**Contents:**

**TActiveTabsorptionTofTwaterTinTplants**

* + **Introduction**
	+ **ImportanceTofTwaterTtoTplants**
	+ **TypesTofTactiveTabsorption**
	+ **TheoriesTofTactiveTabsorptionTofTwater**
	+ **StructuresTinvolvedTinTactiveTabsorption**
	+ **MechanismTofTmovementTofTwaterTinTactiveTabsorptionT**
	+ **FactorsTeffectTactiveTabsorption**

ABOSRPTIONTOFTWATERTBYTPLANT



**THETwaterTisTessentialTinTtheTbodyTofTplant.TItTbringsTaboutTaTnumberTofTplantTactivities.TTheTcytoplasmTcontainsTaboutT65-75%TofTwater,TitTisTusedTphotosynthesisTitThelpsTtoTmaintainsTtheTturgidityTofTcells.TThisTwaterTisTabsorbedTfromTtheTsoilTandTonlyTaTveryTsmallTamountTofTwaterTisTutilizedTbyTtheTplantTforTitsTvariousTfunctionsTandTrestTofTthisTamountTisTlostTinTtranspiration.TiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTTheTintakeTofTwaterTfromTtheTsoilTisTknownTasTabsorption.iTheTrootsTremainsTinTtheTsoilTandTperformsTtheTfunctionTofTabsorptionTofTwater.TTheTmainTrootTtogetherTwithTitsTbranchesTforTtheTrootTsystem.TTheTentireTsurfaceTofTtheTrootsTdoesTnotTtakeTpartTinTtheTabsorptionTofTwater.TTheTmaximumTabsorptionTtakesTplaceTinTrootsThairsTzoneTwhichTisTsituatedT1-10TcmTbehindTtheTrootTtip.TWaterTisTabsorbedTbyTrootsTandTalsoTbyTshoot.TsomeTplantsTalsoTabsorbedTwaterTthroughTtheirTleaves.TheTmaximumTabsorptionToccursTinTtheTregionTiofTrootThairsTwhereTxylemTisTnotTfullyTmaturedTandTtheTepiblemaTandTendodermisTareTpermeable.TRootThairsTareTtheTmainTwaterTabsorbingTorganTofTplantsT.theyTdevelopTinTtheTregionTofTmaturationTandTtheirTnumberTvariesTfromTplantsTtoTplantT.ATrootThairTisTtheTunicellularTtubularTprolongationTofTouterTwallTofTepiblemaT.TCellTwallTofTrootsThairTisTcomposedTofTtwoTdistinctTlayers.OuterTlayerTisTcomposedTofTpectinTandTtheTinnerTlayerTiisTmadeTupTofTcelluloseT.TBothTtheTlayersTareThydrophilicTinTnatureT.CellTwallTisTpermeabletoTbothTsoluteTandTsolventTTheTcellTwallTsurroundsTplasmaTmembraneTandTthinTlayerTofTcytoplasm.TheTplasmaTmembraneTalongTwithTcytoplasmTactsTasTselectivelyTpermeableTmembrane.TTheTcytoplasmTenclosesTaTcentralTvacuoleTthatTcontainsTcellTsap.NucleusTofTtheTcellTisTgenerallyTpresentTatTtheTtip.TAbsorptionTofTwaterTisTtheTbiologicalTprocessTwhichTcanTbeTdefinedTasTtheTtakeTupTofcapillaryTwaterTbyTtheTrootThairsTofTaTplantTfromTtheTsoilTtoTtheTrootTxylemTbyTmanyTwaysTlikeTrespiration,transpirationTandTosmosis.T**

InTplantsTaTscientistTRennerTinT1912T-1915TintroducedTtheTtwoTtypesTwaterTabsorptionTinTplantsTheTnamedTitTas:

1. ActiveTwaterTabsorption
2. PassiveTwaterTabsorption

AfterTtheTtypesTofTwaterTabsorption,TtwoTtheoriesTwereTintroducedTtoTknowTmoreTaboutTtheTconceptTofTactiveTabsorptionTofTwater.

2.TOneTofTtheTtheoryTwasTgivenTbyTtwoTscientistsTAtxinsTandTPriestley.

3.TOneTofTtheTtheoryTcalledTtheTnonTosmoticTtheoryTwasTgivenTbyTBennet,TClarkTPlantsTmainlyTabsorbTcapillaryTwaterTfromTtheTsoil.TThereTareTfivetypesTofTwaterTthatTareTfoundTinTtheTsoilTnamelyT:

1.TRunwayTwaterT

2.THygroscopicTwaterT

3.TGravitationalTwater

4.TChemicallyTcombinedTwater

5.TCapillaryTwater

AmongTrunwayTwater,TgravitationalTwater,ThygroscopicTwater,TchemicallyTcombineTwaterTonlyTtheTcapillaryTwaterTisTusefulTforTtheTplants.

History

1.TInTearliarTdaysTitTwasTconsideredTtheTtwoTtypesTofTwaterTabsorptionTandTThimannTinT1951.

TypesTofTwaterTabsorptionTinTplants­­­

ThereTareTtwoTtypesTofTwaterTabsorptionTthatToccurTinTplantsTthatTnamedTas:

1T.ActiveTabsorptionTofTwater

2.TPassiveTwaterTabsorption

1.T**activeTabsorptionTofTwaterT i i i i i i i i i i i i i i i i i i i i i i i i i i** 2.**PassiveTabsorptionTofTwaterT**

This type of water absorption required the expenditure of metabolic energy by the root cell to perform the metabolic acactivity like respiration iscalled active absorption of water in plants.

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This type of water absorption does not required the use of metabolic energy. The absorption occurs by metabolic activity like transpiration is called passive absorption of water in plants

ActiveTabsorptionTofTwaterTinTplants

TWhenTtheTtranspirationTisTslowTandTsoilThasTsufficientTamountTofTwater,TcertainTforcesTareTdevelopedTinTtheTroot

TandThelpTinTtheTabsorptionTofTwater.TThisTtypeTofTabsorptionTisTcalledTactiveTabsorption.

ThereTareTtwoTtypesTofTtheoriesTthatTexplainTactiveTabsorptionTofTwater.T

1. **OsmoticTtheory**T i i i i i i i i i i i i i i i i i i2.**NonTosmoticTitheory**

OurTmainTtopicTisTtheTactiveTabsorptionTofTwaterTsoTourTmainTfocusTisTonTtheTactiveTabsorptionTofTwaterTtheTquestionTariseThereTthatTwhyTplantTneedTwaterTandThowTitTreachTtoTtheTtopTofTtheTtreeTandThowTitTgoesTintoTtheTenvironmentTwhatTpathTisTselectedTbyTplantsTtoTgetTwaterTfromTsoilTorTtheTmovementTofTwaterTinTtheTrootsTandTwhatTareTtheTstructureTthatTareTinvolvedTinTtheTabsorptionTofTwaterTinTplantsTsoTshortlyTfirstTweTwillTdiscussTallTtheseTthings.TTheTwaterTisTabsorbedTbyTtheToperationTofTosmoticTforcesTandTtheseTforcesTrequireTenergy.TTheTtotalTamountTofTwaterTpresentTinTtheTsoilTrefersTasTholard.TTheTamountTofTtotalTwaterTconsumedTbyTtheTplantsTcalladTasTchesard.TiTi

TiTi

WhyTDoTPlantsTNeedTSoTMuchTWater?TiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTi

WaterTisTtheTmostTlimitingTabioticT(nonliving)TfactorTtoTplantTgrowthTandTproductivityT,andTaTprincipalTdeterminantTofTvegetationTdistributionTworldwideT.SinceTantiquity,ThumanThasTrecognizedTplantsTthirdTforTwaterTasTevidenceTbyTtheTexistenceTofTirrigationTsystemsTatTtheTbeginningTiofTrecordedThistoryT.Water’TimportanceTtoTplantTstemsTfromTitsTcentralTroleTinTgrowthTandTphotosynthesisTandTtheTdistributionTiofTorganicTandTinorganicTmolecules.TDespiteTthisTdependenceTplantsTretainTlessTthenT5%ofTwaterTabsorbedTbyTrootTforTcellTexpansionTandTplantsTgrowth.TTheTiremainderTpassesTthroughTplantsTdirectlyTintoTtheTatmosphereT,aTprocessTreferredTtoTasTtranspirationTcanTbeTincrediblyThighT;aTsingleTirrigatedTcornTplantTgrowingTinTKansasTcanTuseT200LtofTwaterTduringTaTtypicalTsummer whie some large rainfores trees an use nearly1200L of water in isingle day.

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IfTwaterTisTsoTimportantTtoTplantTgrowthTandTsurvival,TthenTwhyTwouldTplantsTwasteTsoTmuchTofTit?TheTanswerTofTthisquestionTliesTinTanotherTprocessTvitalTtoTplantTphtotosynthesis.TToTmakeTsugars,TplantsTmustTabsorbTiTcarbonTdioxideTifromTtheTatmosphereTthroughTsmallTporesTinTtheirTleavesTicalledTstomataT.THoweverT,TwhenTstomataTopenT,TwaterTiisTlostTtoTtheTiatmosphereTatTaTprolificTrateTrelativeTitoTitheTsmallTamountTofTcarbonTdioxideTiabsorbedT;TacrossTplantTspeciesTianTaverageTofT400TwaterTimoleculeTareTlostTforTeachTcarbonTdioxideTimoleculeTgained.TTheTbalanceTbetweenTtranpirationTandTphotosynthesisTformsTanTessentialTcompromiseTinTtheTexistenceTofTplantTistomataTimustTremainTopenTtoTbuildTsugarsTbutTriskTdehydrationTinTtheTprocessT.TiT

**TiTFromTtheTsoilTintoTtheTplantT**

derableTamountTofTwater.TThisTisTimportantTforTtreesTiandTshrubsTsinceTwoodyTrootsTcanTconstituteT~99%TofTtheTrootsTsurfaceTinTsomeTforeEssentiallyTallTofTwaterTusedTbyTlandTplantsTisTabsorbedTfromTtheTsoilTbyTroots.TATrootsTsystemTconsistTofTcomplexTnetworkTofTindividualTrootsTthatTvaryTinTageTalongTtheirTlength.TrootsTgrowTfromTtheirTtips and initiallyTproducedTthinTandTnonwoodyTfineTrootsFineTrootsTareTtheTmostTpermeableTportionTofTaTrootsTsystem,TandTareTthoughtTtoThaveTtheTgreatestTabilityTtoTabsorbTwater,TparticularlyTinTherbaceousT(i.Tnone,Twoody)Tplant.TfineTrootsTcanTbeTcoverdTbyTrootThairsTthatTsignificantlyTincreaseTtheTabsorptiveTsurfaceTareaTandTimproveTcontactTbetweenTrootsTandTtheTsoil

.someTplantsTalsoTimproveTwaterTuptakeTbyTestablishingTsymbioticTrelationshipsTwithTmycorrhizalTfungi,TwhichTfunctionallyTincreaseTtheTtotalTabsorptiveTsurfaceTareaTofTtheTrootTsystem.TRootsTofTwoodyTplantsTformTbarkTasTtheyTage,TmuchTlikeTtheTtrunksTofTlargeTtrees.TWhileTbarkTformationTdecreasesTtheTpermeabilityTofTolderTrootsTtheyTcanTstillTabsorbTconsist.TiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiT



RootsThaveTtheTamazingTabilityTtoTgrowTawayTfromTdryTsitesTtowardTwetterTpatchesTinTtheTsoilTTaTphenomenonTcalledThydrotropism.TPositiveThydrotropismToccursTwhenTcellTelongationTisTinhibitedTonTtheThumidTsideTofTaTroot,TwhileTelongationTonTtheTdryTsideTisTunaffectedTorTslightlyTstimulatedTresultingTinTaTcurvatureTofTtheTrootTandTgrowthTtowardTaTmoistTpatch.TTheTrootTcapTisTmostTlikelyTtheTsiteTofThydrosensing;TwhileTtheTexactTmechanismTofThydrotropismTisTnotTknown,TrecentTworkTwithTtheTplantTmodelT*Arabidopsis*ThasTshedTsomeTlightTonTtheTmechanismTatTtheTmolecularTlevelT.



StructureTinvolvedTinTactiveTabsorptionTofTwater

WeTknowTthatTplantsTabsorbTwaterTthroughTrootsTandTrootsThairTsoTweTwillTdiscussTtheseTstructuresToneTbyTone,

RootTHairs:



RootThairsTareTdelicateTelongatedTepidermalTcellTthatToccursTinTaTsmallTzoneTjustTbehindTtheTrootTgrowingTtip.TtheyTgenerallyTappearTasTfineTdownTtoTtheTnakedTeyeTtheirTfunctionTisTtoTincreaseTtheTrootTsurface i i i i i i i i i iiTandTabsorptiveTcapacityofTrootThairsTusuallyTliveToneTorTtwoTdays.TWhenTaTplantTisTtransplantedTtheyTareTeasilyTtomTofTorTmayTdryToutTinTtheTsun.TRootThairsTareTtheTmainTwaterTabsorbingTpartsTofTplantTtheyTdevelopTinTtheTregionTofTmaturationTandTtheirTnumberTdifferTfromTplantTtoTplant.TATrootThairTisTtheTunicellularTtubularTprojectionTorTprolongationTofTouterTwallTofTepiblema.TCellTwallTofTrootThairTisTcomposedTofTtwoTdistinctTlayers.TOuterTlayerTisTcomposedTofTpectinTandTtheTinnerTlayerTisTmadeTupTofTcellulose.TBothTtheTlayersTareThydrophilicTinTnature.TCellTwallTisTpermeableTtoTbothTsoluteTandTsolvent.TTheTcellTwallTsurroundsTplasmaTmembraneTandTthinTlayerTofTcytoplasm.TPlasmaTmembraneTaloneTwithTcytoplasmTiactsTasTselectivelyTpermeableTmembrane.TTheTcytoplasmTencloseTaTcentralTvacuoleTthatTcontainsTcellTsap.TNucleusTofTtheTcellTisTgenerallyTpresentTatTtheTtip.SoTinTthisTwayTrootThairsTplayTanTimportantTroleTinTtheTabsorptionTofTwater.WhenTtheTwaterTisTexessTinTtheTsoilTtheTrootThairsTabsorbTmoreTwaterTifTplantsTneedTthisTallTdependsTuponTtheTrequirementTofTwaterTbyTplantsT.SoTdifferentTstructureTareTinvolvedTinTabsorptionTofTwaterTinTplants.TWhenTthereTisTscarcityTofTwaterTinTtheTsoilTandTthereTisTnoTwaterTavailableTtoTplantsTthenTthereTwillTbeTnoTabsorptionTofTwaterTandTplantsTbeginTtoTwilt.

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InThigherTplantsTwaterTisTabsorbedTthroughTrootThairsTwhichTareTinTcontactTwithTsoilTwaterTandTformTaTrootThairTzoneTaTlittleTbehindTtheTrootTtips.TRootThairsTareTtubularThairTlikeTprolongationsTofTtheTcellsTofTtheTepidermalTlayerT(whenTepidermisTbearsTrootThairsTitTisTalsoTknownTasTpilloferousTlayerTofTtheTroots.TiTheTwallsTofTrootThairsTareTpermeableTandTconsistTofTpecticTsubstancesTandTcelluloseTwhichTareTstronglyThydrophilicTinTnatureTrootThairsTcontainTvacuolesTfilledTwithTcellTsap.TWhenTrootsTelongate,TtheTolderTrootThairsTdieTandTnewTrootThairsTareTdevelopedTsoTthatTtheyTareTinTcontactTwithTfreshTsuppliesTofTwaterTinTtheTsoil.TLateralTMovementTofTwaterTisTachievedTthroughTroot.TiOftenTrootsTareToverlooked,TprobablyTbecauseTtheyTareTlessTvisibleTthanTtheTrestTofTtheTplant.THowever,Tit'sTimportantTtoTunderstandTplantTrootTsystemsTbecauseTtheyThaveTaTpronouncedTeffectTonTaTplant'sTsizeTandTvigor,TmethodTofTpropagation,TadaptationTtoTsoilTtypes,TandTresponseTtoTculturalTpracticesTandTirrigation.T

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. Diagrammatically the internal structure of a typical root

 Roots typically originate from the lower portion of a plant or cutting. They have a root cap, but lack nodes and never bear leaves or flowers directly. Their principal functions are to absorb nutrients and moisture, anchor the plant in the soil, support the stem, and store food. In some plants, they can be used for propagation.

STRUCTURE OF ROOTS

Internally, there are three major parts of a root:

• The meristem is at the tip and manufactures new cells; it is an area of cell division and growth. i• Behind the meristem is the zone of elongation. In this area, cells increase in size through food and water absorption. As they grow, they push the root through the soil. i• The zone of maturation is directly beneath the stem. Here, cells become specific tissues such as epidermis, cortex, or vascular tissue. i

A root's epidermis is its outermost layer of cell. These cells are responsible for absorbing water and minerals dissolved in water. Cortex cells are involved in moving water from the epidermis to the vascular tissue (xylem and phloem) and in storing food. Vascular tissue is located in the center of the root If we describe the structure of root then upper most layer is the epidermis and comes the cortex and below the cortex there is endodermis and then there is present the vascular bundle means xylem which helps in the transport of liquid substances and phloem which help in the transport of solid substances.Thus they help in the absorption of moisture from the soil and also provide support to plant because they anchor the plants in the soil.





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ActiveTabsorptionTofTwaterTinTvascularTandTnonvascularTplants:

InTvascularTplantsTvascularTbundleTplayTanTimportantTroleTinTtheTabsorptionTandTtransportTofTwater.TVascularTtissuesTwasTanTevolutionaryTadvancementTforTtheTplantTkingdom.TPlantsToriginatedTinTtheTwaterTasTfree-floatingTalgae.TInTtheTaquaticTenvironment,TwaterTandTnutrientsTbathedTplantsTconstantly,TandTeachTcellTcouldTsimplyTabsorbTwhatTitTneededTfromTtheTsurroundingTenvironment.TTheTfirstTplantsTtoTmoveTontoTlandT400TmillionTtoT450TmillionTyearsTagoT--TtheTmosses,TliverwortsTandThornworts,TcollectivelyTknownTasTbryophytesT--TcontainedTsimilarTstructuresTtoTtheseTaquaticTancestorsTandTwereTbestTadaptedTtoTlivingTinTanTenvironmentTwithTwaterTconstantlyTavailable.TAsTevolutionTbroughtTaboutTnewTplantTforms,TtheTabilityTtoTsurviveTinTincreasinglyTdryTenvironmentsTunderlayTmanyTofTtheTkeyTadaptations.TBryophytes,Thowever,TstillTneededTaTconstantTsourceTofTmoistureTtoTsurvive.TInTvascularTplants,TtheTrootsTplayTtheTimportantTroleTofTabsorbingTwaterT--TandTwithTthatTwater,TmineralTnutrientsT--TfromTtheTsurroundingTsoil.TBryophytes,TonTtheTotherThand,TdoTnotThaveTroots.TMossesTcontainTsmall,TtoughTfibersTknownTasTrhizoidsTthatTresembleTtinyTrootsTbutTonlyTkeepTtheTmossTanchoredTinTplace.THornwortsTandTliverwortsTalsoTholdTthemselvesTinTplaceTwithTrhizoids,TbutTtheseTrhizoidsTcontainTonlyTaTsingleTcellTandTaren'tTeasilyTmistakenTforTroots,TasTtheyTareTinTtheTmosses.TBecauseTtheyTlackTroots,TbryophytesTrequireTcontactTwithTwaterTsoTtheyTcanTabsorbTitTdirectlyTintoTtheirTleaves,TjustTasTtheirTaquaticTancestorsTabsorbedTwaterTfromTtheirTenvironment.TMineralTnutrientsTdissolvedTinTtheTwaterTareTalsoTabsorbedTdirectlyTintoTtheTbryophytes'Tleaves.TBecauseTeachTleafTmustTcomeTintoTcontactTwithTwater,TbryophytesTstayTsmallTandTgrowTcloseTtoTtheTgroundTorTonTotherTwater-collectingTsurfaces,TsuchTasTtreeTlimbs.TPlants,TincludingTbryophytes,TdoTnotTabsorbTallTofTtheirTnutrientsTfromTtheTenvironment,Thowever.TTheTkeyTtraitTthatTsetsTplantsTapartTfromTanimalsTisTtheirTabilityTtoTmanufactureTtheirTownTfoodTusingTtheTsun'sTenergy,TaTprocessTcalledTphotosynthesis.TLikeTallTplants,TbryophytesTcarryToutTphotosynthesisTtoTproduceTtheTsugarsTtheyTneedTforTenergy.TUnlikeTvascularTplants,TbryophytesTlackTanyTmeansTtoTtransportTtheseTphotosyntheticTproductsTthroughoutTtheTplant.ThoseTplantsTthatTdoTnotThaveTrootsTandTrootTlikeTstructuresTpresentTinTthemTlikeTrhizoidsTtheyTuseTtheseTstructuresTforTtheTabsorptionTofTwaterTfromTtheTsoilTandTtheyTuseTmetabolicTenergyTsometimesTorTsometimesTnotTuseTenergyT.SoTweTcanTsayTthatTinsteadTofTrootsTtheyTalsoTuseTrhizoidsTforTtheTabsorptionTofTwaterTfromTtheTsoilT.someTotherTplantsTalsoTabsorbTwaterTidirectlyTfromTtheTatmosphereTthroughTtheirTleavesTsoTleavesTalsoTplayTroleTinTtheTabsorptionTofTwaterTandTsomeTotherTplantsTalsoTabsorbTfromTtheTenvironmentTthroughTtheirTstem.ButTrootsTandTrootThairsTplayTactiveTroleTinTtheTabsorptionTofTwaterTfromTtheTsoilTandTuseTmetabolicTenergyTinTorderTtoTgetTwaterTfromTtheTsoilTthatTisTnecessaryTforTitsTmanyTactivitiesTandTalsoTinTtheTphotosynthesisTprocess,TandTalmostTallTotherTmetabolicTactivities.SoTweTcanTsayTthatTeveryTtypeTofTplantTneedTwaterTthatTitTgetTfromTtheTsoil.Ti

CharacteristicsTofTactiveTabsorptionofTwaterTinTplants:

* ActiveTabsorptionTofTwaterTutilizesTmetabolicTenergyT
* RootThairTplayTactiveTroleTofTabsorptionTofTwaterTinTplant(useTmetabolicTenergy).
* OsmosisTandTnon-osmosisTmethodTalongTorTagainstTtheTconcentrationTgradientTplayTroleTinTwaterTabsorption.
* ItTinvolveTsymplastTmovementTofTwaterT(throughTprotoplast).
* AbsorptionTofTwaterTisTindependentTofTtranspiration.TItTmeanTthatTtranspirationThasTnoTroleTinTit.
* ActiveTtransportTofTwaterTusuallyTtakesTplaceTwhenTtheTwaterTlevelTisThighTinTtheTsoil.
* RootsThaveTaTvitalTroleTinTtheTabsorptionTofTwaterTinTactiveTabsorptionTofTwaterTinTplants.
* ActiveTabsorptionTofTwaterTinTplantsTproduceTpositiveTpressureTinTtheTxylemTcannels.
* InTthisTtypeTofTabsorption,TabsorptionTrateTisTcomparativelyTslow.
* InTactiveTabsorptionTofTwaterTiinTplantsTmetabolicTinhibiterTorTtoxinsThaveTquickTinhibitionTeffect.
* ThereTareTtwoTtypesTofTactiveTabsorptionTofTwater.T1-activeTosmoticTwaterTabsorptionT2-activeTnon-osmoticTabsorption.T

ActiveTabsorptionTofTwater

TiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiTiInTthisTprocessTtheTrootTcellsTplayTactiveTroleTinTtheTabsorptionTofTwaterTandTtheTmetabolicTenergyTreleasedTthroughTtheTprocessTcalledTrespirationTisTconsumed.

StepsTinvolvedTinTtheTactiveTosmoticTabsorptionTofTwater:T

FirstTstepTinTosmoticTtheTosmoticTabsorptionTofTwaterTisTtheTimbibitionTofTsoilTwaterTbyTtheThydrophilic

wallsTofTrootThairs.TOsmoticTpressureTofTtheTcellTsapTofTrootThairsTisTusuallyThigherTthanTtheTOPTofTtheTsoilTwater.TiTherefore,TtheTDPDTandTsuctionTpresumeTinTtheTrootThairsTbecomeThigherTandTwaterTfromTtheTcellTwallsTentersTintoTthemTthroughTplasmaTmembraneTbyTosmoticTdiffusion.TiAsTaTresult,TOP,TsuctionTpressureTandTDPDTofTrootThairsThowTbecomeTlower,TwhileTtheirTturgorTpressureTisTincreased.TNowTtheTcorticalTcellsTadjacentTtoTrootThairsThaveThighTOP,TSPT&TDPDTinTcomparisonTtoTtheTrootThairs.TiTherefore,TwaterTisTdrawnTintoTtheTadjacentTcorticalTcellsTfromTrootThairsTbyTosmoticTdiffusion.TInTtheTsameTway,TbyTcellTtoTcellTosmoticTdiffusionTgraduallyTreachesTtheTinnerTmostTcorticalTcellsTandTtheTendodermis.TOsmoticTdiffusionTofTwaterTintoTendodermisTtakesTplaceTthroughTspecialTthinTwalledTpassageTcellsTbecauseTtheTotherTendodermisTcellsThaveTcasparianTstripsTonTthinTwallsTwhichTareTimperviousTtoTwaterTWaterTfromTendodermisTcellsTisTdownTintoTtheTcellsTofTpericycleTbyTosmoticTdiffusionTwhichTnowTbecomeT

turgidTandTtheirTsuctionTpressureTinTdecreased.TInTtheTlastTstep,TwaterTisTdrawnTintoTxylemTfromTturgidTpericycleTcellsT(InTrootsTtheTvascularTbundlesTareTradicalTandTprotoxylemTelementsTareTinTcontactTwithTpericycle).TiItTisTbecauseTinTtheTabsenceTofTturgorTpresumeTofTtheTxylemTvessels,TtheTSPTofTxylemTvesselsTbecomeThigherTthanTSPTofTtheTcellsTofTtheTpericycleTwhenTwaterTentersTintoTxylemTfromTpericycleTaTpresumeTisTdevelopedTinTtheTxylemTofTrootsTwhichTcanTraiseTtheTwaterTtoTaTcertainTheightTinTtheTxylem.TThisTpressureTisTcalledTasTrootTpressure.TOsmoticTmethodTofTwaterTabsorptionTtakesTplaceTinTthisTtypeTofTactiveTabsorptionTofTwater.TInTthisTprocessTtheTrootTcellsTplayTactiveTroleTinTtheTabsorptionTofTwaterTandTmetabolicTenergyTreleaseTthroughTaTprocessTcalledTrespirationTisTconsumed.T



**ActiveTosmoticTabsorptionTofTwater:**

ATtheoryTaboutTtheTactiveTabsorptionTofTwaterTwasTpresentedTcalledTactiveTosmoticTabsorptionTtheory.TThisTtheoryTwasTgivenTbyTAtkinsT(1916)TandTPriestleyT(1923).TAccordingTtoTthisTtheory,TtheTrootTcellsTbehaveTasTanTidealTosmoticTpressureTsystemTthroughTwhichTwaterTmovesTupTfromTtheTsoilTsolutionTtoTtheTrootTxylemTalongTanTincreasingTgradientTofTD.P.D.T(suctionTpressure,TwhichTisTtheTrealTforceTforTwaterTabsorption).TIfTtheTsoluteTconcentrationTisThighTandTwaterTpotentialTisTlowTinTtheTrootTcells,TwaterTcanTenterTfromTsoilTtoTrootTcellsTthroughTendosmosis.TMineralTnutrientsTareTabsorbedTactivelyTbyTtheTrootTcellsTdueTtoTutilisationTofTadenosineTtriphosphateT(ATP).TAsTaTresult,TtheTconcentrationTofTionsT(osmotica)TinTtheTxylemTvesselsTisTmoreTinTcomparisonTtoTtheTsoilTwater.TATconcentrationTgradientTisTestablishedTbetweenTtheTrootTandTtheTsoilTwater.THence,TtheTsoluteTpotentialTofTxylemTwaterTisTmoreTinTcomparisonTtoTthatTofTsoilTandTcorrespondinglyTwaterTpotentialTisTlowTthanTtheTsoilTwater.TIfTstated,TwaterTpotentialTisTcomparativelyTpositiveTinTtheTsoilTwater.TThisTgradientTofTwaterTpotentialTcausesTendosmosis.TTheTendosmosisTofTwaterTcontinuesTuntilTtheTwaterTpotentialTbothTinTtheTrootTandTsoilTbecomesTequal.TItTisTtheTabsorptionTofTmineralsTthatTutilizeTmetabolicTenergy,TbutTnotTwaterTabsorption.THence,TtheTabsorptionTofTwaterTisTindirectlyTanTactiveTprocessTinTaTplant'sTlife.TActiveTtransportTisTinTanToppositeTdirectionTtoTthatTofTdiffusion.TFirstTstepTinTtheTosmoticTabsorptionTofTwaterTisTtheTimbibitionTofTsoilTwaterTbyTtheThydro­philicTcellTwallsTofTrootThairs.TOsmoticTPressureT(O.P.)TofTtheTcell-sapTofTrootThairsTisTusuallyThigherTthanTtheTO.P.TofTtheTsoilTwater.TTherefore,TtheTDiffusionTPressureTDeficitT(D.P.D.)TandTtheTsuctionTpressureTinTtheTrootThairsTbecomeThigherTandTwaterTfromTtheTcellTwallsTentersTintoTthemTthroughTplasma-membraneT(semi-permeable)TbyTosmoticTdiffusion.TAsTaTresult,TtheTO.P.,TsuctionTpressureTandTD.P.D.TofTrootThairsTnowTbecomeTlower,TwhileTtheirTturgorTpressureTisTincreased.TNow,TtheTcorticalTcellsTadjacentTtoTrootThairsThaveThigherTO.P.,TsuctionTpressureTandTD.P.D.TinTcomparisonTtoTtheTrootThairs.TTherefore,TwaterTisTdrawnTintoTtheTadjacentTcorticalTcellsTfromTtheTroot-hairsTbyTosmoticTdiffusion.TInTtheTsameTway,TtheTwaterTbyTcellTtoTcellTosmoticTdiffusionTgraduallyTreachesTtheTinner­mostTcorticalTcellsTandTtheTendodermis.TOsmoticTdiffusionTofTwaterTintoTendodermisTtakesTplaceTthroughTspecialTthinTwalledTpas­sageTcellsTbecauseTtheTotherTendodermalTcellsThaveTcasparianTstripsTonTtheirTwallsTwhichTareTimperviousTtoTwater.TAtTfirst,TwaterTgetsTimbibedTonTtheTouterTcellTwallTsurface.TiAsTtheTcellTwallTisTpermeable,TitTallowsTbothTtheTsoluteTandTsolventTtoTpassTthroughTit.TiWaterTentersTthroughTtheTcellTwallTandTcomesTinTcontactTwithTplasmaTmembrane.TiPlasmaTmembrane,TaTthinTfilmTofTcytoplasmTandTtonoplastTtogetherTactTasTselectivelyTpermeable.

T

CellTsapTremainsTinsideTtheTvacuolesTandTisTseparatedTfromTexternalTsoilTwaterTbyTselectivelyTpermeableTmembrane.TiItThasTbeenTexperimentallyTfoundTthatTosmoticTpressureTofTsoilTwaterTisTalwaysTlessTthanT1TatmTandTosmoticTpressureTofTcellTsapTisTusuallyT2-8Tatm.TiIfTtheTosmoticTpressureTisTmoreTandTturgorTpressureTisTlessTinTrootThairTcell,TitTwillTresultTinTincreasedTdiffusionTpressureTdeficit.TiHighTdiffusionTpressureTdeficitTofTcellTsapTcausesTendosmosisTofTwaterTacrossTtheTcytoplasm,TplasmaTmembraneTandTcellTwallTofTrootThairTcell.TiWaterTentersTintoTtheTrootThairsTasTlongTasTtheTdiffusionTpressureTdeficitTofTcellTsapTisTgreater.TWaterTmovesTfromTrootThairTcellsTtoTcorticalTcellsTalongTconcentrationTgradientTandTfinallyTreachesTupTtoTpericycleTandTendodermis.TiSinceTtheTxylemTelementsThaveTnoTturgorTpressure,TtheirTdiffusionTpressureTdeficitTisThigherTthanTthatTofTtheTsurroundingTcells,TasTaTresultTofTwhichTwaterTentersTintoTtheTxylem.TiThisTtheoryTinvolvesTsimplestTmovementTofTwater,Ti.e.,TtheTwaterTentersTintoTlivingTprotoplasmTofTcellsTandTthenTmovesTintoTtheTlivingTprotoplasmTofTanotherTcell.

TNon-osmoticTabsorptionTofTwater:

ATtheoryTofTnon-osmoticTabsorptionTofTwaterTwasTpresentedTcalledTnon-osmoticTabsorptionTtheory.ThisTtheoryTwasTgivenTbyTThimannT(1951)TandTKramerT(1959).TAccordingTtoTtheTtheory,TsometimesTwaterTisTabsorbedTagainstTaTconcentrationTgradient.TThisTrequiresTtheTexpenditureTofTmetabolicTenergyTreleasedTfromTtheTrespirationTofTrootTcells.TThereTisTnoTdirectTevidence,TbutTsomeTscientistsTsuggestTtheTinvolvementTofTenergyTfromTrespiration.TInTconclusion,TitTisTsaidTthatTtheTevidenceTsupportingTactiveTabsorptionTofTwaterTareTthemselvesTpoor.TItThasTbeenTobservedTthatTabsorptionTofTwaterTtakesTplaceTevenTifTtheTconcentrationTofTcellTsapTinTtheTrootThairTisTlowerTthanTthatTofTtheTsoilTwater.TiNormallyTunderTsuchTconditions,TtheTwaterTmoleculesTshouldTdiffuseToutTfromTrootThairsTintoTexternalTsolutionTdueTtoTexosmosis.TiButTstill,TwaterTisTabsorbedTagainstTtheTconcentrationTgradient,Ti.e.,TfromThigherTdiffusionTpressureTdeficitTtoTlowerTdiffusionTpressureTdeficit.TiThisTtypeTofTabsorptionTtakesTplaceTatTtheTexpenseTofTenergy.TiAccordingTtoTsomeTphysiologists,TtheTenergyTisTsuppliedTbyTcellularTrespiration.TiThus,TnonTosmoticTabsorptionTrequiresTmetabolicTenergy,TwhichTcomesTfromTrespiringTcellsTofTtheTroot.TiFollowingTareTcertainTevidencesTwhichTshowTaTdefiniteTcorrelationTbetweenTrespirationTandTabsorption:

1. RespirationTandTrateTofTabsorption:TItThasTbeenTobservedTthatTfactorsTwhichTaffectTrespirationTalsoTaffectTtheTrateTofTabsorption.TiForTexample,TrespiratoryTinhibitorsTlikeTpotassiumTcyanideTalsoTinhibitTtheTrateTofTabsorption.T
2. WiltingTofTplantsTinTpoorlyTaeratedTsoil:TRespirationTofTrootTisTcloselyTdependentTonTtheTsoilTaeration.TiATwell-aeratedTsoilTsuppliesTrequiredTquantityTofToxygenTtoTtheTcortexTandTtherefore,TrootsTrespireTnormally.TiInTpoorlyTaeratedTorTwater-loggedTsoils,TtheTexternalTsupplyTofToxygenTisTinsufficientTforTtheTrootTrespiration.THence,TabsorptionTofTrootTisTinhibitedTinTsuchTsoilsTandTplantTshowsTsignsTofTwilting.T
3. EffectsTofTauxins:TLikeTotherTmetabolicTactivity,TabsorptionTalsoTincreasesTinTtheTpresenceTofTauxins.

ThereTareTmanyTreasonTforTregardingTtheTactiveTabsorptionTasTunimportant,

* 1. TheTvolumeTofTexudatesTfromTtheTcutTstumpTisTveryTsmallTinTcomparisonTtoTtheTvolumeTofTwaterTlostTinTtranspirationTbyTtheTsimilarTintactTplantsTunderTconditionsTfavourableTforTtranspiration.T
	2. TIntactTtranspiringTplantsTcanTabsorbTwaterTfromTmoreTconcentratedTandTdrierTsoilTsolutionsTmoreTeasilyTthanTtheTsimilarTde-toppedTplants

(iii)TiNoTrootTpressureTcanTbeTdemonstratedTinTrapidlyTtranspiringTplants.TSuchTplantsTmayTshowTevenTaTnegativeTrootTpressureT(i.e.,TifTaTlittleTwaterTisTplacedToverTtheTcutTstumpTitTisTabsorbedTbyTtheTlatter).

ivTiInTconifersTrootTpressureThasTrarelyTbeenTobserved.

TItTisTheldTbyTcertainTworkersTthatTthoughTtheTactiveTabsorptionTisTnotTimportantTquantita­tively,TitToccursTallTtheTtimeTandTsupplementsTpassiveTabsorption.TTwoTmainTargumentsTareTagainstTthisTview.TFirstly,TduringTperiodsTofTrapidTtranspirationTtheTsaltsTareTremovedTfromTtheTrootTxylemTsoTthatTtheirTconcentrationTbecomesTveryTlowTUnderTsuchTconditionsTtheTosmoticTuptakeTofTwaterTcannotTbeTexpectedTtoToccur.TSecondly,TevenTifTweTsupposeTthatTtheTsaltsTareTnotTremovedTdur­ingTperiodsTofTrapidTtranspiration,TtheTlatterTreducesTtheTwaterTpotentialTofTtheTcorticalTcellsTinTrootsTtoTsuchTaTlowTlevelTthatTtheTosmoticTentryTofTwaterTfromTcortexTtoTxylemTisTnotTpossibleTTheTavailableTevidenceTsuggestsTthatTusuallyTtheTwaterTisTpulledTpassivelyTintoTtheTplantTthroughTtheTrootsTbyTforcesTwhichTareTdevelopedTinTtheTtranspiringTsurfacesTofTtheTshoot.TButTunderTcertainTconditionsTsuchTasTwarmTmoistTsoilTandTlowTrateTofTtranspiration,TsaltsTaccumu­lateTinTxylemTofTrootsTresultingTinTactiveTosmoticTabsorptionTofTwater.

**WaterTmovementTmechanism(inTactiveTabsorptionTofTwater):**

InTplantsTdifferentTpathwaysTareTinvolvedTinTtheTwaterTmovementTinTtheTactiveTabsorptionTofTwaterTinTplants,

1-apoplasticTpathwayTiT2-symplastTpathwayTiT3-transmembraneTpathwayT

**ApoplastTpathway**

TheTapoplasticTmovementTofTwaterTinTplantsToccursTexclusivelyTthroughTtheTcellTwallTwithoutTcrossingTanyTmembranes.TTheTcortexTreceiveTmajorityTofTwaterTthroughTapoplasticTwayTasTlooselyTboundTcorticalTcellsTdoTnotTofferTanyTresistance.TButTtheTmovementTofTwaterTinTrootTbeyondTcortexTapoplasticTpathwayTisTblockedTbyTcasparianTstripTpresentTinTtheTendodermis.THereTwaterTpassesTfromTrootThairTtoTxylemTthroughTtheTwallsTofTinterveningTcellsTwithoutTcrossingTanyTmembraneTorTcytoplasm.TTheTpathwayTprovidesTtheTleastTresistanceTtoTmovementTofTwater.THowever,TitTisTinterruptedTbyTtheTpresenceTofTimpermeableTlingoTsuberinTcasparianTstripsTinTtheTwallsTofTendodermalTcells.

T

**SymplastTpathway**:

TheTmovementTofTwaterTfromToneTcellTtoTotherTcellTthroughTtheTplasmodesmataTisTcalledTtheTsymplasticTpathwayTofTwaterTmovement.TThisTpathwayTcomprisesTtheTnetworkTofTcytoplasmTofTallTcellsTinter-connectedTbyTplasmodermata.TTheTsymplastTformsTaTcontinuousTsystemTbecauseTtheTprotoplastTofTtheTcortex,TendodermisTandTvascularTtissueTareTconnectedTfromTcellTtoTcellTthroughTcytoplasmicTstrands,TcalledTplasmodesmata.TiFlowTofTwaterTthroughTcortexTinvolvesTbothTtheTpathways.TWaterTpassesTfromTcellTtoTcellTthroughTtheirTprotoplasm.TItTdoesTnotTenterTcellTvacuoles.TTheTcytoplasmsTofTtheTadjacentTcellsTareTconnectedTthroughTbridgesTcalledTplasmodesmata.TForTenteringTintoTsymplast,TwaterThasTtoTpassTthroughTplasmalemmaT(cellTmembrane)TatTleastTatToneTplace.TItTisTalsoTcalledTtransmembraneTpathway.TSymplasticTmovementTisTaidedTbyTcytoplasmicTstreamingTofTindividualTcells.TItTis,Thowever,TslowerTthanTapoplasticTmovements.TBothTtheTpathwaysTareTinvolvedTinTtheTmovementTacrossTtheTroot.TWaterTflowsTviaTapoplastTinTtheTcortex.TItTentersTtheTsymplastTpathwayTinTtheTendodermisTwhereTwallsTareTimperviousTtoTflowTofTwaterTdueTtoTtheTpresenceTofTcasparianTstripsTHereT,TonlyTplasmodesmataTareThelpfulTtoTallowTpassageTofTwaterTintoTpericycleTfromTwhereTitTentersTtheTxylem.TMineralTnutrientsTalsoThaveTtheTsameTpathwayTasTthatTofTwater.THowever,TtheirTabsorptionTandTpassageTintoTsymplastTmostlyToccursTthroughTactiveTabsorption.TOnceTinsideTtheTxylem,TtheTmovementTisTpurelyTalongTtheTpressureTgradient.



.TTransmembraneTpathway:

TInTplantTroots,TwaterTmovementTfromTsoilTtillTtheTendodermisToccursTthroughTapoplastTpathwayTi.e.TonlyTthroughTcellTwall.TTheTcasparianTstripsTinTtheTendodermisTareTmade-upTofTwaxT-likeTsubstanceTsuberinTwhichTblocksTwaterTandTsoluteTmovementTthroughTtheTcellTwallTofTtheTendodermis.TAsTaTresultTwaterTisTforcedTtoTmoveTthroughTcellTmembranesTandTmayTcrossTtheTtonoplastTofTvacuole.TThisTmovementTofTwaterTthroughTcellTmembranesTisTcalledTtransmembraneTpathway



FactorsTaffectTactiveTabsorptionTofTwater:T

1-AvailableTsoilTwater:T

SufficientTamountTofTwaterTshouldTbeTpresentTinTtheTsoilTinTsuchTformTwhichTcanTeasilyTbeTabsorbedTbyTtheTplants.TiUsuallyTtheTplantsTabsorbTcapillaryTwaterTi.eTwaterTpresentTinTfilmsTinTbetweenTsoilTparticlesTotherTformsTofTwaterTinTtheTsoilTeg.THygroscopicTwater,TcombinedTwater,TgravitationalTwaterTetc.TisTnotTeasilyTavailableTtoTplants.TiIncreasedTamountTofTwaterTinTtheTsoilTbeyondTaTcertainTlimitTresultsTinTpoorTaerationTofTtheTsoilTwhichTretardsTmetabolicTactivitiesTofTrootTcellsTlikeTrespirationTandThence,TtheTrateTofTwaterTabsorptionTisTalsoTretarded.

2-ConcentrationTofTsoilTsolution:

IncreasedTconcentrationTofTsoilTsolutionT(dueTtoTpresenceTofTmoreTsaltsTinTtheTsoil)TresultsTinThigherTOP.TiIfTOPTofTsoilTsolutionTwillTbecomeThigherTthanTtheTOPTofTcellTsapTinTrootTcells,TtheTwaterTabsorptionTparticularlyTtheTosmoticTabsorptionTofTwaterTwillTbeTgreatlyTsuppressed.TiTherefore,TabsorptionTofTwaterTisTpoorTinTalkalineTsoilsTandTmarshes.

3-SoilTair:

AbsorptionTofTwaterTisTretardedTinTpoorlyTaeratedTsoilsTbecauseTinTsuchTsoilsTdeficiencyTofTO2TandTconsequentlyTtheTaccumulationTofTCO2TwillTretardTtheTmetabolicTactivitiesTofTrootsTlikeTrespiration.TiThisTalsoTinhibitsTrapidTgrowthTandTelongationTofTtheTrootsTsoTthatTtheyTareTdeprivedTofTfreshTsupplyTofTwaterTinTtheTsoil.TiWaterTloggedTsoilsTareTpoorlyTaeratedTandThence,TareTphysiologicallyTdry.TiTheyTareTnotTgoodTforTabsorptionTofTwater.

4-SoilTtemperature:

IncreaseTinTsoilTtemperatureTupTtoTaboutT30°CTfavoursTwaterTabsorption.TiAtThigherTtemperatureTwaterTabsorptionTisTdecreased.TiAtTlowTtemperatureTalsoTwaterTabsorptionTdecreasedTsoTmuchTsoTthatTatTaboutT0°C,TitTisTalmostTdecreased.TiThisTisTprobablyTbecauseTatTlowTtemperature.T

1.TTheTviscosityTofTwaterTandTprotoplasmTisTincreasedT

2.TPermeabilityTofTcellTmembraneTisTdecreasedT

3.TMetabolicTactivityTofTrootTcellsTareTdecreased

T4.TRootTgrowthTandTelongationTofTrootsTareTchecked.