

## Commercial Fruit Production and Orchard Management



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**Technical and Vocational Stream  
Learning Resource Materials**

**Commercial Fruit Production and  
Orchard Management  
(Grade 11)**

**Secondary Level  
Plant Science**



**Government of Nepal  
Ministry of Education, Science and Technology  
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## Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline and self-reliance, creativity and thoughtfulness. It is essential to develop in them the linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills. It is also necessary to bring in them the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values so as to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This Learning Resource Material for Plant Science has been developed in line with the Secondary Level Plant Science Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops and seminars, interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Dr. Lekhnath Poudel, Prof. Khemraj Dahal, Lal Prasad Amagain, Shusilraj Subedi, Arjun Prakash Poudel, Nabin Rawal, Kapil Poudel, Samir Sharma, Anita Bolakhe, Mahesh Paudel and Dinesh Timalisina is highly acknowledged. The book is written by Shiv Kumar Das and the subject matter of the book was edited by Badrinath Timsina and Khilanath Dhamala. CDC extends sincere thanks to all those who have contributed in developing this book.

This book is a supplementary learning resource material for students and teachers. In addition they have to make use of other relevant materials to ensure all the learning outcomes set in the curriculum. The teachers, students and all other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning resource material.



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# Unit - 1

## Introduction to Commercial Fruit Production and Orchard Management

### 1.1 Importance and Scope of commercial fruit production and orchard management

#### Importance

##### i. Economic importance

Fruit crops are cultivated by adopting high technology which produces high quality fruit that always gets high price in the market. The price of fruits is always higher than cereals and other agronomic crops.

##### ii. Nutritional importance

It provides all human nutrition like protein, vitamins, carbohydrates, fats, and minerals.

##### iii. Industrial importance

Various processed products like jam, jelly, cold drinks etc. are prepared from different types of fruits and plantation crops; for this purpose, industries are needed.

##### iv. Environmental importance

Fruit trees absorb CO<sub>2</sub> and other harmful gases and dust from environment. It also helps to prevent soil from erosion and landslide and conserve soil.

##### v. Medicinal importance

Many fruits and plantation crops have got medicinal value. They are used to manufacture medicines. E.g. Papaya, Amala, Guava

#### Scope of commercial fruit production and orchard management

##### i) Increasing urbanization and change in food habits

Increasing urbanization due to industrial growth has increased demands for fruits. Change in food habits is also being noticed due to education and assured income which has also helped in increasing demands for fruits.

## **ii) Increased transport facilities**

At present, quick transport facilities by road are available enabling growers to transport fruits, to long distance markets in good condition in a short period of time.

## **iii) Development of new techniques**

Use of growth regulators, drip irrigation for water economy, tissue culture, special horticultural practices like high density planting have helped to increase productivity and also to bring more lands under cultivation.

## **iv) Scope for export of fruits**

There is a good scope for export of grapes, mango, banana, pomegranate, citrus to foreign markets.

## **Other scopes**

- Availability of cheap labour
- Very high production of fruits
- Suitability of climate for fruits is the other factor indicating scope for fruits

## **1.2 Potentiality of fruit production**

1. Due to the wide range of climatic conditions, Nepal has a unique opportunity to develop many fruit crops.
2. Demand for fruits is also growing at a fast rate due to the awareness of balanced diet and changing dietary habits of the people.
3. It is quite evident that fruit farming is far more profitable than cereals, where marketing and other essential facilities exist.
4. Fruit farming is moderately employment intensive and contributes considerably to farmer's income.
5. Based on the successful apple production in some pocket areas, the Agricultural Perspective Plan had identified apple as one of the high value priority commodities in the high hills.

## **Constraints of commercial fruit production and possible remedies**

Almost all types of fruits are being grown in various parts of Nepal but it has not been demonstrated as an economic enterprise. This is because they are constrained by a number of factors which can be broadly categorized as

### **Infrastructural constraints**

Deciduous fruit growing areas are situated in remote places in the mid and high mountains. These areas are not yet accessible to motorable roads and large markets, so farmers are facing big problems in selling their produce. Essential inputs such as fertilizers, plant protection chemicals and horticulture tools etc. are not regularly available and on time. Organized marketing channels, transportation, storage and processing facilities have not yet been developed in all fruit growing areas of the country.

### **Physical and Environmental constraints**

Physically, Nepal is situated in a very difficult region of the world. More than 80% of its geographical area comes under hilly and difficult terrain with very steep slopes, loose soil and rocky structure. In the dry spring months (March to May) when temperatures are high with little rain and no irrigation, fruit trees are seriously stressed due to which productivity is reduced. Some important fruit growing areas like Mustang and Jumla experience strong wind in the spring that causes severe flower and fruit drop.

### **Technical constraints**

- Low priority for fruit research.
- Poor allocation of financial resources
- Lack of trained manpower
- Weak extension system in horticulture
- Inadequate technical information

### **Possible Remedies**

- Agriculture roads should be constructed.
- Inputs like fertilizers, horticultural tools should be readily available in time.

- Research should be conducted in all fruits in potential areas.
- Storage and processing facilities should be provided.
- Loans should be provided for the cultivation of fruits.
- Skilled man power should be entertained.

### **1.3 Classification of fruit on the basis of agro climatic region**

#### **Tropical fruit production region**

This zone comprises terai and inner terai. The altitude ranges from 70-650 masl (metres above sea level). Large numbers of fruit crops are produced in this zone. Mango, litchi, pineapple, jackfruit, banana, papaya, guava are common in this Zone. Similarly, bayer, amala, pomegranate etc are produced in semi-commercial scale.

#### **Sub-tropical fruit production region**

This zone mainly covers the mid hills of the country. The altitude ranges from 650 to 1450 masl. This zone is suitable for citrus species i.e. sweet orange, mandarin orange, lemon etc. and other fruits like pomegranate, guava, etc.

#### **Warm-temperate fruit production zone**

This zone covers upper part of mid-hills. The altitude ranges from 1450-2100 masl. Peach, plum etc are major crops for this region. Pear has been selected as commercial fruit in this region.

#### **Temperate fruit production zone**

This zone covers from the high hills to mountains. The altitude ranges from 2100-3000 masl. Apple and nuts (i.e. walnuts, apricot) are grown for commercial purpose.

# Unit - 2

## Cultivation Practices of Mango

### MANGO (*Mangifera indica*)

#### Introduction

Mango (*Mangifera indica* L.) of family Anacardiaceae is undoubtedly the most popular and choicest tropical fruit due to its delicacy, fragrance and nutritive value. It is accepted as the King of Fruits due to its attractive appearance, luscious taste and captivating (attractive) flavour. Mango is now being commercially cultivated in more than 87 countries of the world. Probably, no other fruit can compete with mango in terms of quality, nutritive value as well as popularity of appeal.

Mango is a drupe/stone fruit with hard and fibrous endocarp and edible fleshy mesocarp.

#### Origin

Mango is indigeous to Northeast India and Burma in the fact hills of the himalayans and is considered to have been originated in the Indo-Burma region.

#### Classification

**Class:** Dicotyledonae

Order: Sapindales

**Family:** Anacardiaceae

**Genus:** *Mangifera*

Species: *indica*

#### Varieties

**Langra:** Mid-season variety, excellent fruit quality, wide adaptability, excellent sugar/acid blend and a characteristically pleasant flavour. Biennial in habit, excessive .fruit drop, trees vigorous and spreading

**Dashehari:** Mid-season, good keeping and canning quality. Excellent fruit quality, biennial in habit, flavour not stable, highly susceptible to mango malformation.

1. **S.B Chausa:** Late variety, juicy, one of the sweetest mangoes lacking somewhat in acidity. Poor fruiting and unpredictable bearing, trees quite vigorous and show apical dominance, very high incidence of floral malformation.

**Bombay Green:** Early variety, taste and flavour excellent, good blend for mango nectar. Biennial in habit, poor keeping quality and highly susceptible to malformation (both).

2. **Alphonso:** Most popular in market abroad, fruits with excellent flavour, shape, size and colour. Very good variety for canning, flavour stable, limited adaptability, spongy tissue develops, biennial in habit.
3. **Fazli:** Very late variety with very large sized fruits (kg/fruit 2) Fruit quality inferior and biennial in bearing
4. **Neelum:** Regular, Dwarf and precocious in bearing. Inferior fruit quality.

### **Some hybrids**

1. **Mallika:** Neelum × Dashehari (1971), Semi vigorous, Regular type.
2. **Amrapali:** Dashehari × Neelum, distinctly dwarf, highly regular and prolific in bearing, suitable for high density orcharding.
3. **Ratna:** Alphonso × Neelum, Regular and absence of spongy tissue.
4. **Arkaaruna:** Bengampalli × Alphonso.
5. **Sindhu:** Ratna × Alphonso, seedless, wt. of stone 6-7gm i.e. Papery seed.
6. **Arka Nellkiran:** Coloured variety (Neelum × Alphonso). Dwarf (Plant height 3-4m), of fruit of medium size (5/kg) with golden apricot colour on ripening. Red blush on cheeks. High pulp to stone ratio, firm and fibreless flesh, excellent sugar-acid blend and pleasing aroma.

## **Climate and soil**

It is tropical fruit but it can be cultivated at the altitude ranging 1100 masl. There should not be high humidity, high rainfall, and frost during flowering and fruiting. The temperature between 24<sup>0</sup>C-27<sup>0</sup>C is ideal for its cultivation. It can be grown best with annual rainfall of 75cm. It can be cultivated in fertile loam soil with good drainage capacity. pH of 5.5-7.5 is considered best for mango cultivation.

## **Propagation**

Since mango is a highly cross pollinated fruit crop, vegetative propagation is usually practiced. Grafting is mainly practiced in mango although layering and cutting are also reported.

## **Grafting**

Inarching is the commercial method of grafting mango although veneer followed by soft wood and epicotyl grafting are being done. For all these grafting methods, seedlings raised from a mixed lot of seeds are generally used as rootstocks since it is believed that in mango, the rootstocks do not influence the performance of grafted tree. Freshly extracted stones from ripe fruits are sown in beds immediately since stone lose their viability if kept for longer period. A spacing of 22cm from seed to seed in the row and about 45cm from row to row is usually adopted. In the following year, the seedlings are lifted in rainy season with a ball of soil 15 days earlier before inarching, potted and kept in partial shade and watered regularly.

## **Inarching**

It is the most common method of propagating mango cultivar with 90% success. This should be done during the growing period when the sap within the tissue of trees flows freely (e.g. July). The actual process consists of removal of a strip of bark about 5-7 cm long with a small layer of wood attached to it, from the potted seedling at a height of 2.2 cm from soil surface. A similar strip is then removed from the scion shoot. The two exposed surfaces on the stock and scion should fit together securely, leaving no gap when these are held together. In this position they are tied firmly with banana fibre or sutali. The complete operation should be done at the commencement of rains for

successful raising of the plants. However, there should be no rain at the time of operation otherwise water gets inside the union and causes rotting. Union of scion and stock takes place in about six weeks. The shoot is cut-off below the union and stock above the union, the grafts are hardened in partial shade for another 2 months before planting.

### **Veneer Grafting**

Success rate is up to 80 percent. This is by far the best method of propagation. Since it is easier, more economical, gives a higher degree of success and is ideal for in-situ orchards. It is a detached method of grafting i.e. the shoot of the mother plant which is to be multiplied can be away from the mother plant and taken for grafting in the nursery. The scion shoot is to be 3-4 months old with some activated buds. It can be secured by defoliating the scion shoot about a week before the actual operation.

A slanting cut about 5cm long on one side of the stock stem is given and the bark along with wood is removed, giving an oblique cut. Then, a slanting cut on one side of scion is made which will just fit with the notch of the stock. It is then wrapped tightly with 1.5cm wide tape of 200-300 gauge polythene film, keeping the terminal ends free in such a way that the cambium rings of both stock and scion came in close contact.

After the successful union (after about 3 weeks), when the scion begins to grow at the top, the upper part of the stock is removed. The plastic wrap is removed after 2-3 months.

### **Epicotyl grafting/stone grafting**

By this method, multiplication of larger number of plants in lesser time is possible. Germinating seeds of 4-10 days old are used as rootstock, which are grafted indoor by deheading them above 5.0 cm above the stone and inserting the scion in the deheaded stock. The scions are prepared by prior defoliation of shoots of comparative thickness. Splice and wedge methods are used for grafting. Grafting is done in rainy season when there is high humidity in the atmosphere.

## Planting

Digging is done at least two months prior to planting. 30-40 kg well rotted FYM+2 kg bone meal+5 kg of wood ash may be applied per pit. For termites, 50ml Chloropyriphos/pit is used. Best time is cloudy weather and evening so as to protect from wilting. 10×10m<sup>2</sup> spacing should be done while planting care should be taken that the graft union remains well above the ground level and the earth ball does not break.

## Irrigation

Irrigation should be done depending upon the moisture condition of the soil. Generally, it is done in 10-15 days interval in winter and 5-10 days interval in summer. Irrigation is necessary during flowering and fruiting stage. It is done by adopting ring method of irrigation.

## Manure and fertilizer

Application of manure and fertilizer depend upon the soil fertility status, irrigation facility, variety and age of the plant.

Age of Plant (Yrs)	FYM/comp ost (Kg)	Nitrogen (g)	Phosphorus (g)	Potassium (g)
1	10	70	35	70
2	20	140	70	140
3	30	210	105	210
4	40	280	175	280
5	50	350	210	350
6	60	420	245	420
7	70	490	280	490
8	80	560	315	560
9	90	630	350	630
10	100	700	385	700

## Training and pruning

It is an important practice during the first to few years after planting. Hence, they need little or no pruning. The crossed dead, diseased branches should be removed

periodically. Any growths appearing on the rootstock below the graft union should be removed. Besides, all flowers appearing during the first three years should be removed as soon as it appears.

### **Intercrop**

Short season crops or filler trees can be grown so as to utilize the inter space. However, the irrigation requirements of intercrop should coincide with that of mango trees. Vegetables having roots within 25 cm depth of soil e.g. tomato, chill, onion etc. can be planted. Filler:-Straw berry, pineapple.

### **Intercultural operation**

Timely weeding and at least one ploughing in September is practiced when the trees are in non-bearing stage.

### **Flowering, pollination and fruit set**

In terai and inner terai, new vegetative flush appear thrice in a year i.e. February-March (Falgun-Chaitra); April-May (Baisakh-Jestha) and July-August (Shrawan-Bhadra)

### **Biennial bearing**

It is synonymous to alternate bearing which indicates yield variation in alternate years i.e. one year of optimum or heavy fruiting is followed by a year of little or no fruiting

### **Major diseases**

#### **● Powdery Mildew:**

Appearance of grayish whitish powder on flower buds, fruitlets and rachis of panicles, which later becomes dark brown.

#### **Control:**

Wettable Sulphur at 0.2% at pre-bloom, full-bloom and post bloom stages.

#### **Anthraxnose:**

The disease affects the tender parts of the trees and the symptoms vary according to plant part affected.

#### **Control:**

- Spray Bordeaux mixture thrice a year in Feb, April and September.

#### **Sooty Mold:**

- The fungus developed on the honey dew secreted by the hoppers on the leaves, twigs and inflorescence forming black encrustations.

**Control:**

- Apply wood ash, saw dust in affected parts.

**Insect Pests of Mango**

**1. Mango Hopper**

- Both adults and nymph suck the sap.
- Hoppers are mostly active during the flowering and fruiting period.

**Control:**

Spraying with malathion 0.5 % or Imidachloprid 0.3% once at the time of panicle emergence and then again at fruit set stage.

**2. Mango Mealy Bug**

- The female can be identified by their flat shape, covered with white mealy powder.
- The nymphs suck juices from young shoots, panicles and flowers pedicles.
- The affected parts dry up resulting reduction of yield.

**Control:**

- Destroy eggs by digging around the trunk during summer (May-June).
- Use of adhesive/sticky/slippy bands around the tree trunk about 30-45cm above the ground level during December.
- Spraying Carbaryl 0.2%.

**3. Mango Stem Borer**

- They make hole in the stem and trunk.
- Leaves and stems get dry in severe attacks. Later whole plant may get dry.

**Control:**

- Adopt clean cultivation.
- Use wire to kill the insect that stay inside the hole.

**4. Mango stone Weevil**

- Larva feed upon the pulp of the mango and reach up to the stone of the fruit.
- The adult feed upon pulp of fruit which make the fruit unmarketable.

**Control:**

- Destroy the affected fruits
- Adopt clean cultivation
- Apply Chlorpyrifos @ 2ml/l of water first when the mango gets marble size and repeat at 15-20 days interval for 2-3 times.

#### 5. Leaf Cutting Weevil:

- They cut the tender leaves of the plant.
- They attack severely in young plants than older plants.

#### Control:

- The affected leaves are destroyed.
- Apply Cypermethrin @ 2ml/l of water.

### Physiological disorder

#### 1. Black Tip

Due to coal fumes of bricks-kilns, the gases like carbon monoxide, ethylene and SO<sub>2</sub>, brick red colour appears towards the tip, along the margins of old leaves and subsequent collapsing of these tissues.

#### 2. Spongy Tissue

A non edible sour, yellowish and sponge like patch with or without air pockets developed in the mesocarp of fruit is broadly termed spongy tissue.

#### 3. Bitter Pit

Small brown lesions of 2-10 mm in diameter (depending on the cultivar) develop in the flesh of the fruit. The tissue below the skin becomes dark and corky. These spots generally turn darker and become more sunken than the surrounding skin and are fully developed after one to two months in storage. Cultural practices that reduce the incidence of bitter pit are calcium sprays, summer pruning and harvesting mature fruit. Avoid nitrogen and magnesium summer sprays fertilizer treatments that result in lowering the soil pH or induce excess vigour, and fluctuating soil moisture.

#### **4. Internal Browning**

Brown discoloration in the flesh, firm but is moist, usually originating in or near the core. Brown areas have well defined margins and may include dry cavities resulting from dryness. Symptoms can range from a small spot of brown flesh to nearly the entire flesh being affected in severe cases. Avoid harvesting over mature fruit. Harvest at the optimum maturity, especially for controlled atmosphere storage.

#### **5. Scald**

Irregular brown patches of dead skin appear which can become rough when severe, developing within 3 to 7 days upon warming of the fruit following cold storage. The warm temperatures do not cause the scald but allow symptoms to develop from previous injury which occurred during cold storage. Symptoms may be visible in cold storage when injury is severe.

#### **6. Sunburn**

Initial symptoms are white, tan or yellowed patches found on the sun exposed side of the fruit. With severe skin damage, injured areas can turn dark brown on the tree. Fruit exposed to the sun after removal from the tree, either on the orchard floor or in field bins, can develop severe sunburn. The best method of control is to avoid sudden exposure of fruit to intense heat and solar radiation. Proper tree training and pruning are critical. Summer pruning must be carefully accomplished to avoid excessive sunburn.

#### **7. Water core**

A pre-harvest disorder resulting in water soaked regions in the flesh, hard and glassy in appearance, only visible externally when very severe. Symptoms often increase rapidly as fruit become over mature but does not increase postharvest. If symptoms are mild to moderate, they may disappear completely in storage. However, when water core is severe, internal breakdown can develop. The most effective way to reduce the incidence of water core is to avoid delayed harvests.

### **Harvesting of mango**

Mango need to be handled carefully when picking them to avoid any bumps or bruises which will prevent them keeping well. Cupping your hand under the mango and pick it. If picking using a ladder then consider one of the excellent mango-harvesting

bags that you wear like an apron to collect them as you harvest.

### **Sign of Maturity**

Fruits generally require 95 to 115 days to mature after flowering. Colour of fruit changes from dark green to pale green. Red blush develops on the fruit shoulders. One or two or three ripe fruits fall from the plant naturally, indicating maturity of the other fruit on the tree.

### **Method of harvesting**

Harvesting should be done by hand as much as possible. The fruit is twisted sharply sidewise or upward.

### **Yield**

The yield of mango depends upon the various factors. Generally, 12-20 fruits are harvested from 5 years old plant. 400-500 fruits are harvested from 10 years old plant. If properly managed, 1500-2500 fruits are harvested from 20 years old plant.

### **Grading**

The fruits graded according to their size, weight, colour and maturity benefits both the producer and consumer.

### **Packaging**

Mangoes must be packed in such a way as to protect the produce properly. The materials used inside the package must be clean, and of a quality use of materials, particularly of paper.

### **Transport**

Road transport by trucks is the most popular mode of transport due to easy approach from orchards to the market. Over loading should be avoided. To reduce bruising, good shock absorbers should be used.

### **Storage:**

Storage at 10 to 13 °C with 85 to 90% RH, give a shelf life of 14 to 28 days for mature green fruit, depending upon variety. Ripe fruits can be stored at 7 to 8 °C.

## **Unit - 3**

# Cultivation Practices of Banana

## BANANA (*Musa paradisiaca*)

### Introduction

Banana is one of the most ancient fruits being used from the beginning of the civilization. It has attained a commercial as well economic importance in many countries of tropical world. Both the fruits and plants can be utilized for diversified products.

### Composition and uses

It is rich source of vitamin and minerals. Ripe fruits are consumed fresh and are also used to prepare jam, jelly, candy, juice etc. Ripe fruits are used for table purpose. Unripe fruits are boiled, dried and powdered to make flour. Banana flour can be used to make ice cream and custard. Chips, sweets, flakes, vinegar, juice, beer is prepared from fruits while paper, board and tissue paper are prepared from the plant. Unripe fruit, male flower or heart is used as vegetable or used for pickle making. Its water (sap) is being used for making ink. Ropes, bags, clothes, decorative things and textile can be made from fibres of pseudo stem and dried midribs.

### Origin

The origin of banana is not clearly identified. A large number of genuses of *Musa* have been reported in various parts of the world, but native home is believed to be South East Asia (Assam, Burma, Thailand, Malaysia, Indo-china regions, etc.).

### Distribution

Major producing countries are- Colombia, Brazil, India, Philippines, Thailand, Uganda, Zaire, Tanzania, Ivory Coast, Burundi, Kenya, Equator, Venezuela, etc.

In Nepal, banana is grown in the terai, inner terai, river basin and lower hills. Jhapa, Morang, Sunsari, Dhanusha, Sarlahi, Bara, Chitwan, Rupandehi, Nawalparasi, Kailali and Kanchanpur are major banana producing districts of Nepal.

### Varieties

### **1. Dwarf Cavendish (Basrai or jahaji)**

This variety is dwarf, leading commercial variety, poor keeping quality, bunch medium to heavy (20kg), susceptible to bunchy top and leaf spot, resistant to panama wilt, leaves thick and dark green with short petiole.

### **2. Robusta /Harichhal**

It is semi-tall and has similar character to Dwarf Cavendish (mother plant) except its better keeping quality and skin colour does not change even after ripening.

### **3. Poovan (China Champa)**

Tall with rose pink colored trunk.

200-250 fruits weighing 15-20 kg/bunch.

Fruits medium to small, yellow skinned, sweet with pleasant flavor.

Resistant to panama wilt, fairly resistant to bunchy top and leaf spot.

Good keeping quality.

### **4. Malbhog (Rasthali)**

Tall, reddish margin of petiole and leaf sheath, fruits 125-150 weighing 10-12 kg, flesh firm, very sweet with pleasant aroma.

Resistant to leaf spot but severe to wilt and weevil problem.

Excellent keeping quality.

### **5. Other varieties**

Plantain, Red banana, Gross Mitchel, William Hybrid, hill banana, Dhurse, etc.

## **Climate and soil**

It can be cultivated in tropical and subtropical region. It can be cultivated up to an altitude of 1600 masl. The ideal temperature is 22-27<sup>0</sup>C but it can be cultivated within the temperature range of 18-30<sup>0</sup>C. It requires 2000-4000mm annual rainfall.

It can be cultivated in wide range of soil but the loam and sandy loam is ideal. The soil should have high organic matter with good drainage facility. The soil pH should be 6-7.5. Alkaline soil is not suitable for banana cultivation.

## **Area and production (2016/17)**

Area (ha): 17839; Productive Area (ha): 15223; Production (mt): 247622; Productivity (mt/ha): 16

## **Propagation**

Some wild varieties produce seed which are used only for breeding programs. Suckers, rhizomes and micro propagation are best propagules for vegetative propagation.

## **Sucker**

Banana sucker are most convenient propagating material. Sucker can be classified as

- **Sword sucker**

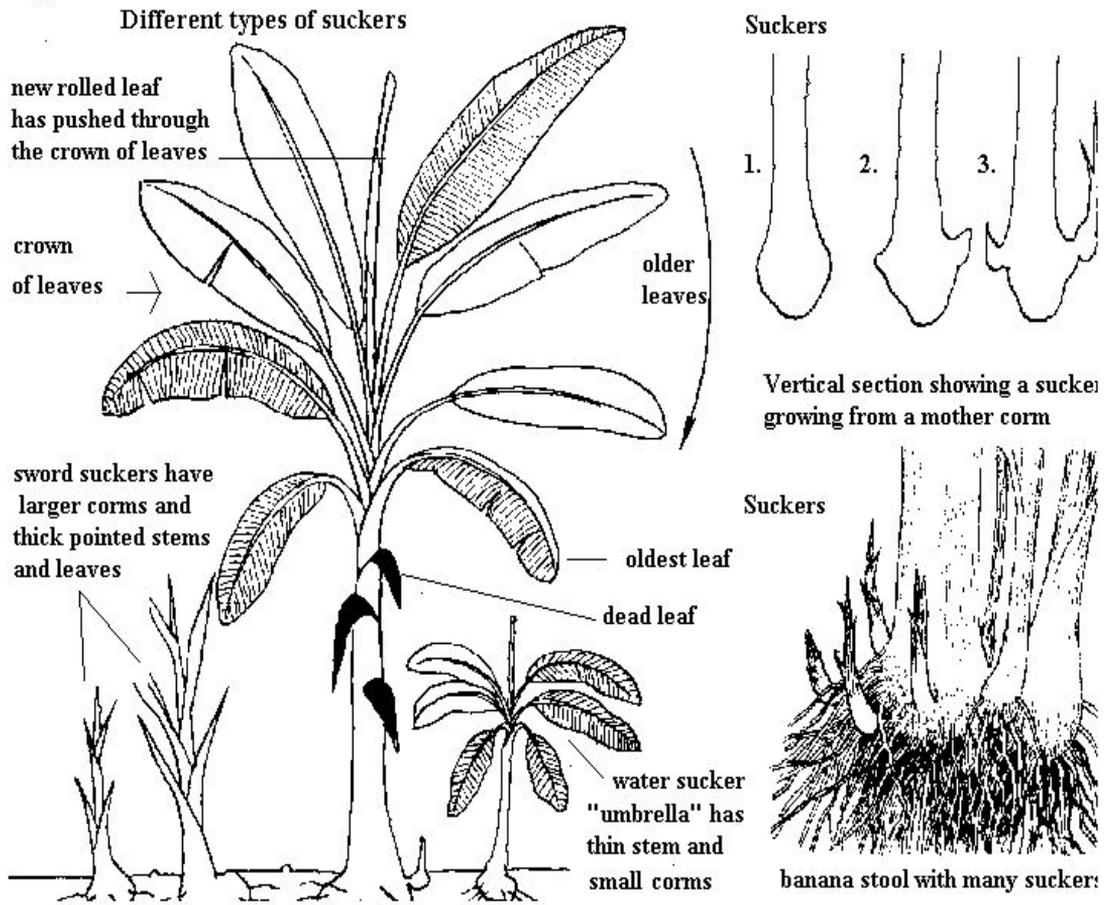
Well developed base with narrow shaped leaf blades at early stages, best for propagation, more vigorous and produce bigger and bigger bunches in 11 months but poor in suckering.

- **Water sucker**

Broad leaved which do not produce healthy banana clump. It requires more than 15 months for flowering.

- **Maiden sucker**

Large one but not fruiting ratoon.



## Rhizomes

These are often called peppers. They are actually corm but generally called rhizome. Rhizome weighing 2 kg can be used for propagation. Rhizome bits take longer time to fruit.

## Micro propagation

Tissue culture produces large number of virus free plants within short period of time.

## **Planting**

The spacing varies greatly according to the variety and climate. Suckers are planted in a pit. If the suckers are tall, about 30cm then it should be cut from the upper part. The spacing is maintained about 2.5m x 3m for tall variety and 1.8m x 1.8m for dwarf variety.

## **Modern Orcharding**

Dwarf varieties as William hybrid can be planted at spacing of 1m×1m as monocrop or mono-stem planting.

## **Pits**

Healthy, vigorous suckers are selected for planting in a pit dug with 60cm×60cm×60cm dimension. The pit soil is mixed with well decomposed FYM/Compost. A single sucker is planted in the center of the pit with 25-30cm deep.

## **Manure and fertilizer**

Generally, young plant of banana requires 20 kg FYM and 200g nitrogen, 150g phosphorus, 250g potassium. Application of Fipronil is recommended in borer infested field. Full dose of phosphorus and FYM is applied during final field preparation. NK is applied in two split doses i.e. first dose is applied at final land preparation and remaining half is applied during fruiting stage. For ratoon crops, manuring has to be done every year.

## **Irrigation**

Irrigation is necessary during flowering stage. In winter irrigation is done at 15-20 days interval based on the moisture in soil. In summer irrigation is done at 7 days interval. Water logging condition is avoided from the base of the plant.

## **Intercropping**

Shade loving and shallow rooted vegetables are considered good for intercropping for few months of banana planting. eg. ginger, turmeric, yam, colocasia. Fruits crops and other perennial crops are planted as mix crops. They are: pineapple, papaya, areca nut, coffee, etc.

## **Cover crop**

A cover crop is a crop planted to manage soil erosion, soil fertility, weeds and/or pests, and, thereby, reduce the use of herbicides and pesticides. The practice consists in planting a species that does not negatively impact banana production and prevents the growth of weeds. These could be domesticated crops or local species. Bananas can also be planted on the mulch of a previous cover crop such as signal grass (*Brachiaria decumbens*) or sunhemp (*Crotalaria*). The mulch will limit the growth of weeds and protect the young banana plants.

## **Pruning**

Old leaves and infected leaves should be pruned regularly. This will reduce the likelihood of leaf diseases and keeps the plantation tidy. Furthermore, it provides natural mulch to the Banana plants. Removal of dried and decayed leaves and plants parts keeps plants healthy, clean ensuring less attack of pest and disease.

## **Intercultural operation**

### **Weeding**

In banana, weeds are serious problem at early stage of growth causing 60-70% losses.

### **Desuckering**

Removal of unwanted suckers is desuckering. It is one of the most critical operations in banana. Several suckers are produced per clump. One flower is allowed every 5 months, 2<sup>nd</sup> flowering during the harvest of first. Use circular pattern, keep kerosene 2-5ml or urea 3-5gm at cut heart of sucker otherwise they keep on coming.

### **Earthing up**

In rainy season, it is essential in order to provide drainage and to avoid water logging at base. This does not allow to exposure and produce sucker and even keep weed population under control.

## **Propping**

Where wind is a problem, pseudo stem requires to be propped up with bamboos at the time of bunch emergence. The support should be provided at neck region to avoid falling over in wind or heavy yield.

## **Wrapping or bagging of bunches**

This practice is done to protect from sun burn, hot wind and dust and for uniform development of fingers. It improves fruit quality. Jute sack, polythene sheet can be used.

## **Flowering**

Normally plants flower in 8-12 months after planting and 3-4 months for maturity. The withered flowers should be removed after the bunch is formed. The male flower is also removed.

## **Pollination**

Female flowers bloom first, in groups called hands. These produce the fruit. Sterile flowers then bloom, followed by the male flowers, which produce the pollen. In the wild, birds move the pollen from the male to the female flowers. Cultivated varieties of banana trees are pollinated in the presence of wild banana trees.

## **Fruit set**

Unfertilized female flowers in cultivated varieties produce fruit after the flower goes too long without fertilization. The ovules cease developing, and the fruit pulp swells as the bananas grow. The purplish bracts that shelter the hands of flowers roll back, and the starchy, green bananas grow in the same cluster formation. The bananas can change yellow either on the tree or hung in a cool, shaded, well-ventilated area.

## **Fruit growth and development**

The ovaries contained in the first (female) flowers grow rapidly, developing parthenocarpically (without pollination) into clusters of fruits, called hands. The fruit (technically a berry) turns from deep green to yellow or red, and may be 12 inches in length and 2 inches in width. The flesh, ivory-white to yellow or salmon-yellow, may be firm, sharp, even gummy with fluid when unripe.

## **Insect pest of Banana**

### **1. Banana weevil**

- The adult mainly damage the plant.
- They make tunnels in the stem or rhizome.
- This tunnel creates bacterial infection.
- The affected plant becomes yellow and fall down even in slow wind velocity.

#### ***Control:***

- Uproot the infected plant and destroy it properly.
- Adopt clean cultivation.
- Remove the unwanted plant from the orchard.
- Spray Malathion @ 2ml/l of water at 15-20 days interval.

### **2. Banana Aphid**

- The adult and nymph suck the sap from the tender part of the plant.
- The affected part reduces in size and decrease the overall production.

#### ***Control:***

- Remove the affected plant parts.
- Spray Dimethoate 30%EC @ 2-3ml/l of water at 15 days interval.

## **Disease of Banana**

### **1. Fungal Disease**

#### **a. Leaf Spot**

C/O: Fungus

S.N: *Cercospora musae*

Symptoms:

- It infects the younger leaves.
- Yellow spots are seen on the lower surface of the leaves.

#### ***Control:***

- Avoid water logging condition.
- Spray Fungicide (Diathane M-45)

### **b. Panama wilt**

C/O: Fungus

S.N: *Fusarium oxysporum* var. *cubense*

Symptoms:

- This is soil borne disease and develops under acidic soil, wet condition and high humidity.
- Yellowing of leaves takes place and the leaves hang around the pseudo stem.
- Cracking and discolouration of vascular bundles are major symptoms of this disease.

**Control:**

- Grow disease resistant varieties like Robusta and Dwarf Cavendish.
- Destroy the affected plant part.
- Select the suckers from the disease free area.
- Apply lime @ 1 Kg per pit during its planting.
- Spray Bavistin @ 1-2 g/l of water in infected plant.

### **c. Anthracnose**

C/O: Fungus; *Colletotrichum musae*

Symptoms:

- Small brown spots are developed on the fruits.
- Later on the spots turn into black.
- The affected fruit become yellow.
- In severe condition, the fruit become black and start to wrinkled.

**Control:**

- Prevent the plant from injury.
- Spray Bavistin @ 1-2 g/l of water.

## **2. Bacterial Disease**

### **Moko Disease**

C/O: Bacteria

S.N: *Pseudomonas solanacearum*

Symptoms:

- Wilting of plant takes place. Petals of the leaves break down from pseudo

stem.

- The leaves get shattering and the fruits ripe before it mature.

***Control:***

- Adopt clean cultivation.
- Use resistant varieties.
- Spray Streptocycline @ 1g/l of water at 15 days interval.

### **3. Viral Disease**

#### **Bunchy top**

Generally, growth of the plant stops and leaves emerge closely. The leaves get crowded. The fruits become smaller.

***Control:***

- Adopt clean cultivation.
- Use suitable pesticide to control the vectors.
- Properly destroy the affected plants.

### **Physiological disorder**

#### **1. Choke throat**

Choke throat occurs when the bunch does not emerge normally from the pseudo stem. The distorted and mishappen fruit is unmarketable. It is caused by stresses such as water logging, cold, high temperature, water or nutrient shortage.

#### **2. Wilting of plants**

Leaves turn yellow from the base, deep and longitudinal cracks appear at the base of the pseudostems and extend up to the corm, damage plants and die.

#### **3. Formation of splitted fingers**

Deep and longitudinal cracks along the fruit appear, secondary infections take place via the cracks of fruits, this disorder is prominent in rainy months. Due to the severe water stress, tissues of the fruits get damaged with the absorption of water. These damaged tissues tend to expand and form cracks.

#### **Stage of maturity**

Angular shape of finger changes to round. Dark green color of finger changes to light or pale green color. In practice, banana is harvested after browning of male bud or leaves.

## **Harvesting**

Banana is harvested by chopping the whole tree with sickle as the tree dies anyway once it is fruited or the bunch is cut with sharp knife at maturity leaving 30-40 cm of the fruit stalk for handling. Fruit is harvested, packed and marketed while still green. Dwarf varieties are harvested after 12-15 months while tall ones are harvested at 15-18 months of planting.

## **Yield**

Yield of the banana depends upon the soil fertility status and variety of the crop. Average production per hectare is 15-40 tons.

## **Grading**

Usually 3 grades

- A grade (over 15 kg/bunch)
- B grade (10-15 kg/bunch)
- C grade (less than 10 kg/bunch)

## **Packaging**

Fruit is cut from the bunch, washed, drained, graded and packed as hands into 13 kg cartons. Bananas are graded into extra-large, large and medium sizes. After harvesting cleaning and grading is done and transported to the market.

## **Storage**

Banana can be stored for three weeks at 13-15<sup>0</sup>C at 85-95% RH. Lower temperature below 13<sup>0</sup>C cause blackness of fruit and flesh become mealy (dryness of fruit) due to chilling injury. Storage can be prolonged by using wax emulsion.

# Unit - 4

## Cultivation Practices of Litchi

### Litchi (*Litchi chinensis*)

#### Introduction

Litchi is a delicious fruit of excellent quality. The Litchi is an important sub-tropical evergreen fruit crop belonging to family *sapindaceae*.

#### Composition and Uses

The fruit has high sugar content which varies between 10 to 14 percent due to cultivar and climatic condition. Besides sugars litchi contains 0.7% protein; 0.3% fat; 0.7% minerals (particularly calcium and phosphorus) and vitamin C (64mg/ 100g pulp) A, B1 and B2. Litchi makes an excellent canned fruit. A highly flavored squash is also prepared from inferior fruits, which is liked by many during summer months. Various other products, such as pickles, preserve, nuts and wine can be prepared from litchi. Dried litchi nut is very popular among the Chinese.

#### Origin

Southern China (Provinces of Kwangtung and Fukien)

#### Distribution

Major producing countries are Australia, India, Indonesia, Israel, Madagascar, Philippines, South Africa, Thailand, USA, and Vietnam.

In Nepal, the terai districts of the Eastern Region where litchi is commercially grown are: Jhapa, Morang, Sunsari, Saptari and Siraha with a total area of 837 hectares.

#### Cultivars

Broadly, there are two types of litchi cultivar in Nepal, namely the Terai and the Hill cultivars.

## **Terai cultivars**

These are introduced cultivars mostly from India. They are being grown in the Terai and low hills. Fruits mature from mid-May to mid-June. The common varieties grown under commercial scale are as follows:

### **1. Muzaffarpur**

It is a heavy bearing cultivar. The fruits are deep orange to pink and are less prone to splitting.

### **2. Dehradun**

Trees are medium in vigor, attaining a height of 5m and spread of 7m. It is a medium to highly yielding cultivar. Fruits are obliquely heart shaped to conical, bright rose- pink in colour.

### **3. China**

The trees are semi-dwarf and alternate bearer. The fruits ripen from the third week of May and the average yield varies between 80 to 100 kg per tree. Fruits are medium to large, mostly globose, a mixture of nasturtium-red and marigold-orange in colour.

### **4. Bombai**

Trees are vigorous and attain an average height of 6 to 7 m and spread of 7 to 8 m, the fruits ripen in the first of second week of May. Fruits are heart shaped and on ripen the tubercles turn carmine- red and interspaces uranium green in colour.

## **Hill cultivars**

The hill cultivars are late in maturity and fruits are harvested from the end of May to the end of June. The fruits are larger than the Terai cultivars and seeds are also a little bit larger. Some of the important cultivars are as follows:

1. Pokhara local
2. Udaypur local
3. Tanahun local
4. Chitwan local
5. Kalika local
6. Gorkha local

## **Climate and soil**

It can be cultivated upto an altitude of 800masl. It requires temperature about 16-20<sup>0</sup>C for flowering. It requires annual rainfall about 1500mm. Loam to sandy loam, deep well drained soil having high organic matter is ideal for litchi. Soil pH from 5.5 to 6.5 is suitable for litchi cultivation.

## **Area and production**

The total area under litchi in Nepal is about 9,096 hectares and most of the commercial areas lie in the Terai (Plain), which falls in the Southern part of the country and runs from east to west. The area under the litchi is also increasing every year as it is found to be a more profitable crop than mango and banana in the Terai.

## **Propagation Methods:**

In Nepal litchi plants are propagated by seed and air layering. The plants raised from seed bear fruits in 7-12 years. In the Terai from the very beginning of litchi cultivation and in recent years in the hills, the litchi plants are propagated commercially by air-layering. The air-layering is done from spring to early summer (mid-March to mid-May). Success rate is as high as 90 percent in spring to summer and decreases gradually when the air-layering practice is carried out too late.

## **Planting system and spacing**

In the Terai flat land, a square system is widely used and in the hills, depending upon the land position, a contour, rectangular or sometimes even a square system of planting is practiced. In the early days of planting neither planting systems nor recommended spacing was followed. However, in recent years the recommended spacing between the plants or rows is maintained at 10-12 m. In the hills, this distance is reduced to 8-10 m due to the terraced type of land.

## **Planting season**

Wherever watering is possible after planting, litchi plants are planted from April to May. Where there are no irrigation facilities and litchi is cultivated under rainfed condition, the saplings are transplanted from 15 June to August. However, early planting (April-May) has given good results in terms of plant growth.

## **Pit digging**

The layout of the orchard is made at least one month before planting by marking and pegging planting points at appropriate spacing. The pits measuring 1 x 1 x 1 m are dug. The pits are refilled with a mixture of FYM, bone meal/ super phosphate and murate of potash as per the recommendation with a basket full of soil from a litchi orchard containing mycorrhizal fungi.

To protect the young plants from hot and desiccating winds, a row of Daincha (*Sesbania sp.*) should be grown around the basin early in the spring.

## **Irrigation**

Irrigate the plant at 7 days interval in summer and at 15 days interval in winter.

## **Manure and Fertilizer**

Amount of manures and fertilizers depends upon the varieties, soil type, fertility status, environment and age of the crop.

<b>Age of Plant (Yrs)</b>	<b>FYM/compost (Kg)</b>	<b>Nitrogen (g)</b>	<b>Phosphorus (g)</b>	<b>Potassium (g)</b>
1	10	50	25	25
2	15	100	50	50
3	20	150	100	75
4	25	200	150	100
5	30	250	200	125
6	35	300	250	150
7	40	350	300	175
8	45	400	350	200
9	50	450	400	250
10	60	500	450	300

## **Training and pruning**

Training and pruning is done in order to maintain proper shape and size of the tree.

These help to maintain desirable structure, form, remove cross, damaged branches. Non fruiting unproductive branches inside the canopy is growing and mature trees should also be pruned, dried, diseased and scissor shaped branches should also be periodically removed. Light pruning after harvest has been found congenial for better growth, fruiting and yield. While harvesting the fruit the panicle is plucked along with 8-10 cm of twig to promote new flush and better bearing for the succession year.

### **Intercropping**

Vegetables that have their roots within 25cm depth of the soil are considered good for intercropping. Tomato, onion, cauliflower, beans, radish, palak, etc. can be used as intercropping.

### **Cover cropping**

It is preferable to take leguminous crops for cover cropping so that nitrogen fixation in the orchard soil is facilitated. Another advantage of cover crops is that they will prevent the growth of weeds. During rainy season (kharif) greengram, blackgram, cowpea are preferable. During winter season (rabi), it is desirable to cultivate chick pea, pea, lentil, mustard, potato, etc.

### **Intercultural operation:**

#### **Weeding**

Weeds in well-developed trees are not a problem. They are a problem in the early stages of plant growth. Farmers keep the young plants and the orchard clean by hand weeding and use mulches of dry grass like rice-straw to keep down the growth of weeds around the young litchi plants and conserve moisture. Applying pre-emergence herbicide Atrazine @ 5 kg a.i per hectare controls weed.

#### **Mulching**

Mulching of young plants around the root and stem zone by using local materials like dry grass, dry weeds, dry straw etc. This mulching practice is commonly done from the end of the monsoon to conserve residual soil moisture. In rainfed conditions, farmers reported that mulched plants growth is faster and fruit production better than

those of non-mulched plants.

### **Flowering**

Flowering in litchi trees occurs once a year in the winter and happens during one growth cycle in the year round continuous growing process.

### **Pollination and Fruit set:**

Litchi trees must flower, pollinate and fully complete fertilization during this cycle for there to be fruit set. When the ovary of a female flower comes into contact with pollen from male flowers, an embryo will develop into a litchi fruit, provided pollination is successful. On a single tree, panicles emerge and develop at different times. This insures that there will be pollen available to fertilize female flowers and obtain good fruit set assuming that there is a pollinator like bees to carry the matured pollen from the male to the female flowers. To a small degree you can get some minimal wind pollination, but insects such as bees, wasps, beetles and flies do most of the work. Litchi can also be artificially pollinated. The ripe pollen must be collected by lightly tapping male flowers into a towel and washed into a solution which can then be immediately sprayed on the receptive female flower clusters.

### **Fruit growth and development**

There are two distinct phases of fruit growth in litchi. During the first phase, there is absolutely no growth of flesh while seeds develop at a high rate and during the second phase the rate of flesh growth overtakes that of seed growth, although seed growth continues simultaneously for some period of the second phase. The total soluble solid and total sugar content of fruits increases markedly at the later part of the second phase of fruit growth.

### **Bearing habit:**

#### **Poor Fruiting/ Non Fruiting / Irregular Fruiting**

Irrigation, nutrition and environmental factors are responsible for the cause of irregular bearing in litchi. Type of soil coupled with management practices also found to be associated with irregular bearing or alternate bearing. Late harvesting and severe pruning and training operations may lead to non bearing in that particular year of training operation.

## Management

Varieties chosen for planting must be regular in bearing, apart from other desirable characters. The cultivars Shahi, Rose Scented, Dehradun are regular bearer, while China, Seedless and Late Bedana are irregular/shy bearers. Orchards should be properly fed with balance nutrition immediately after fruit harvest and irrigation at right time through right method, particularly at aril development stage. The plant protection measures to control major pests and diseases should be followed. Proper pruning and training at the time of harvesting and just after harvesting is needed, while harvesting of the fruit bunches, the branches having 8-10 inches length should be plucked to give rise strong and healthy flush to bear fruits in next year.

### Insect Pest of Litchi

#### 1. Litchi of fruit borer or Nut borer:

- It is a serious pest of litchi.
- Newly hatched caterpillar bore into the fruit and feed on the developing seed.
- Hole made by caterpillar facilitate the entry of pathogen which cause fruit rot.

#### Control:

- Collect and destroy the affected part.
- Spray Dimethoate 30%EC @ 1.5-2 ml/lit at 10-15 days interval.

#### 2. Litchi Red Bug:

- The adult and nymph suck the sap from tender parts, leaves, flowers, fruits.
- It cause premature fruit drop.
- If the pest attacks the fruit in mature condition, it causes drying of fruits.

#### Control:

- Adopt clean cultivation
- Spray Dimethoate 30%EC @ 2ml/l of water during flowering stage at 10 days interval.

### 3. Bark eating Caterpillar:

- This insect attack more in rainy seasons.
- The larvae feed on the bark of the plant.
- Later on make hole in the trunk of the plant and damage internally.

#### Control:

- Use petrol to kill the insect inside the hole
- Use wire to kill the insect.

## Disease of Litchi

### 1. Anthracnose

**C.O:** Fungus

**S.N:** *Colletotrichum gloeosporioides*

#### **Symptoms:**

- The green and succulent organs like leaves, tendrils and even fruits are affected by this disease.
- The disease is identified by gray spot on affected part which later change into black spot.

#### Control:

- Adopt clean cultivation
- Affected part should be collected and destroyed.
- Apply Copper Oxochloride @ 0.03% or 0.3g/l of water.

### 2. Red Rust of litchi:

**C.O** (*Cephaleuros parasiticus*)

#### **Symptoms:**

- Algal growth is developed on tender leaves.
- Cottony mass is developed on the lower surface of the leaves then on developing leaves brown spot are seen.
- The leaves become hardy in nature.
- Finally the affected part turns into brick colour or dark gray colour.

#### Control:

- Spray Sulphur and lime during Kartik-Mangsir and Chaitra – Baisakh.

## **Physiological Disorder**

### **1. Fruit Cracking**

It is the most important disorder. This may occur due to varietal characters, orchard soil management, inappropriate levels of water at maturity stage, light, mechanical injuries, temperature and micro-nutrient deficiency. This can occur after irrigation or heavy rain, or just an increase in relative humidity. The poor managed orchards receiving heavy irrigation at once or heavy rains abruptly after a long gap creating imbalance between temperature and moisture in the environment, cracking becomes more pronounced.

### **Factors Influencing the Fruit Cracking**

#### a) Environmental Factors

- Temperature plays a very important role in the ratio of fruit cracking. Arid and semi-arid zone where temperature is more and humidity or rainfall is very low favours cracking.
- occurrence of hot wind during summer

#### b) Fruit Characteristics

- Maturity: Over maturity, which lead cracking of fruit epidermis.
- Fruit size: It is generally supposed that large fruits are more prone to the cracking then the smaller one.

#### c) Lack of Orchard Management

- Moisture stress
- Moisture imbalance and heavy rainfall or irrigation after a prolonged dry spell, sudden and high fluctuation in the water supply to plants may cause cracking of the fruits.
- Nutrient
- The deficiency of boron and calcium is responsible for cracking in cherry, pomegranate and litchi.
- Insect-pest and disease
- In litchi, due to sun burn, there is the appearance of small dark water-shaped spots, which is finally assuming the shape of raised spots. These areas on the fruit develop longitudinal cracks and starts oozing out from the splits.

- Bagging
- It is also a remedial operation to escape the sunlight from the plant surface because water is loosed by transpiration through stomata.
- Early picking
- Early picking of fruits is also a remedial measure to overcome cracking. This does not allow to over maturity or over ripening which cause cracking of fruit, however it is not practicable in litchi.

## **Management**

Selection of site is a most effective way to minimize rain drainage of fruit orchard. Fruit plants may be covered only on the top and permit free air flow into the sides. Application of calcium @ 2 ml/l liquid formulations and Gibberellins @ 20 ppm, reduces the activity of cellulose and thereby reduced cracking.

### **2. Flower and Fruit Drop**

The flower and fruit drop is thought to be due to failure of fertilization, embryo abortion, nutrition and hormonal imbalance and external factors like high temperature, low humidity and strong westerly winds as well as due to fruit borer and heavy mite attack. Male functional flowers drop after pollen formation.

## **Management**

High fruit holding in litchi can be ensured. Timely treatment of plants for strong and healthy shoot production delays flowering phase and increases the female flower ratio and finally the fruit setting rate. Spraying of ZnSO<sub>4</sub> @ 0.2% at 30 days before panicle emergence induces healthy inflorescence leading to more fruit set.

### **3. Sunburn**

Sunburn also known as lesion browning or pericarp necrosis is a serious problem. Apart from environmental factors, varietal, hormonal, nutritional and soil moisture factors are associated with this disorder. This disorder is physiologically related with PPO (Poly-phenol Oxidize) activities and it also varies with cultivars

## **Management**

Irrigation at regular interval during the fruit growth and ripening stage reduces the sunburn. Planting wind break around the orchard provides protection from desiccating hot winds, thereby low sunburn.

### **4. Retarded/ Underdeveloped Fruits**

This disorder is not well documented but somewhat causing considerable loss due to poor quality fruits or ill developed fruits. The fruit size remains smaller than the normal and juice content or aril development is also very poor. Unavailability of moisture during development stage of fruit is also one of the causes for retarded/ underdeveloped fruit.

## **Management**

Proper nutritional management of orchard is essential. Spraying plain water in early morning hours of the day during the advanced stage of growth and development have been found highly effective in better growth of fruit and quality.

## **Harvesting**

- The number of days taken by the fruit to mature varies with genotype and environment and hence cannot be the deciding factor for its maturity.
- Generally, litchi fruits mature 50 to 60 days after fruit set.
- The development of colour on fruits is dependable criterion of maturity but it differs from variety to variety.
- Generally, fruits turn deep red when fully ripe.
- Fruits harvested at this stage possess excellent quality.
- Maturity of fruit is also determined by the shape of the tubercles which on ripening becomes somewhat flattened and the epicarp becomes smooth.
- Skin colour is usually a determinant of ripeness. The fruit is said to be ready for harvesting when the pericarp is a uniform red. Check the colour of the inner surface of the skin, which should also be red.

## **Method of harvesting**

- Harvesting may be carried out by removing whole panicles using secateurs.
- Fruits are best harvested using clippers, and placed in harvesting bags carried by the harvester.
- The fruits are harvested in bunches along with a portion of the branch and a few leaves.
- It prolongs the storage life of the fruits.
- Harvesting of litchi is usually done in May and June.
- The fruits for local market should be harvested at their full ripe stage, while for distant markets when they start turning reddish

## **Yield**

Yield varies from 80 to 150 kg fruits / tree / year depending upon variety and tree vigor. The mature plant gives 4000-5000 fruit per plant per year. Generally, it yields about 7-8 ton/ha.

## **Grading**

The fruits are graded according to their size, weight, colour and maturity. Grading is normally carried out during or after sorting. Grading systems depend on market requirements, but are normally based on fruit size and colour, and the area of blemish.

## **Packaging**

Wooden crates are made of boards or slats, with a capacity of up to 25 or 50 kg for manual handling, can be used to shift the produce. Plastic crates are now in common uses. Sacks, plastic bags and net bags made from natural or synthetic fibres are also used where produce is transported directly from grower to market.

## **Transport**

For transportation baskets should be packed with soft straw or leaves. Fruits are often damaged when baskets are overfilled, dropped, stacked or packed on their sides. Vehicle should be shaded from both sun and rain. Fruit can be protected by covering the baskets. Transport during the warmer part of the day is avoided.

## **Storage**

- The fruits cannot be stored for more than 2-3 days under room temperature.
- If marketing is delayed, fruits should be kept in cold storage to avoid rapid loss of colour and quality.
- Pre-cooling of fruits should be done before cold storage because without pre-cooling, browning could be more rapid compared to the storage of pre-cooled fruits at 2-5<sup>0</sup>C.
- It can be stored for 5 weeks at a temperature of 1.6-7.2°C in perforated polythene bags.
- Dipping of fruits in 250 ppm ethrel improves the fruit colour.

# Unit – 5

## Cultivation Practices of Pineapple

### PINEAPPLE (*Ananas comosus*)

#### Introduction

Pineapple is one of the most important commercial fruit of the world. It is considered the popular fruit of tropical climate. Pineapple deserves to be called as the ‘heavenly fruit’ owing to its pleasant flavor and exquisite taste, which makes it one of the choicest fruits of the world and is known as “Golden Queen” all over the globe.



#### Composition and uses

Pineapple stems and fruits are the possible commercial sources of protease (Bromelain). It is excellent source of vitamin C, Vitamin A and vitamin B. It is also used for making juice, slice alcohol and citric acid. Fruit core is used for preparing candy.

#### Origin

The pineapple is indigenous to South America and is said to originate from the area between Southern Brazil and Paraguay. The area between 15 to 30 degree south latitude and 40 to 60 degree west latitude is considered to be the place of origin of pineapple.

#### Distribution

It is grown commercially in many tropical and subtropical countries like Australia, Indonesia, China, Thailand, and Brazil. In Nepal, it is grown mainly in Jhapa, Morang, chitwan and Nuwakot.

#### Varieties

##### 1. Natal Queen

It produces many suckers. The fruit weighs 0.75-0.9 kg.

## **2. Alexandria**

It is more vigorous with large suckers and fruit. The fruit is conical, tender, with 'Ripley Queen' flavour.

## **3. Giant Kew**

It bears a large fruit averaging 2.75 kg, often up to 4.5 kg and occasionally up to 10 kg. The core is large and its extraction results in too large a hole in canned slices.

## **4. Singapore Red**

It is also called 'Red Jamaica', 'Singapore Spanish', 'Singapore Queen', 'Singapore Common'. It is second to 'Mauritius' in popularity. The leaves are usually all-green but sometimes have a reddish stripe near the margins. They are rarely spiny except at the tips. The fruits, cylindrical, reddish, with deep eyes, are small 1.6-2.25 kg with slender core, fibrous, golden-yellow flesh; insipid raw but valued for canning. The plant is disease and pest-resistant.

## **5. Red Spanish**

It has pale yellow flesh with pleasant aroma and has squarish in shape. It is well adapted for shipping as fresh fruit to distant markets. Its leaves are spiny.

## **Climate and Soil**

It can be cultivated commercially in a tropical, sub-tropical region. It can be cultivated up to an altitude of 1400 masl. It requires temperature in between 20<sup>0</sup>C-24<sup>0</sup>C. The annual rainfall should be 1000-1500mm for pineapple cultivation. It can also be cultivated in wide range of soil but the loam and sandy loam is ideal. The soil should have high organic matter. The shoots have proper drainage facility. The pH should be 5-6.

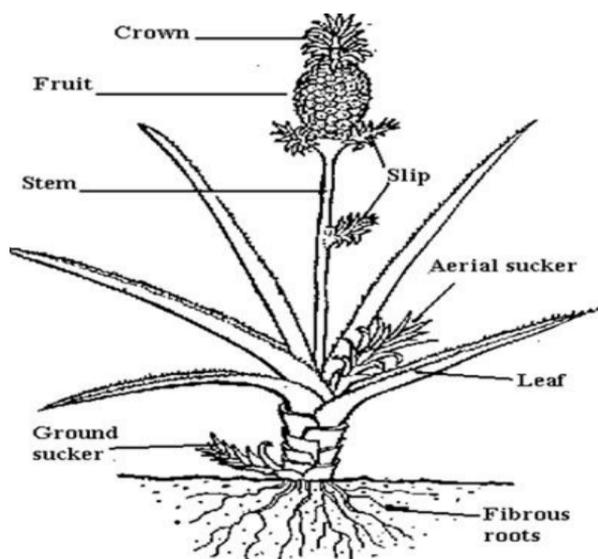
## Area and production

Area (ha): 1597; Productive Area (ha): 803; Production (mt): 11540; Productivity (mt/ha): 14

## Propagation

Vegetative propagation is commercially followed in pineapple. Plants raised from **sucker** (base) need about 17 month to fruit while these from **slip** takes 20 months and the once raised from

**crown** (rosette leaf of tip) need almost 2 years but the slips (side shoots) give larger and uniform fruit than the sucker; so slips are mainly used for propagating materials.



## System of planting

Prior to planting a few (2-3 layers) of lower leaves or slips are removed and they are sun dried for 5-6 days. This allows the callus layers to develop over cut surface reducing losses from decaying micro-organism. During the day of planting, certain fungicidal treatment of planting materials is done by dipping the basal end in the solution of fungicide. Planting may be done in single row or double row system. In single row system, planting distance is 75cm x 60 cm. In single row system we can accommodate about 15,000-20,000 plants/ha – yields about 20mt/ha.

In double row system planting spacing by 25cm x 35 cm x 90 cm is required. High Density Planting (HDP) is adopted in almost all pineapple growing region, we can accommodate about 64,000 plants and gives about 100-120mt/ha of fruit yield. High density orcharding of pineapple has also been practiced in the spacing of 22.5 x 60 x 70 cm. In Nepal day season for planting is the beginning of the rainy season or June or July.

## **Protection of plant**

Pineapple plants require a frost-free environment. They are small enough to be easily covered when frost threatens, but cold weather adversely affects the fruit quality.

## **Irrigation**

Irrigation should be given at the interval of 7-10 days in summer and at 15-20 days interval in winter.

## **Manure and fertilizer**

- About 30 tonnes of FYM/ha/year, along with 500:140:560 kg N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O per hectare for 42,000 plants/ha whereas 600:200:600 kg N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O for 64000 Plants/ha.
- Foliar application of Nitrogen (2-4%) is practiced.
- The nitrogen should be applied in 6 split dose, first after two months of planting and remaining at the interval of two months.
- Potassium should be given in 2 split doses, first at the time of planting and remaining after six months of planting

## **Micronutrients deficiency**

- Iron, zinc and copper deficiency are common in pineapple,
- The deficiencies can be corrected by spraying FeSO<sub>4</sub> (3%), Zn So<sub>4</sub> (1%) as foliar spray.
- Copper deficiency can be corrected by drenching CuSO<sub>4</sub> (1.5-2.0%) at 30-50 ml per plant.

## **Pruning**

Pineapple plants have large leaves that may need trimming to control sprawl, and you can safely prune the ground suckers, the shoots that spring up from the ground as they produce the smallest fruits and are easily discarded. As long as you know you are reducing the crop this way, you can safely prune your pineapple plant any time of year.

## **Intercrop**

Sunn hemp (*Crotalaria juncea*), rapeseed (*Brassica napus*), African marigold (*Tagetes erecta*) are intercropped with pineapples.

## **Cover crop**

Beds planted with sunn hemp or rapeseed had lower population densities of *R. reniformis* than African marigold, weeds, or pineapple plots during cover crop growth, and the subsequent pineapple-growing periods.

## **Intercultural operation**

### **Earthing Up**

This is an essential operation in pineapple cultivation. The main objective of earthing up is to give good anchorage to the plant.

### **Mulching**

It is used to minimize the soil erosion and conserve the soil moisture. The commonly used mulching materials are straw, dry grasses, leaves etc.

### **Flowering**

Individual flowers are small ( $\frac{1}{2}$  -1"), purple-red, subtended by a single yellow, green or red bract, borne laterally on the rachis of a spike of 100-200 individuals. The apex of inflorescence is vegetative, becoming the "crown" on the fruit.

### **Pollination**

Pineapple is highly self-incompatible, exhibiting gametophytic incompatibility where the pollen germinates on the stigma, but fails to grow through the style and effect fertilization. Seedless fruit are set parthenocarpically. If flowers are cross-pollinated, a few small, brown seeds may be found just beneath the peel of the fruit. Humming birds are the natural pollinators.

### **Fruit set**

The time from initial planting to fruit set varies. Pineapples grown outside in the optimum climate can set their first fruit in as little as 16 months. Indoor plants may take 16 to 24 months, or longer, before they flower and form their first fruits. The type

of planting material also impacts the time to first fruit. Sucker-grown plants usually fruit earliest at around 16 months, slips may take 24 months and a crown can take up to 28 months. Ratoon fruits usually begin growing off the side shoots within a year, although they may take longer.

### **Fruit growth and development**

After forcing, the plant enters the “redbud” stage and then flowers. Fruit development occurs during 14–18 months. Very few nutrient applications are made during the flowering and fruit development periods. Pest control chemicals are rarely applied during this period, and only when absolutely necessary.

### **Insect pest of pineapple**

#### **1. Mealy bug:**

- They suck the sap from tender part of the plant, flowers, fruits and leaves.
- The affected part dry off and yield is reduced.

#### Control:

- The affected part is destroyed.
- Spray Imidachloprid @ 0.3 ml/l of water or neem oil 3 ml/l of water.

#### **2. Fruit Fly:**

- Female fly lays egg on skin of the fruit.
- After hatching larva feed on the pulp of the fruit which causes rot and drop.

#### Control:

- Plough the field in summer.
- Spray Malathion @ 0.05% from flowering to fruit set at 15 days interval.

### **Disease of pineapple**

#### **1. Fruit rot:**

**C/O:** Fungus

**S.N:** *Ceratocystis paradoxa*

#### **Symptoms:**

- Fruits are seen attractive from outside but black spots develop in the pulp.
- Fruit starts to rot from its pulp and become unmarketable.

Control:

- Tide seedling with copper fungicide before planting.
- Treat the planting material with propiconazole @ 1ml/lit immediately after removal.

**2. Heart and stem rot (*Phytophthora cinnamomi* and *Phytophthora parasitica*):**

**Symptoms:**

- This disease appears in water logging condition, leaves.
- The tip of the leaves get yellow.
- Lower part of the leaf and heart of the plant start to rot.

Control:

- Deep planting should be avoided.
- Soil should not be allowed to enter the hearts during planting.
- Diseased plants should be removed and burnt
- Bordeaux mixture(1%) spray reduces the disease
- Treat the seedling with Bordeaux mixture before warm week of planting.
- Spray Captan @ 2-3 g/l of water.

## **Physiological disorders**

### **Sunscald**

Sunscald is caused due to the direct fall of sunrays on exposed areas of the fruit and result in damaged to the fruits. For control fruit should be covered with dry straw or banana leaves or with own leaves during the month of Apr-May.

### **Multiple crowns**

It may appear due to genetical factor as well as due to soil and environments reasons which results in impairment in normal growth and development of fruits during ontogeny.

## **Stage of maturity**

Half yellow stage is regarded as ripe and brix and the titrable acidity reach maximum at the stage. Some indicators to judge the maturity of pineapple are:

- The fruit generally changes from dark green to light green yellow and sometimes deep orange with the onset of maturity.
- The fruits become less angular about eyes and the ends of the bracts that protect the eye dry up. When at least 2-3 rows of eyes at the base and turn yellow pineapple may be ready to harvest.
- TSS 8-16% also indicates maturity

## **Method of harvesting**

Harvesting is done by cutting the fruit stalk about 3 cm below each base. The crown is retained so as to increase the shelf life of the fruit. The fruits should be harvested along with 5-7 cm stalk on full maturity because it is non-climacteric fruit.

## **Yield**

- The yield from a plant population of 35,000-40,000 per hectare is about 40-50 tonnes.
- The plant population of 43,000-50,000 per hectare normally varies between 50 and 60 tonnes.

## **Grading**

After pre-grading, washing, waxing, and fungicide treatment, the pineapples are left to dry and then are graded for packaging. Graders remove any fruit that shows signs of fresh mechanical damage or any of the conditions that qualify the fruit for rejection in the pregrading stage. Remaining pineapples are classified for packaging based on size, stage of ripeness, and, if applicable, shape. Fruits of different shape may not be mixed in the same carton.

## **Packaging**

The preferred method of packaging is to place the fruit vertically on the base, and then to place dividers between the fruits to prevent rubbing and movement. With some cartons, this is not possible and fruit are laid horizontally in alternating directions; where two layers of fruit are packed, a layer of card is required between the layers: 6

counts - 1.75 kg fruit, 12 count - 1.25 kg fruit, 12 count - 1.00 kg fruit and 20 count - 0.75 kg fruit. Fruits are normally packed to a net weight of 10 to 15 kg depending on the carton and the market.

### **Storage**

Pineapples require particular temperature, humidity/moisture and ventilation conditions. Recommended ventilation conditions is that air exchange rate should be 40 - 60 times per hour with constant supply of fresh air, so as constantly to remove the ripening gases arising and to keep the CO<sub>2</sub> content of the hold air low. Spoilage may occur as a result both of inadequate ventilation (danger of rotting) and of excessive ventilation (drying-out, weight loss. Pineapples display 2<sup>nd</sup> order biotic activity. They are living organs in which respiration processes predominate, because their supply of new nutrients has been cut off by separation from the parent plant.

At 10-13 °C, the fruits stored for more than 20 days but do not store the fruit at less than 8°C, since it results in browning of pulps. Mature green pineapple can be stored for 2-3 weeks at a temperature of 8-10 °C and relative humidity of 85-95%.

### **Transportation**

Marketing and physical distribution of fresh production inherently means moving the production. The commodities are handled, either manually or mechanically, many times from harvest and through the distribution process before the consumer buys and prepares them to eat.

# Unit – 6

## Cultivation Practices of Citrus

### Mandarin (*Citrus reticulata*)

#### Introduction

Citrus is the collective generic term which comprises a number of species and varieties of fruits, known to world over for their characteristics flavour and attractive range of colours. The attractive evergreen foliage and flowers as well as extraordinary fragrance added aesthetic value of citrus trees. Besides it, Mandarin is highly appreciated for their excellent quality fruit. Balanced ratios and specific blends of acidity and sweetness enriched with vitamins and other nutritive values constitute the citrus juice an excellent food source.

#### Origin and distribution

Mandarin oranges are native to the tropical and sub-tropical regions of Asia such as southern Asia and the Philippines. It is most abundantly grown in Japan, southern China, India, and the East Indies, and is esteemed for home consumption in Australia. The commercial cultivation of mandarin oranges in the United States has developed mostly in Alabama, Florida and Mississippi and, to a lesser extent, in Texas, Georgia and California. Citrus, particularly the mandarin is the most important commercial fruit crop in the mid hills of Nepal. The area under mandarin is 65.16 per cent of the citrus fruits and 26.3 per cent of the total area covered by fruits in the country.

#### Variety

1. Pokhara beauty
2. Kamala
3. Coorg
4. Nagpur
5. Sutsuma
6. Khoku Local

# Sweet Oragne

## (*Citrus sinensis*)

### **Introduction**

Sweet orange is tight skinned with solid control core pulp juicy and sour sweet. Seeds are with whitish cotyledons. This is of great importance for its excellent quality and its rootstock value is limited to some extent.

### **Origin and distribution**

The orange is unknown in the wild state; is assumed to have originated in Southeast Asia, Northeast India, and Southeast China. Sweet orange is commonly known as Junar in Nepali, is successfully grown in 47 out of 75 districts of Nepal

### **Variety**

1. Mausambi
2. Satgudi
3. Hamlin
4. Pineapple
5. Valencia
6. Novel orange
7. Jaffa
8. Malta blood red

# LIME

## *(Citrus aurantifolia)*

### Introduction

Limes are oval or round in shape having a diameter of one to two inches with green flesh and skin. They can be either sour or sweet depending on the variety. Sour limes contain citric acid giving them an acidic and tart taste, while sweet limes lack citric acid and are sweeter in flavor.

### Origin and distribution

Lime is believed to have originated in northern India and adjoining parts of Myanmar, or in northern Malaysia. The lime is now cultivated throughout the tropics and in warm subtropical areas. Acid lime is cultivated in terai, mid hill and high hill districts of Nepal.

### Acid lime group

1. Citron (*Citrus medica*): monoembryonic seed
2. Acid lime (*Citrus aurantifolia*): Sour lime, Mexican lime, Key lime, West Indian lime) or Kagzi lime
3. Tahiti (Persian) lime (*Citrus latifolia*)
4. Rangapur lime (*Citrus limonia*): Mainly used for root stock. It is considered to be hybrid between mandarin and lemon like fruit.
5. Sweet lime (*C. limettioides*)
6. Rough lemon (*C. Jambhiri*): It is indigenously found in Nepal. It is mainly used for making concentrated Nibu juice. An important root stock.
7. Grapefruit (*C. paradisi*): Closely related to pomelo. As the fruits are borne in cluster (upto 12) like grapes.

### Varieties:

- i. Tehrathum local
- ii. Rampur-01
- iii. Rampur-10
- iv. Maxican
- v. Banaras local

# LEMON

## (*Citrus limon*)

### **Introduction**

Lemons are oval in shape and feature a yellow, texturized outer peel. Like other citrus fruits, their inner flesh is encased in eight to ten segments.

### **Origin and distribution**

The lemon, *Citrus limon* (L.) is a species of small evergreen tree in the flowering plant family Rutaceae, native to South Asia, primarily North eastern India. Lime and lemon are extensively distributed throughout the mid hills stretching from Illam district in the east to Darchula district in the far west of the country.

### **Variety**

1. Sunkagati 1
2. Sunkagati 2
3. Nepali amilo
4. Assam amilo
5. Suraka round
6. Eureka
7. Libson lemon
8. Lucknow seedless

# PUMMELO

## *(Citrus maxima)*

### **Introduction**

Pummelo belongs to citrus race and are closely related to Grape fruit. It is a very large, round to pear-shaped, yellowish orange fruit with very thick skin.

The fruit can weight upto 10 kg. The texture is fleshy and has more membrane than many other types of citrus fruit.

### **Origin and distribution**

Pomelo is native plant of Malayu Island and East of India. It is wide spread in China, Japan, Philipines, Indonesia, USA and Thailand.

### **Variety**

1. Chandler
2. Webber
3. Ichang
4. Red Shaddock
5. Reinking

### **Composition and uses of citrus**

Citrus are rich source of vitamin C and minerals. They are rich in citric acid. Ripe fruits are consumed as fresh and also used to prepare jam, jelly, candy etc.

### **Climate and soil of citrus**

Citrus are sub-tropical fruits. They can be cultivated up to an altitude of 700-1500 masl. The ideal temperature is 15-25<sup>0</sup>C. They require 1200-1500mm annual rainfall. They can be cultivated in loam and sandy loam. The pH should be 5-6.5.

### **Propagation and rootstocks in citrus**

#### **Budding**

The most common methods of budding citrus are shield or T-budding. Budding should preferably be done at 20 to 30 cm height on the stock.

## **Rootstocks**

A good citrus rootstock should have high degree of polyembryony, compatibility with the scion, adaptability to various soils, tolerance to cold, drought and wind, tolerance to viruses, fungal diseases and nematodes. Some of used rootstocks are: Sour Orange, Sweet Orange, Rough Lemon, Trifoliolate Orange etc.

## **Planting of citrus**

In citrus, square and rectangular system of planting are generally practiced. The planting density usually varies from 200 to 400 plants per hectare but density planting is also followed using modified agro-techniques. In square system, spacing of 5 m x 5 m (400 plants/ha) and in rectangular system the spacing of 3 m x 5 m (667 plants/ha) can be maintained. In a well prepared land, sapling should be planted in a pit size of 1m x 1m x 1m.

## **Irrigation in citrus**

Irrigation is required during flowering and fruiting stage. Sudden heavy irrigation during flowering and fruiting may cause flower and fruit drop. It requires irrigation at 7-10 days interval in summer and 15-20 days interval in winter.

## **Manure and fertilizer in citrus**

50 kg FYM/plant/yr.

- ☉ 870g Nitrogen/plant/yr.
- ☉ 540g Phosphorus/plant/yr.
- ☉ 830g potassium/plant/yr.

## **Training and pruning in citrus**

An ideal citrus tree should be low headed with a roof like crown. This can be achieved by pruning young trees. Modified center leader is best suited for citrus trees. Trees are trained to single stem with 4-6 well spaced branches for making the basic framework. The lowermost branches should be allowed not to grow below the height of 75 cm from the soil surface. The bearing trees require little or no pruning. Pruning of bearing trees though differs with variety but chiefly consists of removal of dead, diseased, criss-cross and weak branches. Removal of water sprouts and sucker of

rootstock is also highly essential. Pruning of non-bearing trees can be done at any time of the year. But for bearing trees the best time is after harvesting, during late winter or early spring when these are in somewhat dormant stage.

### **Intercropping in citrus**

Interspaces in a young orchard can be economically utilized by growing short duration crops till the citrus plants come into bearing. Selection of intercrop is essential to improve the soil fertility. The intercrop should be of short duration, shallow rooted, non-exhaustive and preferably of leguminous type.

### **Intercultural operations in citrus**

Major weeds can be controlled by hand pulling, hoeing, burning and tillage. However, frequent tillage may destroy the surface structure of soil, thus lowering the water holding capacity and permeability of soil. So, better way to eradicate weeds is use of weedicides. Pre emergence application of Diuron (5kg /ha) or Terbacil (4.5 kg/ha) or post emergence application of Atrazine (5-6 kg/ha) controls weeds significantly. Further, Bromocil (6kg/ ha) is most effective in controlling both monocot and dicot weeds. Glyphosate (5 liters/ ha) is most effective in controlling perennial grasses. Simazine (5 kg/ha) is also highly effective.

### **Pollination in citrus**

Pollination is greatly aided by insects, in particular honey bees. Citrus pollen is heavy and sticky and is not blown by wind.

### **Flowering and fruit set in citrus**

Flower takes place in the month of Jestha-Ashar. The fruitlets develop in the month of Bhadra-Ashoj. Hot winds and excessive heat during flowering and fruit set are highly detrimental for fruit bearing and cause fruit drop and sunburn of the fruit. Low humidity favors colour development, whereas plants not having adequate sunlight produce low yields of poor quality fruits.

## **Bearing habits in citrus**

Some citrus groves tend to have a bearing habit with alternating high and low yields. A heavy crop of fruit tends to deplete carbohydrates and results in a small crop and increased vegetative growth in the following year. Pruning after a light crop and before an expected heavy crop should help reduce alternate bearing. The orientation of branches in space has a marked effect on growth and fruiting. Favouring horizontal branches over upright ones should result in better growth control and more fruit production.

## **Insect pest of citrus**

### **1. Aphid (*Toxoptera citricida*, *Myzus persicae*, *Aphis gossipi*)**

- The adult and nymph suck the sap from tender parts of the plant, leaves, flowers and fruits.
- It causes the stunted growth of plant and reduction in yield.

#### Control:

- ➞ Adopt clean cultivation
- ➞ Spray Dimethoate 30% EC @ 1-2 ml/l or Imidachloprid 17.8% SC 0.3 ml per litre of water.
- ➞ Use lady bird beetle to control the population of aphid.

### **2. Scale insect (*Aonidiella aurantii*, *A. citrina*)**

- They suck the sap from tender parts of the plant, leaves, flower and fruit.
- The affected part gets damage which result premature fruit drop and defoliation.

#### Control:

- ➞ Adopt clean cultivation.
- ➞ Spray the Dimethoate 30%EC @ 1-2ml/l of water.

### 3. Citrus Psylla (*Diaphorina citri*)

- They suck the sap from the tender parts of the plant, leaves, flowers and fruits.
- They create honey dew on the leaves in which shooty mould is developed.

#### Control:

- Establish nursery about 1300masl.
- Destroy the secondary host i.e. Kamini flower of this insect.
- Spray Dimethoate 30%EC @ 2-3ml/l of water.

### 4. Leaf Miner (*Phyllocnistis citrella*)

- Very small larva bore in the tissue of the leaves and make zig-zag tunnel.
- Feed on the chlorophyll internally due to which the tunnel looks silver colour.

#### Control:

- Spray tobacco based pesticide.  
e.g. Soak 250 tobacco in 400 liter of water and mix with 30g surf. Keep it whole night and filter it. Now add one part of this solution in a part of water and spray at 10 days interval.
- Apply 0.06% solution of Thiamethoxam 25 WG

### 5. Stem Borer (*Inderbela spp*)

- The larva feed on the stem and trunk of the plant.
- They make tunnel internally.
- Leaves fall on severe condition.

#### Control:

- Adopt clean cultivation.
- Use wire to kill the insects inside the tunnel.
- Use malathion soaked cotton to plug the tunnels.

### 6. Lemon butterfly (*Papilio demoleus*)

- Female lays eggs on the fruit.
- After hatching larva feed on the pulp of the fruit causing rooting and dropping of fruits.

#### Control:

- Collect and destroy the affected and falling fruits.
- Destroy the larva and eggs of the insect.

- Spray Cypermethrin 10% EC @ 2ml/l of water.

## **Disease of citrus**

### **1. Die-Back**

**C/O:** Fungus

**S.N:** *Colletotrichum gloeosporioides*

#### **Symptoms:**

- The leaves become yellow in initial stage and turn into dark colour and start to fall with beginning of summer.
- Die-back of twig starts leading to dry and finally the plant dies.

Control:

- Remove dead twigs or affected part from the plant.
  - Spray Carbendazim @ 1g + 2 g kauchol/l of water.
  - Bordeaux mixture 2:2:250 in April, July-August and September spray.
- ### **2. Phytophthora rot (Root rot, Crown rot, gummosis)**

**C/O:** Fungus

**S.N:** *Phytophthora parasitica*

*P. citrophthora*

#### **Symptoms:**

- Dark discolouration of bark is developed, water soaked spots developed which cause stem rot, rootlet rot and finally defoliation.
- In advance stage bark cracking and oozing of gums takes place.

Control:

- Avoid water logging condition at the base of the plant.
- Scrap the affected part.

### **3. Citrus Canker**

**C/O:** Bacteria

**S.N:** *Xanthomonas citri*

### **Symptoms:**

- It is a serious disease in citrus fruits.
- It affects the quality of fruit and reduces market value.
- Water soaked with round spots are seen on the leaves and stems as well as in fruits.
- The spots increases slowly and turn into brownish on the leaves, stems and fruits.

#### **Control:**

- Remove and destroy the infected part of the plant.
- Spray Bordeaux mixture @ 1% on cut portion.
- Streptocyclin @ 1g/l of water initially.

### **4. Greening**

**C/O:** Bacteria

**S.N.:** *Libriobacter asiaticus*

#### **Symptoms:**

- Initially vein and veinlet turns yellow and then interveinal chlorosis is observed.
- Leaves become leathery, small, pair in mass and bend downward of seasonal flowering.
- Die-back symptom is another major symptom of this disease.
- Division of cloves are not in equal proportion and seeds are not viable.
- It is transmitted by citrus phyla.

#### **Control:**

- The infected parts are destroyed.
- Spray Diemethoade @ 2-3ml/l of water to control the vector citrus phyla.
- Apply Bordo pest in cut portion.
- Spry Streptocyclin @1g/l of water after pruning.

### **5. Powdery Mildew**

**C/O:** Fungus

S.N: *Oidium tinglytatum*

**Symptoms:**

- White powdery mass appear on the twigs and leaves.
- Fruits are drop before it matures.
- The affected leaves died in later stages.

Control:

- ➡ Destroy the affected plant part.
- ➡ Spray Bavistin @ 1-2g/l of water at 20 days interval but in severe infection spray 8-10 days interval.

**6. Tristeza Virus**

**Symptoms:**

- It is a serious disease of citrus family.
- It cannot be controlled easily.
- Initial symptoms are seen like development of small leaf like green in colour, small fruit with sour test.
- At later stage, the plant wilts and dies.

Control:

- ➡ Destroy infected plant part.
- ➡ Spray Dimethoate 30% EC @ 2 ml/l of water to control sucking pest.

**Physiological disorder in citrus**

**1. Fruit drop**

In spite of very high initial flowering and fruiting, the ultimate yield is often low primarily owing to heavy fruit drop. However, all fruits that fail to mature do not drop at one time but at different times. Fluctuating temperature, low atmospheric humidity, imbalance of soil moisture, lack of proper nutrition, hormonal imbalance, incidence of insect pests and diseases are some factors causing fruit drop. Accordingly, maintenance of appropriate soil moisture level during fruit development can decrease fruit drop problem. Application of growth regulators 2, 4-D (10 ppm), NAA (5ppm),

check fruit drop quite effectively.

## **2. Granulation**

It is a physiological disorder of juice sacs of citrus including mandarins wherein they become comparatively hard and become somewhat enlarged. Young, vigorous trees are more likely to develop granulated fruits than older ones. Similarly, large fruits have more granulation than small ones. Spraying of lime reduces the extent of granulation. The applications of 2, 4-D (12ppm), zinc and copper reduces the incidences of granulation considerably.

## **3. Decline**

After fruitful production from about 15 years, citrus orchards start bearing little crop and become uneconomical. They show symptoms of ill health and decline. The affected trees do not die completely but remain in state of decadence and unproductiveness for a number of years. Initially, only a few limbs of the plants are involved but later whole tree is affected. Plants show sparse foliage, stunted growth, and sickly appearance and in leaves, mid-rib, lateral veins and intervenal area show diffused yellow color leading to ultimate shedding of leaves. As a result of dieback, twigs become short and bear only a few narrow leaves at their basal ends. Such plants are also characterized through excessive flowering and very poor fruit set. Unfavourable soil conditions (presence of hard pan, high pH, poor drainage and high salts), malnutrition, poor orchard management, indiscriminate use of fertilizers, intercropping, incidence of insect pests and diseases are major factors contributing to it. Good cultural practices, improvement in soil fertility and drainage, control of insect pests, nematodes and diseases may be useful to minimize its incidence. Use of resistant and compatible rootstocks and certified bud wood for propagation are strongly recommended for a healthy and productive mandarin orchard.

### **Stage of maturity**

Picking of fruits at proper stage of maturity is paramount importance. Harvesting at

right time not only maximizes profits but also helps build up the demand for quality fruits. Unlike climate fruits, mandarins do not improve in taste after harvesting. Therefore, fruits should be harvested when they attain full size, develop attractive color with optimum sugar: acid blend.

## **Harvesting methods**

Harvesting should be done carefully without causing damage to the fruits. Slight bruising or injury to the rind leads to quick decay of fruits. Harvesting can be done by shaking the branches with a pole and also by hand using a ladder. Mechanical harvesting systems consisting of abscission chemical and trunk shakers, pick up machines and automatic robotic fruit picking are also available.

## **Yield**

Generally, Citrus tree yields about 10-12 tones/ha.

## **Grading and packaging**

Generally, citrus are graded according to their size and appearance. Fruits are usually packed in wooden boxes for distant markets, while for local marketing baskets of split bamboo and mulberry are used. Chopped straw and dry grasses are mostly used for padding. The fruits should be cleaned and polished lightly with a piece of cloth, before wrapping them in tissue paper or newspaper. Use of corrugated fibre board cartons in place of wooden boxes is highly beneficial.

## **Transport and storage**

Citrus are generally transported by rail or road as ordinary cargos without refrigeration which often leads to heavy losses due to decay and fungal infection. Use of shrink films for moisture loss control can be useful. Storage life of mandarins is influenced by many pre and post harvest factors. Green or fully ripe citrus fruit can be stored successfully at 8-10°C with 85-90% relative humidity without impairing fruit quality. Similarly, Kinnow fruits can be stored at room temperature up to 3-4 weeks in perforated 100 gauge polythene bags having 0.5% ventilation area.

# Unit – 7

## Cultivation practices of Pomegranates

### Pomegranate (*Punica granatum*)

#### Introduction

There is no other fruit crop that has high medicinal value compared to that of pomegranate. The pomegranate plant comes in either a tree or a shrub. It is usually grown for its large fruit, but there are some dwarf cultivars used primarily for landscaping or bonsai trees.

#### Composition and uses

It is a rich source of Iron, Vitamin and minerals. Fruits are consumed fresh and also making juice, wine, squash etc. It possess medicinal value and used in increasing blood level during Leprosy. Its rind helps in controlling dysentery.

#### Origin and distribution

The pomegranate is native to Iran. The most important growing regions are Egypt, China, Afghanistan, Pakistan, Bangladesh, Iran, Iraq, India, Burma and Saudi Arabia.

#### Variety

##### 1. Paper Shell

It is round, medium to large; pale-yellow blushed with pink; with very thin rind, fleshy, reddish or pink, sweet, very juicy pulp and soft seeds. Bears heavily.

##### 2. Bedana

It is medium to large, with brownish or whitish rind, pulp pinkish-white, sweet, seeds soft. '

##### 3. Kandhari

It is large, deep-red, with deep-pink or blood-red, subacid pulp and hard seeds.

##### 4. Dholka

It is large, yellow-red, with patches of dark-pink and purple at base, or all-over greenish-white; thick rind, fleshy, purplish-white or white, sweet, pulp; hard seeds. The plant is evergreen and non-suckering.

#### 5. **Muscat Red**

It is small to medium, with thin or fairly thick rind, fleshy, juicy, medium-sweet pulp, and soft or medium-hard seeds. The plant is a moderately prolific bearer.

#### 6. **Kabul**

It is large, with dark-red and pale-yellow rind; fleshy, dark-red, sweet, slightly bitter pulp.

### **Climate and soil**

It can be cultivated between altitudes of 500-1850 masl. It requires temperature about 13-35<sup>0</sup>C but ideal temperature is 18<sup>0</sup>C which provides quality fruits having high juice level. It requires about 500-600mm annual rainfall. It can tolerate drought and frost condition. High humidity during fruiting stage decreases the quality of fruits. Loamy to sandy loam is best soil for its cultivation. Soil pH should be 5.5-7.5. The soil should have proper drainage facility. It can be cultivated in alkaline soil also.

### **Propagation**

Pomegranate seeds germinate readily. Selected cultivars are usually reproduced by means of hardwood cuttings 10 to 20 in (25-50 cm) long. The cuttings are set in beds with 1 or 2 buds above the soil for 1 year, and then transplanted to the field. Grafting has never been successful but branches may be air-layered and suckers from a parent plant can be taken up and transplanted.

### **Planting**

In a well prepared land sapling should be planted in a pit size of 60 cm x 60cm x 60 cm. The spacing should be maintained about 4-5m. It can be planted by adopting square or contour system before onset of monsoon or end of monsoon.

### **Irrigation**

It requires more irrigation during its early years of planting. Irrigation is more essential during flowering and fruiting stage. Less soil moisture may cause flower and fruit drop

and cracking of fruits. Generally, irrigation is done at 15-20 days interval depending upon the soil moisture condition. Heavy irrigation may cause less flowering.

## **Manure and fertilizer**

- The recommended dose of manure and fertilizer are:
- Pomegranate is a hardy plant but it responds well to manure and fertilizers.
- About 20 - 50 kg FYM/tree for bearing trees/year along with 400g N: 200g P: 200g K/tree.
- For pre-bearing plants full dose of P , K and 3/4th of N should be given at the time of bahar (flower induction), remaining 1/4th of N given at 1.5 months after fruit setting.
- At the age of 8-10 years this dose should be doubled.

## **Training and pruning**

The diseased, dried, unwanted and overlapped branches are removed. The suckers are also removed. The main trunk should be cut at the height of 1m which helps to develop lateral branches. 3-5 lateral branches are kept.

## **Intercropping**

Pomegranate have short juvenile period. Plants are also planted closely and remain bushy and spreading in nature, hence, no intercrop should be grown. When planting distance is more than 4m x 4m then intercrops can be grown for the first two to three years. Growing of vegetables and pulses should be preferred over rabi crops and fodder crops. If wheat is to be grown prepare separate irrigation system for irrigation to pomegranate plants during March-April.

## **Intercultural operations**

Pomegranate is closely planted; hence use of a tractor to inter-cultivate is not desirable. Weeds should be manually removed by hoeing the basins once in December at the time of fertilization and then again in May. The left out places may have some weeds/grass growing. If so, spray Gramoxone (paraquat) @ 6 ml/l of water during July. Keep the nozzle of spray close to the weed growth to avoid drift of the chemical.

## **Flowering and pollination**

Pomegranate bears three types of flowers i.e. pure male with rudimentary ovary; hermaphrodite with medium style and hermaphrodite with well-developed style. The

percentage of these flowers varies from cultivar to cultivar. There is no shortage of pollen and pollinating agents. Sufficient number of fruits set from hermaphrodite (pin) flowers. Pollen is available at noon and stigma remains receptive for 2-3 days. Both cross and self-pollination take place.

### **Fruit set**

This deciduous bush typically grows from 12 to 20 feet tall and nearly the same in spread. Some patience is required when growing a pomegranate tree, as it takes five to seven months for fruit to become mature and the tree itself needs 2-3 years before it bears more than a couple of fruits. In addition, the pomegranate tree loses its vigor after 15 years or so, although some cultivars may live hundreds of years.

### **Fruit growth and development**

Following fruit set, the colour of the sepals skin in the developing fruit changes continuously from the prominent orange-red to green. In later stages of fruit maturation, the color will change again until it reaches its final characteristic color as the fruit ripens. The external color ranges from yellow, green, or pink overlain with pink to deep red or indigo to fully red, pink or deep purple cover, depending on the variety and stage of ripening. The fruit ripens 5 to 8 months after fruit set, depending on the variety.

### **Bearing habits**

Some pomegranates have a bearing habit with alternating high and low yields. A heavy crop of fruit tends to deplete carbohydrates and results in a small crop and increased vegetative growth the following year. Pruning after a light crop and before an expected heavy crop should help to reduce alternate bearing. The orientation of branches in space has a marked effect on growth and fruiting. Favouring horizontal branches over upright ones should result in better growth control and more fruit production.

### **Insect pest of pomegranate**

#### **1. Fruit borer (*Virachola isocrates*)**

- It is a serious pest of pomegranate.
- Newly hatched caterpillar bore into the fruit and feed on developing seed.

- Hole is made by caterpillar which facilitates the entry of pathogen that leads to fruit rot.

Control:

- Collect and destroy infected fruits.
- Bagging of fruits is done with butter paper after spraying Dimethoide @ 0.05%.

### 2. Fruit sucking moth (*Othreis spp.*)

- Moth punctures the fruits and sucks the juice.
- Pathogens may enter from puncturing part which cause fruit rot.

Control:

- Collect and destroy the infected fruits.
- Harvest matured fruits earlier.
- Generate smoke in an orchard during night.
- Keep poison bait (Malathion 50 EC @ 2 ml + molasses 200 g + 2 litres of water).

### 3. Thrips (*Scirtothrips dorsalis* Hood)

- They suck the cell sap from the tender parts of leaves, flowers and fruits which cause yellowing of leaves, fruit drop.
- Flower drop and yield is reduced.

Control:

- Adopt clean cultivation.
- Spray Dimethoate 30%EC 2-3 ml/l of water or Fipronil 5 SC @ (50 ml a.i./ha) @ 1 ml/l of water.

## Disease of pomegranate

### 1. Leaf spot

C/O: Fungus

S.N: *Cercospora punica*

**Symptoms:**

- Light brown to dark spots are seen on the leaves.
- In severe infection leaf drop takes place.

Control:

- Adopt clean cultivation.
- Spray Captan @ 2g/l of water at 10-15 days interval.

## 2. Fruit Rot:

C/O: Fungus

S.N: *Colletotrichum gloeosporioides*

### Symptoms:

- Black spots are seen on the lower part of the fruit.
- The spots cover about half portion of the fruit at 7-10 days of infection.
- Finally the infected portion of fruit gets rot and the fruit drop takes place.

Control:

- Apply Mencozeb @ 2g/l of water at 10-15 days interval.
- Apply 2 g Kaucho and 1g Bevistin in 1 lit. of water and spray.

## Physiological disorder

### 1. Fruit Cracking

It is more serious in arid zone. Cracked fruits get affected by fungi and fruits become unfit for consumption. Fruits crack due to wide variation in humidity and soil moisture. Prolonged drought causes peel hardening and when rain comes or irrigation is applied the arils swells and peel cracks. Cracking can be controlled by supplying irrigation at regular intervals. Planting of wind break around the orchard also help in the reduction of fruit cracking. Spray of borax @ 0.1 to 0.2 percent is found effective in fruit cracking.

### 2. Internal Break Down of Arils

Blackening or dis-colouration of arils in ripened fruits is a serious malady throughout the pomegranate growing areas. No cause or remedial measure can be suggested at this stage. The fruit should be harvested at ripening stage without keeping it on the tree for more time than required.

### Stage of maturity

Pomegranate fruits become ready for harvesting after 4-5 months of fruit set. Fruits

are harvested when its colour turns from green to red. It gives metallic sound. The fruits are harvested at full maturity, when rind has developed a typical colour of the respective cultivar. At this stage calyx at the tips dries up.

### **Harvesting methods**

Pomegranate is non climacteric fruit hence should be harvested when fully ripe. Fruits should be harvested with the help of secateurs.

### **Yield**

It yields about 3-4 tons per hectare. Properly managed orchard of 3-4 years gives about 200-250 fruits per plant.

### **Grading and packaging**

Generally pomegranates are graded according to their size, weight and appearance. Fruits are packed as per their grade. Boxes are used for packaging and fruits are cushioned with paper strips/cut pieces. The fruit is transported to the markets. For small markets fruits are packed in wooden boxes of 5 to 10 kg size.

### **Transport and storage**

Pomegranates are generally transported by road. Use of shrink films for moisture loss control can be useful. The suitable temperature for cold storage of pomegranate fruits ranges between 5-10°C, with 90-95% relative humidity. Fruits stored at lower temperatures 0-3°C develop chilling injury.

# Unit – 8

## Cultivation Practices of Grape

### Grape (*Vitis vinifera*)

#### Introduction

Grapes, a long season crop, are often ignored in home gardens, and yet are one of the most widely produced fruits in the world. The grape vine is the source of all wine. Reaching the highest level of quality in wine is only possible by starting with the highest quality fruit. Maximizing fruit quality from any vineyard site can be a lengthy process, because the end results are revealed only after several seasons of comparison.

#### Composition and uses

It is rich source of Vitamin-C and minerals. Ripe fruits are consumed fresh and are also used to prepare juice, candy, wine etc.

#### Origin and distribution

It is native to Caspian Sea. The grape is now widely grown in Washington, New York.

#### Variety

1. Beauty Seedless
2. Delight
3. Perlette
4. Olampia
5. Banglore blue
6. Thompson Seedless
7. Pusa Seedless
8. Dilkhus

#### Climate and soil

Temperature, humidity and light is very important factor for grape cultivation. Mild temperature not more than 38<sup>0</sup>C and not less than 20<sup>0</sup>C are best for its cultivation. The

altitude should lie between 1200-1600 masl. Loam to sandy loam soil having good drainage facility and soil pH of about 5.5-6.5 is ideal for grape cultivation.

### **Propagation**

It can be commercially propagated by hard wood cutting. In this method 2-3 years old branches are taken having 10-12cm length nodes. Cuttings are used to develop saplings. Grapes can also be propagated by tip layering.

### **Planting**

In a well prepared land, sapling should be planted in a pit size of 75 cm x 75 cm x 75cm. The spacing should be maintained about 2m x 2-3m. It should be planted in the month of Poush-Magh. Square or rectangular system of planting is adopted.

### **Irrigation**

It can be cultivated in less moisture condition and dry place but to develop quality fruit, irrigation is necessary during bud formation and fruiting stage. Application of irrigation after long drought, fruit may crack, drop, development of small fruit, no proper colour, development on the fruit etc. are observed in the orchard.

### **Manure and fertilizer**

For bearing trees:

Age of Plant (Yrs)	FYM/compost (Kg)	Nitrogen (g)	Phosphorus (g)	Potassium (g)
1	10	100	60	80
2	20	200	120	160
3	30	300	180	240
4	40	400	240	320
5	50	500	300	400

### **Training and pruning**

Generally, v-system is practiced for grape training. Temperate variety are pruned in Mangsir-Poush and summer varieties are pruned twice i.e. in Chaitra and Kartik. Summer pruning is generally trimming back or foundation pruning while temperate pruning is trimmed as forward pruning. To give appropriate shape, staking should be

provided (bamboo or wooden material are used as staking)

## **Intercropping**

Leguminous crops like green gram, black gram, oilseeds like sesame and groundnut and vegetables crops such as tomato, brinjal, cucumber, pumpkin, bitter gourd, bhindi, etc. And spices like chillies can be successfully grown as intercrops.

## **Intercultural operations**

Weeds between the rows of vines are removed. Within the rows, weeds are manually hoed and removed. Sometimes the post-emergent weedicides, mainly glyphosate at about 2.0 kg/ha or paraquat at about 7.5 kg/ha is sprayed in fully grown vineyards.

## **Flowering**

Development of individual flower parts starts just before budburst and continues until flowering. Flowering (also known as bloom or anthesis) occurs once the flower parts are mature. Flowering extends from early November to late December. The time of flowering is determined by air temperature, soil temperature, scion variety and other factors.

## **Pollination**

Once the cap falls, pollen is released and dispersed. Better release of pollen occurs in dry weather i.e. both rain and strong winds reduce pollen density. If a pollen grain lands on the receptive tissue of the stigma, it may germinate and produce a pollen tube. Pollen germination is optimal at 26 – 32°C. They are normally self-pollinated, but cross-pollination is possible. Wind appears to have little effect on grapevine pollination. Insects visit flowers but they don't appear to play an active role in pollination.

## **Fruit set**

Fruit set occurs when the flower forms a berry. A grape inflorescence contains hundreds of flowers. However, only a portion of those flowers will develop into berries. Fruit set could be considered a “self-thinning” technique that enables the vine to regulate the crop, by adjusting it to the available resources without risking survival of the plant. Percentage (%) of fruit set is a quantitative measure of the proportion of

flowers that develop into berries following bloom.

## **Fruit growth and development**

Three stages of grape berry development have been identified. During stage I, starting at fruit set, berries grow through cell division. Stage II, called the lag phase, starts with a pause in berry growth while seed embryos start to form and grow. Cell division stops, and further growth is through enlargement of cells. Stage III starts at veraison when berries change color, softens, accumulate sugars, and metabolize acids. After veraison, changes occur (color change, softening, sugar accumulation, and acid reduction), which increase attractiveness and palatability to avian and vertebrate animals that consume and disperse grape seeds.

## **Insect pest of grapes**

### **1. Defoliating beetle**

- The beetles feed on leaves and cause defoliating of grape vine.

Control:

- Destroy the affected parts.
- Spray cypermethrin at 2 ml/l water.

### **2. Thrips (*Scirtothrips dorsalis*, *Thrips hawaiiensis* and *Rhipiphorothrips cruentatus*)**

- They suck the cell sap from lower surface of the leaves. The leaves become yellow dry and fall down.

Control:

- Deep ploughing in summer after April pruning or exposure / raking of soil in vineyards helps to destroy its pupal stages and minimizing the incidence.
- Spraying of fungal pathogens namely *Verticillium lecanii* or *Beauveria bassiana* @ 5 mL or 5 g/L helps in reducing thrips population in cold and humid climate especially when the temperatures are between 20-25°C and humidity of above 80%.
- Spray Dimethoate 30%EC @ 2-3 ml/l of water at 10-15 days interval.

### **3. Mealy bug (*Maconellicoccus hirsutus* and *Planococcus citri*)**

- They are soft body insect that suck the sap from all the part of the plant during

various growth stage.

- Particularly, during flowering stage, they secrete honey dew like substances which favour the growth of shooty mould.

Control:

- Adopt clean cultivation.
- Destroy affected parts.
- Soil drenching with imidacloprid 200 SL @ 1.50 mL/L/plant in the basins around the trunk in April-May.
- Foliar spray with methomyl @ 1g/L after 30 days of soil drenching.

## **Disease of grapes**

### **1. Powdery mildew**

**C/o:** fungus

**S.N:** *Uncinula necator*

**Symptoms:**

- The powdery mass appears on the leaves, young shoots, fruits and flowers.
- It causes stunted growth, dropping of flowers and fruits.

Control:

- Destroy the affected plant parts.
- Spray sulphur @0.2% at 12-15 days interval during bud development stage.

### **2. Downy mildew**

**C/o:** fungus

**S.n:** *Plasmopora viticola*

**Symptoms:**

- Pale yellow spots are seen on the upper surface of the leaves and white powdery spots on the lower surface.
- The infected leaves fall down.
- In severe infection, flowers and fruit drop takes place.

Control:

- Destroy affected plant parts.
- Adopt clean cultivation.
- Apply copper oxichloride @ 0.03%.

### 3. Anthracnose

**C/O:** fungus

**S.N:** *Gloeosporium ampelophagum* or *Elsinoc ampetina*

#### **Symptoms:**

- The green and succulent organelles like growing shoot, leaves, tendrils and fruit are affected by disease.
- Gray spot are seen on the infected part which turns black in severe stage.

Control:

- Destroy affected plant parts.
- Adopt clean cultivation.
- Apply copper oxichloride @ 0.03%.

### **Physiological disorder**

Physiological disorders associated with high temperature and low atmospheric humidity in the hot tropical region are dead arm and trunk splitting. Physiological disorders are cane immaturity, water berries, cluster tip wilting, shot berries, uneven ripening and post-harvest berry drop. The eco-physiological disorders are ‘*coulure*’, blossom-end rot, pink berry syndrome, berry cracking and rotting.

### **Stage of maturity**

Grapes are harvested when they are fully ripe. Matured fruit turn into light green color for seedless cultivars. In seeded grapes, fruit becomes dark brown when they are fully ripe.

### **Harvesting methods**

Long nose scissors should be used in harvesting. They are harvested manually by using knife. Fruits should also be harvested with the help of secateurs.

### **Yield**

It yields about 15-20 tons per hectare

## **Grading**

Produce is graded in accordance with the various quality factors. Bunches are graded based on the size and colour of berries and not on the shape of the bunch. Grading is done manually. While grading, the bunch should be held by the peduncle and care should be taken to avoid touching the berries/bunch by the naked palm of the hand.

## **Packaging**

The grapes are packed in ventilated corrugated fibre boxes, pouches and punnets. These boxes are lined with bubble sheet.

## **Transport**

Transportation should be quick. Rough handling of boxes/cartons during loading/unloading should be avoided. Over loading should be avoided. To reduce bruising, good shock absorbers should be used.

## **Storage**

The boxes are closed and shifted to cold storage rooms where the temperature and humidity are maintained at 0-2°C and 90% to 95% respectively. Temperature of 0°C and humidity of 95% are the best for maintaining freshness and preventing decay.

# Unit – 9

## Cultivation Practices of Guava

### Guava (*Psidium guajava*)

#### Introduction

Guava, the apple of tropics, is one of the most common fruit in Nepal. It is now grown all over the tropics and subtropics and has become the most common of the newly introduced subtropical fruit. Guava is quite hardy, prolific bearing and highly remunerative even without much care.

#### Composition and uses

Guava is known as ‘poor man’s fruit’ and ‘Apple of Tropics, owing to its nutritional value and overall consumer preference. Guava is rich source of vitamin C and pectin. Guava is a good source of both thiamin and riboflavin. It contains much iron but 80% of this is in the seed and not utilizable, it is also source of Ca and P. Guava is used as excellent salad and pudding are prepares from the shell of the ripe fruit. Guava jelly is well known to all and the common source. Wild guava makes the best jelly.

#### Origin and distribution

It originated along with a number of other fruit, in tropical America and seems to have been growing from Mexico to Peru. At present the major guava producing country are southern Asian countries, the Hawaiian Island, Cuba and India. This evergreen species is native to Tropical America, but is currently cultivated in tropical and sub-tropical countries around the world including the Himalayan country like Nepal. Major producing countries Cuba, Brazil, India, Burma, Sri Lanka, Pakistan, Bangladesh, Thailand, Indonesia, Florida, Hawali, and Mexico, etc.

#### Variety

##### 1. Lucknow-49

It is also known as ‘sardar guava’ semi-dwarf tree 2.3-3.4 m tall, vigorous

heavy branching type, crown flat, large leaf. Fruit is roundish ovate shaped, skin color primrose yellow with occasional red dots on the skin. Test sweet and keeping quality excellent.

## 2. **Allahabad safeda**

This is the most popular variety. Tree vigorous, medium tall 5.8-6.2m branching heavy tendency to produce long shoots. Fruit is medium, average weight 180 gm roundish in shape, good keeping quality. Used in meadow orcharding now.

## 3. **Banarasi**

Sweetest variety lacks acidity. Medium to tall tree, oblong shape fruit, medium keeping quality.

## 4. **Chittidar**

A tall tree, 5.0-5.8 m, spreading branches, Fruit sub globose in shape, sweet test and good keeping quality.

## 5. **Red fleshed**

Tree attains 3-5m height. The branches are spreading with roundish oval fruit, which has yellowish skin with pink colour flesh.

## 6. **Seedless**

Two types of fruits, completely seedless and partly seeded, are borne on a plant of seedless variety. The completely seedless fruits develop on shoots arising from the stem and these are bigger in size and irregular in shape. The partly seeded fruits are borne on normal shoots at the periphery and are small in size and round in shape. Seedless variety is unfit for commercial cultivation because it gives very low yield.

## **Climate and soil**

It can be cultivated commercially in a tropical and subtropical region. It can be grown up to an altitude of 1500 masl. The temperature ranges between 20<sup>0</sup>C-28<sup>0</sup>C. It can be

cultivated in a wide range of soil. The suitable soil is sandy loam having high organic matter with proper drainage facility. It is sensitive to waterlogged conditions. It tolerates a wide range of pH from 6.5 to 8.5. If the soils are having a pH of 7.5 and above, there are more chances of getting guava wilt.

### **Area and production**

Area (ha): 3658; productive area (ha): 2973; production (mt): 25827; productivity (mt/ha): 9

### **Propagation**

Guava is propagated from seed and also by vegetative method.

#### **Seed propagation**

Seedling trees bear fruit of variable size and quality but such trees are generally long lived. Normally fully matured seed of the current season are used for sowing. The seedling can be raised in the nursery or in the polythene bag. The trees propagated from seed are very large that are not used in modern orcharding like High Density Planting.

#### **Vegetative propagation**

Guava can be successfully propagated by cutting, air layering, grafting and budding.

#### **Cutting:**

Although guava is hard to root, various result of investigation indicate that it can successfully be propagated from cutting under mist.

#### **Air layering**

Air layering is one of the most important commercial methods in practice for propagation of guava shoots selected for air layering should be 1cm in diameter and preferably from previous year growth. Shoots of required size 1.5 cm diameter was girdled. The girdled portion was covered with a ball of moistened sphagnum moss and wrapped with translucent rubber plastic film. After root formation in 3-5 week the shoot was detached and planted in rich compost. Rainy season was found to be more favourable than spring for air layering. It is found that the high percentage of success occurs with air layering when layers were treated with NAA.



## Grafting

Inarching is another important method of propagation in guava. This technique may yield up to success but is more laborious than cutting and layering in this method. For this it is required that scion variety should be grafted with the disease pest and drought hardy root stock. Generally, the dwarf variety root stock should be selected, especially Chinese guava, for modern orcharding.

## Budding

The technique involve in budding is of selecting a proper root stock. The rootstock is prepared by removing side growth up to 20 to 25cm from the base. The different budding techniques like forket, shield, patch, chip, etc. have been tried in guava with different success.

## Planting

It is planted in a pit size of 90x90x90 cm<sup>3</sup> and proper spacing is maintained about 6-8 m x 6-8 m. It is commonly planted by square system of planting.

## Irrigation

At early stage (up to 2 years), it requires 8-10 irrigation per year. Irrigation is done depending upon the climate and moisture content in the soil.

## Manure and fertilizer

The recommended dose of manure and fertilizer is given below:

Age of plant (yrs)	Fym/compost (kg)	Nitrogen (g)	Phosphorus (g)	Potassium (g)
1	10	50	100	50
2	20	100	50	100
3	30	150	75	150
4	40	200	100	200
5	50	250	150	250
6	60	300	200	300

*Note: After six years, the dose remains constant.*

## **Training and pruning**

The main objective of training guava plant is to provide the framework and scaffold of branches, suitable for bearing a heavy remunerative crop without damaging the branches. The system of training followed by them was open centre in which the plant were headed back and four primary shoot were retained for initial framework which were subsequently pruned by cutting one third to half of their length after 3 months. After making the initial framework the two side shoots were permitted to grow initially and after 3-4 years subsequent doubling of selected branches were continued.

## **Intercropping**

Guava can be intercropped with chilli, cabbage, brinjal, turmeric, coriander, leafy vegetables, peas, gram, and beans.

## **Intercultural operations**

Weeds are usually removed by shallow cultivation. Green manuring is usually done during rainy season. Pre-emergence use of diuron (1.6 kg./ha.), oryzalin (1.67 litres/ha.), simazine (1.6 kg./ha.) or atrazine (1.6 kg./ha.) has been found to be effective in control of weeds in guava orchards.

## **Flowering, fruiting season and pollination**

- In Nepal and India (Punjab and Northern India) flowering occurs twice a year, once in February (Falgun) and another in June (Jestha).
- The February (Falgun) flowering is called “Ambe Bahar” and the June (Jestha) flowering is called “Mrig Bahar”.
- In Western and Southern India, there is another flowering time which occurs in October (Kartik) is called “Hasth-Bahar”.
- The Ambe-Bahar fruits ripen during the rainy season. So they become inspid (lack flavor) and watery and fetch less price in the market.
- The Mrig-Bahar fruits ripen during the winter, so they are of excellent quality and fetch a good price.
- The growers, therefore, should encourage their guava plants for Mrig-Bahar flowering. This can be done by stopping irrigation from January (Magh) onwards.

Guavas are primarily self-fruitful, although some strains seem to produce more fruit when cross-pollinated with another variety. Guavas can bloom throughout the year in mild-winter areas, but the heaviest bloom occurs with the onset of warm weather in the spring. The exact time can vary from year to year depending on weather. The chief pollinator of guavas is the honeybee.

## **Insect pest of guava**

### **1. Fruit fly (*Bactrocera correcta*, *Bactrocera dorsalis* and *B. zonata*)**

- Female fly lays egg on soft skin of the fruit.
- After hatching, larva feed on the pulp of the fruit due to which fruit rot takes place and finally fruit drop.

Control:

- ➔ Collect and destroy the affected fruit.
- ➔ Plough the field in summer
- ➔ Use of malathion soaked methyl eugenol traps @ 16 traps/acre for *Bactrocera dorsalis* (Hendel) and *B. zonata* (Saunders)
- ➔ Spray malathione @ 0.05% from flowering to fruit set stage at 15 days interval.
- ➔ Soil drenching with azadirachtin (a neem oil product) or neem seed kernal extract (NSKE) also kills pupating larvae

### **2. Mealy bug (*Ferrisia virgata*)**

- Adult and nymph suck the sap from tender parts of the plant, leaves, flowers, fruits.
- The affected part dry out and yield is reduced.

Control:

- ➔ Plough the field in summer
- ➔ Spray Buprofezin 25 SC 1.0-1.5 l or methomyl 40 SP 1.25 kg with 500 l water/ha
- ➔ Foliar spray of *V. lecanii*/*B. bassiana* ( $2 \times 10^8$  cfu/ml) @ 5 g/ml/l of water after 90–105 days of pruning during high humid months to reduce the population of mealybugs.
- ➔ Soil drenching with Imidacloprid 200 SL @1.5 ml/l of water/plant on the base of the plant around the trunk.

### 3. Scale insect (*Pulvinaria psidii*)

- The adult suck sap from leaves, tender parts, flowers and fruits.
- Honey dew excreted by scale insect cause shooty mould.

Control:

- Remove the infected plant part.
- Spray Dimethoate @ 0.05%
- 

## Disease of guava

### 1. Wilt

C/o: fungus

S.n: *Fusarium oxysporium f.sp. psidii* and *Fusarium solani*

Symptoms:

- Yellowing of leaves occurs from the tip of the plant.
- Later on the affected part get dry and fall down.

Control:

- Uproot and destroy the affected plant and plant parts.
- Avoid water logging at the base of the plant.
- Use resistant varieties like Banarasi, Nasic etc.
- Spray the soil with Propiconazole + Carbendazim @ 0.2% at 15 days interval during early stage of infection.

### 2. Anthracnose

C/o: fungus

S.n: *Colletotrichum psidii*

Symptoms:

- The growing tips gradually turn dark brown.
- Black round spots are developed on the fruits which later on increases the size forming concentric ring of pink colour.
- It also causes pre mature of fruit drop.

Control:

- Keep the orchard clean

- ➔ Remove the affected plant parts.
- ➔ Spray Mancozeb @ 2g/l of water at 10-15 days interval.,

### 3. Fruit canker

C/o: fungus

S.n: *Pestalotia psidii*

#### Symptoms:

- Small to medium sized raised dark brown cankerous spot develop on the fruit surface.
- The fruit infected at early stage develop cracks and finally fall.

Control:

- ☞ Collect and destroy the affected fruits.
- ☞ Spray diathane z-78 @ 2.5g/l of water at 15 days interval.

## Physiological disorder

### Chilling injury

Symptoms include failure of mature-green or partially-ripe guavas to ripen, browning of the flesh and in severe cases, the skin and increased decay incidence and severity upon transfer to higher temperatures. Fully-ripe guavas are less sensitive to chilling injury than mature-green guavas and may be kept for up to a week at 5°C without exhibiting chilling injury symptoms.

### External (skin) and internal (flesh) browning

Guavas are sensitive to physical damage during harvesting and handling all the way to the consumer. Symptoms include skin abrasions and browning of bruised areas.

### Sun scald

Guavas exposed to direct sun light may be scalded. In some countries, paper bags are used to cover guava fruits and protect them from solar radiation and insect infestation while on the tree.

## Pathological disorders

Most of the postharvest disease problems begin in the orchard as latent infection in developing fruits. Diseases include anthracnose (caused by *Colletotrichum*

*gloeosporioides* and associated species), Aspergillus rot (caused by *Aspergillus niger*), mucor rot (caused by *Mucor hiemalis*), phomopsis rot (caused by *Phomopsis destructum*), and rhizopus rot (caused by *Rhizopus stolonifer*). Disease control strategies include good orchard sanitation, effective preharvest management to reduce infection, careful handling to reduce physical damage, prompt cooling to 10°C and subsequent maintenance of that temperature throughout the handling system.

### **Stage of maturity**

Guava fruits are picked at the mature-green stage (color change from dark- to light-green) in some countries where consumers eat them at that stage. In countries where consumers prefer ripe guava, the fruits are picked at the firm-yellow to half-ripe (softer) stage for long-distance transport or at the fully-ripe (yellow and soft) stage for local markets.

### **Harvesting methods**

Currently, guava fruit are handpicked. Guavas require care when being picked and harvest cannot go on for more than 2 to 3 days during the height of the season because of potential losses from insects and overripe fruit.

### **Yield**

Guava yields about 400-500 fruits per plant per year. 8-10 years old plants yield about 900-10000 fruits per plant per year. The average yield of guava is about 8-10 ton per hectare.

### **Grading**

Fruits are graded on the basis of their weight, size and colour.

### **Packaging**

The fruits are packed in baskets made from locally available plant material. For distant markets, wooden or corrugated fibre board boxes are used along with cushioning materials viz. Paddy straw, dry grass, guava leaves or rough paper. Good ventilation is necessary to check build up of heat. Guava is a delicate fruit requiring careful handling during harvesting and transportation. Guavas being perishable in nature are immediately sent after harvesting in the local market and only a small quantity is being sent to the distant markets.

## **Transport**

Road transport by trucks/lorries is the most convenient mode of transport due to easy approach from orchards to the market.

## **Storage**

The fresh fruit has a short shelf life and distant marketing can be done only if it is properly stored. The shelf life can be extended up to 20 days by keeping them at low temperature of 5<sup>0</sup>C and 75-85% relative humidity. It can be stored for about 10 days at room temperature (18<sup>0</sup>-23<sup>0</sup> c) in polybags providing a ventilation of 0.25%.

# Unit – 10

## Cultivation Practices of Papaya

### PAPAYA (*Carica papaya*)

#### Introduction

Papaya (*Carica papaya* L.) is an important fruit crop throughout the tropical and sub-tropical countries. It is an almost herbaceous (succulently soft-wooded), typically unbranched small tree in the family caricaceae. Papaya is one of the most important tropical and sub-tropical short gestation fruit crops and cultivated from the terai to mid hills of Nepal.

#### Composition and uses

It is rich source of vitamin A and minerals. Ripe papaya is eaten fresh as breakfast and dessert fruit. It is made into fruit salad or juice and can be processed as jelly, marmalade, candies and crystallized fruits. Green fruits are pickled or cooked as vegetable.

#### Origin and distribution

It's origin is considered to be lowlands of central America and southern Mexico, possibly West Indies (Caribbean). It is found throughout the tropical and subtropical world; in protected culture in cool subtropical regions.

#### Variety

##### 1. Pusa delicious

This is good variety to fruit yield and quality. It is gynodioceous variety with cent percent productive plants having excellent fruit taste coupled with good flavour and orange flesh colour.

##### 2. Pusa majesty

This is variety with high productivity and better keeping quality of ripe fruit. This is also gynodioceous variety with rich source of papain. This variety is also resistant to papaya nematode.

## **Pusa giant**

This is a vigorous dioecious variety with good size of fruits. The plants are sturdy and tolerant to strong winds and storms and fruit is most suitable for tutti- fruity and petha.

## **4. Pusa dwarf**

This variety is chiefly characterised by dwarf stature of plant with good fruit yield. Fruits are of medium size with oval shape which is preferred by consumers.

## **5. Pusa nanha (mutant dwarf)**

This is extremely dioecious mutant dwarf variety suitable for kitchen gardening, pot and roof cultivation. This variety is ideal for high density orcharding.

## **6. Washington**

The plants are vigorous, stem and leaf stalks are with purple tinge, fruits are medium to large, round to ovate, sweet, pulp orange colour with good flavour.

## **Climate and soil**

It is tropical fruit. It can be grown commercially at the altitude of 1000 masl. The optimum temperature required for proper growth and development lies between 20<sup>0</sup>c-27<sup>0</sup>c. The annual rainfall required for its cultivation is 1000-2000mm. A well drained sandy loam soil having high organic matter is suitable for its cultivation. The pH of the soil should be 6-7. Under water stagnated conditions and in soils with poor drainage foot rot disease may cause heavy mortality. Hence, heavy soils should be avoided as papayas cannot withstand water stagnation for more than 48 hours.

## **Area and production**

Area (ha): 1457; productive area (ha): 1011; production (mt): 12912; productivity (mt/ha): 13

## **Propagation and planting**

It is propagated by seed. Seeds are sown in polybag or directly sown in a well prepared nursery bed at 15cm x 20cm spacing. The seedling become ready for transplanting when plant attain height of 15-20cm and have 4-5 leaves. The pit size of 1-1.5 cubic feet should be dug at 1.8 x 1.8m or at 2.4 x 2.4m apart and filled with top soil mixed

with 5 kg of FYM, 100 grams of neem cake and 40 grams of super phosphate and planting is done during monsoon season.

### **Irrigation**

Irrigation is required at 5-6 days interval in summer and 10-15 days interval in winter by adopting ring method.

### **Manure and fertilizer**

The recommended dose of compost, nitrogen, phosphorus and potassium should be:

**Compost:** 25kg per plant per year

**Nitrogen:** Phosphorus: Potassium: 400:250:400 g/plant/year.

The fertilizer application is done in 2 splits; one in Shrawan/Bhadra and other split in Falgun.

### **Training and pruning**

Papaya trees do not need pruning because their main growing point is terminal. Select one or two of the most vigorous side shoots and remove the others to facilitate growth and fruiting of the remaining shoots. After fruiting, prune the plant to 12 inches from the ground. When new shoots appear, select the strongest as the new leader and cut back the others.

### **Intercropping**

No intercrop should be taken when flowering and fruiting starts. Intercropping of leguminous crop after non leguminous one, shallow-rooted crops after non-leguminous one and shallow-rooted crops after deep rooted ones are gainful.

### **Intercultural operations**

Deep hoeing is recommended during the first year to check weed growth. Weeding should be done on regular basis especially around the plants. Application of fluchloralin or alachlorin or butachlorine (2.0 gm/ha.) is done. As pre-emergence herbicide two months after transplanting can effectively control the weeds for a period of four months. Earthing up is done before or after the onset of monsoon to avoid water-logging and also to help the plants to stand erect.

## **Flowering and pollination**

Papaya pollination is a bit of a mystery. Horticulturists believe it is usually carried out by insects or the wind, although they are not exactly sure how it works. In some cases, hand pollination may be needed to ensure proper fruit set.

The gender of a papaya plant can be determined by its flower male, female, or bisexual. To make sure you obtain at least a few fruit-bearing plants (females), plant several clumps of seedlings, and then thin them down to a single female or bisexual plant after they start flowering (5 to 6 months of age). Female plants can be identified by their flowers location (they appear along the trunk) and by the presence of a miniature papaya fruit inside the base of the flower petals. Bisexual flowers look similar to female flowers, but the miniature papayas inside the base of their petal is surrounding by male stamen. If no bisexual plants are present, one male plant is needed for every 8 to 10 females.

## **Fruit growth and development**

Fruit growth shows two major phases. The first phase of rapid growth lasts about 80 days after flower opening, while the second phase is apparent just before fruit maturity. Flesh color is white in immature fruit to a pale orange-yellow, salmon pink, or red depending upon cultivar in ripe fruit. Total fruit starch declines during the first 80 days of fruit development. Sugars begin to accumulate only during the last 28 to 42 days of fruit development. Fruit development usually takes 130 to 160 days from anthesis in the tropics and can be extended to 190 to 270 days in the cooler subtropics.

## **Insect pest of papaya**

1. **Aphid** (*Aphis gossypii*, *A. citricola* and *A. crassivora*)
  - Adult and nymph suck the sap from tender leaves and shoots.
  - The plant becomes unproductive when aphids attack.
  - It also transmits several viral diseases like Papaya Ringspot Virus (PRSV).

Control:

- ➡ Adopt clean cultivation
- ➡ Spray imidachloprid 0.006 % and mineral oil 1% alternately fortnight.

## 2. Scale insect (*Aspidiotus spp.* and *Aonidiella orientalis*)

- Adult and nymph suck the sap from leaves and tender part.
- Yellow discoloration is seen on the affected part.
- Later on the infected part dry out and yield is reduced.

Control:

- ➡ Adopt clean cultivation
- ➡ Pruning affected plant parts is sufficient to check the spread of scales.
- ➡ Spray delfin @ 2ml/lit of water

## 3. Mites (*Tetranychus cinnabarinus* and *Brevipalpus phoenicis*)

- They make white spots on ripe fruits and also affect the leaves.

Control:

- ➡ A spray of dicofol 0.05% on the underside of leaves during summer brings about good control if the infestation is treated early.
- ➡ Release of the predatory mite, *Amblyseius spp.* also mitigates the problem.
- ➡ Spray sulphur dust @ 0.6g/lit of water.

## Disease of papaya

### ● Collar rot ( stem rot)

**Causal organism:** fungus

**S.n.:** *Pythium aphanidermatum*

**Symptoms:**

- Water soaked patches appear on the collar region of the plant.
- Later on the patches appear in large size and cause rotting of tissue. The plant fall and die in severe condition.

Control:

- ➡ Avoid water logging condition in field
- ➡ Uproot and destroy the affected plant
- ➡ Application of *Trichoderma viridae* (15 g/plant) mixed in well-decomposed FYM should be applied around the root zone of the plants at the time of planting.
- ➡ At the initial stage, scrap the infected part and apply Bordeaux paste.

- **Anthraco nose**

**Causal organism:** fungus

**S.n :***Colletotrichum gloeosporioides*

**Symptoms:**

- Small black spots appear on the leaves and fruits.
- The spots increase in size, penetrating and rotting the internal flesh.
- The affected leaves fall pre-maturely.

Control:

- Collect and destroy infected leaves and fruits.
- The fruits should be harvested as soon as they mature.
- Spaying with Copper Oxychloride (3 g/litre of water) or Carbendazim (1 g/litre of water) at 15 days interval effectively controls the disease.

- **Leaf curl**

**Causal organism:** Leaf Curl Virus

**Vector:** White fly (*Bemisia tabaci*)

**Symptoms:**

- Curling and bending of leaves takes place which cause reduction in the leaves size.
- The leaf margin rolled downward and the affected leaves become zigzag.
- Later on defoliation takes place.

Control:

- Collect and destroy the infected part of the plant.
- Removal and destruction of the affected plants is the only control measure to reduce the spread of the disease.
- Checking the population of white flies also can reduce the infection severity.

- **Powdery Mildew**

**Casual organism:** (*Oidium caricae* and *Laveillula taurica*)

**Symptoms:**

- On the underside of diseased leaves are found patches of whitish powdery

material, which

- On the upper surface, leaves at the infection side show blotches of yellow or pale green usually near the veins, surrounded by normally coloured tissue.
- Early less conspicuous symptoms consist as pale yellow spots near the veins.

Control:

- ➔ The systemic fungicides like Bavistin (0.1%) at monthly intervals are much more effective.

### **Physiological disorder**

Green, slightly sunken areas on ripe yellow fruit are caused by scratch injury when fruit were still green. Unsightly skin freckles (small, brown, slightly raised areas) that are more common on the side of the fruit exposed to the sun is seasonal, developing when rainfall and low temperatures occur 2 months before harvest. Premature ripening of fruit, referred to as “soft fruit,” is related to low calcium content. This condition is more common following periods of heavy rainfall 2 to 3 months before harvest. Sunken, dry, brownish-grey areas are caused by mites feeding on skin during early fruit growth.

### **Stage of maturity**

Fruits are harvested when they are of full size, light green in colour with tinge of yellow at apical end. On ripening, fruits of certain varieties turn yellow while some of them remain green. When the latex ceases to be milky and become watery, the fruits are suitable for harvesting.

### **Harvesting methods**

When papaya plants are short, fruits can be harvested by hand while one is standing on the ground. As the plants grow taller, harvesting aids are required. One technique uses a modified plumber’s helper to snap the papaya from the stem. The fruit is caught before it falls to the ground.

### **Yield**

A young tree yields about 70-120 fruits per plant up to 4 years. Later becomes unproductive after 4 years.

## **Grading**

Fruits are graded on the basis of their weight, size and color.

## **Packaging**

Bamboo baskets with banana leaves as lining material are used for carrying the produce from farm to local market.

## **Transport**

Rough handling of boxes/cartons during loading/unloading should be avoided. Over loading should be avoided. To reduce bruising, good shock absorbers should be used.

## **Storage**

Fruits are highly perishable in nature. They can be stored for a period of 1- 3 weeks at a temperature of 10-13<sup>0</sup>C and 85-90% relative humidity.

# Unit – 11

## Cultivation Practices of Apple

### APPLE (*Malus domestica*)

#### Introduction

Apple (*Malus domestica*/*Malus pumila*) is a temperate deciduous fruit. It belongs to rosaceae family. More than 80% of apple production is done in Europe. In Nepal, Jumla, Humla, Dolpa, Mugu, Kalikot, Manang, Mustang, etc. are the major apple producing areas.

It is one of the most preferred fruit by the consumers. Thallus is its edible portion. The saying 'an apple a day, keeps the doctor away' depicts us about the importance of apple.

#### Composition and uses

It is good source of vitamin, fiber and minerals. Ripe fruits are directly consumed and it is also used to prepare jam, jelly, candy, ice-cream, wine etc.

#### Origin and distribution

Its origin is considered to be in South West Asia, spreading across Europe to France.

#### Variety

##### Based on chromosome number:

- a) **Diploid variety:** It is self-fruitful and a good commercial crop. Eg: All Delicious, Jonathan, Rome Beauty, Anna etc.
- b) **Triploid variety:** It is self-unfruitful and requires pollinizer (golden delicious) e.g. Cox's orange Pippin, Baldwin, Beauty of Bath wine sap, Stayman etc.

##### Based on season:

- a) **Early varieties:** Anna, Vered, Fanny etc.
- b) **Mid varieties:** All delicious, Cox's orange pippin
- c) **Late varieties:** Cortland, Granny Smith

### **Based on chilling requirement (4-7<sup>0</sup>C):**

- a) **Over 1000 hours/high chilling cultivars:** Red Delicious, Golden Delicious, rich-a-red grown at altitude 2000-2500 masl
- b) **Between 500-1000hours/low chilling cultivars:** Tropical Beauty, Anna, Vered, etc. (only 150 hours chilling temperature required in Brazil) at altitude less than 1500masl.

### **Climate and soil**

It can be cultivated at an altitude of 1500-3000m from mean sea level depending upon the variety. The annual rainfall lies between 400-500mm. It require temperature about 15-21<sup>0</sup>c for proper growth and development. It also requires 250-1400 hours of chilling temperature below 7.2<sup>0</sup>C during winter season to break dormancy. It can be cultivated in sandy loam and sandy clay soil having ph range of 6-7. The soil should have proper drainage facility.

### **Area and production**

Area (ha): 12,015; productive area (ha): 3,707; production (mt): 19,850; productivity (mt/ha): 5.36.

### **Propagation and planting**

It is commercially propagated by tongue grafting or T-budding. Seedling rootstocks of wild apple: Siberian crab apple, American crab apple and wild crab apple. The saplings are planted in well prepared land at spacing of 6-8m depending upon variety. The pit size should be 60x60x60 cm<sup>3</sup>. The sapling should be planted in the month of Poush-Falgun.

### **Irrigation**

Moisture stress mainly affects the fruit production. Insufficient moisture cause flower and fruit drop. Younger plants are irrigated twice a week depending upon moisture of the soil. Bearing plants are irrigated once a week in summer.

## Manure and fertilizer

Age of plant (yrs)	FYM/com post (kg)	Nitrogen (g)	Phosphorus (g)	Potassium (g)
1	10	70	35	70
2	20	140	70	140
3	30	210	105	210
4	40	280	175	280
5	50	350	210	350
6	60	420	245	420
7	70	490	280	490
8	80	560	315	560
9	90	630	350	630
10	100	700	385	700

## Training and pruning

The apple tree is trained by modified leader system in which main stem is allowed to grow up to 1.5-2.5 m then headed back to height of 1.2-1.5 m to facilitate lateral branch growth. After then, diseased, dried, crowded, overlapped branches are removed.

## Intercropping

Intercrops viz. pea, cabbage, red clover and French bean may be cultivated along with apple which helps to improve soil texture and nutrient status of soil. Flowering occurred earlier in pea, red clover and French bean. Percent fruit set and fruit maturity (DAFB to harvest) occurred earlier in apple trees intercropped with pea, red clover and French bean.

## Intercultural operations

Hand weeding can be practiced but in large orchards spraying of glyphosate @1.7kg/ha is recommendable.

### **Flowering and pollination**

Flowering occurs in the spring after 50–80 DAP. Apples require cross-pollination—bees moving pollen from a pollen-donating tree to the receiving tree.

### **Fruit growth and development**

Fruits develop from the base of the apple flower after pollination and fertilization and the flower walls around the seed cavity expand to become the fruit flesh. The apple fruit grows initially by cell division for about a week. Final potential fruit size depends primarily on cell numbers, which are produced shortly after bloom. So, for good fruit size thinning effectively and early is critical. Carbohydrate reserves support flower development but are apparently not supporting the fruit growth after bloom. If light is limited, shoot growth seems to have priority and fruit growth and set will suffer if there are too many shoots.

### **Insect pest of apple**

#### **1. San Jose scale (*Quadraspidiotus perniciosus*)**

- They suck the sap from leaves, stem and bark of the tree which cause serious damage.
- It attacks on masses overlapping in layers.

Control:

- ➡ Destroy affected part.
- ➡ Spray Dimethoate 30%EC @ 1.5-2.5 ml/l of water.
- ➡ Adopt clean cultivation.

#### **2. Woolly apple aphid (*Eriosoma lanigerum*)**

- On the aerial part white wooly mass are seen.
- They suck sap from stem, twigs and roots resulting gall formation.
- The affected plants remains stunted.

Control:

- Adopt clean cultivation.
- Spray Dimethoate 30%EC @ 2-3ml/l of water
- Application of Carbofuran @ 30-5g per tree at 5cm depth in the root zone for non bearing trees.

### 3 Apple fruit moth (*Argyresthia conjugella*)

- Moth lays egg on the skin of the fruit.
- After hatching, caterpillars enter into the flesh of fruit and make tunnel on fruit.

Control:

- Adopt clean cultivation.
- Destroy affected parts.
- Spray Dimethoate 30%EC @ 1.5-2.5ml/l of water
- Provide smoke at night time in moth affected areas.

### 4. Stem and shoot borer (*Aeolesthes* sp)

- The larvae bore into branches, stem and tree trunk just under the bark.
- The affected parts get dry and die.
- They affect more on aerial part of the plant.

Control:

- Destroy the affected parts.
- Use petrol or insecticide in the hole to kill the insect.
- Use wire to kill the insect inside hole.
- Use eco neem plus (azadiractin 1%) at 0.5%.

## Diseases of apple

### 1. Apple scab

C/o: fungus

S.n: *Venturia inaequalis*

Symptoms:

- The brownish encrustation is seen on the leaves, stem and fruits resulting into water soaked lesions.

- It causes defoliation of leaves and rotting of leaves.
- Due to attacks the plant fails to develop fruit and tree becomes weak and the yield decreases.
- The developed fruit may crack.

Control:

- Adopt proper pruning so that all branches should get proper amount of light intensity.
- Adopt clean cultivation.
- Spray Mancozeb @ 2-3 g/l of water at 14 days interval.

## 2. Powdery mildew

C/o: fungus

S.n: *Podoshera leucotricha*

**Symptoms:**

- The powdery mass appears on the leaves, young shoots, fruits and flowers.
- It causes stunted growth, dropping of flowers and fruits.

Control:

- Destroy the affected plant parts.
- Spray sulphur @0.2% at 12-15 days interval during bud development stage.

## 3. Crown gall or hairy root

C/o: fungus

S.n: *Agrobacterium tumefaciens*

**Symptoms:**

- Excessive fibrous roots develop which looks like broom usually pea size.
- Galls are developed in the root zone which changes into big size (i.e.6 inch in diameter).
- The galls are in brownish colour in initial stage which later on changes into black colour.
- The galls may be elongated, rounded or irregular in shape.

Control:

- Root injury is avoided.
- Establish nursery in disease free areas.
- Provide proper drainage facility.

#### 4. Collar rot

**C/o:** fungus

**S.n:** *Phytophthora cactorum*

##### **Symptoms:**

- In the infected plant, the collar region near to the ground level turns into brown, soft and spongy.
- The affected plant remain stunted, leaves becomes yellow or brown and leaves dropping takes place.
- The disease kills the plant at later stage.

Control:

- Adopt proper weeding.
- Drench the soil with copper oxychloride @ 4-5 g/l of water.

#### 5. Fruit rot

**C/o:** fungus

**S.n:** *Penicillium expansum*

##### **Symptoms:**

- Water soaked lesions appears on infected fruit.
- Later on increases in size and fruit rot takes place.

Control:

- Deep the fruits in carbendazim @ 0.1% after harvest.

### **Physiological disorder**

#### **1. Bitter pit**

Small brown lesions of 2-10 mm in diameter (depending on the cultivar) develop in the flesh of the fruit. The tissue below the skin becomes dark and corky. These spots generally turn darker and become more sunken than the surrounding skin and are fully developed after one to two months in storage.

## **Control**

Cultural practices that reduce the incidence of bitter pit are calcium sprays, summer pruning and harvesting mature fruit. Avoid nitrogen and magnesium summer spray, fertilizer treatments that result in lowering the soil ph or induce excess vigor, and fluctuating soil moisture.

### **2. Internal browning**

Brown discoloration appears in the flesh, firm but moist, usually originating in or near the core. Brown areas have well defined margins and may include dry cavities resulting from dryness. Symptoms can range from a small spot of brown flesh to nearly the entire flesh being affected in severe cases.

## **Control**

Avoid harvesting over mature fruit. Harvest at the optimum maturity, especially for controlled atmosphere storage.

### **3. Scald**

Irregular brown patches of dead skin which can become rough when severe, develops within 3 to 7 days upon warming of the fruit following cold storage. The warm temperatures do not cause the scald but allow symptoms to develop from previous injury which occurred during cold storage. Symptoms may be visible in cold storage when injury is severe for many years.

## **Control**

Proper harvest maturity, and ventilation in cold storage

### **4. Sunburn**

Initial symptoms are white, tan or yellowed patches found on the sun exposed side of the fruit. With severe skin damage, injured areas can turn dark brown on the tree. Fruit exposed to the sun after removal from the tree, either on the orchard floor or in field bins, can develop severe sunburn.

## **Control**

The best method of control is to avoid sudden exposure of fruit to intense heat and solar radiation. Proper tree training and pruning are critical. Summer pruning must be carefully accomplished to avoid excessive sunburn.

## **5. Water core**

A pre-harvest disorder resulting in water soaked regions in the flesh, hard and glassy in appearance, only visible externally when very severe. Symptoms often increase rapidly as fruit become over mature but does not increase postharvest. If symptoms are mild to moderate, they may disappear completely in storage. However, when water core is severe, internal breakdown can develop.

### **Control**

The most effective way to reduce the incidence of water core is to avoid delayed harvests.

### **Stage of maturity**

The fruits are harvested when it attained full size and colour changes from green to red colour and flesh become firm.

### **Harvesting methods**

Apples need to be handled carefully when picking them to avoid any bumps or bruises which will prevent them keeping well. Cupping your hand under the apple and pick it. If picking is done using a ladder then consider one of the excellent apple-harvesting bags that you wear like an apron to collect them as you harvest.

### **Yield**

It yields about 10-12 ton per hectare.

### **Grading**

Grading of apples is done according to fruit size and fruit appearance or quality. On the basis of fruit size, apples are graded manually. On the basis of fruit colour, shape, quality and appearance, apple fruits can be graded in three or more quality grades.

### **Packaging**

Apples are usually packed in wooden boxes having the capacity to accommodate about 10 or 20 kg. Corrugated fibre board cartons are also used for packing.

### **Transport**

Road transport by trucks is the most popular mode of transport due to easy approach from orchards to the market. Over loading should be avoided. To reduce bruising, good shock absorbers should be used.

## **Storage**

Apples have a long storage life compared to other fruits and can be stored for a period of 4-8 months after harvesting. The fruits can be kept in cold storage at a temperature of about  $-1.1^{\circ}$  to  $0^{\circ}$  C and 85-90% relative humidity.

# Unit – 12

## Cultivation Practices of Plum, Peach, Pear and Apricot

### Plum, Peach, Pear and Apricot

#### Introduction

**Plum** (*Prunus domestica*) is a temperate fruit crop and a member of the rose family Rosaceae. Plums have been cultivated for over 2000 years. Although the fruit quality of plums produced in the subtropical climate is poor, still these fetch a high price in the market because of its early availability. It is available at a time when the competition from other fruits is the least.

**Peach** (*Prunus persica* L.) belongs to the prunoideae subfamily of the Rosaceae with other species collectively referred to as “stone fruits”.

**Pear** (*Pyrus pyrifolia*) is a "pome fruit” produced in the *Rosaceae* family of trees, in the *Pyrus* genus. Pome fruit plants are an average sized trees found in semi-tropical regions around the northern hemisphere. They bear medium-size fruits that characteristically have several small seeds at its center encased in tough coat.

**Apricot** (*Prunus armeniaca*) is a fruit or the tree that bear the fruit. Full of perfume and sweet, golden orange apricots are another summer season delicacies.

#### Composition and uses

Fresh berries are a moderate source of vitamin C, vitamin A, Vitamin K. Plum sections are a great addition to salads. The fruits are being used in the preparation of pie, desserts, jams and jellies.

#### Origin

**Plum:** This species is native to western Asia

**Peach:** Peaches were probably the first fruit crop domesticated in China about 4000 years ago.

**Pear:** It is native to china.

**Apricot:** It was known in Armenia

### **Distribution (Plum, peach, pear, apricot)**

Major producing districts are: Sankhuwasabha, Dhankuta, Sindhupalchok, Rasuwa, Kavre, Nuwakot, Dhadding, Palpa, Baglung, Baitadi, Doti, Dharchula, Bajhang, Rolpa, Parbat, Gorkha, Makawanpur, Bhaktapur, Lalitpur, Kathmandu, Sindhuli, Ramechhap, Bhojpur, Terathum and Illam

### **Varieties**

#### **Plum**

Two types of plum are commonly grown in Nepal. European cultivars grown are Green Gaga, Early Transparent Gage, Stanley, Ruth Gestetner, etc. Japanese cultivars are Santa Rosa, Methley, Satsuma, Formosa, Mariposa, Burbank, Kelsey, Oishi Wase and Shiro.

#### **Peach**

Red Heaven, Elberta, Cardinal, Early Amber, Sunrise, Alex Andre and Inhale.

#### **Pear**

Shriro, Kousi, Housi, Harping, Bretlett, Chojuro, Nelis, Gola

#### **Apricot**

Blenheim, Titon, Bulida, RcaleDimola, Prete, Canino, Kaisa, Charmagz, Shakarpara etc

### **Climate and soil**

Plum, peach, pear and apricot is not very fastidious in its soil requirement and can be grown with success on a wide variety of soils. However, heavy textured soils which can retain moisture are best. Heavy clay remaining water logged for longer periods or coarse sandy soils that dry out readily during summer should be avoided. Deep, sandy loam soils with good drainage, free from alkaline and saline conditions are ideal.

### **Propagation**

Plums are T- or Chip-budded onto rootstocks as like other stone fruits.

## **Planting**

After the scion has grown for one year, the plants can be planted in the field in winter 6m x 6m apart from row-to-row and plant-to-plant in square system, accommodating 275 trees/ha.

## **Irrigation**

Trees must be given sufficient water during March-May depending upon variety to induce new growth, flowering and fruiting. In subtropical trees require highest amount of water during April-May which coincides with the rapid fruit development period. There should be no water stress during this period.

## **Manure and fertilizer**

- FYM: 15 Kg/plot/year
- Nitrogen: 330g/plot/year
- Phosphorus: 150g/plot/year
- Potassium: 90g/plot/year

(All dose of PK in Paush/Magh, N-1/2 after sprouting and remaining 1/2 after fruit picking).

## **Training and pruning**

Plants tree should be trained according to modified leader or open centre depending upon growth habit of the varieties. After four years of planting the leader braches modified and 4-5 well spaced secondary branches are obtained. Since these fruits bear fruit on one-year-old wood and spurs on older wood, only light pruning is given to bearing trees in January to encourage new growth and healthy spurs. a certain amount of thinning of branches and opening of the top of the tree is necessary to admit enough light for development of spurs and better fruit color. Water sprouts which grow on the trunk and main braches should be removed regularly.

## **Intercropping**

Short-statured, shallow-rooted leguminous crops greengram, blackgram, pea and cluster bean can be sown as intercrops during the non-bearing period of the trees.

## **Intercultural operations**

## **Fruit thinning**

Some plum cultivars particularly those of the Japanese group overbear, requiring judicious fruit thinning. Thinning should be done by hand before the pit-hardening stage and fruits should be spaced 5-8 cm apart.

## **Weed control**

A number of weedicides can be effectively used to control wide spectrum weeds in plum orchards. A pre-emergence application of Diuron (4 kg/ha) or Terbacil (3kg) or Simazine (4kg/ha) is recommended. Post-emergence application of Grammoxone @ (2 liter/ha) or Glyphosate (800ml/ha) is very effective.

## **Flowering and pollination**

Most cultivars of apples, pears and plums are, in the main, not self-fertile. This means that in order to produce fruit, these trees need to be planted close to one or more suitable cultivars in flower at the same time. Honey bees are the major pollinator.

## **Insect pest of plum, peach, pear and apricot**

### **1. Pear leaf curl Aphid (*Eriosoma lanigerum*)**

- Adult and nymph suck the sap from leaves and from the tender part of the plants.
- It causes upward curling of leaves.

Control:

- ➡ Destroy affected part.
- ➡ Adopt clean cultivation.
- ➡ Spray Dimethoate 30%EC @ 2-3ml/l of water.
- ➡ Spray Malathion @ 2ml/l of water before flowering.

### **2. Stem and shoot borer (*Sphenoptera lafertei*)**

- The larva makes hole below the bark and feed upon heart wood i.e. cambium.
- Adult feed on bark and leaves.
- The affected branch becomes fragile and broken by wind.

Control:

- ➡ Pruning of affected branches and destroy them.
- ➡ Use wire to kill the insect inside the hole.
- ➡ Soak cotton on petroleum product and plug the hole with it and then

plaster the hole with cow dung.

### 3. Mites

- They suck the sap from the leaves which affect in the growth and development of the plant.
- The growth of plant is reduced and size of leaves also reduce.
- Sometimes upward curling of leaves is also seen.
- The affected leaves become brown in colour.

Control:

- ➡ Adopt clean cultivation.
- ➡ Destroy affected parts.
- ➡ Spray Dimethoate 30%EC @ 2-3ml/l of water.

## Disease of plum, peach, pear and apricot

### 1. Peach leaf curl

C/O: Fungus

S.N: *Taphrina deformans*

#### Symptoms:

- The infected leaves turn pink or bronze colour and curl.
- The infected leaves start to detach from the plant.

Control:

- ➡ Destroy infected plant part.
- ➡ Spray Blitox 50 @ 2-3g/ of water or spray Dithane M-45 @2-3g/l of water at 15-20 days interval.

### 2. Powdery mildew

C/O: Fungus

S.N: *Podosphaera oxycantha*

#### Symptoms:

- White powdery mass appear on the leaves, stems and fruits.
- It causes reduction in production of fruits.

Control:

- ☞ Destroy affected plant parts.
- ☞ Spray Dithane M-78 @ 1.5-2ml/l of water or spray any sulphur fungicide.

### 3. Brown rot or Blossom blight

C/O: Fungus

S.N: *Monilinia laxa*

#### Symptoms:

- Small circular spots are seen on fruits which subsequently cover whole fruit that cause fruit rot and fruit drop.

Control:

- ☞ Destroy the affected plant part.
- ☞ Spray Carbendazim @ 2-3 g/l of water.

## Physiological disorder

### Fruit freezing injury

The freeze injured tissue of most fruits will begin to brown as a result of enzymatic oxidation of phenols released by the injured tissue. When freezing occurs at the fruit surface, the glossy or browning symptoms may be visible without cutting. A fruit freezes because of prolonged exposure to a temperature just below its freezing point. Maintain temperatures just above freezing. This requires good equipment and careful management.

### Skin Discoloration, Inking, Staining, Black Staining

Inking symptoms appear as discolored brown and black spots or stripes but are restricted to the skin. Reduce fruit abrasion damage. Treat fruit gently. Avoid long hauling. Keep picking containers dirt free. Reduce contamination of fruit.

### Internal browning, chilling injury, dry fruit, mealiness, woolliness

Flesh browning, flesh mealiness, black pit cavity, flesh translucency, red pigment accumulation (bleeding), and low flavor.

These symptoms normally appear after placing fruit at room temperature, while some ripening is occurring, following cold storage. For this reason, this problem is usually

experienced by the consumer, not the grower and/or packer.

### **Harvesting**

For local consumption they should be allowed to ripen on the tree, but for distant market they should be picked at the color break stage. Since all fruits do not ripen at the same time these, should be harvested in several pickings. The fruits should be picked along with their stems.

### **Yield**

It yields about 30-35 kg fruit per tree.

### **Grading**

Grading of plum is done according to fruit size and fruit appearance or quality. On the basis of fruit size, plums are graded manually. On the basis of fruit colour, shape, quality and appearance, plums fruits can be graded in three or more quality grades.

### **Packaging**

After grading, fruits are packed in shallow containers about 10-12 cm deep. Packing should not more than three layers deep. After packing fruit should be cooled immediately to 0°C which stop the ripening process for 12 days.

### **Transport**

Road transport by trucks is the most popular mode of transport due to easy approach from orchards to the market. Over loading should be avoided. To reduce bruising, good shock absorbers should be used.

### **Storage**

It can be stored at -2°C for 45 days without any adverse effect and 85-90% relative humidity after treating with 10ppm GA and 1,000ppm CCC.

# Unit – 13

## Cultivation Practices of Walnut, Pecanut and Chestnut

### WALNUT (*Juglans regia* L.)

#### Introduction

Walnut belongs to the family Juglandaceae, is a very important temperate tree nut in the world including Nepal. Walnut trees are very large, broad and spreading with pinnately compound leaves of 5 to 9 leaflets. They are monoecious i.e. the male flowers (catkins) are situated on previous year's growth and the female flowers on tips of the first spring flush of growth of new shoots. Since dichogamy is common, it is necessary to plant two or more cultivars with overlapping bloom times to insure adequate pollination by wind even though the cultivars are self-fertile.

#### Composition and uses

Dry nuts are used for many ceremonial functions, while kernels are used in bakeries, ice cream factories, etc. Hulls are used to make dyes for fabrics. The nut is rich in proteins (15%), fats (65%) and carbohydrates (16%).

#### Origin and distribution

Walnut is native over a wide range of geographic areas extending from the Carpathian mountain of Eastern Europe and Mediterranean countries to the North-western Himalayas.

Major producing countries in the world are USA, Italy, France, China, Turkey, India, Romania, Bulgaria, Iran, Spain, etc. It is grown from eastern to far-western region of Nepal. Important districts are Sankhuwasabha, Illam, Dolakha, Baglung, Dolpa, Mugu, Humla, Jumla, Kalikot, Rukum, Dailekh, Bajura, Bajhang, Darchula, Achham, Doti, Baitadi, etc. The Baitadi district has the maximum area for this produce.

Area and	Eastern	Central	Western	Mid-	Far-Western
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Production	Region	Region	Region	Western Region	Region
Total Area (Ha)	323	340	356	1746	1118
Productivity Area (Ha)	155	148	171	820	483
Production (MT)	417	473	1003	3716	3708
Productivity (MT/Ha)	2.70	3.20	5.88	4.53	7.68

*Table: Area and production of walnut in Nepal (ASD, 2012/13)*

## **Climate and soil**

The temperature tolerance of Persian walnuts varies depending on their particular geographic origin (e.g. -35 to -40<sup>0</sup> F) and they grow at elevations of 1500-2500 masl. Cultivars from the Mediterranean region are much less hardy and tolerate temperatures down to 12<sup>0</sup>F. It tolerates mild winter temperatures. Spring frosts can be very damaging. Very high summer temperatures cause sunburn and darkened, shrivelled kernels. Cool summers, on other hand, result in shrivel and low oil content. Long, warm summers with temperature about 27-30<sup>0</sup>C near harvest time appear to be optimal for good kernel development.

For optimum production, walnut requires good, deep, well aerated soil for their deep root system i.e. about 2m in depth. It can be grown well in soils having pH range of 6.0 to 7.0.

## **Varieties**

### **1. Ashley**

The Ashley leaf out is early and it's medium to large fruits mature early with a 56% kernel percentage. The trees are small and good as filler trees. Fire blight is severe when they are planted in high rainfall areas.

## **2. Hartley**

The Hartley's leafing out time is in a medium range and its trees are medium to tall with large fruits of light colour and thin shells. Average nut size is large with a 47% kernel percentage. Harvesting period is medium to late.

## **3. Payne**

The payne walnut tree is small to medium and its estimated female flowers rate is very high, resulting in high yields of medium size nuts; nuts are borne on both lateral and terminal buds. Average kernel percentage is 52%. Fruits mature early.

## **4. Franquette**

The leafing out time is late and tree is large. It blooms comparatively early and escapes spring frost damage. The nut size is small to medium giving a 48% kernel percentage. It is harvested late in the season.

## **5. Eureka**

The Eureka tree is large with a medium leafing out time. It gives a good yield of medium size nuts with medium maturity. Its nuts have a 50% kernel.

## **6. Chico:**

The Chico leafs out early and produces many female flowers which develop medium sized nuts with 49% kernels. Its maturity period is early to mid season.

Other varieties like Manregians, Hansen, Metcalf, Broadview, etc. are also available but in Nepal, Thin-shelled, Kagji Special, Dante and Black walnut are grown in mid and far west area.

## **Propagation**

Walnuts are commonly propagated by seed and grafting for commercial orchards. Extract seed from well ripened fruit 10 to 15 days after picking. Seeds can be sown during September for early planting in seed beds at 30 cm x 30 cm at 10 cm depth. Seeds germinate within one month. Late planting of seeds can be done in February to March, but seeds must be stratified in cool and moist conditions at 3 to 5<sup>0</sup> C for 4 to 5

weeks using vermiculite/peat/ moss as germination medium. Without stratification at chilling temperatures, walnut seeds can also be sown directly in nursery beds of fields during December to January.

In vegetative methods, tongue grafting method generally gives about a 70% success rate. This grafting needs to be done before leafing out, usually in late February to March. Rootstocks prepared in the nursery beds are selected properly by choosing only healthy ones for grafting. Black walnut seedlings are good for rootstock purposes.

### **Planting**

In a well prepared plot of land, pits are dug using layout systems i.e. square, rectangular or contour. The pit size is usually kept at 1m x 1m x 1m. Apply 20-25 kg compost or FYM, 1-2 kg bone meal and wood ash per pit, mix well with soil and then refill the pits. Walnut saplings are planted in the field from December to March at 12m spacing both ways with the help of planting board. For sapling, this spacing can be reduced to 10m x 10m.

### **Training and pruning**

Young walnut trees are weak and must be given adequate support using bamboo or other materials for 4 to 5 years after planting. They are trained to a modified or central leader with 4 to 5 main laterals distributed up and down and around the main stem to make good and strong scaffolds. After this minimal training, very little pruning is done. Trees are pruned annually by removing about 10% of the shoots to ensure 20-30 cm of new growth every year. Remove all crossing or diseased, weak branches. Female flowers are born at the ends of current season's short terminal shoots. Overly long shoots are usually unfruitful. Some thinning out pruning is usually desirable, especially on heavy-bearing cultivars.

## Manure and fertilizer

Usually no fertilization is done in Nepal, but it is good to apply NPK fertilizers depending upon leaf tissue analysis. Some recommendations are also given by nutrition experts as:

Years	FYM (kg/tree)	Nitrogen (g/tree)	Phosphorus (g/tree)	Potassium (g/tree)
2	20	100	50	20
3	30	150	75	30
4	40	200	100	40
5	50	250	125	50
6	60	300	150	60
7	70	350	175	70
8	80	400	200	80
9	90	450	225	90
10	100	500	250	100

Apply 25 to 50 kg FYM for non-bearing trees and 50 to 100 kg FYM for bearing trees. It is advisable to apply 400 g nitrogen, 200 g phosphorus and 200 g potash per tree for bearing trees. The best source of N is ammonium nitrate or ammonium sulphate. The full dose of super phosphate and murate of potash and a half dose of urea should be applied in October after picking the fruits and the remaining half dose in February every year. Apply these fertilizers in trench uniformly, cover them with soil and then provide irrigation if applicable. Zinc, Copper, Manganese, Boron, Iron and magnesium can also be applied as foliar spray to check the physiological disorders caused by them.

## **Irrigation**

For establishment of plants and trees after planting, they are irrigated regularly based on soil moisture conditions and the plant's need so that plant growth, flowering and fruiting are not affected. Irrigation is very crucial during fruit setting and development stages. Otherwise, fruit drop is enhanced and kernel development is adversely affected.

## **Mulching**

Mulching is essential in walnut orchards when the plants are young, and it is still important after fertilizer is applied to older trees. Place different mulch materials around the plant or tree to help conserve soil moisture, regulate soil temperature, reduce weed growth, etc.

## **Intercropping**

Since there are wider spaces in between trees and tree rows, different crops such as buckwheat, peas, legumes grasses, strawberry, cabbage, cauliflower, radish, lentil, beans, etc. can be taken as intercrops depending upon season and market needs.

## **Flowering, pollination and fruit set**

Walnut is a monoecious tree. Female flowers are born at the tip of the flowering branch whereas male flowers are born at the base of the flowering branch. Staminate inflorescences are pendulous catkins, borne laterally on last year shoots. Pistillate flowers are born terminally on current seasons's shoots. All cultivars appear to be self fertile but dichogamy is common; it is necessary to plant two or more cross compatible cultivars with overlapping bloom times in order to insure adequate pollination. Hartley and Payne is a good combination. It is mainly a wind pollinated crop, and transfer of pollen grains can easily be carried for a 2 km distance, therefore it is better not to plant thin shelled and hard shelled walnut cultivars within this distance.

## **Harvesting**

Walnut is a drupaceous nut with single sigmoid growth curve. They mature 1 to 4 weeks before hull dehiscence. Oils are formed in walnuts by the time the packing tissue is brown and they are mature at this time. The hulls split at the time of maturity in September to October. Mature nuts do not fall all at one time, so trees can be shaken mechanically to drop the matured nuts. Then, the fallen nuts are collected. Hulls

adhering to the walnuts must be removed immediately to avoid discoloration and deterioration in quality. Nuts must be dried to a moisture level of 3 to 4% immediately after harvest in warm air tunnels at 38 to 42<sup>0</sup> C and then kept at cold temperatures for storage. Drying the nuts increase in fatty acids and also brings out favourable changes in flavour components.

## **Yield**

Yield varies with tree age, size, variety and the cultural care given to the trees. A grown up tree yields on an average of 60 to 80 kg of dry nuts/tree. A tree may bear for about 100 years from the age of 8 to 10 years. Grafted or budded plants give fruiting 4 to 5 years after planting. Trees of Payne may bear crops worth harvesting by 5 years, other cultivars may require 7-8 years. It may be 12 to 16 years before a full bearing level is reached.

## **Grading, packaging, transport and storage**

Dehulled nuts are graded based on size, colour, shell seal, and variety. Nuts must be dried down to about 4% moisture in order to prolong their quality. Moisture, heat, light and air are primary factor in deterioration of shelled nuts. The dried nuts are packed and sent to local or distant markets. Keeping dry nuts at cold temperatures in the dark and treating them with an antioxidant greatly increase storage life.

## **Insect pests**

### **1. Husk fly**

This is the most important and serious pest. The fly lays eggs on developing fruits and the maggots destroy them. Use pheromone traps or spray Dipterox.

### **2. Walnut aphid**

The young and adult stages of this aphid suck sap reducing tree vigour, fruit quality and yield. Fruits may drop before they reach to maturity. They excrete honeydew, develop sooty mould and turn the husk surface black. Collect dropped fruits and bury them in soil. Pheromone traps can be used when the tree starts fruiting. Spray Metasystox, sevin or Dimethoate.

### **3. San Jose scale**

This small insect damages both the shoots and the fruits. Dormant spray of diesel oil in winter or spray of 0.03% diazinon in winter is done to control insects.

### **4. Walnut weevil**

The adult weevil lays eggs in new flush and inside developing fruits. The larvae bore into the fruit making canals and adults eat stems, new sprouts and tender fruits. As a result fruits drop before they reach maturity. Collect the dropped, infected fruits and bury or burn them. Spray Sevin@ 2.5g or Thiodan @2 ml per litre of water during the new flush and fruiting stages.

Others, such as Shoot borer and codling moth are also very damaging and these should be controlled by spraying insecticides and keeping the orchard clean. Use of pheromone is also effective for controlling the moth.

## **Diseases**

### **1. Foot and root rot**

This is a fungal disease that attacks the stem where it touches the ground and also the roots. Initially, small infected spots are seen on leaves which when mature fall off, possibly leading to the death of the tree. Avoid planting walnut trees in moist and cool soil. Provide adequate drainage systems. Treat soils with formaldehyde, Trichoderma, or Bavistin before planting. The use of a resistant rootstock i.e. Northern California Black is advisable.

### **2. Walnut canker**

It is caused by bacteria affecting bark and reducing tree vigor. A prolonged dry condition in the soil in the spring season also enhances this disease. No chemical control is effective. Affected parts should be pruned and burnt.

### **3. Leaf blotch**

This fungal disease appears severe during conditions of high humidity and temperature. In the beginning, brown spots or streaks are seen on leaves, tender branches and fruits. Later they appear as large blotches, and both leaves and

fruit will drop. The dropped leaves and fruits must be collected and should be burned. Spray 1% Bordeaux mixture or 2.5 -3.0 g Blitox-50 per litre of water at 10-15 days intervals 2-3 times starting from the new flush.

#### **4. Die-back**

This appears as scattered brown spots on leaves which later become large and cover the whole leaf. Leaves so affected will fall, leaving the plant leafless. Soft and tender branches dry up from tips and become blackened. Young plants may die as well. Prune the diseased leaves and branches and burn them. Also 4 g of Blitox-50 or Indofil M-45 per litre water should be sprayed 2-3 times. After pruning in winter, spray Bordeaux mixture on the trees and use Bordeaux paste on pruning cuts of large branches.

#### **5. Walnut blight**

This is the firing and burning of leaves and flowers causing heavy loss in production. Apply copper and 1000 ppm streptomycin during pre-bloom and post bloom periods.

# PECANUT

## (*Carya illinoensis*)

### Introduction

It belongs to the family Juglandaceae. It is monoecious. It is rich in minerals. It contains 71% fat, 9% protein, 15% carbohydrates.

### Climate

The average monthly maximum temperature should be higher than 28 °C during summer and lower than 23 °C in winter. The average monthly minimum temperature during the summer must rise above 16 °C, but drop below 8 °C in winter. It also requires chilling hours of 400-600 hrs.

### Soil

Sandy loam, deep, fertile soil and well aerated soil is best for its cultivation. Pecan trees grow best in a soil pH of 5.5 to 6.5.

### Varieties

1. Mohan
2. Stuart
3. Mohawk

### Propagation

It can be propagated with seed, patch budding, tongue grafting.

### Planting and Care

Pit size should be 1.5m x 1.5m x 1m. It should be planted during December-January. Spacing should be maintained at 12-20 m

### Manuring

- 10 Kg FYM
- 500 g NPK mixture (15:15:15)/year

### Harvesting

- The shucks split open and are, separated from the nuts.
- Pecans either fall to the ground naturally or knocked off with poles and the collected.
- Nuts are cured for three weeks to improve quality.

### **Insect Pests**

1. Hickory shuck worm
2. Pecan nut case bearer
3. Weevil
4. Aphid
5. Scaler nut

### **Diseases**

1. Pecan Scab
2. Vein spot
3. Leaf blotch
4. Brown leaf spot

### **Disorders**

1. Leaf scorch
2. Rosette

# CHEST NUT

## (*Castanea spp.*)

### Introduction

It belongs to the family fagaceae. In Nepali, it is called “Katus”. It is staple food source for man and animals. Chestnuts are roasted and eaten in Europe. It is used in making bread or cakes. It is also a good timber.

### Species

1. European type: *Castanea sativa*
2. Chinese type: *Castanea mollissima*
3. American type: *Castanea dentata*
4. Japanese type: *Castanea crenata*

### Climate and soil

It can be grown in wide range of climate and soil conditions.

### Varieties

1. Sleeping Giant
2. Jersey Gem
3. Kuling

### Propagation

It can be propagated by seed. Grafting and layering have lesser success.

### Planting and care

- Planted in November-December
- Tree are spaced with 12m
- Pit size should be 1m x 1m x 1m.
- N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O should be 120:100:100 kg/ha.

### Diseases

- Phythophthora
- Crown rot
- Root rot
- Blight

### Insect Pest

1. Weevil
2. Moth

# Unit – 14

## Cultivation Practices of Kiwi fruit

### KIWI (*Actinidia deliciosa*)

#### Introduction

The kiwi fruit (*Actinidia deliciosa*), family Actinidiaceae is an expensive yet emerging fruit crop in Nepal. It is also called “Jhussephal” or “Thekiphal”. The plant is an exceptionally vigorous, deciduous and perennial vine. Leaves are roundish, 12 to 20 cm long and somewhat heart shaped at the base, deep green above with a whitish and densely tomentose underside. Young leaves and shoots are covered with bright red hairs. Its fruits contain very high levels of vitamin C, vitamin A, carbohydrates and protein. Its native home is China, so it is also called the Chinese gooseberry. Kiwi is commercialized in New Zealand where it is the national fruit.

#### Area and Production

Statistics on area and production of kiwi fruit in Nepal are not available. However, official records indicate that kiwi was introduced to Nepal by the Swiss Technical Cooperation Mission in 1980 and planted in Charikot and Jiri of Dolakha. A horticulture development project of JICA brought a few varieties of kiwi and planted them in a kritipur farm in 1987. Commercial farming of kiwi in Godabari of Lalitpur has been started by ICIMOD, which brought some varieties from Kullu, Himanchal Pradesh of India. Today, many farmers of Daman, Bajrabarahi, Banepa, Subba Gaon, Patekhet and Phaskot, Bonch, Illam, etc. have been producing kiwi fruit for sale.

#### Climate and Soil

Kiwi requires chilling temperatures of 600 to 800 hours in winter mild temperatures in spring and fall and warm in summers. If chilling hours are not met, plant delay in bud break and flowering, which limits fruiting considerably severe winters and frosts damage tender young growing shoots. Temperatures over 35°C result in leaf

shrivelling. Leaf burning is usually seen when weather conditions are dry with minimal humidity. They can be grown at altitudes from 820 m to 3000 m above sea level. In windy areas, windbreak trees must be planted to protect from limbs from breakage and rubbing against the fruits. Plants require annual rainfall of 1200 to 1500 mm without hail. Fruit quality is best when they are planted on a south facing slope. Irrigation must be applied from time to time.

Plants require well-drained loam soils with good organic matter and ample water as they are not drought resistant. Water logging is not tolerated at all by this crop as most of its feeder roots lie within the top 50 to 60 cm of soil. The best soil pH is between 6.0 and 6.5.

### **Cultivar**

The kiwi fruit has many cultivars of world fame, such as Hayward, Chico, Monty, Burno, Abbott, Asllison, Vincent, etc. They have male and female flowers in different plants. Important male cultivars for good pollination are Tomori, Khohi and Matua.

### **Propagation**

Many propagation methods are used in kiwi multiplication. Hardwood cutting with stems between 0.5 and 1.0 cm in diameter and 15 to 30 cm in length and 6 to 12 months of age can be cut during the dormant season. When planted in a nursery using IBA dips, success is only 15 to 20%. Soft wood cutting taken as vines 2 to 3 months old during June and dipped in IBA or rootex hormone and planted in nursery beds under intermittent mist chambers or a polythene green house will have a success rate of about 40 to 50%. Root cuttings of pencil or marker-pen size roots and between five and 10 cm in length can become new plantlets to produce good rootstocks for next year's graftage after being planted 5 to 7 cm deep in sand beds with adequate moisture and at an appropriate temperature. Tongue grafting and veneer grafting practiced during dormant stage can have a success rate as high as 90%. Bench grafting is also successful when rootstocks are brought inside the callus house and grafted, sprouted plants are then transferred to nursery beds. T-budding or chip budding done during February will be successful 90% of the ripe fruits and stratified in cold chambers or in nature during cold winters for 2 to 3 months. When the seedlings are of a good sized, budding or

grafting can be performed as needed.

## **Planting**

In a well prepared field, after being laid out in pits of about 1 m x 1m x 1m size, kiwi vines are planted with the help of a planting board during winter (December-January) at a spacing of 5m (row to row) and 6m (plant to plant) or 6m x 5m distances. The pits should be dug about one month before planting and filled back with 20-25kg compost or FYM and 3-5kg wood ash plus 500g bone meal. Also add some NPK (200g N, 100g P<sub>2</sub>O<sub>5</sub> and 200g K<sub>2</sub>O/pit) along with 20-25g Carbofuran for soil insects. The planting distance may also depend upon varieties used. Some varieties need a higher spacing. An example is Hayward. It has vigorous growth habit and requires a spacing of 7m to 8m. Do not plant saplings keeping the graft union near to or below the soil line. Plants should be supported with bamboo or wooden sticks so as to make them straight. These are then mulched around with khar, straw or other dry materials. Maintain the male to female plant ration at 1:5 in T-bar system and 1:8 in overhead system or better fruiting of quality fruits.

## **Training and pruning**

Under ideal conditions, the kiwi plant can grow about 23-35 cm in 24 hours. This plant needs to be pruned 4-5 times a year. These vines can be trained on different system such as T-bar trellis, Overhead or pergola system, Nu Munson system, or pole system, etc. T-bar and pergola system are common with 3 to 5 horizontal wires. One main stem is cut at 1.5 m to 2.0 m with two leader branches. From their branches the fruiting branches or arms are spread towards opposite sides.

To maximize new fruiting wood on kiwi farm pruning is a very important activity. It requires cane management in winter and bunch management of fruiting canes in the summer. It is to be done at least 2 times a year but may require more depending upon location, season and variety. Usually there are two methods of pruning. The fruiting lateral method is good for vigorous varieties such as Hayward and the spur method is good for less vigorous varieties such as Bruno, Monty, etc. the summer pruning is done during June-July when suckers or unnecessary sprouts are also cut. Male plants must be pruned regularly to maximize male flowers. The male flower panicles get wilted after fruit setting periods and they are pruned to assure maximum males during the

coming season.

## **Cultural operation**

### **Manure and fertilizer application**

As described earlier with respect to the planting of vines, manure and fertilizers are necessary for good growth and development of plants and are applied in pits during pit filling time but before planting. NPK fertilizers are applied yearly for vigorous growth of young and adult vines. It requires 30kg compost/FYM, 120 g nitrogen, 60g phosphorous and 60g MOP for 2-5 years old young plants and 800g nitrogen, 600g phosphorous and 800 MOP for plants 6 or more years of age. Nitrogen is applied in split doses of 400g each. One is applied in January and the remainder during June at the start of Monsoon season. If possible an application of 500g bone meal per plant is very useful.

### **Irrigation**

Kiwi requires watering frequently during plant growth and fruit development stages as its rooting depth is low and its growth is faster. The critical periods are flowering, fruit development and fruit maturity stages. At these stages, if dry and hot conditions prevail, water must be supplied through irrigation at 10 to 12 days intervals three to four irrigations are necessary for quality kiwi fruit production. Drip irrigation method is the most efficient methods for quality fruit production.

### **Mulching**

This practice is very useful to get better growth and development of kiwi plants and fruits thereby reducing weed growth and minimizing water requirements. It is done from the beginning of kiwi plantation using different mulch materials such as straw, saw dust, dried leaves plant residues and even black polythene sheets.

### **Intercropping**

Shallow rooted crops vegetables and oats can be grown as intercrop but only during the first few years. Deep rooted crops vine crops millets maize etc are discouraged in kiwi orchards.

### **Weeding**

Many annual and perennial weed species of both monocot and dicot natures are often seen in kiwi plantations, adversely affecting the growth and fruiting of kiwi. These weeds must be controlled by tillage, owing and use of herbicides. Herbicides can be used as pre emergence and post emergence. Contact herbicides are Paraquat Atrazine, Bromacil, Diuron, etc. systemic herbicides are 2, 4-D Dalapon, Glyphoste, etc.

### **Fruiting**

Kiwi plants have an alternate bearing habit. Grafted plants start commercial bearing from 5 years to 15 years after which the yield declines even after adequate care and management practices. Once planted, though it can give fruits for 30 to 40 years. Plants flower during March-April depending upon variety; location altitude etc. flowering occurs on new growth from one year old branches. Fruit thinning is very important operation as kiwi bears many fruit in bunches. It is better to keep 2 to 3 good fruits per bunch by removing diseased, damaged, small and deformed fruits during fruit development phase when they reach the approximate size of a marble. Even flowers can be thinned. By thinning flowers and fruits nutrients are diverted to make plants towards annual bearing. Kiwi fruits are picked when they are mature and hard. Fruits are usually ready to harvest during November. Fruits are kept at room temperatures to soften. The signs of maturity are when a few fruits turn soft or when skin colour changes from greenish to full brown or when small hairs are fallen and TSS reaches 7 to 9<sup>o</sup> Brix. This is obtained around 220 days after flowering.

Fruit yield varies from variety, growing conditions, care and management practices. Usually, the yield of a 7-8 years old plant will be about 50 to 100 kg fruits per vine. Average yield is 25 MT/ha.

### **Marketing and storage**

Harvested fruits are kept in a cool and dry place for nearly 2 days and then they are graded as Super Grade, Grade A, Grade B, and others and mis-shaped fruits. The latter are not taken to markets but used for making other products such as juice, wine, jam etc. the good grades are packed in paper cartons or cardboard boxes with cushion materials between fruit layers and sent to local or distant markets with proper labels.

Kiwi fruits store well in storage chambers. Fruit keep well for 2 months when they are

kept in cold stores at 4 to 5°C while at 0°C the storage period extends to 4 to 6 months. Relative humidity should be 90 to 95 in the chamber.

### **Diseases**

A number of diseases that affect growth of plants and reduce fruit yields are reported. These are root rot, collar rot, twig blight, leaf spot etc. these diseases appear at various stages of plant and fruit growth either in the roots, stems, leaves, flowers or fruits. Crown gall is also noted in the young nursery stage and even on bearing vines. These diseases must be controlled as soon as they appear by using proper fungicides or bactericides. Also, keeping the orchards clean and following summer pruning are very effective methods to reduce the incidence of disease.

### **Insect pests**

Important pests of kiwi are the leaf roller caterpillars, greedy scale, mites, thrips, nematodes, etc. The leaf rollers attack tender leaves at first and later even the older ones, causing deformation of fruits. Keep the orchard clean, do summer pruning and use contact insecticides for its control. The ash to brown colour Greedy scale insects are very small and suck juice from stem, leaf and flowers making the plant weak and low bearing. Use systemic insecticides or servo oil for control when they are noted. Passion vine hoppers not only suck sap from leaves and stems but also release honey dews. These accelerate sooty mould development on plant parts including leaves, stem and fruit making them dark colour. Spray systemic insecticides and fungicides for control of hoppers and mould.

# Unit – 15

## Cultivation Practices of Strawberry

### STRAWBERRY (*Fragaria ananassa*)

#### Introduction

The strawberry (Bhuin Ainselu in Nepali) belongs to the family Rosaceae with a botanical name of *Fragaria x annanasa* Duch. Its origin is somewhere in North and South America. The plant is a perennial herb and is getting commercial popularity in our country. Its leaf is compound with 3 leaflets arising from the central crown. Flowers are white, hermaphrodites and self-fertile. Fruit is juicy and very delicious, and is high in iron and other nutrients. The fruit is probably named strawberry since the plants seed produce runners which look like straws and the beds are mulched with paddy straw to protect fruits from dust and earth.

The fruit is cholesterol free, low in calorie contents and good for heart and diabetic patients. It is high in vitamin C and ellagic acid content. So it is good for cancer patients. As its fruits contain sufficient folic acid, it is recommended to pregnant women before and after delivery. It is rich in minerals (Ca, P, K, and Fe) and is also used to make Jam, Jelly, flavouring for ice-cream, decoration of salads, cakes, etc.

#### Area and production

Of the total world production about 50% is produced in Europe, 30% in North America, and 20% in other countries (Japan, Australia, Newzeland, etc). Major producer are France, Italy, Poland, Spain, USA, Canada, Germany, Belgium, Japan, etc. In Nepal it is mainly grown in Kathmandu, Kaski (Pokhara, and Nuwakot (Kakani) districts with production trials in some other districts. The data on area, production and productivity are not documented so far.

## Climate and soil

It is grown under subtropical, warm temperate and temperate climates. Average maximum temperature is 25°C and average minimum temperature is 4°C. Optimum growth and development of plants and fruits occurs between 14 and 23°. Flowers are killed when temperature reaches -2°C or below. Frost also kills flowers. Flower development reduces at temperatures over 25°C. Optimum temperature for the period between onset of flowering and onset of ripening is 14° (early CVS), 15° (mid-season CVS) and 16° (late CVS). Strawberries are sensitive to photo-periods. Some cultivars need short days (SD) in autumn with hard winters. Some need long days (LD) in autumn with moderate winter and some are day neutral (DN) types. Rainfall should be 3000 to 4000mm. It can be grown successful from 1500 to 2500m altitudes from mean sea level.

Fertile, well-drained soil, rich in organic matter with pH 5.5 – 6.5 is good. Sandy soils and waterlogged areas are not good.

## Cultivar

**Nyoho:** Nyoho is a Japanese cultivar common in Nepal that is high yielding, early bearing, of good quality. Its fruits are desert type- almost heart-shaped-with firm flesh.

**Tioga:** Tioga is an early maturing type for both dessert and processing, with very large fruit, firm flesh and skin, TSS 7%, acidity 0.72%, LD in autumn and moderate in winter.

**Torrey:** Torrey is of excellent dessert quality, with large fruit large of medium firmness, TSS 7.4%, and acidity 0.7%.

**Senga Sengana:** This type yields berries with red skin and a medium firmness, SD in autumn and hard winter.

**Missionary:** The Missionary has a dull-red fruit, almost heart-shaped but somewhat rounded styler end, with firm flesh and a sour but aromatic taste.

SD types (Senga Senegana, Gorella, etc.) require Septentrional culture, which calls for short days in autumn and hard winters, while LD types (Tioga, Chandler, etc.) require Meridional culture—long days in autumn and moderate winters. DN types are Tribute,

Tristar, Silva, Fern, Hecker, Gem, Geneva, etc.

## **Propagation**

Strawberries are propagated by seed for research on breeding and variety development work. The commercial method is vegetative by runners (most common) and suckers. Micro-propagation or tissue culture using meristem/tip portion is also possible.

How are new plants produced from runners? Select healthy mother plants during the end of Chaitra (April), apply fertilizers around the plant, and it will send out runners. These runners can be trapped into plastic bags filled with soil mixture or potted separately. After a few weeks, if the growth of plants in the pot starts then rooting has occurred. The baby plant can be separated from the mother plant by cutting them about 2-3 cm from the mother plant. The soil mixture of the pot is 1 part well decomposed compost, 1 part rice bran/hull and 1 part soil. Add some oil cake powder. Production of these new plants should be completed from April to May/June (Baisak to Jestha). These new plants in the same bag should be kept for 3 months with adequate watering.

## **Planting**

Plough the land thoroughly 2-3 times to make the soil in good tilth. Clean the field, remove weeds stubble, etc. Make raised beds or plots of 90cm to 1m width, about 15cm high and long as necessary. Re-work the bed soil to make it friable, clean and levelled. Healthy runners free of disease and pests are planted in a double row system spaced at 30cm (plant to plant) and 40-50cm (row to row). A bed size of 60cm is okay for a one-row system. Keep bed-to-bed distances at 30cm.

Locate the exact position/area to be planted, and then dig ditch/holes. Mix compost, chemical fertilizers, and soil insecticides, fill back the holes and raise them. Take out the new plant from the bag, position the portion of the runner separated from the mother plant just opposite to the direction of the sunlight. This is necessary to maintain the direction of active growth of the plant/its parts towards the sunshine. Also the flowering and fruiting occurs more in the opposite direction of the separated cut portion of the runner. Plant population may depend upon spacing and planting systems but normally 45000 to 50000 plants/ha are considered adequate, although some growers accommodate even more. Irrigation is required soon after planting.

While planting, it is better to leave some more area towards incident direction of the sun's rays. Planting season is 2<sup>nd</sup> week of Bhadra to 1<sup>st</sup> week of Aswin (August-September). Don't let runners come from these plants. Otherwise, fruits can't be harvested in Magh-Falgun (January – February). The other planting season is Magh-Falgun. Soon after establishment of these plants, they start flowering. Remove these flowers at once. When the plants spread on the bed like mats, the flowering and fruiting will proceed to occur.

### **Training and pruning**

Since it is a herb, no special training is required as in perennial temperate fruits. However, plants may be trained to : (a) 1 stalk system (keep one original stalk and remove all runners), (b) 4 stalk system (keep 4 stalk spreading all direction), or (c) multi stalk system (keep several runners at 30- 35cm distance that come from the main stalk and remove all other runners. Dried leaves and newer runners must be frequently pruned or removed for better fruit growth.

### **Cultural operation**

#### **Manure and fertilizer application:**

Apply 30 MT of FYM or compost/ha during field preparation, all 80 kg phosphorus and 80 kg potash before planting in pits or in planting rows. 100 kg nitrogen is split giving 50 kg in September during planting or after establishment and the remaining 50 kg at flowering.

If nutrient deficiencies are noted, foliar sprays of the deficient nutrient are called for. For the ratoon crops, these major nutrients are given accordingly. Spraying micronutrient like Bo, Mn, Cu at 0.05% increases fruit yield by 13-20% and improve quality with increased sugar, pectin and vitamin C content. Boron plays a dominating role by increasing fruit yield and in controlling gray mould.

An Kakani, farmers are accustomed to applying manure and fertilizers at the rate of compost 30 Dokos, DAP 20 kg, Urea 5 kg, and potash 4 kg/ropani (at transplanting time) and top dressing in Poush (December) @ DAP 10 kg + urea 5 kg/ropani.

### **Irrigation**

Strawberry plants are shallow-rooted. So water is very essential in strawberry farming during in plant growth, flowering, and fruiting. At deficient moisture level in soil, fruit growth and fruit quality are drastically reduced. Frequent and light watering is necessary. In winter, irrigate orchards at 10 days intervals but in summer season, the frequency must be increased to every 2 or 3 days, especially during fruiting and fruit maturity periods. Drip or sprinkler irrigation is better than other methods in hilly areas. Do not water on leaves but to the soil near rooting area.

### **Mulching**

This practice is very helpful not only to reduce water requirements but also to minimize weed growth, keeping soil loose for root growth. Decay of mulch materials also improves soil fertility. In recent years, black polythene mulch is commonly used in strawberry orchards. Mulching also helps fruits avoid touching the soil, minimizing fruit rot problems. If the straw mulch is not used previously, as the fruits reach near to maturity, use mulch of dry straw, khar, pine needles or husk. Mulching is of utmost importance to save the fruit from dirt and rot, developing instead into quality fruit with good color and taste.

### **Netting**

When strawberries start ripening their sweet, soft, and juicy fruit attract not only man but also birds, which can damage fruits considerably. Netting and bird scaring devices must be kept in a strawberry field well before fruits reach maturity stage.

### **Fruiting**

The white or rarely pinkish flowers are borne in a cyme on leaflets peduncles. As fruit matures the receptacles enlarges into flesh edible part and pistils develop into small achenes. Thus the strawberry fruit is botanically an aggregate of achenes. Fruit matures from the base upward on the cyme. Within 4 to 5 weeks after planting, they starts flowering. They give fruits numbers ranging from 20 to 35, but not all at a time. The fruit that sets earliest matures first and gets big.

### **Harvesting and yield**

Fruit maturity indices are change in color from white yellow to redness and also an

increase in TSS. The right stage to harvest is when  $\frac{1}{2}$  to  $\frac{3}{4}$  of the fruit develops red color. Fruit is very perishable pluck fruits individually when the morning fog clears and moisture dries off the plant surfaces or in the late afternoon, but not during high and intense sunshine. To pluck strawberries, capture individual fruits between 2 fingers and pull lightly without damaging them.

From December to April (Mangsir to Chaitra), strawberry plants start flowering and fruiting. In January (i.e at the end of Poush), when fruiting from the 1<sup>st</sup> flush is completed, the older flowers trusses are cut out and then top dress and irrigate the plants. After 2-3 weeks of this operation, new flowering occurs in this second flush which will fruit until the end of Chaitra (April). The taste of fruit from the second flush is not good as of those from the first flush, so market value is less. It yields about 12-15 MT/ha.

### **Marketing and Storage**

After harvesting the fruits are sorted, separating inferior, diseased, malformed fruits from normal and quality fruits.

Use plastic trays or wooden bamboo trays with a 500g or 1000g capacity for packing. They are lined with cellophane sheets. They can be placed in plastic or paper cartons properly sectioned by sheets of cardboard. Soon after grading and packing, strawberries must be marketed quickly, as they are very perishable in nature. Fruits can be kept fresh for one day at room temperature of 20<sup>0</sup>C, but may be stored for 5 to 7 days at 0<sup>0</sup>C and 90-95% relative humidity.

### **Insect Pest of Strawberry**

Due to cooler season after planting, problems of insect and pests are not severe. However, aphids, red spider mites, strawberry blossom weevil, leaf rollers and nematodes are observed to affect fruit yields. Spray Malathion (0.5%) when plants are bearing fruits and Endosulphan (0.5%) when no fruits are present. Growers may consult agriculture offices, plant protection officers and research centers with specific pest problems to tackle. Harvest fruits only after 10 days of applying insecticides.

### **Disease of Strawberry**

After planting, the weather moves toward the cooler season and there is not many problems with diseases. However, some diseases reported are grey mould, wilt, powdery mildew, etc. Apply Thiram or Captan or Dinocap during March-April and June –July or before flowering.

# Unit – 16

## Cultivation practices of Lapsi

### LAPSI (*Choerospondias axillaris*)

#### Introduction

Lapsi are a native fruit of Nepal. The tall subtropical tree can be found growing in many parts of the country. The fruit is greenish-yellow when ripe and roughly resembles a small oval-shaped plum. It is extremely sour, even when fully ripe, and has high vitamin C content. The fruit has a tough fibrous skin and pale yellow flesh, which is firmly attached to a large brown seed.

#### Climate

It is cultivated in mid-hill at altitude of 1000-2000 masl. It requires 10<sup>0</sup>-32<sup>0</sup>C temperature. Annual rainfall of 750-1000 mm is ideal.

#### Soil

Can be grown in wide range of soil but sandy loam is best. It should be fertile and well drained. The pH ranges from 6.5-7

#### Method of propagation

It can be successfully propagated with chip budding. New bud starts from 20-25 days after chip budding. New bud also appears from rootstock so it should be removed otherwise the bud arising from chip budding may die. Chip budding can be done in Magh-Falgun.

#### Field preparation

Mix 50-60 kg well decomposed FYM to the soil which was dug out and fill it again up to 6 inch. This operation should be done in Mangsir.

#### Spacing and planting time

It can be planted as square system of planting with 10-12m of spacing is maintained.

About 120-140 plants prepared by chip budding is required for 1ha of land. Lapsi is transplanted to main field in Poush-Magh. Irrigation should be applied daily up to 8-10 DAT after then 4-5 irrigation in a week. To avoid bending anchorage should be applied.

### **Fertilizer**

FYM: 25-30 Kg/plant

In case of inorganic fertilizer:

<b>Year</b>	<b>Nitrogen (g)</b>	<b>Phosphorous (g)</b>	<b>Potassium (g)</b>
2	100	75	30
3	150	100	50
4	200	125	75
5	250	150	100
6	300	200	125
7	350	250	150

### **Intercultural operation**

After harvesting fruit harrowing should be done in open space in Kartik-Mangsir. Earthing up as well as weeding should be done in Poush-Magh. During rainy season weeding should be done in 15-20 days interval.

### **Mulching**

If there is lack of irrigation, mulching should be done to retain moisture during rain. This operation should be done in last of Magh or beginning of Falgun.

### **Irrigation**

Irrigate daily for few days after transplanting to the field. After then no irrigation is required but if there is dry condition. Irrigate during flower initiation period; fruiting period and fruit maturity stage. Proper facilities of drainage should be done during

rainy season.

## **Training and Pruning**

### **Training**

It is done up to 3 years of planting. 1<sup>st</sup> year: anchorage should be provided with bamboo stick to avoid bending. 2<sup>nd</sup> year: from ground level up to 1m is topped in Poush-Magh. 3<sup>rd</sup> year: 3-4 strong branches are kept which should be in all direction and other remaining branches should be removed; 1-2 branches which are situated in middle should be allowed to grow.

### **Pruning**

During first year of planting, the branches growing from the rootstock should be removed frequently as it arises otherwise chip budded portion may die. Once a year in Poush-Magh pruning should be done. Round shape is maintained by regular pruning.

### **Inter-cropping**

Different types of vegetables can be grown as inter-crop such as chilly, brinjal, tomato, broad leaf mustard, radish, cauli, cabbage, potato etc.

### **Time and method of Harvesting**

Plants propagated with chip-budding starts fruiting from 4-5 years of planting. Plants starts flowering in Chaitra-Baisakh and fruit mature and ripe after 7 months of flowering. Harvesting should be done when fruit colour changes to greenish yellow. Harvesting should be done in Kartik-Mangsir. There is high sugar content when fruit is still in the tree up to Magh. Traditionally, fruit is harvested by shaking the tree.