Cultivation of Fruits, Vegetables and Floriculture
<table>
<thead>
<tr>
<th>Code</th>
<th>ENI95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>Paperback</td>
</tr>
<tr>
<td>Indian Price</td>
<td>1100</td>
</tr>
<tr>
<td>US Price</td>
<td>125</td>
</tr>
<tr>
<td>Pages</td>
<td>760</td>
</tr>
<tr>
<td>ISBN</td>
<td>8186623752</td>
</tr>
<tr>
<td>Publisher</td>
<td>National Institute of Industrial Research</td>
</tr>
</tbody>
</table>
Fruit and Vegetable Cultivation in India is a prominent business sector for exporting merchandise and shipping and thus earning a good amount of international revenue for India. Since its independence India has been trying keep pace with the dazzling prospects of exporting commercial business. India is essentially agrarian and rural, with ample scope for lands for farming and cultivation and it has also helped for the cultivation of a large variety of fruits as well as vegetables. The study of fruit and vegetable production is a subject of enormous scope. It involves the integration of wide spectrum of disciplines. As the new technologies and developments become available, cropping system and production practices changes. India has perhaps been renamed as the vegetable and fruit basket in the world, a factor that weighs fascinatingly upon the cultivation of fruits in the country. India serves as the home to various kinds of vegetable as fruits, and holds a vital position in the field of productions of fruits and vegetables amidst different countries of the world. Floriculture covers all the aspects related to the production and use of flowers and ornamental plants, flower seeds, bulbs etc. The scenario of floriculture is changing fast due to steadily widening export opportunities and large number of people earns their livelihood. Commercial floriculture however is of recent origin. A constituent increase in demand for cut and potted flowers has made floriculture as one of the important commercial trades in Indian agriculture. Floriculture has an annual growth potential of 25 to 30 percent. Of late, large scale commercial companies have started joint ventures with foreign companies to invest in the floriculture sector. The government has invited foreign investment in floriculture, particularly in the areas of refrigerated storage and transportation facilities essential to ensure that flowers do not perish to transit. Cultivation of fruits, vegetables and floriculture is capable of attracting/retaining a large number of progressive rural populations on in farming.

This book majorly deals with integrated development of fruits, scope and importance of fruits, vegetable crops, integrated development of vegetables, floriculture, integrated development of floriculture etc. This publication deals with all the important and relevant aspects of floriculture including production technology, open cultivation in different climates. The book is written in such way that it can be used by commercial growers, home gardeners, professional floriculturists and environmentalists.

Content:
SECTION - I
FRUIT CROPS
1. Integrated Development of Fruits
2. Scope and Importance of Fruits
3. Almond
4. Annonaceous fruits
5. Aonla
6. Apple
7. Avocado
8. Bael
9. Banana
10. Ber
11. Apricot
12. Carambola
13. Cherry
14. Date palm
15. Durian
16. Egg fruit
17. Fig
18. Grape
19. Guava
20. Jackfruit
21. Jamun
22. Karonda
23. Kiwi
24. Limes and Lemons
25. Rootstocks
26. Litchi
27. Loquat
28. Mahua
29. Mandarin orange
30. Mango
31. Mangosteen
32. Olive
33. Papaya
34. Passion fruit
35. Peach
36. Pear
37. Pecan
38. Persimmon
39. Phalsa
40. Pineapple
41. Plum
42. Pomegranate
43. Rambutan
44. Sapota
45. Strawberry
46. Sweet orange
47. Walnut

SECTION - II
VEGETABLE CROPS
48. Integrated Development of Vegetables
49. Agathi
50. Amaranth
51. Ash gourd
52. Beet root
53. Bitter gourd
54. Bottle gourd
56. Broccoli
55. Brinjal
57. Brussels sprout
58. Cabbage
59. Capsicum
60. Carrot
61. Cauliflower
62. Celery
63. Chilli
64. Cowpea
65. Curry leaf
66. Drumstick
67. French bean
68. Garlic
69. Kale
70. Knol Khol
71. Lablab bean
72. Lettuce
73. Muskmelon
74. Okra
75. Onion
76. Palak or Indian Spinach
77. Parsley
78. Pea
79. Pointed gourd
80. Pumpkin
81. Radish
82. Ridge gourd
83. Round melon
84. Snake gourd
85. Spinach
86. Tomato
87. Turnip
88. Watermelon
89. Potato
90. Disease And Pest Management
91. Arrow root
92. Sweet potato
93. Tannia
94. Yam bean
95. Yams

SECTION - III

FLORICULTURE

96. Integrated Development of Floriculture
97. Rose
98. Jasmimes
99. Orchid
100. Site and Soil Selection
101. Land and Layout Preparation for Orchard

Sample Chapter:
Guava

GUAVA (Psidium guajava) is a very popular fruit. It is available throughout the year except during the summer season. Being very hardy, it gives an assured crop even with very little care. Its cost of production is also low because its requirements for fertilizer, irrigation and plant protection are not much. Further its nutritive value is very high. Therefore it is an ideal fruit for the nutritional security. Guava is also grown as a backyard fruit to a great extent. Best quality guavas are produced in Uttar Pradesh, particularly in Allahabad region.

CLIMATE AND SOIL

Owing to its hardy nature, guava is grown successfully in tropical and subtropical regions up to 1,500m above mean sea-level. Best quality guavas are obtained where low night temperatures (10°C) prevail during winter season. It tolerates high temperatures and drought conditions in north India in summers but it is susceptible to severe frost as it can kill the young plants. An annual rainfall of about 100cm is sufficient during the rainy season (July-September). The rains during harvesting period, however, deteriorate the quality of fruits.

Guava is cultivated on varied types of soils-heavy clay to very light sandy soils. Nevertheless, very good quality guavas are produced in river-basins. It tolerates a soil pH of 4.5-8.2. Maximum concentration of its feeding roots is available up to 25cm soil depth. Thus the top soil should be quite rich to provide enough nutrients for accelerating new growth which bears fruits.

VARIETIES

The varietal characteristics in guava are not as distinct as found in majority of other fruits. Its propagation through seeds reduces the distinctive characteristics of a variety in commercial cultivation. Important guava varieties are:

- **Lucknow 49**
  - Also known as Sardar, its fruits are large, roundish-ovate in shape, skin prim-rose-yellow and pulp white, very sweet and tasty. The TSS and vitamin C contents are high. The plants are vigorous.

- **Allahabad Safeda**
  - The most famous variety of Allahabad, it has acquired large variations due to seed propagation. The fruits are large in size, round in shape, skin smooth and yellowish-white. The flesh is white, firm, soft having pleasant flavour, high TSS and vitamin C content. The seeds; are numerous, bold and hard. The trees are tall with profuse branching and broad crown. It can withstand drought conditions.

- **Chittidar**
  - This variety is very popular in western Uttar Pradesh. The fruits are characterized by numerous red dots on the skin, high sweetness, and small and soft seeds. It is otherwise similar to Allahabad Safeda fruits in size, shape and pulp. It has higher TSS content than Allahabad Safeda and Lucknow 49 but lower vitamin C content. The tree characters resemble to those of Allahabad Safeda.

- **Harijha**
  - Harijha is more popular in Bihar because of profuse bearing. The trees are of medium vigour due to sparse branching. The fruit is round in shape, medium large in size and greenish-yellow in colour. Flavour is sweet with good keeping quality.

- **Hafshi**
  - It is a red-fleshed guava having good taste. It is mainly grown in Bihar. Fruit is of moderately big-size, spherical in shape with thin skin. Trees are of medium, vigour but productive.

Apple Colour
Its fruits are medium-sized and pink-coloured. They are sweet in taste with good keeping quality. They require temperature for the development of good pink colour. The trees are of medium vigour but their leaves are greener than others. However, it is a moderate-yielder.

Seedless
All the seedless varieties-Saharanpur Seedless, Nagpur Seedless and others are the same. Two types of fruits, completely seedless and partly seeded, are borne on a plant of seedless variety. The completely seedless fruits develop on the shoots rising from the stem and these are bigger in size and irregular in shape. The partly seeded fruits are born on normal shoots at the periphery and are small in size and round in shape. Seedless variety is unfit for commercial cultivation because it gives very low yield. The plants are very vigorous.

Arka Mridula
This is a seedling selection of variety Allahabad Safeda. Its medium-sized fruits are of excellent quality with high TSS. The white pulp has only few soft seeds. The plants are of medium vigour but high-yielding.

Allahabad Surkha
Allahabad Surkha is an outstanding variety of large, uniform pink fruits with deep pink flesh. The plants produce up to 120kg fruits in its sixth year of fruiting. The fruit is sweet, strongly flavoured with few seeds and is slightly depressed at both ends. The plants are vigorous, dome-shaped and compact.

PROPAGATION
Guava is propagated both by seeds and vegetatively. But vegetative propagation is commercially followed.

Seed propagation
The propagation of guava through seeds should not be encouraged because the seedlings have long juvenile phase, give lower yields and bear poor quality fruits. But the seedlings serve as rootstock material for grafting or budding. The seeds should be sown as soon as possible after extraction from the ripe fruits. Soaking of seeds in water for 12hr or in hydrochloric acid for 3 min. gives about 90% germination. About 1-year-old seedlings become ready for grafting or budding. For planting seedling, seeds should be collected from the plants producing high-quality fruits and high yield.

Vegetative propagation
In northern India, guava is propagated by inarching, giving a very high percentage of success during rainy season. But inarching is cumbersome and gives limited number of plants from the mother plant. Budding has been adopted only on a limited scale in some parts of the country. Where the atmospheric humidity is high. The main problem encountered in this method is disbudding of rootstock making it labour-intensive. Among the various methods of budding-shield, forkert, patch and chip-the patch budding is ideal giving highest percentage of success. However, the best time of budding differs from locality-to-locality. Layering is being commercially followed in the southern and western India with very good results. After bending the plant, its branches are covered with soil leaving the terminal portion open. In a few months the rooting of branches takes place which are then separated from the mother plants and planted in the nursery for further sale. Layering is a labour-intensive method. A limited number of plants can only be multiplied from a mother plant. When mother plants are very tall, air-layering of shoots is done during the rainy season using polyethylene and moist sphagnum moss. Use of root-promoting plant growth regulator, IBA (3.000ppm), promotes the rooting of air-layers up to 100%. The main limitation of air-layering is the poor establishment of air layers in the nursery after detachment from the mother plant. Further, the method is very cumbersome and labour-intensive.

Stooling is the easiest and cheapest method of guava propagation. The self-rooted plants (cuttings or layers) are planted 0.5m apart in the stooling bed. These are allowed to grow for about 3 years. Then these
are cut down at the ground level in March. New shoots emerge on the beheaded stumps. A 30cm wide ring of bark is removed from the base of each shoot rubbing the cambium of the exposed portion in May. All the shoots are mounded with the soil to a height of 30cm. The soil is covered with mulch to conserve the moisture. After a period of 2 months of the onset of monsoon, the shoots are detached from the mother plant at ringed portion and planted in the nursery. The shoots are headed back to maintain the root and shoot balance before planting in the nursery.

By following the technique of ringing and mounding of the shoots, second time stooling is done on the same mother stools in first week of September. The rooted stool layers are detached in first week of November. Thus stooling is done twice on the same mother stools in a year. The stooling of a mother stool can be done for many years. With the advancement in its age, the number of stool layers also increases every year. The growth and development of stool layers are better than seedlings. The application of rooting hormone is not required.

A semi-dwarfing rootstock for guava Aneuploid 82 has been developed.

**CULTIVATION**

**Planting**

The field for planting is prepared during summer season by ploughing, leveling and removing weeds. The pits of 1m x 1m x 1m size are dug and filled with a mixture of farmyard manure and soil. If soil is good and irrigation facilities are available, the preparation of land and digging of pits are not required. The planting is done during the rainy season by adopting square planting system. Guava is commercially planted at a distance of 5-8m. The exact planting distance is, however, decided according to variety, soil fertility and availability of irrigation facilities. Guava Lucknow 49 needs more spacing than Apple Colour and Allahabad Safeda. Under irrigation and high soil fertility, the plants become very vigorous requiring more spacing. In normal conditions, a planting distance of 7m is optimum. High-density planting reduces total soluble solids, sugars and ascorbic acid but increases titratable acidity. The lower plant population results in the spread of crown, while higher planting density causes erect growth of branches making the plant tall and compact. High-density planting gives higher yield/unit area in early years of fruiting.

**Training/pruning**

Traditionally, no pruning is done in guava because the plant bears heavily even without it. But no pruning results in the formation of narrow crotches limb breakage due to heavy fruit load and overcrowding. Therefore, training of plants in young stage to build strong framework and to avoid weak crotches is necessary, whereas fruiting trees should be pruned to check overcrowding in the orchard. The plants should be trained as low headed trees to facilitate multiple hand pickings. The open centre or delayed open centre system may be adopted. The scaffold branches in young plants are to be tipped back to encourage secondary branching. The root suckers, water sprouts and criss-cross branches are to be removed altogether. In Maharashtra, bending of horizontal branches is practised to some extent by tying the branches of 2 adjoining plants to increase fruiting in young plants but it is labour-intensive and creates hindrances in cultural operations.

In every growing season, a large number of new shoots emerge in guava a majority of which are lateral and a few are terminal. These shoots produce fruits. After 1 year most of the lateral shoots dry out, while terminal shoots put forth the extension growth. Hence, to check the overcrowding and to control the plant height the terminal shoots on the periphery may be headed back at about 40cm level in alternate years. Pruning also takes place during harvesting as the fruit is plucked along with the shoot on which it is borne. Pruning is usually recommended after harvesting or in spring. Summer pruning may damage the plant by sun burning.

Manuring and fertilization Although guava is grown without the application of any manure and fertilizer, it
responds very well to their application by giving higher yield and better quality fruits. For guava-growing regions of the country, different fertilizer schedules-600g N, 400g K in northern region; 260g N, 320g P and 260g K in eastern region; 900g N, 600g P and 600g K in southern region and 600g N, 300g P and 300g K/plant/year in western region-have been recommended. The fertilizer application should be based on leaf nutrient status of an orchard, wherever feasible. Time of fertilizer application depends on the crop taken and the region. In north India, fertilizer is given in the first week of May for rainy season crop and in first week of July for winter season crop. In West Bengal, fertilizer are applied in 2 equal split doses, one in January and the other in August. At Bangalore, full K and 70% N are applied in June and full P and 30% N in September. Since 48% of feeder roots of guava are found in the surface soil up to 25cm depth, the fertilizer should be placed in 25cm trenches 1 m away from the trunk for better uptake. Sometimes guava suffers a deficiency which is characterized by eduction in leaf size, interveinal chlorosis, suppression of growth and dieback of leaders. It can be corrected by spraying of ZnSO4 (0.45 kg) and hydrated lime (0.32kg) in water (33 litres). Bronzing is another common problem in guava. It is caused by the deficiency of B, Zn, N, P and K due to low soil pH. The soluble P level of leaves is a better index for bronzing. Guava Luckhow 49 is more susceptible than Allahabad Safeda. It can be reduced by improving the soil pH and treating the soil with N, P, K and Zn at 200, 80, 150 and 80g/year respectively, or fortnightly foliar spraying of these nutrients each at 2% for 4 months.

Aftercare
Guava plants do not require much care after planting. The weeds are removed by shallow cultivation. Green manuring should be done during rainy season and clean cultivation during rest of the year. Leguminous crops can be grown as intercrops during first 3 years of planting to obtain more income and to increase the N content of the soil. Both rainy and winter season crops are very heavy compared with spring crop. Fruit quality of the winter crop is best. Therefore, winter crop is preferred over the rainy season crop. In northern India, normally hot and dry summers along with low soil moisture do not allow summer flowers to set the fruits. But in mild summer and normal soil moisture, the summer flowers set fruits for rainy season crop which is known for its poor quality fruits and severe incidence of fruit fly and fruit-borer. The practice of taking winter crop instead of rainy season crop is known as crop regulation. The rainy season crop can be removed by spraying of urea (10%) on Allahabad Safeda and 20% on Lucknow 49 at the time of peak flowering in summer season. Other methods of removing rainy season crop are hand removal of flowers and fruits, spraying of bioregulators, root exposure, withholding irrigation and pruning of 3/4th of flower-bearing shoots are either costlier or impractical or ineffective.

Irrigation
Guava is mostly grown under rainfed condition and irrigation is rarely practised wherever this facility is available. However, irrigation enhances the yield of guava by making the plant more vigorous and increasing the fruit set. Irrigation is especially desirable after planting for survival of the plants and thereafter for 2-3 years to obtain early good growth. Irrigation of fruiting plants depends upon the adoption of a particular cropping pattern. For the whole year, cropping pattern which is commercially adopted all over the country except the northern region, irrigation is given during summer and autumn season and for the rainy season crop, the irrigation is essential during summer season. Normally, winter season cropping pattern is adopted in north India which requires fortnightly irrigation during October-November. Irrigation is given to make the soil of root zone moist; thus heavy irrigation is unnecessary. The fruit quality of guava is adversely affected by high soil moisture content during harvesting.

HARVESTING AND POSTHARVEST MANAGEMENT
Guavas are harvested throughout the year (except during May and June) in one or the other region of the
country. However, peak harvesting periods in north India are August for rainy season crop, November-December for winter season crop and March-April for spring season crop. In the mild climatic conditions of the other parts of the country, the peak harvesting periods are not so distinct.

Guava fruits develop best flavour and aroma only when they ripen on tree. In most of the commercial varieties, the stage of fruit ripeness is indicated by the colour development which is usually yellow. For local market, fully yellow but firm fruits are harvested, whereas half yellow fruits should be picked for distant markets. The fruits are harvested selectively by hand along with the stalk and leaves.

The plants begin bearing at an early age of 2-3 years but they attain full bearing capacity at the age of 8-10 years. The yield of a plant depends on its age, cropping pattern and the cultural practices. A 10-year-old plant yields about 100kg of fruits every year. If both rainy and winter season crops are taken, more yield may be obtained in the rainy season.

Ripening of guava starts on the tree and continues even after harvest. It is accelerated in rainy season due to high temperature and slows down in winter season due to low temperature. The fruits are packed in baskets made from locally available plant material. For distant markets, wooden or corrugated fiberboard boxes are used along with good cushioning materials-paddy straw, dry grass, guava leaves or rough paper. Good ventilation is necessary to check build up of heat. Guava is a delicate fruit requiring careful handling during harvesting and transporting. The fruits should reach the consumer in a firm condition.

Because of their perishable nature, guavas are disposed off immediately after harvesting in the local market and a very small quantity is sent to distant markets. Since fruits are sold at a cheaper price and are available for a very long period of the year, they are not kept in cold storage. However, shelf-life of guava can be extended up to 20 days by keeping them at low temperature of 5°C and 75-85% relative humidity. It can also be stored for about 10 days at room temperature (18°-23°C) in polybags providing a ventilation of 0.25%.

**GUAVA WILT**

Guava plants are attacked by wilt, which alone causes heavy losses. It is very difficult to find out an orchard of guava more than 30 years in age because most of its plants die at about 20 years of age due to wilt. Various fungi causing wilt are Fusarium roseum oxysporum f. psidii, F. solani, Hacrophomina phaseolina and Gliocladium roseum. Resistant rootstock is the only solution. The planting material should not be obtained from a wilt-infected region or nursery.

**Jamun**

**JAMUN** (Syzygium cumini) is indigenous to India. Its tree is tall and evergreen. It is generally grown as avenue or as wind break. It is widely grown from Indo-Gangetic plains in north to Tamil Nadu in south. It is also found in the lower range of the Himalayas and Kumaon hills.

The refreshing and curative properties of jamun make it one of the useful medicinal plants of India. Fruits are a good source of iron, used as an effective medicine against diabetes, heart and liver trouble. The seed powder of jamun reduces the quantity of sugar in the urine very quickly.

**CLIMATE AND SOIL**

Since jamun is a hardy fruit crop, it can be grown under adverse soil and climatic conditions. It thrives well under both tropical and subtropical climates. It requires dry weather at the time of flowering and fruit setting. Early rains are beneficial for better growth, development and ripening of fruit. Young plants are susceptible to frost.

The jamun trees can be grown on a wide range of soils-calcareous, saline sodic soils and marshy areas. Deep loam and well-drained soils are ideal. It does not prefer very heavy and light sandy soils.

**VARIETIES**

There is no improved variety for commercial cultivation. The most common type grown in north India is

...
known as Rajamun. This is large-fruited type having oblong fruits of deep purple colour. A type having large-sized fruits is known as 'Paras' in Gujarat. Another type found in Varanasi has no seed. A selection known, as Narendra Jamun 6 has been identified with desirable traits at Faizabad (Uttar Pradesh).

**PROPAGATION**

Jamun is propagated both by seeds and vegetative techniques, the most common being by seeds. The seeds have no dormancy, hence fresh seeds can be sown (within 10-15 days) 4-5cm deep at a distance of 25cm x 15cm. The seeds germinate 10-15 days after sowing. The seedlings become ready for transplanting in spring or next monsoon. Its seeds show polyembryony up to 30-40%, hence nucellar/apomictic seedlings can be used to produce true-to-type plants.

Seedling plants bear fruits of variable size and quality. Therefore, vegetative method is desirable for propagation of improved or selected types. Budding is most successful for commercial raising of plants. It is done on one-year-old rootstock having about 10mm thickness. Patch and forkert methods give more than 70% success if performed in March. In low rainfall area, July-August is ideal time.

**CULTIVATION**

**Planting**

Pits of 1m x 1m x 1m size are dug 10m apart for seedling trees and 8m apart for budded plants in a properly cleaned field. Pit digging should be completed before the onset of the monsoon or spring season. They should be filled with a mixture of top soil and well-rotten farmyard manure or compost in a 3:1 ratio. Monsoon season (July-September) is ideal time of planting. But it can also be planted with a good survival rate in spring (February-March) if irrigation facilities are available. About 100-150 plants are required for planting a hectare land.

**Training and pruning**

Young plants need training for the development of framework. Keep the main stem or trunk clean up to a height of 60-90cm from the ground level by removing the basal branches and sprouts. Jamun plants do not require any pruning except removing diseased, dry and crisscross twigs.

**Manuring and fertilization**

In pre-bearing period, 20-25kg well-rotten farmyard manure or compost/plant/ year should be applied. For bearing trees, this dose is increased up to 50-60kg/ plant/year. The ideal time for giving the organic manure is a month before flowering. Grown-up trees should be applied 500g N, 600g P and 300g K/plant/year. This should be spread near the canopy of the plant and mixed in soil by hoeing.

**Aftercare**

Green manuring can be done during the rainy season. Intercropping karonda or phalsa or seasonal vegetable crops in initial years between the rows or interspaces can be done. Sprouts arising from base of its plants should be removed timely and the plantation should be kept weed-free. Jamun is a cross-pollinated crop hence raising of honey-bees near the plantation is desirable for maximum fruit set and productivity.

**Irrigation**

Irrigation should be given just after manuring. Young plants require 6-8 irrigations for better growth. In bearing trees, irrigation should be given from September to October for better fruit bud formation and from May to June for better development of fruits. Normally 5-6 irrigations are required.

**HARVESTING AND POSTHARVEST MANAGEMENT**

Seedling trees start bearing at the age of 9-10 years, whereas budded ones take 5-6 years. Flowering starts during March and continues up to April in north Indian conditions. Fruits ripen during June-July or with the onset of rains. It takes about 3-5 months to ripen after full bloom. Fruits change their colour from green to deep red or bluish black. This is a non-climacteric fruit hence it does not ripen after harvesting.
Fully ripe fruits are harvested daily by hand-picking or by shaking the branches and collecting the fruits on a polythene sheets. Jamun trees need a number of pickings, since all fruits do not ripen at a time. The average yield of fully-grown budded and seedling trees is 50-70kg and 80 kg-100kg/plant/year. Jamun fruits are highly perishable. They can be stored only up to 2 days at ambient temperature. Precooled fruits packed in perforated polythene bags can be stored for 3 weeks at 8-10°C and 85-90% humidity. There is no standard practice for grading of fruits. Blemished or bruised fruits must be sorted out before packing. Fruits are normally packed in bamboo baskets and transported to local markets. In the market, fruits are sold on green leaves or on pieces of newspaper. The fruits prepacked in leaf cup covered with perforated polythene bags have little or no damage, during handling. Handling of fruits during transit from market to home is also easier in this container.

Jamun fruits can be processed into excellent quality fermented beverages such as vinegar and cider, and non-fermented ready-to-serve beverages and squashes. A good quality jelly can also be prepared from its fruits. The seeds can be processed into powder which is very useful to cure diabetes.

**PHYSIOLOGICAL DISORDER**

Heavy drop of flowers and fruits have been observed in jamun at various stages. About 50% flowers drop within 3-4 weeks of flowering. It occurs at very young stage during 5-7 weeks of full bloom. The problem of flower and fruit drop can be minimized by spraying of GA3 (60ppm) twice, one at full bloom and other 15 days after fruit set.

**Karonda**

**KARONDA (Carissa carandas)** is a hardy, evergreen, spiny and indigenous shrub. Widely grown in India, it is found wild in Bihar, West Bengal and south India. It is grown commonly as a hedge plant. Regular plantations of Karonda are very common in Varanasi district of Uttar Pradesh. Fruits, sour and astringent in taste, are the richest source of iron containing good amount of vitamin C. Very useful to cure anaemia, its fruits have antiscorbutic properties also.

**CLIMATE AND SOIL**

Since karonda is very hardy and drought tolerant, it thrives well throughout the tropical and subtropical climates. Heavy rainfall and waterlogged conditions are not desirable. It can be grown on a wide range of soils including saline and sodic soils.

**VARIETIES**

There are no well-established varieties of karonda. Cultivated types are classified on the basis of fruit colour-green-fruited, whitish fruits with pink blush and dark purple fruited. Maroon (a Narendra Selection) and nos. 13, 16, 12 and 3 have been identified as promising types. Natal plum, an African species (Carissa grandiflora), bearing large and dark red fruits is also grown in India.

**PROPAGATION**

Karonda is commonly grown from seeds. Vegetative methods-air-layering and stem (hard wood) cuttings-are not very common. The fresh seeds are sown in nursery during August-September. One-year old seedlings are transplanted. Air-layering is very successful in karonda. It can be performed in the beginning of the monsoon. Rooted layers can be separated 3 months after layering.

**CULTIVATION**

**Planting**

Pits of 45cm x 45cm x 45cm and 60cm x 60cm size are dug and filled with organic manure and soil, in a 1:2 ratio. The planting distance for fence/hedge should be 1-1.5m, requiring 300-400 plants for planting the boundary of one hectare land. In intercropping with fruit trees and with regular planting, 2m distance both ways is required. About 500 plants/ha for intercropping and 1,800 plants/ha for regular planting are needed. Beginning of monsoon is ideal time of planting.
Training/pruning
Regular plantations of karonda can be trained on single or double stem. Therefore, additional unwanted shoots or laterals are removed from time-to-time to give the plant desired shape. Bearing plants normally do not require any pruning. Suckers arising from ground and diseased, dried twigs should be removed.

Manuring and fertilization
Karonda plants grown as protective hedge are hardly manured or fertilized. Manuring, however, is beneficial. Otherwise its plants slowly get exhausted after taking 2 crops and show symptoms of die back. Therefore, 10-15kg well-rotten farmyard manure or compost/plant should be applied before flowering.

Aftercare
Since karonda is a hardy plant, it requires very little care. Suckers appearing from the ground in regular plantation must be removed timely. Hoeing is essential for removing the weeds. Seasonal vegetables (chilli and cauliflower) or medicinal plants (matricaria) can be intercropped in first 2 years of regular plantation.

Irrigation
Water requirement of karonda is very low. Irrigation after planting and manuring is essential. Plantation once established does not need much water. However, if there is no rain during the development of fruit, one irrigation is given, which helps increase the fruit size.

HARVESTING AND POSTHARVEST MANAGEMENT
Plants raised with seeds start bearing in third year of its planting. The plants flower during March. The fruits ripen from July to September in north India. In arid conditions, flowering starts late and fruits ripen in post-monsoon period. Karonda requires 2-3 pickings. On an average a plant provides 3-5kg fruits.

Karonda fruits mature 100-110 days after fruit set. At this stage fruits develop their natural colour. Fruits ripen after this stage, taking about 120 days (after fruit set) when they become soft and attain dark purple/maroon/red colour. There is no standard practice for grading and packing of fruits. Fruits after harvesting are kept in shade. Undesirable or blemished fruits are sorted out. Good fruits packed in baskets are marketed. Storage life of fruits depends upon the stage of harvest. Fruits harvested at maturity, can be stored for a week at room temperature, whereas fruits harvested at ripe stage are highly perishable and can be stored only for 2-3 days. Fruits can be preserved/stored for 6 months in SO2 solution (2,000ppm). Raw or mature fruits are most suitable for making an excellent quality pickle, jelly and candy. Ripe fruits can be processed into ready-to-serve squash and syrup. They can also be dried.

Karonda
KARONDA (Carissa carandas) is a hardy, evergreen, spiny and indigenous shrub. Widely grown in India, it is found wild in Bihar, West Bengal and south India. It is grown commonly as a hedge plant. Regular plantations of Karonda are very common in Varanasi district of Uttar Pradesh. Fruits, sour and astringent in taste, are the richest source of iron containing good amount of vitamin C. Very useful to cure anaemia, its fruits have antiscorbutic properties also.

CLIMATE AND SOIL
Since karonda is very hardy and drought tolerant, it thrives well throughout the tropical and subtropical climates. Heavy rainfall and waterlogged conditions are not desirable. It can be grown on a wide range of soils including saline and sodic soils.

VARIETIES
There are no well-established varieties of karonda. Cultivated types are classified on the basis of fruit colour-green-fruited, whitish fruits with pink blush and dark purple fruited. Maroon (a Narendra Selection) and nos. 13, 16, 12 and 3 have been identified as promising types. Natal plum, an African species (Carissa grandiflora), bearing large and dark red fruits is also grown in India.
PROPAGATION
Karonda is commonly grown from seeds. Vegetative methods—air-layering and stem (hard wood) cuttings—are not very common. The fresh seeds are sown in nursery during August-September. One-year old seedlings are transplanted. Air-layering is very successful in karonda. It can be performed in the beginning of the monsoon. Rooted layers can be separated 3 months after layering.

CULTIVATION
Planting
Pits of 45cm x 45cm x 45cm and 60cm x 60cm size are dug and filled with organic manure and soil, in a 1:2 ratio. The planting distance for fence/hedge should be 1-1.5m, requiring 300-400 plants for planting the boundary of one hectare land. In intercropping with fruit trees and with regular planting, 2m distance both ways is required. About 500 plants/ha for intercropping and 1,800 plants/ha for regular planting are needed. Beginning of monsoon is ideal time of planting.

Training/pruning
Regular plantations of karonda can be trained on single or double stem. Therefore, additional unwanted shoots or laterals are removed from time-to-time to give the plant desired shape. Bearing plants normally do not require any pruning. Suckers arising from ground and diseased, dried twigs should be removed.

Manuring and fertilization
Karonda plants grown as protective hedge are hardly manured or fertilized. Manuring, however, is beneficial. Otherwise its plants slowly get exhausted after taking 2 crops and show symptoms of die back. Therefore, 10-15kg well-rotten farmyard manure or compost/plant should be applied before flowering.

Aftercare
Since karonda is a hardy plant, it requires very little care. Suckers appearing from the ground in regular plantation must be removed timely. Hoeing is essential for removing the weeds. Seasonal vegetables (chilli and cauliflower) or medicinal plants (matricaria) can be intercropped in first 2 years of regular plantation.

Irrigation
Water requirement of karonda is very low. Irrigation after planting and manuring is essential. Plantation once established does not need much water. However, if there is no rain during the development of fruit, one irrigation is given, which helps increase the fruit size.

HARVESTING AND POSTHARVEST MANAGEMENT
Plants raised with seeds start bearing in third year of its planting. The plants flower during March. The fruits ripen from July to September in north India. In arid conditions, flowering starts late and fruits ripen in post-monsoon period. Karonda requires 2-3 pickings. On an average a plant provides 3-5kg fruits.

Karonda fruits mature 100-110 days after fruit set. At this stage fruits develop their natural colour. Fruits ripen after this stage, taking about 120 days (after fruit set) when they become soft and attain dark purple/maroon/red colour. There is no standard practice for grading and packing of fruits. Fruits after harvesting are kept in shade. Undesirable or blemished fruits are sorted out. Good fruits packed in baskets are marketed. Storage life of fruits depends upon the stage of harvest. Fruits harvested at maturity, can be stored for a week at room temperature, whereas fruits harvested at ripe stage are highly perishable and can be stored only for 2-3 days. Fruits can be preserved/stored for 6 months in SO2 solution (2,000ppm). Raw or mature fruits are most suitable for making an excellent quality pickle, jelly and candy. Ripe fruits can be processed into ready-to-serve squash and syrup. They can also be dried.

LOQUAT
LOQUAT (Eriobotrya japonica) is an evergreen, subtropical fruit. It is available in the market during mid-March-May when there is scarcity of fruits. It is scientifically cultivated in China, Japan, Korea and Taiwan. Indigenous to the hills of mild winter and moist regions of the central-eastern China, it was introduced in
India under the name of ‘Japanese medlar’. Its commercial cultivation is mostly confined to Uttar Pradesh (Saharanpur, Dehra Dun, Muzaffarnagar, Meerut, Farrukhabad, Kanpur and Bareilly), Delhi, Punjab (Amritsar, Hoshiarpur and Gurdaspur), Himachal Pradesh (Kangra) and to a small extent in Assam, Maharashtra and hills of south India.

CLIMATE AND SOIL
Loquat is highly specific in its climatic requirements. It needs about 90cm well-distributed rainfall throughout the year. Frost is a limiting factor for its successful cultivation. At certain places, the crop may be destroyed by moderate winter frost, since flowering takes place from October to late-January. At -3°C smaller fruits (diameter<9.5mm) are more susceptible to cold injury than larger ones. Likewise, its cultivation is problematic in areas where summer sets in early along with hot scorching winds. There may be a heavy loss of crop because of sun burning. Loquat requires a well-drained, deep, sandy loam soil with inorganic matter.

VARIETIES
A number of varieties having different qualities and harvesting times are available. A good dessert loquat should be sweet, pulpy, mellow and melting and sub-acid though pleasant in flavour. It should sustain as few seeds as possible.

Early (Varieties which ripen from mid-March)
Golden Yellow: Fruit medium, oval to oblong, golden-yellow. Pulp medium thick, pale-orange, smooth and soft, mild taste, sub-acid, few seeded. TSS 10.5%.
Improved Golden Yellow: Fruit large, oval to pyriform, orange-yellow. Pulp thick, colour orange, smooth and crisp, mild taste, sub-acid, moderately seeded. TSS 9.5%.
Large Round: Fruit medium, ovate globose, pulp thin, creamy-white, coarse and firm, mild taste, sub-acid and few seeded.
Pale-Yellow: Fruit large, oblong to pyriform, corn-coloured. Pulp thin, creamy-white, smooth and melting, pleasant taste, sub-acid and moderately seeded.
Thames Pride: Fruit medium, pyriform, marble colour. Pulp medium, pale-orange, coarse and slightly granular, mild taste, sub-acid and moderately seeded.

Mid-Season
(Varieties ripening from last week of March)
Fire Ball: Fruit small, oblong to ovate, saffron-yellow, pulp thick, corn husk colour, smooth and crisp, taste mild, sub-acid and moderately seeded.
Improved Pale Yellow: Fruit medium, oblong-pyriform, pulp medium thick, cream colour, smooth and soft, pleasant taste, sub-acid and moderately seeded.
Large Agra: Fruit medium, oblong to ovate, pulp medium thick, pale-orange, smooth and firm, pleasant taste, sub-acid and moderately seeded.
Mammoth: Fruit small, oblong-pyriform, colour snowshine. Pulp medium orange, coarse and granular, pleasant taste, sub-acid and few seeded.
Matchless: Pulp medium, orange, coarse and granular, pleasant taste, sub-acid and few seeded.
Safeda: Fruit large, oblong-pyriform. Pulp thick, creamy white, smooth and melting, excellent taste, sub-acid and moderately seeded.

Late (Varieties start ripening from mid-April)
California Advance: Fruit medium, oblong pyriform, pale-yellow. Pulp thick creamy white, smooth, melting, excellent taste, sub-acid and few seeded.
Tanaka: Fruit small, ovate, orange coloured. Pulp medium, yellow, coarse and firm, pleasant taste and sub-acid and few to moderately seeded.
There is "self unfruitfulness" in loquat varieties. Therefore, a pollinizer variety should be planted along with the main variety. On the basis of self-fruitfulness the varieties can be grouped as follows:

1. Self-incompatible: Golden Yellow, Improved Golden Yellow, Pale Yellow and Agra Large
2. Partially self-incompatible: Large Round, Free Ball, Thames Pride, California Pride and Tanaka

The variety Dalforma Advance is the best pollinizer for Improved Golden Yellow.

**PROPAGATION**

Propagation of loquat through air-layering is highly successful. Treatment of smooth, old-ringed shoots with 3% NAA or IBA 2,500ppm is recommended.

Inarching is common method of grafting in loquat. Several rootstocks such as apple, pear, mespilus and cydonia have also been used.

Budded or grafted plants should always be preferred over seedling plants for planting because they develop true-to-type plants, which come into early bearing.

**CULTIVATION**

**Planting**

Monsoon is the best time for planting. Spring planting may be done where adequate irrigation facilities are available. Planting distance may vary with variety and environmental conditions. It is advisable to keep a distance of 6-8m. Pits of 75cm x 75cm x 75cm size are dug and left for exposure to sunlight for 15-20 days.

A dose of 40-50kg well-rotten farmyard manure and 200g single superphosphate along with Aldrin dust (50g/pit) to ward off termites should be given. The plants are planted in mid-August or mid-February. Generally square system of planting is recommended. A planting density of 180-300 plants/ha is considered profitable. High-density planting results in higher yields of the same quality as traditional planting.

**Training and pruning**

Central leader or open system is usually followed to train the loquat. The bearing tree benefits from annual pruning to regulate the crop. The flowers are borne on current years growth. The tree starts flowering during July-August and continues up to January-February. There are 3 flushes. Flowers appearing in the first flush are mostly shed, while the crop from the third flowering is generally poor. The major crop is obtained mostly from the second flush (October-November) of flowers. So, a timely and judicious pruning should be made by snipping off 5cm below the tips towards the May-end. Heavy pruning should be avoided, as it seriously hampers the yield.

**Manuring and fertilization**

Since loquat is a voracious feeder, it needs heavy fertilization for luxuriant growth and bumper fruiting. A fertilizer dose of 750g N, 300g P and 750g K/year to a young plant should be given.

**Irrigation**

Proper and timely irrigation augments loquat yield. Moisture condition of soil should be examined frequently and irrigation decided accordingly. During the swelling of blossom buds, an irrigation should be given. Two to three irrigations are recommended during picking season.

**Aftercare**

The soil should be kept in good physical condition by thorough cultivation, addition of organic matter followed by timely irrigation. For getting increased fruit size, application of Paclobutrazol (500ppm) around the base of the trunk is advised. Girdling too improves leaf photosynthesis, accelerates fruit development and improves fruit quality. Spraying of GA3 (40ppm) and NAA (40ppm) is also helpful to enhance quality as well as yield.

Fruit thinning is essential to obtain enhanced fruit size. It is advocated to clip out the ends of bunches whenever there is overcrowding. The thinning should be done when the fruits are less than 1-2cm in
diameter. Application of growth-regulator NAA (25ppm) is effective.

**HARVESTING AND POSTHARVEST MANAGEMENT**

Loquat trees may start bearing 3 years after planting and give maximum yield at the age of 15 years. However, fruits should be allowed to fully mature on the tree. These should never be pulled from tree by hand as it causes decay. The best method is to harvest bunches with the help of a sharp instrument. Fruit usually takes 70 days to mature after fruit set. California Advance, Golden Yellow and Thames Pride should be harvested at 11% TSS. On an average, a loquat tree yields 16-20kg/ tree. To save the fruits from sun-burning, spraying of 2,4, 5-T (20-40ppm) may be given as it hastens maturity. Covering of developing fruit bunches with paper bags may also prove beneficial. The well-managed trees yield 30-40kg fruits/tree. For efficient marketing, fruits are generally graded into 2 grades. Large and fine fruits free from all defects are put in one grade and remaining ones in the other. As the fruit is very delicate, ii needs very careful packing with sufficient cushion to avoid injury during transit. Loquat fruits could be stored for sometime without much spoilage in polythene bags provided the mouth of the bags are kept open. At room temperature, loquat fruits can be kept for 4-6 days. However, the fruits can be stored for 2 weeks at 11°C temperature and 85-90% humidity.

A major part of total produce is used for fresh consumption. However, it can also be used for making value-added products—jelly, jam, preserves, juice and squash.