fly deposits eggs in the epicarp of developing fruits. After hatching, the maggots enter into pulp and start feeding. The infested fruits become deformed, turn brown, rot and drop off. Fully grown maggots emerge out of the fruit by making a hole and pupate in the soil.	(i) Clean cultivation/sanitation of orchards by picking and destroying the infested fruits should be done. (ii) To escape egg laying on fruits, harvest at green and firm stage and do not allow the fruit to ripe on the tree. (iii) Rake the soil around the trees during summer to expose the pupae to heat and natural enemies.

2. Leaf eating caterpillar (*Euproctis* sp.)**:** The young caterpillars initially remain gregarious and scrap leaves and tender fruits. Later instars disperse and devour leaves, fruits and tender shoots. Affected fruits become unmarketable.	---
3. Lac insect (*Kerria* sp.**) :** Although it is useful if reared commercially for lac production, their presence on ber trees is considered as harmful because they devitalize the trees and affect adversely the yield of fruits.	Remove and destroy the infested dry part and scrap off the infested twigs.

B. Diseases

Disease and symptoms	Control
1. Powdery mildew (*Microsphaera alphitoides*) **:** Young developing leaves and fruits are covered with whitish powdery mass of the causal fungus. This condition results in premature defoliation and fruit drop. Fruits remain small and become cankered and cracked.	---
2. Black fruit spot *(Alternaria alternata)* **:** It produces small, irregular, sunken, black spots on ber fruit. Some times Phoma macrostroma is also associated with the disease at later stages. The infected fruits become disfigured and may drop off before harvest. The disease starts its appearance during February and is very severe during February-March.	---

7. LITCHI

Litchi is one of the important fruits which can be grown successfully in the sub-montane part of the Punjab State comprising parts of Gurdaspur, Hoshiarpur, Pathankot, Roopnagar, SAS Nagar and Patiala districts. In view of the export possibilities of litchi fruit from Punjab, its future appears to be quite bright.

Climate and Soil

The climatic conditions of sub-montane tract of Punjab are suitabale for the growth and fruiting of litchi. In these areas summers are quite hot to encourage vegetative growth of plants and winters are cool enough to provide 200-300 chilling hours to facilitate fruit bud differentation in litchi. Quite frequently, summer temperature rises above 40°C during the period of fruit growth and development. This is favourable for sun-burning and cracking of fruits to varying intensities in all the recommended cultivars.

- **Sub-montane parts of Punjab are more suitable for litchi cultivation.**
- **Air-layering (gootee) is best method for propagation.**
- **Two year old seedling should be planted in the month of September.**

Litchi grows well in deep, fertile, well-drained, medium textured soil, which is free from hard pans of any kind and salinity. Preferably, the soil pH should be around 7.5 to 8.0. In high pH and saline soils, litchi is difficult to establish and flourish. Therefore, such soils should be avoided.

Recommended Cultivars

Dehra Dun (1967) : It is an early, regular and heavy-bearing cultivar, fruits mature in the second week of June. Its fruits have an attractive colour but are prone to splitting. Pulp is sweet, moderately juicy, medium soft in texture, juice has 17 per cent TSS and 0.48 per cent acidity. Pulp stone ratio is 3.75:1.

Calcuttia (1967) : It is heavy bearing cultivar with excellent fruit quality. Its fruits are large, attractive and mature in the third week of June. It is less prone to cracking. Pulp is sweet and soft

in texture, moderately juicy with good flavour, juice has 18% TSS and 0.49% acidity. Pulp/stone ratio is 4.78:1.

Seedless Late (1967): It has shrivelled seed and a much greater proportion of pulp in the fruit. Fruits mature in the third week of June and are more prone to splitting than Calcuttia. It is prone to irregular bearing. Fruits are deep carmine red, pulp is soft, sweet and very juicy with an agreeable flavour, juice has 18.7 per cent TSS and 0.3 per cent acidity. Pulp/stone ratio is 28:1. It comes into bearing rather late.

Propagation

Litchi is propagated commercially by air-layering (gootee). A terminal branch, 45-60 cm long and 1.0-1.25 cm thick is selected. A 4 cm wide ring of bark is removed with a sharp knife. Place wet moss grass on the exposed portion and wrap it with polythene sheet. The ends of wrapped polythene sheet should be tied tightly.

The rooting starts after about 4 weeks. However, the gootee should be removed from the mother tree only when a good number of roots have developed. After severing from the mother tree, remove the polythene sheet and immediately plant the gootee in a nursery bed. Apply irrigation to the gootee after plantation in the nursery. Middle of July to September are the best months for the air layering of litchi.

Planting

Litchi should be planted towards the end of the rainy season when the environmental temperature becomes moderate and the atmosphere has high humidity i.e. in September. Two year old plants should be planted in the field as it considerably reduces field mortality. Young litchi plants if purchased should be planted in the nursery.

Protection of Young Plants Against Cold and Hot Weather

The young litchi plants need protection against winter frost and summer winds upto 4-5 years. Cover the plants with locally available materials like *sarkanda*. Growing of dhaincha around the young plants provide good protection in summer and winter. The *dhaincha* seed should be sown around plants in the basin in

the middle of February. It grows sufficiently by the middle of April to provide shade to the plants of litchi. *Dhaincha* can be tied in winter to act as protection against frost. The open spaces in *dhaincha* stems can be plugged with locally available straw. Root pruning of dhaincha plants is necessary to avoid competition with litchi roots. It should be done three or four times in a year.

- **Cover the young plants with *Sarkanda* and grow dhaincha for frost and summer protection, respectively.**
- **Use wind breaks such as seedling Mango, Jamun and *Eucalyptus* around the orchard to protect plants from strong winds.**
- **Intercrop Peach, Plum in Litchi orchards to get some income during pre-bearing age.**
- **Manage the Litchi nut borer attack by adopting recommended integrated pest management strategies.**

Wind Breaks: Litchi orchards should be protected from strong winds which can cause the uprooting of trees and drop of flowers and fruits. A row of tall growing trees alongwith boundaries of the newly established orchards such as seedling mango, *Jamun*, Eucalyptus etc. should be planted.

Manures and Fertilizers

Dose per tree (g)				
Age of tree (years)	**Farmyard manure (kg/tree)**	**Urea**	**Super phosphate**	**Muriate of Potash**
1-3	10-20	150-500	200-600	60-150
4-6	25-40	500-1000	750-1250	200-300
7-10	40-50	1000-1500	1500-2000	300-500
Above 10	60	1600	2250	600

Farmyard manure, superphosphate and muriate of potash should be applied in December. Half of urea should be applied in the middle of February and the other half in the middle of April after fruit set.

Irrigation

Litchi should be carefully irrigated at all stages of development. Irrigate young plants twice a week during April-June and at weekly intervals in winter. In bearing trees, irrigation need is critical during fruit development which occurs from the second week of May to the end of June. Twice a week irrigation during this period reduces cracking of fruits to a great extent and helps in proper size development.

After the withdrawal of monsoon young orchards should be irrigated at weekly/fortnightly intervals from September onwards. But to the bearing orchards irrigation should be applied at the end of November or first week of December to protect it from frost injury. Later on, irrigation during winter should be applied depending upon rain and soil moisture conditions.

Intercropping

Litchi is a slow growing plant and it takes about ten years to come into commercial bearing. Moreover, there is sufficient space in the orchard to grow intercrops. Besides, intercropping quick growing fruit plants such as peach, plum can be interplanted in litchi orchards. As soon as the litchi orchard comes into commercial bearing the filler plants should be uprooted.

The growing of intercrops not only provides income to the farmer but give protection to the young plants and keep the weeds under control. The type of intercrops depends upon the soil, climate as well as the marketing facilities. Pulses and vegetables should be preferred as intercrops. The irrigation for intercrop and orchard should be independent.

Bagging of Litchi Bunches for Quality Production

The bagging of litchi fruit bunches with white and pink polypropylene non-woven bags at 25-30 days after fruit set provide physical protection against fruit nut borer, sun burning, cracking and also improves pericarp colour and fruit quality.

Fruit Maturity and Harvesting

The fruit is harvested in bunches. As the whole of the fruits do not ripe at one time, spot picking is done. The fruit should be

harvested with as little foliage as possible. The fruit is then packed in small baskets and sent to the market.

For marketing of litchi in local and distant markets, corrugated fibre board boxes of 2 kg capacity having size 340 mm×220 mm× 100 mm and of 4 kg capacity having size 340 mm×220 mm×185 mm of 3-5 ply thickness can be used. For packing 8-10 kg litchi, the corrugated fibre board box of internal size of 420 mm×235 mm×210 mm and 5 ply thickness can be used for domestic as well as distant marketing.

Plant Protection Measures

A. Insect Pests

A number of insects and mite pests are damaging the litchi plants and fruits in the State. Among the various pests, leaf curl mite, fruit borer (especially *Blastobasis* sp.), leaf roller (*Tortrix epicyrta*) and bark eating caterpillar are very serious.

Pests and symptoms of attack	Control
Litchi nut borer (*Blastobasis* sp.) It damages the fruit by entering through a small pin-head size hole near the attachment of peduncle and feeds inside it. Infested fruits become unfit for consumption.	Clean cultivation by removing fallen fruits (mummies) from the orchard and ploughing destroys the carry over of pests to the next crop.

8. PEACH

Peach is a temperate fruit tree but it is possible to grow in the sub-tropical climate of Punjab due to availability of suitable low chilling cultivars and their production technology. In Punjab about 300 chilling hours are available and the cultivars whose chilling requirement is less than 300 hours can be grown successfully. Peach cultivation is distributed throughout the state.

Peaches are highly valued as a table fruit for their attractive colour and palatability. Peaches can be processed as canned and dried products, frozen preserves, jam, nectar, juice, beverage and marmalade. Peaches are also good source of low calorific diet.

Climate and Soil

Sub-tropical climate of Punjab is ideally suited for the cultivation of low chilling peaches during winter months as it is enough to break the dormancy of low chilling cultivars. After fruit setting from March to June, the climate is warm to hot (35°-42°C). This is favourable for the development and maturity of fruits provided adequate water supply is available.

Loamy sand or sandy loam, well drained, fertile soil with lime content less than 10% is suitable for peach cultivation. Heavy wet soils are unfit for peach growing. Soil with an electrical conductivity below 0.5 m mhos/cm, calcium carbonate less than 5%, lime less than 10%, absence of hard pan upto a depth of 120 cm and pH between 6-8 is good for peach.

Recommended Cultivars

A.Yellow Fleshed

Earli Grande (1997) : Tree is semi-vigorous, high yielding and fruit mature in the first week of May (4 days earlier than Shan-i-Punjab). Fruit is large (90 g) and firm fleshed, free stone at full ripe stage and of good keeping quality. Its TSS is 10.5% and acidity is 0.7%.

Florda Prince (1997) : Tree is vigorous and the fruits mature in the fourth week of April. Fruit size medium (65-70 g); yellow with red blush at maturity, flesh firm and free stone at full ripe

stage. Average yield 100 kg per tree; TSS 12% and acidity 0.5%.

Partap (1990) : Tree is medium in vigour and the fruits mature in the third week of April. Fruit size medium (65-70g), almost round, yellow with red over colour: Flesh is firm and free stone at full ripe stage. Average yield 70 kg per tree; TSS 12% and acidity 0.7% .

- **Peach is important source of carbohydrates, minerals and proteins. Peaches can be processed as canned and dried products.**
- **Use 'Sharbati' and Floridaguard - a nematode resistant rootstock for Peach propagation.**
- **For early nursery production of Peach, use stenting technique. Dip basal portion of cuttings in IBA solution (2g/litre water) for 2 minutes.**

Shan-i-Punjab (1979): Tree is vigorous and the fruits mature in the first week of May. Fruit is large, turns yellow with red blush at maturity. Average yield 70 kg per tree, flesh firm and free stone at full ripe stage. It is good for canning. Its TSS is 12% and acidity is 0.74%.

B. White Fleshed

1. Prabhat (2003) : Tree is semi-vigorous and the fruit matures in the 3rd week of April. Fruits are medium round with an attractive red blush, flesh white, juicy, sweet and free stone when fully ripe. Average yield is 64 kg per tree. Its TSS 12% and acidity 0.37%.

2. *Sharbati (1967)*: Tree is very vigorous and the fruit matures in the end of June to first week of July. Fruit medium in size (70 g), clingstone and turns greenish yellow at maturity with pink patches. Yield per tree is 100-120 kg, TSS 13% and acidity 0.33%.

C. Nectarine

Punjab Nectarine (2008): Tree is vigorous and spreading, fruits mature in second week of May. Fruit large, fuzzless, weighing 90 g, round, attractive with 90-100% red blush over yellow ground colour at maturity, flesh yellow, firm, melting and free stone at full ripe stage. Average yield is about 40 kg/plant, TSS 11.5% and acidity 0.8%.

Rootstock

Flordaguard (2010): This rootstock is resistant to root knot nematodes.The trees are vigorous spreading, self fertile and precocious having red leaves. Flowers produced in abundance, deep pink and showy. Fruits pubescent with dull red colour, yellow fleshed and free stone. Fruits ripen from end of June to first week of July.

Propagation

The peach is commonly propagated by budding or grafting on peach rootstock Flordaguard and *Sharbati*.

Root Stock Raising: Procure ripe fruits of *Sharbati/ Flordaguard* in June-July. Extract stones from pulp, wash and dry these under shade for 4-5 days. Treat the stones with Ziram or Thiram or Captan @300g per quintal of stones. Pack the stones in dry gunny/plastic bags and store these under cool dry place till these are used for stratification from November-January.

Stratification is a low temperature treatment in which stones are placed in alternate layers of moist sand at or below 7.2^0C for 100-120 days till the seed dormancy is broken and germination starts. Kernels/seeds can be used instead of stones for raising the seedlings. Wooden boxes or well drained trenches in open space can be used for stratification. When seed germination starts in upper layer it is considered that dormancy of seed is broken. Stones or seeds are removed carefully from each layer of sand without damage to radicle or plumule of germinating seeds. Separate the germinating stones from cracked stones and uncracked stones and sow these separately in well prepared nursery plots. These are sown 30 cm apart in rows at a distance of 15 cm. Normally sowing of seeds is done in the first fortnight of February.

Budding/Grafting : About 40% seedlings from the nursery plots become fit for T-budding in first week of May. The successful budded plants become ready for transplanting in December-January. The rest of the unbudded seedlings or the unsuccessful budded seedlings are used for grafting in December-January.

In the middle of February the scions produce new growth. Usually a scion may produce 3-4 shoots which may be allowed to grow upto April. In May, one of the vigorous shoots is retained and

all others are removed. This practice produces vigorous nursery plants. Polythene tape around the graft union should be removed before it causes girdling. Staking of young grafts is necessary to prevent breakage.

Stenting Technique : Peach plant can be propagated by stenting technique (simultainously grafting & rooting) in the first week of January by dipping the basal portion of cutting of Sharbati (rootstock) in 2000 ppm IBA solution for 2 minutes. This practice cut short the period of propagation by one year.

Crown Gall Disease

The crown gall disease is caused by a bacterium *Agrobacterium tumefaciens* and has been noticed in peach nurseries and orchards. The disease can be easily identified by the formation of tumours of varying sizes especially at the crown portion and sometimes on roots and on the stem at the position of the graft union of the plant.

For raising disease free plants in the orchards following points may be kept in view.

(i) Procure disease free plant material from a reliable source.

(ii) Avoid injury to roots and crown portion of the plant at the time of uprooting from the nursery, replanting and performing other cultural practices in the orchard.

(iii) Keep the plants free from insects, nematodes and rodent injuries.

(iv) Discourage the exchange of plant material without knowing its sanitary conditions.

(v) Uproot and destroy the diseased plants from nursery or orchard whenever noticed.

(vi) While planting, the diseased roots of the plant are pruned and remaining root system is dipped for one minute in 5% solution of bleaching powder and then planted in the orchard.

Planting

Peach should be planted in the orchard during winter when the plants are completely dormant. One year old healthy nursery plants which are free from the incidence of nematodes and crown gall disease should be planted in the orchard from

the end of December to end January. The nematode infestation can be identified by the presence of small root nodules and soil also remain sticking to the roots. Plant to plant distance is kept at 6.5×6.5m in square system of planting. Peach can also be used as filler plant in pear and litchi orchards. Keep the bud/graft union of the plant about 10-15 cm above the ground. Always procure 1.0-1.2 m tall plants for planting an orchard.

High Density Planting

Peach trees should be planted at spacing of 6 m×1.5 m with 'Y' system of training. This practice ensures higher yield and better fruit quality than the traditional planting system.

Training and Pruning

To control tree size and ensure new growth annually for fruit bearing, training and pruning are important canopy management practices.

Training : Peach plants are trained according to the modified leader system. Various steps involved in training are as follows:

i) At the time of planting one year old plants are headed-back to about 90 cm. Cut all side shoots to one or two bud stubs.

ii) During spring and summer months many lateral branches are produced along the whole length of the plant. At the time of first pruning in January, select 4-5 healthy well placed spirally located branches in all directions on the axis of the plant and remove all others. The lowest branch on the trunk should be at 45 cm from the ground level. The top most central branch is called leader.

iii) During the next growing season many new branches develop on the selected primary branches. The leader of the plant also grows in height and some side branches are developed on it. Select 3-4 more well placed branches on the central branch and remove all others if present. At this stage head-back the leader branch very close to some outward growing lateral. The leader is restricted in its vertical growth. Thus, a peach tree is trained to modified leader with a strong framework for future fruiting.

Pruning : In peach, fruit is borne on one year old shoots. Pruning should be done by thinning out some one year old shoots

expected to bear fruit. Some heading-back of old and unsuitably placed branches and sterile parts of flower bud bearing shoots should be done. About 40 per cent of one year old shoots should be thinned out to ensure proper tree growth and improve fruit size and quality. Lengthy and hanging branches should also suitably be shortened by heading back.

Best time of pruning peach is during January. Cuts thicker than 5 cm should be covered with Bordeaux paste followed by Bordeaux paint after 1 or 2 weeks.

Fruit Thinning

Peach is a heavy fruit bearer. If all the fruits are allowed to mature on the trees, they remain small sized and of inferior quality with low marketable yield. Over bearing weaken the trees and causes short life of tree. To overcome these problems, fruits should be thinned annually. In Partap, best time of fruit thinning is during second and third week of March while in Shan-i- Punjab it is third to fourth week of March. Girdling plus thinning done at full bloom or girdling alone done four weeks after full bloom advances fruit maturity by 7-12 days and improves fruit quality in Shan-i-Punjab. Fruit to fruit distance on the shoots should be 10-15 cm. Before starting fruit thinning, shake fruit bearing branches slightly. The weak stemmed fruits are likely to drop naturally. Then start thinning of fruits from base to top of branches. The operation must be completed before pit hardening of fruits. Proper pruning of trees also helps in thinning of fruits.

Manures and Fertilizers

Fruiting is an exhaustive process for the tree. This removes large amount of nutrients from the soil. To prevent the adverse effects of nutrient deficiency in the plant these are applied annually according to the tree age.

Age (Years)	Farm yard manure (kg/tree)	Dose per tree (g)		
		Urea	Super phosphate	Muriate of Potash
1-2	10-15	180-360	190-380	150-30
3-4	20-25	540-1000	570-760	450-830
5 & above	30	1000	760	830

Apply FYM, superphosphate and muriate of potash in December. Split urea in two doses. Apply half of urea in January after pruning and the remaining second half after fruit set in March.

Iron deficiency: Peach trees planted on light textured and high pH soils often exhibit iron deficiency symptoms during summer and rainy season. Interveinal chlorosis (yellowing in between veins) of developing new leaves on the terminal part of shoots are the clear symptoms of deficiency. In severe case, the new leaves may unfold without any green colour (Ivory colour) and later veins may turn green. Typical symptoms appear by the second fortnight of March and with the passage of time these progress and accentuate. Iron deficiency can be corrected by spraying peach trees with 0.3 per cent ferrous sulphate solution (3g ferrous sulphate in one litre of water) on spring flush in April, on summer flush in June and late summer flush in August-September.

Irrigation

In peach, fruit development period starts after fruit set in March and continues during April to June till maturity depending upon the variety. This is the critical period of irrigation for the trees. Trees should not suffer from any moisture stress particularly 25-30 days before maturity of fruit, because the maximum weight gain is during these days.

- **For better quality and higher yield, plant trees at high density spacing 6 m×1.5 m.**
- **Correct iron deficiency by spraying iron sulphate in April, June, and August.**
- **To manage fruit fly infestation, plant early maturing varieties and fix PAU fruit fly trap @16 traps/acre in May.**
- **Integrated management practices should be done to cure crown gall disease.**

Critical period of irrigation for peach varieties

Variety	Critical period
Partap, Florda Prince, Parbhat	End March to third week of April
Shan-i- Punjab, Earli Grande, Punjab Nectarine	Mid April to first week of May
Sharbati	End May to end June

The irrigation frequency depends upon the type of soil and the source of irrigation. It should be given during the first 3-4 weeks after fruit set at weekly intervals. Thereafter, from the second week of April to the start of harvesting, the trees may be irrigated at 3-4 days interval.

Weed Control

Weeds are common in peach orchards during spring and the rainy season. Weeds should be checked by manual ploughing. Application of paddy straw mulch (10 cm layer) @ 4.5 ton per acre during first week of March effectively soppress the weeds. Mulching should be done after application of second split doses of inorganic fertilizers.

Maturity and Harvesting

Peach fruits should be harvested at the right stage of maturity depending upon their market destination. For distant market, the fruit should be picked at firm mature stage i.e. when the ground colour of fruit begins to change from green to yellow in yellow fleshed varieties and fruits yield to pressure very slightly in between cupped hands. For the local market, however, the fruit may be picked when nearly ripe.

In white fleshed varieties colour of the fruit changes from green to straw (dry grass) with pink blush on the sides. Fruits harvested at this stage take 3-4 days to ripe.

All the fruits do not ripen at the same time on the tree. Earlier set fruits mature first and later set fruits mature later. Generally 3-4 pickings are done to complete the harvesting. During picking collect the fruits in baskets/plastic cartons after putting some dry grass or paper strips in it as a cushion to prevent injury or bruises to fruits. Drop bottom picking bags are now available or can be made to order for picking peaches. Transfer the fruits to some shady place with good aeration to make them cool down. Field heat of the fruits can be effectively removed by giving them 10-15 minutes quick dip in cold water followed by surface drying of the fruits in shed. This process slows down the ripening process of fruits and is helpful in extending the shelf life.

Post-harvest Handling

Before packaging, remove the injured, damaged and undersized fruits from the lot and grade the fruits according to

size and stage of maturity. Different grades of fruits are packed separately for better marketing. The commercially accepted fruit grades in peach and packaging size are given following:

Fruit Grade	Fruit size (cm)	Inner size of box (cm)	No.of layers	No.of fruits per layer
Special	5.5-6.3 and above	37×16.5×16.5	3	28-32
Grade-I	4.6-5.5	-do-	4	35-38
Grade-II	Below 4.6	-do-	4	38-43

Generally 2 and 4 kg corrugated fibre board boxes (CFB) are used for packaging of fruits. These are better than wooden boxes. Shelf life of the peach fruits is very short after harvesting. This can be increased by storing the fruit in commercial cold stores where temperature varies between 0°-3.3°C with relative humidity 85-90%. Fruits at this low temperature can be stored for 25 days without affecting their palatability.

Physiologically mature Shan-i-Punjab peach fruits dipped in calcium chloride (2%) for five minutes can be stored for 30 days at 0-1°C temperature and 90-95% relative humidity after packing in corrugated fiber board boxes.

Pack the peach fruits in paper moulded trays and wrap with heat shrinkable or cling film. It improves the shelf life and maintains the quality for 9 days in super market (18-20 ^{0}C) and 4 days in ordinary market (28-30 ^{0}C) conditions.

Plant Protection Measures

Pests and symptoms of attack	Control
1. Peach leaf curl aphid (*Brachycaudus helichrysi*) : It is a polyphagous pest. Sucking of the cell sap from vegetative buds and unfolding leaves results in curling up and yellowing of leaves. Severe infestation affects fruit set and induces premature fruit drop. The pest is active from March to May.	---
2. Peach black aphid (*Pterochlorus persicae*): It is larger than other aphids and darker (almost black) in colour, resembling the colour of peach shoots. A large number of individuals congregate on stems and tender	

shoots and suck the cell sap from the bark of the stem, limbs and branches from April to June. The continuous drain of cell sap devatilizes the trees, which affect the fruit setting capacity as well as fruit size.	---
3. Chaffer and other defoliating beetles: Adult beetles (*Adoretus* sp.) appear with break of monsoon and feed on leaves during night and hide during day. In case of severe attack, fruits are also scrapped near the apical end. Eggs are laid in the soil, grubs feed on roots and other organic matter and sometimes the grubs feeding on roots cause the death of tree.	---
4. Hairy caterpillars (*Euproctis* sp.) are sporadic pests. Females lay eggs in clusters on ventral surface of leaves, covered with yellow hair. On hatching, the young caterpillars feed gregariously on leaf lamina, skeletonizing the same completely. Later, the caterpillars segregate and gnaw the leaves. In case of severe infestation, the entire tree may be defoliated. Young caterpillars have whitish hair while full grown caterpillars have red head, dark brown body with white hair on the head and a tuft of long hair at anal end. Adults are yellow moths with pale transverse lines on forewings.	---
5. Fruit flies (*Bactrocera dorsalis* and *Bactrocera zonata*) : In peach, fruit flies are serious pests which starts damage in early May in Punjab and continues till the crop is over. Fruits nearing maturity are punctured by the fruit flies for egg laying. Its maggots feed and develop in the ripening fruits. The infested part of the fruit rots. Dirty brown fluid oozes from the site of an egg puncture on pressing the infested fruits. Severely infested fruits may drop. Isolated orchards are less infested by fruit flies. In plum, activities of the fruit flies is during first week of April to mid May.	(i) Plant early maturing cultivars of peach i.e. Prabhat, Partap, Florda Prince, Earli Grande, Flordasun and Shan-i-Punjab. (ii) Harvest the ripening fruits and do not allow the ripe fruits on the tree. (iii) Regular removal of fallen fruits from the ground and bury the infested fruits atleast at 60 cm depth. (iv) Shallow ploughing with cultivator immediately after harvest is effective in exposing and killing the pupating maggots/ pupae which are mostly present at 4-6 cm depth.

	(v) In peach, fix PAU fruit fly traps @16 traps/acre in the first week of May while in plum, fix the same in 2nd week of April. Recharge the traps after 30 days, if needed.
6. Flat headed-borer (*Sphenoptera dadkhani*): It is a serious pest on peach. Adult beetles appear in middle of March and feed on foliage. Eggs are laid singly, scattered all over the tree trunk and main branches. On hatching, young grubs feed below the bark making minute irregular gallaries. The bark gets loosened and splits. Full grown grubs bore into the wood. Outside on the bark, gum globules ooze out from the entrance holes. Leaves turn pale and the growth of the tree gets arrested. In severe infestation, the entire tree may die.	---
7. Plum Caseworm (*Cremastopsychae pendula***)** : It nibbles on the bark of tender twigs, branches and stems.	---

B. Diseases

Disease and symptoms	Control
1. Shot hole (*Stigmina carpophila*): Dark brown scattered lesions appear on leaves which enlarge rapidly. Abscission of diseased area forms shot holes.	Collect and dispose off fallen leaves.
2. Bacterial canker and gummosis (*Pseudomonas morseprunosum*): Bacteria attack trunk, branches, shoots, spurs, blossoms, dormant buds, leaves and even fruits. The attacked limbs are girdled when the infection is severe. The death of the limbs above the attacked point occurs occasionally.	Before the commencement of rains apply Mashobra Paint* after clearing the wound. Repeat the treatment on the new lesions.

* For making 5kg of Mashobra paint mix 5.50 litres water, 225g Lanolin, 12g Stearic acid, 150g Marpholin and 25g Streptocycline.

9. GRAPE

Grape is commercially cultivated in Punjab due to its precocity and high economic returns. Besides being grown on commercial scale, it can also be planted in kitchen garden. Fruit contains fair amount of minerals like potassium (0.15-0.25%), calcium (0.004-0.025%) and vitamins like B-complex (391-636 mg/100g). Its juice is a good stimulant of kidneys, mildly laxative and an excellent thrust quincher.

Climate and Soil

Commercially grapes are grown in climate ranging from temperate to tropical around the world. However, grapes do best under a long, hot, dry and rainless summer with adequate sunshine followed by a winter cold enough to induce dormancy in the vines. Specific heat units are required for ripening of a particular cultivar. Perlette, an early ripening variety requires 1600 heat units. Dry weather during flowering, fruit development and maturity is essential for the production of quality grapes. Early rains result in cracking of berries and spoilage of crop. Moist weather also favours the spread of fungal diseases.

- **Grapes are rich source of vitamin B complex, potassium, and calcium.**
- **Superior Seedless and Flame Seedless are promising seedless Grape varieties**
- **Punjab MACS Purple is suitable for red wine and Perlette for vinegar preparation.**

The best soil for grape is sandy loam, well-drained, fairly fertile with good amount of organic matter. Salt affected, nematode infested and water-logged soils should be avoided. Soils having electrical conductivity upto 1.0 mmhos/cm, calcium carbonate upto 10%, lime concretion upto 20% and pH upto 8.7 are suitable for successful cultivation of grape.

Recommended Cultivars

Superior Seedless (2017) : Vines are medium in vigour, bunch is loose, medium to large in size. Berry is seedless, large, amber coloured with crisp pulp. Ripe bunches have TSS (17.0%)

and acidity (0.51%). It is an early maturing variety which ripens during 1st week of June. Average yield per vine is 23.8 kg on Y-trellis system of training.

Punjab MACS Purple (2008) : It is rich in anthocyanins- a source of antioxidants and is suitable for processing in to juice, nectar and ready to serve beverage. It contains 60-65% juice with total soluble solids 17-18% and acidity 0.50%. It has medium and loose bunches. The berry is seeded, medium in size and purple at maturity. It ripens in first week of June. Average yield per vine is 25 kg per vine.

Flame Seedless (2000) : Bunch is medium and well filled. Berry seedless, firm, crisp, light purple at maturity. It also gives good response to quality improvement treatment. Bunches have berries with 18% T S S. It ripens during second week of June. For uniform colour development of Flame seedless grape, retain 75% crop load (80-90 branches/vine) immediately after bunch emergence and spray 400 ppm ethephon (1 ml/litre) at colour break stage. Average yield per vine is 27 kg per vine.

Beauty Seedless (1968) : It performs well under south-western districts. Bunch is medium and well filled. Berry seedless, medium, bluish black. Highly responsive to quality improvement treatment. Treated bunches have oblong berries with 16-18% TSS. Keeping quality is poor. Fruit ripens in the first week of June. Average yield per vine is 25 kg.

Perlette (1967): This variety is cultivated on more than 90% of total acreage of grapes in Punjab. Bunch is medium to large and compact. Berry is seedless, firm, crisp, juicy and light amber. It is highly responsive to quality improvement treatment. Treated bunches have large round berries, with 16-18% TSS. It ripens during first week of June. Average yield per vine is 25 kg.

Propagation

Prepare cuttings during January from vines that bear good crop and are free from the attack of insects, diseases and nematodes. Make cuttings from middle portion of one year old canes. The cuttings should be 30-40 cm long with a diameter of pencil thickness having at least 3-4 buds. Basal cut should be straight and below the node while the top cut should be slanting and 2-3

cm above the node. Plant cuttings in February on well prepared flat beds in the nursery. Keep one third portion of the cuttings above ground and bury the remaining two-thirds in the soil.

Planting

The rooted cuttings of grapevines are transplanted in the field during middle of January to first fortnight of February before they start sprouting. Vines are planted at a distance of 3m×3m in the pits of 1×1×1 metre dimension. If the soil is light the size of the pits can be reduced. The pits should be filled by mixing 50 to 60 kg well rotten farmyard manure with half of the top soil. The refilled pits should be watered a few days before planting the vines. In each pit, add 5 ml of chlorpyriphos 20 EC mixed in about 2 kg soil against white ants.

Training and Pruning

Training : Train the vines on bower system. The vines are trained as single stem upto the height of bower. The axillary shoots on the trunk of vine are pinched off. The growing tip is pinched off at 15 cm below the bower level. Two laterals are selected at the top and they are allowed to grow on either side in opposite direction. These two laterals become primary arms. Develop three pairs of secondary arms from each primary arm and train them along each wire in opposite direction. The length of primary and secondary arms should not be extended too fast. The entire area available for the framework of vine should be covered in instalments otherwise the arms develop too much waste wood which does not encourage the development of fruiting canes.

Grapevines should be trained to Y-trellis structure at a spacing of 1.5 x 4m. This system gives high yield, improves fruit quality and enhances maturity.

Pruning : Recommended pruning intensities for different cultivars in Punjab.

Name of variety	Planting distance (metres)	Training system	Number of canes per vine	Number of buds per cane
Perlette	3×3	Bower	60-80	4
Beauty Seedless	3×3	-do-	60-80	4

The grape variety Flame Seedless and Punjab Purple should be pruned at 4 bud level for higher yield and better quality fruits.

Note: 1. Pruning should be done from mid-January to the first week of February when the vines are in the dormant condition.

2. Badly trained young vines can be re-trained by removing the faulty limbs. In old woody vines, cut the vine at ground level during the dormant season and retain a shoot emerging from vine near the ground level. This single shoot is trained like the newly planted vine

Rejuvenation and Top Working Technology

The old Perlette vines trained on bower system can be successfully rejuvenated by heading back the primary arms leaving behind 1 foot stubs in the month of December-January. Bordeaux paste should be applied after heading back of primary arms.

Flame Seedless variety of grapes can be successfully top worked on Perlette vines. For obtaining maximum success, tongue grafting should be done in the last week of February on one-year old shoots (canes). This technology advances maturity of Flame Seedless by 4-5 days and improves fruit quality.

Manures and Fertilizers

To newly planted vines apply 60 g urea and 125 g muriate of potash in April and repeat the same dose in June. For older vines planted at 3×3 m distance the following fertilizer schedule may be adopted.

Age (year)	Farm yard manure (kg/tree)	Dose per tree (g)		
		Urea	Superphosphate	Muriate of Potash
1	20	400	1500	250
2	35	500	2500	350
3	50	600	3500	500
4	65	800	4000	650
5 and above	80	1000	4500	800

Apply whole Farm yard manure(FYM) and superphosphate as well as half N and K fertilizers after pruning. Apply remaining N and K after fruit set in April. Use of high doses of fertilizers may result in excessive vegetative growth and barrenness. Complete shade under bower is an indication of excessive growth. In that case, the nutrient content of soil should be checked with a soil test and the fertilizer dose be adjusted, if necessary. Give two sprays of urea @ 1.0% first at full bloom and second at fruit-set to get higher yield and better fruit quality in the Perlette grapes.

Irrigation

Time	Number
After pruning in the Ist fortnight of February	One irrigation
First week of March	One irrigation
After fruit set in April till Ist week of May	At 10 days interval
During the rest of May	Weekly interval
June	3 or 4 days interval
July to October	Irrigate when prolonged dry spell or rainfall is insufficient.
November to January	One irrigation if soil gets extremely dry.

In light textured soils, use saline sodic water either in alternate mode with canal water or with press mud @ 6 kg/vine to obtain the good yield and to maintain soil health.

Weed Control

Light cultivation of the field should be done to manage the different kinds of weed flora.

- **Adopt quality improvement technique for obtaining better yield and quality in Perlette.**
- **Control yellow/red wasps, anthracnose and powdery mildew by adopting recommended spray schedules**

Quality Improvement

To get optimum yield and quality adopt the following package of treatments.

1. Thin flower buds one week before flowering by leaving 100-120 flower buds/panicle.

2. When berry size is 4mm, girdle the vine by removing a 4mm wide ring of bark from the main stem and dip the clusters in 40 ppm GA3*. While girdling, there should be no injury to the wood and no piece of bark should remain attached with the wood.
3. One week after the first GA_3 treatment, give a second dipping in 40 ppm GA_3.
4. The field should have sufficient moisture during girdling and at least 3 weeks after that.
5. Two foliar sprays of potassium sulphate @ 1.5% (15g/litre), first one week after fruit set and second at colour break stage, improve the quality and colour of Perlette grapes.
6. Harvest the crop when it attain the requisite TSS content.

Note : *For preparing 40ppm GA_3 solution, dissolve one gram of GA_3 in 50 ml ethyl alcohol in a thoroughly dried container and make the volume to 25 litres by adding clean water. In case of non-availability of ethyl alcohol use 100 ml country spirit or methyl alcohol.

Maturity and Harvesting

Grapes should be harvested only when they are fully ripe. Grapes need repeated picking to harvest the entire crop because they do not ripen at one time. Taste is the most valuable indication of the ripeness of the bunch. If berries near the tip are good to eat, the entire bunch is ripe for picking. Taste of berries supplemented with colour, T S S and sugar-acid ratio gives a fair idea about the time of harvesting. Ripe grape bunches should be carefully clipped with scissors. The bunch should be picked close to the cane so that there should be long cluster stem for handling of bunches during picking, packing, displaying and marketing of fruits. During handling, the natural bloom on berries should not be rubbed off. Harvesting should be done during the cooler part of the day. Bunches should not be exposed directly to the sun after harvesting.

Post- Harvest Handling and Marketing

Unripe, over-ripe, small, mis-shapen, sun-burnt, decayed, soft and bruised berries should be trimmed. Bunches should be graded

according to the fruit maturity and size. Different grades should be packed in different containers. For nearby markets, mulberry or bamboo baskets can be used whereas, for distant markets C F B boxes of 2-4 kg capacity should be used.

Grapes cv. Perlette packed in LDPE bag with single sheet of sulphur dioxide generating pad and kept in Corrugated Fibre Board (CFB) boxes (4 kg) can be stored for 30 days at 0-2^{o}C temperature and 90-95% relative humidity with acceptable quality.

The Flame Seedless grapes harvested at optimum maturity with firm berries having light purple colour and packed in ventilated CFB boxes (4 kg) lined with polythene film containing one sheet of grape guard can be stored with acceptable quality for 45 days at 0-2^{0}C and 90-95% R.H.

Preparation of Red Wine and Vinegar

Red wine with 10.5 percent (v/v) ethanol can be prepared from Punjab Purple grapes by alcoholic fermentation of must (juice+skin) using indigenous yeast *Saccharomyces cerevisiae* G with a fermentation efficiency of 90.4 percent. With this developed small scale (5 litres) technology, wine recovery of 62.4 percent (v/v) can be achieved.

Production technology of grape vinegar from Perlette grapes at 5L scale has been standardized and recommended. This technology will provide an alternative use of Perlette grapes. It is a fruit based natural vinegar with properties of grapes and vinegar blended together. Grape vinegar has shelf life of 2 years.

Special Problems

Water berry: It is characterised by drying of berries usually at the tip of the clusters. Drying may also be scattered within cluster during May and June. The berries look like small cellophane bags, half filled with sap and remain hanging from the clusters. This disorder is caused by over bearing, excessive application of nitrogenous fertilizers and excessive irrigation or water stress. Apply judicious irrigation and nitrogenous fertilizers to overcome this problem.

Plant Protection Measures

A. Insect Pests

Pests and symptoms of attack	Control
1. Grapevine thrips (*Rhipiphorothrips cruentatus*) : It is highly polyphagous. The nymphs and adults rasp the ventral surface of tender leaves and flower-stalks and suck the oozing cell sap. As a result of their intensive feeding, the leaves develop silvery white scorchy patches with curly tips, gradually get deformed and ultimately fall down. Attack on flower-stalks results in shedding of flowers. Fruits are also attacked resulting in scab formation on the berries. The attack occurs during February-March and again in September. The control measures targetted at early stage (February-March) are more effective compared to late stage.	---
2. Hopper (*Arboridia viniferata*) : Nymphs and adults of hoppers usually suck the cell sap from the ventral surface of leaves. The feeding spots on the leaves become pale. In case of severe infestation, the affected leaves turn yellow, gradually start curling, become brown and ultimately fall down. It is serious after rainy season. It is also responsible for an indirect loss by producing honey dew which serves as a substrate for the growth of sooty mould fungus on foliage and fruits. It affects the production of fruit and also depreciate the quality of grapes.	---
3. Leaf roller (*Sylepta lunalis*): The eggs are laid on ventral surface of leaves. On hatching, the young caterpillars feed on epidermis of leaves and skeletonize the same. Later, these caterpillars roll the leaves and feed within. The pest is active during monsoon.	---

4. Defoliating beetles (*Adoretus* sp.): Adult beetles appear with break of monsoon and feed on leaves during night and hide during day. In case of severe attack, fruits are also scrapped near the apical end. Eggs are laid in the soil, grubs feed on roots and other organic matter and sometimes the grubs feeding on roots cause the death of tree.	---
5. Yellow and red wasps (*Polistes hebraeus and Vespa orientalis*) : They cause much more damage by feeding on ripe berries having thin skin and high sugar content.	Burn or smoke the wasp nests in hedges on trees etc. at sun set. On a small scale, the damage by wasps can be avoided by covering the bunches with muslin cloth.
6. Mealybugs (*Nipaecoccus viridis and Maconellicoccus hirsutus*): They are active in grapevine orchards during July-October. Nipaecoccus viridis being the major species causes damage to twigs, branches, leaves and fruits while Maconellicoccus hirsutus is active on tender shoots.	See under citrus.
7. Chafer beetle: Chafer beetle or white grub, *Holotrichia consanguinea* is a key pest of grapes in Punjab. Adult beetles appear with breaks of monsoon and feed on leaves during night and hide during the day in soil. In case of severe attack, fruits are also scrapped near the apical end. Eggs are laid in the soil, grubs feed on roots and other organic matter and sometimes the grubs feeding on roots cause the death of young trees	(i) Clean cultivation helps in reducing the beetle population.. (ii) Ploughing around the trees during winter helps to expose and kill the hibernating pupae and adults. Birds also feed on exposed pupae and adults. (iii) Irrigate the orchard as per recommended schedule as it prevents the beetles from egg laying and also kills grubs and adults of beetle. (iv) Fix Anisole based PAU Chafer Beetle Trap @12 traps/acre at ground level during last week of April for mass trapping of adult Chafer beetles. Recharge the traps if required.

B. Diseases

Disease and symptoms	Control
1. Anthracnose or Die-back (*Elsinoe ampelina*) **:** Small light brown spots appear on young leaves which later enlarge, turn dark brown and give shot-hole appearances. In severe attack early defoliation occurs. Dark brown sunken spots with raised margins develop on new shoots/canes leading to their death from tip backwards. Similar spots appear on laterals of clusters. Under conditions favourable for the disease dark brown depressed spots appear on berries also.	(i) Prune the shoots and canes during January-February and give one dormant spray of Bordeaux mixture after pruning using 125 litres of water/acre. (ii) Spray with Bordeaux mixture in the last week of March using 250 litres of water/acre. (iii) Spray Bavistin 50 WP @ 500 g/acre in last week of April using 500 litres of water. (iv) Spray Bordeaux mixture in the last week of May in 500 litres of water/acre. (v) Spray Score 25 EC @500 ml in mid July and Bordeaux mixture in end July using 500 litre of water /acre. (vi) Spray Score 25 EC @ 500 ml in mid-August and Bordeaux mixture in end August in 500 litres of water/acre. (vii) Spray Score 25 EC @ 500 ml in mid September and Bordeaux mixture in end September using 500 litres of water / acre.
2. Cercospora Leaf Spot (*Cercospora* spp.) **:** It manifests as necrotic small area on leaves with straw coloured centre and reddish brown margins.	Spray the fungicides as recommended for Anthracnose.
3. Downy mildew: (*Plasmopara viticola***) :** Light yellow oily spots appear on upper surface of leaves which on the lower surface are covered with white downy growth of the pathogen. Later the spots become brown and brittle. Leaves with many active spots drop pre-maturely. The disease starts appearing in nursery and on grown up vines in March-April. After rainy season i.e. August-September it may assume serious proportions and continue to appear in humid weather. It affects tendrils and fresh growth of the shoots also.	Same as for Anthracnose

4. Powdery mildew (*Uncinula necator*)**:** White powdery growth of the fungus on leaves, tender branches and berries. The disease infects all aerial parts of the vines. On leaves, white powdery patches appear which enlarge, coalesce and become dirty white at a later stage. In south-western Punjab, it appears in the form of yellowish diffused spots on the upper surface of the leaves and its presence is felt when it appears on the berries as dirty white growth.	Spray the vines with 0.25% Wetable sulphur (1.25 kg) or spray Bayleton @ 200 g or Topas 10EC @ 200 ml in 500 litres of water in mid March, last week of April and first week of May.
5. Rotting of berries (*Black mould rot, blue mould rot* etc.) is caused by various kinds of air borne fungi, such as *Botrytis, Rhizopus, Aspergillus, Penicillum* spp, yeast. Grape berries are attacked when still on vines. The wasps aid in injuring the berries and releasing the juice which serves as substrate for the growth of fungi. In Perlette which has compact bunches the growth pressure ruptures some berries and the released juice flows into other berries where the fungi grow.	(i) For Perlette practise the thinning of bunches as recommended under quality improvement. (ii) Use insecticides or repellants to guard against wasps and other insects causing injuries to berries, as given under recommendation for insect pests.

10. AMLA

Amla known as '*Amrit phal*', is very rich in vitamin C, pectin and minerals and also used in indigenous medicines. It is the main ingredients for the prepration of *Chawanprash* and *Triphla*.

Climate and Soil

Amla tree is hardy and can be grown in variable agro-climatic and soil conditions. The mature tree can tolerate temperature upto 46^0C and young plants need protection from frost during winter. It is a potential crop for degraded and the marginal soils having soil pH 6.0 to 9.5.

Recommended Cultivatars

Balwant (2011) : It is chance seedling developed from cultivar Banarasi. Tree is semi-tall with semi spreading growth and have dense foliage. Fruit is flattened round with moderate size, rough skin and yellowish green with pink tinge. Flesh is slightly fibrous, whitish green, soft, juicy and highly astringent. Stone is moderate in size and rectangular in shape. It is earliest variety and matures in middle of November by producing 110-120 kg yield per tree.

- **Amla is rich source of vitamin C, pectin, and minerals.**
- **Degraded and marginal soils having pH 6.0-9.0 are suitable for Amla cultivation.**
- **Desi Amla should be used as rootstock. Amla is propagated by patch budding during June-September.**
- **Balwant and Neelam are early maturing varieties.**

Neelum (2011) : It is seedling selection from open pollinated strain of cultivar Francis. Tree is tall with semi-spreading growth and dense foliage. Fruit skin smooth, semi translucent and yellowish green. Flesh is almost fibreless and soft. Stone is medium and oval round in shape. It is a mid season variety and matures in end of November by giving 120-130 kg yield per tree.

Kanchan (2011) : It is a chance seedling from cultivar Chakaiya. Tree is tall with upright growth, sparse foliage. Fruit is flattened-oblong and small to medium in size. Flesh is fibrous,

hard and suitable for processing. Stone is small and round. It mature late in mid December by producing 100-120 kg fruit per tree.

Propagation : Amla is propagated by patch budding during June-September. The fruits of desi Amla should be collected during Jan.–Feb. The seeds should be sown in first fortnight of March for raising nursery.

Planting : Amla is planted at 7.5×7.5 m during February-March and August- September. To get good yield, plants of two varieties should be planted together.

Training and Pruning : The tree should be trained to single stem up to the height of 75 cm. Select 4 to 6 well spaced main branches in all directions around the trunk. Remove the dead, diseased, broken, crossing branches and suckers from root stocks.

Manures and Fertilizers : Apply farmyard manure, 15-20 kg to young and 30-40 kg to mature plant during July. In addition, apply 50 g nitrogen (110 g Urea) to each one year plant. Increase N by 50g each year up to 10 years and thereafter apply 500 g of nitrogen (1100 g Urea) to mature plants.

Irrigation : Young plantation shout be irrigated at 10-15 days intervals during summer. Avoid irrigation to bearing plants during flowering.

Harvesting and Processng : Budded Amla plants start bearing after 4-5 years and the trees start commercial yield at 10 years.

a) Prepration of lacto-fermented Indian Gooseberry/Amla beverage: The bioprocess was optimized by fermenting the blend of Indian Gooseberry juice (Indian gooseberry juice (2): Ginger (1): Guava juice (2)) water 1:3 and salt (condiment) @ 1.0% followed by pasteurization at 55ºC for 15 seconds with functional starter culture (consortia of ten allochthonous lactic acid bacteria @ 5.0% (w/v)) by incubating at 37ºC for 24 hrs.

b) Prepration of Amla pickle: Dip the 1 inch aseptically chopped Indian Gooseberry pieces in 5% brine solution followed by the addition of actively grown functional starter culture (consortia of ten LAB strains @ 5% w/v) and fermenting till 48 hrs at 37°C in tightly stoppered sterilized glass jar.

11. PLUM

Plum is a minor fruit crop of Punjab which can be planted as filler or in solid blocks. It is highly productive with medium sized, sub-acidic fruits. Plums are rich in sugars and vitamin-A. Fruits are used either as fresh fruits or processed into squash and jam.

Climate and Soil

Plum is grown under sub-tropical conditions both in plains and in sub-mountane areas of the Punjab. Varieties with chilling requirement below 300 hours can be grown successfully. Areas receiving 100-125 cm rainfall well distributed throughout the growing season are suitable for plum cultivation. Plum orchards are prone to damage by high wind velocity and must be protected by planting wind-break trees.

It can be grown successfully in deep, sandy loam soils with good drainage which are free from alkalinity and salinity conditions. Availability of ample good quality irrigation water is of primary importance while selecting a site for plum plantation. Plum trees will fail to produce commercially acceptable crop if they suffer from water deficit.

Recommended cultivars

Satluj Purple (1990) : It is a self-unfruitful variety and requires Kala Amritsari as pollinizer (pollinizer should be planted as an alternate plant in alternate rows for maximum yield). Trees are medium in vigour with upright growth habit. The fruit is medium large with average weight of 25-30g, roundish, turns into crimson colour on ripening. Fruits are thick skinned with yellow orange firm flesh. It is sweet in taste having 13-14% TSS and 0.6-0.7% acidity and is suitable for table purpose. It is an early variety ripens in the first week of May with average yield of 40 kg per tree.

- **Satluj Purple is an early variety and suitable for table and processing purposes.**
- **Plant Kala Amritsari as pollinator in Satluj Purple for higher fruit setting and yield.**
- **For higher yield and better fruit quality, Satluj Purple trees can also be planted at 6×1.5 m distance.**

Kala Amritsari (1979) : It is self-fruitful, high yielding indigenous variety with vigorous tree. Fruits are medium sized, round oblate depressed at both ends, on ripening turn dark purple. Flesh is yellowish with moderately juicy pulp. Fruits are somewhat acidic with 15% TSS and 1.2 per cent acidity. It ripens in the second week of May. Average yield is 45 kg /tree. Fruits are excellent for jam making.

Propagation

Kala Amritsari is propagated by hard wood cuttings while Satluj Purple by simultaneous grafting and rooting of rootstock cuttings. The time of preparation of cuttings and grafting is from end of December to end of January. Hardwood cuttings of Kala Amritsari should be 15-20 cm in length with 4-5 buds on them and should be of pencil thickness . To increase the rooting success their basal parts (4-5 cm) are dipped in 100ppm IBA solution for 24 hours. For making this solution, dissolve 100 mg IBA in 10-15 ml of alcohol and make up the volume to one litre.

Satluj Purple is multiplied through stenting technique i.e.simultaneous grafting and rooting of rootstock cuttings. The cuttings of Kabul Green Gaze are used as rootstock. Rootstock cuttings about 20 cm in length are tongue grafted with scion wood in the first fortnight of January. The basal parts of the grafts are given 24 hours soaking treatment with 100 ppm (100 mg/litre of water) IBA solution. The cuttings/ grafts are transplanted in well prepared nursery plots at a distance of 15-20 cm in rows spaced 30 cm apart. The plants from the cutting/grafts are available for planting after one year in the month of January.

Planting

Plum is planted either in solid blocks at 6m×6m distance or as a filler trees in mango,litchi and pear orchards during the first fortnight of January. The plants of Kala Amritsari are also transplanted in the orchard of Satluj Purple as pollinizer. Pollinizer plants are planted alternately in the every alternate row of Satluj Purple for effective pollination and improving fruit set in the orchard.

High density planting : Satluj Purple plum trees can also be planted at 6×1.5 m distance with modified leader system and summer pinching (10-15 cm). This practice ensures high yield of better quality fruits.

Training and Pruning

Training : Plum trees are trained according to modified leader system. The training is completed in 3 years from planting. One year old healthy plants about one metre in height are transplanted in the first fortnight of January. The plants are headed back at immature terminal part at planting time. If the branches are present on the stem these are prunned to short stubs. The plants sprout in February and produce numerous shoots during spring and summer months and continue growing until about the beginning of October. During the first dormancy, select 4-5 branches around the central axis spaced at 15-20 cm vertically one above the other. The remaining branches present on the central axis should be removed. At this stage the central terminal branch is called the leader. The lowest branch on the stem should be about 45 cm from the ground. During second year, plant grows in height, produces secondary branches on the selected primary limbs and new branches above the first year extension. In the third year, the tree grows and produces many new branches on primary as well as on the secondary limbs. Out of these wide angled, well-spaced branches are selected and rest are removed. In the end of the year when the plant has developed good frame-work, central leader is headed back close to an outward growing lateral. In this way the modified leader trained plant is ready for bearing fruit.

Pruning : Plum trees bear on one year old growth as well as on short spurs depending upon the variety. Generally, light annual pruning should be done in January. It consists of the removal of thin and crowding twigs and branches within the tree. Criss-crossed and lengthy branches or out of place, dried and diseased branches should be thinned out to admit sunlight in the tree center for the development of better colour of fruits. Besides, water sprouts or suckers arising from the crown part of the tree should also be cut regularly. After every 4 or 5 years of fruiting, heavy pruning of the trees is done by heading back the lengthy branches

about half of their length. The cuts thicker than 4-5 cm should be covered with Bordeaux paste or Bordeaux paint.

Manures and Fertilizers

Manures and fertilizers to the plum trees are applied according to their age.

Age (years)	Farm yard manure (kg/tree)	Dose per tree (g)		
		Urea	Super phosphate	Muriate of Potash
1-2	6-12	60-120	95-190	60-120
3-4	18-24	180-240	285-380	180-240
5-6	30-36	300-360	475-570	300-360
6 & above	36	360	570	360

Apply farm yard manure, super phosphate and muriate of potash in December. Split the N fertilizer in two halves. Apply half of N fertilizer in spring before flowering and second half one month later after fruit set.

Zinc Deficiency

Plum trees growing on light textured soils generally show zinc deficiency symptoms on the current season growth in the summer months. The affected leaves on the terminal parts of branches are narrow, small with interveinal chlorosis. On the growing tips, the affected leaves appear in whorls i.e.rossette form. If the deficiency persists, it may cause die back of the twigs and the fruits become hard and undersized. Zinc deficiency can be corrected by foliar spray (0.6% Zinc sulphate solution) containing 3 kg zinc sulphate and 1.5 kg unslaked lime in 500 litres of water as and when the deficiency symptoms are observed on plants.

Irrigation

The young plum plants upto the age of 3-4 years need irrigation at 4-5 days interval during summer months starting from April to June. Being deciduous, the plums do not require frequent irrigation during winter. Apply irrigation only when the drought

period is prolonged. The bearing trees should be given regular irrigation from fruit set to maturity. In summer, irrigation should be given at an interval of 4-5 days.

Weed Control

Weeds can be checked by manual ploughing in the soil. Application of paddy straw mulch (10 cm layer) @ 4.5 per acre effectively check the weeds. Mulching should be done during first week of March after application of second split doses of inorganic fertilizers.

Control of Pre-harvest Fruit Drop

Two sprays of NAA 10 ppm (Dissolve 1 gram NAA in 10-15 ml alchohal and then make 100 litre solution with water) in 2nd and 4th week of April or one spray of Ethrel 100 ppm (25 ml Ethrel in 100 litres of water) in 4th week of March (after pit hardening) reduced the pre-harvest fruit drop in plum cv. Satluj Purple.

- **Kala Amritsari is propagated by hard wood cuttings while Satluj Purple by simultaneous grafting and rooting of rootstock cuttings.**
- **Manage pre-harvest fruit drop in plum by spraying NAA (10 ppm) in 4th week of March.**
- **Fix PAU fruit fly traps in April to reduce the infestation by fruit fly.**

Caution : i. There should not be any water stress in the orchard at the time of spray of growth regulators.

ii. Ethrel 100 ppm should be sprayed just after pit hardening and neither before nor later than this. Otherwise, it may increase fruit drop.

iii. As the fruit growth is rapid during April, trees should be irrigated frequently.

Improvement in Fruit Quality

Two foliar sprays of potassium nitrate @1.0% (1 kg/100 litre water), first spray after two weeks of full bloom and second 10 days thereafter increases the fruit size and yield of 'Satluj Purple' plum. Care should be taken that no water stress should be there in the orchard at the time of spray.

Fruit Maturity and Harvesting

The maturity of plum fruits is indicated when these have attained normal size and colour. The peak season for plum harvest in Punjab starts from first week of May. The first sign of fruit maturity is the change of green colour to purple, red or yellow according to the variety. For local consumption fruit should be picked at ripe but firm stage. For distant market, fruits are picked when these have developed 50% colour on the skin and should be firm.

Plum fruits are harvested with stem intact avoiding any skin injury. Fruits being perishable in nature should be handled with care. The basket used for picking should be padded with soft dry grass at the bottom and on the sides. Immediately after harvest, transfer the fruit to some shady area under the trees/shed. For local market, fruit should be picked in the early hours of the day and immediately shifted to the shed/tent for sorting, grading and packaging. For distant market the fruits are picked in the evening hours and kept in the orchard shed to cool them overnight for sorting, grading and packaging.

Post-harvest Handling

The fruits which are over ripe, soft, bruised or immature should be discarded. Fruits are graded according to their size, colour and appearance. Different grades of fruits are packed in separate boxes and labeled. Three standard sizes recommended under "Ag-Mark" system of grading of plum along with the box size are as follows:

Grade	Fruit size (diameter in cm)	Inner size of box (cm)	Number of layers	Number of fruits/layer
Special	4.2 & above	36×16×16	3	28-32
Grade-I	3.6-4.2	-do-	4	38-42
Grade-II	Below 3.6	-do-	4	50-56

In general, the fruits should be packed in 5 kg wooden boxes instead of bamboo baskets. To prevent the fruits from injury,

interior of wooden box should be lined with newspaper sheets on all sides and paper strips as padding at the bottom. The fruits are placed in layers. After each layer make a partition of paper strips over lined with newspaper sheet. Top layer of the fruit is covered with a cushion of paper strips and newspaper sheet and finally the lid of the box is nailed.

Plum is a perishable fruit and its shelf-life is short. Low temperature storage prolongs the effective life of fruit. For best results fruit should be picked at the correct maturity and placed immediately in commercial cold stores where temperature is 0^0-3^0C with relative humidity 85-90%. The fruit remains in good condition for 25 days. To facilitate better marketing of plum, refrigerated vans are desirable for transportation.

Storage : The Satluj Purple plum fruits, harvested at colour break stage, followed by post-harvest treatment of calcium nitrate (2%) solution for five minutes, can be stored for four weeks in cold storage (0-1^0C and 90-95% RH) with post storage shelf-life of 2 days at ambient temperature.

Non alcoholic naturally carbonated beverage can be prepared from fruits of Satluj Purple and Kala Amritsari plum at small and large scale. It has three months shelf life and retains its original nutrients.

Plant Protection Measures (as given under peach)

12. BANANA

Cultivation of banana can be made successful under subtropics like Punjab, if planting is so regulated that bunches emerge before winter, so that there is minimum frost damage and choke condition is avoided. This has been made possible by planting tissue culture raised plants at proper time and of specific size. Tissue culture raised plants are known to decrease the time for emergence, maturity of bunches and also improve yield over conventional plants raised from suckers.

Climate and Soil

Banana is a tropical plant which is normally grown in coastal states of India, but it is successful in subtropical climate also by adopting cultural practices so as to escape winter frost damage. It is most suitable for bet area, river banks and central zone comprising districts of Moga, Ludhiana, Fathehgarh Sahib, Mohali, Sangrur, Barnala and paddy growing areas of arid irrigated zone with pH upto 8.5.

It prefers neutral soil pH (6.5-7.5), but can be successfully grown in deep, well drained loam soils with pH up to 8.7 and rich in organic matter. It is a shallow rooted crop, so at the time of selection of soil, drainage and anchorage may be kept in mind.

Recommended Cultivar

Grand Naine (2008): The plants of this variety may attain an average height of 7-8 ft. It produces heavy bunches weighing 18-20 kg and require propping. Average size of fingers is 24 cm in length and 3.5 cm in width. The variety fetch good price in market.

- **Banana is rich in carbohydrate and vitamin K .**
- **Cover the bunches with polythene sheet and stalk with banana leaves for frost protection.**
- **Ethylene gas or solution of ethephon can be used to ripen the banana fruits.**

Propagation

Plants raised through tissue culture are recommended.

Planting

Tissue culture raised banana plants of 30 cm size should be planted between 15 Feb. to 7 March in the field at 1.8 ×1.8 m distance. Before planting pit of 60 cm×60 cm size should be filled with half FYM and half top soil after mixing with 180g DAP (90 g P_20_5) or NPK (12:32:16).

- **Apply recommended doses of fertilizers from April to September for better yield.**
- **Do not allow the suckers to grow till the emergence of panicle and allow one sucker per plant after bunch emergence.**
- **Use ethylene gas or ethephon solution for uniform ripening.**

Manures and Fertilizers

Fertilization 450 g urea (200 g N) and 350 g muriate of potash (210g K_2O) in 5 equal doses should be applied during April, May, June, July, August and September as given below by adopting any one option.

Fertilizer schedule for Banana cv Grand Naine

Dose per plant (g)					
Month	**Urea**	**Option 1**		**Option 2**	
		DAP	**MOP**	**NPK (12:32:16)**	**MOP**
February-March*	-	190	-	280	-
May	60	-	60	-	-
June	60	-	60	-	40
July	80	-	70	-	60
August	80	-	80	-	80
September	80	-	80	-	80

*At the time of planting.

Irrigation

Banana prefers wet soil conditions. Water is crucial for its growth. Little moisture stress can lead to decrease in finger size and colour of leaves. Excess water may lead to breakage of pseudostem near root portion, due to rotting. The details of water requirement are given below:

Irrigation schedule for banana cv Grand Nalne

Irrigation time	Time of Irrigation
March-April	7-8 Days
May-June	4-6 days interval
July onwards during rains	7-8 days interval, as per need
October-February	10-15 days interval

Sucker management : Excessive emergence of suckers from the main plants is a serious problem in banana. The suckers should be periodically removed till 70-80 % plants come into flowering. One healthy sword sucker (sucker with sharp leaves and broad base) is retained per plant opposite to the side of inflorescence.

Spathe removal : Spathe (the reddish terminal portion) should be removed after emergence of 8 hands per bunch. The poorly developed flowers below 8 hands should also be removed to ensure proper development of fingers. Dry leaves and debris touching the developing fruits should also be removed for producing quality fruits.

Propping and earthingup : Heavy bunches and succulent nature of plant may result in lodging, therefore all the plants should be provided with a support under the bunches. Banana is a surface feeder and its roots don't go deeper in the soil, so earthing up is done upto 10 -12 inches of the basal portion of the plant to support and save the plants from winds.

Frost Protection : To save the crop from frost damage, irrigate the fields and smoke the crop with farm waste during expected frost days. In the last week of november cover the bunches with polythene sheets and stalks with banana leaves to decrease the frost injury and breakage of stalks. The bunch coverings are removed in the last week of February.

Fruit Maturity and Harvesting

Emergence of bunches will start during September-October-November. These will be ready for harvesting during April-May. Harvesting should be done carefully so that sap from cut ends should not flow on the fruits otherwise it would lead to blackening of bunches.

Ratooning

Banana yields two-ratoon crops after 1st crop; which means banana yields 3 crops. One sucker per plant should be retained during September after the emergence of panicle or at the time when about 80% of panicles emerged in the field.

Post-Harvest Management and Processing

Ripening: The banana fruits harvested at green mature stage can be successfully ripened in four days by exposing to ethylene gas (100 ppm) for 24 hours in a ripening chamber maintained at 16-18°C and 90-95% RH. The fruits attained uniform colour, excellent quality with shelf-life of 4 days at 16-18°C and 2 days at 30-32°C. The banana fruits harvested at green mature stage can also be successfully ripened in 4 days by dipping in a solution of ethephon 500 ppm (1.25 ml per litre of water) for 2-3 minutes. The fruits should be air dried and kept at 16-18°C and 90-95% RH. The fruits attained uniform colour, excellent quality with shelf-life of 4 days at 16-18°C and 2 days at 30-32°C.

Plant Protection Measures

A. Insect Pests

Tobacco caterpillar, thrips and aphid feed on banana plants. Low population of aphid is active during February-mid April and again during September-October, while thrips is active during May-June.

Pests and symptoms of attack	Control
1. Tobacco caterpillar : It is active during July-September. Gregarious caterpillars cause damage both on upper and lower surface of leaf blades while full grown caterpillars (solitary) eat up the central whorl of plant thus render the plants stunted.	---
B. Diseases	
Diseases and symptoms	**Control**
1. Bacterial soft rot : Pseudostem rots, affected tissues become soft, dark brown or black and breaks at the ground level.	(i) Use disease free planting material (ii) Improve the drainage in field (iii) Avoid injury to rhizome and pseudostem.

13. SAPOTA

Sapota is an important fruit which can be successfully grown in the sub-mountainous parts of Punjab. Sapota trees are ever green with spreading canopy and have long productive life. The pulp is sweet and melting. It is a good source of digestible sugar and has appreciable amounts of protein, fat, fibre and minerals like calcium, phosphorus and iron.

Climate and Soil

The climatic conditions of the sub-mountainous Punjab are suitable for the growth and fruiting of sapota. Sapota is a tropical fruit crop where it flowers and fruits through out the year and when it is grown under subtropical conditions of Punjab it gives only one commercial crop. It prefers warm and humid conditions. The sapota is a hardy, perennial and evergreen tree. It can be grown on a wide range of soils. The soil should be deep, well drained and there should be no hard pan in the sub-soil.

Recommendation Cultivars

Kalipatti (2011) : It is high yielding table variety having dark green, broad and thick leaves. Branches are of spreading type. Fruits are oval shaped with sweet, mellow flesh of excellent quality. Fruits are born singly and contain 1-4 seeds per fruit. Average fruit yield is 166 Kg/ tree.

- **Sapota is rich in sugars, proteins, fat, fiber and minerals like calcium, phosphorus and iron.**
- **It is suitable for cultivation in sub-mountanious parts of Punjab.**
- **Kalipatti has oval while Cricket Ball has round shaped fruits.**

Cricket Ball (2011) : Trees of this variety have less dense branches. The fruit are large in size, round in shape and have 3-5 seeds per fruit. Pulp is gritty, granular with excellent taste and flavour. It is a shy bearer when grown singly but gives good performance when planted with Kalipatti. Average fruit yield is 157 kg/tree.

Propagation

Veneer grafting is a commercial method of its propogation.

Khirni is the best rootstock producing vigorous plants with high productivity. The rootstock seedlings are raised in pots or beds. Seedlings of pencil thickness are suitable for veneer grafting. The plants become ready for sale within one year after grafting.

- **Propagate plants by veneer grafting on Khirni rootstock to develop vigorous plant with high productivity.**
- **Grow Pulses, Peach, Plum, Lemon, Guava and Phalsa as intercrops in orchard till commercial bearing of Sapota.**
- **Harvest sapota when mature. No green tissue and milky latex should ooze out upon scratching with nails.**
- **Use ethephon solution @ 1000 ppm for two minutes to obtain uniform ripening.**

Planting

Sapota being evergreen fruit plant can be planted during February-March and September-October in the pits (1mx1mx1m) prepared about a month earlier. The planting should be done at 9m×9m metre spacing.

Manures and Fertilizers

Age of tree (Year)	Farmyard manure (kg / tree)	Dose (g/tree)		
		Urea	Superphosphate	Muriate of Potash
1-3	25	220-660	300-900	75-250
4-6	50	880-1300	1240-1860	340-500
7-9	75	1550-2000	2200-2800	600-770
10 & above	100	2200	3100	850

Farmyard manure, Phosphorus and Potassium should be applied in the month of December-January. Half of Nitrogen should be applied in the month of March and remaining half in July-August.

Irrigation

Sapota can bear drought conditions up to some extent, but for commercial production it requires assured irrigation. Sapota requires irrigation at 30 days interval in winter and 10-12 days

interval in summer. At flowering time frequent irrigation should be applied to maintain humid conditions in the orchard for better fruit set. Young plants should be watered regularly at 6-8 days interval during hot dry summer season, and as per need during rainy and winter seasons.

Intercropping

Sapota is a slow growing plant and takes about 7-8 years to come into commercial bearing. Besides, there is sufficient space in the orchard to grow intercrops during pre-fruiting years. The type of intercrop depends upon the soil, climate as well as the marketing facilities. Pulses and vegetables should be preferred as intercrops. Quick growing fruit plants such as Peach, Plum, Kinnow, Guava, Phalsa, etc. can be also be inter-planted in sapota orchard as filler plants. Separate arrangement should be made for irrigation and fertilization of intercrops/ interplants.

Fruit Maturity and Harvesting

Sapota fruit is climacteric in nature and should be picked when properly mature. It takes about 10 months from fruit set to maturity. Maturity is judged on the basis of ease with which the brown scurf gets off the fruits surface and development of yellowish tinge intermixed with corky-brown colour on the surface of the fruits. At this stage, no green tissue and milky latex are seen on the fruits when scratched with nails. Properly developed fruits have high TSS and sugars, and reduced acidity, astringency and latex. The fruits should be hand-picked. Harvested fruits should be cleaned of latex and scurf by washing in clean water or by rubbing with gunny bags. Uniform ripening of fruits can be achieved by dip treatment with Ethephon @1000 ppm (2.5 ml/ litre water) for two minutes. The fruits should be graded on the basis of size as big, medium and small. Fruits should be packed in Corrugated Fiber Board boxes of 10 kg capacity with rice straw or paper strips as padding material.

14. PAPAYA

Papaya is an ideal fruit for growing in kitchen gardens and backyards of houses. It is also grown extensively as a filler plant in the orchards as well as main crop under portected conditions. Papaya is quick growing and starts bearing within 8-10 months of transplanting. It is a rich source of vitamins, minerals and enzymes. Papaya contains about 2500 i.u of vitamin A and 85 mg of vitamin C per 100 g pulp. Fruit contains a valuable enzyme papain, which helps in the digestion of protein rich foods.

Climate and Soil

Papaya is a tropical fruit plant. It requires warm and humid climate and can be cultivated upto height of 1000 metres above sea level. It can be grown successfully in Punjab and plains of north India. Papaya is very sensitive to frost and wet soil conditions. It should, therefore, be planted in frost free areas on well drained soils. Young plants must be well protected against frost. They should be covered with transparent plastic envelops, *sarkanda*, straw thatches or any other covering material from November to February against frost damage.

Recommended Cultivars

- **Papaya is rich source of vitamin A and C, enzyme, papain and minerals.**
- **It is ideal for growing in kitchen gardens.**

Red Lady 786 (2013) : Plant are self fruitful and vigorous having height of 238 cm. Fruit bearing starts at 86 cm height from the ground level. Fruits are medium, oblong to oval, flesh reddish orange with excellent taste and flavour. It matures after ten month of planting. Average yield is 50kg per plant. The plants are free from disease and pest incidence under protected conditions.

Punjab Sweet (1993) : It is a dioecious variety having plant height of 190 cm. Fruit bearing starts at 100 cm height from the ground level. Fruits are large, oblong in shape with pointed tip. Flesh colour is deep yellow. TSS ranges from 9.0 to 10.5 percent.

Average yield in 50 kg/ plant. It is least susceptible tocitrusmite,*Eutetranychus orientalis*.

- **Plant Red lady 786 in protected condition at 1.8 m × 1.8 m spacing. All plants bear fruits.**
- **Uproot immediately the collar rot / stem rot and virus infected plants.**

Pusa Delicious (1992): A hermaphrodite variety of medium vigour, having a plant height of 210 cm; fruiting starts at 110 cm height from ground level; fruit is medium to large; fruit shape is oblong to oval, flesh deep orange with excellent taste and flavour; TSS range, from 8-10 per cent. Average yield is 46 kg per plant.

Pusa Dwarf (1992) : It is a dioecious and dwarf variety having plant height of 165 cm. It starts bearing fruit at 100 cm height from the ground level. Fruits are medium in size, oval in shape with orange coloured flesh having TSS of 8-9 per cent. This variety is resistant to lodging and can withstand cold better than other varieties. Its average yield is 35 kg per plant. It is also very suitable for kitchen garden.

Honey Dew (1975) : The plant is of medium height and bears fruit quite heavily on the trunk. The proportion of the male plants is low. The fruit is large, elongated and contains few seeds. The flesh is extra-fine and sweet with pleasant flavour. This variety is also known as Madhu Bindu.

Propagation

Nursery Raising : Papaya seedlings are raised in polythene bags of 25×10cm having about 8 to 10 holes of 1.0 mm diameter on lower part for drainage. Fill the bags with a mixture of farmyard manure, soil and sand in equal proportions. Seeds are sown in the second week of July to third week of September in polythene. When the seedlings have emerged, drench them in poly bags with 0.2% Captan to prevent from damping off disease. The nursery will be ready for transplanting in September-October.

Planting

Dig pits of 50 cm × 50 cm × 50 cm in size at a spacing of 1.5 × 1.5 meters. Fill the pits with a mixture of equal quantity of soil and

the well-rotten farmyard manure. Give a light irrigation to make the soil settle in the pit. In the first week of September to 15th October, transplant the seedlings and give a light irrigation. Under protected structures, papaya *cv.* Red Lady-786 can be planted at 1.8×1.8 m spacing.

Pollination

When the plants have started flowering, thin them out to one plant per pit, taking care the final population of plants has only about 10 per cent males that are well scattered throughout the field for adequate pollination.

Manures and Fertilizers

The plants should be manured at the rate of 1.25 kg of fertilizer mixture i.e. urea, superphosphate and muriate of potash in the ratio of (1:2:1/3) twice a year (February and August) alongwith 20 kg of well rotten farmyard manure.

Ripening of Fruits

Physiologically mature fruits of papaya cv. Red Lady 786 harvested at colour break stage during winter and wrapped in paper can be ripened at 25°C in 72-96 hrs.

Plant Protection Measures

A. Insect Pests

Pests and symptoms of attack	Control
1. Aphid (*Aphis gossypii* and *Myzus persicae***):** Nymphs and adults suck the cell sap. These aphids act as vector of papaya mosaic virus.	---
2. Whitefly (*Bemisia tabaci***):** Both nymphs and adults damage the papaya trees. Tiny, white scale like objects cluster in-between the veins on ventral surface of leaf. The pest is active during dry season. With the sucking of cell sap from the leaves, the affected leaves become yellowish, curl downwards, wrinkle and there is early shedding. It also transmits virus causing leaf curl disease.	---

B. Diseases

Disease and symptoms	Control
1. Anthracnose : (*Colletotrichum gloeosporioides, Gloeosporium sp***).** Fruits are severely affected as all the spots on the fruit become depressed and bear pinkish masses of spores of the fungus. Necrotic spots are produced on the leaves. Profuse fungal growth appears in concentric rings on the lesions.	(i) Improve the drainage in the field. (ii) Destroy the infected fruits. (iii) Avoid bruising of the fruits.
2. Collar rot and Stem rot : (*Pythium aphanidermatum and Phytophthora parasitica***):** Roots and trunk of the plant rot producing wet texture. The fungus causes the yellowing of the foliage, stunting of the growth and poor fruit development leading to the death of the plant.	(i) Improve drainage. (ii) Irrigation water should not come in contact with main stem & affected plants.
3. Papaya mosaic (*Virus***) :** Leaves become small, curled and wrinkled. The diseased leaves show blister like patches of green tissue of yellow background.	Uproot and destroy affected plants immediately.
4. Papaya leaf curl (*Virus***) :** Young leaves at the top of the affected plant become curled, twisted and deformed and deep green. Such plants become stunted and bear no fruit.	Uproot and destroy affected plants immediately.

15. POMEGRANATE

Pomegranate is very much liked for its cool, refreshing juice and also for its medicinal properties. It is commercially grown in India for sweet, acidic taste and table purposes. The bark of the stem, root and rind of the fruit is used for slimming, control of dysentery, diarrhoea and killing of tapeworms. The climatic conditions of Punjab are not highly suitable for cultivation at large scale, hence consult horticulture experts before planting pomergranate for commercial cultivation.

Climate and Soil

Cool winters and hot dry summers produce the best quality fruits . It thrives in hot dry regions with irrigation facilities. The deep loams or alluvial soils are considered ideal. Medium or deep light black soils are useful. Pomegranate can tolerate alkaline and wet soils. The cold winters make the trees deciduous which are otherwise evergreen.

Recommended Cultivars

Bhagwa (2013) : Tree medium in size, bushy, partial deciduous and regular bearer. Fruit medium to large in size, rind smooth, glossy, red in colour, soft seeds having red colour aril. Fruit weight is 215g, juice 45.03%, TSS 13.6% and with low acidity 0.48%. To get well sized and good quality fruits, flower buds/flowers should be removed manually after one month of fruit set in May. It matures in mid August to mid September. Its average yield is 20-25 kg/plant.

- **Grow Bhagwa for red coloured fruits and red arils.**
- **Use hard wood cuttings for propagation of nursery plants and dip the cuttings in IBA (100 ppm) for 24 hours to get higher rooting.**
- **Always remove dead, diseased, broken and water sprouts from the main trunk for single stem up to 30 cm.**
- **Spray Bordeaux mixture for the control of black rot disease.**

Ganesh (1997) : Tree is evergreen, bushy, precocious and regular bearer. Fruit medium, peel colour yellow with pink blush,

arils white with pink tinge. Soft edible seeds, TSS of juice is 13 per cent with low acidity (0.5%). Main crop (ambe-bahar) matures in mid August. To get-well sized and good quality of fruits, flower buds/flowers should be removed manually from 15th April onward. Its average yield is 25-30 kg/plant.

Kandhari (1997): Tree is deciduous, vigorous and upright. Regular bearer, moderate yielding, bears only in ambe-bahar with red splash on the fruit rind, arils light pink with semi hard seeds, juice is sweet with 12 per cent TSS and well blended with acidity (0.61%). To get well sized and good quality of fruits, flower buds/ flowers should be removed from 22nd April onward. Its average yield is 25-30 kg/plant.

Propagation

Pomegranate plants can be prepared by rooting of hard wood cuttings during December. For getting high percentage of rooting, dip cuttings in 100 ppm IBA (100 mg/litre water) for 24 hours, before planting in nursery beds.

Planting

One metre deep pits with one metre diameter should be prepared during November-December. The planting should be done during January. Ganesh should be planted at a distance of 3×3 m, whereas, Kandhari at 4×4 m apart.

Training and Pruning

Develop the plants as a single stem upto 30 cms. Basal branches should not touch the ground. The dead, diseased, broken, criss-crossing branches and water sprouts on the main trunk should be removed.

Manures and Fertilizers

Apply farmyard manure @ 5-6 kg per plant per year of age during December. In addition, apply 20 g N (50g Urea) for each year. The doses (urea 250g) should be stabilized after five years. N should be split into two halves. One should be added in February and other half in April.

Irrigation

In winter, light irrigation should be given during a long dry-spell. During summer irrigate at an interval of 10-15 days.

Plant Protection Measures

A. Insect Pests

Pests and symptoms of attack	Control
1. Aphids : Cause damage to the plants by sucking the cell sap from leaves, flowers and tender fruits.	---
2. Fruit borer: Some times attacks the developing fruits during May-June.	---

B. Disease

Disease and symptoms	Control
1. Black spot: (*Xanthomonas axonopodis pv. punicae*) : Black spots develop on the mature fruits as soon as the rain starts. The intensity increases with the increase in humidity.	Spray Bordeaux mixture during May and again in June and July.

16. STRAWBERRY

Strawberry (Fragaria× ananassa Duch.) is herbaceous annual fruit crop and got the name as grows on cushioning straw material. The fruits are attractive, luscious, tasty and nutritious with a distinct pleasant aroma and delicate flavour. It is a good source of antioxidants including carotenoids, vitamins, phenols, flavonoids, proteins and minerals like P, K, Ca and Fe. Fruits are consumed as fresh and for processing purposes. An array of products like jams, squash, ice-creams, syrups, ready to serve (RTS), cosmetics, confectioneries etc can be prepared from strawberry fruits.

Climate and Soil

Strawberry can be grown on a wide range of soils but thrives better on well-drained, medium sandy loam soil which is rich in an organic matter as nearly 70-90 per cent of its roots are confined to 15-20 cm topsoil. Heavy, clayey and waterlogged soils are not suitable for its cultivation. It grows well on light acidic soils but can also be grown on soils upto 7.5 pH. A temperature of 15-26^{o}C is considered optimum for its vegetative growth and development.

Recommended Cultivars

Chandler (2021): It is mid-season cultivar and fruits are available from first week of February to first week of April. Fruits are medium, conical to sometimes long flat in shape with glossy and attractive skin. Flesh colour is deep red. Average fruit weight is 17.2 g, TSS 8.7 %, acidity 0.83 % and TSS/acid ratio 10.48. Average yield is about 260 g/plant.

Winter Dawn (2021): It is early maturing cultivar and fruits are available from mid January to end of March. Fruits are large, medium conical to wedge shaped with deep red and glossy skin. Flesh color is dark red. Average fruit weight is 20.2 g, TSS 9.1%, acidity 0.82 % and TSS/acid ratio 11.2. Average yield is about 290 g/plant.

Propagation

Strawberry is propagated through runners. Tissue culture plants should be used as mother plants for runner production. The plants can be multiplied in the hilly areas as its plants do not

survive in extreme dry summers under plains of North India. They are also prone to various diseases, high humidity and low sunshine hours during rainy season create problems in its cultivation.

Preparation of Soil and Plant Spacing

Prepare the land thoroughly by deep ploughing followed by harrowing and add well rotten FYM to the soil. Healthy runners either bare rooted or raised in polybags with a medium to the large crown and well-developed root system should be transplanted in evening hours. Plants are transplanted at a spacing of 30 cm × 30 cm on well prepared 15-20 cm raised beds of 80 cm width. The distance of 40 cm between the beds should be maintained and we can accommodate 22,000 plants per acre.

Time of Planting, Mulching and Low Tunneling

The time of transplanting planting strawberry is mid-October. Strawberry seedlings should be transplanted by keeping plant crown slightly above the ground level for proper establishment in between the dripper lines and for the proper distribution of fertilizers and irrigation water. Cover the beds with silver-black polyethylene mulch of 30 μ thickness to improve fruit yield and quality. It protects the plants and their roots against extreme temperature fluctuation, suppress weeds and helps to conserve soil moisture. Strawberry plants should be covered with low tunnel transparent plastic sheet (50 μ thickness) over the iron frame at center height of 60 cm from end-December to mid-February to minimize winter injury, plant mortality and enhancing productivity. Keep the distance between the successive frames at 2.50 m.

Drip Irrigation and Fertigation

Strawberry is a shallow-rooted plant and requires light and frequent irrigations to maintain optimum soil moisture for quality fruit production. Fertigation through drip irrigation system tends to distribute the plant nutrients uniformly in the root zone, where the most of active roots are confined and thus enhancing the nutrient use efficiency.

Adequate water supply is essential throughout the cropping season, particularly during plant growth and fruit development stages. Strawberry is highly susceptible to excessive soil moisture.

Strawberry should be drip irrigated daily with lateral pipes having dripper discharge of 2.2 liters per hour and drippers are placed at 30 cm apart. Start fertigation after 6 days from the date of transplanting and total 44 Kg N, 32 Kg P_2O_5 and 40 Kg K_2O_5 per acre as per given in schedule.

In general, combinations of polyethylene mulch and fertigation considerably promote plant vegetative growth and enhancement of fruit yield.

Drip irrigation schedule for strawberry in minutes/day

Months					
November	**December**	**January**	**February**	**March**	**April**
Time in minutes					
10	14	12	22	29	38

Fertigation schedule for strawberry

Days after transplanting (DAP)	Water-soluble fertilizers	Fertilizer application (Kg/day/acre)
6 -35	NPK (19:19:19) Urea Phosphate (17:44:0) Urea (46:0:0)	0.82 1.00 0.65
36-60	NPK (19:19:19) Urea Phosphate (17:44:0) Urea (46:0:0)	1.68 0.70 0.23
61-90	Muriate of Potash (White) (0:0:60) Sulphate of Potash (0:0:41) Urea (46:0:0)	0.81 0.55 1.00
91-120	NPK (19:19:19) Sulphate of Potash (0:0:41)	0.87 0.55
121-155	Muriate of Potash (White) (0:0:60) Urea Phosphate (17:44:0) Urea (46% N)	0.40 0.18 0.28

Harvesting and Marketing

Strawberry is a non-climacteric and highly perishable fruit crop. Hence, utmost care should be given for harvesting, handling and marketing. Harvest berries when 50 to 75% pericarp of the

berry develops red colour which depend upon the distance to the market. For local markets, pick the fruits at the pink or three-fourth coloured stage. Pick the fruits along with the caps or calyx and the stalk, one to two inches from the calyx. Fruits are usually harvested in morning hours in shallow trays and avoid bulky containers to transport the harvest fruit from the fields to pack house. Discard diseased, misshapen, sunburn and also overripe fruits during sorting, grading and packaging. Strawberry fruits harvested at entirely red (ripe) stage should be packed in 200 g punnets and these punnets should be packed in corrugated fiber trays or ventilated cardboard boxes. Strawberries can be stored at 5 ± 1^{0}C; 90-95 % RH for 6-9 days and at ambient conditions up to 2 days.

17. PHALSA

Phalsa is indigenous to India. Phalsa is highly esteemed as fresh fruit, juice and syrup. The fully mature fruits do not keep long. It is a hardy bush bearing small berry like fruits. It is a minor fruit of the Punjab State.

Climate and Soil

Capable of growing and fruiting in the hot, dry environment. Phalsa can also thrive in the humid tracts of coastal India. Rich loamy soil is considered to be good for deep root system of phalsa. Non alkali soils free from layers of *kankar* are suitable for phalsa cultivation. Any type of soil of loamy texture, free from alkalinity and pan formation is suitable. It is adapted to do well in drought conditions.

Propagation

Phalsa is propagated from seed. For this, good sized and coloured fruits should be obtained in June. The seeds should be sown in well prepared nursery beds in July-August after the onset of monsoon.

Planting

Transplant healthy seedlings during January-February.

Training and Pruning

Phalsa plants should be trained as a bush. Bush like trained plants are prunned annually in January-February at ground level. If trained on single stem to a height of one metre from the ground level, then these are prunned every year at that height

Manures and Fertilizers

Apply 10 kg of FYM and 75 g Nitrogen (170 g urea) per bush soon after pruning.

Maturity and Harvesting

Phalsa bushes start bearing in the second year. Bushes yield a good commercial crop in the third year after planting. The fruits start ripening by end May and its harvesting continues throughout June. Ripe berries are carefully picked on alternate days. The fruit is packed in small baskets or 2 kg packs.

18. LOQUAT

The loquat can be grown successfully in sub-mountainous parts of Punjab. This fruit needs more attention as it ripens during end March-April at a time when there is hardly any fruit available in the market. Thus it commands good price in the market.

Climate and Soil

The loquat trees are resistant to heat and drought. The thick, leathery leaves are well adapted to withstand seasons of neglect without serious injury. However, warm and dry climate is essential at the time of fruit ripening.

The loquat grows well on a fertile and light sandy loam soil. Good drainage is considered essential for better tree performance.

Recommended Cultivars

California Advance (1970) : Fruit medium sized, conical to round in shape. External colour yellow. Flesh creamy white, taste sour-sweet. Fruit contain 2 or 3 medium sized seeds. Ripens during fourth week of April.

Golden Yellow (1967) : It has medium sized egg-shaped fruit with attractive golden-yellow colour. Flesh is yellowish with sour-sweet taste. Each fruit contains 4-5 medium sized seeds. Ripens during third week of March.

Pale Yellow (1967) : It has medium to large fruits, which are slightly conical to roundish in shape, pale yellow in colour. Flesh is white and taste sour-sweet. Each fruit contain 2 or 3 medium sized seeds. Ripens during second week of April.

The recommended cultivars of loquat are self-incompatible or partially self-compatible. So solid blocks of one cultivar can not be planted. California Advance is a good pollinizer for both Golden Yellow and Pale Yellow and should be planted alongwith these varieties.

Propagation

The vegetative propagation is very important to raise good quality true-to-type plants for commercial orcharding. Promising

loquat varieties are generally grafted upon loquat seedlings of commercial varieties.

Rootstock Raising : Loquat seed germinate readily when these are sown immediately after extraction from the fruit. The seeds should not be allowed to dry after extraction as exposure to heat and light tends to result in poor germination. Fresh seeds are sown during April-May in moist sand. When seedlings are 4-5 cm tall, they are transplanted in the nursery for further growth and grafting.

Inarching: The usual technique is to raise the plants through inarching. The best time for inarching is July-August. Air layering is also possible but success is much less.

Planting

There are two planting seasons viz. February-March and August-September. The plants should preferably be planted during August-September when the weather has cooled down sufficiently. Loquat should be planted at 6.5×6. 5 m in square system.

Irrigation

The loquat is more tolerant to drought. However, the best results are obtained when the orchard is irrigated judiciously. During fruit growth period to maturity, three to four irrigations are generally recommended.

Manures and Fertilizers

Age of plant (years)	Farm yard manure (kg/tree)	Dose per tree (g)		
		Urea	Super phosphate	Muriate of Potash
1-2	10-20	150-500	200-500	150-400
3-6	25-40	600-750	500-1200	600-1000
7-10	40-50	800-1000	1500-2000	1100-1500
Over 10	50	1000	2000	1500

All farmyard manure should be applied in September alongwith P and K fertilizers. Apply half dose of urea in October and remaining half during January-February after the fruit set.

Maturity and Harvesting

The loquat tree starts bearing fruit in third year of planting. The harvesting of immature and green fruits should be avoided. All fruits in a cluster usually mature uniformly. Entire cluster may be cut at one go. The fruits should never be pulled from the tree by hand. The fruit should preferably be harvested with clipper. Average yield of loquat tree is about 16 kg. However, well maintained and healthy trees can yield fruit upto 40 kg.

Post-Harvest Handling

Grading: The fruits should be graded in to two categories before packing. The large sized fruits free from blemishes should be placed in one box while all the remaining marketable fruit should be packed in another box. All superfluous stems should be clipped off. Badly bruised, shrivelled or scarred fruits should be discarded.

Packing: The fruits require careful packing. Paper is placed at the bottom of each box. The paper cuttings can be used for providing cushion. The wooden boxes of 14 kg size should be used for sending fruit to nearby markets.

Plant Protection Measures

A. Disease

Disease and symptoms	Control
1. Shoot fruit blight and Bark canker (*Phoma glumerata*) : For symptoms see under pear.	Same as given for pear.
2. Crown rot (*Phytophthora sp*): The fungus attacks the bark producing canker from the ground level upto the main points from where the main limbs emerge. The rot girdles the trunk the next 2-3 seasons. Flowering is profuse on the affected trees, but fruiting is sparse and of low grade. Yellowish-green foliage is characteristics of the disease.The trees show partial or complete wilt symptoms. Ultimately the whole tree may succumb to the disease and dry up completely.	(i) Remove the severely infested trees and burn. (ii) Remove the diseased bark during the dry season by extending the cut an inch beyond the diseased zone on all sides. First treat the cut part with the Disinfectant solution and then apply Bordeaux paint after a week. (iii) Immediately after the above treatment, spray the trees with Bordeaux mixture. Repeat the spray just before the monsoon; during the monsoon and thereafter, too, till October.

3. Root rot/White rot (*Polyporus palustrisis*) : The affected tree shows symptoms of wilt during early leaf fall and increase in the fruit-set. The fruiting bodies which may grow up to 30 cm, or more in diameter usually appear when the rot is fairly well advanced.	(i) Locate the affected trees in early stages by examining the roots and the root collar region of the trees, showing weakening signs. Dig out decayed roots and cut them completely right from the collar region. (ii) Treat the cut end of the roots immediately with disinfecting solution. When dry, apply Bordeaux paste. (iii) Drench the soil from where the dead roots have been dug out with Bordeaux mixture

19. FIG

Fig is commonly known as '*Anjeer*' in North India. As a fresh fruit, it has a luscious taste. Fruits have been prized over centuries for the medicinal and dietary properties. The figs are consumed fresh, dried, preserved, candied, canned or used for jam making.

Climate and Soil

The tree being deciduous it can tolerate frost and low temperature without any injury. Very high temperatures in summer may cause scorching of terminal leaves. Heavy rains at the time of fruit ripening cause splitting of ripe fruits. It is grown on a wide variety of soils and grows well on heavy clays, rich loam and light sandy soils with good drainage.

Recommended Cultivar

Black Fig 1 (2019) : The trees are dwarf. Fruits are medium to large in size, delicious, purplish pink in colour on yellow background and have a medium sized eye. The flesh colour is cream to pink with excellent flavour. Fruits mature from mid-June to first week of July. The average fruit yield is about 13.0 kg per tree.

Brown Turkey (2013): The fruit are medium to large size, delicious with deeply coloured ribs and a medium sized eye. The fruit skin is purplish brown and lighter at the stem end. The flesh is pinkish brown with an excellent flavour. The tree is prolific bearer and yield 53 kg fruit per tree. Fruits mature from last week of May to end June.

Propagation

It propagates readily from hardwood cuttings. Make cuttings from one year old shoots during January. The cuttings should be 25-30 cm long having at least 3-4 buds. The cuttings should be planted on well prepared flat beds in the nursery. Keep one third portion of the cuttings above ground and bury the remaining two-third in the soil.

Planting

The rooted cuttings are transplanted in the field at a distance

of 6m×6m during middle of January to first fortnight of February before they start sprouting.

Training and Pruning

The trees are trained according to modified leader system. The training is completed in 3-4 years from planting. It bears fruits individually in the axils of leaves on current season's growth. A light winter pruning may help to stimulate new wood growth and increase the crop. Mature trees may need a heavy winter pruning approximately after every three years to encourage enough new wood for a good crop. Branches that are diseased, broken or overlapping need to be removed. Bordeaux paste should be used to protect the cut ends.

Manuring and Fertilization

To obtain good yield, adequate nutrition must be ensured in young as well as in mature trees. Nutrient requirements vary according to age of plant and soil type. The annual nitrogen dose can be split into two applications, first half is applied soon after pruning and remaining half is applied two months later when the fruits are developing.

Irrigation

Fig trees are easily stressed in hot dry periods because of their shallow root systems. An even moisture supply is important during fruit development. A sudden increase in water supply during the ripening period will cause fruit to split.

Fruit Maturity and Harvesting

Fruits are picked when they become fully coloured but still firm. A ripe fruit start to bend at the neck. Fruit maturity also becomes evident from sudden increase in fruit size. Fruits are harvested by hand with a twisting and pulling motion. Pickers should wear gloves and protective clothing, as the latex oozing from the detached end of the fruit cause skin irritation. Fruit should be carefully packed to avoid latex drops staining the skin of harvested fruit. Since fresh figs are very delicate, extra care is required in handling and fruits should not be arranged in the carton in more than two layers.

20. DATE PALM

Date palm fruits can be eaten as raw dates (fresh dates), dry dates (*Chhuhara*) and soft dates (*Pind Khajoor*). Fruits have been recognized for high nutritive and calorific food values (1440 cal/kg of fresh fruits). Fruits are also rich source of mineral (15 types), vitamins (7 types), anti oxidants and also have many pharmacological properties. Different types of products like juice, wine, *chutney*, jam, pickles and bakery items can be prepared from fruits.

Climate and Soil

Date palm requires hot and dry summers for quality fruit production and well adapted to the areas having hot summers, less rain and low humidity. It is a hardy fruit and can be grown on wide variety of soils. It can tolerate pH up to 10 and more alkali or salt as compared to other fruit crops. It is also tolerant to drought and flooding conditions.

- **Date fruit are rich source of minerals, vitamins and antioxidants.**
- **Cultivation of dates should be done in areas having hot summers, less rain and low humidity at ripening time.**
- **Grow Hillawi and Barhee varieties for raw eating and *Chuhara* making at *doka* stage.**

Recommended Cultivars

Hillawi (2016) : The trees are tall and vigorous in growth. The fruit is oblong elliptical with obtuse apex, light orange with yellow shade skin at *doka* stage. The orange fruit weight is 15.2g, TSS 29.6% and pulp stone ratio 9.7:1. It is early in ripening as the fruit reach at full *doka* stage in mid July. This variety is low in astringency and best suited for raw eating and *chhuhara* making at *doka* stage. Its average yield is 90-95 kg/tree at *doka* stage.

Barhee (2016) : Trees are semi vigorous and medium in height. The fruits are oval in shape and yellow in colour at *doka* stage. The average fruit weight as 12.2 g, TSS is 25.4% and its

pulp stone ratio 9.1 : 1. It is late in ripening as the fruit reach at full *doka* stage in mid August. This variety is low in astringency and best for raw eating at *doka* stage. Its average yield is 65-70 kg/tree at *doka* stage.

Propagation

Date palm is generally propagated by off-shoot (suckers). It is very slow process and unable to multiplying the nursery plants at commercial scale. Tissue culture is recommended for date palm propagation. Plants raised by tissue culture are true to type and are more superior to conventionally propagated plants.

Planting

Date palm is planted in square system at distance of 8 m×8 m during February- March and August – September.

Training and Pruning

Date palm is monocotyledonous single stem plant and generally do not branch. Therefore diseased, dried and damaged leaves must be removed during the winter. Very old leaves must be removed as these are less efficient in photosynthesis. Besides removal of leaves, dethorning close to fruit bunches is also essential which helps in pollination, thinning of bunches, spraying and harvesting of fruits. After fruit set twisting of bunch is done during April-May to withstand bunch breakage from high wind velocity. 70-100 leaves per palm are required for optimum productivity.

Manures and Fertilizers

Apply well rotten FYM @ 10 kg per plant per year upto the age of 5 years and afterwards apply 50 kg Farm yard manure every year in November-December. Also apply 4.4 kg urea in two splits doses, first half before flowering and the remaining in April after fruit set to fully grown (5 years or more) trees.

Irrigation

Date palm is resistant to drought and salinity as compared to other fruit crops. One irrigation prior to spathe emergence is critical for normal fruiting. Irrigation after fruit set is given regularly. In light soils, irrigation is given at 10-15 days interval in summer and 30-40 days interval during the winter.

Flowering, Pollination and Fruit Development

Flowering in date palm starts by spathe emergence. It takes place from late winter to spring which is influenced by temperature fluctuations, cultivars and sex of the plant etc. Date palm is dioecious plant (bearing male and female flowers on separate trees) and requires artificial pollination for good fruit setting. The plantation of female and male trees is done in the ratio of 10:1 for the proper pollination. Hand pollination is done by dusting pollen on freshly opened female spathe in the early morning hours for at least 2-3 days or by hanging strands of male inflorescence in inverted condition on female spathe. For collection of pollen from male spathe, the mature male spathe are swept on paper. The collected pollen is kept for 6 hrs in sunlight followed by 18 hrs in shade and can be stored in airtight glass vial in cool place at normal temperature for 8 weeks. After fertilization fruit set take place. There are four fruit development stages in date palm viz. Kimri (fruit attains pea size and remain hard green), *Doka* (fruit attains full growth, remains hard and their colour changes into yellow or red), *Dang* (softening of fruit start from tip and finally whole fruit soften), Tamar (fruits is fully ripened, fruit weight decreases as a result of dehydration of fruits).

- **Datepalm can be propagated using suckers or tissue culture. Tissue culture plants are true to type and better than suckers.**
- **Datepalm is dioecious plant and hand pollination is must for higher fruit setting.**
- **Use one male plant for ten female plants to ensure good pollination**

Fruit maturity and Harvesting

Date palm bear fruit after five years. The dates are harvested at different stages of maturity depending upon the varieties, demand of consumers and climatic conditions. For fresh and dry dates, the bunches are harvested at full doka stage and for soft dates bunches are harvested at partial dang stage.

21. BAEL

Bael belongs to citrus family and is considered as a medicinal fruit plant,which can thrive well under water scarce conditions. The plant sheds its leaves during summer months. Its fruits are rich in riboflavin, vitamin A and carbohydrates. The fruits and other plant parts are also used in the preparation of several Ayurvedic medicines since ancient times. The pulp of fresh ripe fruits have laxative properties and good for heart and brain. Fruit pulp is used for preparing *sherbet* and is cool and refreshing drink during summer months.

Climate and Soil

The *bael* tree grows successfully in sub-tropical climate where summer is hot and winter is mild. It has a wider adaptability to adverse soil and climate conditions. It can thrive well even in saline and alkaline soils, where many other fruit trees fail to establish. However, well-drained sandy loam soil is ideal for raising *bael* orchards.

Recommended Cultivar

Kagzi (2017) : Tree are semi-vigorous, medium to large with dark green leaves. The fruits are medium to large sized (1.18 kg) with thin shell and contain 28-32 % TSS. Fruit matures between mid-April to mid–May. Its average yield is 107 kg per tree.

Propagation

For raising rootstock seedling, the seeds are sown in nursery beds, after fruit harvest in May. The seeds do not undergo dormancy and germinate within 12-15 days after sowing. The pencil thickness, seedling of one year are patch budded in June.

Planting

The *Bael* can be planted during February-March and August-September with earth balls in the pits. The planting is done of 6 m×6 m spacing for the budded plants and at wider spacing for seedling plants.

Training and Pruning

To maintain the proper framework of a tree with well-spaced primary scaffolds, the plant must be trained during young age to have no branches upto 75 cm from ground level. Pruning in *bael* is usually not required. However, the dried, diseased and criss-cross branches should be removed when plants are deciduous, preferably after fruit harvest.

Manuring and Fertilization

Application of manure is done in June after fruit harvest and before the onset of rainy season. Apply 10 kg FYM and 40:50:30 g N: P: K/plant/year respectively. These doses should be increased every year in the same proportion up to the age 10 years. Further, 100 kg FYM, 900 g urea, 3000 g superphosphate and 500 g murate of potash should be added every year after age of 10 years. Whole of FYM, half dose of N, whole of P and K should be applied before flowering in June and the remaining dose of N should be given after fruit set in others. The fertilizers should be applied in and around active root zone areas.

Irrigation

The plant is hardy in nature and once established can withstand intermittent drought conditions, however, young plants needs to be watered at frequent and regular intervals. During summer period, when trees shed their leaves, requirement of water is considerably reduced.

Fruit Maturity and Harvesting

Bael fruits remain on the tree for a long time. The tree flowers in May-June and fruits become ready for harvest after one year in April-May. It is climacteric fruit which mature when fruit skull colour change from light green to cream tinge and flesh colour become light to deep orange. At the time of ripening, the tree generally sheds their leaves and fruits become exposed completely. Mature bael fruits are harvested individually from the tree along with a portion of fruit stalk. Harvesting of fruits by shaking the tree should be discouraged to avoid cracking of fruits.

22. FRUIT NUTRITION GARDEN

Fruits are rich source of vitamins, minerals, nutrients and antioxidants and play an important role in maintaining good human health. Most of the urban and rural population are meeting their daily dietary requirement of fresh fruits from the retail fruit market which are generally costly and contain high amount of pesticide residue. Now a days, the pesticide residue issue in fruits has resulted in higher demand of fresh fruits free of chemicals or with minimum use of pesticides. Keeping this in view, a "Fruit Nutrition Garden" model of dimension 25 m×25 m area (625 sq m) by growing 21 different fruits plants have been recommended by PAU **(Fig. 1, see at the end of cover page)**. This model will be sufficient to meet the daily dietary requirement of fresh fruits around the year. In addition to nutritional security, it also saves expenditure incurred for the purchase of fruits and will provides fresh fruit free of pesticide residues.

Fruits plants are perennial in nature and come into bearing after at least 2-3 years of planting, hence, proper care should be taken while selecting the fruit type, variety and planting plan. The taller and vigorous fruit plants like mango, litchi, sapota and jamun should be planted on North side of the nutrition garden to prevent shading on other fruit plants. The middle portion of the proposed garden, should be planted with medium statured plants such as citrus and guava. On the South-East side the deciduous fruit plants like pear, peach, plum and pomegranate should be planted. On the Southern border row, the region specific plants like papaya and banana can be planted because these plants are sensitive to frost and need appropriate protection from winter. The Eastern border row should be planted with grape varieties on Y-trellis system. The karonda and phalsa can be planted towards Western side, while Sweet lime can be planted on Northern side as boundary plantation.

Important points to be kept in mind

- At the time of establishing "Fruit Nutrition Garden" the recommended Package of Practices of different fruits like

quality of nursery plants, planting time, initial care, training and pruning, irrigation, fertigation, insect-pests, diseases, harvesting etc. must be followed properly to get year around availability of fresh fruits. The care must be taken to remove all the sprouts below the bud/graft union, so as to avoid over growth of root stocks.

- The fruit plants especially papaya, banana and mango, litchi, amla and guava should be protected from frost.
- Beside these, use of natural/bio-control methods for the control of weeds, like hoeing, paddy straw/plastic mulch, nutrient requirement by adding Farm Yard Manure, control of insect pests by neem sprays and use of PAU fruit fly traps and net etc should be adopted to reduce the load of pesticides for obtaining residue free fresh fruits.

23. MUSHROOM CULTIVATION

Five mushrooms, three in winter season namely, Button, Dhingri and Shiitake and two in summer namely, Paddy and Milky are suited for indoor cultivation under natural conditions of the Punjab and adjoining areas. The mushroom house should have pucca floor with a provision of cross ventilation.

BUTTON MUSHROOM (*Agaricus bisporus)*

This is also known as White button or European mushroom. This variety can be cultivated from September to March to get two crops.

Compost Preparation : It starts from mid September.

Ingredients : Wheat straw (turi) 300 kg, Wheat bran (Chokar) 15 kg, Calcium ammonium nitrate (CAN) 9 kg, Urea 3 kg, Superphosphate 3 kg, Muriate of potash or potassium sulphate 3 kg, Molasses 5 kg, Gypsum 30 kg and Lindane (20%) 60 ml or Lindane dust (5%) 250 g, Furadan (3G) 150 g. Instead of Calcium ammonium nitrate (CAN) 9 kg and Superphosphate 3 kg, one can use Urea 6.5 kg and Diammonium phosphate (DAP) 1.0 kg.

Stacking : Spread dry wheat straw on pucca floor and wet it thoroughly for 48 hours. Fertilizers and wheat bran are moistened separately for 24 hours and then mixed with the wetted wheat straw. Prepare a stack by using wooden boards of 5'×5'×5' dimensions. The length of stack can be increased depending upon the amount of compost to be prepared.

Turning : Turn the stack seven times by giving first three turnings on every fourth day and rest four turnings on every third day. Add molasses, gypsum, furadan and lindane at the first, third, sixth and seventh turning, respectively. The compost is ready in 24 days of stacking. The final grade compost should be dark brown, free from ammonical smell with optimum pH (7.5+0.5) and adequate moisture (65-70%) level.

Note : A combination of wheat straw and paddy straw (1:1 or 1:2, w/w) can be used and the paddy straw can be added after eight days of composting with wheat straw.

Filling and Spawning : Dismantle the stack and allow it to cool, then test its moisture content and pH. Fill the container (trays or fruit crates) upto 3.5" with compost and seed it. Add more compost upto the level of 7" and broadcast the remaining seed on the surface. Seed is added at the rate of 300g/sq.m. bed area. Cover the trays with newspaper sheets, arrange them indoors and spray water at least twice a day. Polythene bags (18"×24") can also be used. These are filled with spawned compost @ 10 kg/bag.

Casing : The spawn impregnated compost is covered with a mixture of farmyard manure and sandy soil (4:1;v/v) disinfected with 4-5 per cent formalin solution uniformally (1250 ml, 40 per cent formalin required for 200 kg casing soil for compost prepared from 300 kg straw).

Disinfection of the casing mixture : Moisten the farmyard manure and sandy soil mixture. Then drench with 4-5% formalin, add Furadan (3G) @ 20g/100 kg and cover with gunny bags or tarpaulin for at least 48 hours. Thereafter, it should be turned periodically to avoid fumes at the time of use.

Procedure of casing : After 2-3 weeks of spawning, remove the newspaper sheets from the trays and cover the spawn run compost with 1.25-1.5" thick uniform layer of disinfected casing material.

Arrangement of tray/crates/bags : The trays/crates should be stacked one above another to increase the total cropping area and the distance between the two lines should be 2 to 2.5 feet while between two containers it should be 1 foot. Bags are arranged on a shelf system.

Appearance of mushrooms : Small buttons of mushrooms start appearing about 2 weeks after casing and each one matures in 4-5 days. No ventilation is required till buttons appear but provide ample ventilation (6-8 h/day) during cropping period.

Picking : Mushrooms should be picked daily just before they open out. Picking should be done by gently twisting the head (do not cut or pullout) causing least disturbance to the adjoining buttons.

Packing : Small packets of 200 g each should be made in perforated polybags for marketing as fresh mushrooms.

Yield : One square metre bed gives about 8 kg of fresh mushrooms in one season.

DHINGRI (*Pleurotus* spp.)

This is also known as Oyster mushroom. It's three crops can be taken from October-March.

Materials required : Polythene bags of various sizes (12"×16", 16"×20", 16"×24"), cut paddy straw or wheat straw, spawn, gunny threads, etc.

Straw wetting : Wet the straw for 16-20 hours with clean water on pucca floor and drain away the excess water.

Filling and Spawning : Spawn should be used @ 10% on dry weight basis. Fill the bags up to 2" with straw and broadcast small bits of spawn on it. Cover this spawn with 2" thick layer of straw and again spawn it. In this way fill the bag to its capacity with alternating layers of 2" straw and spawn. Each layer of straw should be spawned with approximately equal amount of spawn. Tie the upper end of the bag with the gunny thread and give cut on the lower edges to drain off the excess water. Stack these bags in the room where light is available.

Appearance of mushrooms : After 3-4 weeks, small mushroom primordia appear, cut the polythene bags and water the spawn impregnated straw to keep it moist. Fruit bodies appear in 3-4 flushes. Daily watering and lot of ventilation (6-8 h/day) is required at the time of cropping.

Picking : Mushrooms should be picked daily just before they open out. Picking should be done by gently holding the mushroom and moving it upwards or downwards (do not cut or pullout) causing least disturbance to the adjoining mushrooms.

Packing : Small packets of 200g each are made in perforated polybags for marketing. This mushroom can also be dried in shade or sun.

Yield : Each crop will yield 500-600 g of fresh mushrooms per kg of dry straw.

SHIITAKE MUSHROOM (*Lentinula edodes*)

One crop of this mushroom can be grown during October to mid February.

Materials required : Wheat straw, wheat bran, Polypropylene bags (12"x16"), PP-rings, non absobent cotton, spawn.

Substrate preparation : Wheat straw is wetted overnight (16-20 h) to attain 60-65% moisture. The wet straw is supplemented with wheat bran @10% on dry weight basis. Mix throughly and fill in the straw in heat resistant polypropylene bags @ 2 kg wet straw/bag. Fit a PP-ring at the mouth of the bag and plug with non absorbent cotton. Sterilize the bags at 20 pounds per square inch for 1 h.

Spawning :Cool the bags and inoculate aseptically with spawn @4% (wet wt. basis). Incubate at 22±2^{0}C for complete spawn run which takes about 50 days. When the bags turn brown, remove the PP bags and dip the blocks in chilled water (4-5^{0}C) for 5-10 mins.

Appearance of mushrooms : Keep the blocks in the growing room for fruiting at less than 20^{0}C. Small buttons of mushrooms start appearing in about 2 weeks and each one matures in 4-5 days. No ventilation is required till buttons appear but provide ample ventilation (6-8 h/day) during cropping period.

Picking : Mushrooms should be picked daily just before they open out. Picking should be done by gently twisting the head (do not cut or pullout) causing least disturbance to the adjoining mushrooms.

Packing : Small packets of 200 g each should be made in perforated polybags for marketing as fresh mushrooms.

Yield : Cropping period continues for about 60 days. A yield of about 40 kg/100 kg dry straw is obtained.

PADDY MUSHROOM (*Volvariella volvacea*)

This is also known as Paddy straw or Chinese mushroom. Four crops of this variety can be obtained from April to August.

Materials required : Fresh paddy straw (not more than 1 year old), bamboo sticks, spawn (mushroom seed) etc.

Preparation of bundles : Process the paddy straw into bundles each weighting 1 kg approx. Tie the bundles at both ends and cut the unequal protruding parts of the bundles.

Laying of beds and spawning : Wet the bundles for 16-20 hours in clean water. Drain off excess water by placing the bundles on sloping surface. Beds are laid on slightly raised platform. One bed comprises of 22 bundles arranged in 4 layers of 5 bundles each, with two loose bundles at the top. 300 g of spawn should be used per bed (75g/layer).

Watering : Beds should be watered twice a day except for the first 2-3 days after laying. Adjust the watering according to the site and local environmental conditions.

Ventilation : No ventilation is required until buttons appear and ample ventilation (6-8 hrs per day) should be given as the crop appear.

Appearance of mushrooms : Small buttons of mushrooms start appearing after 7-9 days of spawning, and will be ready for picking on the tenth day. Mushrooms continue to appear for 15-20 days in 2-3 flushes. It takes about a month to have one crop of this mushroom.

Picking : Mushrooms should be picked daily just before they open out. Picking should be done by gently holding the mushroom and rotating it (do not cut or pullout) causing least disturbance to the adjoining mushrooms.

Packing : Small packets of 200 g each should be made in perforated polybags for marketing. This mushroom can be dried in shade or sun under natural climatic conditions.

Yield : A bed of 22 kg dry paddy straw yield 2.5-3 kg of fresh mushrooms in each crop.

Milky mushroom (*Calocybe indica)*

Three crops of this variety can be obtained from April to September.

Materials required : Wheat straw, polythene bags (12"x16"), spawn, gunny thread, casing soil, etc.

Substrate preparation : Wet wheat straw for 16-20 hours with clean water.

Filling and spawning : Fill straw in gunny bags and boil for 45-50 mins. Allow the straw to cool overnight. Fill boiled straw in polythlene bags upto 2" with straw and spread spawn of milky mushroom over it. Cover this spawn with another 2" thick layer of straw and again spawn (with layered). Five such layers are prepared so that 2kg wet straw is filled in each bag and spawned with about 70-80 g of spawn. Tie the upper end of the bag with gunny thread and stack in the growing rooms.

Casing :After two weeks of spawn run, the mouth of bags is opened and 1" thick formalin disinfected casing soil (FYM+Sandy Soil : 4:1 v/v) is spread over the spawn impregnated straw.

Watering and ventilation : Fine spray of water is started twice a day and high humidity, 75-80% is maintained. Ample ventilation (6-8 hrs per day) should be given as the crop appear.

Appearance of mushrooms : Fruiting bodies start appearing in next 14-15 days and cropping period continues for 35-40 days.

Picking : Mushrooms should be picked daily just before they open out. Picking should be done by gently holding the mushroom and rotating it (do not cut or pullout) causing least disturbance to the adjoining mushrooms.

Packing : Small packets of 200 g each should be made in perforated polybags for marketing. This mushroom can be dried in shade or sun under natural climatic conditions.

Yield : About 50-60 kg of fresh mushrooms are harvested from 100kg of dry wheat straw.

Mushroom spawn can be purchased from the Department of Microbiology, PAU, Ludhiana and State Department of Horticulture, Hoshiarpur, Jalandhar, Patiala and Sangrur. The University imparts training on Mushroom Cultivation at main campus Ludhiana and Krishi Vigyan Kendras located in different districts.

24. BEEKEEPING

A normal colony of the honey bees (*Apis mellifera*) has a laying queen, thousands of worker bees and occasionally hundreds of drones. Besides, all stages of brood, honey and pollen are also present. Honey bees, apart from providing various valuable hive products, increased fruit setting in various fruit trees like soft pear, plum, citrus, etc.

1. Starting Beekeeping

Keep following points in consideration for starting beekeeping:

- **Training:** Acquire training from the PAU Ludhiana or from KVKs located in various districts heads of Punjab.
- **Bee flora:** Bee flora is basic requirement for beekeeping. Major utility bee flora in the Punjab includes *Brassica* spp., *Eucalyptus*, Egyptian clover, sunflower, cotton, pigeon pea, wild forest multiflora, etc. Among the fruit trees, amla, litchi, soft pear, ber, guava, etc. constitute important bee flora.
- **Bee equipment:** Main equipment required in beekeeping include ten frame wooden Langstroth hives, bee veil, hive tool, smoker, uncapping knife, drip tray, comb foundations, queen excluders and honey extractor.
- **Season for starting beekeeping:** February-March and October-November are suitable periods for starting beekeeping in the Punjab.
- **Apiary siting:** Apiary should be established on an up-land and away from the main roads and railways. Hives should be placed under shade during summer and in sunny places during winter. The entrances of hives should preferably be towards south-east direction. Row-row distance between colonies must be at least 10 feet and colony-colony distance in a row must be at least 3 feet.

2. Seasonal Bee Management

A) Spring season (mid February - mid April)

- With warming of the season, unpack honey bee colonies.

- In the beginning of season following winter, examine the colonies on a clear sunny day at noon time, clean the bottom board and burn or burry the collected debris.
- Provide more space as raised combs or frames with foundations or super chamber to cope up with increased brood rearing and food storage.
- Provide stimulative feeding (sugar: water = 1:2, w/w) in colonies to boost foraging.
- Populous and congested colonies may issue swarms. To check swarming, keep destroying gyne cells raised under swarming impulse, provide more space, clip half of one side wings of the queen or fix queen guard at hive entrance. Divide the colonies with persistent urge for swarming.
- Replace combs older than three years and also queen older than one and a half years of age.
- Be vigilant brood mites and diseases and in case of their occurrence, undertake appropriate management measures.
- This period is the best for colony multiplication, mass queen bee rearing, royal jelly production and pollen collection.
- Extract ripe honey as and when available in the supers.

B) Summer season (mid April - June)

- Shift colonies to shady places, preferably under thick canopy.
- Ensure provision of fresh water in/ near apiary for the honey bees by placing water bowls under legs of hive stand, or throwing some sticks in the water reservoir of tubewell.
- Be vigilant brood mites and diseases and in case of their occurrence, undertake appropriate management measures.
- Extract ripe honey as and when available in the supers.

C) Monsoon season (July - mid September)

Stronger colonies start robbing weaker ones because of scarcity of bee flora and food reserves in the colonies. Weak colonies are also more prone to the attack of bee enemies and diseases. High humidity and incessant rains impair foraging and stagnating rain water cause drowning of colonies. To overcome these problems, following operations are advised:

- Examine the bee colonies very quickly lest robbing starts.
- Clean the hive debris and burn it to get rid of harbouring wax moth inoculum.
- Keep the colonies at raised place and clear the vegetation growing around the colonies to improve ventilation in colonies.
- Keep the colonies tilted a bit down anteriorly and properly covered with top covers lined with metal sheet on the top.
- Remove extra empty combs from the colonies and store them under air-tight condition with fumigation.
- Depending upon the colony strength and the need, provide sugar syrup feeding (sugar: water 1:1, w/w) inside the hives.
- If honey bee colonies are short of pollen, bee collected pollen or pollen substitute patty (mixture of 42 g brewer's yeast + 4 g parched gram flour + 4 g skimmed milk powder kneaded with 50 g of 50 per cent aqueous sugar solution) or pollen supplement patty prepared by adding 10 per cent pollen in the pollen substitute should be provided to the colonies.
- To prevent robbing, provide sugar feeding to all the colonies very late in the evening, make colonies bee proof, except hive entrance, by plugging cracks and cervices and reducing the entrance to one-bee wide before feeding and prevent spillage of feed in the apiary or outside the colonies.
- To check robbing, place grass soaked with one per cent carbolic acid or kerosene oil at the hive entrance of colony being robbed and make a long and one-bee narrow tunnel with mud to the colony entrance or close entrance of the colony being robbed in the case of heavy robbing; spot out and shift the robber colony 3 km away.
- Laying worker/weak colonies should be united with the stronger colonies using newspaper method.
- Protect honey bee colonies against predatory wasps, ants and birds.

D) Autumn season (mid September - November)

Autumn season is the second best season for colonies growth and multiplication. During this season, colonies can be migrated

to pigeon pea, ber, guava and toria growing belts. The State beekeepers may also migrate their colonies outside Punjab on Brassica and ajwain. Almost all the operations that are followed during spring season hold good during autumn season too. By the end-November (before chilling winter), extract surplus ripe honey. Towards the end of the season, shift colonies gradually to sunny places.

E) Winter season (December - mid February)

To sustain bee activities and brood rearing, following operations should be followed:

- Shift colonies to *raya* and *gobhisarson*) growing area of the Punjab, Haryana or Rajasthan. And towards the end of the season the colonies may be migrated to the coriander growing belt in Rajasthan.
- Place/ move the colonies to sunny places.
- Examine colonies only on some calm and sunny day during noon time in the beginning of the season.
- Unite weaker colonies with stronger ones, using newspaper method, at the onset of winter. Very weak colonies can be united into single chamber using vertical queen excluder.
- Provide supplementary sugar: water (2: 1, w/w) feeding, if required, before winter packing. This feed preferably be provided in drawn combs or in division board feeder.
- Plug cracks and crevices, narrow down the hive entrance and place colonies with entrance facing south - east to protect bees from chilly winds.
- Don't keep coloniesin the open area all around; keeping them near some walls serving as wind breaks helps.
- Provide inner packing to weak colonies with dry paddy straw (*prali*) wrapped in newspaper or polythene sheets. Give outer packing with polythene sheet.

3. Maximizing Honey Production: For maximizing nectar collection, follow the under-mentioned practices:

- Colonies should be headed by freshly mated, prolific queen bees in the beginning of spring to get the colonies strengthened

about 45 days in advance of nectar flow and not on the honey flow.

- Ensure to provide required space in the form of raised combs or comb foundations at the initiation and during the nectar flow.
- Curb drone population, if and when not required, by removing combs with drone brood cells, destroying drone brood, excluding drones using drone traps, requeening the older drone layer queen bees by freshly mated one and by using only worker brood cell combs or CFs in the brood chamber.
- In view of the weather, provide ventilation to colonies to hasten honey ripening by providing more space/ chambers, staggering the chambers, increasing hive entrance size, by providing extra gate in supers and using screened inner covers.
- Maintain colonies strength, at least on single super, during the nectar flow.
- Increase colony strength by uniting weaker colonies with stronger ones and following double queen management system.
- Use queen excluder between brood chamber and honey chamber during honey flow.
- Extract ripe honey from the supers by the end of nectar flow.

4. Bee Diseases and Enemies

A. Diseases

- **European Foulbrood (EFB):** It is a bacterial disease in which infected larvae (in open brood cells), first turn dull white to yellowish white, later brownish yellow and then brownish; body segmentation becomes faint, and the larvae turn soft and pasty. The dead larvae can mostly be attached to the cell walls in upright condition. Dried scales of the larvae are rubbery and easily removable.
- **Sacbrood:** It is a viral disease affecting very late larval or prepual stages. The infected sealed brood depicts holes in the cappings. The head of dead larva/prepupa is predominantly raised and becomes pointed and darker, the affected larva/

prepupa turns greyish, then straw coloured and finally to dark colour. Dead brood, upon taking out with forceps, comes out like a water filled sac with body margins showing greenish yellow fluid in the body. Dried dead brood scale is boat/slipper shaped.

Management of Bee Diseases: Maintaining stronger and nutritionally adequate colonies headed by young queen bees provide bees tolerance against bees.Isolation of diseased colonies, maintaining hygienic conditions, checking robbing and drifting and avoiding transfer of hive parts from diseased to healthy colonies, requeening, shook swarm and destruction of the severely infected colony help in checking incidence and further spread of the bee diseases to healthy colonies.Maintaining hygienic colonies through their screening using pin-prick method would facilitate in imparting resistance against disease incidence.

B. Enemies

a) Wax Moths: Wax moths attack live colonies as well as stored combs. Larvae of wax moths eat away the combs by making silken tunnels in the combs and presence of uncapped bee pupae with fine black elongated faecal pellets on their abdomen is another symptom.

Management

- **Apiary management:** Maintain bee colonies stronger, keep bottom boards clean, burry or burn the collected debris, keep cracks and crevices in the hives plugged, and remove extra empty combs from the colonies and store them properly with fumigation. Keeping the infested combs in sun during noon hours for a short period also helps in killing the wax moth larvae.
- **Management of stored combs:** Keep surplus combs in chambers arranged in stacks and fumigate them with burning sulphur @ 250 g per m3 of chamber space under air-tight condition and repeat the treatment after 15 days.

b) Ectoparasitic Mites

- **Brood mite** (*Tropilaelaps clareae*)**:** The cappings of affected brood cells are sunken and sometimes punctured. The infested

pupae are sometimes without cappings (bald). Infested bees with shortened and twisted wings and dead pupae may be seen lying on the ground in front of the hive.

Management: Dust powdered sulphur on top bars of combs @ 1 g per comb for the management of this mite. Alternatively, formic acid (85%) @ 5 ml per day for 14 days, taken in a vial with a thick cotton wick with one end dipped in acid below and the other out side the vial to facilitate evaporation of the acid, placed on bottom board, can also be used. Avoid the use of formic acid during honey flow.

- ***Varroa* mite:** Adult *Varroa* female is dorso-ventrally flattened, brown to dark brown and shiny, shaped like a tiny crab - more in width than length. Heavily infested colonies usually show patches of bald brood cells. Pupal anterior appear eaten with grey markings/ specs on head side. Dead or dying newly emerged smaller bees, with malformed wings, legs, thorax and shortened abdomen, may be found on the ground in front of hive.

Management

i) Non-Chemical

- **Trapping *Varroa* on drone brood:** Varroa mite is more attracted to drone brood. During breeding season, put one or two empty drone brood combs in the centre of the brood nest to trap the mite population. The sealed drone brood comb part is cut and destroyed. Destruction of existing drone brood comb part in infested colony also reduces its carry over.
- **Sticky paper:** The placement of a sticky paper covered with 8 mesh screen on the bottom board or use of Varroa bottom board make the fallen mites stuck to it and prevents their return to the brood combs.
- **Dusting icing sugar:** Dusting finely ground sugar @ 20 grams per 10 bee frame strength colony, uniformly between the inter-comb spaces in the late evening time, reduces infestation of the mite.

ii) Chemical

- **Use of formic acid:** Treat colonies with formic acid (85%)

@ 5 ml per day continuously for two weeks as detailed under brood mite. It should not be used during honey flow.

- **Use of oxalic acid:** Trickle 5ml of 4.2 per cent solution (w/v) of oxalic acid prepared in 60 per cent sugar solution in water (w/v) in between every two combs of bees, three times at weekly interval, in the late evening in the infested colony.

c) Wasps : Yellow spotted brown wasp causes damage to honey bee colonies by catching the bees during monsoon and post monsoon period (July-November) with peak activity in September in the Punjab plains.

Management: Kill the fecundated female wasps during early spring by flapping, and destroy newly developed wasp nests either by burning or pesticidal application. Placing obstructions at the entrance or fixing queen guard at hive entrance checks entering of wasps inside the colony or their approaching near hive entrance to catch bees. Placing wasp traps in apiary and use of large mesh nylon nets around the colonies, is also helpful.

d) Black Ants : Serious attack of black ants may lead to death of the colony or its absconding. The ant nests in the apiary should be destroyed by drenching with pesticidal applications and then covering it with dry soil. Place the hives on the iron stands with legs in water/used engine oil filled bowls.

e) Bee Eating Birds: Green bee eater and king crow catch the flying bees/queen bees. Green bee eater is more serious as it attacks the apiary in flocks. These birds should be scared away by the use of tinsel tapes, bird scarer or use of nets around the colonies.

5. Diversification in Beekeeping

Diversify beekeeping by producing hive products other than honey by following technologies developed by PAU for production of beeswax, pollen, propolis, royal jelly and mass queen bee rearing. Renting out honey bee colonies as an input for augmenting pollination of orchards and field crops is another option of increasing income from apiary. Use 8 Apis mellifera colonies (each of 10 bee-frames) per 5 acres for enhancing soft pear fruit setting.

25. PAU FRUIT FLY TRAP

AN ECO-FRIENDLY TECHNIQUE FOR MANAGEMENT OF FRUIT FLIES IN KINNOW, GUAVA, PEAR, PEACH, MANGO AND PLUM

How to use the traps?

- Fix PAU fruit fly traps @ 16 traps/acre in the second week of April in Plum, first week of May in Peach, third week of May in Mango, first week of June in Pear, first week of July in Guava and second week of August in Kinnow **(Plate-2)**.
- The traps should be kept in these fruit crops till the fruit harvesting is over. Traps should be fastened to the trees using metallic wires/tags, at a height of 1-1.5 metre from ground level, depending upon the height of fruit tree, at a place receiving no direct sunlight.
- Recharge the traps if required (with appearance of fresh damage on fruits).

Likely impact of using PAU fruit fly traps

- This is an eco-friendly technology as there will be no pesticide residue in fruits and environment.
- There will be a significant increase in the number of high quality marketable fruits resulting in increased fruit yield of all these four crops.
- Fixing of traps in the orchards is cheap in comparison to spraying of insecticides.
- Instant mass trapping of male fruit flies.
- Chances of mating reduced to a greater extent as a large number of male fruit flies are trapped immediately after fixing the traps in the respective orchards.
- Fixing of traps provide effective control of fruit flies for longer period as compared to spray of insecticide. For monitoring, trap is effective even for longer duration.
- Traps can easily fit in IPM programme and are effective even during rainy season.

- Use of traps is safe to natural enemies.
- Same trap can be used in different fruit crops by recharging the plywood block.
- A single trap has capacity to trap about 6000 male fruit flies
- Significant quantity of water is also saved using this technology which is required for conducting spray of insecticides for management of fruit flies.

Condition when PAU fruit fly traps are less effective

- If fixed in the orchards after infestation on fruit is started.
- If fixed in kitchen gardens instead of orchards.
- If fixed in the orchards early/late than the recommended time/ number.
- If fixed in the orchards less than recommended number.
- If vegetable like cucurbits are grown in the orchards.
- If sanitation practices not properly followed in the orchards.

Availability of traps

- PAU fruit fly traps are available for sale in the Entomology Laboratory of the Department of Fruit Science, PAU, Ludhiana @ Rs. 118/trap.
- Booking of traps at PAU, Ludhiana can be made on Mobile No. 9988686072, 8872399221, Telephone No. 0161-2401421 or 0161-2401960 Ext. 303 (Fruit Science), on any working day (Monday-Friday) from 9.00 am to 5.00 pm.
- Traps can also be booked by e-mail: sandeep_pau.1974@pau.edu
- Orders for purchase of traps can also be made at PAU, Krishi Vigyan Kendras/Farm Advisory Service Centre/Regional Research Stations/Fruit Research Stations situated in the State of Punjab and Deputy Director Horticulture and Horticulture Development Officers of the State Department of Horticulture, Punjab.

26. MANAGEMENT OF OTHER HORTICULTURAL PESTS

I. Squirrel

The squirrel (*Funambulus pennenti*) lives in nest of twigs and leaves on trees. Fruits and seeds are its major food. In orchard, it causes damage to a variety of fruits such as guava, ber, peach, plum, pomegranate, mulberry, grapes and jamun. For its control, traps should be used. Keep the traps on squirrels active sites during morning and evening as these are more active during these periods. Methods for the use of traps is the same as given for rats and mice.

II. 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, the lesser bandicoot 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 of vegetable crops at growth stage and fruits at ripening stages. Seedlings are also destroyed under heaps of soil made by rats. The lesser bandicoot rat during burrowing, loosens the soil resulting in the drying of 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, rats coming out of flooded burrows should be killed with sticks.

ii) Traps can be used to control rodents. Place 16 traps per acre at damage and activity sites of rodents. Kill the trapped rats

by drowning in water and the interval between two trapping at the same location should not be less than 30 days.

B. 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. Keep the height and width of bunds to the minimum.

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.

C. Biological Control

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

D. 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 edible refined oil and mix it thoroughly with 25 g of 80% zinc phosphide powder.

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 edible refined oil and 20 g of powdered sugar in 1 kg of any cereal flour or bajra, sorghum or cracked wheat.

Poison Bait Placement and Timings

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 lesser bandicoot 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 bromodiolone 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 : To increase the efficacy of zinc phosphide bait do pre baiting. 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 rodenticides 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 gloves. Avoid the contact of poison with mouth. Wash exposed skin and hands after mixing.
3. House hold utensils should never be used for preparation of the rodenticide baits.
4. Polythene bags used for storage and carrying the rodenticide bait should be buried after use.
5. Collect and bury left over rodenticide bait and dead rats from the orchard.
6. Zinc phosphide is toxic and there is no antidote for it. In case of its accidental ingestion, induce vomitting 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.

Integrated approach

No single method is 100% effective in controlling rats and mice. Left over population reproduce reaching the original size in short time. Therefore, adopt an integrated approach by using different methods at different stages of the crop.

Village level campaign

Control of rats and mice in smaller area usually become ineffective due to their migration from the surrounding untreated fields. Therefore, for better results, village level anti-rat campaign to cover maximum possible area, both cultivated and uncultivated, should be organized.

III. 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 farmer's 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, 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 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

1. As far as possible, sowing of maize and sunflower crops should be avoided in and around the orchards. Prepare the nurseries of fruit trees at the right and recommended time and keep it covered with thorny bushes or nylon net.
2. The trees in the vicinity of fruit nursery should be pruned so that birds may not establish their nests on them.
3. Weed and grasses should be removed regularly as they provide shelter to birds.
4. Birds should be prevented from nest making on trees. Older nests on trees should be removed before the birds start their breeding activities.
5. Fruit trees planted solitary should be covered with nylon net with mesh size of 2.5 to 5.8 cm. Grapevines should be covered with 1.25 cm size nylon net. It should completely cover the vines from above and also touch the ground on all sides. This nylon net is effective in preventing the entry of even small birds like sparrow. Wasps and other flying insects which cross the net can also fall prey to birds sitting outside the netted area.
6. Grow the less costly crops like daincha or millet around the orchard, these crops are preferred by the birds and even prevent bird damage to orchard. In addition to this, these crops being tall also act as wind breakers and help in preventing lodging of small plants during stormy/rainy days.

7. Preferably, fruit trees should be planted away from the perching sites of birds or cluster of trees and also no electricity wires should pass above the fruit trees.
8. To prevent the parakeet damage, fruit trees should be planted in large block area (at least two-three acres) because parakeets avoid feed/venturing in the interior of the orchard.

C. Use of Reflective Ribbon

Reflective ribbon should be tied with wooden stick or bamboo at least 1-3 feet above the fruit nursery or at the outer side of the orchard. If there is more than 10 meters gap between wooden sticks, then additional wooden stick should be installed for support. Ribbon should be installed from north to south direction. Ribbon should be slightly twisted and loosely tied. By using the ribbon in this way, the rays of rising sun from east and setting sun from west fall on the ribbon, due to which the ribbon reflects the light and also produces wavering voice with the blowing wind, which scares the birds away.

D. Alarming Calls

Playing of cassettes (available at Centre for Communication and International Linkages, 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

Fertilizer Sources for the Supply of Nitrogen, Phosphorus and Potassium

(A) Nutrient contents of different fertilizers

Fertilizer	N (%)	P_2O_5 (%)	K_2O (%)	Other
Ammonium sulphate	20.5	-	-	
Ammonium chloride	25.0	-	-	
Calcium ammonium nitrate	25.0	-	-	
Urea	46.0	-	-	
Superphosphate (single)	-	16.0	-	
Diammonium phosphate	18.0	46.0	-	
Urea-ammonium phosphate	28.0	28.0	-	-
Nitro phosphate	20.0	20.0	-	-
Sulphate of potash	-	-	48.0	
Sulphated phosphate	13.0	33.0	-	15(s)
Muriate of potash	-	-	60.0	
Manganese Sulphate	-	-	-	30 (Mn)
Zinc Sulphate (Heptahydrate)	-	-	-	21 (Zn)
Zinc Sulphate (Monohydrate)	-	-		33 (Zn)
Ferrous Sulphate 7 H_2O	-	-	-	19 (Fe)
Copper Sulphate S1 H_2O	-	-	-	24 (Cu)
Gypsum	-	-	-	16 (G)
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_2O_5	
Superphosphate	6.2 kg
Diammonium phosphate	2.2 kg
Urea-ammonium phosphate	3.6 kg
For 1 kg of K_2O_5	
Muriate of potash	1.7 kg

Note: Urea-ammonium phosphate (28-28), and diammonium phosphate (18-46) contain both nitrogen and phosphorus. By adding one kg of phosphorus (P_2O_5) 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 - II

Instruction for Proper Use of Drip Irrigation System in Orchards

The drip irrigation system has great potential to use irrigation water judiciously and efficiently along with improvement in the yield. Drip system supplies water in the near vicinity of the roots of the plants through devices called drippers/emitters @ 2-10 litres per hour at a low pressure (0.20-1.5 kg/cm^2) to meet daily crop consumptive use. Sometimes in place of drippers, micro sprinklers are used which supply water @ 20 to 40 litres per hour depending upon the nozzle size and the working pressure. Field surveys show that drip systems allow irrigation of 50 to 200 per cent additional area enabling it to give additional produce.

* For drip system the water may be available from canal system, stored rainfall and/or tubewell. In case of tubewell irrigation (good quality water), the water can be directly pumped through mesh filter into the drip systems. In case of canal water supply, the water should be first stored in the storage tank. Then it should be pumped into drip system through sand filter and mesh filter.
* The storage tank should be lined.
* Its capacity should be according to the command area and availability of canal water. For 10 acres of command area, water storage tank of 800 m^3 capacity is sufficient.
* The floating inlet should be adopted to reduce the sucking of silt load.

Components and working of the system

* Control unit i.e. pumping, filteration and fertilizer application units.
* The distribution network i.e., a network of main, sub main, lateral and emiters/micro sprinklers.
* The miscellaneous components, i.e. joints, flow and pressure regulating valves and water meters etc.

Caution : Quality components of ISI mark should be used.

The diameter of the main and submain (PVC) lines (25-75 mm) should be selected very carefully according to the size of the area to be irrigated. The mains and submains are laid 45-60 cm below the soil surface to avoid damage during interculture and deterioration due to ultraviolet radiation. The lateral lines (12-16 mm) are spread along the lines of trees and length of each line depends on length of the plant row. These laterals are joined with the main/submain line with the help of adopters. The discharge of the drippers may differ from the specifications of the company, hence it should be ensured that the discharge of the drippers may not vary more than 10 percent of the specified one during working of the system.

For operating this system in a big orchard, divide the command area into 2 to 4 sub-units so that each sub-unit is not more than 10 to 15 acres, which results in proper, judicious and economical utilization of irrigation of water. Due to less spread of plant/tree under drip irrigation, closer plant spacing in drip irrigated orchards is possible.

Fertigation

Fertigation involves the application of fertilizers with irrigation water at a slow and controlled rate to meet nutritional requirements at different stages of crop growth. Under this system, the fertilizers can be applied in 10 splits as compared to 1-2 splits and thus such applications result in increased crop yields with substantial savings in fertilizer and irrigation water. The application of liquid fertilizers makes the nutrients continuously available to the plants. Fertilizers containing one or more elements can also be applied by injecting them through suction side of the pump or by injecting under pressure in the irrigation pipes or by injecting in the irrigation pipes through a ventury. Easily soluble fertilizers should be applied to avoid precipitation, clogging and damage to the components of the system.

Maintenance

* Maintain motor, diesel engine, main pump, pressure regulator and fertilizer injector.

* In case of canal water supply, sand filter should be cleaned after every 2-3 weeks depending upon the silt load by back washing.
* Mesh filter should be cleaned every day.
* Measure the emitter discharge periodically to check any clogging.
* After 3-6 months remove any algae or bacterial formation from the drip pipes using one litre hydrochloric acid (HCI) in 1000 litres of water. Pump this solution in the pipes by injection, keep it for 15-20 hrs in them and then flush it out.

Initial cost is more but is compensated through coverage of more command area under irrigation and thereby increasing the productivity.

APPENDIX – III

Use of Tractor Operated Pick Positioner for Harvesting of Fruits and Pruning of Trees

Pruning of trees and harvesting of fruits is done manually by conventional methods like climbing on trees and using ladders. Harvesting of fruit is a labour-intensive operation, which accounts for in many cases, about 50 percent of total production cost. It is a tedious, stoop type job in addition to the costly operation along with other issues of safety and quality of picking. For fruit picking and tree pruning, person has to locate the exact position to stand on the ladders or sit over the tree to do the operation. Mechanized picking of fruit will provide the same or better quality produce, at a much faster rate. The person can work for long duration due to reduction in drudgery and will not expose to physical strains. The tractor mounted pick positioner developed by the PAU is definately solution to harvesting/pruning operations for horticultural crops.

It consists of a movable platform for the stand of person which can be lifted up to the height of 9.60 m (32 feet) for harvesting and pruning of fruits **(Plate 3)**. The platform can be moved in vertical plane only and the horizontal movement of platform can be achieved by changing the position of the tractor. A supporting frame has been developed to reduce the excessive vibrations for smooth transportation of the machine. A double acting hydraulic cylinder powered by tractor hydraulic system is installed between the main bar and vertical bar. The weight of pick positioner is about 470 kg and it acts as a cantilever on tractor. The pick positioner during the pruning and harvesting operation is safe along the longitudinal direction as well as along the lateral direction. Pick positioner may be used as an attachment with existing tractor or a dedicated machine for fruit picking and pruning of trees.

By using pick positioner, there is a saving of labour requirement, upto 90% for pruning and 75% for picking and harvesting operations. Bruising of fruits can also be avoided by using the machine. Pick positioner also helps in picking the

fruit attached at the end of branches, which is not possible with conventional methods.

The fuel consumption of tractor is about 5.5 l/hr when tractor engine is running during the operation but it can further be reduced up to 2.5 l/hr, if tractor engine is stopped after positioning the platform at required height. Pick positioner not only increases the fruit picking and tree pruning capacity of a labourer but also reduces drudgery of the labourer by about 25%. The machine is especially useful for Multi-Purpose Co-operative Societies/Agro Service Centers for fruit picking and tree pruning on custom hiring basis besides other rural miscellaneous household activities.

APPENDIX - IV

Tractor operated offset rotavator

Tractor operated offset rotavator having automatic side shifting mechanism is recommended for interculture operation and seedbed preparation for intercrops in fruit trees and agro-forestry fields. Presently, interculture operation in orchards is performed manually which is time consuming and labour intensive. Sometimes tractor drawn cultivators are also used but the weeds between the trees in a row are left as such. However, a tractor P.T.O. operated offset rotavator can be used for tillage and interculture in orchards especially under the tree canopy **(Plate 4a and 4b)**.

The offset rotavator can be operated by any tractor of 45 horse power or above. This offset rotavator machine has a hydraulic powered side shift mechanism that is automatically activated by a feeler rod/ sensor due to touch of the tree trunk and side shift the machine behind the tractor. When the machine passes the tree trunk, pressure on sensor is relieved and the machine automatically moves between the trees row. Thus; sensor based automatic side shifting mechanism allows the tractor driver to concentrate on forward motion of tractor and reduces the chance of damage to tree trunk. Tractor PTO powers the hydraulic side shift system as well as rotavator blades.

Offset rotavator can be used in different orchards of kinnow, pear, peach etc. A weeding index up to 98% can be achieved. Plant damage due to abrasion to tree trunks was limited to 1.5-3.5%. Field capacity of the machine is 0.20 hectare per hour and fuel consumption of tractor with machine is about 7.5 litres. The machine is easy to operate in kinnow orchard because of no problem of entanglement of branches with machine or tractor. However, pruning of lower branches of fruit trees like pear, peach, etc. is desired for easy movement of tractor and machine near to tree trunk. This machine saves about 60% cost of weeding and 92% labour time.The machine can also be used for field preparation for intercrops like wheat, maize, etc.However, the machine is not for use in orchards of very young age group; having drip/ sprinkler system for irrigation; during fruit bearing stage, for grapevines, etc.

APPENDIX - V

Waiting Periods of Different Pesticides in Fruit and Vegetables Crops

Recommended Pesticide	Crop	Waiting Period (Days)
Malathion	Brinjal, Okra, Cabbage, Grapes	1
Quinalfos	Brinjal, Cabbage (Autumn)	4
	Cabbage, Cauliflower (Winter)	7
	Kinnow	7
	Grapes	10
Chlorpyrifos	Peas, Chilli	7
Cypermethrin	Tomato, Cabbage, Okra	1
Fenvalerate	Cabbage, Brinjal, Cauliflower	1
Deltamethrin	Kinnow	1
Triazophos	Okra, Kinnow, Cauliflower	7
	Brinjal	4
Dicofol	Brinjal, Cucumber	1
Ethion	Brinjal	5
	Cucumber	7
	Pear	1
Fenvalerate	Pear, peach, Guava	2
Spinosad	Cauliflower	7
	Cabbage	5
Indoxacarb	Cauliflower, Cabbage	3
Propargite	Brinjal	1
Cypermethrin	Kinnow	3
Carbaryl	Grapes	3
Profenofos	Tomato	5
Flubendiamide	Tomato	3
Emamectin Benzoate	Okra, Cabbage	3
	Cauliflower	5

APPENDIX - VI

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. While handling the 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 up 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 burry them afterwards.
14. Do not burn pesticide 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 vomitting. Give one tea-spoonful (15 g) common salt 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 vomitting when the stomach is full of fluid.

b) If the patient is already vomitting, 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 the 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 to drink.

f) Give hypodermic injection of stimultants, such as caffine and epinephrine.

g) Give fluid administration of dextorse 5% intervenously.

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.

APPENDIX - VII

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) 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 split 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 legging 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 tournaquet of cloth should be a few tied centimeters proxymal or above the site of bite. It should be tight to an extent that a finger passes 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 mouth 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 areals, use of rubber gloves and dry shoes when working with electric circuit.

First Aid

a) Prompt switching of 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 bites

a) Cooling of the part with ice pads.

b) Removal of stings.

c) Cleaning with soap and water.

d) Local and systemic anti allergics to be given.

e) Perfumes and bright colours attract these insects and should be avoided.

f) Sensitive person can have severe anaphyllatic shock with even a single bite. Every such patient must get the medical aid from a doctor.

APPENDIX - VIII

Antidotes of 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 (endosulphan, lindane etc)	No specific antidote. For convulsions : Diazepam 10 mg intravenous (I/V). Could be repeated upto 30-40 mg. After that, it should be mixed with drip. Phenobarbitone 100-300 mg in drip.
Organophosphates (monocrotophos, chlorpyriphos, methyl parathion acephate, triazophos, malathion, quinlphos, 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 I/V 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 fasiculation 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
Carbamates (Carbaryl carbofuran etc.)	Atropine : 2-4 mg I/V as a test dose. If no effect double dose may be given every 10 minute till atropinization. Maintain upto 24-48 hours. Warning: Do not use oxime or morphine.
Pyrethroids (cypermethrin, fenvalerate, deltamethrin etc).	Only symptomatic treatment, antihistamine are of value, if large amounts are ingested to cause nervous infestation, pentabarbitone (0.7g/day) should be used. For diarrohoea treat by atropine.
Cartap hydrochloride (Padan, Caldan etc)	Dimercaprol (BAL) 3-4 mg/kg body weight. (Comes as 3 ml, 10% solution alongwith benzyl benzoate in arachis oil). Given deep intram uscular every 4 hours for 2 days and then twice for another 10 days.

Aluminium phosphide (celphos. phostoxin etc)	No specific antidote, induce vomiting with 5% sodium bicarbonate. Give activated charcoal slurry with sorbitol 50-100 g orally, diazepam 5-10 mg I/V slowly over 2-3 minutes. Phenobarbitone 600-1200 mg diluted in 60 ml noral saline. Maximum dose 1-2 g. Dimercaprol (BAL).
	Dopamine 4-6 ug/kg/min I/V. Magnesium sulphate 3g I/V bolus followed by 6 g in 12 hours for 5-7 days. Administering 5% glucose I/V can minimize liver and kidney damage. Warning : Do not give water or water based drinks
Naturalyte (Spinosad)	No specific antidote. Treat symptomatically
Oxadiazine (Indoxacarb)	No specific antidote. Treat symptomatically
Phenyl Parazole (fipronil)	No specific antidote. Treat symptomatically
II FUNGICIDES	
Carbendazim (Bavistin, Agrozim, Parazim, Derosal etc.)	Atropine: 2-4 mg I/V as a test dose. If no effect, double dose may be given every 10 minute till atropinization. Maintain upto 24-48 hours.
Streptocycline	Injection of adrenalin, antihistamine and cartisone in case of acute anaphylactic shock, high or low blood pressure, profuse respiration and urticaria.
Copper oxychloride Copper sulphate (Blitox etc.)	Dimercaprol (BAL) 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.
Edifenphos (Hinosan) probenphos (Kitazin)	Atropine: 2-4 mg I/V as a test dose. If no effect, double dose may be given every 10 minutes till atropinization. Maintain upto 24-48 hours. 2-PAM : 1-2g I/V 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 fasiculation persists. To be continued every 6-8 hours for 1-2 days or 5% solution as infusion @ 1/2g/hr.
Methoxy ethyl mercuric chloride (MEMC), Agallol, Ceresan etc.	Activated charcoal, egg white or 5% sodium bicarbonate solution (gastric lavage). High colonic irritation : 5% sodium formaldehyde sulfoxylate (fresh 100-200 ml) intravenous. For faster treatment, sodium citrate, oral 1-4 g every 4 hours. For spasms, 100 ml (10%) calcium gluconate intravenous.

Mancozeb, Thiram, Zineb	Ascorbic acid (vitamin C) intravenous @ 0.2 g/min.
Ridomil Gold (4% metalaxyl+64% mancozeb)	No specific antidote for metalaxyl. Antidote for mancozeb as given above may be recommended as this combination contains 64% mancozeb
Triadimifon (Bayleton)	No specific antidote, gastric lavage with 5% sodium bicarbonate.
Dinocap (Karathane)	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.
Carboxin (Vitavax)	Treat symptomatically
Captan (Captaf)	If ingested, induce vomiting by administering a spoonful of salt in hot water.
Chlorothalonil (Kavach)	Treat symptomatically
Propiconazole (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 I/V 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 fasiculation 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 10-15g daily intravenously.
Glyphosate (Roundup)	Ingestion : immediately dilute by swallowing milk or water.
Isoproturon (Arelon, Delron Milron etc.)	Flush eyes with soap. Wash skin with soap and water.
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.

IV. 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 - IX

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 expert or Pest Control Operators.
2.	Carbaryl	Not to be sprayed at flowering stage of crops.
3.	DDT	Restricted for use in Public health only.
4.	MEMC (methoxyethyl Mercuric chloride)	-do-
5.	Methyl bromide	Restriction for its sale and use is similar to that of Aluminium phosphide.
6.	Sodium cyanide	Use of sodium cyanide shall be restricted for fumigation of cotton bales by Plant Protection Adviser to the Govt. of India.
7.	Lindane	Only for use in termite control in buildings, termite control in sugarcane in agriculture and for export only.
8.	Methyl parathion	Use is permitted only on those crops where honey bees are not acting as pollinators.
9.	Monocrotophos	Banned for use in vegetables.
10.	Fenthion	Banned for use in Agriculture except for locust control.

(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.	Nicotin sulphate
6.	Chlorobenzilate	22.	Nitrofen

S.No.	Name of Pesticide	S.No.	Name of Pesticide
7.	Chlordane	23.	Paraquat-di-methyl sulphate
8.	Chlorotenvinphos	24.	Pentachloro Nitrobenzene (PCNB)
9.	Copper acetoarsenite	25.	Pentachlorphenol (PCP)
10.	Dibromochloropropane (DBCP)	26.	Phenyl mercury acelate (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	31.	Endosulfan
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 - X

Performa for Referring Sample to Plant Clinic, PAU, Ludhiana for Diagnosis of Disorders

Name and address of the farmer	
Crop	Variety..... Age of the crop.....
Problem noticed (Approx. date)	
Sowing date	
Area (under the crop)	.....(acres)
Source of seed	
Is this problem related to weather ?	Yes/No
If yes, type of Weather	Rain/High temp./Storm/Frost/Hot dry Spell/Wet condition/Hail/Any other (Specify)
Suspected disorder	Insect damage/Disease/Nutritional/Input Phytotoxicity/Any other
Symptoms	Holes/Excreta/Rotting/Blight/Yellowing/Wilting/Mottling/Mosaic/Root swelling/Distortion/Any other
Extent of spread	Less than 25%/25-50%/50-75%/More than 75%
Spread pattern	Whole Crop/Patches/Isolated plants
Crop rotation	Wheat-Rice/Wheat-Cotton/Any other (Specify)
Soil type	Sandy/Loamy sand/Clay/Loam
Soil/Water analysis report	Copy attached/Not attached
Drainage system	Good/Moderate/Poor
Source of irrigation	Canal/Tubewell/Rainfed
Irrigation applied	1/2/3/4/5/More than 5
Industrial plant in adjoining area	Yes/No
If yes,	Distance in Mts.....
Name the Inputs used	Dose..... Timing.....
Diagnosis by field functionary (Extension Scientist)	
(Signature and Address of Extension Scientist)	
To be sent to	**Director, Extension Education** **PAU, Ludhiana-141004**

Appendix - XI
Important Telephone Numbers of Punjab Agricultural University, Ludhiana for the Convenience of the Farmers 0161-2401960 to 2401979

Name/Designation	Telephone Number	
	Office	Mobile
Dr. Jaskarn Singh Mahal Director Extension Education	0161-2401644	----
Dr. Gurmeet Singh Buttar Additional Director Extension Education	0161-2401074	94176-48885
Dr. Gurjinderpal Singh Sodhi Additional Director Extension Education	--	94176-26843
Dr. Tejinder Singh Riar Additional Director Communication	0161-2405731	98142-10269

Help Line Numbers for the Farmers

Kisan Call Centre, Chandigarh	**1800-180-1551 (Toll Free)**	
Seed Shop	419 (Ext. No.)	---
Dr. Surinder Kumar Thind Plant Clinic	417	94630-48181
Dr. Khuswinder Singh Brar Plant Breeding & Genetics	435	94175-77458
Dr. Amarjit Singh Plant Pathology	505	94637-47280
Dr Yuvraj Singh Pandha Entomology	504	98727-44194
Dr. Amit Kaul Agronomy	401	81464-00233
Dr. Rajiv Gupta Soil Science	506	81462-00940
Dr. Dilpreet Talwar Vegetable Science	452	83608-35919
Dr. Jaswinder Singh Brar Fruit Science	303	99158-33793

Dr. Mahesh Kumar Narang FP&PE	446	94173-83464
Dr. Arshdeep Singh Food, Vegetable & Fruit Processing	305	98762-35555
Dr. Rakesh Sharda Soil & Water Enggineering	284	98555-45189
Dr. Raj Kumar Economics & Sociology	461	81460-96600
Dr. Tarsem Chand Processing & Food Engineering	384	97790-00640
Dr. Ranjit Singh Landscaping & Floriculture	440	94631-46872
Dr. Dharminder Singh Extension Education	321	98726-12124
Dr. (Mrs.) Neena Singla Rat Management	382	93573-25446
Dr. (Mrs.) Tejdeep Kaur Kaler Bird Management	382	98559-65904
Biocontrol Lab, Ludhiana	320	---
Biocontrol Lab, Abohar	01634-225326	---
Biocontrol Lab, Gurdaspur	01874-220825	---
Biocontrol Lab, Bathinda	0164-212159	---

Phone Number of Heads of Various Departments

Plant Breeding & Genetics	224
Wheat Section	250
Cotton Section	334
Maize Section	437
Oilseed Section	433
Pulses Section	413
Fodder Section	443
Entomology	320
Plant Pathology	319

Agronomy	308
Soil Science	317
Vegetable Science	370
Fruit Science	303
Landscaping & Floriculture	440
Extension Education	321
Farm Machinery & Power Engineering	257
Economics & Sociology	301/461
Microbiology	330
Rats & Birds Control	429

Associate/Deputy Directors of Krishi Vigyan Kendras

Dr. Bikramjeet Singh, Amritsar	0183-2505672	98723-54170
Dr. Amritpal Singh Dhaliwal, Bathinda	0164-2215619	98142-49159
Dr. Gurmeet Singh Butter, Faridkot	01639-253142	94176-48885
Dr. Jaswinder Singh, Fatehgarh Sahib	01763-221217	94173-60460
Dr. Gurjant Singh Aulakh, Ferozepur	01632-246517	95018-00488
Dr. Sarbjit Singh Aulakh, Gurdaspur	01874-220743	94640-70131
Dr. Maninder Singh Bons, Hoshiarpur	01884-243647	98157-51900
Dr. Sanjiv Kataria, Jalandhar	01826-292053	99889-01590
Dr. Satbir Singh, Kapurthala	01823-250652	99882-27872
Dr. Devinder Tiwari, Ludhiana	01628-261597	81465-00937
Dr. Gurdeep Singh, Mansa	01652-235590	88722-00121
Dr. Amandeep Singh Brar, Moga	01636-207110	81465-00942
Dr. Nirmaljit Singh Dhaliwal, Sri Muktsar Sahib	01633-210046	98556-20914
Dr. Vipin Kumar Rampal, Patiala	0175-2225473	81465-70699
Dr. Gurpreet Singh Makkar, Ropar	01881-220460	94678-34156
Dr. Amandeep Singh Brar, SBS Nagar	01822-233056	81465-00942

Dr. Mandeep Singh, Sangrur	01672-245320	99881-11757
Dr. Narinderpal Singh, Pathankot	---	98762-95717

Senior Most Extension Specialists of Farm Advisory Services

Dr. Ajay Choudhary, Abohar	01634-225326	94639-74499
Dr. Narinderpal Singh, Amritsar	0183-2501989	84270-07023
Dr. Navdeep Singh Gill, Barnala	---	81461-00796
Dr. Amarjit Singh Sandhu, Bathinda	0164-2212684	88722-00120
Dr. Navtej Singh, Mohali	0172-2775348	98722-18677
Dr. Harinder Singh, Faridkot	01639-250143	97800-90300
Dr. Jagjot Singh Gill, Ferozepur	01632-242136	82839-32427
Dr. Sumesh Chopra, Gurdaspur	01874-220828	98148-30820
Dr. Gurpartap Singh, Hoshiarpur	01882-222392	950-1434300
Dr. Maninder Singh, Jalandhar	0181-2225768	81460-88488
Dr. Pardeep Kumar, Kapurthala	01822-232543	95010-23334
Dr. (Mrs) Gurpreet Kaur, Patiala	0175-2200646	94633-69063
Dr. Raminder Singh Ghuman, Ropar	01881-222257	98885-21200
Dr. Buta Singh Romana, Sangrur	01672-234298	94172-81311
Dr. (Mrs) Parminder Kaur, Tarntaran	---	98770-85223

Directorate Research

Dr. N.S. Bains Director Research	0161-2401221 216 (Ext. No.)	98722-18677
Dr. Gurjit Singh Mangat Addl. Director Research (Crop Improvement)	263	98145-16464
Dr. P.P.S. Pannu Addl. Director Research (NR&PHM)	---	98727-33111

Dr. Gursahib Singh Addl. Director Research (FSN & E)	2401960/325 ---	98159-59515
Dr. Ajmer Singh Dhatt Addl. Director Research (Horticulture & Food Science)	---	99151-35797
Dr. Rajinder Kumar Director (Seed)	438	94649-92257
Dr. Balkaran Singh Deputy Director (Farm)	253	81469-00244

Regional Research Station/Seed Farm

Abohar	01634-225326
Bathinda	0164-2212159, 0164-2215619
Bahadurgarh (Patiala)	0175-2381473
Faridkot	01639-251244
Gurdaspur	01874-220825
Gangian (Hoshiarpur)	01883-285075
Ladowal (Ludhiana)	0161-2801566
Kheri (Sangrur)	016732-85020
Kapurthala	01822-255094, 01822-255095
Amloh (Naraingarh)	01765-230126
Ballowal Saunkhri (SBS Nagar)	01885-241601, 01885-241607
Jallowal (Lesriwal) Jalandhar	98141-37547
Usman (Tarntaran)	98146-93189
Dyal Bharang (Amritsar)	98555-56672

APPENDIX - XII

Scientific Names of Fruit Crops

Name of crop	Scientific Name
Kinnow	*Citrus reticulata*
Sweet orange	*Citrus sinensis*
Lime	*Citrus aurantifolia*
Lemon	*Citrus limon*
Grapefruit	*Citrus paradisii*
Mango	*Mangifera indica*
Soft pear	*Pyrus communis*
Pathar Nakh / Hard pear	*Pyrus pyrifolia*
Peach	*Prunus persica*
Plum	*Prunus domestica*
Grapes	*Vitis vinifera*
Guava	*Psidium guajava*
Ber	*Zizyphus jujube*
Litchi	*Litchi chinensis*
Loquat	*Eryobotrya japonica*
Papaya	*Carica papaya*
Pomegranate	*Punica granatum*
Banana	*Musa paradisii*
Sapota	*Manilkara acharas*
Amla	*Emblica officinalis*
Phalsa	*Grewia asiatica*
Fig	*Ficus carica*
Date palm	*Phoenix dactylifera*