

## (B) FRUITS OF ARID AND SEMI-ARID AREAS



**Date-palm.** (*Phoenix dactylifera* L.). Some of the imported varieties of date-palm have been cultivated successfully in Punjab. This tree thrives in light as well as in heavy soils, provided the depth is adequate (2.5 to 3 metres) and the drainage is good. The plant is not affected by frost and requires intense heat in summer for the development and ripening of the fruits. The maxim 'head in fire and feet in water' indicates the conditions that are ideal for date-cultivation. If the water-table is within 3 to 3.5 metres from the surface, mature trees need no surface irrigation. A wet season during flowering and fruit-ripening is limiting factor in the successful cultivation of the date-palm. South-western Punjab, northern Rajasthan and Kutch offer suitable conditions for date growing.

### Climate

The date palm is a tree flourishes well under varied sets of climate. However, for proper maturity of fruit, the date requires prolonged summer heat without rain or high humidity during the ripening period. A light shower with prolonged periods of cloudy weather and high humidity may cause more damage than a heavy rain followed by clear weather and drying winds. The mean temperature between the period of flowering and ripening of the fruit should be above 21<sup>o</sup> C rising to 27<sup>o</sup> C or higher for at least one month. For successful fruit maturation, nearly 3000 heat units are required. The heat units available in most of the north-western districts of India, counted from the time of flowering, i. e. end February to July, indicate that these are suitable for date palm cultivation. Taking this into consideration, parts of Rajasthan extending from Sri Ganganagar to Anupgarh, Jaisalmer and Barmer and Kutch district of Gujarat will be suitable for date cultivation. The climate of Abohar (Panjab) should be considered marginal because of rainfall (30 cm) and high humidity at the time of ripening (July-August) being the limiting factor.

### Soil

The date palm can be grown in soils containing more alkali or salts. It can tolerate such condition better than many other fruit plants. In view of the large investment required to bring a date garden into bearing and maintain it on profitable production, sandy loam soil, 2 or 3 metres deep with good water holding capacity and drainage is most desirable. Date palm can tolerate high soil salinity. In the soil having 4 per cent salt concentration, dates can survive well provided the root system does not come in contact with a stratum of soil where the sodicity is more than 1 per cent.

### Choice of Varieties :-

**Hillawi** : It is soft date from Iraq. This variety is relished both in **doka** and **dang** stages. Total soluble solids range between 28 to 42% and astringency in the fruit at **doka** stage is low or almost absent. It is an early variety yielding good crops and is somewhat more tolerant to rains. Dry dates (Chhuhara) of good quality and cured soft dates (Khajoor) can be prepared. Its fruit at **dang** stage (fresh form) is very delicious. Average yield ranges from 50 to 80 kg per palm.

**Khadrawi** : It also originated from Iraq. This variety proved successful under Abohar conditions. The trees of this variety are comparatively less tall and yield good crops. It can be used both for dry dates and soft dates. The yield ranges from 40 to 70 kg per palm.

**Shamran** : It is a mid-season cultivar tolerant to high humidity. The variety yielding prolific crops. The fruits can be cured into good quality. **Chhuhara** and also softened with salt treatment. Fruit is medium to large, oblong to oblong-oval and yellow at **doka** stage. Its yield per palm is 40 to 70 kg.

**Medjool** : The variety originated in Morocco and has large size fruits. It is late in ripening and has proved particularly good in preparing dry dates of attractive bold size and good quality. Its yield is 35 to 50 kg per palm.

**Barhee** : It is soft date from Iraq. The variety has proved extremely good for table use in fresh form (**doka stage**). The **doka** fruit contains about 32% TSS, has golden yellow colour and has a very pleasant taste because of low astringency and high pulp content. The trees of this variety are prolific in yields and the fruit is ready for eating late in the season i.e. first fortnight of August at Abohar. Its yield ranges from 60 to 110 kg per palm.

**Hayany** : It is soft date originated from the UAR. The berries have attractive deep colour. The fruits could be consumed as fresh in the **doka** stage as ripening does not proceed further under Abohar conditions. The yield per palm ranges from 30 - 40 kg.

**Zaidi** : It is a mid season variety, slightly tolerant to rain or high humidity. The fruit is small to medium, obovate and yellow at **doka** stage.

### **Propagation Techniques :**

The date palm are always propagated through suckers (offshoots) for commercial plantation. The suckers usually arise near the ground around the trunk. The offshoots arising at a higher level from the ground on tree trunk and with no roots give very poor survival. These are separated from the mother palms during March or August-September. The leaves are trimmed off 4 - 5 days before their detachment. The inner leaves should be cut back by one-half and the outer ones by two-thirds. The tender young unopened leaves near the central bud and parts of the bare stalks of the old leaves necessary to protect the bud, should be kept on the offshoots. The outer whirl of leaves may be fastened to afford protection from heat and cold to the central bud also facilitate detachment and transport.

The suckers weighing approximately 25 to 30 kg and well rooted should be removed. Expose the point of detachment and set a chisel (12 cm wide and 19 cm long) sharpened at the face and welded to a 150 cm long handle of 4 cm diameter. Drive in the chisel by hammering at the other end. It is very important that no injury is caused to the mother palm. Cut surface should be coated with tarcol or some suitable material immediately and earthed up.

### **Planting Operation :**

The offshoots are planted 6 to 7 metres apart in the already prepared pits of 1 \* 1 \* 1 m size immediately after detachment. In this way 202 to 275 plants/hectare will be accommodated. If transported from long distance, the offshoots may be kept in the straight. The soil around the offshoots should be pressed firmly. The field is irrigated immediately after planting. Thereafter, frequent light irrigations are given to keep the soil always moist. At Abohar, the offshoots removed in March survived better in direct field planting than those removed in August-September. However, the separation could be done both in February-March and August-September.

### **Orchard Cultural Practices :-**

#### **Irrigation :**

Date palm is known as drought resistant fruit tree and is able to survive for long periods without irrigation. However, continuous drought condition retards the growth of the plant. If water is available, date palm uses it lavishly. Date palm is highly tolerant to excessive irrigation and floods. Continuous stagnation of water or waterlogged conditions are injurious for its growth. To maintain maximum growth, the root zone up to 2 - 3 m should be kept moist and not allowed to dry. Light but frequent irrigation should be given after planting. The full grown trees on the lighter soils are usually irrigated 7 to 10 days during mid-summer and every 15 to 30 days during winter. Such soils requires 2.75 to 3.75 acre-meters of water per year and 30 to 45 acre-centimeter per month is needed during summer. On heavy soils, half the amount may be enough. Each irrigation of 10-15 acre-centimeters is usually sufficient. Irrigation is withheld when ripening starts to facilitate harvesting, hasten fruit ripening and to reduce fruit drop caused by high humidity.

#### **Manuring and Fertilization :**

Generally the farmers do not apply manure to the date palm. The trees certainly respond to manuring as indicated by increased vigour and growth. The results of studies conducted at Abohar shows that 25 to 50 kg of farmyard manure and 1 to 2 kg ammonium sulphate per palm should be added. The quantities may be reduced if some leguminous crop has been grown in the date palm. Farmyard manure is applied during December-January. The nitrogen dose should be given a fortnight before flowering i.e. **in the first week of February.**

#### **Intercropping :**

Intercropping in date palm with suitable crops bring good income and also improves the fertility of the soil. During the first few years, intercropping can be practised with no shortage of irrigation. Intercrops such as gram, peas, mash, moong, moth, senji and lentil can be sown during summer. Intercropping of some vegetables in plantation located near the cities, can be practised if sufficient irrigation and manuring facilities are available. The filler trees like grapes can be tried with good success.

#### **Fruit Thinning :**

Excess load of fruit may cause shrivelling of berries, breaking of spathe stalks, more damage due to rain and humidity, delay in ripening and alternate bearing. It also reduced size and produce poor quality of fruit. It is, therefore necessary to keep only optimum quantity of fruit and thin out the rest. This is usually accomplished either by reducing the number of fruits on each bunch and or by removing some of the bunches. The number of fruit that a palm can safely carry depends on the cultivar, age, size and vigour of the palm and number of green leaves on it. Under normal conditions, 1 - 2 bunches in the 4th year and 3 - 4 bunches in the 5th year may be left. Normally 8 - 10 bunches per palm are retained in India. Small, defective and broken bunches should be removed.

In short-stranded varieties like Khadrawi, the strands are generally cut back to even up the bunch from the top. Most of the fruit thinning is done by the removal of half to two-third of strands from the centre. In the long

stranded varieties like Deglet Noor, one-third to half strands are cut in similar way as in Khadrawi, in addition, strands are also cut back to remove about one-third of the flowers. The desirable number of fruits to be left is between 1300 and 1600 per palm depending on the variety. The per cent thinning is generally done 40 - 50 in Khadrawi, 50 - 55 in Hallawi, 50 - 60 in Zaidi and Barhee. Ethephon 100 - 400 ppm after 10 to 30 days from fruit set was found effective in fruit thinning of cv. Hayany. The biennial bearing habit of the treated palms were found to reduce by ethephon treatment. It also advances the ripening of fruit.

#### Harvesting and Processing :-

Harvesting of dates generally depends upon the weather conditions. The rain and high humidity in the atmosphere at the ripening time is a limiting factor in its cultivation. When the climate is favourable, it is preferable to leave the fruit of most varieties on the palm until it reaches the stage of maturity at which it is to be consumed or stored. The changes associated with ripening and the period during which the fruit may be consumed extend from the peak of the **khalal** stage, when the fruit has its most intense red or yellow colour and maximum weight, to the final **tamar** stage, when it has lost the greater part of its moisture content and will keep without special attention to storage. Most of the people like to eat the fruit in **khalal** stage. At least two varieties of dates Hillawi and Barhee, are liked most for eating in khalal stage. Dates are hand-picked at the stage of maturity. All the dates in the same bunch do not ripen at same time, it has been the practice to make several pickings to harvest the fruit during a season. Sometimes, when the season is favourable and more than 70 per cent fruit is ripe, the entire bunch is harvested.

The research conducted on curing of dates in Panjab (Abohar) have revealed that the rain and high humidity in the atmosphere at the time of ripening (July and August) do not allow the ripening process on the tree to proceed satisfactorily beyond **doka** stage. If the fruit is retained on the tree, there is checking, splitting and rotting. High humidity and rainfall also cause the fruit to drop. Therefore, the crop has to be harvested at **doka** stage. Though in comparatively drier seasons partial crop on some trees may become **dang** (mellow and soft) but the quantity of such fruit is limited. The berries are removed and graded manually on the basis of size and colour.

Scientists working at Abohar (Panjab) have developed a technique to transform satisfactorily the date fruit at **doka** stage into dry dates (**Chhuhara**) of good quality. At least four varieties Hillawi, Khadrawi, Shamran and Medjool have yielded very good product. **Chhuhara** obtained from Medjool, which is a large-sized variety, compare very well with the high quality **Chhuhara** imported from Middle East countries. The technique developed involves immersion of fruit at **doka** stage in boiling water for 6 to 8 minutes and then drying either in temperature-controlled oven (air-circulation type) for 80 to 120 hours at 48<sup>o</sup> to 50<sup>o</sup> C or in the sun for 10-15 days if weather is dry. Thus, an average of 45 per cent fruit product is obtained. Fruits at advanced **doka** stage or when they attain one-fourth, one-half or full **dang** (the berries become mellow and soft starting from the distal end) can be converted into soft dates (**khazoor**) of good quality by drying either in the oven at 40<sup>o</sup> C or in the sun. Thus, for soft dates, only drying the berries at partial or full dang stage is required with no other treatment and this way a final product of soft **Khazoor** ranging from 50-60 per cent is obtained. Hillawi and Barhee yielded 50-100 kg fruit per palm at doka stage. The average yield from Khadrawi and Shamran is obtained 40-70 kg fruit per palm. The yield from Medjool palm is upto 50 kg but its fruits are very large in size.

Artificial ripening of fruit at **doka** stage to transform it into **dang** stage was also attempted at Abohar. For these studies, berries were treated with 0.5 per cent to 2.0 per cent common salt (sodium chloride) and similar concentrations of acetic acid in combination with 1.0 per cent salt. The fruits to be treated with salt were spread on polythene sheet and requisite quantity of salt was applied by rubbing and smearing uniformly on the berries. The fruits which were given acetic acid plus salt treatments, were first dipped in solutions of desired acetic acid concentrations for 2 minutes followed salt application by the method described above. Each treated lot was packed into wooden boxes lined with old newspapers and packed in laboratory at room temperature. The boxes were opened after 24 hours. From these studies, it was found that 2 per cent salt, 60 to 70 per cent of the **doka** fruit were transformed into **dang**. However, the **dang** obtained by this treatment was not as good in taste as that of naturally ripened on the tree, but still it was edible and generally acceptable on account of its having lost the astringency. But such products cannot be stored more than 24 hours and, as such, should be consumed to as early as possible.

#### Insect-pests :-

The most important pests of dates are follows :

(i)**Date Stone beetle (Cocotrypes dactyliperda F.)** : It attacks unripe fruits and the adult penetrates the fruit and reaches the stone by constructing a direct circular hole through the pulp and both adults and grubs feed inside on the pulp and results in the drop of unripe fruit. Hillawi and Khadrawi, which ripen early, are more susceptible to this pest. Spraying the plants with 0.075% per cent Malathion has proved effective for its control.

(ii)**Nitiduled beetle (Haptoncus luteolus Ev)** : The larve penetrate the fruit and eat the inner portion of the pulp. Their attack is followed by fungal decay. The adult is brownish yellow, oval, slightly oblong, 2.3 + or - 0.13 mm long and 1.16 + or - 0.21 mm broad. Initially, the dropped fruits are attacked. Then the peat spread to fruit bunches on the tree and cause the fruit to drop. The pest over winters as pupae in the soil. Spraying

wiht Malathion (0.075 per cent) gave satisfactory results. Regular removal of dropped fruits and their destruction also helps in minimising the effect.

(iii) **Cigar hoeing beetle (*Lasioderma testaceum* Duft)** : It is reported as pests of stored dates in India. For the control of these pests, fumigate the dates and keeping material with Methyl bromide at a dose of 1/2 kg/27 cubic meter giving an exposure of 24 hours.

(iv) **Termites** : They feed on the roots of the newly transplanted suckers which may ultimately cause them to wither and die. As a preventive measure, 10 per cent BHC mixed in each pit @ 30 g before planting is recommended.

#### Diseases :-

Much less work has been done for the investigation of diseases of date palm in India. Studies conducted at Regional Fruit Research Station, Abohar, have found two diseases.

(i) **Graphiola leaf spot (*Graphiola phoneicis*)** : It is also called as false smut or palm leaf pustule. It is a serious disease. This disease is more acute in the areas where humidity is more. Numerous hard black smut like pustules are seen scattered developing epidermily on the upper and lower surfaces of leaflets and also on rachis. The pustules at maturity consists of round, hard, black cups about 0.50 \* 0.25 mm. These cups contain yellow spores. Older leaves are more affected, they loose their chlorophyll and dry up. For its control, remove and burn the affected leaves to check further contamination and spray the trees with 2 : 2 : 250 Bordeaux mixture (2 kg copper sulphate + 2 kg unslaked lime mixed in 250 litres of water.)

(ii) **Fruit rot** : It often causes considerable loss when humid weather occurs during the ripening season. Under such conditions, various fungus may develop in the fruit and cause spotting, dropping and rotting. The damage may be reduced by better ventilations of the branches and protecting the fruit from rain. In addition, spray the bunches with a mixture of 5 per cent fahana (**ferlic dimethyl dithiocarbamate**) in sulpher.



**Phalsa. (*Grewia asiatica* L.)** Phalsa is a small bush which grows all over the country except at higher elevations. In Punjab, Haryana, Uttar Pradesh and Andhra Pradesh, it is grown commercially. The fruit is berry-like, globular, smooth, deep reddish brown and comes in the market in May and June.

#### Climate

**Phalsa** relish distinct winter and summer for best growth, yield and quality. In regions having no winter, the plant does not shed leaves and produce flower more than once, thus yielded poor quality fruits. Full grown plants can tolerate freezing temperature for

a short period. The plants can tolerate temperature as high as 44°C. High temperature during fruit development favours ripening of fruits. At flowering time, clear weather is needed, whereas rains at that time affect fruit-setting adversely.

The **phalsa** is one of the hardiest fruit plants and can be grown successfully throughtout Punjab and Haryana. Being deciduous in habit, it can withstand frost quite well. However, care should be taken to select sites which are not subject to very low temperatures during winter. It can also grow successfully in hot and dry climatic conditions, such as those prevailing in the districts of Ferozepur, Bhatinda and Sangrur of Punjab. It can withstand occassional drought and water shortages better than fruit plants. However, for raising profitable crop of **phalsa**, satisfactory arrangements for irrigation need to be made.

#### Soil

The **phalsa** is not at all fastidious in its soil requirements and can grow quite successfully in almost every kind of soil. Around Amritsar (Punjab), where the soils are comparatively heavy, its plants grow well and bear bumper crops. At many other places such as Ludhiana, it yields well under lighter soil conditions. Though the ideal soil for growing **phalsa** is the rich loamy type. Under water logged conditions plants become chlorotic and make poor growth.

Proper soil drainage is another factor which should be kept in mind. However, soils where water stagnates for many days during the rainy season or those which have a poor sub-surface drainage and are water-logged should not be selected for commercial cultivation of **phalsa** .

#### Choice of Varieties :-

In **phalsa**, no distinct cultivar is identified. Some growers have, however, given names as Local and Sharbati. Two distinct types i.e. Tall and Dwarf were recognised at Hissar. Dwarf type was found to be more productive.

**1. Tall type** : Plant height is 4.5 m, leaf size 20 \* 18 cm. Leaves are light green in colour. Average fruit size is 2.07 cm and weighing 0.48 g. Average yield per bush is 5.2 kg. Pulp is 81.5 per cent, juice 5.4 per cent. TSS 14 per cent and Acidity 4.64 per cent.

**2. Dwarf type** : Plant height is 3.4 m, leaf size 18 \* 15 cm. Leaves greenish white in colour. Fruit size is 2.26 cm, weight 0.54 g. Average yield is 3.5 kg per bush. Pulp 60.3 per cent, juice recovery is 34.6 per cent. TSS 12.1 per cent with acidity 3.63 per cent.

## Propagation :

**Raising of seedlings :** For raising the **phalsa** seedlings, large sized, purple black coloured fruits are collected when the crop is ready in the end of May or beginning of June. After extracting from the fruits, the seeds should be washed and dried under shade. These seeds are sown in raised beds when there is sufficient humidity in the atmosphere. Rainy season (July-August) is the best time for sowing of seed. The seeds on raised beds are sown in lines which are 10 - 15 cm apart from each other. In the rows, the seed should be sown 4 - 5 cm apart and 1.5 to 2 cm deep. The seeds should be covered with sand or light soil mixed with well rotten and dry farmyard manure. The beds should be watered regularly with water, but too much watering should be avoided as the excessive moisture conditions cause poor development of the plants. The beds should be kept free from weeds. Initially, one hand weeding is recommended, otherwise the roots of small plants get damaged if weeding is done with khurpa etc.

When the seedlings come out and have made 5 - 7 cm growth, light dressing of calcium ammonium nitrate or Ammonium sulphate at the rate of 50 g/sq metre of nursery area is applied. This encourage rapid growth of the seedlings. Seedlings are ready for transplanting in the following winter i.e. during January-February.

**Propagation through cuttings :** The **phalsa** plants can also be multiplied through hard-wood cuttings. The cuttings should be prepared during December-January and kept for callusing. The use of root promoting harmones such as Indole butyric acid @ 100 ppm enhances the success of rooted cuttings.

## Planting Operation :

Land is prepared well before the plants are set in the field. When there is enough time, a cover crop such as **guara, jantar or senji** may be sown in the soil. After these crops produce enough vegetative growth, they should be buried into the soil. Before planting, the orchard site should be properly laid out according to the square or the hexagonal system. Half metre deep pits or half metre diameter should be dug and refilled with a mixture of top-soil and well rotten farmyard manure in the ratio of 1 : 1. To save the plants from possible attack of white ants add 30 g of BHC 10 per cent dust to each pit. After this, the field is thoroughly irrigated and transplanting is done when the soil is in friable condition.

The **phalsa** plants are spaced at various distances in different regions of India. Eight to twelve months old seedlings are better for planting in the field. The plants are spaced at 1.5 metres apart by which 4400 plants are accommodated in one hectare by the square system of planting.

The **phalsa** plants should preferably be transplanted in the field during January-February before they start new growth. The plants being dormant at that time, they can be lifted from nursery with bare roots. However, for transplanting during August-September, the seedlings have to be lifted from the nursery alongwith earth balls. Transplanting in the rainy season, is, therefore, a little more cumbersome and riskier than that done in the spring, when the plants are dormant.

## Flowering and Fruiting :

Flowering in **phalsa** starts from February-March and continues till May. The first flower to open is at the base. Flowers are borne in the axil of leaves. The flower are mostly cross pollinated and honey-bee seems to play major role in pollination.

The flower buds become plumpy before anthesis. The first sign of anthesis is the appearance of a slit in sepals at the base of the bud. The slit widens and at first only one sepal falls apart. The other sepals fall one by one and the whole process of flower opening is complete within half an hour. The dehiscence of anthesis in **phalsa** takes place before the flowers are completely open.

## Orchard Cultural Practices :-

### Irrigation :

**Phalsa** is regarded a drought resistant fruit plant. However, it can be observed that in Punjab, Haryana and other neighbouring Northern Indian regions, irrigation is essential for securing high yield of better quality fruits. Its plants do not need any irrigations till January. Adequate supply of irrigation water at regular intervals specially during flowering and fruiting periods is very essential for ensuring better health of plants and more profitable yields. A light irrigation should be given after pruning and fertilization of the plants. During the early

part of the spring, when the new growth starts and the temperature is usually low, the irrigation interval may be kept at about 2 - 3 weeks. The demand for water increases a great deal after the middle of April and consequently the irrigation interval may be reduced to 7 - 10 days. At this time, the plants should not be allowed to suffer from water shortage; as it would adversely affect the yield and quality of fruit. Regular irrigation should be applied to the plants till the fruit is harvested and the monsoon sets in.

As the roots of the plants are active during winter, adequate soil moisture should be maintained in the root zone. During winter, one or two light irrigations may suffice if there are no rains.

### Interplanting :

Many fruit plants grown in the plains of North India such as mango, litchi and pear comes into bearing on commercial scale very late. These fruit plants have a slow rate of growth and the space between the tree rows remains unoccupied for several years. The growers can, therefore, utilize the empty space between the permanent fruit trees for raising some quick-growing fruit plants like phalsa. **Phalsa** has another advantage over other quick-growing fruits suitable for interplanting that it is kept low-headed by severe pruning every year and does not cause overcrowding in the orchard. **Phalsa** being a deciduous plant, does not require much water during the dormant period (winter months). **Phalsa** should be interplanted only in the middle of the permanent tree rows. As soon as the permanent trees come into bearing, the **phalsa** plants should be uprooted, so that the main fruit crop does not suffer.

### Manuring and Fertilization :

Generally, **phalsa** is planted on comparatively poor soils. Some cover crop such as **gurar, jantar or senji** should be grown in the field where **phalsa** is to be planted. This practice adds sufficient quantity of organic matter to the soil and enriches it.

In order to get profitable crops of good quality, full grown **phalsa** plants should be given 10 - 15 kg of well rotten farmyard manure, soon after planting. Nitrogenous fertilizers (about 1 kg of CAN or Ammonium sulphate per bush) should also be applied, preferably in two split dose-one at the time of flowering and second after fruit-setting. Higher yield of **phalsa** can be obtained by application of 100 kg N, 40 kg P and 25 kg K per hectare, respectively. Trials at Rajasthan Agricultural University, Udaipur revealed that application of NPK @ 100, 40, 25 kg per hectare gave higher yield.

Zinc and iron were found to influence berry size and juiciness in phalsa.  $ZnSO_4$  @ 0.4 per cent at prebloom stage and after berry set improved the juice content. Ferrous sulphate at 0.4 per cent alone or in combination with zinc improved the berry size.

### Pruning :

The general practice of cutting back the **phalsa** plants to the ground level every year during the dormant period is not in order. Investigations carried out on this aspect have shown that the phalsa plants pruned to a height of one metre during January-February produce a greater number of new shoots than those which are pruned to the ground level. The growers are, therefore, advised to prune their **phalsa** plants at a height of one metre from the ground level.

The **phalsa** plants are rather slow in shedding their leaves winter. The best time for their pruning is when the plants have shed their leaves and in all cases the operation should be finished well before the start of new growth.

### Use of Growth Regulators :

Growth regulators have proved effective in increasing the fruit set and yield in phalsa.  $GA_3$  at 10 ppm increased the setting of fruit and yield appreciably. CCC at 250 ppm sprayed twice at an interval of 7 days after 50 per cent fruit set increased the fruit size. Ethephon at 1000 ppm resulted in maximum ripening in 5 days after application. SADH 1000 ppm at early stage of plant growth reduced the plant height and brought improvement in yield and fruit quality. Spraying of  $GA_3$  at 60 ppm once at the beginning of flowering, another after 15 days and etrel at 1000 ppm when ripening of berries had just started, increased the fruit retention percentage and yield. They also reduced the harvesting span and increased the TSS of the fruit.

## Harvesting of Fruit :

The **phalsa** plants begins to bear fruits in the second year. A good commercial crop is usually obtained during third year. In the Punjab and Haryana, the harvesting season of phalsa fruit starts by the end of May and lasts till the end of June. The fruits should be picked when the colour has changed to a deep reddish brown and the pulp tastes sweet. Several pickings are necessary as all the fruits do not ripen at one time. The fruit-picking is usually done on alternate days.

Under optimum conditions, a **phalsa** bush yields on an average about 4 - 5 kg of fruit.

## Insect pests :-

**Psylla** : A tiny insect causes severe damage to the phalsa foliage and young shoots. Its infestation over a long period of time results in the deformation of floral and vegetative parts. The plant growth is greatly arrested and gives a sickly appearance. Fruit set is severally reduced resulting in great financial loss to the growers.

The pest can be controlled by spraying one kg of carbaryl (Sevin 50% WP) in 500 litres of water or 300 ml Malathion 50 EC or 300 ml of Rogor 30 EC in 300 litre of water per acre as soon as new growth starts in March.

## Diseases :-

**1. Brown spot** : The disease is caused by fungus **Cercospora grewiae**. The brown spot of phalsa is quite wide spread in the Punjab and is very severe from June to August. It results in premature leaf-fall when the attack is severe. The disease first appears as tiny lesions on the upper and lower surface of the leaf. In the beginning, these lesions are covered with a white mass of fungus. Gradually, the lesions enlarge and become reddish brown to dark brown. Many times, several lesions coalesce to form big spots which are very conspicuous and may cover a large part of the leaf.

To control this disease, the leaves and prunings should be collected soon after removal and destroyed to check the fresh infection of the new leaves, the plants should be sprayed with Bordeaux mixture 2 : 2 : 250.

**2. Pinspot of phalsa** : The disease is caused by **phyllosticta grewiae**. The disease can appear any time during the growing season of **phalsa** and may cause considerable damage to the foliage. Small brown to dark brown, circular to irregular pinspot like lesions appear on the leaves.

This disease can be controlled by sprays given above for the brown spot of phalsa.

**Phalsa.** (*Grewia asiatica* L.) *Phalsa* is a small bush which grows all over the country except at higher elevations. In Punjab, Haryana, Uttar Pradesh and Andhra Pradesh, it is grown commercially. The fruit is berry-like, globular, smooth, deep reddish brown and comes in the market in May and June.

**IRRIGATION.** The banana-plants require very heavy irrigation. Irrigation is given in most places once in seven to ten days. Stagnation of water in the soil is not very congenial to the proper growth of banana and, hence, the drainage of soil is also essential.

*Phalsa* is commercially raised through seeds. The seeds are sown in well-prepared nursery-beds, 5 to 7 cm apart, in rows normally kept at 25 to 30 cm apart. The best time of sowing is July-August. The seedlings, thus raised, are ready for the transplanting in the following January-March or July-August.

A *Phalsa* plantation is raised by transplanting the seedlings, 3-4 metres apart, according to the square system of planting. February is considered the best month for this purpose.

*Phalsa* is not ordinarily manured. However, with about 10-15 kg of farmyard manure per bush, better returns can be obtained. It can stand drought and does not need frequent watering.

Pruning is an essential operation in *phalsa* cultivation and is done in January. Severe pruning is practiced by some growers almost to the ground level.

Harvesting is done during May-June and since the fruits ripen gradually, several hand-pickings are necessary. The average yield per plant is 5-6 kg.



**Custard-apple. (*Annona squamosa* L.) or *sitaphal*** is a small tree seldom more than 4.5 metres high and is both cultivated and found growing in a semi-wild state throughout Peninsular India. A dry-and-hot climate suits it most. It flourishes in lighter soils, and grows well even on the slopes of hills, but cannot stand cold or frost.

This fruit-tree is propagated through seeds and by grafting. There is considerable variation in the fruit-trees when propagated from seeds. 'Bullock's-heart' (*ramphal*) provides a suitable rootstock for grafting by inarching or budding. Grafted plants give fruits earlier (in about two years) than seedlings which take three to four years. The plant flowers from April and November. The yield per tree varies from 25 to 30 kg. Fruits are mostly consumed locally, but they can be transported over long distances if they are picked before they are fully ripe and are packed in a single layer in well-ventilated wooden boxes with soft padding material.

**Bullock's-heart. (*Annona reticulata* L.).** The Bullock's-heart is an allied fruit which is rarely cultivated. It prefers a heavier soil than custard-Apple and is less resistant to cold and frost. It is easy to propagate by inarching. It gives fruits from January to May and the yield goes up to 45 kg per tree.

Cherimoyer is the best of the family and performs best in subtropical climate. It is propagated by inarching on Bullock's heart rootstock. The tree bears fruits from the sixth year onwards and gives about 100 fruits per year.

Attemoya is a cross between custard-apple and cherimoyer and is similar to the latter in its growth requirement.



**Aonla. (*Phyllanthus emblica* L.).** It is indigenous to India and the tree is characterized by very small leaves which are attached to branchlets in such a way that each branchlet looks like a compound leaf. The tree attains good height. It is quite hardy and can be grown without much care in all types of soil, except very sandy.

The 'Banarsi' *aonla* is the most important cultivar which is propagated vegetatively. In the District of Pratapgarh of Uttar Pradesh, there are many commercial orchards. The important varieties grown are 'Banarsi', 'Chakiya' and 'Pink-tinged'. These are vegetatively propagated and highly valued unlike the seedling-trees which produce unmarketable fruits.

The commercial practice of propagating *aonla* is by shield-budding which is done in June. The two-year-old seedling *aonla* is used as rootstock. Budded *aonla* plants are planted in the fields during rains at a distance of 11 metres each way. It can also be planted as a windbreak around an orchard.

The budded plants will commence bearing from the 10th year. The vegetative growth of the tree continues from April to July. Along with the new growth in the spring, flowering also commences. The flowers are of two types : *i* male, and *ii* female. Fruits are fully mature by January-February. Under conditions in southern India, the fruits are found throughout the year at one place or another.



**Fig. (*Ficus carica* L.).** Fig has never been grown extensively in India. Maharashtra formerly had more than 500 hectares, but largely because of diseases, this figure has decreased to less than 125 hectares. Southern India reports somewhat less than this area, and there are a few fig-groves in Hyderabad and in other parts of the country. The types are not of the best quality and it is likely that they are hybrids between the European and other species. The climate of most parts of India seems to be suitable for the cultivation of fig. Rain at the time of fruit ripening is undesirable. Various types of soil are used

successfully.

**VARIETIES.** There is as yet little basis for recommending specific varieties for different parts of India. The variety most commonly grown in Maharashtra and southern India is known as the 'Poona' fig.

**PROPAGATION AND PLANTING.** The plants are almost entirely grown from cuttings. Budding and grafting are easily done. Several species of *Ficus* are compatible as rootstocks. Cuttings made in winter are ready for planting out in the rainy season. Some prefer to plant the cuttings *in situ*. The spacing of fig-trees depends on the size they are to reach and this depends mainly on the type of pruning. Generally, a spacing of 4.5 to 5 metres is adopted.

**CULTURE.** Tillage to keep down weeds is necessary and irrigation during the dry season when the fruits are growing and maturing is desirable. The tree is deep-rooted and drought-resistant, but does not bear well under conditions of water deficiency. A good supply of nitrogen is also required for heavy bearing, and the use of farmyard manure is also recommended. A fertilizer mixture containing 0.225 kg of N, 0.45 kg of P and 0.45 kg of K per tree may be applied.

**PRUNING.** The fig-tree can stand very heavy pruning. Most of the fruit is borne on the growth of the current year. Some annual pruning seems desirable, but the most efficient type in each of the areas where the fig is grown in this country is not known.

**HARVESTING.** The ripe fruit is delicate and must be harvested carefully and used within a few days. Where figs are grown for drying, they may be allowed to fall from the tree on clean dry ground.



**Jujube. (*Ziziphus mauritiana* Lamk.).** Jujube, ber or bor, is estimated to occupy about 4,000 hectares mainly in the northern, eastern and western parts of India. Almost any soil is suitable, even if it contains enough alkali to prevent the growth of some crops. The tree can stand prolonged drought and also water-logging. It cannot stand frost.

### Climate

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 up to a height of 1,000 meters above sea-level, beyond this it does not bear well. Ber relishes hot and dry climate for its successful cultivation, but the trees need adequate watering during the fruiting season. Excessive atmospheric humidity is considered a limiting factor for satisfactory fruiting. Frost during winter does not have much effect on the tree. It can very well withstand hot and dry weather during summer months of May - June, its tree enters into dormancy by shedding its leaves. New growth starts in July with the advent of rains and the growth period continues till the middle of November when it is inhibited with the onset of cold weather.

### Soil

Ber provides a good scope for cultivation on soils which have so far been considered marginal or even unsuitable for growing other fruits. Its tree develops a deep tap-root system within a short period of growth and as such adopts itself to a wide variety of soils. Ber is well known for its ability to thrive under adverse conditions of salinity, drought and water-logging. The research work conducted at the Punjab Agricultural University has revealed that ber can flourish even in soils with pH as high as 9.2. Ber cultivation can succeed even under constraints of irrigation and fertilization, however, for good tree growth and yield, deep sandy-loam soils with neutral or slightly alkaline reaction and good drainage are more desirable.

### Promising Varieties :-

**Umran :** This variety is cultivated in a large scale in Punjab and Haryana. The fruit is large, oval in shape with a roundish apex and has an attractive golden yellow colour which turns into chocolate brown at full maturity. The fruit is sweet, with 14-19 per cent TSS and has pleasant flavour and excellent dessert quality. It is a prolific cropping variety, yielding 150-200 kg of fruit per tree. The fruits ripen late from second fortnight of March to mid-April and have a good keeping quality. It is susceptible to powdery mildew.

**Sanaur-2 :** This is a selection from Sanaur - a small town near Patiala, which is known for ber cultivation. The fruit is large and oblong with a roundish apex. On ripening, fruits attain a light yellow colour and TSS of 18-19 per cent. Like Umran, it is also a prolific bearer-yielding about 150 kg fruit per tree. It is a mid-season variety, ripening during second fortnight of March under Panjab conditions and has been found fairly resistant to powdery mildew disease.

**Kaithli :** This variety is a selection from Kaithal in Haryana. The fruit is medium in size, oval in shape and has a tapering apex. Fruit pulp is soft and sweet with TSS of 14-16 per cent. Fruits ripen in the second fortnight of March to first week of April. The average yield is 120 kg fruit per tree. This is an excellent variety but appears to be more susceptible to powdery mildew disease.

**Z.G.-2 :** The fruit is medium in size and roundish in shape with smooth skin. The fruit pulp is soft with an excellent sugar-acid blend. When ripe the fruits attain light yellow colour and TSS of 15-16 per cent. The average yield amounts to 150 kg fruit per tree and the ripening time extends from second fortnight of March to first week of April. This variety is recommended for growing for local markets only. It is less susceptible to powdery mildew.

Sanaur-5, Gola, Sanaur-4, Chuhara and Laddu are other important varieties of ber, which have good taste and bears heavily.

### **Planting and After Care :-**

**Planting :** The ber plants can be planted in February-March and again in August-September, but the latter season of planting gives a better success. Recently, Punjab Agricultural University has also recommended the bare-rooted (without earth ball) planting of ber during December-January.

One metre deep pits of one metre diameter should be dug and left exposed for one month before actual planting. Pits should be refilled with a mixture of top-soil, about 20 kg well-rotten farmyard manure and 1 kg superphosphate per pit. To avoid attack of white ants 30 g of BHC 10 per cent dust is added to each pit. The refilled pits should be about 2-3 cm higher than the ground level and irrigated thoroughly, so that the loose soil settles down firmly. A plant may be set in the centre of a pit with the help of planting board, maintaining the same level of soil at which it stood in the nursery. The budding point should remain about 15-20 cm high from the ground level. The plants should be immediately watered after plantation. They should be irrigated after every 4-6 days atleast during the first two months and subsequently after every 7-10 days for another 3-4 months or until the plants get fully established.

The grafted ber is spreading in habit and grows into a big tree. The tree requires proper spacing for its healthy growth and fruiting. For obtaining good income, ber plants should be planted 7.5 metres apart in square system (from row to row and plant to plant) thus accommodating 180 trees per ha.

**Lifting plants from the nursery :** The budded ber plants should be transplanted during February-March or August-September. The plants are dug out from the nursery with good-sized earth-balls so that their root-system is not much distributed. The plants should be packed carefully to keep the earth-ball intact. The earth-ball should be kept moist throughout the period of transportation and upto plantation so that the roots of tree do not dry up in the intervening period.

While lifting bare-rooted plants, the leaves and shoots of the budded ber plants are removed before uprooting them from the nursery. These plants are also headed back at a height of 60-75 cm from ground level. Then, these plants are dug from the soil with the help of Spade and Khurpa to keep maximum feeding roots with them. These plants are tied loosely in bundles and are wrapped in moist rice straw. Such plants can easily be trained according to modified central leader system. The bare-rooted plant should be lifted from nursery from mid-December to early-February.

**Planting as Windbreak :** Besides regular ber plantations, the tree can also be successfully planted as a windbreak around the commercial orchards to provide an effective wind screen. The tall-growing trees like Safeda, Arjun and Simbal should be interplanted with ber, being a low-headed tree.

### **Rootstock and Propagation :-**

Seeds of **Katha ber (Zizyphus mauritiana Lamk)** are generally used for raising rootstock, which are easily available from the wild growing trees and possess the qualities of a good rootstock. The ber plants should be budded on **Zizyphus mauritiana** (Elongated Dehradun) for higher fruit yield. Ber plants raised on semi-vigorous rootstock **Zizyphus mauritiana** (Coimbatore) can profitably be planted at a closer spacing of 6 x 6 m. Umran trees grafted on this rootstock show a spread of 6 metre as compared to the recommended rootstock viz. **Zizyphus mauritiana** (Elongated Dehradun) on whom the tree spread to an area of 7.5 metre. Thus about 50% more plants/ha can be accommodated with over 20% increase in yield of equally good quality fruit.

Seeds of **Mallah ber (Zizyphus numularia)** can also be used as rootstock. The seedlings of Mallah ber are slow growing and become buddable after longer period than the seedlings of **Katha ber**.

**Raising of Rootstock :** The germination of ber seed is quite a difficult process on account of the stony nature of the shell (endocarp) which contains the seed. A large percentage of seed stones are non-viable and require elimination at the time of sowing. Seed stones collected from dropped fruits contain 50-70 percent non-viable seeds. Seeds should be dipped into a salt solution of 17-18 percent concentration for 24 hours before sowing. The floating seeds should not be sown as these are generally non-viable. The ber seeds can also be sown by cracking the hard shell (endocarp). They germinate rapidly in about 8-10 days. However, for commercial purpose, stones should be sown as such to avoid injury to embryos. To get best root-stock material, it is important that seeds should be collected only from healthy and vigorous-growing wild ber trees. The ber seedlings raised from **Katha** ber stones, which are sown during March-April, after fresh extraction, in well-prepared nursery field at a distance of 15 cm in rows 30 cm apart. Germination starts in about 3-4 weeks and seedlings make a rapid growth. The seedlings should be trained to the single stem. Nearly one-fourth of the seedlings attain buddable size of a lead pencil by August, while the rest are ready for budding by April next.

**Budding :** The propagation of ber by budding is the most successful method. Both Shield or T-budding and ring-budding methods are employed but the former is preferable, because it is easier to perform. Budding operation should be done when there is proper flow of sap in the stock to be budded. Shield-budding is done during March-April or August-September, but it has been found that August-September budding gives a far better success. The buddlings make growth at a very fast speed. Plants budded in April usually become saleable in August-September, where as those budded in rainy season are ready for planting by February-

March next. The ring-budding is preferable during June-July when the new growth starts. Shield-budding done during August-September has given success of 75-81 per cent, whereas budding in April has given a little success. The highest budding success is also achieved in June.

**Selection of Stock and Scion :** The stock seedlings should be healthy and vigorous and it is allowed to grow as a single stem only. The budding is done when the stock stem has attained the thickness of a lead pencil. It is essential that bud sticks are taken only from selected trees which are known for bearing a heavy fruit crop of good quality. The mother plant from which the scion bud-sticks are obtained for budding should be healthy, vigorous, free from diseases and insect-pests and should be true-to-type. Two to three months old shoots with plump buds should be selected. Bud-sticks, about 30 cm long, are cut from the selected mother plants. For sending to distant places, about 20 cm long bud-sticks should be taken. The leaves of the bud-sticks should be cut away, keeping the leaf stalks attached to the buds. These should be tied in small bundles and wrapped in moist piece of cloth. The bud-sticks should be kept moist till they are used for budding. The bud sticks can be kept for 2-3 days in good condition.

#### **Flowering and Fruiting :-**

The whole period of bud development is divided into eight stages. It takes 21 days to 22 days for passing through various stages of bud development. The flowering period lasts for about two and a half months from September to November. The peak of flower anthesis is at 6 A. M. in Sanaur-2, Sanaur-5 and Chhuhara ultivers and 2 P.M. in Thornless, Khaithli and Umran cultivars. The dehiscence of anthers starts just after anthesis and completes within 4 hours. Pollen grains are highly viable - the viability ranging between 87 to 91 percent in different cultivars. Pollen grain germinability is also quite high to 36 - 48 per cent. The peak receptivity in stigma is found on the day of anthesis. It does not set any fruit by self-pollination, thereby shows self-incompatibility.

Fruit-setting starts in second week of October and continues upto first fortnight of November. The ber fruit reaches to ripe stage in about 180 days after fruit-setting. The fruit growth in terms of length and diameter shows three distinct phases and follows a pattern of 'Double Sigmoid' curve.

#### **Orchard Cultural Practices :-**

##### **Training and Pruning :**

**Training :** The ber plants start bearing within 2-3 year of their planting in the orchard. In the fourth year, the trees bear commercial crop. Hence, the ber plants should be properly trained during the first 2-3 years, to build up a strong framework. The young budlings should be given support with a bamboo stake to avoid the breakage of the bud-union and to support the main stem. The commercial varieties are spreading in nature, therefore, staking is absolutely essential during the first two years to train the tree properly. The plant will make vigorous growth during the first year. Many secondary branches will emerge from the main stem. All the branches upto 75 cm from the ground level should be removed. Four or five laterals which are most favourably located around the main stem should be selected to make the proper framework. At the end of the year, the main stem should be headed back to some outgrowing laterals.

**Pruning :** The pruning of ber trees is highly desirable to maintain their vigour and productivity as well as to improve fruit size and quality. Pruning also saves the fruit from being affected by the powdery mildew disease and strong winds. The ber tree remains young upto 30 years, if proper pruning is done regularly. Ber fruit is borne in the axils of leaves on the young growing shoots of the current year. Hence, a regular annual pruning is essential to induce a good and healthy growth which will provide a maximum fruit bearing area on the trees as well as to improve the fruit size and quality. In unpruned ber tree, the canopies of the trees get unnecessarily enlarged, the growth and branchlets become weak and both fruit size and quality gets impaired. Ultimately, such trees become economically unproductive besides occupying large orchard space. Some thinning out of the branches of ber trees is also necessary to avoid too much crowding so as to admit adequate sunlight and facilitate proper aeration. Ber pruning experiments have shown that the light pruning, i.e. heading back of 25 per cent of the previous year's growth (branchlets, shoots, etc) is desirable to obtain heavy yield, good fruit size and better quality. The lower branches should be pruned suitably to prevent them from spreading on the ground. The diseased, broken and intercrossing branches should also be thinned out. Severe pruning after every four-five years, is recommended.

The ber trees shed their leaves and enter into dormancy by the end of May. The best time for taking up pruning would, therefore, be end-May or beginning of June.

##### **Irrigation :-**

Irrigation is essential during the development of fruit, i.e. from October to February at intervals of 3 or 4 weeks depending upon the weather. Trees will continue to bear even if no irrigation is applied during this period but the yield is substantially reduced because of heavy fruit drops and smaller size of the remaining fruit. The quality of fruit is also very poor. It has been observed that the fruit become large and their quality is improved the fruit shedding is very much minimised if irrigation is applied during fruit development period. Irrigation should be stopped in March as fruits on the branches lying on the ground get damaged and their ripening is delayed. The harvesting of fruit is over in April and they become dormant in May-June and shed their leaves.

They need little or no irrigation during this period. If irrigation is applied during the dormant period, the trees would continue to put fourth growth haphazardly which is not desirable. Under Panjab conditions there are sufficient rains during July to September when the tree produce the maximum fresh growth. During the second half of September and in October the trees come into flowering. At this time, light irrigation should be given.

#### **Manuring and Fertilization :**

Proper nutrition of ber tree is necessary to get good crop over the years. The fruit becomes large and attractive and get decent price in the market. 20 kg farmyard manure and 100 g nitrogen (400 g CAN) is recommended for one year old ber tree. Similar amount of farmyard manure and nitrogen should be increased every year up to the age of five years. The quantity of farmyard manure and nitrogen should be stabilized at 100 kg and 500 g (2 kg CAN), respectively, after the age of five years.

Farmyard manure should be supplied in May-June. Half of the CAN may be applied during rainy season (July-August) and the other half at the time of fruit-set (October-November). The fertilizer should be evenly spread in the basins of trees upto the periphery. After adding the fertilizer, light hoeing with spade or khurpa should be given to the basins to mix it thoroughly with the soil.

#### **Intercropping :**

The ber tree begins to bear after one year of its planting in the field. To develop the tree properly, it is advisable that no fruit should be taken at least for the first two-three years. Intercropping can be successfully practised on the vacant land in the young orchard during the first four years. Only leguminous crops of short stature like gram, moong and mash can be grown to get some income from the land in these initial years. These crops also enrich the soil by fixing nitrogen. The other exhaustive and tall-growing crops should not be grown in the ber orchard as they deplete the soil of its nutrients to a greater extent and compete for light with the trees.

Manures and fertilizers, irrigation and plant protection measures should be given seperately to the fruit trees and intercrops according to their needs.

#### **Weed Control :**

Pre-emergence application of Hexuron 80 WP (diuron) at 1.2 kg/acre can be made during the first fortnight of August when field is free from growing weeds and stubbles. Glycel 41 SI (glyphosate) at 1.2 litres/acre or gramoxone 24 WSC (paraquat ) at 1.2 litres/acre as post-emergence should be sprayed when the weeds are growing actively preferably before weeds flower and attain a height of 15-20 cm. Dissolve the herbicide in 200 litres of water per acre to give complete coverage of weeds/field. Spray Glycel and Gramoxone during the calm day to avoid spray drift to the foilage of the fruit trees.

**Control of Fruit Drop :** Spray application of 20-30 ppm Naphthalene acetic acid once in the second week of October and again in the second week of November, check 11 per cent fruit drop in Sanaur-5 and 10 per cent in Kaithli cultivars of ber.

#### **Harvesting and Fruit Handling :-**

**Harvesting :** The ber tree grows quickly and the first crop can be harvested within 2-3 years of planting. The fruit itself requires about 22-26 weeks to mature after fruit-setting. The peak season of harvesting in north India is in mid-March to mid-April but some early varieties may ripen by end-February. This period being a slack season for other kinds of fruits, 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. golden yellow colour in Umran. Normally four to five pickings have to be made as all the fruits on the tree do not ripen at the same time. In no case, the fruit should be allowed to become over-ripe on the trees, as they deteriorate in taste and quality and thus fetch lower price in the market.

#### **Insect-pests :-**

**Fruit-fly (*Carpomyia vasuviana costa*) :** It causes great damage to ber fruits. The larvae feed inside the fruits and render them unfit for human consumption. To control the pest, pick and destroy the infested fruits and spray 500 ml of Roger 30 EC (Dimethoate) in 300 litres of water during February-March, care being taken that sprayings are stopped atleast 15 days before fruit harvest.

**Leaf-eating caterpillar (*Porthmologa paraclina Meyrick*) and ber beetle (*Adoretus pallens Harold*) :** The plantation should be watched carefully during rainy season regarding the attack of these insect-pests. Leaf-eating caterpillars feed on leaves and cause huge damage. To control these, spray with 750 g Sevin 50 per cent (Carbaryl) in 250 litres of water as soon as the damage is noticed.

**Lac insect (*Laccifer lacca*):** This insect also causes serious damage by sucking the sap from the twigs which usually dry up. To control this insects, remove and destroy the infested dry twigs. Spray the trees with 250 ml of Rogor 30 EC (Dimethoate) or 100 ml of Dimecron 85 WC (Phosphamidon) in 250 litres of water in April and again in September.

### Diseases :-

**Powdery mildew** : The disease is caused by **Microsphaera alphitoides f.sp. Zizyphi** and appears from September to December. It has become a big menace to ber orchards in north India. If not checked in time, the disease can wipe out the entire crop. Young developing leaves and fruits are covered with whitish powdery mass of the causal fungus. The disease causes premature defoliation and heavy fruit-drop. Affected fruits remain small and become cankered and disfigured. Sometimes the attack is so severe that the entire crop is lost either through drop or rendered unmarketable, thus causing heavy economic losses to the growers. The disease can be controlled by 3-4 spray of 0.05 per cent Karathane 40 EC (50-80 ml in 100 litres of water) or 0.25 per cent wettable sulphur (250 g in 100 litres of water). First spray must be given before flowering (first fortnight of September), second spray after fruit-set in early October and the third in the end of October. Another spray can be given if need arises.

**Leaf spots** : Two leaf spots of ber are very common in ber growing regions, i.e. 'Phoma Leaf Spot' caused by **Phoma macrostoma** Mont. and 'Black Mould of Leaf' caused by **Isariopsis indica**. Both diseases are caused by different fungi, while the Phoma leaf spot appears on the upper surface, the black mould makes its appearance only on the lower surface of leaves. In case of Phoma leaf spot symptoms appear when the leaves have fully expanded, in the Black mould case the symptoms can appear even on young leaves. Phoma leaf spot appears with grey centre, yellow margin and dark fungal growth on the mid-rib, main vein, petioles and the leaves. Black mould spot appears as small circular, small finger-like projections like softy tufts. Both the leaf spots of ber can be controlled by spraying the following fungicides as given below :  
**First spray** : Bordeaux mixture 2 : 2 : 250 or with 0.3% copper oxychloride 50% (300 g in 100 litres of water) should be sprayed both on upper and lower surface of leaves with the appearance of disease in August or when the leaves have expanded.

**Second spray** : This spray should be given after 14 days of the first spray with 0.2 per cent Dithane M-45 WP 75% (200 g per litres of water) both on upper and lower surface of leaves.

First and second spray should be repeated alternatively at 14 days interval till the fruits are fit for marketing. Thereafter sprayings are stopped a week before harvesting.



### Jamun Climate

Jamun is successfully grown under tropical and subtropical climate. It also occurs in the lower range of the Himalayas upto an elevation of 1300 metres and in the Kumaon hills upto 1600 metres above sea level. It is widely grown in the larger parts of India from the Indo-Gangetic plains in the North to Tamil Nadu in the South. It is one of the most hardy fruit crop and can be easily grown in neglected and marshy areas where other fruit plants can not be grown successfully. Jamun is somewhat more susceptible to cold and drought than the seedling mango trees. It requires dry weather at the time of flowering and fruiting. For ripening of fruit and proper development of its size, colour and taste, early rains are considered very beneficial. The fruits show remarkable improvement in these respects after the very first shower of rain.

### Soil

Jamun tree is exact in its soil requirements. The tree requires deep, loam and well-drained soil for its optimum growth and good fruiting. Its cultivation should be avoided in very heavy or light soils.

### Choice of Varieties :-

**Ra Jamun** : It produces big sized fruit with average length of 2.5 - 3.5 cm and of diameter 1.2 - 2.0 cm. Fruits are oblong in shape, deep purple or bluish black in colour at fully ripe stage. The pulp colour of ripe fruit is purple pink and the fruit is juicy and sweet. The stone is small in size. It ripens in the month of June-July. The variety is very common among the people.

**Small sized Jamun** : It is a late maturing variety. The average length of fruit is 1.5 - 2.0 cm and diameter is 1 - 1.5 cm. The fruit is slightly round in shape, deep purple or blackish in colour at full ripe stage. The colour of the pulp is purple, less in juice, weight and sweetness of pulp in comparison of that of 'Ra Jamun'. The stone is very large. Fruits ripen in the month of August .

### Propagation and Rootstock :

Though lot of jamun plantation is seen on road side or scattered plantation at farmer's field, yet no single well established orchard is reported in North India. Also no systematic work has been done on its propagation. The most common method of jamun propagation is by seed. Seedling plant bears fruit of variable size and quality. For improved and selected true-to-true, vegetative methods of propagation like inarching and air-layering have been advocated.

**Sexual Propagation** : Seeds are sown fresh in flat nursery beds during July when this fruit ripens. The seeds should be sown at a distance of 15 cm in rows which are 25 - 30 cm apart. The seedlings can also be raised in polythene bags of 22.5 - 30 cm size. The bags should be filled with a mixture of soil and farmyard manure in equal proportion. To drain out excess water the polythene bags should be pricked from all sides before filling the mixture. It has been seen that more than one seedling comes out from a single seed. These seedlings are separated in different bags when they are about two weeks old.

Plants grown from seed become transplantable during next spring season. But it is advisable to keep them in nursery upto next rainy season which is the best time of its plantation.

#### **Vegetative Propagation :-**

**T-budding and patch budding :** According to the recent research conducted at Punjab Agricultural University has revealed that jamun can be best propagated through T-budding as well as through patch budding. The seedling of jamun is used as a rootstock. The per cent success is higher in T-budding (70%) than patch budding (60%). The best time for budding in both the cases is either during February-March or during August-September. However, the success during August-September is higher.

**Inarching :** The rootstock used for propagating jamun is the jamun seedlings. For raising the rootstock, seeds are collected from healthy, vigorously growing and high yielding jamun trees. Seedlings are raised either in bed or in pots singly. In the month of June-July one or two year old rootstocks are inarched with the matching thickness of scion. Rootstocks are watered if necessary till the grafts are separated from the parent tree. The union will complete in a period of about six weeks.

**Veneer grafting :** Veneer grafting gives 31 per cent success when one year old seedlings are used as rootstocks. The shoots are taken from spring flush and the method is employed in the month of July.

#### **Planting Operation :**

Jamun can be transplanted during spring (February-March) or during monsoon (August-September). However, the later season of planting is considered better because the plants easily get established during the rainy season. The plants are transplanted with earth ball and are given irrigation till they get established. The size of the pit should be 1 \* 1 \* 1 m and these should be filled with a mixture of surface soil, silt and well rotten farmyard manure. The jamun is planted at the distance of 10 - 12 metres in square system, thus accommodates 105 - 75 plants per hectare.

#### **Flowering and Fruiting :**

The flowering in jamun starts in the first week of March and continues up to the middle of April. The trees are in full bloom in the second week of April. The inflorescence in jamun is generally borne in the axils of leaves on branchlet. The flowers are hermaphrodite, light yellow in colour. The maximum anthesis and dehiscence were recorded between 10 A.M. and 12 Noon. The pollen fertility was higher in the beginning of the season. The maximum receptivity of stigma was observed one day after anthesis. Jamun is a cross-pollinated fruit. The pollination is done by honeybees, house flies and wind. The maximum fruit set i.e. 32.6 - 36.0% was obtained when pollination was done one day after anthesis. Thereafter, a sharp decline was observed in fruit set.

Three distinct phases of fruit growth in jamun are recorded. During the first phase (15 - 52 days after fruit set), the rate of growth was slow. In the second phase (52 - 58 days after fruit set), the rate of development was quite rapid and the third and last phase (58 - 60 days after fruit set) comprised comparatively slow growth with little addition of the fruit weight. The length and diameter of fruit showed a continuous increase with advancement of maturity. The colour of jamun fruit changed from dark green at fruit set to light reddish colour at partial ripening and dark or bright purple at full ripe stage. The fruit took 63 days for complete ripening from fruit set. The ripe jamun had 76 per cent edible portion and 3 : 1 : 1 pulp to seed ratio. TSS and sugars followed an increasing trend, while tannin content followed a decreasing trend during growth and development.

#### **Orchard Cultural Practices**

##### **Irrigation :**

During the initial year, the jamun plants required 8 - 10 irrigations in a year while bearing trees (full grown) required 4 - 6 irrigations during the summer months of May and June when fruits ripen. In the remaining period of the year, irrigation may be given when there are no rains or dry spell persists. During winter month, irrigation proves useful as it protects the plants from frost injury.

##### **Intercropping :**

To supplement the income from pre-bearing period of jamun, intercropping should be practised judiciously. Intercropping also improved fertility of the soil. Fruit crops like peach, plum, guava, kinnow, kagzi lime, phalsa and papaya can be grown as filler trees. Such filler trees can be uprooted when the jamun trees starts bearing commercial crop. The leguminous crop like gram, peas, moong and mash can be grown successfully. In addition, intercrops of vegetables near established market may be taken with cauliflower, cabbage, knol, khol, radish, brinjal, turnip, carrot etc.

##### **Manuring and Fertilization :**

During the pre-bearing period of jamun, a dose of 20 kg well rotten farmyard manure should be applied. To the bearing tree 80 kg FYM per tree should be supplied annually for proper growth and fruiting. Sometimes in highly fertile soils, the plants produce profuse vegetative growth and fruiting is delayed. Under such conditions, the manures should not be given and irrigation should also be given sparingly and withheld in

September-October and again in February-March. This procedure will prove beneficial in fruit bud formation, flowering and fruit setting. Ringing and root pruning are also helpful.

#### **Training and Pruning :**

Jamun plants should be trained according to the modified leader system. Regular pruning is not required in jamun plants. However, in later years, the dry twigs and crossed branches are removed. While training the plant, the framework of branches is allowed to develop above 60 - 100 cm from the ground level.

#### **Flower and Fruit Drop :**

In jamun, the flower and fruit drop start just after opening of flowers and continue up to maturity. About 65 per cent flower and fruit drop in the first five weeks and since then a maximum of 19 - 21 per cent flowers and fruits drop off up to maturity. Only 12 - 15 per cent flowers reach maturity. The flower and fruit drop are found at 3 stages. The first drop takes place during bloom or shortly thereafter. This proves to be the heaviest drop as about 52% of the flowers drop off after 4 weeks from flowering. The second drop starts about 35 - 40 days of full bloom and apparently there is no difference between the developing and aborting fruits. The third drop takes place after 42 - 50 days of full bloom and continues till 15th July.

**Control :** The extent of flower and fruit drop in jamun may be reduced by two sprays of 60 ppm GA<sub>3</sub>, one at full bloom and the other 15 days after initial setting of fruit.

#### **Harvesting and Fruit Handling :**

The grafted jamun starts bearing after 6 - 7 years while the seedling one after 8 - 10 years of planting. The fruit ripens in the month of June-July. The main characteristic of ripen fruit at full size is deep purple or black colour. The jamun fruit is non-climacteric in nature. The fruit should be picked immediately when it is ripe, because it can not be retained on the tree in ripe stage. The ripe fruits are picked singly by hand and in all cases care should be taken to avoid all possible damage to fruits. For harvesting, the picker climbs the tree with bags of cotton slung on the shoulder. The fruits of jamun are generally harvested daily and sent to market on the same day. The fruit is highly perishable and can be kept in good condition for about 2 - 3 days under ordinary conditions.

The average yield of fruit from a full grown seedling jamun tree is about 80 - 100 kg and from a grafted one 60 - 70 kg per year.

The storage life of jamun fruit is 6 days at room temperature and 3 weeks at low temperature (9°C and RH 85 - 90% ) when pre-cooled fruits are kept in perforated polythene bags.

#### **Insects-pests :-**

##### **1. White-fly (*Dialeurodes eugeniae*)**

It damages the tree in all parts of India. Sometimes the fruits of jamun get wormy due to attack of fruit fly. Pests can be controlled by maintaining sanitary situation in the orchard. Pick up the affected fruits and bury them deep in soil. The area under the tree should be dug so that the maggots in the affected fruits and the pupae hibernating in the soil may be destroyed.

##### **2. Leaf eating caterpillar (*Carea subtilis*)**

It is reported to damage the plant in South India at Coimbatore. The insect infests the leaves and may defoliate the trees. The pest can be controlled by spraying 625 ml Rogor in 500 litres of water.

##### **3. Squirrels, Parrots, Crows and Birds**

The jamun fruits are also damaged by these squirrels, parrots, crows and birds. For keeping them away, beating of drum or flinging small dry earthen balls through a sling is useful.

#### **Diseases :-**

Leaf spot and fruit rot

The disease caused due to ***Glomerella cingulata***. Affected leaf shows scattered spots, light brown or reddish brown in colour. The affected fruits rot and shrivel.

The disease can be controlled with fungicide like Dithane Z - 78 at 0.02% or Bordeaux mixture (2 : 2 : 250).