DKSGACA Manual No. 6/2021

Subtropical and Temperate Fruit Production

A LABORATORY MANUAL

SUBJECT CODE: HORT- 505


Prepared by: Dr. Yogendra Singh,
Dr. Divya Slathia, Dr. Amit Saurabh & Dr. Shalini Singh
(Assistant Professors, Horticulture)

Department of Horticulture
Dr. Khem Singh Gill Akal College of Agriculture,
Eternal University, Baru Sahib
District Sirmour – 173101 Himachal Pradesh
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2021

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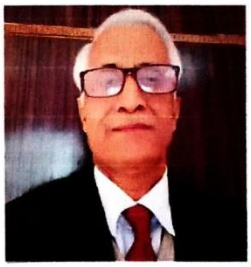

Foreword

India is endowed with a diverse climate ranging from tropical to temperate and it is possible to grow an array of horticultural crops in one or other parts of our country. These crops assume importance as they provide nutritional security, increase employment opportunities, supply raw materials for growing agro-processing industries and increase foreign exchange earnings through export. Further, the horticultural crops mainly fruit crops, plantation crops, trees and ornamental plants provide environmental security for our immediate living surroundings. Horticulture is the science, art, technology and business involved in intensive plant cultivation for human use. India is a very important contributor to the world's supply of fruits and vegetables with a total production of 98.58 million tonnes of fruits and 187.47 million tonnes of vegetables. Horticultural crops cover 13.08% of the total area under Agriculture and contribute to about 31% of the Agricultural Gross Domestic Product (GDP). Horticultural crops account for 38% of the total export of Agricultural commodities. The production and utilization of these horticultural crops account for an ever increasing proportion of the total value of the agriculture and food industry worldwide. New crops and markets, advanced cultivars and new production and utilization technologies are feeding this growth. Especially during the last fifteen years, development in horticulture has gradually moved from rural to urban areas and from traditional agricultural enterprise to the corporate sector adopting improved technology, greater commercialization and professionalism in the management of production and marketing. With this perceptible change in the concept of horticulture development in the country, the area and production of these crops show a steady increase. Yet, to meet the growing demand for the horticultural products, both domestic and export purposes, besides horizontal expansion in areas, vertical reach productivity increase is necessary. This can be achieved by planned research and development in horticulture sector.

Laboratory manual on subtropical and temperate fruit production is a very comprehensive work containing all the detailed information for orcharding on scientific lines. The students of horticulture in college and universities, fruit growers, subject matter specialists, scientists and technical experts, extension workers and nurserymen will be considerably benefited because quite exhaustive details have been incorporated on various aspects of fruit production.

I appreciate and congratulate Dr. Yogendra Singh, Dr. Divya Slathia, Dr. Amit Saurabh and Dr. Shalini Singh, Assistant Professors, Department of Horticulture for their painstaking efforts to compile this manual.

(S.K. Sharma)
Dean

PREFACE

This practical manual is of immense importance for the students because the required information is compiled in detail and consequently more time can be diverted for practical purpose. The practicals of horticultural fields are always fascinating as they provide an opportunity to the students to apply scientific principles and aesthetics of art in few horticultural operations such as layout of the orchards. These practical skills acquired by the students would be helpful to them in their professional career. The "Practical Manual on Subtropical and Temperate Fruit Production (HORT-505) contains elaborate information on the field exercises. The identification of important cultivars, observation on growth and development of fruit crops, practices in growth regulation, the tools and implements for horticultural crops use, nomenclature and identification of fruit plants, diseases of fruit crops; analyses of quality attributes, visit to tropical, sub-tropical and temperate zones and project preparation for establishing commercial orchards are the important exercises of this course and students will study them in detail. It is hoped that Practical Manual on "Subtropical and Temperate Fruit Production" will be very useful to the post-graduate students as a teaching aid. The information included in this manual is considered to be of utmost value to the students of Fruit Science, nurserymen, fruit growers, subject matter specialists and extension workers in the field of fruit production.

For his guidance, motivation, and moral help in the preparation of this manual, I am grateful to Dr. S.K. Sharma, Dean, Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib; Sirmaur (H.P.).

17-05-2021

Dr. Yogendra Singh
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Exercise-1

Identification of important cultivars

1. Apple

Red Delicious:

The plants are vigorous, form spur freely. Fruit large in size and oblong-conical, calyx end prominently lobed and red stripped over yellow, firm texture, maturity mid to late (ending August), biennial bearing and self-unfruitful and can be stored for 3-4 months. Flesh creamish, juicy; aromatic and sweet. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

Starking Delicious:

The plants are vigorous, form spur freely, fruit large in size, oblong conical in shape; ground greenish-yellow covered with dark red stripes all over the fruits. Flesh creamish, juicy, aromatic, sweet in taste and fruit quality excellent. The fruits cannot be stored for a long time. They ripen in 2nd week of August.

Anna:

Plants are medium in vigour, low chilling; fruits are oblong to conical with smooth calyx end, yellowish with red blush and early season maturity. It is recommended for Himachal, Pradesh, Jammu & Kashmir, Uttarakhand, Tamil Nadu (Ooty and Kodaikanal), Nagaland and Mizoram.

Chaubattia Anupam

Plant are medium to vigorous, fruits are medium in size and oblong conical in shape with lobes at calyx end, red striped over greenish yellow back ground and early in maturity. It is recommended for Jammu & Kashmir, Uttarakhand and Mizoram.

Richared:

The trees are vigorous, form spur freely, fruits large in size, oblong-conical in shape; ground colour greenish-yellow, covering with red wash all over. Lenticells are conspicuous. It also ripens in third week of August.

Maayan:

Plants are spreading and medium in vigour, very low chilling; fruits are medium in size and globose to slight conical in shape with smooth calyx end, striped red coloured skin over green yellow ground and very early maturing. It is recommended for Jammu & Kashmir, Tamil Nadu (Ooty and Kodaikanal), Arunachal Pradesh, Nagaland, Mizoram and Sikkim.

Michal:

Plants are spreading and medium to vigour, very low chilling; fruits are medium in size and globose to slightly conical in shape with smooth calyx end, striped red coloured skin over green yellow ground and very early maturing. It is recommended for Jammu & Kashmir, Uttarakhand, Tamil Nadu (Ooty and Kodaikanal), Arunachal Pradesh, Nagaland, Mizoram and Sikkim.

Ambri:

This is the only indigenous variety grown in India. It originated in Kashmir perhaps from a seedling. The plants are vigorous in nature. Fruit medium to large in size, oblong in shape; red streaks over a greenish-yellow background. The pulp white in colour, crisp and very sweet. The fruits ripen in the last week of September. They can be stored for 4-5 months under normal storage in Kashmir and for 10 months in cold storage. It is an attractive apple cultivar with an extra-ordinary keeping quality. It is recommended for Jammu & Kashmir and Uttarakhand.

Baldwin:

Discovered as a chance seedling, the plants are moderately vigorous, spreading, producing spurs freely. The fruit large in size and round to oblong in shape, ground colour pale-green, flushed with dull purplish brown. Sometime traces of red stripes are present. The fruits mature in the beginning of August. The fruits last for 3-4 months under ordinary storage conditions. The plant bears late in life and is a biennial bearer. It is a triploid variety of apple. It was cultivated extensively in Kullu Valley, but with the introduction of Red Delicious group, it has almost been completely removed.

Mollies Delicious:

Plants are medium to large in vigour, early blooming, fruits are globose to conical in shape and lobes are present but not prominent, red stripped skin over greenish yellow ground, early to mid in maturity. It is recommended for Jammu & Kashmir, Uttarakhand, Tamil Nadu (Ooty and Kodaikanal), Arunachal Pradesh, Nagaland and Mizoram.

Shlomit:

Plants are upright and medium in vigour, very low chilling cultivar ; fruits are medium in size and globose to conical in shape with smooth calyx end, light to medium dark red colour skin over green yellow ground and very early maturing. It is recommended for Jammu & Kashmir, Uttarakhand, Tamil Nadu (Ooty and Kodaikanal), Arunachal Pradesh, Nagaland and Mizoram.

Tydeman's Early Worcester:

Plants are medium vigorous, fruits are roundish to slightly conical towards the base with smooth calyx end, bright dark red skin over yellow ground, early season maturity (second week of July), very good pollinizer for early to mid-flowering apple varieties. It is recommended for Himachal Pradesh, Jammu & Kashmir, Tamil Nadu (Ooty and Kodaikanal), Uttarakhand, Arunachal Pradesh, Nagaland, Mizoram and Sikkim.

Golden Delicious:

This is most popular cultivar of all apple-growing areas of the world. In India, it is commercially used as a pollinizer for Delicious apples. It is not popular in Indian market as a commercial cultivar because of its yellow colour. However, some orchardists are getting good price from it. Its plants are moderately vigorous, spreading, producing spurs freely. Fruits are medium in size and round conical to oblong in shape. Ground colour greenish yellow in colour which turns to golden-yellow on ripening and late season maturity (last week of September). Some fruits are half flushed with pale orange colour. Flesh is creamish, crisp, fine textured, juicy, sweet, little acidic with very good aromatic flavour. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

Granny Smith:

The plant is very vigorous and crops heavily, but it is not much good for areas with short growing seasons. A chance seedling from the backyard of Marie Ann Smith, Australia. Fruits are roundish globose to slightly conical, calyx end smooth, bright green in colour, slippery skinned; dual purpose cooking/eating and sometimes slight yellow tinge appears upon the green bluish and mid in maturity. It also acts as a pollinizer. The flesh is hard, crisp and juicy. The flavour is tart, becoming very sweet if tree ripened. The fruit will store for several months after maturity without needing refrigeration. It is an excellent pollen source for other varieties. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

Vance Delicious:

A mutant of Delicious. Plants are vigorous, spreading; fruits are medium to large in size, conical in shape with lobed calyx end, striped red skin on yellow ground; flesh greenish in colour, turning to creamish-yellow on ripening; firm, juicy, aromatic and very sweet. The fruits ripen 12-13 days earlier than Starking Delicious. It develops good colour at low altitudes and marginal areas. At higher altitudes it may over colour and turn to dark blackish-red in colour. It is more productive than Starking Delicious.

Bright -N- Early:

Plants are medium in vigour, good spur development, precocious, fruits are prominently conical with distinct lobed calyx, solid red colour on whole fruit and mid in maturity. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

CITH Lodh Apple-1:

Plants are medium in vigour, mid-season flowering, bearing mainly on spurs as well as on shoots, its bears large size fruit and globosely oblong conical in shape and smooth lobes, red striped/ blushes over yellow ground and early to mid-season maturity. It is recommended for Jammu & Kashmir and Arunachal Pradesh.

Cooper -4:

Plants are compact to medium in vigour with good spur development. Fruits are medium in size, oblong to conical in shape with prominently lobed calyx end, solid dark colour covering whole fruit skin, very firm texture and maturity in mid-season. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

Jonagold

It is developed by crossing of Jonathan and Golden Delicious. Plants are very vigorous and have a spreading growth habit. The fruits are striped red over a yellow ground colour, fine textured, juicy and are very sweet and with a bit more acidity than Golden Delicious. It is a late season variety. Consistently rated as one of the finest culinary apples. The fruits are frequently large in size. Requires a pollinizer (self-infertile due to being triploid).

Gala Must:

Plants are medium in vigour, fruits are large in size and globosely round, calyx end smooth, red blush /strip over yellow ground and mid in maturity. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

Gala:

Trees are vigorous, semi spur type, fruits are medium in shape and oval to globose in shape, precocious and regular bearer, solid blush of red colour on slightly golden yellow ground, mid in maturity. Various strains of Gala are Scarlet Gala, Royal Gala, Galaxy Gala, Gal Gala and Imperial Gala. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

Red Chief:

Plants are compact and spur type, spur density is very high, fruits are slightly oblong to sharp conical in shape, end distinctly lobed, solid stripped dark red covering the whole fruit, develop full colour even under mid hills, mid maturity (ending July to second week of August). It develops colour 15 days earlier than Starking Delicious. Flesh is creamish yellow, firm, juicy, aromatic and sweet in taste. This is a limb sport of Starkrimson.

Red Spur:

Plants are medium in vigour and spur type. The trees are two-thirds to those of standard Delicious cultivars. Trees have close internmodal growth habit. Fruits are medium to large in size, oblong to conical in shape, dark red and mid in maturity (late August). They resemble to those of Richared. Flesh creamish-yellow, firm, juicy and sweet in taste. It matures 2 weeks earlier than Starking Delicious.

Oregon Spur:

Tree size is two-thirds the size of standard Delicious cultivar. It forms spurs heavily. Fruits are medium to large in size, conical in shape and blushed with dark red colour. Fruit may be uniformly coloured. Flesh creamish-yellow, firm, juicy and sweet in taste. The fruits ripen a few days earlier than Starking Delicious in Kullu valley. It is recommended for higher altitudes.

Royal Delicious:

Plants are vigorous, fruit oblong to conical in shape and dark red stripped, firm texture, mid maturity (mid-August), biennial bearing and self-unfruitful. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

Red Gold:

Plants are medium in vigour, fruits are round to slightly oblong, medium in size, dark to dull red in colour, early to mid-season maturity (mid to late July to first week of August). It is a good pollinizer. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

Lal Ambri:

Plants are vigorous; fruits are large oblong to conical in shape with prominent calyx end, dark red blush on yellow ground, mid to late season maturity. It is recommended for Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand.

2. Almond

California Paper Shell:

The plant is upright appropriate for high density plantations. It bears flower and nuts on both spurs as well as on long shoots with better ability to renew fruiting wood. The nut and kernel are large in size with extra light colour, papery shell that gives shelling percentage of 50%. This variety is also appropriate for export market. It is a regular bearer variety, bloom during 2nd Paper Shell week of March and ready to harvest after 152 days from the date of full bloom. It is suggested for Jammu and Kashmir, Himachal Pradesh and Uttarakhand.

Drake:

Plants are low in vigour, spreading and mid blooming. Nuts are small to medium in size, bold and roundish with pointed apex and light creamy whitish brown in colour. Semi soft shelled and mid-season maturing cultivar. It is recommended for Jammu and Kashmir, Himachal Pradesh and Uttarakhand.

IXL:

The plant is spreading type and of intermediate vigour. It bears flower and nuts on both spurs as well as on long shoots with well ability to renew fruiting wood. It is a regular bearing variety, which blooms in the third week of March and is ready for harvesting after 151 days from the date of full bloom. It is recommended for Jammu and Kashmir, Himachal Pradesh and Uttarakhand.

Merced:

Plants are medium in vigour, upright growth habit, mid blooming; nuts are medium in size, bold, somewhat flattened and light brown in colour. Paper shelled and mid to late season maturity. It is recommended for Jammu and Kashmir, Himachal Pradesh and Uttarakhand.

Mukhdoom:

It is a regular bearer, blooms during 1st week of March and ready to harvest after 141 days from the date of full blooms. The plant has a spreading/ drooping type of growth habit. It bears flowers and nuts on long shoots and spurs with better ability to renew fruiting wood. The shell colour is medium, soft type plump that gives a shelling percentage of 42%. It is suggested for Jammu and Kashmir, Himachal Pradesh and Uttarakhand.

Ne-Plus Ultra:

Plants are vigours in nature and spreading, mid blooming; nuts are medium to large flattened, bold and light brown in colour, paper shelled and mid-season maturity. It is a suggested for Jammu and Kashmir, Himachal Pradesh and Uttarakhand.

Non-Pareil:

Plants are moderately vigour, upright to spreading, mid blooming; nuts are medium, bold and light brown in colour, thin shelled and early season maturity. It is regular bearer cultivar. It is recommended for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

Pranyaj:

Plants are moderate in vigour and spreading, mid blooming, nuts are medium in size, brown in colour and flattened to bulge; kernel is medium to large in size. Papery shelled and mid-season maturity variety. It is suggested for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

Primorskij:

Plants are spreading and moderately vigour, mid to late blooming; nuts are medium to large, bold, slightly flattened and brown in colour and kernel medium to large in size. Soft papery shelled and late season maturity. It is suggested for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

Shalimar:

The plant has a spreading/drooping type of growth habit. It is a regular bearer variety, which blooms during 2nd week of March and ready to harvest after 143 days from the date of full bloom. It bears flowers and nuts on both long shoots and spurs with good ability to renew fruiting wood. Nuts are long in size and bold with tapering at curved pointed apex. Nut colour is creamy brown to slightly whitish, soft shelled and mid-season maturity. It is a suggested for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

Waris:

Plant has a straight type of growth habit and medium to vigorous, mid blooming. It is suitable to grow under high density orcharding. It bears flowers and nuts on long shoots and spurs. Nuts are medium in size, bold and bulged at shoulder with sharply pointed apex. Nut colour is brown to creamy whitish, soft shelled and mid to late season maturity. It is a regular bearer variety. It is suggested for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

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3. Apricot

Australian:

It ripens in end July to late August. Fruit size is extra-large and highest amongst the cold arid cultivars. Fruits are round in shape with acute apex, structure district, mid flavour and medium sweet and acidic in nature. It is not suitable for table purpose. It is better for processing. It is recommended for Jammu & Kashmir.

Charmagaz:

It is a self-incompatible cultivar and needs a pollinizer. The fruits are medium in size and roundish flat in shape. The skin is straw yellow with a light yellow flesh which is very sweet and highly flavored. It is suitable for dessert and drying purposes. It is recommended for Jammu & Kashmir and Himachal Pradesh.

CITH Apricot-1:

It is a self-fertile cultivar and mid-season blooming; fruits are very large in size, round symmetrical, average fruit weight (79g) and smooth distal end, yellowish orange and reddish blemishes. It is early maturing cultivar and tolerant to major pests and diseases. It is suggested for Uttarakhand and Himachal Pradesh.

CITH Apricot-2:

It is self-fertile cultivar and early to mid-season blooming type. Fruits are large in size, oblate, asymmetrical with slightly pointed beak, yellow orange with reddish on exposed surface, early maturing and tolerant to leaf curl. It is suggested for Uttarakhand and Himachal Pradesh.

CITH Apricot-3:

It is self-fertile cultivar and early to mid-season blooming type. Fruits are medium in size, oblate in shape, asymmetrical with slightly pointed beak, yellow orange with very little reddish tinge, early mid maturing cultivar and better quality and tolerant to major pests and diseases. It is suggested for Jammu & Kashmir, Uttarakhand and Himachal Pradesh.

Halman:

Plants are spreading and vigorous. Fruits are large with roundish in shape, skin deep yellow golden in colour, sweet kernel, suitable for drying and early to mid-season maturity in cold arid zone. It is recommended for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

Kaisha:

Plants are vigorous and spreading type; fruits are medium in size with roundish flattened shape and prominent suture, skin pale lemon yellow with red blush, free stone and early season maturity cultivar. Medium sweet and acidic in nature. It is not suitable for table purpose. It is good for processing purpose. It is recommended for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

Harcot:

Plants are upright to spreading and vigorous. Fruits are medium to large with roundish heart shape. Skin yellow orange and red blushed, sweet kernel and early to mid-season maturity. In shape, elliptical with truncate base, skin greenish to light yellow with red and blush towards the sun exposed surface. Pulp is light yellow in colour; sweet/acid ratio is good and pleasant flavour. It is recommended for Uttarakhand and Jammu & Kashmir.

Nari:

It is a late ripening cultivar available after mid-August**.** Fruits are medium in size, oblong in shape, elliptical with truncate base, skin greenish to light yellow with red and blush towards the sun exposed surface. Pulp is light yellow in colour; TSS: acid ratio is good and pleasant flavour. It is suggested for Jammu & Kashmir and Himachal Pradesh.

New Castle:

Plants are vigorous and spreading, fruits are medium to large in size with roundish shape and skin is lemon/barium yellow in colour and early season maturity. It is recommended for Uttarakhand, Jammu & Kashmir and Himachal Pradesh.

Rogan:

Fruits are small in size, highly juicy, round in shape, gloss skin straw yellow, very soft and slightly acidic sweet pulp. It bears smallest fruit amongst all cultivars. It is recommended for Jammu & Kashmir.

Rokchey Karpo:

It is an early season cultivar, matures in end July to mid-August. Fruits are medium to large in size, round with compressed pedicel end. Pulp light pale, juicy sweet and mild acidic with pleasant flavour. It is recommended for Jammu & Kashmir.

4. Bael

Narendra Bael -4

Plants are spreading and oblong fruit shape, fruit quality excellent and heavy bearer. It is recommended for Uttar Pradesh.

Goma Yashi

Fruits are good quality with large in size, ovate in shape, greenish yellow in colour. Flesh colour is straw. It is recommended for Rajasthan.

CISH B-1

It is mid-season cultivar which ripens during April- May. Plants are tall, vigorous with dense canopy, upright growth habit; average weight of fruit is 1.0kg. Suitable for canning and slices preparation. It is suggested for Uttar Pradesh, Uttarakhand, Bihar, Jharkhand and Rajasthan.

CISH B-2

Plants are dwarf with medium spreading habit. Foliage is sparse and almost thorn less, precocious with moderate bearing habit. Fruits are oblong to round in shape. Suitable for processing with pleasantly aromatic pulp. It is recommended for Uttar Pradesh, Uttarakhand, Bihar, Jharkhand and Rajasthan.

Narendra Bael -5

Prolific bearer and fruits are medium in size, round in shape having smooth surface at maturity, low mucilage, moderately fibrous and have soft flesh with excellent taste. It is recommended for Uttar Pradesh, Rajasthan, Bihar, Jharkhand and Uttarakhand.

Narendra Bael -6

Fruits are medium in size, round with smooth surface and have thin rind, few seeds, soft flesh, low mucilage and mild acidic.

Narendra Bael-7

Fruits are very large in size, flattened round, yellowish green in colour. It is recommended for Uttar Pradesh.

Narendra Bael-9

Prolific bearing, fruits are medium to large in size with oblong in shape, low fibre and seed content. It is recommended for Uttar Pradesh, Rajasthan, Bihar, Jharkhand and Uttarakhand.

Narendra Bael-16

Fruits are elliptical round, pulp yellow, average weight of fruit is 1.3 kg, TSS 31% and medium seed and low fibre content. It is suggested for Uttar Pradesh.

Narendra Bael-17

Fruits are attractive in colour, oblong in shape; big sized, average weight of fruit is 1.75 kg, fibre content low and excellent fruit quality with low seed content.

Pant Shivani

Trees are tall, vigorous, dense, upright growth, precocious and heavy bearer. Fruit weight ranges from 2 to 2.5 kg. It is an early mid-season cultivar with ovoid oblong shape, lemon yellow on ripening, fiber and mucilage content medium, rind medium thick, pulp light yellow with very good taste and pleasant flavour.

Pant Aparna

Its trees are dwarf with drooping foliage, almost thorn less, precocious and heavy bearer. The leaves are large, dark green and pear shaped. It is late cultivar with small fruit size (0.6-0.8 kg); globose shape, and seed, mucilage, fibre and acidity are low. Its flesh is yellow, sweet, tasty and having good flavour.

Pant Urvashi

Trees are tall, vigorous, dense, upright growth habit, precocious and heavy bearer. It is mid-season cultivar. Fruits are ovoid, oblong. The fruit weight range from 1.5 to 2.5kg. It is recommended for Uttar Pradesh and Uttarakhand.

Pant Sujata

Trees are medium dwarf with drooping and spreading foliage, dense, precocious and heavy bearer. Fruit weight varied from 1to 1.5 kg. It is recommended for Uttar Pradesh and Uttarakhand.

5. Cherry

Bigarreau Napolian (Double)

Plants are medium to vigorous, early season flowering, fruits are longish large, medium to large in size and heart shaped, skin colour creamy red yellow and early to mid-season maturity. It is recommended for Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Bigarreau Noir Gross (Mishri)

Trees are medium to large in vigour, fruits are with obtuse heart shape, skin dark red colour which finally changes to blackish purple and mid to late season maturity. It is recommended for Jammu & Kashmir, Uttarakhand and Arunachal Pradesh.

Black Heart:

Vigorous trees, mid-season flowering, fruits are medium in size and heart shaped with compressed apex, skin colour deep shiny blackish purple and early to mid-season maturity. It is suggested for Jammu & Kashmir, Uttarakhand and Arunachal Pradesh.

CITH Cherry-01:

Plants are semi spreading, precocious, regular and prolific bearing cultivar selected from Bigarreau Napolian (Double Gilass) cherry orchard. Fruits are large in size, ovoid in shape, attractive, dark red coloured with long pedicels. Fruits have good acid/sugar balance and high in TSS. It is recommended for Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

CITH Cherry-02:

Trees are upright growth habit, precocious, prolific and regular bearer selected from Local Mishri. Fruits are large with attractive red colour and high in TSS as compared to Mishri and mature 10 days earlier than ‘Mishri. It is recommended for Jammu & Kashmir, Uttarakhand and Arunachal Pradesh.

Guigne Noir Gross:

Plants are medium to large in vigour, mid-season flowering; fruit are medium in size and roundish obtuse heart shaped; skin colour dark red and early season maturity. It is suggested for Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Guigne Noir Hative (Makhmali):

Trees are medium to vigour, late flowering, very large sized fruit with ovoid obtuse heart shape, skin shining dark blackish brown to full black, small stone and mid to late season maturity. It is suggested for Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Lambert:

Plants are medium in vigour, mid flowering, fruits are large, round in shape, skin deep ruby red blackish in colour, susceptible to rain cracking and mid to late season maturity. It is suggested for Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Stella:

Plants are medium spreading in vigour and precocious in bearing, mid to late flowering, very large fruit with heart shape, dark red skin turning black at maturity, small stone and mid to late season maturity. It is suggested for Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

6. Carambola

Arkin:

Arkin synonym is 'Star King Sweetie. It is developed through selection in Florida from the seeds imported from Thailand in 1973. The flowers have long styles. Fruits are medium in size, similar to 'B2', average weight 90 to 200 g. Fruit colour is golden yellow at early maturity stage and becoming yellow orange at ripening. Ribs are thick, somewhat more compact than those of 'B10', with a relative large angle and the edges of the wings are also slightly rounded. The texture is excellent and sweet flavor, juicy and relatively less acidity, although its malic acid content is higher than that of 'Golden Star'. Fruits are suitable for fresh as well as processed fruits. The cultivar is a relatively high resistance to mechanical damage and to insects of the others genus which includes drilling or fruit sucker moths. Fruits are also relatively insensitive to chilling injury during storage.

B-2:

This variety has originated from Malaysia. Plants are slow growing and flowers have long styles. Fruits size is 8-12 cm long and 8 cm in width, average fruit weight ranges between 100-200 g and somewhat elongated. Colour of the fruit is greenish yellow and becoming completely yellow at maturity. The ribs have large angles with deep furrows. The fruits are sweet in taste. The pulp is having a fine texture and very juicy, thus makes it suitable for fresh fruits as well for processing. Fruits are relatively resistant to

transport but the storage period is not very long. ‘B2’ is a good pollinizer for ‘B10’. ‘B2’ is quite sensitive to damage by fruit flies.

B-10:

It is developed in Malaysia and it is the most widely acknowledged cultivar worldwide. The plants grow vigorously and flowers have short styles. Fruits are large in size (14 cm x 78 cm); average fruit weight ranges between 100 to 200g, although fruits can weigh up to 315 g after suitable thinning. Fruit colour varies from yellow to golden reddish or orange. The ribs are more compact than B2, the edges of the wings are slightly rounded and the texture is good, with a good TSS content varying between 8-12 percent. Fruits are slightly acidic and forming more juice content is useful both as fresh fruits and processing and moderately resistant to fruit flies.

B17:

This variety is native to Malaysia and is also known as ‘Cristal Honey’ or ‘Honey Carambola’. Fruits are cylindrical in shape, large in size and uniform, with elongated, large wings, which make them very appropriate for packing in boxes. The fruit is generally elongated with whitish sugar spots and ripens to a golden yellow colour. It is crispy, juicy, and extremely sweet with a brix of as high as 15-18%.

Cheng –Tsey:

This cultivar is also known ‘Chun Choid’ originated in Taiwan. Fruits are large in size and may weigh up to 315 g after thinning. They have very deep and firm furrows. Their TSS content is high, acidity is low and the texture is good and fruits are orange in colour at maturity.

7. Grapes

2A Clone of Thompson Seedless:

It is late ripening type, white seedless, suitable for fresh eating and for making into raisins. This cultivar is highly responsive to hormonal treatments for increased berry size and bigger clusters. Average yield 25t/ha of fresh fruit and 4-5 tonnes of raisin yield per hectare. It is recommended for Maharashtra, Karnataka and Andhra Pradesh.

Anab-e-Shahi:

It is late ripening and high yielding variety (35t/ha) but highly susceptible to downy mildew disease. Berries are elongated, medium to large in size. Juice is clear and sweet with TSS ranges between 18 to 20%. Fruits have a good keeping quality and used for table purpose. It is suggested for Andhra Pradesh, Punjab, Tamil Nadu and Karnataka.

Bangalore Blue:

Berries are small in size, dark purple seeded with thick skin. Juice is clear and pleasantly flavoured with TSS 16-18%. Fruit having good keeping quality and used for juice making and wine. It is recommended for Karnataka and Mizoram.

Dil Kush:

It is mutant of Anab-e-Shahi. White colour seeded fruits, sweet in taste with few seeds. It is recommended for Karnataka and Andhra Pradesh.

Fantasy Seedless:

Fruits are medium in size, obviate and purple black berries. Vines are vigorous hence proper nutrient and water management is required. Average yield 24 t/ha. Over bearing to be avoided during initial years. It is suggested for Maharashtra and Karnataka.

Flame Seedless:

It is early maturing cultivar and seedless, berries are very crisp and having good flavours. Berries are susceptible to crack due to rains or to morning humid weather during ripening. Average yield 25 t/ha of fresh fruit. It is recommended for Maharashtra, Haryana, Tamil Nadu and Punjab.

Manik Chaman:

This is clone of Thompson Seedless. It is like a variety of Sonaka known for drought and salt tolerance. It is recommended for Maharashtra and Karnataka.

Manjri Naveen:

It is early ripening cultivar, white seedless with naturally bold crisp and mildly muscat flavoured berries. Average yield 25 t/ha. It is recommended for Maharashtra and Karnataka.

Perlette:

Berries are seedless, small sized, spherical to slightly ellipsoidal and yellowish green in colour. The juice is clear with 16-18% TSS. Keeping quality is good and is used for table purpose. Variety is not suitable for raisins due to compactness of clusters. It is highly susceptible to anthracnose. Average yield is up to 35t/ha. It is recommended for Punjab, Haryana and Himachal Pradesh.

Pusa Seedless:

It is a selection from Thompson Seedless. It resembles with Thompson Seedless with regard to most of the characters, but its berries are more elongated. The berries have high TSS content and are suitable for both table purpose and raisin making. It is suggested for Punjab, Karnataka and Himachal Pradesh.

Red Globe:

Naturally bold red seeded table grape. Due to good keeping qualities and bold berries, it has good market demand. Average yield 25t/ha. It is recommended for Maharashtra, Karnataka and Tamil Nadu.

Sharad Seedless:

It is mutant of Kishmish Chorni (Black Seedless). Fruits are black to purple in colour with medium sized berries. This is early grape variety; availability is from December to February. It is recommended for Maharashtra and Tamil Nadu.

Sonaka:

It is also similar to Thompson Seedless (clone of Thompson Seedless).The berry elongation is better and the berry skin is thin but it is more susceptible to berry cracking and rotting if it rains at harvest. It is recommended for Maharashtra, Tamil Nadu and Karnataka.

Tas-e-Ganesh:

It is similar to Thompson Seedless in all respect except in the size of berries and the clusters are larger than those of Thompson Seedless. This mutant responds more to girdling, resulting into a better quality fruit than Thompson Seedless.

Thompson Seedless:

It has wide adaptability of agro-climatic zone. Berries are seedless, elongated, golden yellow with medium-thin skin. The juice is straw coloured, sweet with a TSS of 20-22%. Good keeping quality and used for table purpose and raisin making. Average yield 20-25t/ha. It is recommended for Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Himachal Pradesh and Manipur.

Hybrids

Arka Chitra:

This hybrid is a cross between Angur Kalam × Anab-e-Shahi. The plants are moderately vigorous with a yield potential of about 38 t/ha and 34 kg/vine. TSS varies from 20-21ºbrix and acidity from 0.4-0.6%. This hybrid is tolerant to powdery mildew. It is suitable for table purpose. It is recommended for Andhra Pradesh and Karnataka.

Arka Hans:

It is a cross between 'Bangalore Blue × Anab-e-Shahi'. Clusters are medium in size, yellowish green, ellipsoidal to spherical, very sweet (TSS 18-21 ºbrix) and pleasant foxy flavoured, seeded berries. It is resistant to anthracnose disease. Very good for quality wines by suitable acid amelioration. It is recommended for Andhra Pradesh, Karnataka and Tamil Nadu.

Arka Kanchan:

A hybrid between Anab-e-Shahi × Queen of the Vineyards'. Clusters large in size, golden yellow, ellipsoidal to ovoid, sweet (TSS 17-20 ºbrix) and pleasant muscat flavoured seeded berries. It is good for fresh eating purpose and for making dry white table and dessert wines. It is recommended for Andhra Pradesh, Karnataka and Tamil Nadu.

Arka Krishna:

This cultivar is a cross between Black Champa × Thompson Seedless. The bunches are good filled weighing on an average of 255 g/bunch, dark coloured, seedless. TSS varies from 20-21 ºbrix and acidity from 0.6-0.7 per cent. This cultivar is good for juice purpose. It is recommended for Andhra Pradesh and Karnataka.

Arka Majestic:

A hybrid between Angur Kalam × Black Champa. The plants are vigorous with a yield potential of 38t/ha and 34kg/bunch, deep tan coloured, uniform round berries, having 2-3 small seeds per berry and bold roundish berries weighing on an average 7.7g. It is suggested for Andhra Pradesh and Karnataka.

Arka Neelamani:

A hybrid between Black Champa × Thompson Seedless. The plants are vigorous with a yield potential of 28 t/ha and 25 kg/vine. The bunches weigh on an average of 360 g/bunch, black, seedless and average berry weight is 3.2g with crispy pulp, TSS varies from 20-22º brix. It is recommended for Andhra Pradesh and Karnataka.

Arka Shyam:

A hybrid between Bangalore Blue × Black Champa. Clusters are medium in size, bluish black, spherical to ovoid, sweet (TSS 20-25 ºbrix) and mild foxy flavoured seeded berries. It is resistant to anthracnose. It has excellent quality for making dry table and dessert wines. It is recommended for Andhra Pradesh, Karnataka and Tamil Nadu.

Arka Soma:

A hybrid between Anab-e-Shahi × Queen of Vineyards. The bunches are well-filled, weighing an average of 410 g/bunch, greenish yellow in colour, round to ovoid in shape and average berry weight is 3.8g. TSS varies from 20-21ºbrix and acidity 0.5%. It is used to make excellent white sweet wine. It is recommended for Andhra Pradesh and Karnataka.

Arka Trishna:

A hybrid between Bangalore Blue × Convent Large Black. It is an improvement over Bangalore Blue cultivar. The bunches are well filled, weighing an average of 130g, deep tan coloured, round to ovoid in shape and average berry weight is 3.34g. TSS varies from 22-23º brix and acidity from 0.3-0.4%. It is male sterile hybrid resistant to anthracnose and tolerant to downy mildew disease and good for wine. It is suggested for Andhra Pradesh and Karnataka.

Arka Vati:

A hybrid between Black Champa and Thompson Seedless. Clusters are medium in size, yellowish green, ellipsoidal to spherical, sweet (TSS 22-25 ºbrix) and seedless berries. It is suitable for raisin making, fresh table use and dessert wines. It is recommended for Andhra Pradesh and Karnataka.

Pusa Navrang:

This hybrid is a cross between Madeleine Angevine × Rubired, an early ripening (1st week of June), basal bearer and fruits having red pigment both in peel and pulp. The bunch is loose, medium in size with round and medium sized berries. It is ideally suited for coloured juice and wine making and is resistant to anthracnose disease. It is recommended for Punjab, Andhra Pradesh, Karnataka and Mizoram.

8. Hazelnut

Gentile Delle Langhe:

Trees are medium in vigour; stone comparatively soft, kernel weight 2.4g with complete kernel filling, kernel colour creamy white, prominent brownish streaks with pointed beak. It is suggested for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

Kashmir Selection:

Plants are mostly large in vigour and single to multi branched, kernel weight ranges from 0.48-055g. It is recommended for Jammu & Kashmir and Uttarakhand.

Tonda Giffani:

Trees are medium in vigour, stone hard kernel weight 1.8 g, nut flat with brownish colour prominent towards stem end and brown streaks towards tip. It is recommended for Jammu & Kashmir Himachal Pradesh and Uttarakhand.

Tonda Romaana:

Trees are medium in vigour; stone moderately hard, kernel weight 1.98g, kernel filling partial with dark brownish colour at stem end turning brownish towards end. It is recommended for Jammu & Kashmir, Himachal Pradesh and Uttarakhand.

9. Jamun

CISH J-37:

A superior accession selected at ICAR-Central Institute for Subtropical Horticulture, Lucknow derived from the mother tree with a height of 12-15m, yield 200-300 kg plant^{-1} (about 45 years old) and mid-season maturity during the second week of June. The fruit is oblong and average weight of fruit is 24.05 g, length 3.90 cm, diameter 3.03 cm. It has bold fruits and high pulp quality (pulp content 90 to 92 %) and TSS 16 -17 ºbrix.

Konkan Bahadoli:

It is a selection from local Jamun trees that grows in Village Bahadoli. Fruits are large in size, average fruit weight is 25-28 g, pulp content (83.3%). On an average per kg weight has 40 to 50 fruits.

Goma Priyanka:

It is semi-dwarf; spreading growth habit, dense foliage with drooping branches, early ripening; average fruit weight is 19.86 g, pulp content 85.06 %. Fruits are good in taste having TSS 16.86 ºbrix. Fruits are rich in Vitamin C (45.44 mg/100g). Yield potential is 30 kg/plant.

Dhoopdal:

Jamun variety from Belgaum district, selected for its large-sized sweet fruits. Average fruit weight is 19.86 g, pulp-85.06 % and 16.8 brix TSS.

CISH J-42:

Fruits are unique, said to be seedless with pulp content of 97-98% and average fruit weight is 16-18g and TSS 14-15º brix. It has good keeping quality.

Rajendra Jamun-1:

This was released from Bihar Agricultural College, Bhagalpur; Bihar. It is an early (May-June), high yielding (450 kg/ tree), TSS 18.20 ºbrix; acidity 0.31%, average fruit weight is 12.86 g with 88.40% pulp.

Ra Jamun:

Fruits are big in size, oblong with deep purple or bluish black colour at full ripe stage. Fruit is juicy with small seed size and ripens in the month of June-July.

10. Kiwi

Abbot:

It is an early blooming and maturity, purely pistillate cultivar, medium size fruit, average fruit weight is 45-60g, oblong in shape, fruit skin covered with dense hairs, fruits are sweet in taste and slightly tapering at distal end in comparison to peduncle attachment. It is recommended for Arunachal Pradesh, Sikkim, Himachal Pradesh, Mizoram and Uttarakhand.

Allison (male):

It is a good pollinizing cultivar for all the cultivars. It synchronizes with almost pistillate cultivars of kiwifruit except Hayward

Allison:

Allison is the most popular variety in India. While it gives higher fruit production, its fruit size is smaller than Hayward. It is resembled with Abbott, except that its fruits are slightly broader in proportion to the length. Length and breadth ratio is about 1.6:1 and fruit weight ranges from 40 to 90g/fruit. It is an early flowering and maturity variety, heavy-bearer and sweet in taste. Fully grown in yield 80 to 90 kg/vine. It is suggested for Arunachal Pradesh, Sikkim, Himachal Pradesh, Nagaland, Mizoram and Uttarakhand.

Bruno:

Good fruit bearing, purely pistillate, fruits are medium in size, average fruit weight is 45-60 g, slightly tapering shape towards stem end and low chilling requirement. It is recommended for Arunachal Pradesh, Sikkim, Himachal Pradesh, Mizoram and Uttarakhand.

Hayward:

The Hayward kiwi is the main green variety produced for the world's markets and dominates production in most growing regions. It is moderately hairy and more rounded than other kiwi varieties. Hayward has the best eating quality of the existing green varieties, mainly due to higher levels of sweetness. The skin is thin (can be eaten without much discomfort) and the flesh is an attractive green with a white centre. It is a purely pistillate cultivar, fruits are large in size; average fruit weight is 38-120g, it has good keeping quality, superior in flavour. It is recommended for Arunachal Pradesh, Sikkim, Himachal Pradesh, Nagaland, Mizoram, Uttarakhand and Meghalaya.

Monty:

It is late in flowering but short maturity period, purely pistillate cultivar; fruits are oblong in shape, medium in size, slightly tapering and flat at both ends; average fruit weight is 40-65g and prolific bearing habit. It is suggested for Arunachal Pradesh, Sikkim, Himachal Pradesh, Mizoram and Uttarakhand.

Tomuri:

It is a staminate cultivar and good pollinizer; flowers usually appear in groups, bold and healthy in comparison to pistillate flowers. It is recommended for Arunachal Pradesh, Sikkim, Himachal Pradesh and Mizoram.

11. Litchi

Bedana:

It is a late maturing cultivar. Trees are vigorous. Fruits are medium in size with good flesh recovery. The fruits are conical with vermillion to carmine in colour having dark blackish brown tubercles at maturity. Pulp is creamy white, soft, juicy and sweet. It is recommended for Bihar, Jharkhand, West Bengal, Uttar Pradesh and Uttarakhand.

Bombai:

The trees are vigorous and regular bearers. Ripe fruits have attractive deep red colour, with grey white, soft, juicy and sweet flesh. The cultivar matures early. Fruits are large in size and bear in large bunches. This cultivar has tiny under developed fruit attached to the fruit stalk of each fully developed fruit. It is recommended for West Bengal and Assam.

Calcuttia:

It is late season variety and fruit ripens in the last week of June. It can be successfully cultivated even in hotter areas provided there is protection from strong hot winds and

provision for plenty of water for irrigation. Fruits are large in size. It is recommended for Punjab, Uttar Pradesh, Uttarakhand, West Bengal, Himachal Pradesh and Tamil Nadu.

China:

It is an important cultivar in India that ripens when most of the other cultivars have been harvested. It is tolerant to hot winds, fluctuations in soil moisture and fruit cracking. Trees are dwarf and high yielders but prone to alternate bearing. Fruits are large in size, medium to heavy in weight, oblong in shape and rose in colour with dark tubercles at maturity. It is recommended for Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, West Bengal, Nagaland and Assam.

Dehradun:

It is a medium vigorous plant which produces medium to high yield. The fruits start ripening by the third week of June. Fruits possess oblique-heart to conical shape with bright rose pink colour. The pulp is greyish-white, soft, and moderately juicy with TSS 18 ºbrix, 10.4 % sugar and 0.44 % acidity. Highly susceptible to sunburn and cracking. Fruit yield is 80-90 kg/tree. It is recommended for Uttarakhand, Punjab, Uttar Pradesh, Jharkhand, Himachal Pradesh and Tamil Nadu.

Shahi:

Trees are very vigorous with regular bearing and produce fruits ranging from 100-150 kg/plant. This is an early season cultivar. The fruits are medium in size. Mature fruits are prone to cracking with low humidity and poor moisture content in soil. Fruits are globose-heart or obtuse in shape having rose madder and fuchsia purple background with red tubercles at ripening. Pulp recovery is 65 to 70 % with TSS 19-21 ºbrix. It is recommended for Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Sikkim and Assam.

Elaichi:

Trees are moderately vigorous, attain, average height of 6-7m. It is a mid-season variety which ripens in the first week of June, the variety yields of 50-60 kg/plant annually. Fruits are less suitable to sun burn and cracking. It is recommended for West Bengal.

Late Large Red:

It is also known as Muzaffarpur. It is most important variety in Bihar and its adjacent states. This variety bears profusely every year with an average yield of 80-100 kg/tree. Fruits are large in size, oval or oblong conical with crimson red tubercles. It is recommended for Bihar, Jharkhand, West Bengal, Odisha, Madhya Pradesh, Nagaland and Meghalaya.

Late Seedless:

It is also known as late Bedana. Fruits are medium to large in size. Pulp (aril) is creamy white, soft, juicy and sweet containing TSS 17-20º brix. Seed is very small, shrunken, glamorous and dirty chocolate in colour. Overall fruit quality of the cultivar is good. It is recommended for Punjab, Uttar Pradesh, Bihar, Jharkhand and Tamil Nadu.

Purbi:

Fruits are medium to large in size, oblong conical in shape, ripening at the end of May or first week of June. Peel is thick, very rough with attractive bright red colour. Fruits are egg-round to lopsided heart-shaped with uneven shoulder and fruit tip is distinctly pointed. Pulp is soft, juicy with pleasant flavour, having TSS 19-20 ºbrix and 0.44 per cent acidity. Fruits are less susceptible to cracking. It is recommended for Bihar, Jharkhand and West Bengal.

Rose Scented:

Trees are very vigorous and high yielders but mature fruits are prone to cracking. Fruits have distinct aroma and hence called as Rose Scented. It is one of the most popular mid-season cultivar. Fruits are medium to large in size, globosely heart or obtuse in shape with rough skin and having purplish rose colour with red tubercles at ripening. Pulp is grayish white, soft, moderately juicy and sweet. It is recommended for Uttar Pradesh, Uttarakhand, Bihar, Punjab, Tamil Nadu and Himachal Pradesh.

12. Loquat

California Advance:

Fruits are medium in size, oblong pyriform and pale yellow in colour. Thick pulp, smooth melting, excellent taste, sub acid and few seeded. It is recommended for Uttar Pradesh, Uttarakhand, Punjab and Himachal Pradesh.

Fire Ball:

Fruits are small in size, oblong to ovate in shape, saffron yellow in colour, thick pulp, corn husk in colour, smooth and soft, mild taste, sub acid and few seeded. It is recommended for Uttar Pradesh, Uttarakhand, Punjab and Himachal Pradesh.

Golden yellow:

Fruits are medium in size, oval to oblong in shape and golden yellow in colour. Medium pulp, pale orange, smooth and soft, mild taste, sub acid with few seeded. It is recommended for Uttar Pradesh, Uttarakhand, Punjab and Himachal Pradesh.

Improved Golden Yellow:

Fruits are large in size, oval to pyriform in shape and orange yellow in colour. Thick pulp, orange in colour, smooth and crisp, mild taste, sub acid and moderately seeded. It is recommended for Uttar Pradesh, Uttarakhand, Punjab and Himachal Pradesh.

Improved Pale Yellow:

Fruits are medium in size, oblong pyriform in shape, medium to thick pulp, cream in colour, smooth and soft, pleasant taste, sub acid and moderately seeded. It is recommended for Uttar Pradesh, Punjab and Himachal Pradesh.

Large Agra:

Fruits are medium in size, oblong to ovate in shape, medium to thick pulp, pale orange in colour, smooth and firm, pleasant taste, sub acid and moderately seeded. It is suggested for Uttar Pradesh, Uttarakhand and Himachal Pradesh.

Mammoth:

Fruits are medium in size, oblong pyriform in shape and snow shine in colour. Medium pulp, orange in colour, coarse and granular, pleasant taste, sub acid and few seeded. It is recommended for Uttar Pradesh, Uttarakhand, Punjab and Himachal Pradesh.

Matchless:

Fruits are medium in size. Medium pulp, orange in colour, coarse and granular, pleasant taste, sub acid and few seeded. It is suggested for Uttar Pradesh, Uttarakhand, Punjab and Himachal Pradesh.

Pale Yellow:

Fruits are large in size, oblong to pyriform in shape and corn in colour. Thin pulp, creamy, white in colour, smooth and melting, pleasant taste, sub acid and moderately seeded. It is recommended for Uttar Pradesh, Uttarakhand, Punjab and Himachal Pradesh.

Safeda:

Fruits are large in size, oblong, and pyriform in shape. Thick pulp, creamy white in colour, smooth and melting, excellent taste, sub acid and moderately seeded. It is recommended for Uttar Pradesh, Uttarakhand, Punjab and Himachal Pradesh.

Yellow:

Fruits are medium in size, oblong and pyriform in shape. Thick pulp, creamy white in colour, smooth and melting, excellent taste, sub acid and moderately seeded It is tolerant to wilt, brown leaf spot, thrips and nematodes. It is recommended for Karnataka, Nagaland, Manipur, Mizoram and Meghalaya.

13. Peach

Crest Haven:

Produces top notch free stone fruit with golden yellow skin and flesh. Mid to late season variety, blooms late, fruit lasts well on the tree. Excellent for freezing and canning. It is recommended for Himachal Pradesh, Jammu & Kashmir, Uttarakhand and Arunachal Pradesh.

Early Grande:

It ripens in the first week of May. Fruits are large with red blush surface. Flesh yellow, firm with some red colour next to pit. Semi free stone when fully ripe. The average yield is 95 kg/tree. The fruit possess excellent keeping quality. It is recommended for Punjab.

Fantasia:

Trees are vigorous, fruits are large ovate in shape, bright yellow with red blush over the major part of fruit skin and early to mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Flora Red:

An excellent, mid-season table peach, it matures in the beginning of June. Fruits are large in size, almost red at maturity, juicy with white flesh and free stone. Its average yield is 100 kg/tree. It is recommended for Uttarakhand, Himachal Pradesh and Tamil Nadu.

Florida Prince:

Its fruit ripen in the last week of April. Fruits are medium to large, round with little or no tip, red blush with yellow ground colour, flesh melting, yellow with some red colour, semi cling. On an average it yields 100 kg/plant. It is recommended for Punjab and Madhya Pradesh.

Florida Sun:

It matures in the last week of April. Fruits are medium to large in size, roundish and yellow with red blush. Flesh is yellow, juicy and sweet. With free stone, on an average it yields 75 kg/plant. It is recommended for Himachal Pradesh, Jharkhand, Madhya Pradesh, and Tamil Nadu.

Glo Haven:

A large peach with yellow free stone flesh has mostly red skin no fuzz, milder flavour, excellent for canning and fresh eating. It is recommended for Himachal Pradesh, Jammu & Kashmir and Uttarakhand.

J.H. Hale:

Trees are medium in vigour, fruits are medium to large in size, roundish ovate in shape, red purple yellow skin colour, free stone, mid to late season maturity. It is recommended for Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

July Elberta:

Plants are medium in vigour, hardy and productive, fruits are medium to large in size and round in shape; skin dull red blushed over yellow base, free stone and early to mid-season maturity. It is recommended for Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Manipur and Meghalaya.

Paradelux:

Plants are medium in vigour, fruits are large in size and oblong flat with prominent beak in shape, yellow skin and flesh and late season maturity. It is recommended for Himachal Pradesh, Jammu & Kashmir and Uttarakhand.

Partap:

It matures in the third week of April. The fruits are yellow with red blush. Flesh colour is also yellow with red coloration. It has better firmness and keeping quality than Parbhat and Florida Sun, the average yield being 70 kg/plant. It is suggested for Punjab.

Prabhat:

It is earliest ripening cultivar and fetches good income to the growers. Fruits are medium in size, roundish with an attractive red blush. It is white fleshed when fully ripe, the average yield being 50 kg/tree. It is recommended for Jammu & Kashmir, Uttarakhand, Jharkhand, Haryana and Madhya Pradesh.

Red Haven:

Plants are medium in vigour; fruits are medium in size with prominent suture, distinct apex, golden yellow skin with red blush, free stone and early in maturity. It is recommended for Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Red June:

Trees are medium in vigour; fruits are large in size, roundish with rounded beak in shape, distinct suture, yellow with red blush on the shoulder, free stone and early season maturity. It is recommended for Jammu & Kashmir, Himachal Pradesh, Mizoram, Nagaland, Manipur and Meghalaya.

Shan-e-Punjab:

It matures in the first week of May. Fruits are very large in size, yellow with red blush, juicy, very sweet; excellent in taste and free stone. Since fruits are firm in texture, they

can withstand transportation. It is suitable for canning, the average yield being 70 kg/plant. It is recommended for Punjab, Haryana and Mizoram.

Sharbati:

Fruits are large in size, greenish yellow with rosy patches, very juicy with excellent taste and flavour. Fruits mature during June end to first week of July, the average yield being 100-120 kg/tree. It is recommended for Uttarakhand, Haryana, Jharkhand, Madhya Pradesh and Mizoram.

Snow Queen:

Plants are spreading, vigorous, fruits are small to medium in size, bright red colour on cream white background having smooth surface, flesh white, cling stone, maturity during mid-June. It is recommended for Himachal Pradesh, Jammu & Kashmir and Uttarakhand.

Sun Haven:

Trees are medium in vigour; fruits are medium to large size, yellow fruit skin, semi free stone and early season maturity. It is recommended for Himachal Pradesh, Uttarakhand, Jammu & Kashmir, Mizoram and Nagaland.

Sun Red:

Plants are low in vigour; fruits are small to medium in size with bright red skin, semi free stone and early season maturity. It is suggested for Himachal Pradesh, Jammu & Kashmir, Uttarakhand, Meghalaya, Mizoram and Manipur.

14. Pear

Baggugosha:

Trees are upright and vigorous and irregular bearing habit. It has small green, yellow fruit with tapering stem-end. The fruits are sweet in taste and somewhat gritty. It ripens in August and has average yield of 100 kg/tree. It is recommended for Haryana, Punjab, Himachal Pradesh, Jharkhand, Manipur and Mizoram.

Bartlett:

Plants are vigorous upright; fruits are large in size with light green colour which turns to golden yellow, oblong to obtuse pyriform with a prominent neck making a fruit bell shape and mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand, Jammu & Kashmir and Meghalaya.

Conference:

Trees are medium to moderately vigorous; fruits are medium in size, pyriform with long neck, brown rusted colour over light green ground and late season maturity. It is recommended for Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Fertility:

Plants are vigorous and upright; fruits are small to medium in size, pyriform in shape, brown russetted in colour and mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand and Meghalaya.

Flemish Beauty:

Plants are vigorous, fruits are large in size, obovate to obtuse pyriform in shape, creamy yellow colour skin with slightly red blushed, mid-season maturity and acts as a good pollinizer. It is recommended for Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Jargonellae:

Trees are upright with spreading branches, fruits are obtuse pyriform to oblong pyriform in shape, lemon yellow over green base with faded red blush on skin and mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand and Jammu & Kashmir.

Kashmirinakh:

Trees are medium in vigour, fruits are small to medium in size, obovate to slightly conical in shape, skin light to dark green which turns to light yellow and mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand, Jammu & Kashmir, Arunachal Pradesh and Mizoram.

Kieffer:

Plants are vigorous; fruits are large in size, pyriform in shape, golden yellow in colour and early season maturity. It is recommended for Himachal Pradesh, Uttarakhand, Tamil Nadu and Punjab.

Laxton's Superb:

Trees are medium in vigour; fruits are medium in size, yellowish green with slight red blush and maturity in mid-season. It is recommended for Himachal Pradesh, Uttarakhand and Arunachal Pradesh.

Max Red Bartlett:

Plants are medium in vigour, fruits are large in size, typical pyriform obovate in shape, red blushed skin and mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand, Jammu & Kashmir and Arunachal Pradesh.

Patharnakh:

It is also called sand pear. It is heavy bearing and good keeping quality. Fruits are round in shape and green with prominent dots. The flesh is crisp and juicy. These fruits are tough and firm and can withstand transportation very well for long distance without spoilage. It is recommended for Haryana, Punjab, Himachal Pradesh, Jharkhand and Mizoram.

Red Bartlett:

Plants are medium in vigour; fruits are large in size, dark red maroon in colour over light green yellow round and mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand, Manipur and Meghalaya.

Starkrimson:

Trees are medium in vigour; fruits are medium in size, obtuse pyriform in shape, dark red to crimson in color and early to mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand, Manipur and Meghalaya.

15. Pecannut

Burkett:

Plants are upright with medium vigour, nuts are more or less round in shape, base flattened to pointed, apex pointed, shoulder is even and grayish in colour with black strips around the apex, kernels are dark brown to chrome yellow, moderate in ease of removal of kernel. It is recommended for Himachal Pradesh, Uttarakhand and Jammu & Kashmir.

Cheyenne:

Trees are medium and compact in vigour, protoandrous, nuts are medium in size, oblong with slight pointed at apex, brown in colour, kernels are light brown, loosely filled easy to remove from grooves. It is recommended for Himachal Pradesh and Uttarakhand.

Mahan:

Trees are upright and vigorous, nuts are extra-large, oblong cylindrical, base flattened with moderately pointed apex, shoulder uneven and brown in colour with dark strips at the apex, kernels are amber brown in colour and easily removable from the grooves. It is recommended for Himachal Pradesh, Uttarakhand and Jammu & Kashmir.

Nellies:

Plants are upright and medium in vigour, nuts are oblong in shape, cylindrical and tapering towards the end, light brown in colour with dark strips at base, kernels are amber in colour, moderately filled and easily removable from shell. It is recommended for Himachal Pradesh, Uttarakhand and Jammu & Kashmir.

Schley:

Trees are medium and compact in vigour, self-pollinated, nuts are medium in size, oblong cylindrical in shape with evenly pointed apex and base, shoulder even and dark brown with prominent black strips around the apex, kernels are light brown, moderate removal from grooves and good kernel quality. It is recommended for Himachal Pradesh, Uttarakhand and Jammu & Kashmir.

16. Persimmon

Fuyu:

Plants are vigorous and spreading, non-astringent and pollination constant cultivar. Fruits are medium to large in size, tomato shape, flesh is firm, pale to light yellow orange, sweet and can be eaten when hard, late in maturity and very good keeping quality. It is recommended for Himachal Pradesh.

Hachiya:

Trees are vigorous and upright spreading, astringent and pollination constant cultivar, fruits are large in size, oblong conical glossy skin with deep orange colour, firm flesh, good for drying and mid to late in maturity. It is recommended for Himachal Pradesh.

Hyakume:

Plants are vigorous and spreading, non-astringent and pollination constant cultivar, fruits are large in size, roundish oblong to oblate and buff yellow to light orange marked with rings, firm flesh, juicy; mid-season maturity. It is suggested for Himachal Pradesh.

Jiro:

Plants are slightly upright and vigorous, non-astringent and pollination constant cultivar, fruits are large in size, oblate truncate in shape, orange red in colour, firm flesh, good keeping quality and mid-season maturity. It is recommended for Himachal Pradesh.

17. Pistachio Nut

Chiko:

Trees are moderate in vigour and upright, male plant, very good pollinizer for early cultivars like Bronte and Red Allepo. It is recommended for Jammu & Kashmir.

Joley:

Plants are medium in vigour and upright, precocious and alternate bearer, blooming early to mid-season, female cultivar, nuts are small to medium in size and kernels are crisp. It is recommended for Jammu & Kashmir.

Kerman:

Plants are moderately vigorous and upright, spreading habit, blooming in mid to late season, female cultivar, precocious and alternate in bearing, nuts are large and round in shape, white in colour and late season nut maturity. It is recommended for Jammu & Kashmir.

Peter:

Trees are moderate in vigour and upright, male plant and very good pollinizer for Kerman, good producer of durable pollen with longer bloom period. It is recommended for Jammu & Kashmir.

18. Plum

Au-Rosa:

It is high yielding cultivar, with having TSS 19.3 ºbrix. It is recommended for Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Meghalaya and Mizoram.

Beauty:

Trees are upright and medium in vigour; fruits are small to medium in size with round shape, skin translucent red over yellow base and early season maturity. It is recommended for Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Mizoram.

Burbank:

Plants are low in vigour and somewhat drooping; fruits are medium in size, bright red mottled skin colour and deep yellow flesh and early to mid-season maturity. It is recommended for Jammu & Kashmir, Himachal Pradesh, Nagaland and Mizoram.

Frontier:

Trees are upright and vigorous; fruits are large in size, rounded to slightly heart shape at base, red purple skin and yellowish flesh colour, free stone and mid-season maturity. It is recommended for Himachal Pradesh, Uttarakhand, Meghalaya, Nagaland and Mizoram.

Kanto-5:

High yielding, recommended for cultivation in temperate regions. It is recommended for Jammu and Kashmir, Himachal Pradesh, Nagaland and Mizoram.

Kubio:

High yielding cultivar, TSS 8.3 ºbrix, recommended for cultivation in temperate regions. It is recommended for Jammu and Kashmir, Uttarakhand, Arunachal Pradesh, Nagaland and Mizoram.

Mariposa:

Trees are upright vigorous, large heart in shape, skin mottled maroon over green base, almost free stone and mid to late season maturity. It is recommended for Himachal Pradesh, Meghalaya, Nagaland and Mizoram.

Methley:

Trees are medium to vigorous; fruits are small to medium in size with roundish heart shape, reddish purple maroon skin with dark red flesh, good pollinizer and very early season maturity. It is recommended for Jammu and Kashmir, Himachal Pradesh, Meghalaya, Nagaland and Mizoram.

Red Beauty:

Trees are medium to vigorous, fruits are medium in size with globose in shape, bright red skin colour and yellow flesh and very early season maturity. It is recommended for Jammu and Kashmir, Himachal Pradesh, Meghalaya, Nagaland, Mizoram and Jharkhand.

Satluj Purple:

Its fruits are quite large in size, bright crimson with thick flesh, possessing excellent shipping quality. They ripen in the second week of May; their average yield is 30 kg/tree. Since this variety is self-incompatible, it should be planted with variety Kala Amritsari. It is recommended for Punjab.

19. Pomegranate

Bhagwa:

It is also known as Shendria or Sinduri, Astagandha and Kesar. This is a selection from F_2 population of the cross Ganesh × Gulesha Red. Fruits are attractive glossy red rind. Arils are blood red in colour. It is soft seeded variety. It is recommended for Maharashtra, Gujarat, Himachal Pradesh, Uttar Pradesh and Rajasthan.

Co-1:

It is high yielding selection. Fruits are medium in size with attractive rind, soft seeds, higher pulp content and sweet in taste. It is recommended for Tamil Nadu.

Dholka:

The fruits are big in size. The flesh is pinkish white, seeds are soft, but the juice is acidic. Rind is greenish white to red and arils are whitish to pinkish white in colour. Arils are whitish to pinkish white. It is soft seeded variety. It is recommended for Gujarat.

G-137:

This is a clonal selection from Ganesh. Trees are spreading habit, fruit surface smooth, yellow with red tinge. Fruits are large in size with deep pink and bold aril, sweet in

taste, soft seeds and prolific bearer. It is recommended for Maharashtra, Andhra Pradesh and Karnataka.

Ganesh:

This is a selection from open pollinated seedlings of Alandi. Fruits are pinkish yellow to reddish yellow rind. Arils are light pink, turns whitish during warmer month. It is suggested for Maharashtra, Gujarat, Tamil Nadu and Himachal Pradesh.

Jalore Seedless:

It is a selection of local a variety. Rind is reddish yellow to pinkish yellow. Arils are light pink in colour. It is soft seeded variety. It is recommended for Rajasthan.

Jyoti:

This is selection from mixed population of Bassein Seedless and Dholka. The fruits are medium to large sized with attractive colour having dark red arils. The seeds are very soft with high pulp and juice contents.

Mridula:

This is a cross between Ganesh and Gulshan Rose Pink. Arils are blood red in colour and rind is red. It is soft seeded variety. It is recommended for Maharashtra, Tamil Nadu and Rajasthan.

Ruby:

This is a complex hybrid between Ganesh, Kabul, Yercaud and Gulshah Rose Pink. The rind is pinkish yellow to reddish yellow. Fruit contains red and bold aril. It is soft seeded variety. It is recommended for Karnataka and Maharashtra.

20. Strawberry

Camarosa:

Plant growth is similar to Chandler. Compared to Chandler, leaf colour is distinctly lighter on the underside. Individual leaflets are larger, somewhat longer and narrow than Chandler. It produces fruit early and has good storage properties. It is recommended for Maharashtra, Haryana and Jammu & Kashmir.

Chandler:

Fruits are exceptionally high dessert quality with outstanding colour and flavor. It is very resistant to physical damages caused by rain. Plants are tolerant to viruses. Fruits are large in size, flesh and skin firm. It is recommended for Himachal Pradesh, Uttarakhand, Maharashtra and Haryana.

Pajaro:

It is very successful under summer. Plants are tolerant to virus. Fruits have good dessert and processing quality. Fruits are quite susceptible to physical damage caused by rain. It is recommended for Maharashtra and Haryana.

Sweet Charlie:

Plants of Sweet Charlie are smaller and more compact when compared to Camarosa. Leaves are generally slightly cupped, medium to dark green. It is recommended for Maharashtra, Meghalaya and Himachal Pradesh.

Tioga:

An early maturity cultivar, it is tolerant to viruses. Fruits are very large, flesh and skin firm, dessert and processing quality good. It is recommended for Himachal Pradesh and Maharashtra.

Winter Down:

It is a high productive cultivar. Fruits are medium to large in size and moderately resistant to botrytis and anthracnose. It is recommended for Maharashtra, Meghalaya and Jammu & Kashmir.

Exercise-2

Observation on Growth and Development of Fruit crops

Growth is the fundamental property of all living organisms. It is an irreversible permanent increase in size, volume or mass of a cell or organ or whole organism accompanied by an increase in dry weight. Where, development is sum total of growth and differentiation. It is governed by both environmental and internal factors. The development of a plant is highly complex phenomena.

*** Difference between growth and development**:

Growth	Development
It is on addition in length/thickness.	It includes differentiation of organs including reproductive organs.
Growth may occur without development.	Development may occur in absence of growth.
It is more or less quantitative process.	It is a qualitative process.

Type of growth:

Growth can be classified into different types based on different aspects. Growth is of two types:

(a) **Indefinite/Unlimited/Indeterminate growth**- Growth exhibited by root, stem and branches.

(b) **Definite/Limited/Determinate growth** -Growth exhibited by leaves, flowers, fruits etc.

* Based on number of reproductive phases in life, classified into.

(a) **Monocarpic/Determinate species:** Monocarpic plants flower only once in their life. Only one reproductive phase -Annuals.

(b) Polycarpic/Indeterminate species: Polycarpic plants flower every year in particular season. Species have more than one reproductive phase in life. Most of the fruit crops are polycarpic in nature.

*** Phases of growth:**

Growth comprises of three phases Cell division, cell enlargement and cell maturation/differentiation. Total growth period is divided into three stages initial lag phase-slow; middle lag phase / exponent phase- rapid; final-steady phase- gradually decline. Growth at all phases is not equal. Growth completely stops at the end. The total time taken by a cell or organ to complete all phase is called “grand period of growth”. Graph plotted of time and organ growth is called “grand period of growth curve." (Fig-1)

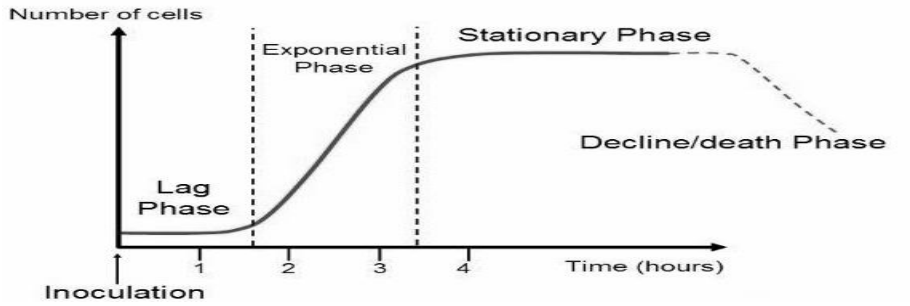


Figure: 1 (1) Lag/ Initial Phase, (2) Lag/ Exponential Phase, (3) Final /Steady Phase

*** Different phases of growth:**

Growth can be measured by auxanometer in terms of length. While growth rate is measured in terms of absolute growth rate (AGR) and relative growth rate (RGR).

(i)AGR – Total growth of each plant or organ per unit tree.

AGR = dw/ dt Where, dw = increase in weight and dt = change in time

(ii)RGR – Growth per unit time expressed per unit of weight or volume

RGR = dw/ dt x 1 / Wo Where, dw = difference between final and initial weight; Wo = initial weight and t=time

Type of growth curves in fruit crops:

1**. Sigmoid/ Single sigmoid curve** – Fruit under goes slow enlargement at the early (a) and last stages of growth (c), while growth is considerably faster during the middle development stage (b). Ex: Apple, pear, pineapple, banana, avocado, almond, strawberry, loquat, date palm, papaya, mango and lemon.

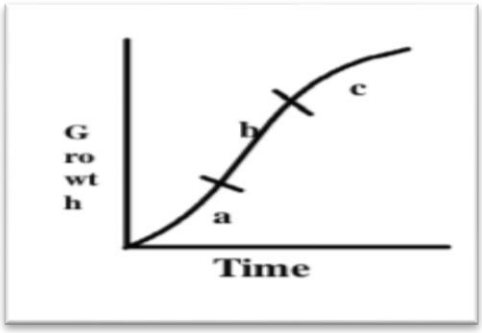


Figure 2: Single sigmoid curve

2. Double sigmoid curve: Three stages are seen:

a. Ovary, nucleolus and integuments of the seed grow rapidly, but the embryo and endosperm grow little.

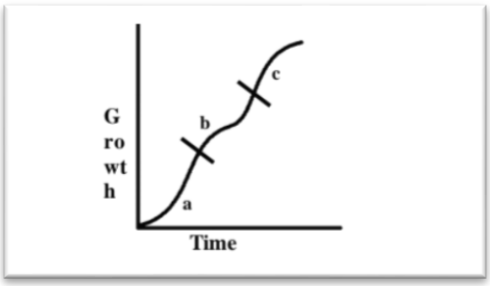


Figure 3: Double sigmoid curve

b. Embryo and endosperm grow rapidly, but the ovary does not increase much in size, sclerification of the pit also begins and embryo achieve full size by the end and the amount of endosperm material increases greatly.

c. A new surge of ovary growth begins and continues to fruit ripening.

Ex: Peach, plum, apricot, ber, raspberries, fig, blackberry, blueberry, cherry, pecanut, persimmon, guava, grapes, olives etc.

3. Triple sigmoid curve: Five stages are seen:

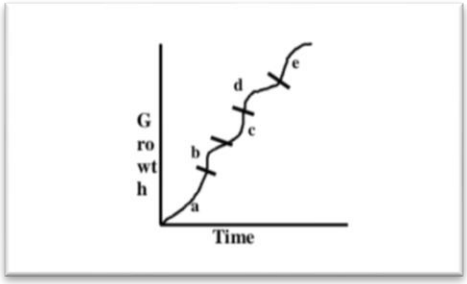


Figure 4: Triple sigmoid growth curve

a. Initial rapid growth, seeds reaching full size (0-9 weeks).

b. Slow growth, seeds hardens and start to colour, first very large respiratory response to ethylene (9-12 weeks)

c. Rapid growth, seeds become dark brown, response to ethylene increases (12-17 weeks)

d. Very little growth, seeds dark brown, softening starts, soluble solids starts to increase, respiratory response to ethylene rises to a maximum and then decreases (17-21 weeks)

e. A smaller but significant growth increase to approximately final size. The fruit matures, the seeds becoming very dark brown and free in the tissues.

Example: Kiwi fruit.

Every plant has two distinct phases or development namely vegetative and reproductive. In the vegetative phase, i.e. leaves; roots, shoots etc., and in reproductive phase flowers and fruits are produced. In annuals, these phases occur for a short period, each phase occurring only once and that too within the same season. In the biennials the vegetative phase occurs for one season and in the following season the reproductive phase. In such cases, the two phases are intercepted by a period of rest in winter in the northern latitudes.

The vegetative growth is for several years depending upon the variety, planting material, species, growing conditions etc. This is known as the pre-bearing period. After pre-bearing plant enter to reproductive phase starts bearing flowers and fruits. Once the perennial tree complete its pre-bearing period, the cycle of vegetative and reproductive phases might occur in each season or the reproductive phase may occur hand in hand with vegetative phase. In some trees the vegetative and reproductive growth may occur in alternate years known as alternate bearing. In some other trees, the vegetative growth may occur for two, three or more years followed by reproductive growth for one year and again vegetative growth for two or more years. This is known as irregular bearing.

If vegetative shoot arises from a bud, it is known as a vegetative bud, while the buds which produces floral parts only or a shoot with flowers is known as the flower bud/ fruit

bud/blossom bud. In case, the bud produces only floral parts, it is known as a pure flower bud and if it produces a shoot with flowers and leaves it is known as mixed bud.

Classification of fruit plants on the basis of flowering Habit:

According to Kozlowski (1971) there are four groups of fruit plants based on their season of flowering.

a) Year round/ ever flowering species: Plants produce flowers throughout the year irrespective of photo thermal changes.

Examples are Fig and Papaya.

b) **Seasonal flowering species**: Plants produce flowers in the particular season, any variation in environmental factor during favourable season leads to continuance of vegetative phase.

Examples are Guava, Litchi, Apple and Pear.

c) Non Seasonal flowering species: Plants produce variation of flowers from plant to plant and from part to part. The variation is more prominent around the equator and the plant becomes seasonal, as they grow away from the equator.

Examples are Mango, Cashew nut and Coconut.

d) Gregarious flowering species: Flowering occurs at particular times in a year is influenced by the atmospheric causes like rainfall in drier period or chilling induces indefinite flowering. Differentiation, formation may take place at congenial time but flower opening and anthesis require an impulse due to temperature. Example: Quince.

The physiological and morphological changes that occur in a vegetative bud in its preparation to change over to the reproductive phase or to become a flower bud may be called as the flower bud initiation. Further, development changes that occur in an initiated flower bud leading to the formation of the embryonic flower inside the bud are known as flower bud differentiation. Both the steps of initiation and differentiation together may be called as flower bud formation. Depending upon species or variety or kind of fruit tree, there may be varying periods of interval between the formation of the flower bud and the actual production of flowers.

Phases of Fruit Development:-

Fruit development can generally be considered to occur in four phases:

a) Fruit set.

b) A period of rapid cell division.

c) A cell expansion phase.

d) Ripening/ maturation

Seeds are ripened ovules; fruits are the ripened ovaries or carpels that contain the seeds. Fruits develop from organs of the flower and thus involve differentiation or redifferentiation of preexisting organs. Evolutionarily, floral organs represent modified leaves and so the fruit is also a modified leaf.

*** True and false fruits:**

True fruits	False fruit
Fruit derived from a single ovary. Outside of the fruit is called the pericarp and develops from the ovary wall. During fertilization an embryo is formed in the ovule. This results from the fusion of male and female reproductive cells (a nucleus in the pollen grain and a nucleus in the female egg cell in the ovule). There are other nuclei in the pollen grain and the egg cell and these also fuse and form a structure known as the endosperm. This becomes a food store for the developing seeds.	Fruits are composed of tissues derived from flower parts (e.g. sepals, petals, stamens, stigma and style) other than the ovary or from more than one ovary. Ex. Apple.

*** Fruit Ripening:**

Ripening represents the shift from the protective function to dispersal function of the fruit. Ripening occurs synchronously with seed and embryo maturation. Ripening involves the softening, increased juiciness and sweetness and colour changes of the fruit. Fleshy fruits are either climacteric or non-climacteric. Ethylene is a major regulator of the ripening process.

*** Growth and development of some fruit crops**

Banana	Inflorescence emerges 9-12 months after planting and fruits are ready to harvest after 3-4 months.
Ber	Flowering during Sep-Nov in North India and August in Western India. Flowering period is for 50-70 days. Fruits are harvested 170-180 days after blooming. Fruits are harvested during Nov-Apr.
Guava	Vegetative propagated and seedling ones starts commercial yield after 2-3 years and 4-5 years respectively. Flowering and fruiting twice in North

	India, while thrice in South India and Western India. Bahar treatment was followed in guava for flower regulation. There are three bahars i.e. Ambe bahar, Mrig bahar and Haste bahar. **a.** Ambe bahar: Plants were stressed during Dec-Jan which leads to flowering and fruiting during Feb-Mar and Jul-Aug respectively. **b**. Mrig bahar: Plants were stressed during Apr which leads to flowering and fruiting during Jun-Jul and Nov-Dec respectively. **c.** Haste bahar: Plants were stressed during Aug-Sep which leads to flowering and fruiting during Oct-Nov and Feb-Apr respectively. Fruits require 5 months from full bloom to maturity
Litchi	Vegetative propagated plants take 3-5 years in North India and 6 years in South India for flowering. Seedlings take 10-15 years. North India- Flowering starts last week of Jan- first week of Feb and fruit ripens during May-Jun. South India -Flowering starts in Dec and Fruit ripens in Apr-May. Fruits take 105-120 days for maturity from flowering.
Mango	Commercial yield is obtained after four-five years old in vegetative propagated trees, whereas seedlings take seven years. Flower bud differentiation occurs during October – February. Flowering period is for 14-21 days. Availability of fruits is from February to July. Fruits are ready for harvesting in 5-6 months from flowering.
Papaya	Flowering and fruiting throughout the year. Starts flowering five months after planting and harvesting 9-10 months after planting.
Sapota	Economic yield obtained after 7 years in vegetative plants and 10 years in seedlings. Sapota flowers throughout the year in tropical condition with two main seasons are July-Nov and Feb-Mar. Require 7-8 months for harvesting from flowering.

Exercise-3

Practices in growth regulation

Introduction

The main objective of growth regulation practice (crop regulation) is to force the tree for rest and produce profuse blossoms and fruits during any one of the two or three flushes. This aims to regulate uniform and good quality fruits and maximize production as well as profit to the grower. Fruit crops like, citrus, pomegranate and guava flowers and fruit three times in a year. A good harvest is possible only if crop is regulated to single season (bahar). The selection of bahar at a location is mainly determined by availability of water, occurrence of disease and pests and market position.

Bahar or Resting Treatment:

- To regulate fruiting, water is withhold for about 2 months in advance of normal flowering season.
- To obtain higher fruit yield during a particular period, plants are given a resting period by which the natural tendency of the tree is altered with artificial means.

Type of flowering (bahar period)	Time of flowering	Time of harvesting
1. Ambe Bahar	January-February	June-August
2. Mrig Bahar	June-July	November-January
3. Hasth Bahar	September- October	February-April

1) Citrus

Bahar treatment

- If left to nature the trees may bloom and fruit irregularly through-out the year.
- In order to overcome this problem and to force a full crop in any of the three seasons, as required by the grower and the traders, Bahar treatment is practiced in citrus orchards.
- In citrus trees generally bloom three times a year, i.e., in January-February (Ambe bahar), June-July (Mrig bahar) and October (Hasth bahar).
- Trees are treated for Ambe bahar (January-February), in November or December.
- In this method, from November onwards the amount of water is gradually reduced in successive irrigations and completely stopped in December.
- About the middle of December, the land is ploughed.
- When the trees start showing wilting symptoms (3-4 weeks), the soil around the tree to a distance of 120 cm is dug to a depth of 10 cm and the recommended manure is added to the soil and the trees are irrigated.

- The first irrigation that follows is sparing while the subsequent ones are more plentiful.
- Flowers appear about a month after the first irrigation.
- In Maharashtra, the roots are also exposed for about 10 days as part of the bahar treatment.
- However, this treatment is considered to be harmful in the long run and not encouraged as a routine practice.

Use of growth regulators:

- After conducting large-scale pilot trials at the Fruit Research Station, Anantharajupet, a schedule of three sprays of 2, 4-D at 10 ppm, during flowering, 15 days after fruit set and two months before harvest was recommended to increase the fruit set, to reduce the fruit drop and to improve the yields by 35% to 50% in sweet orange.
- Fruit retentions for three weeks beyond the normal harvest period were possible with the same spray when done one month before harvest.

2) Pomegranate

- Pomegranate flowers continuously when watered regularly.
- The plants under such conditions may continue bearing flowers and bear small crop irregularly at different periods of the year, which may not be desirable commercially.
- To avoid this trees are given bahar treatment.
- Irrigation is withheld two months prior to the bahar followed by light earthing up in the basin.
- This facilitates the shedding of leaves. The trees are then medium pruned 40-45 days after withholding irrigation.
- The recommended doses of fertilizers are applied immediately after pruning and irrigation is resumed.
- This leads to profuse flowering and fruiting.
- The fruits are ready for harvest 4-5 months after flowering.
- In tropical condition, there are three flowering seasons, viz., January-February (ambe bahar) June- July (mrig bahar) and September-October (hasth bahar).
- The choice of flowering/fruiting is regulated taking into consideration the availability of irrigation water, market demand and pest/disease incidence in a given locality.
- Generally in North Gujarat taken Hasta bahar for pomegranate production.
- The fruits from hasta bahar are harvested during the month of March to April.
- They have very attractive rind with dark coloured arils.

- Since the availability of the fruits during this season is limited, they fetch high value.
- Optimum water stress cannot be developed during this period as withholding of irrigation coincides with the rainy season. This leads to poor flowering and thus affects the yield.

3) Guava

Time of flowering and fruiting in guava:

- Under natural conditions, guava tree produces flowers and fruits twice in a year in Northern India, but it is thrice i.e. almost throughout the year in Western and Southern India.
- Which results in rest period and ultimately guava tree bears small crops at different times of the year, this pattern of flowering and fruiting is not desirable for commercial cultivation.

Regulation of flowering and fruiting in Guava for Mrig bahar

Throughout India, Mrig bahar is preferred over Ambe bahar and Hasth bahar.

Therefore, it becomes necessary to regulate flowering so that Mrig bahar can produce heavy flowering and fruits are available in winter.

The following practices are adopted for this purpose:

To restrict irrigation water:

The guava tree should not be given irrigation from February to middle of May. Thus the tree sheds its leaves during hot season (April- May) and goes to rest. During rest period, tree can conserve food material in its branches. In the month of June tree is well cultivated and manure followed by irrigation. After about 20-25 days the tree would blaze into profuse blossoms. The fruits mature during winter.

To expose roots:

Upper soil around the trunk (45-60 cm radius) is removed with care to expose the roots to the sun. That will result in reduction in supply of soil moisture from soil to the top and the leaves begin to shed and the trees go to rest. After 3-4 weeks, the exposed roots are again covered with soil. Manuring and watering is done.

To do deblossoming:

It can be done with the use of growth regulators like, Naphthalene Acetamide (NAD) @ 50 ppm (parts per million) is found to be effective. It can also be done manually on small scale.

When flowers of Ambe bahar are deblossomed, the tree becomes more potential to produce more flowers and fruits in Mrig bahar.

Bending:

Trees having erect shoots and bearing habit is very poor, in such trees shoots may be bent and tied on the pegs driven on the ground. Thus dormant buds become activated which in turn bear flowers and fruits.

Exercise-4

Tools and Implements for Horticultural Crops

In order to carry out various cultural operations in the nursery as well as in the orchards, several tools and implements are required from time to time. Some tools are simple and are used for simple operations. However, special equipment's are required for specific operations. Some of the tools and implements required for different operations in horticultural crops are described below:

Sn. No.	Horticultural tools	Description and their use
1.	Hoe 	Long handled with flat and perpendicular blade at the end. Used to remove weeds by agitating and grooming the soil surface. Used to dig, move and hill soil during preparation for planting.
2.	Mattock 	For digging hard soils.
3.	Axe 	Axe is multipurpose cutting tool used for felling and delimbing of trees, splitting of logs for firewood and dressing of logs for timber conversion.
4.	Spade 	A long handled tool traditionally used for digging, shoveling soil and compost. Moving shrubs and plants.
5.	Round Point Shovel 	All-purpose shovel, rounded, sharp point widely used garden tool. Used to dig large holes and transport heavier materials such as wet soil and rocks. Its sharp edges can cut the roots and sods as well as break up compacted soil.
6.	Square Point Shovel 	Good for scooping and transferring heavy materials (soil, rock and cement).
7.	Cultivators 	Used to break up compacted soil, spread fertilizers and compost, remove shallow rooted weeds without disturbing the roots of surrounding plants.
8.	Forks 	Used for digging of soils in situations where the use of spade may be difficult for turning of soils. Used to till large areas of soil and break up compacted clods. To rake out weeds and stones.
9.	Trowels (planting/digging) 	A small hand held tool used to dig small hole (for planting & transplanting small plants/saplings).

10.	Garden Rake (or "soil rake") 	A long handled tool used to create a fine tilt and level the seedbeds (Short steel tines ideal for raking soil or moving heavy material). Collect plant debris and stones from the seedbed surface. Break soil clumps and spread fertilizers or compost.
11.	Leaf Rake 	Long, flexible steel tines for raking leaves.
12.	Watering can 	A portable water container used for watering smaller areas and containers.
13.	Pegs 	Used for securing net, line or fleece to the ground.
14.	String (Garden Twine) 	Used for lay outing activities and tying plants to stakes. Available in natural jute and coated.
15.	Wheelbarrow 	It is carrier, usually having only one wheel, a tray bolted to two handles and legs. Used to transport seedlings soil, compost as well as small loads.
16.	Anvil Clippers 	One blade & one flat surface, best for extremely hard wood.
17.	Shears 	The different types of shears like hand shear; lopping shears, tree trimmers etc. are needed in a garden. Pruning, shears should not be very expensive but these should be made up of good steel. Similarly, these should make a smooth and clean cut with least injury to the plant.
18.		
19.	Budding Knife  	A small knife designed for delicate budding - grafting with a single eye or bud.
20.	Budding/grafting tape 	Used for wrapping graft-union point while grafting and/ or budding fruit species.

21.	Lopping Shear 	Long handles provide extra leverage for pruning thick branches.
22.	Pruning Saw 	Short, sharp saw for cutting limbs too thick for hand or lopping shears.
23.	Hedge shears 	Hedge shears are gardening tool used for trimming (cutting, pruning) hedges or solitary shrubs (bushes).
24.	Machete 	A large, strong blade usually around half a meter long. Effective in cutting small branches and heavy underbrush.
25.	Measuring tape 	Made from steel or wooden and used for layout of seedbed, plots and plant spacing.
26.	Gloves 	Used to protect hands and fingers from cuts, blisters, calluses, sun damages, abrasions and dirt.
27.	Fruit Harvester 	Clip and pick fruit picker.
28.	Secateurs 	It is considered as the most important tool for a propagator or a nursery man. Secateur is used for excising scions, lopping off the rootstock, removing the undesirable sprouts/shoots from the stock, preparation of scion sticks and for pruning operation. Its blade should be of a good quality because poor quality blades may not give smooth cuts to the stock and scion.
29.	Crates 	Crates (plastic, wooden) used for collecting harvested fruits.

Exercise-5

Nomenclature and Identification of Fruit plants

A system or scheme of naming plants is known as nomenclature. Binominal is a universal custom, whereby a plant is given two-word name; one designating the genus or group into which it falls and the other distinguishing a particular plant from other plants in the group. This two-word or binominal appellation both classifies and names the plant. The name of the author is also associated with the name of the plant.

Nomenclature of Fruit Plants

S. No.	English Name	Common Name	Botanical Name	Family
1.	Apple	Seb	*Malus pumila* Mill	Rosaceae
2.	Apricot	Khurmani	*Prunus armeniaca* L.	Rosaceae
3.	Aonla	Amla	*Phyllanthus officinalis* Gaerth	Euphorbiaceae
4.	Almond	Badam	*Prunus amygdalus* Mill	Rosaceae
5.	Bael	Bil	*Aegle marmelos* Correa.	Rutaceae
6.	Cherry (Sweet)	Cherry (Sweet)	*Prunus avium* L.	Rosaceae
7.	Cherry (Sour)	Sour cherry	*Prunus cerasus* L.	Rosaceae
8.	Carambola	Kamrakh	*Averrhoa carambola* L	Oxalidaceae
9.	Grape	Angoor	*Vitis vinifera* L.	Vitaceae
10.	Hazel nut	Bhatia badam	*Corylus avellana* Mill.	Betulaceae
11.	Jambolan	Jamun	*Syzygium cuminii* Skeels	Myrtaceae
12.	Litchi	Litchi	*Litchi chinensis* Sonn.	Sapindaceae
13.	Kiwifruit	Chinese gooseberry	*Actinidia deliciosa*	Actinidaceae
14.	Loquat	Loquat	*Eriobotrya japonica* Lindl.	Rosaceae
15.	Mangosteen	Mangosteen	*Garcinia mangostana* L.	Guttiferae
16.	Quince	Beedana	*Cydonia oblonga* Mill.	Rosaceae
17.	Peach	Aru	*Prunus persica* L.	Rosaceae
18.	Persimmon	Japani phal	*Diospyros kaki* L.	Ebenaceae
19.	Pomegranate	Anar	*Punica granatum* L.	Punicaceae
20.	Pecan nut	Pecan nut	*Carya illinoinensis* Koch	Juglandaceae
21.	Pistachio nut	Pista	*Pistacia vera* L.	Anacardiaceae
22.	Pear	Nashpati	*Pyrus communis* L.	Rosaceae
23.	Plum	Alubokhara	*Prunus bokhariensis* Schneid.	Rosaceae
24.	Strawberry	Strawberry	*Fragaria chiloensis* Duch	Rosaceae
25.	Walnut	Akhrot	*Juglans regia* L.	Juglandaceae.
26.	Wood apple	Hathi seb	*Feronia limonia* L.	Rutaceae

Exercise- 6

Diseases of Fruit Crops

1. Apple (Malus *domestica)*

Apple Scab

Causal organism: *Venturia inaequalis*

Symptoms: Affected leaves become twisted or puckered and have black, circular spots on their upper surface. On the under surface of leaves, the spots are velvety and may coalesce to cover the whole leaf surface. Severely affected leaves may turn yellow and drop. Scab can also infect flower stems and cause flowers to drop. Fruits show small, rough, black circular lesions. The centre of the spots become corky and on mature fruits, yellow halo is seen around the lesions.

Fig: Apple Scab

Management: Use resistant varieties. Prune so the tree has good light and air penetration and branches are not too close together. Rake up and burn the fallen old leaves. Spray Tridemorph (0.1%) before flowering; Mancozeb (0.25%) at bearing stage; 5% urea prior to leaf fall in autumn and 2% before bud break to hasten the decomposition of leaves. Spray Carbendazim @ 50 g per 100 litre of water at petal fall stage.

Marssonina Leaf Blotch of apple

Causal organism: *Marssonina coronaria*

Symptoms: The disease symptoms appear in form of dark green circular patches on upper surface of leaf giving rise to 5-10 mm brown leaf spots which become dark brown in due course. On maturity it also develops on lower surface of the leaf. Small blacks a cervuli are visible on the surface of leaf. When lesions are numerous, they coalesce and to form large dark brown blotches and the surrounding areas turn yellow.

Fig: Marssonina Leaf Blotch

Management: Collect and dispose fallen leaves and fruits by burning or burying them. Fungicide spray of Mancozeb (0.2%), Copper Oxychloride (0.3%) is used to control Marssonina Leaf Blotch.

Powdery Mildew of Apple

Causal organism: *Podosphaera leucotricha*

Symptoms: Disease appears when the buds develop into new leaves and shoots. Small patches of white or grey powdery masses on under surface of leaves occur. Leaves grow longer and narrower than normal leaves and the margin is curled. Twigs covered with powdery mass. Affected fruits remain small and deformed and tend to develop roughened surface**.**

Fig: Powdery Mildew

Management: Rake and remove fallen leaves. Spray Dinocap 0.05% or Chinomethionate 0.1%.

Fire Blight of Apple

Causal organism: *Erwinia amylovora*

Symptoms: The initial symptoms usually occurs on leaves, which become water soaked, then shrivel turn brownish to black in colour and fall or remain hanging on the tree. The symptom spread to twigs. Terminal twigs wilt from tip to downward and also spread to branches. Fruits become water soaked, turn brown, shrivel and finally become black with oozing of water.

Fig: Fire Blight

Management: Removal and destruction of affected plant parts. Removal of blighted twigs. Spray 500 ppm Streptomycin Sulphate.

Black Rot of Apple

Causal organism*: Botryosphaeria obtuse*

Symptoms: Leaves may have many large brown spots that start round and become patches as they grow together. The spots are dry and like paper. Spots on fruit may appear any time during the season and infected fruit rot and hang on the tree. The fungus also causes cankers on branches.

Fig: Black Rot

Management: Prune out and burn branches with cankers and dead wood. Prune to open up the tree for good air movement and light penetration. Remove dead fruit from tree at each fall. Application of one of the ethylene

bisdithiocarbamate (EBDC) fungicides (Polyram, Manzate and Dithane). After petal fall, Captan at full rate, or a combination of benlate and captan may be applied.

2. Apricot (*Prunus armeniaca*)

Bacterial Canker of Apricot

Causal organism: *Pseudomonas syringae*

Symptoms: Appears on branches and trunk as gummy cankers and water-soaked areas in spring. Brown leaf spots become shot holes in foliage in summer. Fruit develops dark, deeply sunken, sour-smelling areas, causing them to be more susceptible to Brown Rot.

Management: Remove and destroy pruned debris (do not mulch). Prune in late summer when tissues are resistant to disease. Consider painting on pruning site with a tree-wound dressing to protect against re-infection. Plant disease-resistant trees. Control ring nematodes. 2 autumns, 1 winter and 2 pre-bloom sprays with copper hydroxide may be undertaken.

Powdery Mildew of Apricot

Causal organism: *Podosphaera tridactyla*)

Symptoms: Whitish-gray powdery mold or felt-like patches on buds, young leaves, and twigs. Leaves may crinkle and curl upward. New leaves may be stunted, short and thin in structure. New shoots are stunted. As fruit infection progresses, white powdery appearance passes and brown to pink patches remain. Affected areas on fruit may harden and crack.

Management: Prune to keep tree canopy open to light and air circulation, which naturally reduces development of most fungal infections. Spray of Neem oil is effective.

Brown Rot of Apricot

Causal organism: *Monilinia fructicola*

Symptoms: Blossoms will brown and wilt. Foliage presents with a blighted appearance. Cankers may appear on twigs. Fruit turns brownish with lighter spots. Fruit rots quickly, developing a sour smell and fuzzy gray/brown spores appear. Infected fruit mummifies and may drop or hang on the tree if not removed.

Fig: Brown Rot

Management: Remove and destroy infected (mummified) fruit and pruning debris from planting site. Grow resistant varieties. Copper and Sulfur fungicides are effective for disease control.

Bacterial Leaf Spot of Apricot

Causal organism: *Xanthomonas campestris* pv. *pruni*

Symptoms: Purplish, black or brown spots appear on underside of leaves. Often the spots fall out, leaving small holes in the foliage. Leaves may turn yellow and fall. Infected fruits present with spots, sunken areas, and oozing gummy residue. As the fruit continues to grow, the spots become cracks. Severe defoliation affects fruit size, causes sunscald, and stresses trees going into winter. Cankers develop slowly, growing larger and deeper.

Fig: Bacterial Leaf Spot

Deforms small branches, giving them a knotted appearance, and weakens them, causing breaks, tears, or dieback.

Management: Plant resistant varieties and keep a clean, well-maintained growing site. Remove infected fruit and pruning debris from planting site. Copper sprays are more effective for prevention than control.

Crown Gall of Apricot

Causal organism: *Agrobacterium tumefaciens*

Symptoms: Trees appear stunted and slow growing; leaves may be reduced in size. Immature, fruit-bearing aged trees may see little or no fruit. Woody, tumor-like growths called galls appear especially at the crown (ground level).

Fig: Crown Gall

Management: Avoid injury to tree, especially at planting time, as sites of injury are where the gall bacteria enter from the soil. Avoid planting in previously contaminated areas with crown gall. Chemicals that effectively control crown gall are not available.

3. Bael (*Aegle marmelos*)

Fruit Canker of Bael

Causal organism: ***Xanthomonas sp.***

Symptoms: Disease spread spots on parts of tree, leaves and fruits.

Management: Prune diseased twigs, branches and burn them or give application of streptomycin sulphate (20g/100 Litre water) + Copper oxychloride (0.3%) at on interval of 10-15 days.

Fig: Fruit Canker

Sooty Mould of Bael

Causal organism: ***Meliola sp.***

Symptoms: Splotchy black stains or coatings on leaves, stems, and fruit.

Management: Spray wettable Sulphur + chlorpyriphos/methyl parathion + gum acacia (0.2 + 0.1 + 0.3%).

4. Carambola (*Averrhoa carambola*)

Algal Leaf Spot of Carambola

Causal organism: ***Cephaleuros virescens***

Symptoms: Orange, rusty pustules on leaves; stems, twigs and fruit; swelling tissue; leaves on infected twigs wilting and turning yellow; dieback of shoots.

Management: Maintain proper irrigation, pruning and fertilization regimes in carambola plantations; appropriate copper based fungicides may be required to control the disease in severely infected plantations.

Fig: Algal Leaf Spot

Alternaria Black Spot of carambola

Causal organism: ***Alternaria alternate***

Symptoms: Small, circular light brown or black spots on skin of fruits; lesions develop sunken centres and olive-brown spores.

Management: Avoid wounding fruits during harvest.

Fig: Alternaria Black Spot

Pythium Root Rot of Carambola

Causal organism: *Pythium ultimum*

Symptoms: Canopy has sparse appearance; wilting during periods of water stress; foliage may show symptoms of nutrient deficiencies.

Management: Plant only disease-free nursery stock; plant in areas with no history of the disease; avoid planting trees in low lying areas.

5. Cherry (*Prunus avium*)

Cherry Leaf Spot

Causal organism: *Blumeriella jaapii*

Symptoms: Brown spots on leaves gradually expanding with reddish brown margin. Spots occur on the both leaves. Then there are many spots on leaves appear to have been burnt.

Fig: Cherry Leaf Spot

Management: Sanitation is a critical component of cherry leaf spot control. Fungicides with an active ingredient of Myclobutanil or Captan will protect leaves from infection with cherry leaf spot.

Bacterial Gummosis of Cherry

Causal organism: *Pseudomonas syringae* pvs. *syringae* and *morsprunorum*

Symptoms: Cankers on twigs at bases of flower and leaf buds, in pruning wounds or at the base of spurs which exude amber colored gum. Cankers spread upwards and form sunken areas in winter, infected buds may be symptomless.

Fig: Bacterial Gummosis

Management: Avoid using high fertilizer rates in late summer. Prune when trees are fully dormant (January and February). Spray with copper hydroxide.

Coryneum Blight/Shot Hole of Cherry

Causal organism: (*Thyrostroma carpophilum*)

Symptoms: Small red spots on young leaves which enlarge and become purple with a tan-white center. The spots then drop out of the leaf blade to leave a "shothole." Severe leaf infections produce numerous holes and give the affected leaves a very tattered appearance. Fruit infections begin as purple-red spots on the fruit skin as early as shuck-split and may occur as late as at harvest.

Fig: of Coryneum Blight

Management: Avoid overhead watering, as leaves must be moist for infection to occur. Prune and destroy dead buds and cankered twigs if present. Apply a fungicide at petal fall, shuck fall, and 2 weeks later.

6. Fig (*Ficus carica*)

Rust of Fig

Causal organism: *Cerotelium fici*

Symptoms: Small, yellowish spots on the upper surface of the leaves. As these spots (or lesions) grow larger, they turn a reddish-brown color but remain relatively smooth. On the lower surface of the leaf, the lesions are a reddish-brown color and have a slightly raised, blister-like appearance. Heavily infected leaves often turn yellow or brown, particularly around the edges, and drop prematurely.

Fig: Rust of Fig

Management: Increase air movement in the canopy by regular pruning of branches. Avoid overhead irrigation, instead use trickle tape to apply water at soil level. Fungicide spray of Mancozeb or copper is beneficial.

Leaf Mosaic Virus of Fig

Symptoms: Large, yellowish spots on the leaves. These spots contrast sharply with the normal green foliage, creating a mottled effect. As the disease progresses, the spots become surrounded by a rust-colored ring, which is caused by the sub-epidermal or epidermal cells dying. Some fig tree varieties also develop mosaic lesions on the fruits. The virus also causes premature fruit drop**.**

Fig: Leaf Mosaic Virus

Management: Control attack of mites specially *Aceria fici* (Eriophid mites).

Alternaria Rot of Fig

Causal organism: *Alternaria spp.*

Symptoms: Small, olive-green specks or sunken yellow-olive lesions covered in green spores on fruit. Water-soaked areas on fruit surface where figs touch.

Management: Reduced by picking fruit before it is overripe. Clean picking boxes and containers also reduce rot during storage. Reducing dust in the fig orchards may also limit the disease as well as reduce spider mite populations.

7. Grapes (*Vitis vinifera*)

Downy Mildew of Grapes

Causal organism: *Plasmopara viticola*

Symptoms: Irregular, yellowish, translucent spots on the upper leaf surface and powdery growth on lower surface. Affected leaves become yellow, brown, dry and cause premature defoliation. Dwarfing of tender shoots, with brown, sunken lesions on the stem. White growth of fungus on berries, which subsequently becomes leathery and shrivels. Infection of berries results in soft rot formation with no cracking.

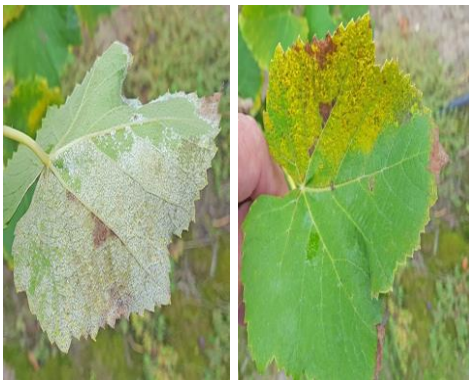


Fig: Downy Mildew

Management: Spray Bordeaux mixture (1%) or Ridomil (Metalaxyl + Mancozeb) 0.4%.

Powdery Mildew of Grapes

Causal organism: *Uncinula necator*

Symptoms: Formation powder like growth on upper surface of the leaves followed by malformation and discolorations. Discolorations of stem to dark brown. Floral infection cause shedding of flowers and poor fruit set. Early berry infection results in shedding of affected berries. At later stages appear as powdery growth and cracking of skin. Occurrence is almost certain during sultry warm conditions with dull cloudy weather.

Fig: Powdery Mildew

Management: Spray wettable sulphur (0.25%) or Chinomethionate (0.1%) or Dinocap (0.05%).

Bird's Eye Spot/Anthracnose of Grapes

Causal organism: *Gloeosporium ampelophagum*

Symptoms: It appears first as dark red spots on the berry, which then become circular, sunken; ashy-gray and in later stages get surrounded by a dark margin. The fungus also attacks shoots, tendrils, petioles, leaf veins and the fruit stems. The spots gradually unite and girdle the stem, causing death of the tips. Commonly appear on warm wet weather in low lying and badly drained soils.

Fig: Anthracnose

Management: Clipping of infected twigs. Spray of copper oxychloride (0.2%) or Mancozeb (0.25%)

8. Jamun (*Syzygium cumini*)

Anthracnose of Jamun

Causal organism: ***Glomerella cingulata***

Symptoms: Affected leaves show small scattered spots, light brown or reddish brown in colour. Affected fruits show small water soaked, circular and depressed lesions. Ultimately, the fruits rot and shrivel.

Management: Spraying with Dithane Z- 78 @ 0.2% or Bordeaux mixture at 4:4:50 concentrations.

Fig: Bacterial Blight

9. Kiwi (*Actinidia deliciosa*)

Armillaria Root Rot of kiwi

Causal organism: ***Armillaria mellea***

Symptoms: Vines may completely collapse; white mycelial mats may be present under bark close to the soil line; cortical tissue has a dark discoloration and white mycelial strands are present; root-like rhizomorphs extend from roots into soil.

Management: Ensure that land to be used for new kiwi plantings is completely cleared of roots which are greater than 1 inch in diameter; ensure kiwi vines are adequately irrigated but not overwatered.

Bacterial Blight of Kiwi

Causal organism: ***Pseudomonas spp.***

Symptoms: Brown, sunken lesions on petals covering flower buds; yellow-orange discoloration of petals; small yellow spots may appear on leaves after periods of rain.

Management: Avoid injuries to the plant which allow bacteria to enter. Spray with copper or sulfur.

Crown Gall of Kiwi

Causal organism: *Agrobacterium tumefaciens*

Symptoms: Reduced plant vigor, small leaves, poor growth, open canopy, reduced yield, galls may be too small.

Management: Avoid injury to kiwi vines; existing galls can be surgically removed.

Fig: Crown Gall

10. Litchi (*Litchi chinensis*)

Leaf Blight of Litchi

Causal organism: *Alternaria alternata*

Symptoms: Tip of the leaf as light brown to dark brown necrosis that advances towards both the margins of the leaf leading to complete necrosis of the affected leaves that dries up subsequently.

Management: Fungicidal spray of Copper oxychloride (0.25%) or Thiophanate methyl (0.15%) Chlorothalonil (0.15%) or Difenconazole (0.05%) can be done.

Fig: Leaf Blight

Panicle and Fruit Blight of Litchi

Causal organism: *Alternaria alternata*

Symptoms: Blighting of panicles and fruits occurs. Panicles shrivel and dry up as a result of necrosis, while necrosis of the pedicel leads to complete drying of the rind of developing fruits.

Management: Application of natural fungicides such as Trichoderma, Mycorrhiza etc. Spray of Thiophanate methyl (0.1%) or Carbendazim (0.1%).

Fig: Panicle and Fruit Blight

First spray just after panicle initiation and second spray at colour-break stage of fruits (20 days before harvest).

Wilt of Litchi

Causal organism: *Fusarium solani*

Symptoms: Young trees of litchi, often below five-year age, wilt in less than a week time. The first symptoms appear as yellowing of foliage, drooping leaves followed by gradual wilting and drying, leading to complete death of the plant within 4-5 days.

Management: Application of castor cake or neem cake as manures along with biocontrol agents like *Trichoderma harzianum*, *Trichoderma viride*, *Pseudomonas fluorescens* etc. effective in managing the disease. In absence of biocontrol agent, drench rhizosphere soil with Hexaconazole or Carbendazim (0.1%). Soil should be free from waterlogging.

11. Loquat (*Eriobotrya japonica*)

Shoot/Fruit Blight and Bark Canker of Loquat

Causal organism: *Phoma glomerata sp.*

Symptoms: The canker appears on bud scars, twigs or in crotches. Small circular brown spots appear around a leaf scar or superficial wound. As the canker enlarges the centers become sunken with the surrounding healthy bark. The fungus perpetuates itself on the trees in bark cankers.

Management: Remove the cankers and decorticate along with 2 cm of healthy bark. Apply Bordeaux paste on the cut ends and wounds. Spray Bordeaux mixture twice at an interval of one month.

Collar Rot of Loquat

Causal organism: *Phytophthora sp.*

Symptoms: Fungus produces canker from ground level to point from where scaffolds emerge. The rot girdles the trunk during 2-3 years. Affected trees flower profusely. The foliage becomes yellowish green. The trees show wilting and ultimately dry up completely.

Management: Avoid flooding the orchard. Uproot the infected trees and destroy. Scrap the infected portion and cut some healthy bark also. Apply Bordeaux paint. Spray the trees with Bordeaux mixture @ 2:2:250.

Root Rot/White Rot of Loquat

Causal organism: ***Polyporus palustrisis***

Symptoms: The affected trees show symptoms of wilt during early leaf fall and increased fruit set. The fruiting bodies appear, when the rot is fairly well advanced.

Management: Locate the infected trees at the early stage, by examining the roots and root collar region of trees. Dig out decayed roots and cut them completely right from the collar region. Treat the cut ends with disinfectant solution. Then apply Bordeaux paste. Drench the soil from where roots have been dug out, with Bordeaux mixture @ 2: 2: 250.

12. Peach (*Prunus persica*)

Peach leaf curl

Causal organism: ***Taphrina deformans***

Symptoms: It attacks the leaves, causing curling and blister formation. The leaves start turning yellowish or reddish and fall off prematurely. The infected portion develops a pink or reddish bronze colour. Growth of the tree is affected with a reduction in yield.

Fig: Peach Leaf Curl

Management: Pruning and burning of infected shoots. Spray the plants with Bordeaux mixture 1% or 0.1% Carbendazim. Spray Mancozeb 0.25% at 20 days before harvesting.

Powdery mildew of Peach

Causal organism: ***Sphaerotheca pannosa***

Symptoms: Small superficial white powdery mass appear on leaves and spread on entire plant parts. Fruits turn pinkish and finally dark brown in colour.

Management: Spraying wettable sulphur (0.3%) or Carbendazim (0.1%).

Fig: Powdery Mildew

Brown rot of Peach

Causal organism: *Monilinia fructicola*

Fig: Brown rot

Symptoms: The first symptoms on mature fruit are small brown spots, which rapidly show brown rot with pustules developing conidia. Blossom blight, twig and dieback and fruit rot. Some infections are symptomless until fruit ripens. Symptoms may occur while in storage.

Management: Control insect damage and wounding. Spray with Copper or sulfur at coverage at pink bud, full bloom and petal fall stage.

Post-harvest: Cool fruit rapidly after harvest Short soak in 50º C water.

Peach Scab

Causal organism: *Cladosporium carpophilum*

Fig: Peach Scab

Symptoms: Small, round, olive-colored spots develop on the fruit close to the stem on the side that is exposed to the sun. As these spots enlarge, they merge and become odd-shaped dark green or black blotches. Severely infected fruits may be stunted, misshapen, or cracked. Leaves have round and yellowish green spots on the underside. Diseased leaves may dry up and drop off prematurely.

Management: Avoid planting fruit trees in areas that are low-lying, shaded, or have poor air circulation and improper drainage. Use recommended fungicides which include captan, chlorothalonil and sulfur.

13. Pear (*Pyrus communis*)

Fire Blight of Pear

Causal organism: *Erwinia amylovora*

Fig: Fire Blight

Symptoms: Cankers are formed on twigs and branches in the previous season. In the spring the bacteria begins to multiply at the same time growth starts. As the bacterium increases, ooze is formed at the margin of the canker. Insects are attracted to the ooze and it is carried to the open blossoms. Blossoms are blighted within 7-10 days after infection. After blossom infection, bacteria spread into the fruit peduncle and finally into the twig. Ooze is continually being produced which can add to secondary infection.

Management: Adopt tolerant varieties like Kieffer, Orient, Garber or Douglas. Maintain balanced fertilizer level. Do not use excess nitrogen. Prune during dormant months. Avoid summer pruning. Prune 8 to 12 inches below visible sign of disease. Apply bactericides at five day intervals between early and late blooms.

Leaf Blight and Fruit Spot of Pear

Causal organism: *Entomosporium maculatum*

Fig: Leaf Blight

Symptoms: Spots appear as small purple marks which with age develop into purple margins with brown centres. Fruit spots are one-fourth inch in diameter, black, and slightly depressed. They coalesce to cover a large portion of the fruit surface. Secondary infection can occur during the spring and summer when the temperature is near 24º C and surface moisture is on the leaves.

Management: Fungicides should be applied three to four times at full leaf development and continued further.

Powdery Mildew of Pear

Causal organism: *Podosphaera leucotricha*

Symptoms: Disease appears when the buds develop into new leaves and shoots. Small patches of white or grey powdery masses on under surface of leaves occur. Leaves grow longer and narrower than normal leaves and the margin is curled. Twigs are covered with powdery mass. Affected fruits remain small and deformed and tend to develop roughened surface.

Fig: Powdery Mildew

Management: Rake and remove fallen leaves. Spray Dinocap 0.05% or Chinomethionate 0.1%.

14. Plum (*Prunus domestica*)

Brown Rot of Plum

Causal organism: *Monilinia fructicola*

Symptoms: Fungus cause blight of blossoms and twigs and a soft decay of fruits. Infected blossoms are brown and water-soaked. The fungus grows down the pedicel into the stem which may cause twig dieback. Diseased blossoms and fruit generally become covered with "tufts" of brown fungal material. Fruit infection usually occurs near maturity.

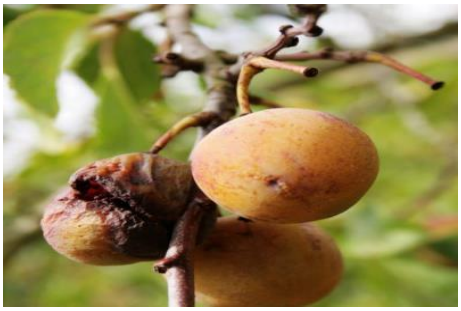


Fig: Brown rot

Management: Control by repeated fungicide applications of copper or sulfur and sanitation.

Bacterial Canker of Plum

Causal organism: *Pseudomonas syringae*

Symptoms: Cankers develop at the base of infected buds on trunk and scaffold limbs. Cankers spread more rapidly above the point of infection than below and only slightly to the sides. This results in a long, narrow canker. Cankers develop during the fall and winter but are not visible until late winter and early spring.

Fig: Bacterial Canker

Management: Remove and destroy pruned debris (do not mulch). Prune in late summer when tissues are resistant to disease. Consider painting on pruning site with a tree-wound dressing to protect against re-infection. Plant disease-resistant

trees. Controlling nematodes. 2 autumns, 1 winter and 2 pre-bloom spray with copper hydroxide.

Bacterial Spot of Plum

Xanthomonas campestris* pv. *pruni

Symptoms:

On Leaf: First small, pale green colour irregular lesions are formed. Angular lesions surrounded by yellow hole are formed. Inner portion of the lesion turn black and drops out giving a "shot hole" or "ragged" appearance and the leaf falls off prematurely.

Fig: Bacterial Spot

On Fruit: Large, sunken black lesions are common on some cultivars, while on others only small pit like lesions appear.

On Twigs: Cankers are perennial and continue to develop in twigs of 2 to 3 years old. Inner bark is penetrated, resulting in deep seated cankers which deforms and kills the twig.

Management: Planting resistant cultivars. Spray with copper hydroxide.

Plum Pox Virus

Symptoms: Symptoms appear on leaves, fruits, flowers, and seeds. Leaves and fruit show chlorotic (yellowing) and necrotic (browning) ring patterns, and chlorotic bands or blotches. The fruit of plum can be misshapen and deformed. In eastern and central Europe, sensitive plum varieties can exhibit premature fruit drop and bark splitting.

Fig: Plum Pox Virus

Management: Use of resistant varieties. Control Aphids by using insecticides like Pyrethrum, Cypermethrin etc.

15. Persimmon (*Diospyros kaki*)

Crown Gall of Persimmon

Causal organism: ***Agrobacterium radiobacter***

Symptoms: Trees appear stunted and slow growing. Leaves may be reduced in size. Little or no fruit. If plant is dead, inspect roots for hard, woody tumors.

Management: Avoid crown gall persimmon tree diseases by protecting the tree from open wounds.

Leaf Spot of Persimmon

Causal organism: ***Alternaria alternata***

Symptoms: Appear as small brown or purple spots on leaves. Leaves may turn yellow and fall. Weakens the tree.

Management: Use the fungicide chlorothalonil after the buds begins to open.

16. Pomegranate (*Punica granatum*)

Bacterial blight of Pomegranate

Causal organism: ***Xanthomonas axonopodis*** **pv.** ***punicae***

Symptoms: On leaves small, water soaked, brown to dark brown spots appear while on fruits oily, dark brown to black spots with L or Y shaped cracks are formed.

Fig: Bacterial Blight

Management: Pruning in September-October is beneficial to pomegranate plants and suppresses the pathogen. Spraying streptocycline (500 ppm) + copper oxychloride (2000 ppm) found most effective.

Heart rot or black heart of Pomegranate

Causal organism: *Aspergillus niger*

Fig: Heart rot

Symptoms: Heart rot is characterized by black rot of the fruit core that spreads from the calyx area, whereas the outer peel and the hard rind retain their healthy appearance. At the beginning of disease development, the fungus causes brown soft rot of the arils, which becomes black and dry as the fungus grows. Eventually, the fungus grows from the lower loculus into the upper loculi, causing rot of the entire fruit.

Management: The disease can be controlled by spraying of Bavistin (0.5%), Dithane M-45 (0.25%) or Dithane Z-78 (0.25%) at an interval of 10-15 days from the onset of flowering.

Alternaria fruit spot of Pomegranate

Causal organism: *Alternaria alternata*

Symptom: Small reddish brown circular spots appear on the fruits. As the disease advances these spots, coalesce to form larger patches and the fruits start rotting. The arils get affected which become pale and become unfit for consumption.

Management: All the affected fruits should be collected and destroyed. Spraying Mancozeb 0.25 % effectively controls the disease.

Cercospora fruit Spot of Pomegranate

Causal organism: *Cercospora sp.*

Symptom: The affected fruits showed small irregular black spots, which later on coalesce, into big spots.

Management: The diseased fruits should be collected and destroyed. Two to three spray at 15 days interval with Mancozeb 0.25%.

17. Quince (*Cydonia oblonga*)

Leaf Blight of Quince

Causal organism: ***Diplocarpon maculatum***

Symptoms: Dark red spots on leaves, brown spots on leaves, leaves dropping from plant, small raised purple spots with white centre on leaves, no fruit produced; tree defoliation.

Management: Remove all fallen leaves from orchard, avoid overhead irrigation, applications of appropriate fungicides may be required, and orchards treated for scab are usually free of leaf blight.

Fire Blight of Quince

Causal organism: ***Erwinia amylovora***

Symptoms: Blossoms wilting and dying shoots shriveling and dying, cankers on branches, plant appears as scorched by fire, watery exudate may be present on infected areas.

Management: Cut out diseased wood, treat with Bordeaux mixture or approved fixed copper materials for organic production, streptomycin or copper application to blossoms.

18. Strawberry (*Fragaria* × *ananassa*)

Angular Leaf Spot of Strawberry

Causal organism: ***Xanthomonas fragariae***

Symptoms: Very small water-soaked lesions on lower surfaces of leaves which enlarge to form dark green or translucent angular spots which ooze bacteria; lesions may coalesce to form reddish spots with a chlorotic hole.

Angular Leaf Spot

Management: Use only certified planting stock, rotate crops and avoid overhead irrigation.

Leaf Scorch of Strawberry

Causal organism: *Diplocarpon earlianum*

Fig: Leaf Scorch of Strawberry

Symptoms: Irregular dark purple or brown blotches on upper leaf surface which may colaesce to produce large purplish brown patches, tissue between blotches may turn purple or red, lesions may also develop on flowers and fruits, affected petals may wither and drop from plant, lesions may girdle peduncles causing death of fruit.

Management: Plant resistant varieties, regular renewal of plants, plant in an area with good air circulation and drainage in full sun, remove all foliage from plants at harvest.

Anthracnose of Strawberry

Causal organism: *Colletotrichum fragariae*

Fig: Anthracnose of Strawberry

Symptoms: Round black or light gray lesions on leaves, numerous spots may develop but leaves do not die. Dark brown or black sunken, circular lesions on stems, petioles and runners, plants may be stunted and yellow, plants may wilt and collapse, and internal tissues discolored red. Firm dark brown to black rot on buds, plants with single buds may die. Light brown water-soaked spots on ripening fruit which develop into firm dark brown or black round lesions.

Management: Fumigation and soil solarization helps to reduce the soil inoculum. Wash all soil from plant crowns prior to planting. Plant only disease free transplants do not use excessive amounts of nitrogen fertilizer.

Gray Mould Strawberry

Causal organism: *Botrytis cinerea*

Fig: Gray Mould of Strawberry

Symptoms: Blossoms turning brown and dying, misshapen fruit, patches of rot on fruit which enlarge and often affects entire fruit, masses of gray mycelium on surface of rotting tissue, no leakage of fluid from fruit, Fruit becomes dried and mummified.

Management: Remove and destroy all dead or infected material, remove decaying fruit, grow fruit under plastic, use plastic mulch to reduce fruit contact with soil, plant in areas where wind will rapidly dry wet plants and fruit.

Exercise-7

Analyses of Quality Attributes

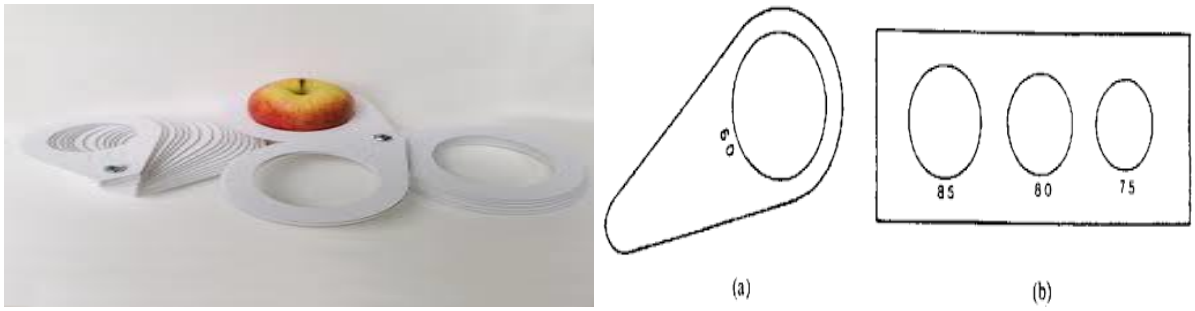
The word “quality” comes from the Latin *qualitas*, which means attribute, property or basic nature of an object. Nowadays it can be defined as the “degree of excellence or superiority”.

Quality factors for fruits includes the following: Maturity, firmness, the uniformity of size and shape, the absence of defects, skin and flesh color, aroma etc. Quality is a complex notion of several attributes that are simultaneously assessed by the consumer either objectively or subjectively. The another significant attribute which normally followed by consumer is determination of maturity, in this there are two significant stages of development leading to achievement of physiological maturity (when a plant or parts will continuous ontogeny even if detached) or horticulture maturity (when a plant parts possesses the pre-requisites for utilization by the consumer for a particular purpose). Maturity indices are important for deciding when a given commodity should be harvested to provide some marketing flexibility and to ensure the attainment of acceptable eating quality to the consumer.

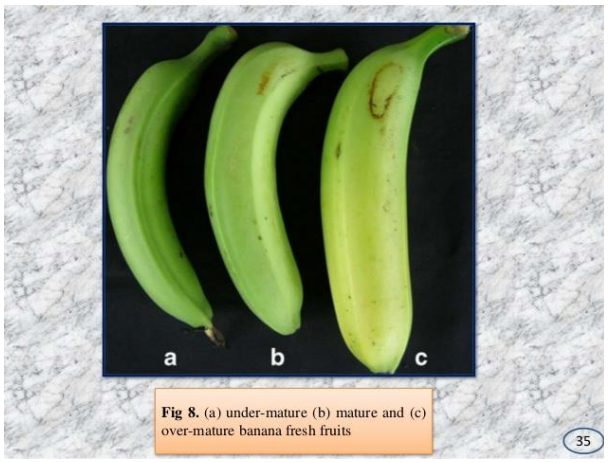
Method for quality analysis:

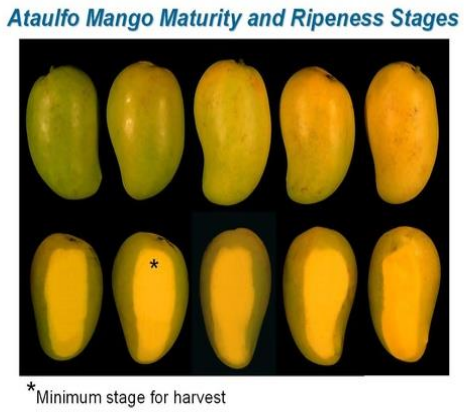
1. *Visual:* The visual appearance of fresh fruit is one of the first quality determination made by the buyer whether the retailer. Often the appearance of the commodity is most critical factor in the initial purchase while other consumer purchases may be more related to texture and flavor.

a) **Size and shape:** Fruits can be assessed by their final shape and size at the time of harvest. Fruit shape may be used in some of instances to decide maturity. For example, “full cheek” in mango or the “finger” angularity in bananas. Size is generally of limited value as a maturity index in fruits, with these produce size is often specified as a quality standard, with large size generally indicating commercial over-maturity and under-sized produce indicating an immature state. Size and shape charts and sizing rings are available for many commodities. These charts can be used by workers to compare produce before harvesting when it is still on the plant.



Sizing rings





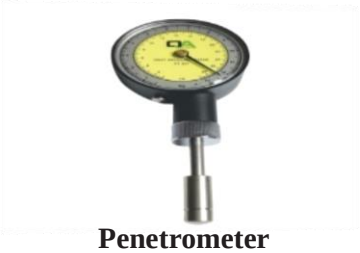
Maturity stages:

b) Colour: We perceive colour when light reflected off the fruit surface. Colour perception depends on the type and intensity of light. There are instruments which are used to check specific colour value. This instrument popularly known as Colour flexes.

Colour flex

2. **Firmness:** As fruit matures and ripens it soften by dissolution of the middle lamella of the cell walls. The degree of firmness can be estimated by finger or thumb pressure, but more precise measurement is possible with pressure tester or penetrometer.

a) Penetrometer- It measures the pressure necessary to force a plunger of specified size into pulp of the fruit.



Penetrometer

b) Refractometer- It measures the TSS (total soluble salts) value of fruits. Put small drops on the angled prism, look through the eyepiece while pointing the refractometer at a source of direct light and note the value.

Refractometer (TSS)

3. Specific gravity: Specific gravity in fruit increases with maturity. It is very rarely used Specific gravity of fruits increases with maturity. It is very rarely used to determine the harvest time of fruits and vegetables, but in many fruits it is useful to grade the crop according to their maturity. Maturity of fruits on the basis of specific gravity is determined by placing the fruit in a tank of water and those that float will be less mature than those that sink.

4. Chemical Measurement: Measurement of chemical characteristics of produce is an obvious approach to the problem of maturity determination. The total soluble solids of the fruit can be measured with Refractometer which indicates the harvest maturity of vegetables like muskmelon Watermelon Acidity is readily determined from a sample of extracted juice by titration.

5. Computational Method:

(a) Calendar Date: For perennial fruit crops grown in seasonal climate which are more or less uniform from year to year calendar date for harvest is a reliable guide to commercial maturity. Time of flowering is largely dependent as temperature and the variation in number of days from flowering to harvest can be calculated for some commodities by use of degree day concept Such harvesting criteria can be developed by the growers based on their experiences

(b) Heat Units: An objective measure of the time required for the development of the fruit to maturity after flowering can be made by measuring the degree days or heat units in particular environment. It has been found that a characteristics number of heat unit or degree days are required to mature a crop under usually warm conditions maturity will be advanced and under cooler conditions maturity is delayed. The number of degree days to maturity is determined over a period of several years by obtaining the algebraic sum from the differences, plus or minus between the daily mean temperatures and a fixed base temperature (commonly the minimum temperature at which growth occurs). The average or characteristic number of degree days is then used to forecast the probable date of maturity for the current year and as maturity approaches, it can be checked by other means.

Maturity indices for selected fruits

Sr. No.	Name of the Fruit	Maturity indices
1.	**Almond**	➢ Hull dehiscence (splitting). ➢ Development of abscission zone. ➢ Separation of the hull from the shell. ➢ Decrease of the fruit removal force and drying of hulls and kernels.
2.	**Annona**	➢ Change in skin colour from dark-green to light-green or greenish yellow. ➢ Days to full bloom (100-115 days). ➢ Cream colour between segments of the skin ➢ Increase surface smoothness
3.	**Apple**	➢ Days from full bloom to harvest (DFFB) for delicious group 13544 and optimum maturity 140-150 days after full bloom
		➢ Starch Index for red delicious – 2.5 and golden delicious 3. ➢ TSS-11 to 13% ➢ Heat unit ➢ 'T ' stage
	Apple- Red Delicious **Apple –Golden Delicious**	➢ 11% TSS 18 lb firmness ➢ 12% TSS 18 Ib firmness
6.	**Asian Pear**	➢ Skin colour change from green to yellowish green ➢ 180 days from full bloom
7.	**Avocado**	➢ Will not ripen on the tree minimum dry weight (17 to 20.5 % dry weight standard set for each cultivar)
8	**Bael**	➢ Mature green fruit ➢ Fruit size
9.	**Ber**	➢ Change in skin colour ➢ Days from flowering to maturity ➢ Specific gravity <1
10.	**Cherry**	➢ Colour development ➢ TSS
11.	**Kiwifruit**	➢ Minimum firmness 141bf (8mmtip) ➢ TSS 6.2%
12.	**Litchi**	➢ TSS acid ratio of 30-40 ➢ Bright red in colour

13.	**Peaches**	➢ Freeness of Pit ➢ Pit Discoloration ➢ Sugar: acid ratio ➢ Ground colour change from green to yellow
14.	**Pears**	➢ Harvest mature-green ➢ Less than 60% starch ➢ Fruit firmness ➢ TSS 10% 'Anjou' and 'Bose' ➢ Starch Index
15.	**Plum**	➢ Skin colour changes: ground colour from green to yellow or red ➢ Days from full bloom ➢ TSS
16.	**Pomegranate**	➢ External red colour ➢ Metallic sound when tapped ➢ Red colour of juice ➢ Minimum TSS 12.5% ➢ Acidity of juice below 1.85%Closing of calyx ➢ Grain cracking sound when pressed from outside ➢ Days from fruit set to harvest – 120-135.
17.	**Sapota**	➢ Milky latex visible ➢ Skin colour change from light brown with a tinge of green to light – brown to dark – brown (potato colour). ➢ Weight of fruit 65-75gm ➢ Specific gravity 1.025-1.057 ➢ No green tissue present when scratched
18.	**Strawberry**	➢ Half to one fourth of skin develops colour
19.	**Walnut**	➢ Ease of removal of hull ➢ Packing tissue turn brown stage (PTB)
20.	**Phalsa**	➢ Change in fruit colour
21.	**Persimmon**	➢ 'Hachiya' blossom end is orange and reddish colour for other cultivars change to a yellowish green colour.

Exercise-8

Visit to Tropical, Sub-Tropical and Temperate Zones

Agro ecological zone is defined as land units in terms of major climate, suitable for certain range of crops and cultivars. Fruits are broadly classified on the basis of their temperature requirement such as, temperate, subtropical and tropical. However, some fruits may be grown under more than one climate. For example, mango is grown under both tropical and subtropical climates. Grape and peach can be grown in both temperate and subtropical regions.

Characteristics of different zones

Temperate zone: Vegetative and flower buds of most of the temperate zone fruits enter into dormancy in late summer or autumn and require a substantial amount of winter cold before they can resume growth in the following spring.

i. These fruit plants are frost - hardy and even tolerant to snowfall and ice.
ii. The soil is mainly shallow and acidic in nature.
iii. Rainfall is adequate. In India, temperate zone climatic environment occurs at sufficiently high elevations.
iv. Jammu & Kashmir, Himachal Pradesh, Uttarakhand, part of Uttar Pradesh, Arunachal Pradesh, part of Nagaland, Nilgiri and Pulney hills in Tamil Nadu.
v. Temperate fruits- Apple, Pear, Peach, Nectarine, Plum, Apricot, Almond, Cherry, Walnut, Kiwifruit, Pecan nut and Persimmon.

Subtropical zone:

i. Temperature is intermediate in nature,
ii. Chilling temperature, if occurs, is for a brief spell and beneficial for many fruits,
iii. The fruits grown have no distinct rest period,
iv. Light frost may occur in this zone,
v. Rainfall varies widely from low to high,
vi. Soil reaction is generally neutral,
vii. Soil fertility status is not satisfactory,
viii. The majority areas have sandy loam and alluvial soil,
ix. The fruits have no marked photoperiodic requirement,
x. Chief regions of Sub-tropical zone - Punjab, Haryana, Uttar Pradesh, North districts of Bihar, West Bengal, Madhya Pradesh, Rajasthan and Assam
xi. Sub-tropical fruits - Sweet Orange, Mandarin, Grapefruit, Lime, Lemon, Litchi, Grape, Guava, Phalsa, Fig, Pomegranate and Avocado

xii. Tropical fruits like Mango and Banana can also be grown in this zone, whereas, the low chilling cultivars of Peach, Pear, Plum and Almond of temperate zones can also be grown in sub-mountainous tracts of sub-tropical zone.

Tropical zone:

i. Chilling temperature is practically absent,
ii. High temperature occurs during most part of the year,
iii. Day and night temperature variation is narrow,
iv. Photoperiodic requirement in very insignificant,
v. Rainfall varies widely,
vi. Soil type varies greatly (clay loam, alluvial, saline, sandy and laterite)
vii. Part of Madhya Pradesh, part of Maharashtra, Gujarat, part of Odisha, part of West Bengal and part of Andhra Pradesh
viii. Most commercial fruits: Mango, Banana, Sapota, Pineapple, Papaya, Pomegranate, Grapes and Cashew nut.

Besides, the arid region of India which occupies nearly 12 percent of the total land area is of immense importance for fruit growing because of the development of highly efficient irrigation management methods.

Zones of fruit growing in the State

- Sub-tropical sub-mountainous and low hills. (Zone I)
- Sub-temperate sub humid mid hills (Zone II)
- Wet temperate high hills (Zone III)
- Dry temperate high hills and cold deserts (Zone IV)

Zone I: - Sub-tropical sub-mountainous and low hilly zone.

- Areas up to 914 m above mean sea level such as Una, Kangra, Chamba, Sirmaur and Solan.
- Soil - sandy loam to loamy sand.
- Rainfall near about 100 cm / annum.
- About 40 % of the cropped area of the state.
- 83% of total cropped area in this zone is rain fed.
- Zone suitable for the cultivation of mango, citrus, litchi, loquat, guava, papaya, and low chilling cultivars of peaches and plum.

Zone II: - Sub-temperate sub humid mid hills

- Hills with elevation ranging from 915 to 1523 m above mean sea level such as mid hills of Solan, Shimla Chamba, Mandi, Kullu and Kangra districts.
- Moderate to heavy monsoon rains and mild temperate climate.
- Soil is neutral to acidic, sandy loam and clay loam.
- Rainfall near about 100- 300 cm/annum.
- About 37 % of the cropped area of the state.
- 76 % of the total cropped area in this zone is rain fed.
- Zone suitable for the cultivation of stone fruits, pome fruits, walnut, lemon, galgal, pomegranate, olive, kiwi and strawberry.

Zone III: - Wet temperate high hills

- High hilly moist zone with elevation from 1524 to 2472 m above mean sea level i.e. the higher reaches of Shimla, Mandi, Kullu, Sirmaur and Chamba.
- Soil- neutral to acidic.
- Climate- humid temperate.
- About 22 % of the cropped area of the state.
- 93 % of the total cropped area in this zone is rainfed.
- Most suitable fruit crops in this zone: pome fruits.

Zone IV: - Dry temperate high hills and cold deserts

- High altitude dry zone in the northwest above 2472 m above mean sea level comprising of Lahaul-spiti, Kinnaur and Bharmaur areas of Chamba Districts.
- Low rainfall during summer (250-400 mm) with heavy snowfall (3-5 m) during winters.
- Comprises of about 2% of the cropped area of the state.
- 60 % of the total cropped area in this zone is rain fed.
- Soil has coarse texture having neutral pH.
- Apple is the main crop besides pear, nuts, prunes, grapes and even drying cultivars of apricot.

Exercise-9

Project preparation for establishing commercial orchards

Establishment of an orchard is a long-term investment and hence needs thorough planning. Any mistake committed during selection of site, planting distances, choice of crops/varieties, quality of nursery stocks etc., reflects greatly on the orchard performance or efficiency. Hence it is advisable for the orchardist to seek the guidance of an experienced horticulturist.

Planning: While planning an orchard, the following critical components need adequate attention.

Roads: A well-laid out internal network of main, cross roads and paths is essential for efficient movement of men and machinery.

Orchard structures: This includes establishment of adequate number of buildings like office, implement shed, godown-cum-store and pump houses etc. at convenient locations as far as possible in a centralized manner to ensure efficient supervision and watch-and-ward. In any case, the area under roads and buildings should not exceed 10% of the total orchard area.

Fence and windbreak: A strong, impenetrable fence is one of the main prerequisites to successful orcharding. It is intended to protect orchards from damage by trespass of wild and domestic animals and pilferage. It is an expensive item and needs judicious planning. It is done in many ways. Temporary fences erected with thorny bushes would lead to recurring annual expenditure of repair and maintenance costs while construction of wall and barbed wire fence are quite expensive.

The orchard trees should be protected from high velocity winds which could cause harm by uprooting trees, breaking branches, causing premature fruit drop, erosion of top soil and evaporation of soil moisture. Use of windbreaks by growing tall, mechanically strong, compact and quick-growing trees planted at close spacing's all along the fence is essential. The windbreaks are needed to be established at least 2-3 years before planting trees. Care should be taken by opening 1m deep trench all around the orchard to avoid competition between windbreak and orchard trees for water and nutrients. Some trees used as windbreak are: *Casuarirna equisetifolia, Grevillea robusta, Artocarpus hirsuta. Eucalyptus, Acacia auriculiformis, Carissa carandas, Syzygium* sp. etc.

Irrigation

Efficient orcharding, to a great extent depends on optimum use of water especially during critical stages of plant growth and development. Main sources of irrigation are either open wells or borewells with distributary pipelines laid out along the gradient connecting

various blocks preferably availing the expertise of a water management specialist. Necessary care is required to avoid waterlogging.

Spacing

Spacing depends on crop, varieties within the same crop, rootstocks employed, cropping system and management practices. Adoption of optimum spacing is intended towards harnessing solar energy, avoiding root competition and efficient exploitation of water and nutrients. The concept of high-density orcharding is increasingly gaining acceptance to optimize productivity. Further, spacing's may also vary depending on the cropping system adopted to harmonise various compatible crops. Spacing's generally followed for different fruit crops are given in Table.

Table. Commonly followed spacing in fruit crops

Crop	Spacing
Pineapple	30cm x 60cm x 90cm
Banana, papaya and grape	1.8-2m to 3m x 1.8m-2 to 3m
Passion fruit, phalsa and pomegranate	2m x 3m, 3m x 3m
Custard-apple	4.5m x 4.5m
Date palm, fig, mandarin, lime, lemon and sweet orange	6m x 6m
Pumelo and grapefruit	6-7m x 6-7m
Guava and cashewnut	6-8m x 6-8m
Sapota, loquat, avocado and star-apple	8-9m x 8-9m
Aonla, mangosteen and nutmeg	9-11m x 9-11m
Mango, jamun, litchi and ber	10-12m x 10-12m
Jackfruit and bread fruit	12m x 12m

In close planting, plants grow tall and slender without proper canopy spread. Thus they become prone to damage by strong winds compared to trees with low headed crown. Further, cost on pruning, plant protection and harvesting comes higher.

Such plants produce low yields of poor size and inferior quality. The trees in closely planted gardens appear sick and are prone to rapid attack by pests and diseases and interculture becomes difficult.

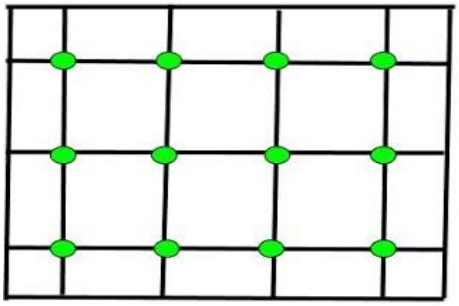
Selection of planting material

The planting material should be vigorous, true-to-type derived from healthy mother plants. It should be propagated on standard rootstocks with guaranteed performance. Low or high budded or grafted plants should be avoided. The roots should be free from knots and

possess sufficient lateral and fibrous roots. The planting material should be certified by the concerned authorities.

A careful plan is necessary for the most efficient and economic management. The layout should aim at providing maximum number of trees per hectare, adequate space for development of trees and cultural operation. The system of layout is broadly divided into two categories viz., vertical row (eg. Square and Rectangular System) and alternate row planting (eg. Hexagonal, Quincunx and Triangular system).

Square system: This is a common system of planting adopted in plains. The distance from plant to plant and row to row is kept equal. The planting is done at each corner of the squares. The square system of the layout is easy to draw and provides equal space to each fruit plant. The space at the center of square remains unutilized which is the main demerit of the system.

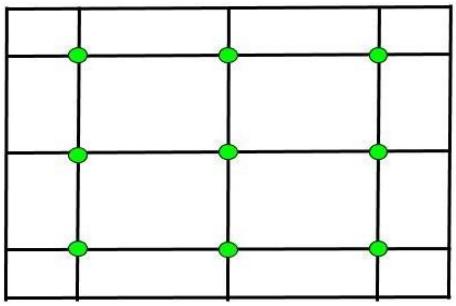


Square System

The central place between 4 trees may be used to grow short-lived trees or intercrops may be cultivated. The accommodation of total number of plants in a given area is calculated as follows:

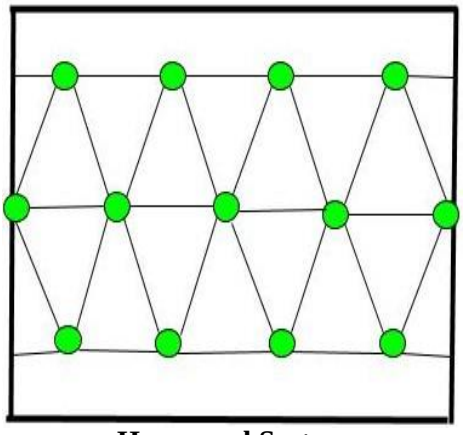
Total number of plants= (Area of the land)/ (Plant to plant distance × Row to row distance).

Rectangular system: In this system of planting row to row distance is kept more than the plant to plant distance. The main disadvantage of the system is a greater loss of income in case of no practice of intercropping. The accommodation of plants can be calculated as follows: Total number of plants= (Area of the land)/(Plant to plant distance × Row to row distance).



Rectangular System

Hexagonal system: In this system of planting fruit trees are planted at the corners of triangles have all sides equal in length and are called equilateral triangles. In this way six trees form a hexagon with seventh tree in the centre. So it is also called as ‘septule’. It provides equal spacing but layout is difficult. The one corner of six equilateral triangles meets at a point and forms hexagon whose all six sides and angles are equal in



Hexagonal System

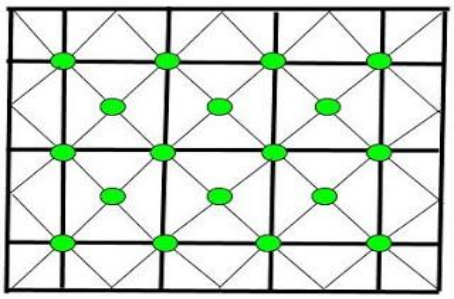
length and degree, respectively. The six plants are planted at the six corners and seventh at the midpoint of the hexagon. The 15% more trees could be accommodated in the hexagonal system than square system if the distance between rows and trees remains equal.

Total number of plants= (Area of the land)/ (Area occupied by single plant)

Area occupies by single plant=3⁄4×A×A ×2

Where, A= length of a side of triangle or spacing between plants

Quincunx or diagonal system: The quincunx system has been developed to utilize the space between four trees that remains unutilized in the square system. The planting is done similar to the square system except an additional plant is planted at the center of the square. The main crop is called primary fruit crop and filler crop is called secondary or supplementary fruit crop.

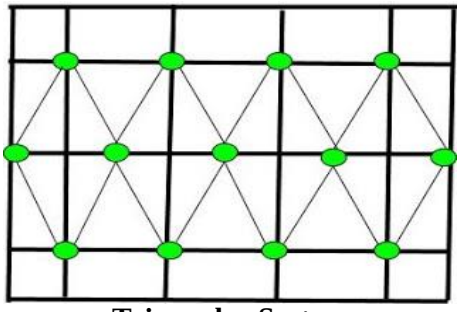


Quincunx system

The income is increased and the growth of the weeds is suppressed. The acute competition between primary and filler fruit crops for water, nutrients, sunlight and air along with overlapping of branches and overcrowding of trees are the disadvantages of the quincunx system of planting. The number of plants requires to plant the available land can be calculated by following formulae: Total number of plants= [(Area of the land)/(Plant to plant distance × Row to row distance)]×2

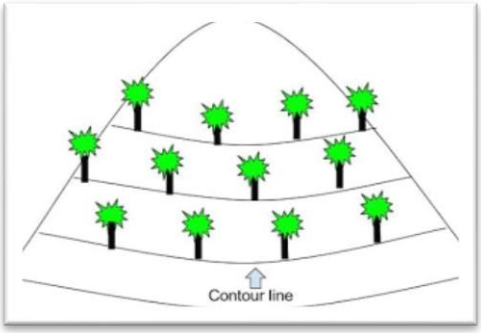
Triangular system: The triangular system is similar to the square system; the only difference

is that the trees in the alternate rows are planted in the middle of the two corners of the squares whereas in the alternate rows also planting is done at the corners of the squares in the square system of planting. Thus trees are planted at the corners of triangles whose base and altitude are kept equal in length the one corner of such six isosceles triangles meeting at the same point to form a hexagon whose all six sides and angles are not equal in length and degree, respectively. The six trees are planted at the six corners and seventh tree at the midpoint of the hexagon.



Triangular System

Contour system: The contour is an imaginary line connecting the points of equal height on a slope. This system has been evolved for the planting of fruit trees on hilly and slopes topography with the objective to minimize the soil erosion. The trees are planted on the bench terrace prepared on the contour. The one row of shrubs and grasses may be planted between two rows of fruit trees to reduce water flow and thereby soil erosion more effectively.



Contour system

The double hedge system accommodates about 22% more plants than single hedge system. The number of plants accommodates in contour system can be calculated by following formulae:

Where,

N=Number of hedges, D= distance between plants, H= distance between hedges,

V= vertical distance between rows

Terrace system: Planting of trees in flat strip of land formed across a sloping side of a hill, in terraced fields rise in steps one above the other and help to bring more area into productive use and prevent erosion.

Terrace system

Planting of horticultural crops:

The minimum vertical distance between any two trees is called as planting distance. There are 2 principles in deciding the planting distance.

1. Trees when fully grown, the fringes of trees should touch each other but the branches should not interlock.
2. The root of trees spread over larger area than top of the tree, so there should be enough space for roots to feed without competition.

There are certain factors which decide the planting distance.

(1) ***Kind of fruit tree*** – Mango (10 x 10 m), Guava (5 x 5 m) whereas Papaya are planted at 2 x 2 m spacing.

(2) ***Rainfall*** – In low rainfall areas wider spacing should be provided than high rainfall area.

(3) ***Soil type and soil fertility*** – In heavy soil less spacing should be given because the top and root growth are limited.

(4) ***Root stocks*** – Trees of some variety grafted on different root stocks will grow to different size and such trees require different planting distance (eg.) Apple.

(5) ***Pruning and training*** – Trees trained on head system require closer spacing than the other type of training.

(6) ***Irrigation system*** – If the spacing between the trees is too wide, the yield per unit area would be greatly reduced. So it is more profitable to plant the trees closer together and supply the needed water and food materials. If the trees are planted, closely they grow tall rendering pruning, spraying and harvesting difficult. There is root competition and inadequate nutrition and the trees as such give fewer yields and produce smaller fruits of poor colour. Close planting results in a greater yield per unit area in the early life but less in the later years.

Planting and Aftercare

Planting: After completion of layout, the pits of required dimension are opened at appropriate spacing's depending on weather conditions at least a fortnight or a month before planting which also facilitates curing. Then they are covered using jungle soil, farmyard manure, treated with termite ideas and kept ready for planting. For identifying planting spot, one could use planting board to ensure accuracy.

The planting board is a rectangular plank 152 cm long, 10cm wide and 3cm thick. The grafts are placed erect in the centre of the pits using planting board and pressed tightly all around. The bud/graft union should remain well above the soil level. The plants are then given copious irrigation and provided with stakes to avoid filling. In hills and semi-arid tracts, it is better to go for in-situ method of planting which involves planting of mature, healthy seeds of suitable rootstocks and grafting of trained single stem either by side or veneer method using selected scion material. This method ensures better survival of grafted/budded plants.

Aftercare

The transplants should be irrigated frequently to facilitate better establishment. The quantum and frequency of irrigation depends on type of soil and weather conditions but it is essential to keep the soil always moist to the levels of field capacity. Mulching of basins also helps conserve soil moisture and reduce weed growth. Precaution is however, needed to avoid waterlogging by ensuring adequate drainage as excess water is harmful to young plants.

Other post-planting orchard operations include, covering/protecting plants against sun, soil operations, application of manures and fertilizers, weed and water management, raising of cover, inter, companion mixed and multistoried crops are essential components of

orchard productivity and efficiency. For improving productivity of majority of orchard crops, it is important to maintain higher organic matter content in the soil which helps in improving soil structure, water-holding capacity, buffering capacity besides enriching microbial activity. In pre-bearing orchard, it is possible to grow intercrops. Growing intercrops also helps in regular cultivation, efficient weed; pest and disease management.

Leguminous cover crops enrich soil fertility and assist in soil conservation. It is required to ensure that the intercrop chosen should not deplete the orchard soil and become competitive to the main crop. It is normal that quick growing fruits like pineapple, papaya, banana, phalsa and guava, and short-duration vegetable-cole crops, cucurbits, tomato, chilli, ginger, turmeric and root crops like tapioca and yam are included as intercrops. The choice of crops mainly depends upon the suitability, facilities of disposal, environmental conditions, flow of finance and the market demand.