

**THEORY**

**Introduction to field crops** – Agricultural Classification of field crops.

**Family description, economic parts, economic uses, value additions, in the following crops:**

**Cereals and Millets:** Rice, Wheat, Maize, Sorghum, Pearl millet, Finger millet, Foxtail millet, Little millet, Barn yard millet, Proso millet and Kodo millet.

**Pulses:** Redgram, Blackgram, Greengram, Soybean, Bengalgram, Horsegram, Cowpea, Lablab and Dew gram.

**Oilseeds:** Groundnut, Gingelly, Castor, Sunflower, Safflower, Niger, Rape and Mustard, jatropha.

**Fibre crops:** Cotton, jute, Mesta, Sunnhemp, Agave and Silk cotton.

**Sugars:** Sugar cane, Sugar Palm and Sugar beet.

**Forage Crops: Grasses** – Napier, Pearl millet – Napier, Guinea grass, *Cenchrus* sp., Johnson grass, Marvel grass, Spear grass, Buffalo grass and Bermuda grass.

**Cereal Fodders:** Sorghum, Pearl millet, Maize and Minor-millets.

**Legume fodders:** Lucerne, Cowpea, Desmanthus, Desmodium, Stylosanthus, Clitoria and Siratro.

**Tree fodders:** Agathi, Glyricidia, Erythrina, Subabul and *Acacia* sp.

**Green and green leaf manures:** Sunnhemp, Sesbania, Daincha, Tephrosia, Glyricidia, Neem and Pungam.

**Narcotics** – Tobacco

**PRACTICAL**

Family features - observation and description of habit, morphology of root, stem, leaves, inflorescence, flowers, floral parts-stamen, ovary and economic parts of the above mentioned crops in Cereals, Pulses, Oilseeds, Fibre crops, Sugars, Forage grasses, Cereals and Legume fodders, tree fodders, Green and Green leaf manure, Narcotics.

**LECTURE SCHEDULE**

1. Introduction to field crops - Agricultural Classification of field crops.  
Family description, economic parts, economic uses, value additions, in the following crops:
2. Cereals: Rice.
3. Cereals: Wheat and maize.
4. Millets : Sorghum, Pearl millet and
5. Finger millet, Small millets- Foxtail millet, Little millet,
6. Barn yard millet, Proso millet, and Kodo millet.
7. Pulses : Redgram, Blackgram, and Greengram.

8. Pulses : Soybean, Cowpea, Bengal gram, Lab-lab and Dew gram.
9. MID SEMESTER EXAMINATION.
10. Oilseeds: Groundnut, Gingelly.
11. Oilseeds: Castor, Sunflower, Safflower.
12. Oilseeds: Rape, Mustard, Niger and jatropha.
13. Fibres: Cotton.
14. Fibres: Jute, Mesta, Sun hemp, Agave and Silk cotton.
15. Sugars: Sugar cane, Sugar palm and Sugar beet.
16. Forage Crops: **Grasses** - Napier, Pearl millet-Napier, Guinea grass, Cenchrus and Johnson grass. **Cereal fodders**: Sorghum, Pearl millet, Maize, Minor millets. **Legume fodders**: Lucerne, Cowpea, Desmodium, Desmanthus, Stylosanthus, Clitoria and Siratro.
17. **Tree fodders**: Agathi, Glyricidia, Erythrina, Subabul and Acacia. **Green and Green leaf manures**: Sunhemp, Sesbania, Daincha, Tephrosia, Glyricidia, Neem, Pungam, Narcotics.

### PRACTICAL SCHEDULE

1. Observing general morphology of roots, stems and leaves.
2. Observing general morphology of inflorescence - flowers, stamens and pistils Family characters and Botany and economic parts of the following crop plants:-
3. Rice.
4. Wheat.
5. Maize, Sorghum and Pearl millet.
6. Finger millet, Foxtail millet, Little millet, Barn yard millet, Proso millet and Kodo millet.
7. Redgram, Blackgram, Greengram and Bengal gram.
8. Cowpea, Soybean Lab-lab and Dew gram.
9. Groundnut, Gingelly.
10. Sunflower, Castor, Safflower.
11. Niger, Rape and Mustard and Jatropha.
12. Cotton.
13. Jute, Mesta, Sunnhemp, Agave and Silk cotton.
14. Sugar cane, Palm sugar and Sugar beet.
15. Napier, Pearl millet - Napier, Guinea grass, Cenchrus, Cereal fodder. Legume fodders: Lucerne, Cowpea, Desmodium, Desmanthus, Stylosanthus, Clitoria and Siratro.
16. Tree fodder: Agathi, Glyricidia, Erythrina, Subabul and Acacia. Green and Green leaf manures – Danicha, Sunnhemp, Tephrosia, Glyricidia, Neem, Pungam, Narcotics.
17. PRACTICAL EXAMINATION.

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# TAMIL NADU AGRICULTURAL UNIVERSITY

## PBG 101 – Fundamentals of Crop Botany (1+1)

### PRACTICAL MANUAL

*Course Teacher*

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CENTRE FOR PLANT BREEDING AND GENETICS  
TAMIL NADU AGRICULTURAL UNIVERSITY  
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# 1. MORPHOLOGY OF ROOTS, STEM AND LEAVES

## 1. MORPHOLOGY OF ROOTS

**Root:** Root is that portion of the plant which grows downward into the soil.

**a. Tap root system:** The primary root and its branches form the tap root system of the plant. The primary or tap root normally grows vertically downwards to shorter or longer depth, while the branched roots grow obliquely downwards or in many cases spread horizontally outwards.

**b. Adventitious root system:** Roots that grow from any part of the plant body other than the radicle are called adventitious roots. They may develop from the base of the stem replacing the primary root or in addition to it, or from any node or internode of the stem or the branch, even from the leaf under special circumstances.

**c. Modification of tap roots:** This modification is meant for storage of food.

**i. Fusiform root:** When the root (hypocotyl) is swollen in the middle and gradually tapering towards apex and base having more or less spindle shaped appearance, it is said to be fusiform (eg) Radish.

**ii. Napiform root:** when the root is considerably swollen at the upper part (usually the hypocotyls), becoming almost spherical and sharply tapering at the lower part, it is said to be napiform. (eg.) Turnip and beet.

**iii. Conical root:** When the root is broad at the base and gradually tapers towards the apex like a cone. It is said to be conical. (eg.) Carrot.

### **d. Branched root modification (for respiration):**

- **Pneumatophores:** Many plants growing in marshy places develop special kind of roots called respiratory roots or pneumatophores for the purpose of respiration. Such roots grow from the underground roots of the plant but rise vertically upwards and come out of the water like so many conical spikes. Each root is provided towards the upper end with numerous pores or respiratory spaces through which air is taken for respiration. (eg.) Rhizophora.

### **e. Adventitious roots modification:**

#### **i. For storage of food:**

- **Tuberous or tubercular root:** This is a swollen root without any definite shape as in sweet potato. Tuberous roots are produced singly and not in clusters.
- **Fasiculated roots:** When several tubercular roots occur in a cluster or fascicle at the base of the stem, they are said to be fasciculated (eg) Dhalia, Asperagus.
- **Nodulose roots:** When the slender root becomes suddenly swollen at the apex, it is said to be nodulose (eg) Mangoginger.

- **Moniliform or beaded root:** When there are some swellings are in the root at frequent intervals it is said to be moniliform (eg.) Momordica, Portulaca and wild vine.
- **Annulated root:** When the root has a series of ring like swellings on its body, it is said to be annulate. (eg.) Psychotria – medicinal plant.

## ii. For mechanical support:

- **Prop or stilt root:** In plants like banyan, a number of roots are produced from the main stem and often from the branches. These roots grow vertically down wards and penetrate into the soil. Gradually they get stouter and act as pillars supporting the main stem and the branches or the plant as a whole. Such roots are known as prop or stilt root.
- **Climbing roots:** Plants like betel produce climbing roots from their nodes and often from the internodes to ensure a foothold on neighbouring objects.
- **Buttress roots:** In certain large forest trees, some of the stout roots around the base of the main trunk show prolific abnormal growth, particularly on the upper side. They at first grown obliquely downwards from the base of the trunk and then spread horizontally outwards at the ground level some times to a considerable length. They are meant to give support to the huge trunk and maintain it in an upright position.

## iii. For vital functions:

- **Sucking roots or Haustoria:** Parasites develop a kind of roots which penetrate into the tissue of the host plant and suck it,. Such roots are known as sucking roots (eg.): dodder, broomrape.
- **Respiratory roots:** In Jussiaea, an aquatic plant the floating branches develop adventitious roots which are soft, light, spongy and colourless. They usually develop above the level of water and serve to store up air. Thus they facilitate respiration.
- **Epiphytic roots:** There are certain plants, commonly the orchids which grown perched on branches of trees. They never penetrate the supporting plant as do the parasites. Instead of sucking roots they develop a special kind of aerial roots which hang freely in the air. Each hanging root surrounded by a spongy tissue called velamen. With the help of this, hanging root absorbs moisture from the surrounding air. Vanda, an epiphytic orchid is a fairly common example.
- **Assimilatory roots:** Branches of Tinospora climbing on neighbouring trees produce long, slender hanging roots which develop chlorophyll and turn green in colour. These green roots are assimilatory roots.

## 2. MORPHOLOGY OF STEM

**Stem:** There is a variety of stem structure adopted to carry the diverse functions. They may be 1. aerial, 2. underground. The nature of stem, height of the plant, duration, mode of life determine the habit.

a. **Herbs:** These are small plants with soft stem. According to their duration, they are classified as annuals, biennials and perennials.

- **Annuals:** These plants attain the full growth in one season. During this period, they produce flowers and seed and then die at the end of the season. (eg.) Sunflower, rice.
- **Biennials:** These are those plants that live for 2 years. They attain their full vegetative growth in the first year and produce flowers and seeds in the second year. Afterwards, they die off. (eg.) cabbage, carrot and raddish.
- **Perennials:** Perennials are those plants that persist for many years. (eg.) Banana.

b. **Shrubs:** They are medium sized plants of hard and woody stem which branches profusely from near the ground so that plant becomes bushy in habit without having a clear trunk. They are larger than herbs and smaller than trees. (eg) Garden crotons.

c. **Trees:** They are very tall plants with clear trunk and have hard woody stem and broader. (eg) mango tree.

d. **Climbers:** It has thin and long stem with diffused branches. They often develop the special organs by which they cling to the neighbouring objects for support and for assist for climbing. Climbers are classified according to their mode of climbing.

- Rootlet climber
- Hook climber
- Tendril climber
- Leaf climber
- Stem climber or twiner
- Lianes

e. **Modification of stems:**

**I. Underground modifications of stems:**

For the purpose of perennation, stems develop underground and lodge there permanently lying in a dormant defoliated condition for some time and then giving off aerial shoots annually under favourable conditions. They are always thick and fleshy, having a heavy deposit of reserve food material in them. This can be readily distinguished by the presence of nodes and internodes, scale leaves and buds. The functions of this modification is a) perennation, b) to store up food material, c) to propagate.

i. **Rhizome:** It is a prostrate, thickened stem creeping horizontally under the surface of the soil. It is provided with distinct nodes and internodes which bears some scaly leaves at the nodes. It possesses a bud in the axil of the scaly leaf and ends in a terminal bud. Some slender adventitious roots are given off from its lower side. The rhizome may be unbranched or some times the axillary buds grow out into short, stout

branches. It remains dormant underground and with the approach of the vegetative season the terminal bud and axillary buds grow into aerial shoots (eg) Canna, ginger, turmeric.

- ii. **Tuber:** This is the swollen end of a special underground branch. The underground branch arise from the axil of a lower leaf, grows horizontally outwards and ultimately swells up at the apex. It has on its surface a number of 'eyes' or buds which grow up into new plants. Adventitious roots which are abundantly formed in other underground stems are usually absent from a tuber. A tuber is often very much swollen owing to a heavy deposit of food material, becoming almost spherical. (eg) Potato, Jerusalem artichoke.
- iii. **Bulb:** This is an underground modified shoot consists of shortened convex or slightly conical stem, a terminal bud and numerous scale leaves. The scale leaves often simply called scales, grow from upper surface of the stem, while a cluster of adventitious roots are given off from its base. The inner scales are commonly fleshy, the outer ones dry. The scales may occur surrounding the stem in concentric rings, as in onion, the fleshy scales stores food, while the dry scales give protection. The bulb is vertical in direction and its terminal bud gives rise to the aerial shoots.
- iv. **Corm:** This is a condensed form of rhizome consisting of a stout, solid, fleshy, underground stem growing in the vertical direction. It is more or less rounded in shape or often somewhat flattened from top to bottom. It contains a heavy deposit of food material and often grows to considerable size. It bears one or more buds in the axils of scale leaves and some of these buds grow up into daughter corms. (eg) Amorphophallus, Gladiolus.

**II. Subaerial modification of stems:** These are meant for vegetative propagation.

- i. **Runner:** This is a slender, prostrate branch with long or short internodes, creeping on the ground and rooting at the nodes. The runner arises as an axillary bud and creeps some distance away from the mother plant, then strikes roots and grows into a new plant. They may break off from the mother plant and grow up as independent daughter plant. (eg) Marsilea, Strawberry.
- ii. **Stolon:** This is a slender lateral branch arising from the base of the plant. At first it grows obliquely upwards to some extent and then it bends down to the ground, striking roots at the tip and producing a bud. The later soon grows into a daughter plant (eg) Mint, Strawberry.
- iii. **Offset:** Like runners this originates in the axil of a leaf as a short, more or less thickened, horizontal branch. It elongates only to a certain extent and produces at the apex a tuft of leaves above and a cluster of small roots below. The offset often breaks away from the mother plant (eg.) water lettuce, water hyacinth.



- iv. **Sucker:** Like the stolon, the sucker is also a lateral branch developing from the underground part of the stem, but it grows obliquely upwards and directly gives rise to a leafy shoot or a new plant. Occasionally it grows horizontally outwards only to a certain extent, but soon it turns up as in *Chrysanthemum* or it may be shorter and stouter as in banana.

### III. Aerial modifications:

Vegetative and floral buds which would normally develop into branches and flowers often undergo extreme degrees of modification. Metamorphosed organs are stem tendrils for climbing, thorn for protection, phylloclade for food manufacture and bulbil for vegetative reproduction.

- i. **Stem tendril:** This is a thin, wiry leafless, spirally curled branch, by which climbers attach themselves to neighbouring objects and climb them. Stem tendrils are seen in *Vitis*, passion flower etc.
- ii. **Thorn:** The thorn is a hard often straight and pointed structure. It is regarded as a modified branch because it arises in the axil of a leaf or sometimes at the apex of a branch, which is the normal position of a bud. In lemon, pomegranate, axillary bud is modified into a thorn. In *Carissa* the terminal bud is modified into a pair of thorns.
- iii. **Phylloclade:** This is a green, flattened, cylindrical stem or branch of unlimited growth consisting of succession of nodes and internodes at short or long intervals. It develops in many xerophytic plants where the leaves fall off early or modified into spines, evidently reducing the evaporating surfaces. It then takes over all the functions of leaves, particularly photosynthesis. It also functions as a storage tissue retaining plenty of water and mucilage. Further, because of strong development of cuticle it can reduce transpiration to a considerable extent. (eg) Cacti – prickly pear (*Opuntia dillenii*). The phylloclade is otherwise called cladophyll.
- iv. **Cladode:** In some plants, one or more short, green, cylindrical or sometimes flattened branches of limited growth develop from the node of the stem or branch in the axil of a scale leaf. Such a branch is known as the cladode. (eg). *Asparagus*.
- v. **Bulbil:** It is a special multicellular body especially meant for the reproduction of the plant. It may be the modification of a vegetative bud or a floral bud. In any case, it detaches itself from the mother plant and grows up into a new independent one (eg): Onion, Agave American, *Dioscorea bulbifera*.

### 3. BRANCHING

The mode of arrangement of branches on the stem is known as branching. There are two principal types of branching – lateral and dichotomous.

### A. Lateral branching:

When the branches are produced laterally, that is from the sides of the main stem, the branching is called lateral. The branching may be racemose or indefinite or monopodial and cymose or definite.

- i. **Racemose type:** The growth of the main stem is indefinite, that is it continues to grow indefinitely by the terminal bud and gives off branches laterally in acropetal succession i.e the lower branches are older and longer than the upper ones. As a result of this branching, the plants takes on a conical or pyramidal shape.
- ii. **Cymose type:** The growth of the main stem is definite, the terminal bud does not continue to grow, but lower down, the main stem produces one or more lateral branches which grow more vigourously than the terminal one. The process may be repeated over and over again. As a result of cymose branching, the plant spreads out above and becomes more or less dome shaped.

Cymose branching may be of the following kinds:

- **Uniparous cyme:** If in the cymose type, only one lateral branch is produced at a time, the branching is said to be uniparous or monochasial. The uniparous type of branching is otherwise called sympodial. It has two distinct forms:

**Helicoid or one sided cyme:** When successive branches develop on the same side, forming a sort of helix as in *Saraca*.

**Scorpioid or alternate side cyme:** When successive lateral branches develop on alternate sides forming a zig zag as in *Vitis vinifera*.

- **Biparous cyme:** If in the cymose branching two lateral axes develop at a time it is called biparous or dichasial (eg.) Four O' clock plant, datura.
- **Multiparous cyme:** If more than two branches develop at a time, the branching is said to be multiparous or polychasial as in ***Croton sparsiflorus***.

### B. Dichotomous branching:

When the terminal bud bifurcates, that is divide into two producing two branches in a forked manner, the branching is termed as dichotomous. It is common among the 'flowerless' plants as in *Riccia*, *Lycopodium phlegmeria* and in flowering plants such as *Hyphaene*.

## 4. MORPHOLOGY OF LEAVES

**Leaf:** It is normally green in colour and it is considered the most important vegetative organ of the plant, since food materials are prepared in it.

### **A. Parts of leaf:**

**i. Leaf base:** It is the part of the leaf attached to the stem. Leaf base usually bears two lateral branches or outgrowths known as stipules.

**ii. Petiole:** It is the stalk of the leaf. A long petiole pushes out the leaf blade and thus helps it to secure more sun light. When the petiole is absent, the leaf is said to be sessile and when present, it is said to be petiolate or stalked.

**iii. Leaf blade or lamina:** It is the green expanded portion. A strong vein known as mid rib runs centrally through the leaf blade from its base to the apex. It is the most important part of the leaf since this is the seat of food manufacture for the entire plant.

## **5. STIPULES**

Stipules are the lateral appendages of the leaf borne at its base. This portion is to protect the young leaves in the bud and when green they manufacture food material in the same way as in the leaves. When stipules are present, the leaf is said to be stipulate and when absent exstipulate.

### **Kinds of stipules:**

According to the shape, portion, colour and size of the stipules they are of the following kinds.

**i. The lateral stipules:** These are two free stipules usually small and green in colour borne on the two sides of the leaf base as in China rose, cotton etc

**ii. Scaly stipules:** These are small dry scales, usually two in number borne on the two sides of the leaf base as in Desmodium.

**iii. Adnate stipules:** These are the two lateral stipules that grow along the petiole upto a certain height adhering to it and making it somewhat winged in appearance as in rose, peanuts and strawberry.

**iv. Interpetiolar stipules:** These are the two stipules that lie between the petioles of opposite or whorled leaves, thus alternating with the later. They are seen in Ixora.

**v. Ochreate stipules:** They form a hollow tube encircling the stem from the node upto a certain height of the internode in front of petiole as in Polygonum.

**vi. Foliaceous stipules:** These are two large green leafy structures as in pea, *Cassia auriculata*.

**vii. Bud scales:** These are scaly stipules which enclose and protect the vegetative buds and fall off as soon as the leaves unfold. (eg) banyan, jack.

- viii. **Spinous stipules:** In gum tree, Indian plum, Mimosa, the stipules become modified into two sharp pointed structures known as spines one on each side of the leaf base. Such spinous stipules give protection to the leaf against the attack of herbivorous animals.

## 6. LEAF BLADE

**Apex of the leaf is said to be:**

- i. **Obtuse:** It is rounded as in banyan.
- ii. **Acute:** It is pointed in the form of an acute angle, but not stiff as in China rose.
- iii. **Acuminate** of **caudate:** It is drawn out into a long slender tail as in Ficus religiosa.
- iv. **Cuspidate:** It ends in a long rigid shape (spiny) point, as in date palm, pineapple.
- v. **Truncate:** It ends abruptly as if cuts off in a straight line as in Indian sago palm.
- vi. **Retuse:** The obtuse or truncate apex is furnished with a shallow notch as in water lettuce.
- vii. **Emarginated:** The apex is pointed with a deep notch as in Bauhinia.
- viii. **Mucronate:** The rounded apex abruptly ends in a short point as in Ixora.
- ix. **Cirrhose:** It ends in a tendril as in glory lily, or in a slender curled, thread like appendage as in banana.

**7. Margin of the leaf:** The margin of leaf may be:

- i. **Entire:** Even and smooth as in mango, jack, banyan etc.
- ii. **Repend:** Shallowly wavy or undulating as in mango.
- iii. **Sinuate:** Deeply undulating as in polyalthia.
- iv. **Serrate:** Cut like the teeth of a saw and the teeth directing upwards as in rose.
- v. **Biserrate:** Doubly serrate (each tooth serrated again)
- vi. **Serrualte:** Minutely serrate.
- vii. **Dentate:** Teeth directly outwards at right angles to the margin of the leaf as in melon and water lily.
- viii. **Runcinate:** Serrated with the teeth pointed backwards.
- ix. **Crenate:** Teeth round as in Bryophyllum.
- x. **Fimbriate:** Fringed with fine segments.
- xi. **Ciliate:** Fringed with fine segments.
- xii. **Spinous:** Provided with spines.

**8. Surface of the leaf:** The leaf is said to be:

- i. **Glabrous:** Surface is smooth and free from hairs or outgrowth of any kind.
- ii. **Rough:** Surface is somewhat harsh to touch.
- iii. **Glutinous:** Surface is covered with a sticky exudation as in tobacco.
- iv. **Glaucous:** Surface is green and shining.
- v. **Spiny:** Provided with spines.
- vi. **Hairy:** Covered densely or sparsely with hairs. A hairy surface may be:
  - a) **Pubescent:** Covered with short, soft straight hairs.
  - b) **Pilose:** Thinly covered with long, soft hairs.
  - c) **Villos:** Thickly covered with long soft hairs.
  - d) **Tomentose:** Densely covered with short soft more or less tangled hairs like cotton.
  - e) **Floccose:** Cottony with lot of hairs easily detachable.
  - f) **Hispid:** Beset with rigid or bristly hairs.
  - g) **Hissute:** Covered with long, coarse stiff hairs.

## 9. SHAPE OF THE LEAF

- i. **Acicular:** leaf is long, narrow and cylindrical i.e. needle shaped as in onion.
- ii. **Linear:** leaf is long, narrow and flat as in many grasses.
- iii. **Lanceolate:** shape is like that of a lance, as in bamboo.
- iv. **Elliptical or oval:** leaf has more or less the shape of an ellipse as in guava.
- v. **Ovate:** leaf is egg shaped i.e., broader at the base than the apex as in banyan.
- vi. **Obovate:** leaf is inversely egg shaped as in jack.
- vii. **Oblong:** blade is wide and long, with two margins running straight up as in banana.
- viii. **Round or orbicular:** leaf is circular in outline as in lotus.
- ix. **Cordate:** blade is heart shaped as in betel. When the leaf is inversely heart shaped, it is said to be obcordate.
- x. **Reniform:** leaf is kidney shaped as in Indian pennywort
- xi. **Oblique:** two halves of the leaf are unequal as in begonia.
- xii. **Spathulate:** shape is like that of a spatula i.e. broad and somewhat rounded at the top and narrow towards the base as in Calendula.
- xiii. **Sagittate:** shape is like an arrow.
- xiv. **Hastate:** two lobes of a sagittate leaf are directed outwards as in Ipomoea.
- xv. **Cuneate:** Shallow notch.
- xvi. **Falcate:** leaf is sickle shaped as in Eucalyptus.
- xvii. **Lyrate:** Shape is like that of lyre i.e with a large terminal lobe and some smaller lateral lobes as in radish.
- xviii. **Pedate:** leaf is like the claw of a bird with the lobes spreading outwards as in Vitis.

## 10. VENATION:

The arrangement of the veins and the veinlets in the leaf blade is known as venation. There are two principal type of venation viz., reticulate when the veins are irregularly distributed forming a network and parallel when they run parallel to each other.

### A. Reticulate venation:

#### i. Pinnate or unicostate type (unus – one; costa – a rib)

There is a strong midrib or costa, this gives off lateral veins which proceed towards the margin or apex of the leaf like plumes in a feather. These are then connected by smaller veins which pass in all directions forming a network as in mango.

#### ii. Palmate or multicostate type;

In this type, there are a number of more or less equally strong ribs which arise from the tip of the petiole and proceed outwards or upwards. There are two types.

**Divergent:** When the main veins diverge towards the margin of the leaf as in castor.

**Convergent:** when the veins converge to the apex of the leaf as in Indian palm.

**B. Parallel venation:****i. Pinnate or unicostate type:**

In this type of venation, the leaf has a predominant midrib and this gives off lateral veins which proceed to each other towards the margin or apex of the leaf blade as in banana ginger.

**ii. Palmate type:** There are two forms.

**Divergent type:** The veins arise from the tip of the petiole and proceed towards the margin of the leaf blade in a more or less parallel manner. (eg.) Palmyra

**Convergent type:** when a number of more or less equally strong veins proceed from the base of the leaf blade to apex in a somewhat parallel direction as in rice. (eg.) Grass, Bamboo.

**Functions of the veins:** Veins are rigid structures and their mechanical function is to give necessary strength to the leaf blade. A very important physiological function of the veins is to carry water and inorganic salts into the leaf blade and finally the prepared food material from the leaf into the main body of the plant, particularly the storage organs.

**Simple leaf:** A leaf is said to be simple when it consists of a single blade which may be entire or incised.

**11. COMPOUND LEAF:** The incision of the leaf blade goes down to the midrib (rachis) or to the petiole so that the leaf is broken up into a number of segments called leaflets, these being free from one another, that is not connected by any lamina and more or less distinctly jointed at their base.

**A. Pinnately compound leaf:** It is defined as the one in which the midrib known as the rachis bears laterally a number of leaflets arranged alternately or in an opposite manner as in tamarind and gold mohar. It may be of the following types.

**i. Unipinnate:** When the midrib of the pinnately compound leaf bears the leaflets directly it is said to be unipinnate as in rose etc, when the leaflets are even in number the leaf is said to be paripinnate as in tamarind, when the leaflets are odd in number the leaf is said to be imparipinnate as in rose etc.

**ii. Bipinnate:** when the compound leaf is twice pinnate i.e. the midrib produces secondary axis which bear the leaflets is said to be bipinnate as in gold mohar and mimosa.

**iii. Tripinnate:** when the leaf is thrice pinnate i.e. the secondary axes produces the tertiary axis which bear the leaflets it is said to be tripinnate as in drumstick.

**iv. Decompound:** when the leaf is more than thrice pinnate it is said to be decompound. Eg. Carrot, coriander.

**B. Palmately compound leaf:** It is defined as the one in which the petiole bears terminally, articulated to it a number of leaflets which seem to be radiating from a common point like fingers from the palm as in silk cotton tree.

**12. DURATION OF THE LEAF:** The leaf varies in its duration.

**i. Caducous:** The leaf veins in its duration it may fall off soon after it appears and then it is said to be caducous.

**ii. Deciduous or annual:** If it lasts one season, usually falling off in winter

**iii. Persistent or evergreen:** If persists for more than one season.

**13. PHYLLOTAXY: (phyla: leaves; taxis: arrangement)**

It means the various modes in which the leaves are arranged on the stem or the branch. The objective of this arrangement is to avoid shading one another so that the leaves may get the maximum amount of sunlight to perform their normal functions, particularly manufacture of food.

- i. **Alternate or spiral:** when a single leaf arises at each node as in tobacco, sunflower etc.,
- ii. **Opposite:** When the two leaves arise at each node standing opposite each other.  
In opposite phyllotaxy one pair of leaves is most commonly seen to stand at a right angle to the next upper or lower pair. Such an arrangement of leaves is said to be decussate. This is seen in ixora, etc., Sometimes, however, a pair of leaves is seen to stand directly over the lower pair in the same plane. Such an arrangement of leaves is said to be superposed as in Rangoon creeper. (eg.) guava
- iii. **Whorled:** When there are more than two leaves at each node and these are arranged in a circle or whorl as in nerium etc.,
- iv. **Leaf mosaic:** The setting or distribution of leaves in some definite patterns is noticed. Such pattern of leaf distribution is known as leaf mosaic. Leaves are in special need of sunlight for manufacture of food material, and this being so, they tend to fit in with one another and adjust themselves in such a way that they may secure the maximum amount of sunlight with the minimum amount of overlapping e.g. railway creeper.

## 2. MORPHOLOGY OF INFLORESCENCE, CALYX, COROLLA, ANDROECIUM AND GYNOECIUM

### **Inflorescence:**

The reproductive shoot bearing commonly a number of flowers or sometimes only a single flower is called the inflorescence. It may be terminal or axillary and may be branched in various ways. These may primarily be classified into two distinct groups viz., racemose or indefinite and cymose or definite.

### **A. Racemose inflorescence:**

Here the main axis of inflorescence does not terminate in a flower, but continues to grow and give off flowers laterally in acropetal succession i.e. the lower or outer flowers are older than the upper or inner ones or in other words, the order of opening of flowering is centripetal.

The various forms of racemose inflorescence may be described under three heads.

- those in which the main axis is elongated
- those in which the main axis is shortened.
- those in which the main axis becomes flattened, concave or convex.

### **i. With the main axis elongated:**

- Raceme:** The main axis is elongated and it bears laterally a number of flowers which are all stalked, the lower or older flowers having longer stalks than the upper or younger ones as in radish. When the main axis of the raceme is branched and the lateral branches bear the flowers the inflorescence is said to be a compound raceme or panicle.
- Spike:** The main axis elongated and the lower flowers are older, opening earlier than the upper ones as in raceme, but the flowers are sessile e.g. Amaranthus.
- Spikelets:** These are very small spikes with one or few flowers (florets). Spikelets are arranged in a spike, raceme or panicle and may be sessile or stalked on the main inflorescence. Each spikelet bears at its base two minute scales or bracts called empty glumes, slightly higher up it bears a third bract called flowering glume or lemmas and opposite to the lemma it bears a small two nerved bracteole called palea. Each flower of the spikelet remains enclosed by the lemma and the palea. Each flower of the spikelet in opposite rows. Spikelets are characteristic feature of the gramineae. (paddy, wheat etc).
- Catkin:** This is a spike with a long and pendulous axis which bears unisexual flowers only (eg.) Mulberry, Oak.
- Spadix:** This is also a spike with a fleshy axis which is enclosed by one or more large often brightly coloured bracts called spathes as in banana and palms.



**ii. With the main axis shortened:**

- a. Corymb:** Here the main axis is comparatively short and the lower flowers have much longer stalks or pedicels than the upper ones so that all the flowers are brought more or less to the same level as in wall flower (*Cheiranthus*).
- b. Umbel:** The primary axis is shortened and it bears at its tip a group of flowers which have pedicels of more or less equal length so that the flowers are seen to spread out from a common point in the umbel, there is always a whorl of bracts forming an involucre, and each flower develops from the axil of a bract. There are two types compound umbel or branched one and simple umbel or unbranched one.

**iii. With the main axis flattened:**

**Head or capitulum:** The main axis or receptacle is suppressed, becoming almost flat and the flowers are also without any stalk so that they become crowded together on the flat surface of the receptacle. In it, the outer flowers are older and open earlier than the inner ones. Although the inflorescence looks like a single flower, it really consisted of a clustered mass of small sessile flower (florets) usually of two kinds ray florets (marginal strap shaped ones) and disc florets (central tubular ones). The inflorescence is surrounded at the base by one or more whorls of often green bracts forming an involucre (eg). Sunflower, Safflower.

**B. Cymose inflorescence:**

The growth of the main axis is soon checked by the development of a flower at its apex and the lateral which develops below the terminal flower also ends in a flower and therefore its growth is also checked. The flowers may be with or without stalks. The flowers develop in basipetal succession i.e. the terminal flower is the oldest and the lateral ones younger or in other words the order of opening of the flower is centrifugal. The cymose inflorescence may be uniparous, biparous or multiparous.

- i. Uniparous or monochasial cyme:** (unus: one; parere: to produce). Here the main axis ends in a flower and it produces only one lateral branch at a time ending in a flower. The lateral and succeeding branches again produce only one branch at a time like the primary one. There are two forms of uniparous cymes.
  - a. Helicoid or one sided cyme:** The lateral axes develop successively on the same side, evidently forming a sort of helix as in begonia.
  - b. Scorpioid or alternate sided:** The lateral branches develop on alternate sides, evidently forming a zig zag as in cotton.
- ii. Biparous or Dichasial cyme:** (True cyme): Here the main axis ends in a flower and at the same time it produces two lateral younger flowers or two lateral branches. The lateral and succeeding branches in their turn behave in the same manner (eg.) Jasmine, Ixora.
- iii. Multiparous or polychasial cyme:** The main axis as usual ends in a flower and at the same time it again produces a number of lateral flowers around. There being a

number of lateral flowers developing more or less simultaneously, the whole inflorescence looks an umbel., but is readily distinguished from the latter by the opening of the middle flower first (eg.) Madar, Calotropis.

- iv. Compound and mixed forms:** The main axis of the inflorescence is branched and the branches bear the flowers the inflorescence is said to be compound. For example, when raceme is branched it is called a compound raceme or panicle.

**c. Special types:**

- i. Cyathium:** There is a cup shaped involucre, often provided with nectar secreting glands. The involucre encloses a single female flower (reduced to a pistil) in the center, seated on a comparatively long stalk and a number of male flowers (each reduced to a solitary stamen) around this, seated on short stalks. That each stamen is a single male flower is evident from the facts that it is articulated to a stalk and that it has a scaly bract at the base. The female flower in the center matures first, and then the stamens just surrounding it and ultimately the marginal ones. (e.g): Euphorbia.
- ii. Verticillaster:** This is a condensed form off cymose inflorescence with a cluster of sessile or almost sessile flowers in the axil of a leaf forming a false whorl at the node. The first axis gives rise to two lateral branches and these branches and the succeeding ones bear only one branch each on alternate sides (e.g.) labiatae family.
- iii. Hypanthodium:** When the fleshy receptacles forms a hollow cavity, more or less pear shaped with a narrow apical opening guarded by scales and the flowers are borne on the inner wall of the cavity, the inflorescence is a hypanthodium as in ficus. Hence the female flowers develop at the base of the cavity and the male flowers higher up towards its mouth.

## **2. CALYX**

Calyx is usually green (sepaloid), sometimes coloured otherwise (petaloid). In its symmetry the calyx may be regular, zygomorphic or irregular. It may again be polysepalous (sepals free) or gamosepalous (sepals united).

## **3. COROLLA**

It may be regular or irregular. It can be gamopetalous or polypetalous.

### **Forms of corolla:**

#### **A. Regular and polypetalous:**

- i. Cruciform:** It consists of four free petals each differentiated into a claw and a limb and these are arranged in the form of a cross as in cabbage, cauliflower etc.
- ii. Caryophyllaceous:** It consists of five petals with comparatively long claws and limbs of the petals are placed at right angles to the claws.
- iii. Rosaceous:** This form consists off five petals as with the previous case, but these have very short claws or none at all and the limbs spread regularly outwards as in rose, tea.

## **B. Regular and gamopetalous:**

- i. Companulate or bell shaped:** when the shape of the corolla resembles that of a bell as in gooseberry, it is said to be companulate.
- ii. Tubular:** When the corolla is cylindrical or tube like, that is more or less equally expanded from base to apex as in the central florets of sunflower, it is said to be tubular.
- iii. Funnel shaped or Infundibuliform:** The corolla is shaped like a funnel, as in thorn-apple (*Datura*).
- iv. Rotate or wheel shaped:** when the tube of the corolla is narrow and short and the limb of it is at a right angle to the tube, the corolla having more or less the appearance of wheel as in jasmine.
- v. Hypocrateriform or salver shaped:** Sometimes in a rotate type the corolla tube is seen to be comparatively long and the corolla as a whole more or less salva-shaped as in *Ixora*.

## **C. Zygomorphic and polypetalous:**

**Papilionaceous or butterfly like:** It is composed of five petals of which the outermost one is the largest and known as the standard or vexillum; the two lateral ones, partially covered by the former are somewhat like two wings of a butterfly are known as the wings or alae and the two inner most ones, apparently united to form a boat shaped cavity are the smallest and are together known as the keel or carina e.g.: papilionaceous family.

## **D. Zygomorphic and gamopetalous:**

- i. Bilabiate or two lipped:** In this form the limb of the corolla is divided into two portions or lips – the upper and the lower with the mouth gaping wide open (eg.) *Leucas*, *Adhatoda* etc.
- ii. Personate or masked:** This is also two lipped like the previous one but in this case the lips are placed so near each other as to close the mouth of the corolla. The projection of the lower lip closing the mouth of the corolla is known as the palate (eg): snapdragon.
- iii. Ligulate or strap shaped:** When the corolla forms into a short narrow tube below but it flattened above like a strap as in the outer florets of sunflower, it is said to be ligulate.

#### 4. Aestivation:

The mode of arrangement of sepals or petals in a floral bud with respect to the members of the same whorl (calyx or corolla) is known as aestivation.

- i. **Valvate:** when the members of a whorl are in contact with each other by their margins or when they lie close to each other without any overlapping as in madar, Annona.
- ii. **Twisted or contorted:** when one margin of the sepal or the petal overlaps that of the next one and the other margin is overlapped by the third one as in cotton. Here the overlapping is regular in one direction giving a twisted appearance.
- iii. **Imbricate:** In aestivation of five parts one beings exterior, one interior and rest three having one margin exterior and the other interior.
  - a. **Descending imbricate:** Posterior petal is outermost as in pea. It is otherwise called as vexillary aestivation.
  - b. **Ascending imbricate:** Posterior petal is innermost as in cassias.
- iv. **Convolute:** Petals and sepals folded and rolled like a scroll.

#### 5. ANDROECIUM

It is composed of a number of stamens or microsporophyll. Each stamen consists of a filament, anther and connective. Each of the two anther lobes has two chambers or loculi called the pollen sacs or microsporangia, thus there are altogether four loculi in each anther. Pollen grains are very minute in size usually varying from 10-20 (microns) and are like particles of dust.

##### A. Attachment of filament to anther:

There are four principal ways in which the filament is attached to the anther. The anther is said to be:

- i. **Basifixed or innate**      Filament is attached to the base of the anther as in mustard.
- ii. **Adnate:**      Filament runs up the whole length of the anther from the base to the apex.
- iii. **Dorsifixed:**      Attached to back of the anther as in passion flower.
- iv. **Versatile:**      Attached to the back of the anther at one point only so that the latter can swing freely in the air as in palms, spider lily.

**B. Cohesion of stamens:** The term ‘cohesion’, ‘connate’ and ‘coherent’ are used to designate the union of members of the same whole (e.g): stamens with each other, carpels with each other. There may be different degrees of cohesion of stamens and these may be called the adelphous condition when the stamens are united by their filaments only, the anthers remaining free, the syngenesious condition when the stamens are united by their anthers only, the filaments remaining free or the synandrous conditions when the stamens are united by both the filaments and the anthers. Different types are:

**i. Monadelphous stamens: (mono: single; adelphous: brother)**

when all the filaments are united together into a single bundle but the anthers are free, the stamens are said to be monadelphous (eg): malvaceae family.

**ii. Diadelphous stamens:** when the filaments are united into two bundles, the anthers remaining free, the stamens are said to be diadelphous (eg) papilionaceous family.

**iii. Polyadelphous stamens:** when the filaments are united into a number of bundles – more than two – but the anthers are free the stamens are said to be polyadelphous (eg) castor, silk cotton.

**iv. Syngenesious stamens:** (syn: together or unites; gen: producing) when the anthers are united together into a bundle or tube, but the filaments are free the stamens are said to be syngenesious (eg.) sunflower, marygold etc.

**v. Synandrous stamens:** when the stamens are united throughout their whole length by both the filaments and the anthers they are said to be synandrous. (eg.) cucurbitaceous family.

**C. Adhesion of stamens:**

The stamens ‘adhesion’, ‘adnate’ and ‘adherent’ are used to designate the union of members of different whorls (eg) petals with stamens, stamens with carpels. The stamens are said to be:

**i. Epipetalous:** when they are attached to the corolla wholly or partially by their filaments as in Datura, Sunflower.

**ii. Epiphyllous:** when attached to the perianth as in liliaceae.

**iii. Gynandrous:** when united with the carpels, either wholly or by their anthers only as in calotropis.

**D. Length of the stamens:** In labiate, there are four stamens of which two are long and two are short. Such stamens are said to be didynamous. In cruciferae, there are six stamens of which the inner four are long and the outer two short. Such stamens are said to be tetradynamous.

**E. Dehiscence of the anther:** Dehiscence of the anther may be: (1) longitudinal, 2) transverse, 3) porous, 4) valvular. (anther lobes open like a trap door or shutter)

## 6. GYNOECIUM OR PISTIL (GYNO: FEMALE)

It is composed of one or more carpels or megasporophylls which bears female spores or megaspores (embryosac). The pistil may be simple (made of one carpel) or compound (made of two or more carpels). When the carpels are united together it is called as syncarpous. A gynoecium having free carpels is termed as apocarpus. (eg.) Polyalthia, Michelia. Each pistil consists of three parts-stigma, style and ovary. The ovary contains one or more little roundish or oval egg like bodies which are the rudiments of seed and are known as the ovules. Each ovule enclose a large oval cell known as the embryosac.

### Placentation:

The placentation is a ridge of tissue – a parenchymatous outgrowths – in the inner wall of the ovary to which the ovule or ovules remain attached. The placenta most frequently develop on the margins of the carpels, along with their whole line of union called the suture or at their base or apex. The manner in which the placenta are distributed in the cavity of the ovary is known as placentation.

### A. Type of placentation:

In the simple ovary, there is only one common type of placentation known as marginal and in the compound ovary placentation may be axile, parietal, central, free-central, basal or superficial.

- i. **Marginal:** In marginal placentation, the ovary is one chambered and the placenta develops along the junction of the two margins of the carpel, called the ventral suture as in leguminaceae. The line or suture corresponding to the midrib of the carpel is known as the dorsal suture. No placenta develops here.
- ii. **Axile:** In axile placentation, the ovary is two to many chambered usually as many as the number of carpels and the placenta bearing the ovules develop from the central axis corresponding to the confluent margins of carpels and hence the name axile (lying in the axis) as in lemon, orange, tomato etc.
- iii. **Parietal:** (parieties: wall): In parietal placentation, the ovary is one chambered and the placentae bearing the ovules develop on the inner wall of the ovary. Their position corresponds to the confluent margins of carpels and their number corresponds to the number of carpels as in Carica. In cruciferae (eg.) Mustard, the placentation is also parietal although the ovary is two chambered. In them, the ovary is at first unilocular but soon a false partition wall develops across the ovary dividing it into two chamber while the seeds remain attached to a wiry frame work called the replum.
- iv. **Free-central:** In free-central placentation, the placenta arises from the base of the ovary, projects far into its cavity as a swollen central axis and bears the ovules all over its surface. Since the placenta lies free in the single chamber of the ovary, the placentation is said to be free central. This is seen in primrose.
- v. **Basal:** In basal placentation, the ovary is unilocular and the placentae develops directly on the thalamus and bears a single ovule at the base of the ovary as in compositae.
- vi. **Superficial:** In superficial placentation, the ovary is multilocular, carpels being numerous as in axile placentation but the placenta in this case develop all around the inner surface of the partition walls as in waterlily (nymphaea).

### 3. MORPHOLOGY OF OVULE AND FRUITS

#### 1. OVULE

Each ovule is attached to the placenta by a slender stalk known as the funicle. The part of attachment of the body of the ovule to its stalk or funicle is known as the hilum. In the inverted ovule, the funicle continues beyond the hilum along side the body of the ovule forming a sort of ridge, this ridge is called the raphe. The upper end of the raphe which is the junction of the integuments and the nucellus is called the chalaza. The main body of the ovule is called the nucellus and it is surrounded by two coats termed the integuments. A small opening left at the apex of the integuments is called the micropyle. Lastly, there is a large oval cell lying embedded in the nucellus towards the micropylar ends, this is the embryo sac which bears the embryo and is the most important part of the ovule.

**A. Forms of ovules:** The ovule is said to be:

- i. **Orthotropous: (ortho- straight; tropos – a turn): or straight:** when the ovule is erect or straight so that the funicle, chalaza and micropyle lie on one and the same vertical line as in piperaceae, casuarinaceae.
- ii. **Anatropous: (ana – backwards or up) or inverted:** when the ovule bends along the funicle so that the micropyle lies close to the hilum, the micropyle and the chalaza, but not the funicle lie on the same straight line, this is the commonest form of ovule.
- iii. **Amphitropous: (amphi-on both sides) or transverse:** when the ovule is placed transversely at a right angle to its stalk or funicle.
- iv. **Campylotropous (Kampylos – curved) or curved:** when the transverse ovule is bent round like a horse shoe so that the micropyle and the chalaza do not lie on the same straight line as in cruciferae.

#### 2. FRUIT

The fruit can be mentioned as a mature or ripe ovary. A fruit consists of two portions viz., the pericarp (peri-around; carpos – fruit) developed from the wall of the ovary and the seeds develop from the ovules.

When only the ovary of the flower grows into the fruit it is commonly known as the true fruit, but after it is found that the floral parts such as the thalamus, receptacle or calyx may also grow and form a part of the fruit. Such a fruit is known as the *false or spurious fruit*.

#### **Classification of fruits:**

Fruits whether true or spurious may be broadly classified into three groups viz., simple, aggregate and multiple or composite.

**A. Simple fruit:** When only one fruit develops from the single ovary (either of simple pistil or of syncarpous pistil) of a flower with or without accessory parts (true or spurious fruits) it is said to be a simple fruit. A simple fruit may be dry or fleshy. Dry fruits may again be dehiscent or indehiscent or schizocarpic (in which the carpel or carpels split into one seeded parts).

### **I. Dry fruits:**

#### **a. Dehiscent or capsular fruits:**

- i. Legume or pod:** This is a dry, monocarpellary fruit developing from a superior, one chambered ovary and dehiscing by both the sutures as in papilionaceae.
- ii. Follicle:** This is also a dry, monocarpellary superior, one chambered fruit like the previous one, but it dehisces by one suture only. Simple follicle is rare (eg.) madar. Most commonly follicle develop in an aggregate of two, three or many fruits.
- iii. Siliqua:** This is a long, narrow, many seeded fruit developing from a superior, bicarpellary ovary with two parietal placenta. It dehisces from below upwards along the two ventral sutures into two valves, leaving a two ribbed wiry frame work called the replum with seeds attached to it and false septum across the replum (eg.) cruciferae.
- iv. Capsule:** This is a many seeded uni or multilocular fruit developing from a superior (or sometimes inferior) bi or poly carpellary ovary and dehiscing in various ways. All dehiscent fruits developing from a syncarpous ovary are commonly known as capsules (eg); cotton, lady's finger.

#### **b. Indehiscent or Achenial fruits:**

- i. Caryopsis:** This is a small, dry, one seeded fruit developing from a superior, monocarpellary ovary with the pericarp fused with the seed coat. (eg.) gramineae.
- ii. Achene:** An achene is a small, dry, one chambered and one seeded fruit developing from a superior or inferior monocarpellary ovary but unlike the previous one, the pericarp of this fruit is free from the seed coat. Simple achene are found in four o' clock plant. Most commonly achenes develop in an aggregate.
- iii. Cypsela:** This is a dry, one chambered and one seeded fruit developing from an inferior, bicarpellary ovary with the pericarp and seed coat free as in compositae.
- iv. Samara:** This is a dry, indehiscent one or two seeded fruit developing from a superior bi or tricarpellary ovary with one or more flattened wing like outgrowths (eg.) yam (*Dioscorea*).
- v. Nut:** This is a dry, one chambered and one seeded fruit developing from a superior, bi or polycarpellary ovary with the pericarp hard and woody (eg.) cashew nut.



**c. Splitting or schizocarpic fruits:**

- i. Lomentum:** This is a type of dry, indehiscent legume constricted or partitioned between the seeds into a number of one seeded compartments. The fruit splits transversely along the constructions or partitions into one seeded pieces as in sensitive plant (*Mimosa*).
- ii. Cremocarp:** This is a dry, indehiscent, two chambered fruit developing from an inferior, bicarpellary ovary. When ripe, the fruit splits apart into indehiscent one seeded pieces called mericarps. The mericarps remain attached to the prolonged end (carphore) of the axis. Cremocarp is the characteristic fruit of umbelliferae.
- iii. Double samara:** In maple (*Acer*), the fruit develops from a superior, bicarpellary ovary and when mature it splits into two samaras each with a wing and a seed.
- iv. Regma:** This is a dry, indehiscent fruit developing from a syncarpous pistil. It splits away from the central axis into as many parts called cocci as there are carpels, each part containing one or two seeds. The seeds are liberated later on the decay of dry pericarp (eg.) *Euphorbia*.
- v. Carcerule:** This is small, dry indehiscent four chambered fruit developing from a superior bicarpellary pistil. This is the characteristic fruit of labiatae.

**II. Fleshy fruits:**

- i. Drupe:** This is a fleshy, one or more chambered and one or more seeded fruit developing from a monocarpellary or syncarpous pistil with the pericarp differentiated into epicarp which forms the skin of the fruit, the mesocarp which is often fleshy and endocarp which is hard and stony and hence this fruit is also known as stone fruit. (eg.) mango.
- ii. Bacca or berry:** This is a superior (sometimes inferior), usually many seeded fleshy or pulpy fruit developing from a single carpel or more commonly from a syncarpous pistil with axile or parietal placentation (eg.) tomato, In berry, the seeds at first remain attached to the placentae, but afterwards they separate from them and lie free in the pulp.
- iii. Pepo:** This is also a fleshy or pulpy many seeded fruit like the berry but it develops from an inferior, one celled or spuriously three celled syncarpous pistil with parietal placentation. This the characteristic fruit of cucurbitaceae. The seeds lying embedded in the pepo remain attached to the placentae.
- iv. Pome:** This is an inferior, two or more celled, fleshy, syncarpous fruit surrounded by the thalamus. The fleshy edible part is composed of the thalamus while the actual fruit lies within (eg.) apple and pear.
- v. Hesperidium:** This is a superior, many celled fleshy fruit developing from a syncarpous pistil with axile placentation. Here the endocarp projects inwards forming

distinct chambers and the epicarp and the mesocarp fused together, form the loose or tight skin (rind) of the fruit as in orange, lemon.

- vi. Balausta:** This is a special type of inferior, many chambered and many seeded fruit developing from a syncarpous pistil with usually two whorls of basal carpels lying within the receptacle but during the development of the ovary, the outer carpels become tilted up and superposed. The result is that two layers of chambers are formed, with the outer or upper ones occupying a parietal position. The pericarp of the fruit is tough and leathery and the chambers made of thin wall of carpels. The testa of the seed is filled with an acid juice while the tegmen is horny.

**B. Aggregate fruits:** An aggregate fruit is a collection of simple fruits developing from the apocarpous pistil of a flower. An aggregate of simple fruits borne by a single flower is otherwise known as an 'etaerio'. Common forms are:

1. an etaerio of follicle: madar .
2. an etaerio of achene: rose, lotus
3. an etaerio of drupes: raspberry
4. an etaerio of berries: custard apple.

**C. Multiple or composite fruits:**

A multiple or composite fruit is that which develops from a number of flowers juxtaposed together, or in other words, from an inflorescence. Such a fruit is otherwise known as infructescence.

- i. Sorosis:** This is a multiple fruit developing from a spike or spadix. The florets fuse together by their succulent sepals and at the same time the axis bearing them grows and becomes fleshy or woody and as a result the whole inflorescence forms into a compact mass (eg.) pineapple, jack fruit.

If the jack fruit is cut longitudinally into two halves, there is a long central axis which is the inflorescence axis or peduncle. The edible part is perianth, which becomes thick, succulent and juicy. Inside the edible portion, there is a membranous bag containing one seed. The bag represents the pericarp. Between the edible flakes, there are numerous elongated whitish structures, these are sterile flowers. The spines on the tough rind represent the stigmas of the carpels.

- ii. Syconus:** Syconus develops from a hollow, pear shaped, fleshy receptacle which encloses a number of minute male and female flowers. The receptacle grows, becomes fleshy and forms fruit. It really encloses a number of true fruits or achenes which develop from the female flowers lying within the receptacle at its base (eg.) Ficus.

## 4. CEREALS

### RICE AND WHEAT

#### 1. RICE – *Oryza sativa* L. (2n = 24)

- Family** : Poaceae. (Graminae)
- Habitat** : Tropical and subtropical
- Habit** : Semiaquatic, free tillering, annual herbaceous species with fibrous adventitious root system.
- Roots** : The young roots are white, thick, short and relatively unbranched. Later they branch freely and become flaccid and brown. The roots can grow under low oxygen concentrations. Initially roots are positively geotropic but at panicle initiation, they grow horizontally and upwards to produce a dense surface mat giving more stability to the plant.
- Stem** : The jointed stem of rice called culm is made up of a series of nodes and internodes. Erect, cylindrical, hollow at the internodes and shorter at the base and becoming progressively longer at top.
- Leaves** : Leaves alternate on the stem in two ranks one at each node. The leaf sheath is continuous with the blade. There may be swelling at the base called pulvinous. The uppermost leaf below the panicle is called the flag leaf. The ligule is a small, white, triangular scale that looks like a continuation of the sheath. At the base of the blade, i.e. around the junction between the blade and sheath, there is white band called the collar. A pair of hair and sickle shaped auricles are located at the junction between the collar and the sheath. Leaf sheath encircles the whole or part of the internode. Leaf blade long narrow pubescent having spiny hairs on the margins.
- Inflorescence** : Loose terminal panicle. Usually 10-30 cm long. It may be erect or drooping, base of the peduncle is enclosed in the sheath of flag leaf.

#### Spikelet structure:

Spikelets occur in single, attached to secondary rachis. Spikelets are laterally compressed, borne on a short pedicel and is subtended by two miniature sterile glumes that are lanceolate in shape. Lemma is tough, large, boat shaped, strongly five nerved, apex is solid or it may be awned. Palea is narrower than lemma and strongly three nerved. The extended tips of the lemma & palea are the “apicules”. Perianth is modified and restricted into small fleshy transparent portions called

lodicules. At anthesis, the lodicules become turgid and thrust the lemma and palea apart exposing the fertile stamens. Stamens are six in number in two rows, filaments are slender, anthers versatile, pistil with single ovule and two plumose stigma.

### **Grain structure:**

The seed of the paddy is called “caryopsis”. The ovule after fertilisation develops into the seed with its coats (outer cell layer) completely fused together with the developing ovary wall or pericarp. Under this circumstances, the fruit coat or the pericarp is fused with the seed coat.

- 1. The pericarp or fruit coat:** The pericarp is made up of distinct layers of quadrangular cells which form the epicarp. These cells have slight thickening and are followed by cells which are much compressed and form the mesocarp consisting of two to three layers. The endocarp is a single layer of tube cells. The colour in the rice grain is found in the pericarp layer in the mature stage.
- 2. The seed coats:** Due to the pressure brought out by the developing seed on the pericarp, the testa and tegmen become much pressed down and out of shape. A few layers of such cells below the pericarp can be diagnosed as the integuments of seed coats.
- 3. The aleurone layer:** A prominent layer of rectangular cells which contain protein lying next to the seed coats. This layer is known as the aleurone layer. This layer in rice is not coloured unlike in the case of maize.  
It has been observed that in coloured varieties of rice, the aleurone layer is thicker than in the white rice varieties. The coarse rices generally have a larger aleurone layer than the finer rices. It has also been found that in poor soils, the aleurone layer is thin and improves in thickness with the fertility of the soil and manure.
- 4. The endosperm:** The entire mass of tissue below the aleurone layer is made up of cells which contain plenty of starch grains and these form the endosperm.
- 5. The embryo:** The scutellum has an upper free part which has a fleshy projection known as the ventral scale. Below this upper ventral scale and almost at the middle of the free part there is another outgrowth which can be called as the ‘inner ventral scale’ and this inner ventral scale is peculiar to rice embryos only. On the surface of the embryo this outgrowth along with the epiblast forms a continuous covering around the plumule. The structure between the scutellum and the plumule is the mesocotyl.

### **Economic Importance:**

Whole grain is cooked and eaten. Rice grain is used for producing parched rice, popped rice and beaten rice which are used as food. Rice flour is used for preparation of many edible item and is used in ice cream making. Starch from rice is used in textile industry and also for manufacture of dextrin and glucose.  
Rice bran is a valuable livestock and poultry feed  
Rice bran oil is used for making soaps and cosmetic  
Rice straw is used for cattle feeding. Making straw boards paper and mats.

## 2. WHEAT – *Triticum* spp.

*Triticum monococcum*                      **2n = 14**

*T. dicoccum*                                      **2n = 28**

*T. aestivum*                                      **2n = 42**

**Family**                      : Poaceae.

**Habitat**                      : Subtropical, temperate

**Habit**                        : Erect, annual which grows from 30 to 120 cm.

**Roots**                        : Mostly adventitious and fibrous.

**Stem**                         : Cylindrical with distinct nodes and internodes. Nodes are swollen and internodes are hollow. Usually there are six internodes and the sixth is the spike bearing one.

**Leaves**                      : Simple, alternate in distichous alternate leaves arranged to right and left side of the stem on one plane arrangement, long, linear lamina with leaf sheath covering the internodes, ligule membranous, auricles prominent, claw shaped and clasp the stem. The two halves of the lamina are unequal and show a tendency to twist.

**Inflorescence** : Terminal distichous spike, with tough rachis, awned or awnless, glabrous or hairy.

### Structure of spikelet:

The wheat inflorescence is a terminal distichous spike (ear), spikelets are sessile and borne singly at the nodes on alternate sides of the zig zag rachis. Each spikelet consists of two to five florets attached alternately on opposite sides of a short central axis called rachilla and is covered by two sterile or empty glumes. Lemma broad with an acute tip or awn, palea thin. The lower lemmas are fertile while the top one or two are sterile. Lodicules two, stamens three with thin filaments and large anthers superior ovary, styles two, single ovule, bifid feathery stigma.

### Structure of the grain:

The fused pericarp and testa surrounds both the endosperm and the embryo with the scutellum in direct contact with the surface of the endosperm. The axis consists of the primary root, which is enclosed by the coleorhiza, and the plumule with the protecting sheath of the coleoptile enclosing the primordia of two or three foliage leaves and the shoot apex. The part of the axis between the point of attachment of the scutellum and the plumule is called the mesocotyl which is the internode between the scutellum representing the cotyledon and the coleoptile representing the next leaf.

**Fruit:**

Dry one seeded indehiscent known as caryopsis containing 70% carbohydrate and 11% protein.

**Economic Importance:**

Wheat is the staple food for most of the temperate and sub tropical regions of the world. The chief use of wheat is the flour for making bread biscuits, cookies, chapatti, etc. Industrially, it is used in preparation of starch, gluten, malt, distilled spirit. Wheat bran is rich in protein and used as valuable live stock feed.

## 5. MILLETS

### MAIZE, SORGHUM AND PEARL MILLET

#### 1. MAIZE – *Zea mays* (2n = 20)

- Family** : Poaceae.
- Habitat** : Tropical and subtropical
- Habit** : Tall herbaceous annual, growing upto four meters, often single stalked rare tillering.
- Roots** : Adventitious generally thick and fibrous, stilt roots from the bottom nodes and often pigmented.
- Stem** : Robust erect solid and cylindrical. Succulent, nodes short at base and progressively become longer and thicker. The base of the stem is often pigmented.
- Leaves** : Distichous, each with leaf sheath, ligule, auricle and lamina. Sheath entire progressively become longer and thicker.
- Inflorescence** : The inflorescence is unisexual (diclinous) and monoecious. Staminate (male) inflorescence is terminal and known as **tassel** and pistillate (female) is axillary and called as **cob**.

**Tassel** : It is a terminal lax panicle with spikelets arranged in rows in central axis and lateral branches. Spikelets occur in pairs. One is pedicelled and the other sessile but identical; the glumes  $G_1$  and  $G_2$  are long and membranous within the glumes, there are two florets, both staminate. Both the florets possess lemma ( $L_1, L_2$ ), palea ( $P_1, P_2$ ) and two fleshy lodicules, stamens are three in number, versatile, pistil is rudimentary.

**Cob** : The ear bearing branch (cob) is much like main shoot. It is produced in lateral branch in the axil of one of the longest foliage leaves. The cob is covered by the leaf like structures called husk (bracts). These husks are enlarged leaf sheaths arising from each node, forming a protective covering around the inflorescence. The ear is a spike with thickened axis (shank) on which paired spikelets are borne in longitudinal rows. Each paired spikelet is associated with a socket or cupule. Both the spikelets are sessile and identical. Each spikelet is two flowered, having a pair of small membranous glumes. The lower flower is nonfunctional,

represented by a lemma and palea. The upper one is fertile and consists of a membranous lemma and palea and knob shaped ovary having long thread like style called *silk*. They emerge from the top of the husk. The style is receptive throughout the length and at the tip are usually cleft into two branches. Lodicules are generally absent.

**Fruit** : Kernal as grain is a caryopsis. Maize grains are fully exposed naked and oblong in shape. It contains starch 79% and protein 9%.

### **Economic Importance:**

As human food: Corn flake, Corn meal, Corn puff, Pop corn, Corn syrup, Corn oil, Corn rice

As cattle feed : Grain as feed for poultry, piggery and cattle.  
Green fodder for silage and dry fodder

Industrial uses:

Corn starch - Textile

Corn grits - Corn flakes and starch

Brewer's grits - In breweries and distilleries.

Corn maida - Bread, biscuit, vermicelli, *bajji*, *pakoda* etc. Also used in gum manufacturing industry.

Corn oil - Cosmetic, edible oil - improves blood circulation, reduce fat. etc., used as salad oil.

Corn syrup - Shoe polish and paper making

Corn sugar - Chemicals and leather industry

Glucose - Fermented liquor

Zein - Utilised for making artificial fibers with good tensile strength and wool - like qualities

Corn cake - Cattle and poultry feed.

## **2. SORGHUM – *Sorghum bicolor* (L.) Moench (2n = 20)**

**Family** : Poaceae.

**Habitat** : Tropical and subtropical

**Habit** : Annual herbaceous, erect, single stalked or with tillers.

**Roots** : Fibrous root system. At lower nodes of stem stilt roots appear as a circle.

**Stem** : Erect, solid, 50 to 180 cm in height, slightly furrowed on alternate sides, pithy dry or juicy with light green thickened nodes. Internodes are short at the base and longer above.



**Leaves** : Simple, alternate, glabrous, long, lanceolate, leaf blade is ribbon like with an acute apex, midrib prominent, ligule is short, membranous and fringed present at the junction of leaf sheath and leaf blade. Below the leaf surface waxy coating will be there which prevents evaporation of water.

**Inflorescence** : Usually compact panicle or semi compact or loose (lax) panicle. Terminal peduncle erect or recurved. The joints of the rachis bears paired spikelets. One is sessile while the other spikelet is pedicellate. Sessile spikelet is bisexual or hermaphrodite, pedicelled one is male or sterile. Sessile fertile spikelet is comparatively larger than staminate spikelet.

***Fertile (perfect) (or) sessile spikelet*** : It has two glumes of approximately equal length ( $G_1$  and  $G_2$ ) having two flowers inside; lower one is sterile with empty lemma ( $L_1$ ) and no palea ( $P_1$  absent); upper floret is perfect, bisexual consists of membranous lemma ( $L_2$ ) two cleft at apex and with long or short arm, a small thin delicate palea ( $P_2$ ). Two lodicules present adjacent to fertile lemma, lodicules are fleshy and truncate. Stamens three and versatile, pistil with roundish single celled ovary and two long styles ending in a feathery stigma.

***Staminate (or) pedicelled spikelet*** : Spikelets are with long or short pedicel, two leathery boat shaped glumes enclose two florets. The lower floret is represented by the lemma ( $L_1$ ) only and the upper floret is staminate with short awned lemma ( $L_2$ ); palea ( $P_2$ ) absent; two lodicules; three stamens; pistil absent.

**Fruit** : Caryopsis.

#### **Economic Importance :**

Flour of sorghum is used for making porridge, biscuits or unleavened bread. Pop sorghums with horny endosperm used for popcorn making. Sorghum is also widely used for brewing beer which is a valuable dietary supplement because of its high vitamin B content. Sorghum with sweet stems containing upto 10 per cent sucrose, are used for brewing and manufacture of syrup. Sugar varieties containing 18 per cent Total Soluble Sugar(TSS), the juice is extracted, sterilized, fermented with yeast for 48 hrs. Distillation is done and 45% ethanol extracted. The grain is also used as valuable stock feed. Fodder sorghum principally used as fodder, hay and silage making.

### 3. PEARL MILLET (CUMBU) – *Pennisetum glaucum* L. (R.Bs.) (2n = 14)

- Family** : Poaceae.
- Habitat** : Tropical and subtropical
- Habit** : Erect, annual, tillering habit and growing up to three meters.
- Roots** : Fibrous root system.
- Stem** : Solid, slender or stout, round. Nodes slightly swollen with ring of silky while internodes are cylindrical and glabrous. The internodal length increases from the base of the culm upwards.
- Leaves** : Linear, usually with sparse hairs or very hairy or glabrous. The base of the blade is slightly auricled. The ligule is narrow membranous with fringe of hairs. It closely surrounds the stem. The leaf sheath completely encircles the stem.
- Inflorescence** : Terminal panicle, spiciform (or) cylindrical, peduncle thin, cylindrical, clothed with soft more or less wooly hairs below the base of the spikelets. Central rachis cylindrical bearing densely packed clusters of spikelets arranged spirally on the rachis. Rachilla small bearing involucre of bristles (feather like bristles) and a cluster of one or two spikelets. Each spikelet has two florets enclosed in two glumes. The lower glume (G<sub>1</sub>) is short, broad and membranous. The upper glume (G<sub>2</sub>) is larger. The lower floret is staminate or sterile and the upper floret is hermaphrodite. Lower floret contains L<sub>1</sub> (broadly oblong to ovate and cuspidate) and P<sub>1</sub> may be present or absent. Lodicules absent. Stamens three with characteristic pennicillate anthers (hairs at the tip of the anthers), no ovary; lodicules absent. The upper *Perfect floret* : L<sub>2</sub> is long and oblong and P<sub>2</sub> is tougher than P<sub>1</sub>; stamens-three anthers; ovary superior with single style, bifid at the tip into two plumose stigma. Flowering is protogynous.
- Fruit** : The grain is caryopsis, almost oval with one of its end tapering (attachment point to the spike). The colour of the grain varies from whitish yellow to grey. Embryo elliptic present on tapering end. Hilum masked by black dot.

#### **Economic Importance :**

Flour : preparation of cakes or unleavened bread

Grain : malted seed is an important source of beer, feed for poultry and other livestock

Green plant : fodder

Straw : feed for livestock, bedding, thatching, fencing and fuel

## 6. RAGI, TENAI, SAMAI, KUDIRAIVALI, PANIVARAGU AND VARAGU

### 1. RAGI (Finger millet) – *Eleusine coracana* Gaertn (2n = 36)

- Family** : Poaceae.
- Habitat** : Tropical and subtropical
- Habit** : Annual, herbaceous, tillers well and branches freely.
- Root** : Fibrous root system
- Stem** : Compressed, elliptic, bearing many distichous leaves.
- Leaves** : Linear with distinct midrib and ligule with fringe of hairs.
- Inflorescence** : Terminal digitate spikes, spikelet borne on a long peduncle from the end of which four to five spikes radiate in a whorl called fingers with an odd one a little lower down the whorl called as the **thumb**. Rachis of the spikes are flat; spikelets are sessile, arranged in two rows alternately attached to one side of the rachis. Each spikelet is having 3-7 flowers enclosed by common glumes (G<sub>1</sub> and G<sub>2</sub>). Florets are hermaphrodite with boat shaped lemma and a small palea with two lodicules; three stamens with long filaments and short oblong anthers; ovary with two styles with plumose stigma. The terminal floret sterile.
- Fruit** : Utricle, rich in calcium, phosphorus and Iron.

#### **Economic importance:**

Grain : Food in the form of cake, porridge, sweet meat. Used for malting and brewing Flour for making different edible things. Grains can be stored for long periods upto ten years or more without deterioration or weevil damage. It is an important famine food.

Ragi malt: Food for the aged and children.

Straw : Cattle feed.

## 2. TENAI (Foxtail millet or Italian millet) – *Setaria italica* Beauv (2n = 18)

- Family** : Poaceae.
- Habitat** : Tropical and subtropical
- Habit** : Annual with tillers, 1 to 1.5 m in height with smooth jointed internodes.
- Stem** : Erect, slender, internodes shorter at the base becoming longer above.
- Leaves** : Narrow, linear, leaf sheath longer than internodes glabrous or hairy, ligule short, thick, prominent midrib.
- Inflorescence** : Terminal spike like panicle, 8 to 22 cm long, drooping, usually compact, sometimes loose, cylindrical, borne on a thin peduncle (pilose). Spikelets have very short pedicels. Each spikelet or two spikelets subtended at the base by a number of bristles which are slightly flattened and set with minute and upward pointing hairs along the edges. Morphologically bristles represent barren floral branches. Spikelets two, protected externally by two glumes. The lower flower sterile, the upper flower perfect, lemma ( $L_1$ ) equal in length to the spikelets, sterile palea ( $P_1$ ), small membranous. Lemma ( $L_2$ ) is smaller than  $L_1$  contains a bisexual flower, palea ( $P_2$ ) membranous, edges incurved, stamens three, lodicules two, superior ovary with two styles, plumose stigma.

**Fruit:** A caryopsis, broad, smooth, whitish, 2mm long, enclosed by lemma and palea, contains protein 10 per cent and carbohydrate 72 per cent.

### Economic Importance:

Foxtail millet may be cooked and eaten like rice, either entire or broken, flour used for making porridge and puddings. In Russia it is used for brewing beer. It is also used as bird feed for feeding cage birds.

## 3. SAMAI (Little millet) – *Panicum sumatrense* Linn. (2n = 36)

- Family** : Poaceae.
- Habitat** : Tropical and subtropical
- Habit** : Annual growing erect to about 0.75 to 1 metre, tillering.
- Stem** : Slender, usually leafy upto the panicle without hairs.

- Leaves** : Linear, leaf sheath often glabrous rarely hairy if hairy with tubercled hairs, ligule membranous and hairy.
- Inflorescence** : A panicle, much branched erect or curved; upto 25cm long, branches slender. Spikelets solitary, densely arranged sometimes two; glumes are very shiny two enclosing two florets. Lower one will be sterile with L<sub>1</sub>, P<sub>1</sub>. L<sub>2</sub> and P<sub>2</sub> encloses upper bisexual floret, two lodicules, stamens three, ovary superior with two styles and plumose stigma.

**Economic Importance:**

The grain is used as food and the straw as fodder.

**4. KUDIRAIVALI (Barnyard millet) – *Echinochloa frumentacea* (2n = 36)**

- Family** : Poaceae.
- Habitat** : Tropical
- Habit** : Annual, herbaceous, growing upto 0.75 m in height tillering sparsely.
- Stem** : Smooth and slender.
- Leaves** : Flat glabrous or slightly hairy, ligule absent.
- Inflorescence** : Digitate panicle, contracted or pyramidal, spikes many, thickened with densely packed in 3-5 rows, turgid, glumes two (G<sub>1</sub>, G<sub>2</sub>), lower floret (L<sub>1</sub>, P<sub>1</sub>) sterile, upper floret (L<sub>2</sub>, P<sub>2</sub>) fertile, hermaphrodite, stamens three, ovary superior, styles two with plumose stigma.

**Economic Importance:**

The grain is used as food and young shoots are used as a vegetable in Java.

**5. PANIVARAGU (Proso millet) – *Panicum miliaceum* Linn (2n = 36)**

- Family** : Poaceae.
- Habitat** : Tropical
- Habit** : Annual, normally a metre long, free tillering.
- Stem** : Slender, internodes solid or hollow nodes distinctly swollen and pubescent.

- Leaves** : Leaf sheath open or split, hairy and prominently hairy at the juncture of the leaf sheath and lamina ligule short with a fringe of silky hairs, lamina linear, narrow, soft and hairy.
- Inflorescence** : It is a lax panicle, spikelets numerous with two glumes.  $G_1$  is short (half the length of spikelet),  $G_2$  is as long as the spikelet.  $L_1$  and  $P_1$  sterile.  $L_2$  and  $P_2$  are fertile, stamens three, ovary with bifid style, lodicules two

**Economic Importance:**

Grains are used as food and the straw is used as fodder.

**6. VARAGU (Kodo millet) – *Paspalum scrobiculatum* Linn ( $2n = 40$ )**

- Family** : Poaceae.
- Habitat** : Tropical
- Habit** : Erect, herbaceous annual growing to half to three-four metre in height tillers upto eighteen.
- Stem** : Base of the culm is pinkish, nodes villous or hairy, internodes solid and fully ensheathed.
- Leaves** : Linear, ligule membranous and hairy.
- Inflorescence** : It is a panicle with two to eight spikes on the main rachis. Each spike having broad, flat rachis with series of depressions in which the spikelets are situated, arising from either side of the ridge, running the entire length of the rachis.
- Fruit** : Caryopsis tightly enclosed by the hardened  $L_2$  and  $P_2$  grain contains 10.6% protein and 59% carbohydrates. High keeping quality, mainly used as a famine reserve. Contains toxic principles mostly confined to glumes.

**Economic Importance:**

Used as human food and fodder for livestock.

## 7. PULSES

### REDGRAM, BLACKGRAM, GREENGRAM AND BENGALGRAM

#### 1. REDGRAM (Pigeonpea, Arhar) – *Cajanus cajan* Millsp. (2n = 22)

- Habitat** : Tropical
- Habit** : Annual, biennial or perennial shrub erect and branching.
- Root** : Tall, upright dense root systems. Large clusters of nodules are produced under favourable condition.
- Stem** : Woody and striated.
- Leaves** : Trifoliately compound, central leaflet longer than lateral ones, stipules small, lamina hairy with the under surface greyish due to dense hairs, along with the hairs there are yellow glands which are prominent.
- Inflorescence** : Axially or terminal racemes on long peduncle. Flowers are papilionaceous, bracteate, bracteolate, calyx- sepals five, gamosepalous, corolla - petals five, one standard, two wing and two keel petals, polypetalous, androecium - stamens ten (9+1), diadelphous, gynoecium - ovary superior, bicarpellary and unilocular with a few ovules capitate stigma.
- Fruit** : A pod. It is variable in shape, size, constriction, texture and pubescence, pods with deep constrictions are known as beaded while others are flattish.

#### Economic Importance:

The green pods and green seeds are eaten as vegetable. The ripe dry seeds are boiled and eaten as pulse.

Two different ways of making split pulse (*Dhal*)

- i. Wet method: By soaking seeds in water for 6-10 hours, smearing them with red earth, drying them in sun and splitting them in the mill. The dhal recovery is 80 per cent.
- ii. Dry method: Seeds are well dried in sun and directly splitting in the mill. In this method the recovery percentage is 66 per cent.

Dried husk and broken pieces of seed are used as cattle feed

Green leaf and tops of the plant is used as fodder and for making silage.

Dried stake is used as fuel and as thatching material.

## 2. BLACKGRAM (*Vigna mungo* L.) – Hepper (2n = 22)

- Habitat** : Tropical
- Habit** : Annual, herbaceous, 30-100 cm in height, erect, semi erect to trailing or spreading types, plant densely hairy.
- Stem** : Slightly ridged, covered with brown hairs, hairs pointed downwards. Stem colour dust brown much branched from the base.
- Leaves** : Trifoliate, alternate, stipulate, stipules narrow and falcate, petiolate, pulvinate, stipellate, stipel small and flat, leaflets ovate, entire, acute, sparsely hairy on both surfaces, palmately reticulate.
- Inflorescence** : Axillary raceme with the flowers congested at the top of the peduncle, flowers five to six, bracteate, bracteolate, bracteoles 2, pedicillate, bisexual hypogynous, zygomorphic, complete, pentamerous.
- Pod** : Mature pod is puff to brown colour, 6-8 mm long (shorter than mug bean) round, erect with long and dense hairs and short hooked beak.
- Seed** : Oblong with square ends, black. Hilum white and concave, seed coat surface is smooth. Cotyledons white in colour.

### Economic Importance:

Dried grain used in preparation of *idli*, *dosai*, *vadai* etc.,. Flour used in bakery for preparation of bread and biscuit. Green seed and pod are eaten as vegetable. Dried or green plants are used as fodder. Broken grain, seed coat and *bhusa* (*pottu*) are excellent fodder.

## 3. GREENGRAM (*Vigna radiata* L.) – Wilezek (Mungbean) (2n = 22)

- Habitat** : Tropical
- Habit** : Herbaceous annual with slight tendency for twining in the upper branches, plant sparsely hairy.
- Root** : Tap root system.
- Stem** : Erect or semierect and green in colour.
- Leaves** : Trifoliate with long petioles, stipules with basal appendages, stipels minute, leaflets entire, ovate, lobed leaes are also present.



- Flowers** : Papilionaceous, ten to twenty crowded in axillary racemes on long peduncle, stamens diadelphous (9+1), ovary with long bearded style. Flowers light yellowish or olive yellow.
- Pods** : Immature pods are green, mature pods are olive grey or brown colour. Upon maturity it dehisces by both sutures into two halves.
- Seeds** : Globular, green and the surface has fine wavy ridges. Hilum is white and flat cotyledon is yellowish in colour.

**Economic Importance:**

Seed as food for human beings, green and dry plant as fodder.

**4. BENGALGRAM (Chickpea, Channa) *Cicer arietinum* (2n = 16)**

- Habitat** : Subtropical and temperate.
- Habit** : Herbaceous annual, branching from the base, mostly erect and with a few spreading branches, 25-50 cm tall, all parts of the plant are covered with glandular hairs. Rich in oxalic acid (6%) and malic acid (94%). The two cultivated types are Desi and Kabuli.
- Desi type** : Plants are having smaller dark green leaves dwarf with purple flowers. Seeds are brown coloured wrinkled, smaller in size.
- Kabuli type** : Tall with pale green leaves. Flowers are white and seeds comparatively larger, smooth and white in colour.
- Stem** : Greyish in appearance. Main stem is rounded, branches are usually quadrangular ribbed and green.
- Leaves** : Imparipinnate with 15 small leaflets hairy serrated ovate.
- Flowers** : Solitary, axillary, pedicels jointed. The colour varies from white to bluish papilionaceous, zygomorphic, persistent and forming an oblique tube with dense glandular hairs. Petals five, standard broad and clawed, wings free, keel incurved, stamens (9+1) diadelphous, didynamous, ovary superior, style filiform, beardless with terminal stigma.
- Pod** : Inflated, one or two seeded. Seeds angular with prominent beak and small hilum. Colour ranging from white red to black. Cotyledons are thick and yellowish.

**Economic importance:**

Dried seeds soaked in water, cooked and eaten.

Dhal used in various food preparations.

Popped grain - '*Pottu kadalai*'

Broken seed as dhal - '*Kadalai paruppu*'

Flour used in various food preparations.

Roasted seeds are taken as food and also used in preparation of various dishes. Green pods and tender shoots used as vegetable. Dried plant as cattle feed.

An acid liquid from glandular hairs is collected by spreading a thin cloth over night. The liquid collected contain 94 per cent malic acid and 6 per cent oxalic acid. It is used as vinegar and also as medicine.

## 8. COWPEA, SOYBEAN, LAB LAB AND DEW GRAM

### 1. COWPEA – *Vigna unguiculata* (L.) Walp (2n = 22)

- Habitat** : Subtropical and tropical
- Habit** : Annual, twining, rarely suberect and erect herb.
- Stem** : Slightly ridged, almost glabrous and hairy at the nodes.
- Leaves** : Alternate, stipulate, stipules large foliaceous, petiolate, pulvinate, pinnately trifoliate, leaflets stipelate, ovate, entire acute, both surface with scattered short hairs, palmately reticulate and lateral leaflets oblique.
- Inflorescence** : Axillary raceme with flowers congested at the top of the nodes, peduncle often in alternate pairs flowers showy, white or yellow or pink, bracteate, bracteolate bracteoles two, shortly pedicellate, bisexual, hypogynous, zygomorphic complete, pentamerous, cyclic. Stamens 10 diadelphous, filaments alternately long and short anthers uniform, ditheous, introse. Ovary superior with capitate stigma.
- Pods** : Either flabby or inflated
- Seeds** : Sub reniform to subglobose

#### Economic importance:

Tender pod as vegetable cowpea, tender leaves used as greens. Sprouted seed as vegetable, grain as pulse. Whole plant as green fodder. Cowpea and maize green fodder mixture is excellent for cattle.

### 2. SOYABEAN OR SOYBEAN – (*Glycine max* L. ) Merrill (2n = 40)

- Habitat** : Subtropical and tropical
- Habit** : Herbaceous annual densely clothed with fine ferreuginous hairs height varies from 0.5 metres to 2 metres.
- Stem** : Suberect or climbing.
- Leaves** : Trifoliate, long petioled, leaflets ovate acute, five to ten cm long, subtended short stipulate small pointed stipules.

**Inflorescence** : Flower small, numerous upto twelve on short racemes arising in the axils of the leaves, white or purple. Calyx hairy, standard broad, notched, auricled at the base, pale coloured whitish or light purple, with deep purple veins at its base, stamens ten often diadelphous, ovary short, hairy with short curved style and apical stigma present above the stamens.

**Fruit** : Pods linear to oblong profusely hairy. The seed of soybean is oval with the colour varying from light yellow to black. The hilum is prominent. Seed viability is poor.

**Economic importance:**

Most important source of oil and protein. Unripe seeds are used as vegetable. Dried seed are eaten whole, split or sprouted and used. Substitute for black gram in preparation of flour for *idli*. Soya milk, Soya sauce, Soya oil are used for edible purpose. The whole plant as fodder and seed as cattle feed. Soya meal or protein used to manufacture synthetic fibre, adhesive, fire fighting foam. Soya flour used in bakery.

**3. LAB LAB – *Lablab purpureus* (L.) Sweet (2n = 22, 24)**

Two plant types:

Garden bean – *Lablab purpureus* var. *typicus* – Avarai

Field Bean – *Lablab purpureus* var. *lignosus* - Mochai

**Habit** : Trailing herb.

**Leaves** : Alternate, petiolate, pulvinate, stipulate, pinnately trifoliate leaflets, entire, acute, sparsely hairy, lateral leaflets oblique.

**Inflorescence** : Axillary raceme, flowers congested at nodes in a long peduncle. Bracteate, Bracteolate, pedicillate (short pedicel) calyx companulate sepals five gamosepalous. Corolla papilionaceous. Polypetalous descendingly imbricate 10 stamens, filaments alternately long and short, anthers ditheous, introse ovules monocarpellary, unilocular with few ovules.

**Fruit** : Legume or pod

**Seed** : Non – endospermous, large thick, ovoid, slightly flattened.

**Difference between Garden Bean and Field Bean**

Character	Garden bean	Field bean
1. Habit	Perennial, cultivated as an annual twiner	Annual, bushy straggler
2. Plant parts	No pungent smell	Has a characteristic smell due to an oily secretion.
3. Flower	White or purple	Usually white
4. Pericarp	Slender or soft	Tough, firm and parchment like.
5. Seeds	Long axes of seeds are parallel to the length of the fruit	Long axes of seeds are at right angles to the length of fruit.
6. Edible part.	Whole fruit	Generally seed alone.

**Economic Importance:**

Seed as source of protein and pod as vegetable.

**4. DEW GRAM (Moth Bean) *Vigna aconitifolia* Jacq. (2n = 22)**

**Habitat** : Subtropical and tropical

**Habit** : It is an annual plant with a spreading and prostrate habit.

**Stem** : Angular and hairy with short internodes. Main axis is about 15 – 30 cm in height. Many primary branches 30 –150 cm. Long radiate from the main axis giving the plant its spreading habit. Internodes of the primary branches are longer.

**Leaf** : Alternate and trifoliate with deeply lobed leaflets. Terminal leaf slightly larger with 5 acuminate lobes. Lateral leaflets are three lobed, petiolate, stipulate and stipules are lobed.

**Inflorescence** : Axillary, long – peduncled capitate raceme peduncle is hairy like the stems. Small yellow papilionaceous flower are clustered in the peduncle. Bracteoles are twice as long as the calyx, their setaceous ciliated tips protruding beyond the buds. Stamens 9 + 1. ovary is minutely hirsute with twisted style and flat stigma bearded on the lower side.

**Pod** : Puff to yellowish brown, have short stiff bristles and the beak is short and curved 4 –9 seeds in a pod.

**Seed** : Grey or black mottled, reniform with rounded or truncate ends. Hilum is linear and white.

**Economic Importance:**

It is used as a whole or split pulse to make savoury dish seed as a source of protein (25 – 31%) and phosphorus (0.28 – 0.44%). Bhusa is used as fodder.

## 9. OILSEEDS

### GROUNDNUT AND SESAMUM

#### 1. GROUNDNUT (Peanut) – *Arachis hypogaea* linn (2n = 48)

- Family** : Fabaceae
- Habitat** : Tropical and subtropical
- Habit** : Low growing annual herb.
- Stem** : There are three cultivated forms (1) bunch, (2) semispreading and (3) Spreading types. The central axis of the stem erect, often hairy with short internodes. Some what angular slightly pithy. In bunchy types, the lateral branches also grow almost erect whereas, in the spreading (prostrate) types the laterals are procumbent or prostrate.
- Varietal forms** :
1. *A. hypogaea* subsp hypogaea var hypogaea – Virginia runner
  2. *A. hypogaea* subsp hypogaea var hirsuta – Peruvian
  3. *A. hypogaea* subsp fastigiata var vulgaris – Spanish bunch
  4. *A. hypogaea* subsp fastigiata var fastigiata – Valencia

Subspecies	Variety	Type	Description
<b>Hypogaea</b>	Hypogaea	Virginia	No floral axis on main stem alternating pairs of floral and vegetative axes on branches, branches short less hairy.
	Hirsuta	Peruvian	No floral axes in main stem alternating pairs of floral and vegetative axes on branches long more hairy.
<b>Fastigiata</b>	Vulgaris	Spanish	Floral axes on main stem sequential floral axes on branches more branches, upright branches.
	Fastigiata	Valencia	Floral axes on main stem, sequential floral axes on branches, little branched, curved branches.

- Leaves** : Alternate, paripinnately compound leaves stipules adnate, the petioles fairly long with two pairs of ovate leaflets, has a central groove running throughout the length, the leaflets are arranged opposite to each other in pairs, stipules absent, pulvinus of the petiole is distinct above the joint of the adnate stipules.
- Flowers** : Single or three to four per leaf axils in condensed raceme. The flower is sessile, yellow in colour with fairly long calyx tube which gives the false appearance of a pedicel. A single bract and two bracteoles are present in each flower.

- Calyx** : Tubular, slender, ending in five lobes, of which three are united into one big structure and the two linear lanceolate. The long slender calyx tube is also called as Hypanthium.
- Corolla** : Papilionaceous, five, keels are united.
- Androecium** : Stamens monadelphous, eight fertile and two staminodes. The eight anthers are dimorphic with four having long anther lobes and four with rounded anther lobes.
- Gynoecium** : Monocarpellary, superior ovary arises at the base of the flowers, style slender passes through the length of the calyx tubes, stigma terminal, hairy, ovary unilocular with one to three ovules on marginal placentation.
- Fruit** : An indehiscent pod carried on a long stalk which is the gynophore or carpophore. One to three seeds per pod. The testa is commonly rose or varying from dark purple to red colour or variegated.
- Development of pod** : On fertilization, the thalamus position below the ovary begin to grow into a peg or gynophore. The peg grows towards the soil i.e. positively geotropic to begin with, a lignified tissue forms a protective cap at the tip for the fertilized ovary. The peg carrying the ovary pushes itself into the soil. After entering the soil to a specific depth which is characteristic for a variety, it takes a horizontal position and the ovary begins to develop into a pod.

### **Economic Importance:**

- ❖ The nuts are eaten raw or after roasting. For this purpose bunch types with extra large kernels are preferred since they contain relatively low oil content than Virginia type.
- ❖ Kernel rich source of phosphorus, vitamin, protein (26 %) and oil (45 to 50 %).
- ❖ Oil as a cooking media.
- ❖ Hydrogenated oil - for preparation of vanaspathi / vegetable ghee.
- ❖ Manufacture of margarine - butter like substance.
- ❖ Peanut butter.
- ❖ Oil cake as cattle feed.
- ❖ Moist oil cake for production of aflatoxin from *Aspergillus flavus*.
- ❖ Oil -Non drying.
- ❖ Pharmaceutical industry. Soap industry. Lubrication.
- ❖ New textile fibre **Ardil** - manufactured from peanut protein.

## 2. GINGELLY (SESAME)– *Sesamum indicum* Linn (2n = 26)

- Family** : Pedaliaceae
- Habitat** : Tropical and subtropical
- Habit** : Herbaceous, annual growing to a metre or more
- Stem** : Erect, quadrangular, longitudinally furrowed with dense hairs.
- Leaves** : Various arranged, opposite below, alternate above, the leaves are entire, lanceolate whereas the leaves below are broad lobed with serrated margins.
- Inflorescence** : Axillary, solitary or in groups of two to three flowers, shortly pedicellate with two aborted glands on either side of the pedicel.
- Calyx** : Five lobes, gamosepalous
- Corolla** : Tubular, ventricose, slightly gibbous at base, two lipped, the upper lip of two lobes usually smaller, the lower bigger and of three lobes, a ring of hairs is often present inside the corolla towards the base below the stamens. Flowers variously coloured from pure white to purple or to deep violet.
- Androecium** : Stamens 4, epipetalous, didynamous, anther cells oblong parallel, a fifth staminode may be present.
- Gynoecium** : Superior ovary, bicarpellary, looks like four by the formation of many ovules on axile placentation. The style is forked at the tip and carries the two stigmatic hairy lobes.
- Fruit** : Oblong or ovoid capsule with bony walls, loculicidal in dehiscence, two types of fruits are recognized. One is four loculed and the other eight loculed.
- Seeds** : Seeds compressed, ranging from white to brown or black testa with a smooth or rough surface enclosing an embryo with prominent cotyledon. Endosperm found as a thin layer around embryo. Endosperm contains oil and protein.



**Economic Importance:**

- ❖ Seeds mixed with jaggery and eaten - *chikki*.
- ❖ Good source of cooking oil - (85% unsaturated fatty acid).
- ❖ Manufacture of margarine.
- ❖ Soap, paint, illuminant, base for scented oil
- ❖ Carrier for antibiotics, vitamins and hormones.
- ❖ Oil cake - rich in calcium, phosphorus and the vitamin niacin ; used as cattle feed.
- ❖ Seed and green plant have medicinal value.

## 10. SUNFLOWER, CASTOR AND SAFFLOWER

### 1. SUNFLOWER – *Helianthus annuus* Linn (2n = 34)

- Family** : Compositae (Asteraceae)
- Habitat** : Tropical and subtropical
- Habit** : Tall annual herb. Two varieties:  
1. Tall unbranched, single headed type  
2. Short branched, multiheaded type.
- Stem** : Rough, hairy and pithy.
- Leaves** : Simple, alternate, large, rough, hairy, cordate, irregularly toothed on the margins, pointed at the apex.
- Inflorescence** : Heterogamous Capitulum (Head). Receptacle is flat, slightly convex with two to three rows of large pointed involucre of bracts; head has outer row of ray florets and inner rows of disc florets. Florets are subtended by broad scales (Bracteoles). Ray floret; with ligulate corolla, yellow in colour, zygomorphic and calyx is reduced to pappus hairs. Normally florets are sterile or sometimes pistillate. Disc floret : Actinomorphic, bisexual, calyx is reduced to pappus hairs, gamosepalous, corolla united to form a tube. Stamens five, syngenesious anthers, epipetalous stamens, ovary inferior, monocarpellary with single ovule and the style passes through syngenesious anthers with bifid stigma.
- Fruit** : It is an **achene**, broad, angular, large.

#### Economic Importance:

Oil as cooking media (90% Poly unsaturated fatty acid (PUFA) and 10% Saturated Fatty acid). It has non cholesterol and anti cholesterol properties. Used in cooking and for salads. Used in paints, varnishes, soap, cosmetics. Oil cake and hulls as cattle feed and fuel . From dried stalk paper is made. Sunflower also produce excellent honey and wax. Fried sunflower seeds are edible.

## 2. CASTOR – *Ricinus communis* Linn. (2n = 20)

- Family** : Euphorbiaceae
- Habitat** : Tropical and subtropical
- Habit** : Tall annual or perennial growing to a shrub or small tree.
- Stem** : Glabrous, pithy with prominent nodes and leaf scar, colour of stem is rose or green.
- Leaves** : Alternate, palmately seven to eleven lobed, glands serrated, petiole four to twelve inches long, glands distributed on the petiole. Some varieties have ashy coating (bloom) on the surface of the leaves.
- Inflorescence** : Monoecious, flowers in a terminal panicle with female flowers in the upper part and male flowers at the base. In some lines male and female flowers occur mixed together (interspersed). Male flower perianth five, greyish, splitting to three to five valvate segments, stamens many in branched filaments (polyadelphous), anthers subglobose round, yellow; Female flower ovary superior, tricarpellary, syncarpous, style short and branched trifold or bifid.
- Fruit** : A schizocarp, may be smooth or spiny, on maturity splits into three one seeded cocci.
- Seed** : Testa smooth, the hilum is almost concealed under the caruncle which is an integumentary proliferation at the micropylar end. The raphe is prominent. A tiny embryo with a distinct plumule and two thin flat distinctly nerved papery cotyledon is embedded in the endosperm.

### Economic Importance:

Paints, varnishes and other protective coverings  
Illuminant  
Lubricant for aeroengines.  
Hydraulic brake fluid.  
Soap, printing ink, wax, polish.

### 3. SAFFLOWER – *Carthamus tinctorius* Linn. (2n = 24)

- Family** : Compositae
- Habitat** : Tropical and subtropical
- Habit** : Annual herb presenting a thistle like appearance, plants may be glabrous or pubescent.
- Stem** : Erect, woody, glabrous and grooved.
- Leaves** : Alternate, rigid, entire and unarmed or spinulose – serrate.
- Inflorescence** : Head or capitulum homogamous, outer involucre bracts ovate – oblong, constricted above the base, green spinous or not, inner involucre bracts oblong-acute. Florets are tubular, light yellow to orange red in colour, hermaphrodite, bracts and bracteoles of each floret modified into thin soft hairs. Calyx absent corolla long, tubular, arising on the inferior ovary, stamens five, epipetalous, syngenesious, ovary inferior, bicarpellary, single celled, single ovuled, basal or ascending in placentation, sometimes a few of the marginal florets are sterile.
- Fruit** : An achene which is obovate, truncate at top, exendospermous.

#### **Economic Importance:**

- ❖ Cooking media (Saffola)
- ❖ Good drying oil
- ❖ Corolla used in dyeing industry.
- ❖ Oil cake - stock feed
- ❖ Preparation of paints and varnishes.

## 11. NIGER, RAPE AND MUSTARD

### 1. NIGER – *Guizotia abyssinica* Cass (2n = 30)

- Family** : Compositae
- Habitat** : Tropical
- Habit** : Herbaceous, annual growing about a metre in height.
- Stem** : Erect and smooth.
- Leaves** : Sessile, linear or lanceolate, obtuse with serrated margin.
- Inflorescence** : Heterogamous head or capitulum. Outer involucre bracts ovate or broadly elliptic green. Outer ray florets are ligulate or pistillate, inner disc or tubular florets are hermaphrodite, florets yellow, calyx reduced to a short rim of scales. Stamens five, epipetalous, syngenesious anthers. Ovary inferior, bicarpellary, single celled, single ovuled, basal placentation, style bifid.
- Fruit** : An achene, globose, dorsally compressed, tip rounded black and exendospermous.

#### Economic Importance:

Seeds as a source of drying oil (3 – 45%)

### 2. RAPE AND MUSTARD – *Brassica* spp. (2n = 16, 18, 20, 22),

The group rape and mustard includes the oil yielding species of Brassica.

Rape seed : *Brassica campestris*

Indian mustard: *B. juncea* (brown mustard, Rai)

Black mustard : *B. nigra* (Banarasi rai)

- Family** : Cruciferae
- Habitat** : Temperate and subtropical
- Habit** : Herbaceous annual
- Leaves** : Alternate, exstipulate, simple leaves, often pinnately lobed. The lower leaves are known as the stem leaves and the upper leaves arising on the axis of the inflorescence known as floral leaves.

**Inflorescence** : It is a long racemose with a few bracts. Flowers conspicuous, actinomorphic. Sepals four, erect or spreading; petals four with narrow basal claw, spreading or erect limb. Stamens six, the outer two shorter than the four inner. Gynoecium superior, two joined carpels with single short style and capitate stigma, ovules many in parietal placentation.

**Fruit** : **Siliqua** type, dehiscent by the carpel walls splitting longitudinally along the line of the placenta from base to top. The seeds are black or white depending on the varieties. The cotyledon contain the oil

**Economic Importance:**

- ❖ Seed as condiment
- ❖ Oil as cooking oil
- ❖ Oil - illuminant, lubricant, soap industry, fertilizer industry, plastic industry
- ❖ Green plant as fodder
- ❖ The essential oil in mustard has medicinal properties. Used as counter irritant
- ❖ The leaves of young plants used as green or leafy vegetable.

## 12. FIBRES

### COTTON

#### 1. COTTON – *Gossypium* spp. (2n = 26, 52)

- Family** : Malvaceae
- Habitat** : Tropical and subtropical
- Habit** : Herbaceous annual growing to a height of 1-1.5m. primary axis is erect and branched. Branches are dimorphic in nature. 1. Vegetative axillary bud (monopodial), 2. fruiting extra axillary bud (sympodial) in upper nodes.
- Vegetative branch** : Vegetative branches are monopodial and they are morphologically similar to main stem. Do not bear flowers directly bud gives out secondary branches.
- Fruiting branch** : Fruiting branches are sympodial. They arise from the axes of subtending leaf, another branch develop terminating in a fruiting point.
- Leaves** : Alternate, cordate, petiolate, 3-9 lobed and palmately veined. The size, texture, shape and hairiness are widely varying.
- Flowers** : Simple, solitary, terminal extra axillary showy, yellow to cream in colour and hermaphrodite. Bracteoles called epicalyx, three in number few and deeply serrated and usually foliar persistent at the base of the flower. Nectary gland is present on each bracteole. The buds of flowers appear at first as small pyramidal shaped green structures and are known as 'squares'.
- Calyx** : Five, united, cup shaped.
- Corolla** : Five, polypetalous, a purple spot is found on the innerside of the claw of the petal (petal spot) in some species.
- Androecium** : Stamens many and form staminal column bearing many filaments, reniform anthers.
- Gynoecium** : Superior ovary, pentacarpellary, style slender, passes through staminal column with three to five lobed stigma. Ovules many in axile placentation.

**Fruit** : Loculicidal dehiscent capsule called boll. Seeds 1-9 in each locule, subglobose seeds are covered with one to two layers of hairs. Lint arises from the epidermal layer and fuzz arises from the sub epidermal layer. Fuzz cannot be separated from the seed. Lint is separable.

**Economic Importance:**

Cotton lint is a valuable textile fibre. Various plant parts are useful.

Lint - Textile, absorbent cotton, wiping , polishing material, clothing, house hold articles, industrial articles, twines, cellulose, plastic. In Industries for making tyre cord and machinery belt.

Cotton seed- Cattle feed, Cotton seed oil- oil 20 per cent (semi drying oil)

Root bark - ergot like drug.

Stalk - Fuel, paper pulp, bast fibre extracted.

Leaves - Fodder.



## 13. JUTE, MESTA, SUNHEMP, AGAVE AND SILK COTTON

### 1. JUTE – *Corchorus* spp. (2n = 14)

**Family** : Tiliaceae

**Habitat** : Tropical and subtropical

There are two species *C.olitorius* and *C.capsularis*.

***C.olitorius*** : Tall growing herbaceous annual growing upto five meters. It is an upland species. Stem is green or reddish. Branches develop more than capsularis. Leaves glabrous, flowers axillary, stamens 3-60, ovary elongated 5-6 carpelled. Fruit is an elongated capsule, 5-6 loculed with lengthwise ridge on the pericarp. Seeds smaller than that of capsularis, blackish to bluish green in colour.

***C. capsularis*** : Herbaceous annual growing from 1.5 to 4 m, stem slender, cylindrical greyish. Branches sparsely produced, leaves simple, alternate, stipulate, ovate to oblong, acuminate, coarsely toothed, flowers small, yellow, axillary cymes of two to five, stamens 2-30, ovary superior, 5 carpelled, syncarpous with axile placentation.

**Fruit** : Capsule, wrinkled, hairy, tooth five loculed seeds smaller and brownish in colour.

**Fibre** : The fibre in jute is a bast fibre extracted from the base of the stem. Fibre occur in long wedge shaped bundles outside the xylem. They are grouped in concentric rings alternating with the thin walled tissue of the phloem which disintegrate during retting. Each of the fibre bundles represents one strand of filament composed of four to fifty cells. Individual fibre is less than 2-3 mm and polygonal in cross section. The cells which make up a fibre strand are elongated and the longest fibre cells occur in the stems of the longest internodes. In general, the fibre cells of jute are much shorter than other fibre and hence the use of jute fibre is limited to coarse fabrics only.

### Economic Importance:

Jute is used chiefly for rough weaving. The thick cloth made from jute is used for making gunny-bags, sails for country boats. Another type of fine cloth prepared from jute fibre is chiefly used as a cloth to sleep on. Jute is also extensively used in manufacture of carpets, curtains, shirtings and twine and ropes. Jute butts (short fibres) are used for making paper.

## 2. MESTA (Kenaf) – *Hibiscus cannabinus* (2n = 36)

- Family** : Malvaceae
- Habit** : Herbaceous annual growing to a height of even 5 metres.
- Stem** : Straight with small prickles.
- Leaves** : Alternate, stipulate, variously lobed with serrated margins, stipules long and pointed.
- Flowers** : Solitary with short pedicels and axillary, epicalyx stiff, consisting of seven to eight bracteoles, which are connate below and free above and inserted on the base of calyx. Calyx bristled, lanceolate, united upto the middle. Corolla longer, spreading, pale yellow to sulphur colour with crimson or purpled center.
- Androecium : Stamens numerous on a staminal column.
- Gynoecium: Ovary superior, five carpelled, style passes through staminal column and terminates in five stigmatic branches.
- Fruit** : Capsule, five loculed, each locule containing four to five seeds. Capsule pointed and bristled, seed glabrous.

### Economic Importance:

Fibre is mixed with jute for manufacture of bags, sacks, netting, ropes. Also used in the manufacture of sand paper and abrasives. The seeds contain about 20 per cent oil which is sometimes extracted and used as a lubricant and for illumination; for manufacture of soap, linoleum and in paints and varnishes.

## 3. SUNHEMP – *Crotalaria juncea* (2n = 26)

- Family** : Papilionaceae
- Habit** : Erect annual with a few lateral branches.
- Leaves** : Alternate, short petiolate, lanceolate, obtuse with a small bristle like apex, lamina covered with soft silver coloured hairs on both sides, stipules substate, small.
- Inflorescence** : Terminal raceme

- Flowers** : Bracteate, Papilionaceous, bright yellow
- Calyx** : Gamosepalous of five lobes, deeply cleft into two lips, the upper two lobed and lower lip of three lobes.
- Corolla** : Polypetalous, standard broad, wing oblong, keel much pointed, lightly twisted at the apex.
- Androecium** : Stamens ten, monadelphous, dimorphic with five short versatile anthers on slender filaments alternating with long basified anthers with flattened filaments.
- Gynoecium** : Ovary superior, monocarpellary, marginal placentation, ovules few, style long bearded at the top, stigma small, oblique, pod oblong, unflated, 1" to 1.5" long downy.
- Seeds** : Kidney shaped, exendospermous.

**Economic Importance:**

- Source of base fibre. Used for making cigarette papers, tissue paper and fishing net.

**4. SISAL – *Agave sisalana* (2n = 138)**

- Family** : Agavaceae
- Habit** : Perennial herb with short thick stem.
- Habitat** : Tropical
- Stem** : It bears close rosette of leaves. Bluish green in colour.
- Leaves** : Sessile, linear or lanceolate, thick, fleshy, covered with wax tip tapers into sharp spine.
- Inflorescence** : Terminal on a gigantic woody stalk or peduncle, flowers panicle, zygomorphic, bracteate, perianth united, 6 limbed, stamens 6, inferior ovary, tricarpeal, ovules many, axile placentation, style slender, stigma simple.

**Economic Importance:**

- Source of leaf fibre for industrial fabrics, matting twines and ropes
- Pulp for paper making
- Sap from inflorescence may be fermented to produce alcoholic drinks.

**5. SILK COTTON – *Ceiba pentandra* (2n = 27 to 84)**

<b>Family</b>	: Bombacaceae
<b>Habit</b>	: Deciduous, fast growing tree, 10-30m tall.
<b>Habitat</b>	: Tropical tree; thrives best at elevations below 1,500 ft; suited to wide range of conditions, but for high production requires abundant rainfall during the vegetative period for flowering and fruiting; easily damaged by high wind.
<b>Roots</b>	: Very shallow tap rooted.
<b>Stem</b>	: Trunk tapering, wide near ground, with or without short conical spines on trunk and branches; branches dimorphic; crow thin; branches whorled usually of 3 branches giving a pagoda form.
<b>Leaves</b>	: Alternate, glabrous, crowded at the ends of twigs; stipules small, lanceolate, falling early; petiole long with pulvinus at both ends; lamina digitate with 5-11 leaflets, shortly stalked, lanceolate, acuminate, entire or slightly toothed; in areas with a dry season leaves are deciduous.
<b>Inflorescence</b>	: Axillary fascicle.
<b>Flowers</b>	: Pedicellate, articulate at top.
<b>Calyx</b>	: Long, glabrous, five lobed, gamosepalous.
<b>Corolla</b>	: Petals five, united at the base, obovate, dirty white, foetid milky smell, glabrous, densely silky.
<b>Androecium</b>	: Staminal column united at base, dividing into five branches with 2-3 one celled convoluted anthers.
<b>Gynoecium</b>	: Ovary five celled, style constricted at base with a dilation above top of staminal tube; stigma five lobed.
<b>Fruits</b>	: Ellipsoidal leathery pendulous capsules, usually tapering at both ends.
<b>Seeds</b>	: Dark brown, obovoid, embedded in copious white, pale yellow or grey floss.

## 14. SUGARS

### SUGARCANE, SUGARPALM AND SUGARBEET

#### 1. SUGARCANE – *Saccharum officinarum* L.

- Family** : Poaceae
- Habitat** : Subtropical, tropical
- Habit** : Perennial grass growing erect and tall, upto 6-8 metres, also called as giant grass'
- Stem** : More or less cylindrical, solid, jointed with distinct nodes and internodes, the nodes are provided with root primordial and intercalary meristematic tissue.
- Leaves** : Alternate, distichous, enclosing a bud in the axil, lamina linear with a distinct midrib, margins and surface quite rough. Ligules simple.
- Inflorescence** : Silky panicle called 'arrow'. The main axis carries a number of lateral branches repeatedly branches and ultimately ending in rachis which bear the pair of spikelets. Of the paired spikelets, one is sessile and the other pedicellate. Both are identical in size, shape and structure. Each spikelets are deciduous. Glumes 1 and 2 are epaleate, sterile and as long as the spikelets and these glumes enclose the floral parts. Lemma 1 epaleate and sterile, lemma 2 is absent but its palea alone is present and faces glume 2 and encloses the bisexual flower. Lodicules two, truncate at top, stamens three, ovary superior with two styles and plumose stigmas.
- Fruit** : A caryopsis seeds are being used only in breeding work.

#### **Economic Importance:**

The stem yields the sucrose on crushing, the left out after crushing is the 'bagasse' used in paper making and the 'molasses' used for making the alcoholic drinks and 'pressmud' as a basic organic manure.

#### 2. SUGAR PALM – *Borassus flabellifer* L.

- Family** : Arecaceae (Palmae)
- Habitat** : Tropical
- Habit** : Tall, stout, greyish black, unbranched.

- Leaves** : Simple, palmately fan shaped, petiole spinous.
- Inflorescence** : Dioecious, branched, peduncle sheathed with open spathe, male flower small, mixed with scaly bracts, sepals three, imbricate, petals three, shorter, obovate spathulate, imbricate, stamens six, pistillode of three bristles, female flowers large, globose, perianth fleshy sepals reniform, imbricate, petals three, smaller, staminode, ovary tricarpeal.
- Fruit** : A large subglobose drupe.

**Economic Importance:**

Juice from male peduncle used as toddy, fermented into arrack, treated with lime and boiled down into jaggery. Wood is used as rafters, posts, fences. Leaves are used for thatch, fans, hats, baskets etc.

**3. SUGARBEET – *Beta vulgaris* (L)**

- Family** : Chenopodiaceae
- Habitat** : Subtropical
- Habit** : Herb, annual
- Stem** : Very much reduced.
- Leaves** : Arise in basal rosettes on the much condensed stem. Succulent, spiral, ovate to oblong-ovate, entire or wavy, surface smooth or crinkly, base cordate, the colour ranges from dark red to light green.
- Inflorescence** : Terminal open panicle. Flower small sessile and occur singly or in groups to two or seven, bracts are linear, flowers bisexual, nearly epigynous, actinomorphic, pentamerous, perianth five lobed, lobes concave and incurved. Stamens five, anthers dithecous, ovary embedded in the fleshy receptacles and three celled, syncarpous, unilocular with a single ovule, style short, stigma short.
- Fruit** : Nut like enclosed in hard woody perianth.

**Economic Importance:**

As a source of sugar (12-18%) from swollen hypocotyls and base of the stem. Also used as vegetable.

## 15. FORAGES AND LEGUME FODDER

**NAPIER, CUMBU NAPIER HYBRID, GUINEA GRASS, CENCHRUS.**

**LUCERNE, DESMODIUM, DESMANTHUS, STYLOSANTHUS, CLITORIA AND SIRATRO.**

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### FORAGES

#### 1. NAPIER GRASS – *Pennisetum purpureum* Schumach.

- Family** : Poaceae
- Habitat** : Tropical
- Habit** : Perennial, tall, profuse, tillering with creeping rhizomes.
- Leaves** : Linear, long, dull green with hairy ligules.
- Inflorescence** : Terminal, dense, spiciform panicle. Yellow or tinged with brown or purple spikelets lanceolate, one or two flowered, G1 and G2 minute. Lemma one paleate, staminate lemma two paleate, bisexual, stamens three, penicillate anthers, style long, connate bifid stigma.
- Grain** : Small, oblong

#### **Economic Importance:**

Leaf contains 5-7% protein with balanced proportion of calcium and phosphorus. It is coarse for hay making.

#### 2. CUMBU NAPIER HYBRID *Pennisetum glaucum* (2n=14) x *P. purpureum* (2n =28)

↓  
Hybrid 2n = 21 (triploid, sterile)

It appears like *P.purpureum* with greenish bristles. Hybrid is high yielding good as a green fodder and as well as for silage.

#### 3. GUINEA GRASS – *Panicum maximum* Jacq

- Family** : Poaceae
- Habitat** : Tropical
- Habit** : A dense, erect, perennial, rhizomatous grass, culms with big internodes, slender and glabrous nodes and leaf sheath pubescent.

- Leaves** : Leaf blade long, upto 60 cm., and 2-2.5 cm broad, little rough and succulent, linear, non droopy.
- Inflorescence** : Open terminal panicle with stiff branches in whorls. Spikelets small glumes two, stamens three, ovary with two stilar and plumose stigmas.
- Grains** : Small enclosed by the rigose lemma and palea and deciduous.

**Economic Importance:**

It is a very good grass for grazing, green fodder and silage making grown in many sewage farms. It is free from all known toxic principles. It contains 5-8% protein with well balanced calcium and phosphorus. It is useful as a soil binder to protect against soil erosion.

**4. KOLUKATTAI GRASS – *Cenchrus* spp.**

- White kolukattai : *C. ciliaris*
- Neela Kolukattai : *C. glaucus*
- Black klolukattai : *C. setigerus*

- Family** : Poaceae
- Habitat** : Tropical
- Habit** : Perennial grass with underground rhizomes.
- Stem** : Aerial branches, tufted, erect or decumbent, tillering.
- Leaves** : Leaf sheath slightly compressed, shorter than the internodes with scattered hairs, ligule short, thin, membrane fringed with hairs, the leaf blade is linear with hairs scattered above and sparse at the lower surface.
- Inflorescence** : A raceme of spikes, floral axis flattened and grooved, one to three spikelets subtended by involucre of bristles, connate at the base, spikelets sessile, oblong lanceolate, first glume is small, hyaline, ovate-lanceolate, second glume ovate, acute hyaline and one-third to half the length of the lemma, first lemma paleate, staminate or sessile, second lemma paleate with hermaphrodite flower, stamens three, ovary with two plumose stigmas, lodicules absent, grain small, oblong.



**Economic Importance:**

Suited for grazing as well as a fodder. It makes a good hay as it retains its nutritive value even when ripe. It is suited to grow under tree esp *Laecana* sp.

**LEGUME FODDER****1. LUCERNE (ALFALFA) – *Medicago sativa* Linn.**

- Family** : Fabaceae
- Habitat** : Subtropical, tropical
- Habit** : Deep rooted perennial, herb.
- Stem** : Erect, 50-60 cm height, arising from the crown which is a woody base.
- Leaves** : Alternate, narrow and sharply toothed.
- Inflorescence** : Axillary raceme, flowers small, yellow, white, purple, violet or blue, bracteolate, zygomorphic, hermaphrodite, bracteate.
- Calyx** : Five, gamosepalous.
- Corolla** : Five, gamopetalous, papilionaceous.
- Androecium** : Stamens ten, diadelphous (9+1), didynamous.
- Gynoecium** : Ovary superior, monocarpellary with many ovules, style simple, stigma capitate.
- Fruit** : Spirally coiled legume.

**Economic Importance:**

It is a very good fodder crop with 22-25% protein with well balanced calcium and phosphorus. Dried leaves are powdered and used in the preparation of concentrates. It is also used in poultry feed.

**2. VELIMASAL (DESMANTHUS) – *Desmanthus virgatus***

- Habitat** : Subtropical and tropical
- Habit** : Perennial shrub, can be maintained as a hedge plant, tolerant to heavy grazing with quick regrowth.

- Stem** : Slender, become hardly twig by repeated cutting.
- Leaves** : Bipinnate, leaflets small in pairs.
- Inflorescence** : In small peduncled heads, flowers small, calyx and corolla five gamo, numerous stamens, ovary superior, monocarpellary with many ovules.

**Economic Importance:**

Leaves are good fodder for cattle. Quick regrowth is advantageous for introduction of this crop in varying cropping systems.

**3. DESMODIUM – *Desmodium tortuosum***

- Habitat** : Subtropical and tropical
- Habit** : Shrub, 15-30 cm in height.
- Stem** : Very slender
- Leaves** : Pinnately trifoliate, stipulate.
- Inflorescence** : Axillary or terminal racemes. Flowers small, purple, red or white. Calyx five united, corolla five papilionaceous, stamens 10 (9+1). Ovary superior, seeds reniform and compressed.

**Economic Importance:**

It is very good shade tolerant green manure-cum-fodder crop. It can be grown in coconut gardens.

**4. STYLOSANTHES (MUYAL MASAL)– *Stylosanthes scabra* and *Stylosanthes hamata*.**

- Habitat** : Tropical forests.
- Habit** : Shrub, with many branches.
- Stem** : Woody twig.
- Leaves** : Pinnately trifoliate, stipules large, adnate to the base of the petiole.
- Inflorescence** : Small, yellow in dense terminal heads. Calyx five, tubular, corolla five, standard orbicular, wings oblong, free keel incurved, stamens ten, monoadelphous, dimorphic anthers, superior ovary, monocarpellary. Ovules two to three, style filiform, stigma minute, pods compressed, hooked at apex, seeds compressed.

**Economic Importance:**

Leaves are rich in protein.

**5. SIRATRO – *Macroptilium atropurpureum***

**Habitat** : Tropical

**Habit** : Herb, erect or climbing.

**Stem** : Slender, twining.

**Leaves** : Pinnately trifoliate.

**Inflorescence** : Axillary raceme, flowers showy with long pedicels, bracteate and bracteolate, calyx five, united corolla five, papilionaceous, wing large than standard, stamens 10 (9+1), ovary monocarpellary, many ovules, style long, pod incurved, shattering.

**Economic Importance:**

Drought tolerant, grown as a perennial pasture legume, prevent soil erosion, as a cover plant in coconut gardens.

**6. CLITORIA – *Clitoria ternata***

**Habitat** : Tropical

**Habit** : A twining herb.

**Stem** : Slender, twining.

**Leaves** : Pinnately trifoliate with persistent stipules.

**Inflorescence** : Solitary, axillary, calyx five tubular, corolla showy, standard large, erect wings falcate (sickle shaped), stamens 10 (9+1), ovary monocarpellary, many ovules, style incurved, pod linear, oblong.

**Economic Importance:**

Grown in waste lands for fodder field boundaries, etc.

## 16. TREE FODDERS & GREEN AND GREEN LEAF MANURES

### TREE FODDERS

#### 1. GLYRICIDIA – *Glyricidia sepium*

**Family** : Fabaceae

This is a medium tall tree, quickly growing of to about 10 m height with attractive flowers. For green manure purpose it could be kept low by pruning at constant height.

#### **Economic Importance:**

Used for shade, green leaf manure and also as fodder. Withstands severe pruning. Fix atmospheric nitrogen.

#### 2. SUBABUL (Savundal) – *Leucaena leucocephala* (or) *L. glauca*.

**Family** : Mimosaceae

**Origin** : Tropical America

**Habitat** : Subtropical, tropical

**Habit** : A tall single trunked tree occurs and many branched shrubs also.

**Leaves** : Bipinnate, leaflets small in many pairs, stipulate calyx five, tubular, corolla five tubular, stamens 10, exerted, ovary monocarpellary, many ovuled, pod stalked flattened.

#### **Economic Importance:**

It is a very good tree fodder.

### 3. ERYTHRINA – *Erythrina indica*

**Family** : Fabaceae

Erythrina is a tall deciduous tree. It grows upto a height of 18 meters. The bark is smooth, yellowish or greenish grey in colour. The stem is erect, prickly, spines black. Leaves are trifoliate and the leaflets are 10-15 cm long, broadly ovate, acute, smooth. The leaf petiole is not prickly. Flowers are large, red about 5 cm long, pea shaped in dense racemes. A variety of *e.indica* produces white flower. Tree bears flowers during February to May. Fruits are 10-15 cm long, slightly swollen by seeds.

### 4. *Acacia arabica*

**Family** : Leguminaceae

**Habit** : A medium size, deciduous tree. Crown is very well developed.

**General Description** : Bark dark brown, shade varying to almost black; long fissures have developed. White, pointed spines occur on the bark. Leaves 2-5 cm long; 3 to 5 pairs of pinnae; a number of glands occur; leaflets in 10-20 pairs; linear, glabrous. Flowers fragrant, yellow in axillary globes heads which are 1 cm in diameter. Peduncles in slender fascicles, a whorl of bracts appear above the middle. Calyx tube cup shaped. Sepals are double the length of sepals. Fruit is pod containing 8-15 seeds; stalked, convex, fleshy, distinct compartments occur between the seeds.

**Flowering** : Occurs during the monsoon months.

**Fruiting** : Takes place in the winter season.

## GREEN AND GREEN LEAF MANURES

**1. Daincha – *Sesbania aculeate* (Family – Fabaceae):** A quick growing succulent crop which adapts itself to varying conditions of soil and climate. A soft stemmed shrub with or without prickles, growing to 1.5-2.0 metres, leaves long, pinnately compound, with small oblong leaflets, stipules small and deciduous, flowers yellowish in lax axillary racemes, partly drooping, fruiting profuse, fruit long, cylindrical with 25-30 seeds per pod, seeds oblong, greyish brown in colour. Ninety days crop yields upto 4500 kg of green material and a 150 days crop about 8000 kg.

**2. Wild Indigo – *Tephrosia purpurea* (Family – Fabaceae):** Perennial undershrub, grow to about 0.50 to 0.75 meters with a hardy stem. Leaves pinnately compound with leaflets having parallel nerves and silky beneath. Flowers small, pinkish carried on extra axillary racemes. Pods flattish about 2.5 cm long with about 5 seeds. It yields 15,000-20,000 kg/ac.

**3. Pungum – *Pongamia glabra* (Family – Fabaceae):** Leguminous, moderate sized evergreen tree. It grows in coastal forest, in tidal river banks and inland mostly along streams and river banks. It is grown along roadsides as an avenue tree. The trees are established by means of planting 2-3 months old seedlings raised from seeds and planted 4-5 meters apart. Loppings may be taken once or twice a year. A tree yields approximately 100-150 kg green material per lopping.

**4. Neem – *Azadirachta indica* (Family – Meliaceae):** This is a profusely branching large evergreen tree and gives plenty of foliage. It comes up in all types of soils. One or two loppings are taken with favourable seasons, each loppings gives about 150-200 kg of green matter.

**5. *Sesbania speciosa* (Family – Fabaceae):** The plant has a greyish appearance with soft greyish tomentose hairs on stems and leaves. The stem is pithy but if allowed to grow it becomes woody.

Leaves compound, long with numerous leaflets, leaflets near the pulvinus the longest and gradually reduced in size towards the tip of the leaf. Stipules prominent with curved acuminate tip almost encircling the stem near the point of attachment. Inflorescence is a long lax drooping raceme with many yellowish flowers with purple splashes on the standard, wing petals deep yellow and the keels pale yellow, fruiting profuse, fruits long, flat, quadrangular ending in a tapering tip.

## 17. TOBACCO

### TOBACCO – *Nicotiana tobacum*

- Family** : Solanaceae
- Habitat** : Tropical.
- Habit** : Stout, annual herb about three metres high.
- Stem** : Erect, thick producing a few branches.
- Leaves** : Simple, petiolate, cordate or semicordate shaped and evenly spaced leaves apex acuminate, winged petiole, frilled auricle clasping the stem. Glandular hairs on the surface of leaves excrete gums which makes surface sticky.
- Inflorescence** : Panicle, flowers pedicellate and hermaphrodite, sepals five forming a calyx tube, corolla tube 10-15 mm long and 2-3 mm wide, lower half cylindric, pale green or creamy, upper half similar in colour or pink to red, stamens inserted on base of corolla throat, erect with four stamens of one length, the fifth being shorter. Superior ovary, bicarpellary, axile placentation, ovules numerous, style slender, stigma capitate, capsule narrow, elliptic, ovoid, acute or blunt, seeds numerous and minute.

## GLOSSARY

**Abaxial:** the side or face away from the axis.

**Abortive:** defective, not develop.

**Acuminate:** ending in a narrowed tapering point with concave sides.

**Anatropous:** a reversed ovule with the micropyle close to the hilum.

**Androecium:** the male element; the stamens as a unit of the flower.

**Anemophilous:** Wind-pollinated.

**Anther:** the part of the stamen containing the pollen.

**Arborescent:** of treelike habit

**Aristate:** with a long bristle like point.

**Articulate:** jointed, or with places where separation takes place naturally.

**Basifixed:** attached or fixed by the base.

**Bipinnate:** when the primary divisions (pinnae) of a pinnate leaf are themselves pinnate.

**Bisexual:** having both sexes present and functional in the same flower.

**Blade:** the expanded part of a leaf or petal.

**Bract:** a reduced leaf subtending a flower or flower stalk.

**Bracteole:** a secondary bract on the pedicel or close under the flower.

**Bracteole:** a secondary bract on the pedicel or close under the flower.

**Bulbel:** small bulbs arising from the parent bulb

**Bulbil:** an aerial bulb or bud produced in a leaf axil or replacing the flower, which on separation, is capable of propagating the plant.

**Bush:** a low thick shrub without a distinct trunk.

**Calyx:** the outer envelope of the flower, consisting of sepals, free or united.



**Carpel:** one of the foliar units of a compound pistil or ovary; a simple pistil has only one carpel.

**Caruncle:** an outgrowth near the hilum of a seed.

**Catkin:** a close bracteate, often pendulous spike.

**Caudate:** ending abruptly in a tail-like tip or appendage.

**Caulescent:** stemmed or stem-bearing.

**Compound:** of two or more similar parts in one organ, as in a compound leaf or compound fruit.

**Conduplicate;** folded together lengthwise.

**Connate:** united or joined.

**Deciduous:** falling off or subject to fall, applied to leaves, petals, etc.

**Decumbent:** reclining or lying on the ground.

**Denticulate:** finely dentate.

**Determinate:** when the terminal or central flower of an inflorescence opens first and the prolongation of the axis is arrested.

**Dioecious:** Male and female reproductive organs are situated on two different individuals.

**Distichous:** Used for a type of alternate leaf arrangement having successive leaves on opposite side of the stem so that two vertical rows of leaves are seen on the stem which are opposite to each other.

**Embryo:** A young plant which is developing from an egg cell after fertilization or without fertilization.

**Endocarp:** the inner layer of the pericarp of angiospermic fruit which is internal to mesocarp and external to seed.

**Endosperm:** Used for the nutritive tissue which is developed in the embryo sac of flowering plants from the fusion of one female nucleus with one or more others or with a male nucleus or both.

**Epicalyx:** Used for the extra whorl of sepals like floral appendages in some flowers that are lying external to the whorl of sepals. Individual segments are known as episepals.

**False fruit:** A fruit which is formed from other parts of the flower as well as the gynoecium.

**Fertilization:** The fusion of gametes which results in the formation of a zygote.

**Gamopetalous:** Used for describing corolla in a flower in which petals get fixed along their margins upto the base to form a corolla tube.

**Gynandrous:** Stamens that are inserted on the gynoecium.

**Habitat:** The immediate environment that is occupied by an organism.

**Hermaphrodite:** A plant having both male and female reproductive organs in the same flers of some individual.

**Homogamous:** Having all the flowers in an inflorescence, the same.

**Hypogyny:** Used for the arrangement of flower parts in which stamens, sepals and petals get inserted below the level of insertion of ovary.

**Incomplete flower:** A flower lacking sepals or petals or both.

**Indehiscent:** A fruit that doesnot open to disperse its content.

**Inferior ovary:** Used for describing condition of ovary in angiospermic flower in which sepals, petals and stamens get inserted above the level of ovary.

**Involucre:** Used for the whorl or bracts around or beneath a condensed inflorescence such as capitulum or umbel which is resembling and carrying out the function of calyx.

**Labiate:** A corolla in which one or more petals are formed into a lip.

**Lemma:** The outer bract of a grass floret.

**Lodicule:** A scale below the ovary of a grass flower which represents the reduced perianths.

**Midrib:** The largest vein in a leaf which is running through the middle of the lamella longitudinally.

**Monoecious:** An individual in which male and female reproductive organs get separate in different reproductive structures but both type of male and female flowers are present on the same plants.

**Multiple fruit:** A fleshy fruit developing from a complete inflorescence.

**Node:** The part of stem where the leaf or leaves arise.

**Obscure:** A venation which is poorly developed so that hardly more than the mid rib can be seen.

**Ovule:** The nucellus having the embryo sac and is enclosed by 1 or 2 integuments which after fertilization and subsequent development becomes a seed.

**Palaeo ethano botany:** Refers to the science dealing with the study of fruits and seeds found in archeological sites.

**Panicle:** a branched raceme in which each branch is bearing a raceme of flowers.

**Parthenocarpy:** The development of a fruit without involving the formation of seeds as a result of (a) lack of pollination (b) lack of fertilization (c) lack of embryo development.

**Pedicellate:** A flower or a fruit having a stalk.

**Peduncle:** Main axis of inflorescence on which flowers are borne.

**Perianth:** The floral envelop, it includes calyx and corolla or any one of them.

**Petiole:** Refers to the stalk that attaches the lamina of leaf to the stem with its base strengthened by widening.

**Phyllotaxy:** Refers to the arrangement of leaves on the stem.

**Pinnate:** A compound leaf having leaflets arranged in two ranks on opposite sides of the rachis.

**Pistillate:** A flower which has carpels but no anthers.

**Placenta:** The part of an ovary to which the seeds get attached.

**Placentation:** The arrangement of the placentas in a syncarpous ovary.

**Pollination:** Refers to the transfer of pollens from male reproductive organ to female reproductive organ in flowering plants by involving some physical agency like wind, water or air or some biological agency like birds, insects, animals. If pollens of a plant reaches the female organ of the same plant it is called self pollination, and if pollens of one plant reach the female organ of the some other plant of same species, it is called cross pollination.

**Polyadelphous:** Having a large and indefinite number of stamens.

**Protogyny:** The maturation of female reproductive organs before there occurs the maturation of male organs as in rosaceae and cruciferae.

**Procumbent:** A plant or its part that is trailing loosely along the ground surface.

**Rachilla:** The axis in the center of a grass spikelet.

**Rachis:** The main axis of a pinnately compound leaf to which the leaflets are arranged.

**Rayfloret:** One of the small flowers radiating out from the margin of a capitulum.

**Sepals:** One of the parts (lobes) forming the calyx of a flower. It is generally green and protects the rest of the flower in the bud.

**Sessile:** Refers to a structure that is unstalked such as a leaf with no petiole or stigma with no style.

**Species:** Refers to the smallest unit of classification commonly used. In sexually reproducing organisms it represents a maximum interbreeding or potentially interbreeding group, breeding true within its own limits in nature.

**Stipules:** Refers to basal appendages of a leaf or petiole. They may photosynthesize or be scales and may protect the axillary buds.

**Style:** The narrow part of the gynoecium which bears the stigma.

**Synandrous:** Having several united stamens.

**Syncarpous:** Refers to a gynoecium in which two or more carpels get fused.

**Syngamy:** The fusion of gametes.

**Tetradynamous:** Used for describing condition of androecium in which two long and two short stamens are present.

**Tetramerous:** Describing flower in which units of different whorls are in fours or multiples of four.

**Trichome:** A hair.

**Unilocular:** Having one nucleus.

**Vein:** A single vascular bundle or a group of closely associated bundles in a leaf.

**Velamen:** Water absorbing tissue which is present on the outside of aerial root in certain plants.

**Venation:** The pattern of veins in a leaf as observed from its upper surface or lower surface.

**Verticillaster:** a kind of inflorescence looking like a dense whorl of flowers. It is a combination of two crowded dichasial cymes, one at each side of the stem.

**Zygomorphic:** Divisible in half by one longitudinal plane only.

## brhy; mfuhjp

Accessory bud	Jiz bkhl;L
Acropetal succession	Edp neh;fpa thpir (m) Edp neh;fpa tiuf;Toa
Achene	btoah cyh; rpW fdp
Acuminate	ePs; Th; Edp (c/k;) muR
Acute	Th; Edp (c/k;) kh
Adnate	ntw;WUg;g[ld; ,ize;j
Adventitious bud	ntw;wpl bkhl;Lf;fs;
Adventitious roots	ntw;wpl nth;fs;
Aerial root	Mfha nth;
Aerial stem	jiunky; jz@L
Aestivation	,jHikg;g[
Aggregate fruit	jpus; fdp
Alate	,wF ,jGila
Alternate	khw;W ,iy mikt[
Androecium	Mzfk;
Anther	kfue;j nfruk;
Antipetalous	my;ypia xjpj vz@zpf;ifa[ld; mjw;F vjph;kiwahf mike;j kfue;j jhs;fs;
Awn	Th; Ko
Axial placentation	mr;R R{y; xl;Lkiw
Axillary bud	nfhz bkhl;L
Basal placenation	jsr; R{y; xl;L
Basifixed	fPH; mize;jiy
Basipetal	EdpapypUe;J fPH;nehf;fp
Berry	KG rijf; fdp
Bicarpellary unilocular ovary	,U R{y; ,iy xw;iwaiwr; R{yfk;
Bifid	ghjptiu 2 Mf gpst[gl;l
Bifoliate	,U rpw;wpiya[ila
Bilabiate	<hpjH; tot my;yp tl;IKila
Bilobed	,U ,jH;fSila
Bilocular	,uz;L miwfSila
Bisexual flower	,U ghy; g{
Bipinnate	,ul;ilr rpwFf; Tl;oiy
Bract	g{tor; brjpy;
Bracteate	g{tor; brjpYilait
Bracteolate	g{f;fhk;gor; brjpYila
Calyx	g[y;yp tl;lk;
Capsule	,izr; R{yf btofd
Carpels	R{yf ,iyfs;
Caryopsis	btoah cyh; fzjhdpak;

Catkin	bjh F fjph; k rhp
Cladode	,iyj; bjhHpy; jz@L
Cordate	,ja totk;
Corolla	my;yp tl;lk;
Cotyledons	tp;j;jpiyfs;
Cumeate	Mg;g[ totk;
Dehiscent	btof;Fk; jd;ika[ila
Diadelphous	,Ufw;iw kfue;jj;jhs;
Drydehiscent fruit	cyh; btofdpfs;
Drupe	cs;bshl;L rijf;fdp
Ebracteate	g{tor; brjpy;fsw;wit
Ebracteolate	g{f;fhk;gor; brjpy;fsw;wit
Elliptic	ePs; tl;l totk;
Endocarp	fodkhd cs;nshL
Endosperm	Kis R{y; jpR
Epicalyx	g[wgl;yp ,jH;fs;
Epicotyl	tpj;jpiy nky; jz@L
Epipetalous	,ize;j my;yp ,jH;fSilait
Falcate	mhpths; totk;
False septum	nghypr; Rth;
Filament	kfue;jf; fk;gp
Fleshy fruit	rijf; fdp
Floralaxis	g{ mr;R
Floral bract	kyuor; brjpy;fs;
Free central placentation	jdp bry; Nyfk;
Fusiform	fjph; nfhy; totk;
Gynoecium	btz;zfk;
Gynophore	Nyff; fhk;g[
Imparipinnate	XU rpw;wiyapy; KotJ
Incomplete flower	KGikaw;w g{
Indefinite	vz;zKoahj
Indehiscent dry fruit	btoah cyh; fdpfs;
Inferior ovary	fPH;kl;l Ny;ig
Inflorescence	g{ bfhj;J
Internode	fq ,ilbtsp
Involucel of bracts	Tl;l g{tor; brjpy;fs;
Keel petal	glF my;yp ,jH;fs;
Laciniate	Fwfpa ePz;l gFjpfshf gpst[gl;l
Lamina or blade	,iyj;jhs;
Lanceolate shape	<l;o totk;
Lateral bud	,ilbkhl;L
Lateral branching	gf;f thl;oy; fpisj;jy;

Leaf base	,iyaog; gFjp
Leaf blade	,iy myF
Leaflet	rpw;wpiy
Leaf scales	brjpy; ,iyfs;
Leaf sheath	,iyao ciw
Leaf spines	,iy Kl;fs;
Leaf tendrils	,iy gw;Wf; fk;gpfs;
Ligulate	ehf;Ftot my;yptl;lk;
Marginal placentation	tpspk;g[ Ny; xl;L
Mesocarp	kj;jpa fdp mLf;F
Micropyle	tpijj;Jis
Middle lamella	eLbkd; Rth;
Midrib	ika euk;g[
Monoadelphous stamens	XU fw;iw kfue;jj;jhs;
Monocarpellary pistil	Xw;iw Ny; ,iy Nyfk;
Multilocular	gy miw Nyfk;
Node	fq
Nut	bfhI;ilf; fdp
Oblanceolate	jyifPH; <l;o totk;
Oblong	ePs; tl;l totk;
Obovate	jyifPH; Kl;il totk;
Obtuse	kGfpa Edp
Open carpels	jpwe;j Ny; ,iyfs;
Oval	Kl;il totk;
Ovary	Nyfk; fUg;ig
Ovoid	Kl;il totk; nghd;w
Ovules	Ny;fs;
Palea	ckp
Palpate	mf tisthf Ftpe;jit
Palmaately compound leaf	mf Tl;oiy
Parellel venation	,izg; nghf;F euk;gikg;g[
Parietal placentation	Rth; Ny; xl;L
Paripinnate	,U rpw;wpiyfshy; KotJ
Pedicel	g{f;fhk;g[
Peduncle	k";rhp; fhk;g[
Pepo	XU Nyiwapy; gytpijfSila fdp
Perianth	g{ ,jH;fs;
Pericarp	fdpj; njhy;
Petal	my;yp ,jH;fs;
Petiole	,iy fhk;g[
Phylloclade	,iyj; bjhHpy; jz;L
Phyllolade	,iyj; bjhHpy; fhk;g[

Pinnately compound leaf	rpwFf; Tl;oiy
Placentation	NH;miw xl;L Kiw
Plumose	,wF nghd;w
Plumule	tpij Kisj; jz;L
Pollen	kfue;jk;
Pollination	kfue;jr; nrh;f;if
Pubscent	cnuhk';fSila
Raceme	Edptsh; k";rhp
Rachis	ikaf; fhk;g[
Reniform	rPWePuf totk;
Sepals	g[w tpjH;fs;
Septum	FWf;Fr; Rth;
Spathe	kly;
Staminate	Mz; g{ cila
Stigma	Ny; Ko
Style	Ny; jz;L
Subglabrous	Xust[ cnuhks';fsw;w
Superficial	nkbyGe;jthhpahd
Superior ovary	nky; kl;l Ny;ig Nyfk;
Syncarpous pistil	,izr; Nyfk;
Taproot	Mzpnth;
Tetradynamous	,U kl;l cauKilaJ (4 : 2) ehd;F ePskhft[k; 2 Fl;ilahft[k; ,Uf;Fk; (c/k;) fLF
Tomentose	mlh;j;jpahf bkd;Kofshy; NHg;gl;l
Trichomes	J}tpfs;
Trichotomous	\d;W rkkhd fpisa[ila
Triploid	\d;W ,iyfSilaJ
Twisted	jpUF ,jH; mikt[
Unisexual flower	XU ghy; g{
Variegated	gy epwKila
Venation	euk;gikg;g[
Vestigial	KGikahd tsh;r;rpailah ghfKila
Zygomorphic	,U gf;f rkr;rPUila