MODULE 30 - PINUS

OBJECTIVES

At the end of this session, students will be able to:

1. Learn about the habit of Pinus appearing like a pyramid or cone.
2. Learn about the vegetative organs like root, stem, branches and leaves of Pinus
3. Learn about the reproductive organs such as male cone, female cone, pollination and fertilization, as well as seed formation.
4. Learn about seed germination and formation of new plants
5. Learn about the economic importance of Pinus

SUMMARY

Pinus is classified under Gymnosperms because its seeds are naked. This module deals with morphology, anatomy and reproduction in Pinus. The plant body of Pinus is sporophyte. Gametophytic generations are not independent. The male gametophyte is produced by the germination of pollen grain inside the pollen chamber while female gametophyte is endospermous, which is also found inside ovule. Thus, diploid or sporophytic generation dominates in the life cycle. Such a life cycle is called diplobiontic.

TRANSCRIPTION

1. INTRODUCTION

‘Pinus’ is commonly known as ‘Pine’. You might have seen this tree when you have visited the mountain slopes in Kashmir, Himachal Pradesh, Uttaranchal, don’t you? Yes, those tall, conical trees on the mountain slopes – they are Pinus or Pine.

We are going to learn in terms of Morphology of Vegetative Parts and Reproductive Parts; Anatomy of Stem, Leaf and Root; Its Reproduction and its Life Cycle.

Let us first know about its systematic position. It comes under

Kingdom – Plantae

Sub kingdom – Embrophyta
Group – Tracheophyta or Spermatophyta
Sub Group – Gymnosperms
Division – Coniferophyta
Class – Coniferopsida
Order – Coniferales
Family Pinaceae
Genus – Pinus

Pinus is the largest genus of the family Pinaceae with 100-105 species spread world wide. It is found in temperate to sub-alpine regions on high altitudes. Let us know its distribution in India.

Almost six species have been reported from different parts of our country. It occurs in Himalayan region, hill slopes of North-East India like Kashmir, Himachal Pradesh, Uttaranchal, Assam, Manipur, Andaman & Nicobar Islands. In MP it is common in Pachmari.

Common Indian species are:

Pinus raxburghii, also known are Pinus longifolia, popularly known as 'Chir Pine'.

Pinus Gerardiana, known as 'Chilgoza Pine'.

Students, you might have seen those Chilgoza dried fruits? Ya. They are obtained from Chilgoza Pine or Pinus gerardiana.

Pinus wallichiana, known as Pinus excelsa. It is also called silver pine, silver fir, blue pine or kail.

Pinus insularis or Pinus khasya, popularly known as Khasi Pine.

Pinus merkusi or Marcus Pine, and,

Pinus armandii.

So these are the Indian species of Pinus.

2. EXTERNAL MORPHOLOGY

Now, come to the external morphology of Pinus tree. Pinus, the main plant body of Pinus, is sporophytic, which is evergreen, perennial and xerophyte.

It has a conical or pyramidical appearance or we can say ‘excurrent habit’, just because of its spiral growth or lateral branches. Its plant body is differentiated into well developed root, stem and lea

THE TAP ROOT

The tap root of Pinus, it is the main root system. It has lateral roots, which is well developed and it helps in anchorage and absorption of water. You know, because Pinus are found on hill slopes, so it requires good anchorage & good absorption of water system.

On the lateral roots are found ectotrophic mycrorhizal fungal association, which forms symbiotic association with Pinus tree, hence is very important for the growth of Pine.

STEM

Now comes to the Pinus Stem.

Pinus stem is erect, aerial, cylindrical, branched. It is woody, although the stem has bark which is scaly, brown and rough.

Let’s come to the Pinus stem. Pinus stem is divided into two branching system. One is branches of unlimited growth, which are also known as ‘long shoot’. And the other is branches of limited growth which is known as ‘dwarf shoot’.

Both the shoots have scale leaves, which are known as ‘Cataphylls’. Dwarf shoot bears cataphylls as well as foliage leaves or needles. Thus branches or dimorphic.

PINUS LEAVES

It has juvenile leaves or primordial leaves which are only found in its young stage. Otherwise we can say that there is a dimorphism found in the leaves of Pinus. That means, it has two types of leaves. One is called scale leaves and the other one is foliage leaves or Pinus needle.

Let us know about scale leaves of Pinus. They are non-green, brown, membranous, or we can say very thin, small and brown in color, found in both long and dwarf shoot.

Then the foliage leaves or Pinus needles. They are green, photosynthetic; asicular, that means they are needle-like. That's why we call Pinus needle instead of saying foliage leaves of Pinus. They are pointed also.

When we talk about the needles of Pinus on the dwarf shoot, it is known as 'spur'. There are different types of spurs in Pinus, which are based on the number of needles found in it. Like:

If there is one needle in a spur, then it is called unifoliar or monofoliar spur. If there are two needles it is called bifoliar. With three needles it is trifoliar; four is quadrifoliar and five are pentafoliar spurs.

3. ANATOMY OF ROOT & STEM

ANATOMY OF ROOT

Now we come to the anatomical part. Anatomy, that means internal structure. So we will first learn about the internal structure of the root.

The outermost layer of Pinus root is called 'Piliferous layer', which is a single layer. Then comes the cortex, which is paranchymatous. After cortex there is endodermis single layer and multilayered pericycle. The stele or the vascular system – the stele is diarch, triarch or tetrarch, i.e. xylem is exarch, with resin canals. Phloem altrernates with xylem. But students please remember that there are no vessels present in the xylem and no companion cells are found in phloem. Secondary growth is just like that of a dicot root.

ANATOMY OF STEM

OK. Now we will learn about the internal structure of the Pinus stem. Or stem anatomy.

The outer most layer of the stem is epidermis which is single layered, but remember, it is cuticularised, that means it is meant for retarding transpiration because it is a xerophytic plant.

Next comes the cortex, which is sclerenchymatous; that is also a xerophytic character. Resin canals are found in the cortex of Pinus stem. Then endodermis and pericycle, which is not very distinct.

Vascular bundles are called conjoint, collateral, endarch and open. Primary cambium is found with medullary rays. Xylem is present, which is exarch, but vessles are absent,

and phloem, in which companion cells are absent. Pith is parenchymatous but poorly developed.

Like other dicot plants the secondary growth of stem is similar in Pinus also.

Now when the secondary growth takes place cambium gets activated. It forms secondary phloem from outside and secondary xylem inside. The growth is so massive that it forms a bulk of secondary tissues. And that is why the stem of Pinus gets broadened.

You see many rings in the Pinus stem. What are those rings? They are called annual rings and they are formed due to the secondary growth and the activity of cambium. Spring wood has wide tracheids while autumn wood has narrow tracheids. That is why you see those broad rings and narrow rings. They are the annual rings of Pinus. They are very important and they show the secondary growth. Resin ducts are present both in the primary and secondary wood of Pinus.

4. ANATOMY OF FOLIAR LEAF/NEEDLE

Now come to the anatomy of Pinus foliar leaf that is called Needle.

It is very important because you people get Pinus needle in your practical also. It is very simple.

You cut a thin section of the needle, double stain it, mount it and see it under a compound microscope. What do you see? It is a triangular structure with outer cuticle, then epidermis. It has sunken stomata. Presence of cuticle and sunken stomata shows its xerophytic characters.

Then comes the sclerenchymatous hypodermis.

Mesophyll cells are present but they may also show infoldings. It is an important character of Pinus needle. They are called armed parenchyma or transfer cells.

Then comes the endodermis which is single layered and pericycle which is multi-layered. But what you find is the sclerencymatous, T-shaped transfusion tissues. It is also a xerophytic character shown in Pinus needle. Near xylem are seen trachedal cell and near phloem are found albuminous cell. Both together are called transfusion tissue.

Vascular bundles are usually two. Conjoint, collateral and endarch .

This is the structure of Pinus needle.

5. REPRODUCTIVE PARTS OF PINUS I – MALE CONE

Now we come to the reproductive part of Pinus.

Pinus is hetrosporous or we can say monoecius species. It has male cone as male reproductive organ and female cone as female reproductive organ.

Male cones are more frequent on the lower branches and they are more in number, while female cones are found singly, are less in number and usually are on the top of the branches.

When we come to the male cone, it is made up of microsporophylls, which has microsporangia filled with microspores or pollen grains.

Let's talk about the female cone. It is made up of megasporophyll which has megasporangia and megaspores. It is made up of bract scales and ovuliferous scales. Ovuliferous scale bears two ovules on upper surface.

This is how male and female cones are formed.

STRUCTURE OF MALE CONE

Yes, let us come to the structure of Pinus male cone or male strobili. It is born in clusters, but these are small, yellow-green when they are young, but become brown or dark when they become mature.

The longitudinal section of Pinus male cone shows that there is a cone axis on which microsporophylls are arranged spirally. Microsporophyll has sack-like structure that is microsporangium. Inside microsporangium are found microspores or what we can say pollen grains of Pinus.

Let's talk about the development of microsporangium of microspore. It is eusporangiate type of development.

What do you mean by eusporangic development? It means that it is formed from a group of cells. Inside microsporangium are microspores or pollen grains. Pollen grain is a haploid structure which has intine and exine. And exine forms balloon-like wings, which helps spores or pollen grains in pollination by wind. So it is unicellular and haploid.

6. REPRODUCTIVE PARTS OF PINUS II – FEMALE CONE

Now we will talk about the female cone of Pinus.

It is oval to elongate, very beautiful. You might have seen these female cones in the drawing-rooms as a part of an arrangement – yes.

They are larger, develop singly and fully. There is only a three-year life cycle of Pinus female cone. So third year cone is a matured cone, which takes part in seed formation.

Now, when we come to the structure or the longitudinal structure of the female cone – it is made up of many megasporophylls which are arranged spirally on the cone axis. Megasporophylls are made up of two types of scales, that is, ovuliferous scales and bract scales.

Ovuliferous scales are flat, triangular, known as apophysus. They are bigger and woody, while bract scales are small, membranous. They get folded and help in fertilization and pollination.

On the ovuliferous scale, at the base of it, are two ovules. The ovule of Pinus is anatotropous, unitegmic. That means it is made up of one integument.

These integuments are made with three layers. Outer and inner layer in fleshy, while the middle layer is stony. The upper part of the ovule is not covered with integument and it forms a pore opening known as micropyle.

Inside micropyle is pollen chamber and then the inner part of the ovule. Now this is the structure of the ovule.

These are the sporophytic structures of Pinus.

7. GAMETOPHYTIC REPRODUCTION I

Now we are going to learn about the gametophytic phase.

So the gametophytic phase starts with the development of gametophyte with the germination of pollen grain and with the formation of megaspore in the female cone to forma a female gametophyte.

Microspore or pollen grain – it is the first structure of male gametophyte, so first we are going to learn about the development of male gametophyte.

The development of male gametophyte from the pollen grain takes place in two stages, that is, the development of male gametophyte before pollination and the development of male gametophyte after pollination.

Let us talk about the development of male gametophyte before pollination. The pollen grain inside the microsporangium gets divided and forms a four-celled structure. Upto this four-celled structure it is called the immature male gametophyte.

This male gametophyte gets transported from the male to the female cone through wind pollination. You have to remember that those balloon-like wings help these pollen grains in pollination.

At the time of pollination a transverse slit is formed in the microsporangia of male cone and these pollen grains, in the form of four-celled structure of gametophyte, come out and they are so numerous in number that they are like a yellow-colored cloud in the sky, which is known as ‘sulphur spray’. These pollen grains get distributed all over the area and reach the female cone where there is ovule.

When this male gametophyte, in a four-celled structure, reaches the female cone, the micropyle end of the female cone or the ovule, it starts discharging a sticky substance through which the pollen grains get stuck. This substance gradually becomes drier and the pollen grains start coming inside of the micropyle; then come into the pollen chamber, where they get developed into the rest of the stages of male gametophyte.

8. GAMETOPHYTIC REPRODUCTION II

Now we’ll switch over to the female gametophyte.

You have seen that the female gametophyte is in the form of an ovule, but the inner side of the ovule gets divided into megaspore and this development is also eusporangiate, that is, it is formed from a group of cells. Now, it forms megaspore and megaspore develops into archegonia. Archegonium has egg cells. So, this is how the female cone gets the development of the female gametophyte or endosperm.

Now, here pollen grains are ready for fertilization and they are in the pollen chamber.

We will switch over to the rest of the development of the male gametophyte.

In the pollen chamber a pollen tube is formed which pushes inside and reaches the archegonia and the pollen grains get divided into many cells in which there are two male nuclei or two male gametes. One of the male gametes enters into the archegonium and it fertilizes the egg.

Now the fertilization takes place and the embryo is formed. This embryo gradually forms the seed inside the female strobilus.

When it gets matured the seeds come out and spread nearby area through wind because they possess one wing.

The germination of the seed takes place through epigeal type of germination and first of all the juvenile leaves are formed and the young root or radicle root goes inside the soil and the plumule comes outside.

Juvenile leaves soon get degenerated and needles or foliage leaves develop into a shoot. This is how reproduction or life cycle gets completed.

GLOSSARY

1. Gymnosperms = A group of plants bearing naked seeds.
2. Morphology = External structure.
3. Anatomy = Internal structure
4. Chilgoza = Edible seeds of Pinus gerardiana.
5. Excurrent habit = Pyramid like or cone like appearance having elder branches at base and youner branches at the top.
6. Cataphylls -= small brown colored scale leaves.
7. Dwarf shoot = Branch of limited growth bearing needles.
8. Mylorrhiza = Fungus associated with Pinus root.
9. Symbiotic = Mututally beneficial.
10. Ectotrophic = Growing on external surface.
11. Xerophyte = Growing in dry condition.
12. Evergreen = A tree having green leaves throughout the year.
13. Juvenile = Young and youthful.
14. Vessel – Xylem tissue looking like a pipeline.
15. Diarch = At two places.
16. Triarch =At three places.
17. Tetrarch = At four places.

18. Secondary growth = Growth in girth
19. Xylem = Plant tissue meant for conduction of water and minerals.
20. Secondary xylem = Wood.
21. Phloem = Plant tissue meant for conduction of food.
22. Annual ring = One year's growth of wood.
23. Resin = Sticky, fragrant secretion of plants.
24. Cambium = Plant tissue meant fro secondary growth.
25. Trachoid = Xylem tissue with sapta.
26. Vascular bundles = Collection of vascular tissue.
27. Cojoint = Xylem and phloem in the same vascular bundle.
28. Collateral = Having phloem outside xylem.
29. Endarch = Having first formed xylem towards centre.
30. Heterosporous = Having two types of spores.
31. Spore = A reproductive cell.
32. Ovule = Structure containing female gamete in plants.
33. Fertilisation = Causing egg to grow into a new individual.
34. Anatropous ovule = Inverted ovule.
35. Gametophyte = Gemete bearing stage of a plant.
36. Sporophyte = Spore bearing stage of plant.
37. Pollination = Transfer of pollen grain from male cone to ovule.
38. Archegonium = Sex organ bearing egg or female gamete.
39. Embryo = Unborn offspring.
40. Seed = Fertilized ovule capable of developing into similar plant.
41. Germination = Sprouting.
42. Epigeal = type of germination in which cotyledons come out in the soil.

FAQs

1. Where does Pinus grow in nature?

Ans: On hill stations like Kashmir, Simla, Mussoorie, Darjeeling. In Madhya Pradesh it is common in Pachmari.

2. Why is Pinus classified under the order Coniferales?

Ans: Because it bears cones for reproduction.

3. How many species of Pinus are found in the world?

Ans: About 105 species.

4. How many species of Pinus are found in India?

Ans: Six. These are Pinus roxburghic, Pinus wallichiana, Pinus insulares, Pinus merkusic, Pinus gerardiana and Pinus armandi.

5. How does a Pinus tree look?

Ans: Pinus tree has pyramid like shape. Elder branches are larger than younger branches, so that looks like a cone. This type of pattern is called excurrent habit. It is due to this habit that the Pine tree becomes an object of attraction for photographers, painters and common man.

6. What is the peculiar feature of the root system of Pinus?

Ans: The roots are infected by Mycorrhiza, a symbiotic fungus which provides moisture and minerals to Pinus. In return Pinus provides it with the food material.

7. Does Mycorrhiza decide the distribution of Pinus?

Ans: Yes. Pinus grows in nature only at such places where the soil contains Mycorrhiza. That's why in MP Pinus is common innPachmarhi, but is totally absent in places like Pipariya, Hoshangabad, Bhopal, Indore, Jabalpur, etc.

8. List three plant organs in Pinus which are dimorphic or of two types.

Ans: (a) Leaves occur in two forms – scaly leaves or cataphylls & foliage leaves or needles
(b) Branches have two types of growth. Branches with indefinite growth or long shoots bear scale leaves only, while those with limited growth or dwarf shoots bear scale eaves as well as foliage leaves.
(c) Cones are of two types – male and female cones.

9. What is 'spur'?

Ans: Dwarf shoot, along with needles, is called ‘spur’.

10. Can we identify different species of Pinus on the basis of spur?

Ans: Yes. Pinus monophylla has only one needle or unifoliar spur, Pinus sylvestris has bifoliar spur, Pinus roxburghic has trifoliar spur, Pinus quadrifoliar has tetrafoliar spur while Pinus wallichiana has pentafoliar spur.

11. What is the peculiar feature of xylem tissue of Pinus?

Ans: It has no vessel, that is why the wood of Pinus is called non-porous.

12. What is the peculiar feature of the phloem of tissue of Pinus?

Ans: it has no companion cells.

13. What is the function of xylem tissue?

Ans: To conduct water and minerals.

14. What is the function of phloem?

Ans: To conduct food.

15. What are resin canals?

Ans: these are cavities formed in the root stem, leaves and cones which secrete a thick resin known as oil of turpentine.

16. How is the oil of turpentine obtained from Pinus?

Ans: By applying superficial oblique cuts on old stem. The phenomenon is called ‘bleeding’.

17. What is the commercial use of the oil of turpentine?

Ans: In varnish and paint.

18. What are annual rings?

Ans: these are growth rings. One annual ring is produced in one year. By counting annual rings we can know the age of the Pinus tree. Each annual ring has spring wood and autumn wood.

19. Out of teak tree and Pinus which possesses more prominent annual rings?

Ans: Pinus, because seasonal changes in mountains are more acute than on plains.

20. What is armed parenchyma?

Ans: It is mesophyll tissue whose cell wall is folded inwards so that, volume remaining the same, surface area can be increased. These cells are called ‘transfer cells’. This is a xerophytic adaptation.

21. Why does Pinus reveal xerophytic characteristics even though it grows on mountains?

Ans: Atmospheric pressure in mountains is low. Therefore, the vapor pressure outside is less than the vapor pressure inside the leaf. Hence vapor from leaves diffuses outside. Had there been no low

22. Pinus is considered as an evergreen tree. Does it mean that there is no leaf fall or the leaf fall is gradual?

Ans: Leaf fall is gradual.

23. Why is humus formation slow in pine forest?

Ans: Needles of Pinus contain resin canals. Therefore, they are not decomposed easily by fungi or bacteria. That is why litter decomposition or humus formation is slow in pine forest.

24. Why is Pinus tree called monoecious?

Ans: Because male & female cones are separate but are produced on the same tree on different branches.

25. What is the equivalent of male cone?

Ans: Dwarf shoot in Pinus and Angiosperm.

26. What is equivalent of female cone?

Ans: Long shoot in Pinus and inflorescence in Angiosperms.

27. What is produced by the male cone in Pinus?

Ans: Microspore

28. Why is the microspore of Pinus called ‘pollen grain’?

Ans: Because it is used for pollination.

29. At what cell stage is the pollen grain of Pinus pollinated?

Ans: 4-celled stage – 2 prothallial plus one tube cell and one generative cell.

30. What is the peculiar feature of the pollen grain of Pinus?

Ans: It is winged.

31. What is the morphology of the wings in pollen grains of Pinus?

Ans: It is a balloon-like expansion of exointine or middle wall of pollen grain.

32. What is the nature of Pollination in Pinus?

Ans: Anemophilly or wind pollination.

33. What is the color of pollen grains in Pinus?

Ans: Yellow

34. What are sulphur showers?

Ans: Yellow clouds of pollen grains of Pinus seen in the pine forest in the month of March are called sulphur showers.

35. Where does the pollen grain get lodged in the 4-celled stage?

Ans: In pollen chamber of ovule.

36. What is the peculiar feature of the female cone of Pinus?

Ans: it is woody and looks like a decorative article.

37. What is found in the female cone of PInus?

Ans: Bract scales and ovuliferous scales. Ovuliferous scale is woody and bears two ovules on upper surface.

38. What is the nature of ovule in Pinus?

Ans: Anatropous or inverted.

39. Pinus is surrounded by how many integuments?

Ans: Single integument with three layers – outer fleshy layer, middle stony layer and inner fleshy layer.

40. What is microphyle?

Ans: Opening in ovule for the entry of pollen grain.

41. What is pollen chamber?

Ans: Disintegrated cells of nucleus form pollen chamber and pollen grain can lodge before fertilization.

42. How many male gametes are found in male gametophyte (mature pollen grain) of Pinus?

Ans: Two.

43. What is the peculiar feature of male gamete of Pinus?

Ans: Male gametes are of unequal sizes and non-ciliated. Generally the longer male gamete takes part in fertilization.

44. What are the female sex organs in Pinus?

Ans: Archegonia, each having one egg or female gamete inside it.

45. How much time is required between pollination and fertilization?

Ans: 14-15 months.

46. What is the product of fertilization in Pinus?

Ans: Oospore, which later grows into embryo.

47. What is the peculiar feature of embryogeny in Pinus?

Ans: Polyembryogeny or birth of twins is common. In the beginning four embryos are formed, but later on only one survives.

48. What happens to ovule after fertilization?

Ans: The ovule forms seed.

49. How is the single wing of Pinus seed formed?

Ans: by splitting of the upper surface of ovuliferous scale.

50. What is the importance of wing in Pinus seed?

Ans: for dispersal of seed by wind.

51. How much time is required from the appearance of cone to seed setting?

Ans: Three years.

52. Seeds of which species of Pinus are called ‘Chilgoza’?

Ans: Pinus gerardinia. This plant is common in Kashmir.

53. What type of germination takes place in Pinus?

Ans: Epigeal, that means the cotyledons or seed leaves come above the ground.

54. What is the economic importance of the wood of Pinus?

Ans: The wood is used to prepare paper and matchboxes, as well as splinters. Tall stems are used to erect electric poles because wood is a bad conductor of electricity. The wood is also used to construct houses on hill stations. Packing boxes are also prepared from the wood.

55. What is amber?

Ans: It is the fossil resin of Pinus succinifra. Being fragrant it is used to prepare showpieces.

56. Does Pinus produce fruits?

Ans: No. Pinus is a gymnosperm. Its seeds are naked and not inside the fruit.