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1. Morphology of flowering plants dr.arif 1.Root 2.Stem 3.Leaf 4.Flower 5.Fruit 6.Seed 2. dr.arif Morphology of Root Characteristics : 1. Root is defined as the descending part of the plant axis. 2. It is positively geotropic. 3. It is positively hydrotropic 4. It is negatively phototropic. 5. It develops from the radicle of the embryo during seed germination. Roots are generally not green and cylindrical. 7. They produce only similar organs i.e. secondary and tertiary roots 8. They do not show nodes and internodes 3. Morphology of Root 1. Region of root cap - The tender apex of the root is protected with a multicellular cap like structure called root cap. - The cells of the root cap secrete mucilage for lubricating the passage of root through the soil. - In many hydrophytes like Pistia and Eichornia, root cap is replaced by root pocket. 2. Region of cell division or meristematic region : - It is a small region about 1 mm in length. - It is the growing part of the root and is protected by the root cap. - It is made up of thin walled, compactly arranged meristematic cells which have the power of division. - This region helps in longitudinal growth by the addition of new cells 3. Region of elongation : - It lies just above the meristematic region. - The cells of this region are newly formed and they elongate rapidly. This increases the length of the root. - The cells of this region help in the absorption of mineral salts. 4. Region of root hairs : - This region is covered with numerous root hairs after every 10 to 12 days and is responsible for absorption of water. - Region of maturation or cell differentiation : - It is the major part of the root. - The outer layer of epidermis, periderm, phloem, xylem, phloem, etc. - The cells undergo differentiation to form different types of primary root tissue like cortex, endodermis, xylem, phloem, etc. This region helps in fixation of plant body into the soil and also in conduction of absorbed substances. - Lateral roots also develop from this region of the root. dr.arif 5. Morphology of Root dr.arif FUNCTIONS OF THE ROOT : - The normal functions of the roots are fixation or anchorage of the plant body into the soil (substratum), absorption of water and minerals from the soil and conduction of absorbed materials up to the base of the stem. SECONDARY : - In some plants roots perform certain special functions and such roots undergo necessary modifications. - Some roots become fleshy or swollen for the storage of food materials e.g. carrot, radish, asparagus, sweet potato, Dahlia, etc. - After becoming green some roots manufacture food by photosynthesis e.g. Tinospora, Trapa, Orchids etc. - Some roots help in exchange of gases (respiration) e.g. Rhizopora, Sonneratia etc. - In parasitic plants like Cuscuta, adventitious roots penetrate the host stem to obtain food and water. - Sometimes roots also take part in vegetative reproduction e.g. Sweet potato. - Aerial roots absorb moisture from the air e.g. Orchids. Thus modified roots perform different functions. 6. dr.arif Morphology of Root TAP ROOTS OR TRUE ROOTS: - develops from the radicle of an embryo during seed germination is called a true root or tap root. - The main root is called primary root. - Its branches of first order are called secondary roots and branches of secondary order are called tertiary roots and so on. - The main root along with its branches forms a tap root system e.g. Mustard (Brasicae), Sunflower (Helianthus) etc. - Presence of a tap root system is a characteristic feature of dicotyledonous plants. The tap root normally grows vertically downwards to a lesser or greater depth, while secondary and tertiary roots grow obliquely downwards or some grow horizontally outwards. - All lateral branches are produced in acropetal succession, i.e., the older and longer branches are near the base and the younger and shorter ones are near the apex of the main root. 7. dr.arif ADVENTITIOUS ROOT SYSTEM : - A root that develops from any other part other than the radicle is known as adventitious root. - Such roots may develop from the base of the stem, nodes or from leaves. - In monocots, radicle is short lived and the stem a thick cluster of all equal sized roots arises. This is known as the adventitious root system of grasses (monocots) look like fibres. - Fibrous roots do not grow very deep into the soil. Morphology of Root TAP ROOTS : 1. Storage of food 2. Respiration 1. Storage of food 2. Support 3. Special functions 9. dr.arif Morphology of Root MODIFICATIONS OF TAP ROOT : 1. Storage of food - The tap root (primary) becomes fleshy and swollen due to the stored food. - The secondary roots remain thin. - Hypocotyl (embryonic region between cotyledons and radicle) may also join the tap in storing food. - Stem is reduced and discoid in the beginning and bears radial leaves. - The swollen tap root acquires some typical shape and is accordingly classified into the following three types : 10. dr.arif Morphology of Root MODIFICATIONS OF TAP ROOT : 1. Storage of food FUSIFORM ROOT : - The storage root which is swollen in the middle part and tapers towards the base and apex is called Fusiform root e.g. radish (*Raphanus sativus*). CONICAL ROOT : - The storage root which is broader at the base and gradually tapers towards the apex is called Conical root e.g. carrot (*Daucus carota*). NAPIFORM ROOT : - The storage root which is much swollen, almost spherical and abruptly tapers around the apex is called Napiform root e.g. beet (*Beta vulgaris*). 11. dr.arif Morphology of Root MODIFICATIONS OF TAP ROOT : 2. Respiration - Plants growing in saline swamps, marshy places and salt lakes are called halophytes. - Many halophytes develop special kinds of roots called respiratory roots or pneumatophores. - Roots of these plants do not get air for respiration as the soil is water logged. As a result, absorption of minerals is affected. - Such plants produce special roots from the underground roots of the plant near the soil, which grow vertically upwards i.e. negatively geotropic and come out of the soil in the form of conical spikes. - They occur in large number around the tree trunk and are provided with pores called lenticels. - The lenticels help in gaseous exchange required for respiration - e.g. Rhizophora, Avicennia, Sonneratia, Heritiera (*vern* or *sundri*) etc. 12. dr.arif Morphology of Root MODIFICATIONS OF ADVENTITIOUS ROOT : 1. Storage of food SIMPLE TUBEROUS ROOTS : - These roots become swollen and do not assume a definite shape. - They are always borne singly. - These roots arise from the nodes of the stem and enter in the soil e.g. cennia, Sonneratia, Heritiera (*vern* or *sundri*) etc. 13. dr.arif Morphology of Root MODIFICATIONS OF ADVENTITIOUS ROOT SYSTEM : 2. Mechanical Support PROP ROOTS: - These roots arise from horizontal branches of trees like Banyan tree (*Ficus benghalensis*) and grow vertically downward till they penetrate the soil. - Secondary growth occurs in these roots, so that they become thick and act like pillars to provide mechanical support to the heavy branches. CLIMBING ROOTS: - Climbing plants like pipes produce roots from their nodes, by means of which they attach themselves to some support or climb over it. - e.g. money plant (*Pothos*), kallirrhoe (*Piper nigrum*), pan (*Piper betle*). 14. dr.arif Morphology of Root MODIFICATIONS OF ADVENTITIOUS ROOT : 2. Mechanical Support STILT ROOTS: - These roots normally arise from a few lower nodes of a weak stem in some monocots, shrubs and small trees. - They grow obliquely downwards and penetrate the soil and provide mechanical support to the plant. - In plants like maize, sugarcane, bajra and jowar, the roots grow in whorls. - After penetrating the soil they provide support to the plant. - In screw pine or Pandanus, these roots arise only from the lower surface of the obliquely growing stem to provide support. - These roots bear much folded multiple root caps. 15. dr.arif Morphology of Root MODIFICATIONS OF ADVENTITIOUS ROOT : 3. Special Functions EPIPHYTIC ROOTS : - Some plants like orchid grow perched on the horizontal branches of big trees in forest to get sunlight. Such plants have green leaves and can photosynthesize. These plants are called epiphytes. - Epiphytes develop special aerial, hanging roots called epiphytic roots. These roots are spongy due to presence of a special tissue called velamen, which is situated outside the cortex. - The cells of velamen tissue are hygroscopic, have porous walls and with the help of velamen tissue these roots absorb moisture from the atmosphere e.g. Vanda, Dendrobium, etc. - These roots fulfill the need of water in epiphytes as they do not have normal roots penetrating the soil to absorb water. These roots are also called assimilatory roots as they are greenish white in colour, have chloroplast and can photosynthesize up to a certain extent. 16. dr.arif Morphology of Root MODIFICATIONS OF ADVENTITIOUS ROOT : 3. Special Functions SUCKING ROOTS OR HAUSTORIA: - These are highly specialized and microscopic roots, developed by parasites to absorb nourishment from the host. - In partial parasites like Viscum album, they penetrate only xylem elements of the host to absorb water and minerals. - In total parasites like Dodder or Cuscuta (Amarvel), they establish a connection with the vascular strand of host and suck food directly from phloem and water and minerals from the xylem. - Such roots are called parasitic roots, sucking roots or Haustoria. 17. Function Types Modifications Primary Secondary Tap Adv Storage Of food Support Conical Fusiform Napiform Prop Stilt Climbing Epiphytic Parasitic Resp. roots Storage Of food Simple Fasciculated 18. dr.arif Morphology of Stem CHARACTERISTICS : - The aerial part of the plant body is collectively described as shoot system. - Main axis of this shoot system is called the stem. - Stem can be defined as the ascending part of the plant axis, which develops from the plumbule. - It is usually negatively hydrotropic, negatively geotropic and positively phototropic. - It bears a terminal bud and axillary buds in the axis of leaves, for growth. - It is differentiated into nodes and internodes. - At the nodes, it produces dissimilar organs such as leaves and flowers and similar organs such as branches, exogenously i.e. originate from outer tissue. - The young stem is green and is capable of performing photosynthesis. 19. dr.arif Morphology of Stem BUDS Vegetative Floral The buds which develop into branches are called vegetative buds. - Apical buds : located at the apex of stem. - Axillary buds : located in the axis of leaves. - Accessory buds : located on the sides or above the axillary buds. - Adventitious buds : located at areas other than nodes. The buds which develop into flowers are called floral buds. 20. dr.arif Morphology of Stem FUNCTIONS OF STEM: - The primary functions of stem are to produce and support lateral appendages such as branches, leaves, flowers and fruits, conduction of water and minerals to different parts of shoots and transport food to all plant parts. - Stems may, however, get modified to perform additional or functions such as - storage of food and water, - proliferation and propagation, - procuring support for climbing, - perennation i.e. to tide over unfavorable conditions - synthesis of food (photosynthesis). 21. dr.arif Morphology of Stem MODIFICATIONS of STEM AERIAL Sub-aerial Aerial 1. Rhizome 2. Tuber 3. Corm 4. Cladod 5. Bulbil 22. dr.arif Morphology of Stem UNDERGROUND MODIFICATIONS RHIZOME: - In many herbaceous plants, stem develops below the soil and is called underground stem. - Such stem remains dormant during unfavorable conditions and gives off aerial shoots under favorable conditions. - These underground stems often store food and become fleshy. - Underground stem performs three functions - storage of food, perennation and vegetative propagation. They can be differentiated from roots by stem like internal structure, exogenous branching, presence of nodes and internodes, - occurrence of foliage leaves or scale leaves at the nodes with axillary buds - absence of root cap 23. dr.arif Morphology of Stem UNDERGROUND MODIFICATIONS RHIZOME: - prostrate, dorsiventral thickened brownish stem, which grows horizontally under the surface of the soil. - It shows distinct nodes and internodes. It possesses a terminal bud and axillary buds in the axis of each scale leaf present at the node. - Rhizome remains dormant under the soil and at the onset of favorable conditions, the terminal bud grows into the aerial shoot which dies at the end of the favorable season. 24. dr.arif Morphology of Stem UNDERGROUND MODIFICATIONS RHIZOME: - Growth of rhizome takes place horizontally with the help of the lateral bud. - This type of rhizome is called sympodial rhizome - e.g. ginger (*Zingiber officinale*), turmeric (*Curcuma domestica*). - In some plants, growth of rhizome occurs with the help of terminal bud. - These are called monopodial rhizomes - e.g. Lotus, Peperomia (fern) etc. 25. dr.arif Morphology of Stem UNDERGROUND MODIFICATIONS TUBER: - Tuberous roots are usually the swollen ends or tips of special swollen underground branches, due to the storage of food (Carbohydrate etc.). - The tuberous roots show nodes and internodes bear scale leaves with axillary buds, commonly called eyes. - Under favorable conditions these eyes sprout and produce aerial shoots. - Thus tubers help in vegetative propagation. Tuberous roots do not produce adventitious roots, thus they differ from rhizomes e.g. potato (*Solanum tuberosum*). 26. dr.arif Morphology of Stem UNDERGROUND MODIFICATIONS BULB: - It is a condensed, disc-like underground stem, which itself does not store food material. - The upper surface of disc-like stem is usually conical and bears centrally placed apical bud and many concentrically arranged overlapping scale leaves. - Inner scale leaves or bulb bases store food and are thick and fleshy, while outer fleshy leaf-like layers are thin and dry. - It is also called bulbil. - When the fleshy scale leaves surround the apical bud in the form of concentric rings, it is called tunicated bulb e.g. onion. - Sometimes they may partially overlap each other by their margins only, such bulbs are called scaly bulbs e.g. garlic. 28. dr.arif Morphology of Stem UNDERGROUND MODIFICATIONS CORM: - Corm is a short, stout, fleshy, upright and thickened underground stem. - It bears many buds in the axis of scale leaves which develop into daughter corms. - At the bases or even outer sides of stem adventitious roots develop. - Corm is a condensed form of rhizome growing vertically - e.g., Arbi (*Colocasia*), zingiber (*Amomum phaeum* etc.) 29. dr.arif Morphology of Stem AERIAL MODIFICATIONS STEM TENDRIL: - It is a modification of stem in which axillary bud modifies to form a thin, wiry, and highly sensitive structure called tendril. - Tendrils help the plant to attach itself to the support and climb. - They are found in plants with weak stem. The tendrils are leafless, coiled structures with sensitive adhesive glands for fixation. - An example of axillary tendril is *Passiflora* (Passion flower). - In *Vitis* apical bud is modified into tendril, while in *Antigonon*, floral bud is tendrillar. 30. dr.arif Morphology of Stem AERIAL MODIFICATIONS THORN: - Thorn is a hard, pointed usually straight structure produced by modification of axillary bud. - Leaves, branches and flowers are developed on thorns at the nodes, indicating that it is a modified stem. - It provides protection against browsing animals. - In *Cucurbita*, extra axillary bud is modified into tendrill, while in *Antigonon*, floral bud is tendrillar. 31. dr.arif Morphology of Stem AERIAL MODIFICATIONS PHYLLOCLADE: - The phylloclade or cladophyll is a stem which gets transformed into leaf like structure. - The phylloclade is green, flattened structure with distinct nodes and internodes. - It is thick, fleshy and succulent, in *Opuntia* or *Nopan*, cylindrical in *Casuarina* and *Euphorbia tirucalli* and - ribbon like in *Muehlenbeckia*. - In xerophytes, leaves get modified into spines or get reduced in size to check the loss of water due to transpiration and thus stem takes up the function of leaf, i.e. photosynthesis. 32. dr.arif Morphology of Stem AERIAL MODIFICATIONS CLADODE: - These are green branches of limited growth (usually one internode long) which have taken up the function of photosynthesis. - True leaves are reduced to scales or spines. - e.g. *Asparagus* (*Asparagus officinalis*). - When axillary bud becomes fleshy and rounded due to storage of food, it is called bulbil. - It gets detached from the plant, falls on ground and develops into a new plant. - e.g. *Bioscorea* 33. dr.arif Morphology of Stem SUB-AERIAL MODIFICATIONS CORM: - Corm is a short, stout, fleshy, upright and thickened underground stem. - It is the part of stem which grows above the soil obliquely and produces green leaves to form aerial shoots. - It is shorter and thicker than runner. - It helps in vegetative propagation. 34. dr.arif Morphology of Stem SUB-AERIAL MODIFICATIONS TUBER: - Tuberous roots are usually the swollen ends or tips of special swollen underground branches, due to the storage of food (Carbohydrate etc.). - The tuberous roots show nodes and internodes bear scale leaves with axillary buds, commonly called eyes. - Under favorable conditions these eyes sprout and produce aerial shoots. - Thus tubers help in vegetative propagation. 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They spread in different directions and bear new crowns above and tufts of adventitious roots below. - Each runner has one or more nodes. The nodes bear scale leaves and axillary buds. - e.g., Lawn grass (*Cynodon dactylon*), Hydrocotyl (*Centella asiatica*), - Oxalis, etc. 34. dr.arif Morphology of Stem SUB-AERIAL MODIFICATIONS STOLON: - Stolon is a slender lateral branch that arises from the base of the main axis. - Initially stolon grows upwards like an ordinary branch and then bends down and touches the soil where its terminal bud gives rise to a new shoot and adventitious roots. - e.g., *Nerium*, *Alstonia* 48. MODIFICATIONS OF LEAVES: - In this type, two leaves arise from each node in opposite direction. It is of two types: DECUSATE : When one pair of leaf is placed at right angle to next or lower pair of leaf, it is said to be opposite decussate phyllotaxy e.g., *Calotropis*, *Ocimum*, etc. SUPERPOSED: In this type, all the pairs of leaves of the stem are arranged one above the other, e.g., *Jamun*, *Guava*, etc. WHORLED OR VERTICILLATE PHYLLOTAXY: - In this type more than two leaves arise from each node and form a whorl around it. - e.g., *Nerium*, *Alstonia* 48. MODIFICATIONS OF LEAVES: - Leaves of some plants possess a pair of lateral dr.arif Morphology of Leaf PARALLEL VENATION: - In this type, leaves arise laterally on the stem partially or completely. Leaves of some plants possess a pair of lateral dr.arif Morphology of Leaf SIMPLE LEAF : - Simple leaves are those in which single leaf blade or lamina is present. - e.g., *Mango*, *Peepal*, *Papaya*, etc. COMPOUND LEAF : - Compound leaves are those in which the leaf blade or lamina is divided into number of segments known as leaflets or pinnae. - The leaflets never bear axillary buds in their axis. 45. o a sheath covering the stem partially or completely. Leaves of some plants possess a pair of lateral dr.arif Morphology of Leaf LAMINA OR EPICOTYLEDON: - This is the largest, most important, green and flattened part of the leaf. - It plays a vital role in photosynthesis, gaseous exchange and transpiration. - The leaf is known as dorsiventral when its ventral surface is structurally different from dorsal surface, e.g. dicotyledonous leaves. - The leaves having both similar surfaces are called isobilateral. Such leaves are found in monocot plants 41. LEAF BASE OR HYPOPODUM: - The part of leaf attached to the stem or branch is known as leaf base. It may assume different shapes in different plants. In some leguminous plants, the leaf blade may become swollen which is caudocot, the leaf base expands into a sheath covering the stem partially or completely. Leaves of some plants possess a pair of lateral dr.arif Morphology of Leaf LEAF BASE OR HYPOPODUM: - The part of leaf attached to the stem or branch is known as leaf base. It may assume different shapes in different plants. In some leguminous plants, the leaf blade may become swollen which is caudocot, the leaf base expands into a sheath covering the stem partially or completely. 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