ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY

LAM, GUNTUR – 523 240, ANDHRA PRADESH

ANGRAU

PRACTICAL MANUAL

on

FRUITS, VEGETABLES AND THEIR MANAGEMENT

(Course No.: DA – 281)

Name:_____

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PREFACE

This Course material is prepared as ready reckoner to the Teachers and Students of Agricultural Polytechnics. This is compiled from different sources of information including previous manuals of ANGRAU and PJTSAU, online resources, and textbooks for easy understanding with relevant photos. The authors are thankful to the content providers.

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AUTHORS

Fruits, Vegetables and their Management
DA - 281
Credit Hours: 3 (2+ 1)

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Ex.No. 1 Date:_____

DESCRIPTION AND IDENTIFICATION OF FRUIT CROPS

Aim: To study the different fruits and their botanical description

S.No	Crop Name	Botanical description
1	Mango	Botanical name : *Mangifera indica* Family : Anacardiaceae Fruit : Drupe Economic part : Mesocarp
2	Banana	Botanical name : *Musa paradisiaca* Family : Musaceae Fruit : Berry Economic part : Mesocarp and endocarp
3	Citrus	Botanical name : *Citrus sps.* Family : Rutaceae Fruit : Hesparedium Economic part : Juicy placental hairs
4	Grape	Botanical name : *Vitis vinifera* Family : Vitaceae Fruit : Berry Economic part : Pericarp and Placentae
5	Guava	Botanical name : *Psidium guajava* Family : Myrtaceae Fruit : Berry Economic part : Thalamus and pericarp
6	Pomegranate	Botanical name : *Punica granatum* Family : Punicaceae Fruit : Balusta Economic part : Juicy seeded coat
7	Papaya	Botanical name : *Carica papaya* Family : Caricaceae Fruit : Berry Economic part : Mesocarp

8	Sapota	Botanical name	:	*Achras zapota*
		Family	:	Sapotaceae
		Fruit	:	Berry
		Economic part	:	Mesocarp
9	Apple	Botanical name	:	*Malus pumila / Malus sylvestris*
		Family	:	Rosaceae
		Fruit	:	Pome
		Economic part	:	Fleshy thalamus
10	Straw berry	Botanical name	:	*Frajeria spp.*
		Family	:	Rosaceae
		Fruit	:	Aggregate fruits
		Economic part	:	Fleshy thalamus

Assignment: Draw the diagrams of the all fruits neatly

Ex.No. 2 Date:_____

DESCRIPTION AND IDENTIFICATION OF VEGETABLES

Aim: To study the different vegetables and their botanical description

S.No	Crop Name	Botanical description
1	Tomato	Botanical name : *Solanum lycopersican* Family : Solanaceae Origin : Peruvian and Mexican region Economic part : Fruit (Berry)
2	Brinjal	Botanical name : *Solanum melongena* Family : Solanaceae Origin : Indo Burma region Economic part : Fruit (Berry)
3	Chilli	Botanical name : *Capsicum fruitiscens* – Bell pepper *Capsicum annum* - Chilli Family : Solanaceae Origin : Indo Burma region Economic part : Fruit
4	Bhendi/Okra	Botanical name : Abelmoschus esculentus Family : Malvaceae Origin : South Africa Economic part : Fruit (Pod)
5	Dolichos bean	Botanical name : *Dolichos lablab* Family : Fabaceae Origin : India Economic part : Fruit (Pod)
6	Cluster bean	Botanical name : *Cyamopsis tetragonolobus* Family : Fabaceae Origin : West Africa Economic part : Fruit (Pod)
7	French bean	Botanical name : *Phaseolus vulgaris* Family : Fabaceae Origin : Central America Economic part : Fruit (Pod)

8	Cowpea	Botanical name	:	*Vigna uniguiculata*
		Family	:	Fabaceae
		Origin	:	West and East Africa
		Economic part	:	Fruit (Pod)
9	Pea	Botanical name	:	*Pisum sativum*
		Family	:	Fabaceae
		Origin	:	Ethiopea
		Economic part	:	Fruit (Pod)
10	Cucumber	Botanical name	:	*Cucumis sativus*
		Family	:	Cucurbitaceae
		Origin	:	Indo Chaina
		Economic part	:	Fruit (Pepo)
11	Ridge gourd	Botanical name	:	*Luffa acutangula*
		Family	:	Cucurbitaceae
		Origin	:	Spain
		Economic part	:	Fruit (Pepo)
12	Bottle gourd	Botanical name	:	*Lagenaria siceraria*
		Family	:	Cucurbitaceae
		Origin	:	Malabar region of India
		Economic part	:	Fruit (Pepo)
13	Snake gourd	Botanical name	:	*Trihcosanthesanguina*
		Family	:	Cucurbitaceae
		Origin	:	China
		Economic part	:	Fruit (Pepo)
14	Pumpkin	Botanical name	:	*Cucurbita moschata*
		Family	:	Cucurbitaceae
		Origin	:	North America
		Economic part	:	Fruit (Pepo)
15	Water melon	Botanical name	:	*Citrullus lanatus*
		Family	:	Cucurbitaceae
		Origin	:	South Africa
		Economic part	:	Fruit (Pepo)

16	Onion	Botanical name	:	Allium cepa
		Family	:	Alliaceae
		Origin	:	Central asia
		Economic part	:	Bulb
17	Garlic	Botanical name	:	Allium sativum
		Family	:	Amaryallidaceae
		Origin	:	Utter Pradesh/ India
		Economic part	:	Cloves
18	Cabbage	Botanical name	:	*Brassica oleracea* var *capitata*
		Family	:	Brassicaceae
		Origin	:	Mediterranean region
		Economic part	:	Head
19	Cauli flower	Botanical name	:	*Brassica oleracea* var *Botrytis*
		Family	:	Brassicaceae
		Origin	:	Mediterranean region
		Economic part	:	Curd
20	Carrot	Botanical name	:	*Daucus carota*
		Family	:	Apiaceae
		Origin	:	Central Asia
		Economic part	:	Root
21	Radish	Botanical name	:	*Raphanus sativus*
		Family	:	Brassicaceae
		Origin	:	Europe and Asia
		Economic part	:	Root
22	Beetroot	Botanical name	:	*Beta vulgaris*
		Family	:	Chenapodiaceae
		Origin	:	Mediterranean area
		Economic part	:	Root
23	Amaranthus	Botanical name	:	*Amaranthus blitum*
		Family	:	Amaranthaceae
		Origin	:	Central and South America
		Economic part	:	Leaves

24	Palak	Botanical name	:	*Beeta vulgaris* Var. Bengalensis
		Family	:	Chenopodiaceae
		Origin	:	Indo – China
		Economic part	:	Leaves
25	Drumstick	Botanical name	:	*Moringa olerifra*
		Family	:	Moringaceae
		Origin	:	South West India
		Economic part	:	Fruit (Pod)

Assignment: Draw the diagrams of the all fruits neatly

Ex.No. 3 Date:_____

COMMERCIAL VARIETAL DESCRIPTION OF MANGO

Aim: To study the different commercial varieties and hybrids of mango and their description

There are nearly 1000 mango varieties in India. Of these, however only about 20 varieties are grown on a commercial scale.

The commercial varieties of mango in India are specific to different regions of the country.

The important commercial varieties of mangoes

Andhra Pradesh	Banganapalli, Suvarnarekha, Neelum and Totapuri
Bihar	Bombay Green, Chausa, Dashehari, Fazli, Gulabkhas, KishenBhog, Himsagar, Zardalu and Langra
Gujarat	Kesar, Alphonso, Rajapuri, Jamadar, Totapuri, Neelum, Dashehari and Langra
Haryana	Chausa, Dashehari, Langra and Fazli
Himachal Pradesh	Chausa, Dashehari and Langra
Karnataka	Alphonso, Totapuri, Banganapalli, Pairi, Neelum and Mulgoa
Madhya Pradesh	Alphonso, Bombay Green, Dashehari, Fazli, Langra and Neelum
Maharashtra	Alphonso, Kesar and Pairi
Punjab	Chausa, Dashehari and Malda
Rajasthan	Bombay Green, Chausa, Dashehari and Langra
Tamil Nadu	Alphonso, Totapuri, Banganapalli and Neelum
Uttar Pradesh	Bombay Green, Chausa, Dashehari and Langra
West Bengal	Fazli, Gulabkhas, Himsagar, Kishenbhog, Langra and Bombay Green

Varieties grown and recommended for different tracts of Andhra Pradesh:

Coastal districts: Suvarnarekha, Baneshan, Juicy varieties and Rajpuri.

Rayalaseema area: Neelum, Bangalora, Baneshan, Rumani, Cherukurasam, and Panchadarakalasa.

The important mango varieties grown on a commercial scale in AP are- Baneshan, Neelum, Bangalora, Rumani, Khader, Mulgoa, Panchadarakalasa, chinasuvarnarekha, cherukurasam, Janardhanpasand.

Classification depending on utility:

1. **Table varieties:** Baneshan, Neelum, Bangalora, Rumani,Alphonso,Mahamooda and Goa bunder.
2. **Juicy varieties:** Chinnarasam, Peddarasam, Cherukurasam, Kothapallikobbari, Panchadarakalasa. Panakalu, Phirangi laddu.
3. **Table and juicy varieties:** Chinnasuvarnarekha , Peter.
4. **Off-season Varieties:** Neelum, Bangalora, Baramasi, Rumani,Royal special.
5. **Pickle varieties:** Achar pasand, Tellagulabi of Nuzivid, Alipasand, Guddemar (Hamlet)
6. **Varieties for preservation:** Baneshan and Bangalora.

Commercial varieties and their description

1. **Alphonso**

   One of the most popular variety of India, it is mainly grown in Ratnagiri area of Maharashtra and to a small extent in parts of south Gujarat and Karnataka. Its fruits are medium-sized (250g), with attractive blush towards the basal end. Pulp is firm, fibreless with excellent orange colour. It has good sugar : acid blend. Keeping quality is good. It is susceptible to spongy tissue.

2. **Baneshan /Banginapalli**

   A widely cultivated, early-maturing mango of south India. It is the main commercial variety of Andhra Pradesh. Its fruits are large-sized, weighing on an average 350–400g. The pulp is fibreless, firm and yellow with sweet taste. Fruits have good keeping quality.

3. **Bombay Green**

   It is one of the earliest varieties of north India. Its fruits are medium-sized, weighing about 250g each. Fruits have strong and pleasant flavour. Pulp is soft and sweet.

4. **Chausa**

   Late-maturing variety of north India, it matures during July or beginning of August. Fruits are large, weighing about 350g each. Fruits are bright yellow with soft and sweet pulp.It is shy bearing.

5. **Dashehari**

   One of the most popular variety of north India, it is a mid-season mango. Fruits are medium-sized, with pleasant flavour, sweet, firm, and fibreless pulp. Stone is thin and keeping quality good.

6. Gulab Khas

It is indigenous to Bihar. Regular and heavy-bearer, it is mid-season mango. Fruits are small to medium-sized. It has rosy flavour. Fruits are ambre-yellow with reddish blush towards the base and on sides. Keeping quality is good.

7. Kesar

Popular in Saurashtra region of Gujarat, Kesar is an irregular-bearing mango. Fruits are medium-sized. Flesh is sweet and fibreless. It has excellent sugar : acid blend. Fruits ripen to attractive apricot-yellow colour with red blush. It has good processing quality.

8. Langra

An important commercial mango variety of north India, it is biennial-bearer and a mid-season variety, with good quality fruits. Flesh is firm, lemon-yellow in colour and scarcely fibrous. It has characteristic turpentine flavour. Keeping quality is medium.

9. Neelum

A heavy-yielding, late-season mango in south India, it has regular-bearing habit. Fruits are medium-sized with good flavour. Flesh is soft, yellow and fibreless. Keeping quality is good.

10. Totapuri

Widely grown in south India, Totapuri is a regular and heavy-bearing mango. Fruits are medium to large with prominent sinus. Fruit quality is medium. It has a typical flavour and flat taste. Flesh is cadmium-yellow and fibreless.

Mango hybrids and their characters

S.No	Hybrid	Place of research	Parentage	Important characters
1	Mallika	IARI, New Delhi	Neelum× Dashehari	Regular-bearers, high TSS, good colour, uniform fruits, moderate keeping quality
2	Ratna	FRS, Vengurla	Neelum × Alphonso	Regular-bearers, free from spongy tissue and fibre
3	Arka Puneet	IIHR, Bangalore	Alphonso× Banganapalli	Regular-bearer,attractive skin colour, medium-sized, free from spongy tissue. Good keeping quality, good sugar : acid blend

Assignment: Draw the diagrams of the mango varieties

Ex.No: 4 Date:_____

COMMERCIAL VARIETAL DESCRIPTION OF BANANA

Aim: To study the different commercial varieties of banana and their description

India has an array of cultivars grown throughout the country depending upon preference, resource availability and production system.

In banana there are three types. They are table varieties, culinary types and hill bananas. There are several varieties in banana but the commercially important varies are-

1. **Table varieties:** Poovan, dwarf Cavendish, Robusta, Grand nine, Rasthali, Grosmichel, Virupakshi, Nendran, Monthan.
2. **Culinary varieties:** Monthan. There are also other varieties like Yenugubontha and boodidhabontha belonging to this group.
3. **Hill Bananas**: Virupakshi (Syn: Sirumalai)

Banana cultivars grown in different states of India

State	Cultivars
Andhra Pradesh	Dwarf Cavendish, Robusta, Rasthali, Amritpant, Thellachakrakeli, KarpooraPoovan, Chakrakeli, Monthan and YenaguBontha
Assam	Jahaji (Dwarf Cavendish), Borjahaji (Robusta), Honda, Manjahaji, Kulpait and Bharat Moni
Bihar	Dwarf Cavendish, Alpon, Muthia, Kothia and Gauria
Gujarat	Dwarf Cavendishand Gandevi Selection
Karnataka	Dwarf Cavendish, Robusta, Poovan, Rasabale (Rasthali), Hill Banana, Monthan and Elakkibale
Kerala	Nendran (Plantain), Palayankodan (Poovan), Rasthali, Monthan and Red Banana
Maharashtra	Dwarf Cavendish, Basrai, Robusta, Lal Velchi, Safed Velchi, RajeliNendran and Clones of Basrai
Tamil Nadu	Virupakshi, Robusta, Red Banana, Poovan, Rasthali, Nendran, Monthan, Karpuravalli, Sakkai, Peyan and Matti
West Bengal and Orissa	Champa, MortmanRasthali, Amrit Sagar, Giant Governor, Lacatan and Monthan

Commercial varieties and their description

1. **Dwarf Cavendish /Basrai /Vamanakeli**

   It is the leading commercial cultivar contributing to 58% of the total production owing to its high yield, ability to withstand strong winds, The selection produces bunches weighing 55–60kg and performs better under light soil condition with higher inputs. It will take 11 months duration for harvesting. It tolerant to Panama wilt

2. **Robusta /Pedda Pacha Arati**

   The plants bear bunches weighing 25–30kg each with good-sized slightly curved fruits. Plants take approximately a year to complete their life-cycle. Like Nendran it is freshly planted every year. Propping requirement makes the crop investment intensive. It is highly susceptible to sigatoka leaf spot limiting its cultivation in humid areas but is resistant to Panama wilt.

3. **Grand Naine**

   It is a tall mutant of Dwarf Cavendish. Well-spaced hands, fingers of bigger size and heavy bunches. It bears bunches weighing 25–30kg with uniform long fingers throughout the bunch. Crop takes about 12 months to come to harvest

4. **Rasthali/Amrithpani**

   This is the choicest table banana for its tasty, crisp, good sour-sweet blended and pleasant flavoured fruits. Plant is medium-statured. Crop takes about 13–15 months to come to harvest with bunches weighing 15–18kg each. It has about 6–7 hands with bold, stout fruits, turning golden-yellow on ripening.

5. **KarpuraChakkarakeli**

   It is the leading commercial cultivar of southern and north-eastern states. It bears heavy bunches weighing 20–24kg each with closely packed short and stout fruits having a conspicuous beak. The fruits/bunch vary from 150–300. Though fruits are slightly acidic and crop duration is 16–17 months. However, it is severely affected by banana-streak virus.

6. **Tellachakkarakeli**

   It is the leading commercial cultivar of east and west Godavari districts. It bears bunches weighing 6-8kgs. The fruits/bunch vary from 60-80, crop duration is 12 months. However, it is resistant to Panama wilt.

7. **Nendran**

   Bunch weight varies from 8 to 15kg with 30–50 fingers/bunch. Fruits have a distinct neck with thick green skin turning buff-yellow on ripening. The fruits remain starchy even on ripening.

8. **Virupakshi /Sirumalai**

   Long-duration crop, tall stratured, small bunches and curved fruits are constraints. Bunches weigh 11–13kg each having on an average 60 stout fruits/bunch. Fruits have a very good keeping quality.

9. **Bontha / Monthan**

   It is fairly tall and robust, growing to a height of 2.5–3.0m. Its bunches weighing 18–20kg each bear 60–70 fruits which are bold, stocky, knobbed and pale-green. A few allied members of Monthan are suited for making chips.It is susceptible to Panama wilt.

10. **YenuguBontha**

    It is a mutant variety. Its bunches weighing 18–20kg each bear 60–70 fruits. Crop takes about 13–15 months to come to harvest and susceptible to Panama wilt.

Assignment: Draw the diagrams of all banana varieties

Ex.No. 5 Date:_____

IDENTIFICATION OF IMPORTANT CITRUS SPECIES

Aim: To study the different species of citrus

There are several citrus fruits in the world. Some are ancient ones and some are recent ones. Citrus species readily crosses with each other .so new types are coming up from time to time.

There are 16 species in the genus Citrus as per Swingle (1943) and 144 species as per Tanaka (1950).Hence classification of the kinds and varieties are complicated. An abundance of locally used names and changing botanical nomenclature also hinders distinct classification.

Some of the Important Citrus Species:

S.No	Common Name		Scientific Name
1	Sweet orange	:	*Citrus sinensis*
2	Mandarin Orange	:	*Citrus reticulate*
3	Acid lime	:	*Citrus aurantifolia*
4	Lemon	:	*Citrus limon*
5	Grape fruit	:	*Citrus paradise*
6	Pummelo	:	*Citrus grandis*
7	Citron	:	*Citrus medica*
8	Sweet lime	:	*Citrus limettoides*
9	Gaganimma	:	*Citrus pennivesiculata*
10	Vadlapudi Orange	:	*Citrus madaraspatana*
11	Sour Orange	:	*Citrus aurantium*
12	Rough lemon	:	*Citrus jamberi*
13	Rangapur Lime	:	*Citrus limonia*

Assignment: Draw the diagrams of all citrus species

Date:_____

Ex.No. 6

EXTRACTION OF PAPAIN FROM PAPAYA FRUITS

Aim: To study the procedure, extraction and uses papain

Papain:

- The cultivation of Papaya for producing papain will be a profitable proposition. Substantial quantities of papain can be extracted by adopting correct techniques.
- Papain is the proteolytic enzyme present in the milky latex obtained from green fruits of papaya. This enzyme is exclusively exported and there is great demand in the international market.
- Papain is used in breweries, especially for clarification of beer, medicines, cosmetics, tanning industry, tenderization of meat and fish, extraction of animal and plant protein from various animals and plants etc.
- In the medicinal field, papain finds use in the treatment of insect bites, itching of skin, cancer, displaced disk in the spinal cord, dyspepsia and other digestive ailments, ring worm infection, skin lesions and disorders of kidney. Several proprietary pharmaceutical preparations using papain are available in the market now.

Papain extraction:

- The latex should be tapped from 75 to 90 days old immature papaya fruits early in the morning up to 10.00am.
- On the selected fruit, four longitudinal incisions should be given using a razor blade attached to bamboo splinter. The depth of the cut should not be more than 0.3cm.
- The tapping has to be repeated four times on the same fruit at an interval of 4 days. The latex should be collected in aluminum trays and shade dried. The dried latex is then packed in polythene bags.
- Before drying, potassium meta-bi-sulphate (KMS) 0.05% has to be added to the latex for better colour and keeping quality. The latex can also be dried in oven at a temperature range of 50-55 OC.
- Papain yield ranges from 1.23g to 7.45g per fruit and the cultivar. Washington variety recorded the highest mean yield of 7.45g per 100-150g of dried latex / tree / year.

- Varieties suitable for Papain: CO-2, CO-4, CO-5, Coorg honeydew, Pusa majesty and Pusa delicious.

Time for papain extraction: Cool and wet period–gives more papain. July to August is the best period.

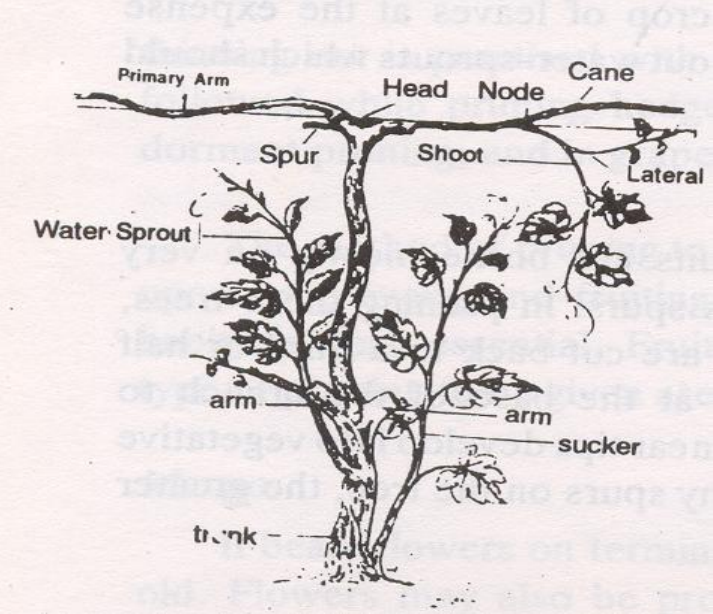
Assignment: Draw the diagrams of papain extraction

Ex.No. 7 Date:_____

TRAINING AND PRUNING IN GRAPE

Aim: To study the different training and pruning methods in grape

Proper methods of pruning and training contribute towards higher production of better quality fruits in grape. Training mainly concerns with giving the form and the direction of the trunk and arms and the position of the shoots. Before actually discussing the subject of training and pruning it is necessary to understand the various terms commonly used in these operations to make the subject more intelligible.



1. **Trunk:** The main stem of the vine which is vertical
2. **Arms/Cordons (Primary):** The main branches arising from the trunk or extensions of the trunk usually grow vertically
3. **Arms/Cordons (Secondary):** The branches arising from primary arms or extensions of the primary arms or cordons.
4. **Head:** The region of the trunk from which the arms or canes arise
5. **Shoot:** The young growth(herbaceous) of the current season developing from a bud situated on the arm or trunk
6. **Shoot** : The matured shoot of the past season
7. **Spur:** The shortened cane or part of the cane left after pruning
8. **Fruiting spur** : The spurs having a few buds some of which (usually the apical ones) sprout and grow into fruiting shoots.

Training: In the natural habitat, a grape vine is robust climber but it can be trained on any fashion. Although a no. of training systems are known only four namely bower, kniffin, telephone trellis, and head system are followed in India.

1. **Head System:**
   - This is the cheapest and easiest system of training grape vines. In this system the vines are trained like dwarf bush.
   - Less vigorous varieties and varieties producing fruitful shoots from the basal buds are suitable for this system. Ex. Beauty seedless, Perlette, Delight and Gold.
   - In this system the plants are spread very closely to accommodate 2000-2500 plants per acre.
   - The vine is allowed to grow to a single stem with the help of stakes. After attaining a height of 3‘ the plant is topped and two lateral branches are encouraged.
   - The plant is again topped at 4‘ height by which two or more laterals are developed. After keeping 4 laterals, the rest of the shoots are thinned out.
   - These later cut to two buds at the first dormant pruning, will produce secondary arms.
   - Generally two arms of about 20-30cm are kept on each lateral.
   - At the time of second pruning, normally 1-2 fruiting spurs are kept on each secondary arm. After 3-4 years, the vine becomes like a dwarf bush and needs no stake.

Advantages:

- Simplicity in shape
- Ease in training
- In expensive to establish
- Possibility of cross cultivation

Dis-advantages:

- The vines are slow to come to full production
- Increased possibility of bunch rot and poor colour
- The bud and flower drop is maximum compared to other systems.

2. **Pendal System:**
   - This system is also called as Arbour, Pergola, Mandwa, Over head or Bower system.
   - In this system the vines are spread over a criss cross net work of wires usually 7‘ (2.1m) above the ground supported by pillars(Concrete, stone or iron).

- Galvanized wires of 5,8 and 10 gauge thickness and turning buckles are used.
- Only the best growing shoot from the plant is allowed to grow upright along the stake provided up to the bower height.
- When the vine reaches the wires, it is pinched off 15cm below the pendal level to facilitate production of side shoots close to the wires.
- Two vigorous shoots in opposite direction are selected and allowed to grow in opposite directions on the wires overhead.
- These two shoots develop into primary arms. On each primary arm three laterals on either side at a distance of 60cm (2‘) (along the wires) are kept as secondary arms.
- Thus, there will be 12 secondary arms on each, which after maturity form fruiting canes.
- These primary and secondary arms for the permanentframe work of the vine. The vines are allowed to trail straight along the wires by tying intermittently with banana fibre.

Advantages:

- Greater spread of the vines.
- Better exposure of the foliage to the sun, resulting in better maturity of the canes.
- Higher production.
- More uniform bunch colour
- Superior quality of fruits, which are free from sunscald.

Dis advantages:

- It is the most expensive than all other systems
- Pruning, training and spraying operations become difficult
- The spraying material cannot reach effectively the leaves and shoots.

3. Telephone system (Over head trellis / Telephone trellis system):

- This system is suitable for moderately vigorous varieties with more apical dominance.
- It is relatively less expensive than kniffin system.
- The usual spacing provided for each vine is 3x3m.
- Trellies are erected by using the granite stone pillars of 8‘ length and 6”x6” thick at the ends and 8”x4”x4” in the middle of the lines.
- The middle pillars may be spaced at 20‘ distance. Cross arms of 41/2‘ length are fixed on each pillar at a height of 5‘.These can be iron blades of 4”width and ¼” thick or the angle iron pieces of 2”x2” width and¼” thick.

- Three wires of 8 gauge thick galvanized iron are pulled horizontally over the cross arms at a regular spacing of 2‘ using turning buckles at the end of pillars are supported side ward.
- In this system the vines are allowed to grows straight up to a height of 1.5m (5‘) and then trained over head on a canopy of usually 3or 4 wires (45-60cm apart) fixed to the cross angle arms supported by vertical pillars or posts.
- The young growing vines are supported by bamboo sticks. After reaching the height of telephone (5‘) the tip should be pinched off to encourage side shoots close to wires.
- Two vigorous side shoots (cross to wires) are selected as primary arms from which four vigorous laterals on each side along the wires are allowed to develop on secondary arms.
- Each complete secondary arm can carry 6-8 fruiting units.

Advantages:

- Greater spread of the vine
- Better exposure of the foliage to the sun resulting in the better maturity of canes.
- Higher production
- More uniform bunch colour
- Superior quality of fruits free from sunscald
- Vines in general give more uniform performance.

Dis advantages:

- Cost of establishment is high. At present rates it may cost 60-70 thousand rupees.
- It is a system difficult to develop i.e. vine training needs a lot of skill and effort.
- The bunches are not as well exposed to light as kniffin system.
- Not suitable for vines making low to moderate growth.

4. Kniffin System:

- It is also called as **espalier** system.
- It is a system of training grape vine in which the arms of the vine are tied to horizontal wire at the same level above the ground.
- This system is not as common as the bower system.
- It is suitable for the moderately vigorous varieties with less apical dominance.
- Closer planting is adopted for this training system with in the row and 3m (10‘) between the rows.

- Galvanized iron wire of 8 gauge thickness is stretched parallel to the ground at a height of 75cm above which two or more wires are stretched at successive heights of 60cm.
- When the plant crosses the first it is topped leaving a bud above the wire.
- Two laterals are developed on either side of the plant along the wire and the terminal shoot is allowed to grow vertically.
- Similarly, a pair of laterals is developed along the second and third wire. Thus each vine will have six arms.
- In some cases only two pairs of laterals are developed at a height of 41/2‘ (1.35m) and 61/2‘ (1.95m) from the ground level and in such cases it is called four arm kniffin system.
- This system is suitable for Beauty seedless, Early Muscat, Bhokri and Delight.

Advantages:

- This system is cheaper when compared with bower system.
- It is good for small clustered varieties which require fruit thinning for improved quality.
- The system allows more lateral spread of fruit bunches than cordon system.
- The average yields are 10-15kg per vine when planted at 3.0 mx3.0 m spacing.

Dis-advantages:

- Cultivation is possible in one way
- The lower arms become unproductive after some years.
- The arms produce fruiting wood mainly at the extreme ends only.
- Its cost of establishment is about 50-60 thousand rupees per hectare.
- This system is mainly confined to research institutes and it is not popular with the farmers in any of the regions of the country.

Pruning:

- In grape pruning is done only once in North India during the month of January to make the fruitful buds to sprout but in south India, pruning is done twice in a year, once in summer and again in winter.
- Grape vines in these regions grow continuously without any dormancy (due to tropical climate).Hence by pruning in April (summer) the vines are forced to have a rest period, which helps in fruit bud differentiation.

- Pruning time mainly depends on rainfall and temperature. Pruning is adjusted so that there is no coincidence of rainfall with fresh growth and flowering and also winter doesn‘t set in with in 8-10 days after pruning.

Pruning refers to the judicious removal of any plant part

- To establish and maintain desired vine shape
- To increase productivity
- To facilitate various cultural operations
- To distribute proper amount of bearing wood over the vein
- For consistent productivity

Summer pruning:

It is done during March-April in the states of A.P. and Karnataka, but in July in Tamil Nadu.In this pruning the canes are cut back to one or two bud level for building up the fresh vegetative growth. Hence it is called **back pruning** or **growth pruning**.

Winter pruning:

This is done during the last week of November in A.P. and Maharastra, and in December in Tamilnadu. The mature canes (about 6 months old) are pruned. Entire foliage and immature shoots are removed. Levels of pruning differs with varieties.Anab-e-shahi and Bhokri are pruned to 5 bud level, Thompson seedless to 10 buds, Bangalore Blue to 4 buds and Gulabi to 9 buds. This pruning is also called as **forward pruning**.

- Some of the varieties like Perlette, Beauty seedless, Bangalore blue, Bhokri etc. produce fruits on the shoots arising from the basal buds on the cane. In such varieties the canes are headed back to 4-5 buds. Such varieties are called **Spur pruned** varieties**.**
- On the other hand the Pusa seedless, Thompson seedless varieties in which the fruitsare produced on the shoots arising from terminal buds, the canes are headed back to 8-12 buds. Such varieties are called **Cane pruned** varieties**.**

Assignment: Draw the diagrams of all training methods followed in grape

Ex.No. 8 Date:_____

LAYOUT OF KITCHEN GARDEN

Aim: To study the different features and layout of a kitchen

Introduction:

Kitchen garden is the growing of fruits and vegetables at the backyard of house by using kitchen waste water. Otherwise called as Home garden or Nutrition garden or Kitchen gardening or Vegetable gardening

Advantages of Kitchen garden:

- Supply fresh fruits and vegetables high in nutritive value.
- Supply fruits and vegetables free from toxic chemicals.
- Help to save expenditure on purchase of vegetables.
- Vegetables harvested from home garden taste better than those purchased from market.
- Effective utilization of kitchen waste water and kitchen waste materials.
- Exercise to the body and mind.

Site selection:

- Backyard of house
- Preferably open areas with plenty of sunlight near the water source

Size and shape of vegetable garden depends on

  - Availability of land
  - Number of persons in family and
  - Spare time available for its care
- Nearly five cents of land (200 m^2) is sufficient to provide vegetables throughout year for a family consisting of five members
- A rectangular garden is preferred than a square plot or a long strip of land.

Crops suited for Kitchen garden:

- Fruits: Mango, Banana, Sapota, Guava, Papaya, Acid lime, Amla
- Vegetables: Tomato, Brinjal, Chilly, Onion, Bhendi, Bitter gourd, Snake gourd, Ridge gourd, Bottle gourd, Cucumber, Cluster bean, Cowpea, Dolichos bean, Amaranthus, Palak, Gogu, Beetroot, Radish, Curry leaf, Moringa
- Spices: Turmeric, Ginger, Coriander, Fenugreek

Layout of Kitchen garden

- Fence – Barbed wire fence or live fence with agathi
- Perennial crops (Mango, Sapota, Acid lime, Amla, Morniga) should be planted at the peripheral areas of kitchen garden
- One or two compost pits may be provided on one corner
- Fences on all sides should be trained with Cucurbitaceous vegetables (Bottle gourd, Bitter gourd and Snake gourd)
- Some vegetables are direct sown – (Amaranthus, Bottle gourd, Bitter gourd and Snake gourd)
- Some vegetables are nursery transplanted (Tomato, Brinjal, Chillies, Onion)
- Divide the area into equal sized plots for raising annual vegetable crops
- As intensive and continuous cropping is done in a kitchen garden.
- Fertility and texture of soil may be maintained by applying adequate quantities of organic manures frequently.
- Ridges and furrows are formed in each plots.
- Season of planting: June – July, September – October
- Bee-hive may be provided for ensuring adequate pollination of crops besides obtaining honey.
- However, in order to harvest good crop, chemical fertilizers are also essential.
- Pick and destroy the larvae found on fruits and vegetables and then spray Neem oil @ 4 ml/liter of water or Neem Seed Kernel Extract @ 3 %.
- Avoid spraying of toxic chemicals.
- Spacing for crops

Tomato, Brinjal and Chillies	:	60 x 60 cm
Cow pea	:	60 x 45 cm
Bitter gourd	:	2 x 2 meter
Onion	:	15 x 10 cm
Tapioca	:	60 x 60 cm
Yam	:	60 x 60 cm

- Initially irrigate the plots and transplant the seedling at the required spacing and irrigate on the third day of planting.
- Direct planting dibble 2-3 seeds/hill and irrigate sufficiently and also irrigate on the third day of sowing after germination thin 2 seedling.

Maintenance of Kitchen garden

- Grow the plants on the fence by training

- Dump all the kitchen waste in the manure pits and maintain in wet condition

Irrigation: As and when necessary

Manures and Fertilizers:

- Apply the decomposed kitchen waste to all the crops
- Complex fertilizers @ 5 gram/plant at 30, 60 and 90 day of planting

Weeding: As and when necessary

Harvest: When there is a colour change from green to yellow or orange

Plat Protection

- Pick and destroy the larvae found on fruits and vegetables and then spray
- Avoid spraying of toxic chemicals.

Organic method of plant protection

- Neem oil
- Neem seed kernel extract
- Panchakavya

Implements used in kitchen garden

- Spade, Pick Axe, Hoe, Hand sprayer, Secature

Assignment: draw a neat layout modern kitchen garden indicating the cropping patteren in each plot

Ex.No. 9 Date:_____

NURSERY RAISING TECHNIQUES IN VEGETABLE CROPS

Aim: To study the establishment of a nursery, preparation of nursery beds and sowing of seeds

Nursery: Nursery is a place where plants are grown, nurtured and sold out. Generally, various commercial crop growers require a good quality saplings or grafts of genuine type.

The importance of the best quality planting material as an initial investment is a well realized factor for persons engaged in Horticulture field. But in general good quality & assured planting material at reasonable price is not available.

Certain vegetables like tomato, brinjal, chillies, cabbage, cauliflower, knolkhol etc respond well to transplanting because they are able to regenerate roots in large numbers in a short time after transplanting.

Advantages of nursery raising in vegetable production

- → It is very easy and convenient to look after the young tender seedlings growing in a small but compact area of a nursery.
- → Favourable conditions of growth can be provided easily to the growing seedlings in a nursery.
- → It eliminates the problem of seed emergence in heavy soils.
- → It provides temporary protection from extreme weather conditions.
- → Timely and easy management of pests and diseases in short growing period of 4-5 weeks.
- → Weed control is easy in a small compact area.
- → There is economy of land and more time is available for the preparation of land where transplanting is to be done.
- → Uniform crop can be harvested if the crop is raised through nursery sown seedlings.

Layout and Management of vegetable nursery

1. **Selection of site:** As far as possible, the nursery bed should be selected in an elevated open space that is away from the shade and root system of the trees. The selected soil should be well be drained, rich in organic matter and the pH range should be in between 6-7 and free from soil born pests and diseases.

2. **Fence:** Prior to the establishment of a nursery, a good fence with barbed wire must be erected all around the nursery to prevent trees pass of animals and theft. The fence could be further strengthened by planting a live hedge, with thorny fruit plants.
3. **Sterilization of nursery beds:** It is mainly done to protect the seedlings from the soil born pests and diseases by two ways.

a) **Physical Sterilization:** the dried leaves and other waste material is spread over the ground and burnt. This helps in killing the exposed grubs and soil pathogens.

b) **Chemical Sterilization:** If there a gap of 7-10 days for sowing the seed, formalin can be used @10ml/lt of water. For effective absorption of chemicals, cover the drenched area with polythene sheet. If the seed is to be sown immediately 0.2 to 0.3% copper fungicide solution may be used for drenching. For controlling grubs and other soil born insects phorate 10g or Thimmet 10G should be used @2-5gm square meter area.

4. **Soil Preparation:** Dig the soil to 20cm depth by using crow bar or spade and expose the soil to the sun. Then the soil is made in to beds of convenient size. During land preparation well decomposed FYM or compost or leaf mould is incorporated for enriching the fertility and physical condition of the seed bed.
5. **Seed bed preparation:** The width of the bed should not exceed 1m to avoid trampling, while attending the needed operations like watering, weeding, manuring, raking etc. the length may be about 3 meters. In between two seed beds leave a gap of 30cm which can serve as paths or drainage channels to let out surplus rain water.

Types of nursery beds

a) Raised nursery bed: the level of the seed bed can be raised to 15cm height from ground level after removing the pebbles, stones, plant stumps and other unwanted materials. This facilitates better drainage flow and reduces the incidence of damping off.

b) Flat nursery bed: These are preferred where the rainfall is not heavy, Field is levelled and well drained. It is also easy to prepare. The soil however becomes more compact and roots may damage during uprooting the seedlings.

c) Sunken nursery bed: In dry areas, the bed is kept 10−15 cm below the ground level, which helps in conserving water. It facilitates the deposition of irrigation water or rainwater for a longer time. In case of water scarcity, this type of bed helps to conserve the moisture.

6. **Seed treatment:** only viable seed of required variety has to be selected. It should be free from weeds and off types. The seed should be treated with Thiram or Captan @2-3g/kg of seed.
7. **Seed sowing:**

→ Sow the seeds at 1 cm depth.

→ The general rule for sowing depth is 2-3 times of the thickness of seed.

→ Mix a little of sand in the seed for uniform distribution in the rows and cover it with soil or farmyard manure.

→ Avoid broadcasting seeds in the nursery-bed. Thick sowing or sowing with broad casting also leads to increase in an incidence of damping off disease.

8. **Watering**

→ Provide light irrigation to the nursery beds with rose can till the seeds germinate.

→ During summers, irrigate the beds twice in a day i.e. both morning and evening.

→ During winters, irrigation once in a day is sufficient.

→ Keep beds moist but not wet otherwise “damping-off of seedling” may appear.

→ Watering in the beds depends upon the weather condition. If temperature is high, irrigation is applied whereas irrigation is not needed during rainy days.

9. **Thinning**

→ It is an important operation to remove weak, unhealthy, diseased, insect-pest damaged and densely growing plants from the nursery beds keeping distance of about 0.5 to 1.0 cm from plant to plant.

→ The thinning facilitates balanced light and air to each and every plant. It also helps in monitoring the disease and insect pest infestation.

10. **Interculture and weed control**

→ Timely weeding in nursery is very important to get healthy seedlings. If there are some weeds in the seed bed, remove them manually either by hand or by hand hoe.

→ For good quality seedlings, spray urea @ 0.3 per cent when the plants are 8-10 cm tall.

11. **Plant protection**

→ Adoption of plant protection measures in the nursery against the incidence of insect pest and diseases is very important task to get the healthy seedlings.

→ Damping off is a very serious disease affecting seedlings in the nursery. Timely care for controlling diseases and insect-pests is essential.

12. **Hardening of the plants in the nursery:** Withhold irrigation in the nursery beds 4-5 days before the date of transplanting but on the day of transplanting, first apply water to the nursery beds and then take out the plants for transplanting. Hardened plants withstand unfavourable weather conditions like hot day winds or low temperature more efficiently than non-hardened seedlings.
13. **Transplanting:** After 4-6 weeks of sowing, the plants become 10-15 cm tall and are ready for transplanting.

Assignment: Draw neatly different types of nursery beds

Expt: 10 Date:_____

DIRECT SOWING AND TRANSPLANTING IN VEGETABLES

Aim: To know the different methods of direct methods and transplanting methods

Seed: Plant propagation is made in two ways, Sexual (by′ seeds) and asexual (by vegetative means). Biologically, seed is a ripe, fertilized ovule and a unit of reproduction of flowering plants.

Methods of seed sowing: The sowing method is determined by the crop to be sown. There are two sowing methods which differ in their merits, demerits and adoption.

1. Direct sowing
2. Transplanting

1. Direct sowing: Direct seeding method involves sowing seeds directly into the soil. This is done in different ways

a) Broad casting
b) Drilling
c) Line sowing
d) Dibbling

a) Broad casting: It is the scattering of seeds by hand all over the′ prepared field followed by covering with wooden plank or harrow for contact of seed with soil. Crops like gogu, amaranthus, methi, coriander, etc. are sown by this method.

Advantages:

- ☛ Quickest & cheapest method
- ☛ Skilled labour is not uniform.
- ☛ Implement is not required
- ☛ Followed in moist condition.

Disadvantages:

- → Seed requirement is more
- → Crop stand is not uniform
- → Result in gappy germination & defective wherever the adequate moisture is not present in the soil.

b) Drilling: It is the dropping of seeds into the soil with the help of implement such as seed drill, seed-cumferti driller or mechanical seed drill and then the seeds are covered by wooden plank or harrow to have contact between seed & soil.

Advantages:

- ☛ Seeds are placed at proper & uniform depths
- ☛ Uniform row to row spacing is maintained
- ☛ Seed requirement is less than 'broad casting'
- ☛ Sowing is done at proper moisture level.

Disadvantages:

- → Require implement for sowing
- → Plant to plant (Intra row) spacing is not maintained
- → Skilled person is required for sowing.

c) Line sowing: Most of the vegetables are sown by line sowing. Spacing in between the lines and plants given by nature of crop.

Advantages:

- ☛ Seeds are placed at proper & uniform depths
- ☛ Uniform row to row spacing is maintained
- ☛ Seed requirement is less than 'broad casting'

Disadvantages:

- → Skilled person is required for sowing.

d) Dibbling: It is the placing or dibbling of seeds at cross marks′ (+) made in the field with the help of maker as per the requirement of the crop in both the directions. It is done manually by dibbler.

Advantages:

- ☛ Spacing between rows & plants is maintained
- ☛ Seeds can be dibbled at desired depth in the moisture zone
- ☛ Optimum plant population can be maintained
- ☛ Seed requirement is less than other method
- ☛ intercrop can be taken in wider spaced crops

Disadvantages:

- → Laborious &time consuming method
- → Require more labour, hence increase the cost of cultivation
- → Only high value & bold seeds are sown
- → Require strict supervision.

2. Transplanting:

- ☛ It is the raising of seedlings on nursery beds and′ transplanting of seedlings in the laid-out field. For this, seedlings are allowed to grow on nursery beds for about 3-5 weeks.
- ☛ Besides the advantages & disadvantages of dibbling method, initial cost of cultivation of crop can be saved but requires due care in the nursery. This method is followed in crops like Tomato, brinjal, chilli, cabbage, cauliflower and etc.

Methods of field preparation for transplanting:

The field can be made into beds of convenient size or ridges and furrows.

a. **Bed system**: if water stagnation or inundation is not a problem in a particular soil and if the crop is being cultivated during winter season. The field can be devided into beds. These beds are used for transplanting of Tomato or brinjal.
b. **Ridge and furrow system:** The entire field is devided into ridges and furrows after allocating the irrigation and drainage channels. The seedlings are planted over ridges to provide better drainage during rainy season. During summer season the seedlings are transplanted in furrows for better moisture retention.

Methods of Transplanting

The seedlings can be transplanted in square, rectangular or triangular system

a) **Square system:** in this system the spacing between two plants of the same row and different rows seems to be the same.
b) **Rectangular system:** In this system the spacing between two plants of the same row and the spacing between the two plants of different rows is not equal.
c) **Triangular system:** In case of cucurbits and other vine crops, triangular system is preferred to avoid overcrowding of vine.

Beds are watered one day before the transplanting of nursery to prevent jerk to the roots. The field is irrigated before actual transplanting to get the seedlings established early & quickly which reduce the mortality.

Assignment: to draw the diagrams of different direct sowing and transplanting methods

Ex.No. 11 Date:_____

VISIT TO FRUIT ORCHARDS

Aim: To observe the orchard and study the different practices adopted by the nursery men and grower for cultivation of horticultural crops

Details of information to be collected by the student

a. Location of the orchard
b. Name of the orchard
c. Crops grown
d. Method of propagation adopted to each crop
e. Planting system
f. Types of fertilizers
g. Methods of application of fertilizers
h. Irrigation method adopted
i. Training and pruning methods
j. Problems faced by the farmer

Assignment: the student should write the report and remarks on the observation of aspects in their visit.

Ex.No. 12 Date:_____

VISIT TO FRUIT MARKETS

Aim: To observe the fruit market, available fruits in the market and cost of different fruits

Details of information to be collected by the student

a. Location of the market
b. Name of the market
c. Fruits available
d. Method of packaging
e. Packing material
f. Cost of each fruit
g. Problems faced by the seller

Assignment: The student should write the report and remarks on the observation of aspects in their visit.