TOPIC:LIGHT,TEMPERATUREANDQUALITYOFLIGHT Light:

Lightisakindofenergythattravelintheformofwavesaswellasparticles.

Lightwave:

Lightwaveistransverseelectro-magneticinwhichelectricandmagneticfieldtravelin thedirectionofpropagationofwaveandit90°withrespecttoeachother.



Lightwavehasspecificwavelengthandfrequency.Thefrequencyoflightisinversely proportionatetothewavelengthoflight.

v

v=c π

c=πv

WhereCisconstantcalledspeedlightanditsvalueis3×10m/s.

ParticleNature:

LightisalsoaparticlewhichwecallPhoton.Photoncontainanamountofenergythatiscalled quantum(p1.Quanta),thesequantanotincontinuousformbuttravelina discretepacketwhichdependuponthefrequencyoflight.

E=hv

Wherehisplank’sconstantanditsvalueis6.626×10-34js.

RoleofLightinPhoto-synthesis:

Sunisthebasicsourceoflight.Sunlightislikearainofphotonsofdifferentfrequencies.Someour eyesaresensitivetosmallportionoflightcalledvisiblelight.Whenthesevisiblelightpass fromtheprismtheygivesevencolorsofdifferentfrequencywavelength.

700nmR

O

I

Y

G

B

V

400nm

Thelightbelow400nmofwavelengthcalledultravioletlightwhichareharmfulforanimal andplant.

Thelightabove700nmofwavelengthcalledIRradiationwhicharenoeffectonplantand arereflectinupperatmosphere.

AbsorptionSpectra:

Thepartoflightusuallyabsorbbyphoto-syntheticpigmentofplantsiscalledAbsorptionSpectra.

Theabsorptionspectrumforaparticularsubstanceinanon-absorbingsolventcanbe determinedbyaspectrophotometer.



Spectrophotometryisatechniqueusedtomeasuretheabsorptionoflight.

Chlorophyllabsorbhavecertainwavelengthoflightwithinthevisiblerangeofthe moreeffectivelightabsorbedbychlorophyllisredandblue.Thegreenpartofthevisible lightusuallyreflectthatiswhychlorophyllappeargreen.

Whenchlorophyllmoleculeabsorbslight,theyexcitedfromgroundstatetohighenergystate.

chl+hv=chlx

Absorptionofbluelightexcitechlorophylltohigherenergystatethanabsorptionofred lightbecausetheenergyofphotonishigherwhentheirwavelengthisshorter.

Theabsorptionspectraofchlorophyllandcarotenoidasshowninthefollowingfigure.



ActionSpectra:

Thepartoftheabsorblightspectratodriveprocessofphotosynthesis.

OR

Theabilityofdifferentwavelengthoflighttodrivetheprocessofphotosynthesis.

# OR

Comparativeabilityofdifferentwavelengthoflighttodrivephotosynthesis.

Theactionspectrumshowsthemagnitudeofaresponseofabiologicalsystemtolight,asa functionofwave.Forexample,anactionspectrumcanbeconstitutedformeasurementof oxygenevaluationatdifferentwavelength.



Intheabovefigureactionspectrumdrawb/wo2evaluationresponseandwavelength.The actionspectraofoxygen(o2)evaluationmatchtheabsorptionspectraofintackchloroplast quitwell,indicatingthatlightabsorptionbythechlorophyll’smediateoxygenevaluation.

ActionspectraweremeasuredbyT.WEngelmannin1800s.Engelmannusedaprismtodisperse sunlightintoarainbowthatwasallowedtofallonanaquaticalgalfilament.Apopulationofo2

(oxygen)seekingbacteriawasintroducedintothesystem.Thebacteriacongregatedinthe regionofthefilamentthatevaluedthemostoxygen.Theseweretheregionilluminatedbyblue lightandredlightwhicharestronglyabsorbbychlorophyll.

LightRoles:

Inlightreactionofphotosynthesislighthastworoles:

1.Photo-excitation

2.Photo-lysis

1)Photo-excitation:

Whenlightfallonantennacomplexofchlorophyllbofphoto-systemIIand chlorophyllaofphotosystemI,thesefigmentsabsorbitandbecomeactivated.It releasesanelectron,theelectronbecomeexcitedtoahighenergylevelwhicharecapturedby primaryelectronacceptor.

2

e

P

=

I

I

2)Photo-lysis:

Whenwaterfallonphoto-system,thewatermoleculesbreakupintotwo componenthydrogenandoxygen.

4HO→4H+4OH

2 4OH→2HO+O

2 2

TheHydrogencombinewithNADP,formNADPH2.

QualityofLight:

Thequalityoflightisalsoimportantforplant.Onthebasisofplantlightperiod(Quantity) plantweredividedintothreecategories:

 ` 1.Short-DayPlant

2.Long-DayPlant 3.Day-NeutralPlant

1.Short-DayPlant:

Theplantwhichproducedfloweriflightisprovidedbelowthecriticalvalue.

e.g.Tobacco,Soyabean,SugarCane,Potato,Riceetc.Shortdayplantalsocalledlong nightplantbecausetheirdarkperiodislongerthancriticalvalue.

2.LongDayPlant:

Theplantwhichproducefloweriflightisprovidedabovethecriticalvalue. ExampleofLongDayPlantisWheat,Oat,Spinach,Radish.

3.DayNeutralPlant:

Plantswhichindependentondaylength.DayNeutralPlantproduceflowerafteraperiod ofvegetativegrowth.

ExampleisTomato,Sunflower,Litton,Cucumberetc.

Notonlyquantityoflightisimportantforplantbutqualityoflightisalsoveryimportantforplant. Borthwickin1954performanexperimentandproofthatqualityoflightandquantityoflightboth importantforplant.

Borthwicktaketwoplant,oneplantwasshortdayplantandtheotherplantwas longdayplantandperformtheflowingexperimenttoprovetheimportanceoflightforplant.

1.Hetakeshortdayplantandfexposedtoshortdayperiodoflight.They produceshortflowerthenheexposeddayplanttodayperiodoflighttheyremain

vegetative.

 Short-Day LongDay

 White Black flowering White Black

 9/1 9/1

 5 ShortDayPlant 5 Vegetative

2.Borthwicktakelongdayfirstlyheexposedtoshortdayperiodoflight.They remainvegetativeandcannotproducedflower.Thenheexposedtolongdayperiod,theplant produceflower.

|  |  |
| --- | --- |
| Short-Day | LongDay |
|

|  |
| --- |
| White |

Black |

|  |  |
| --- | --- |
|  |  |

 |
| 9/15 Vegetative | 9/15flowering |

3.Hetakeshortdayplantandexposedtoshortdayperiodoflightbutbreaktheirdark periodthroughredlight.So,duetowhichtheirdarkperiodiseffect,sotheyremainvegetative. Thenheexposedtolongdayperiodbutgiveredlightduringnight,sotheyproducedflower.

 Red LongDay Red

ShortDayPlant

 Vegetative

Flowering

9/1

5

4.Hegive1Rlighttolongdayplantduringshortdayperiod,theyproducedandhegive1R lightduringlongdayperiodtheyremainvegetativeandcannotproducedflower.

Long-DayPlant

 1 1

S.D

 9/1 9/15

5

5.ThenhetakeshortdayplantandexposedtoshortdayperiodbuthegiveRed then1Rlight,sotheplantproducedflower.Inlongdaytheplantcannotproducedflowerand remainvegetative.

 Red1R Red1R

S.D WhiteBlackflowering L.D

WhiteBlack

6.Finally,hetakeslongdayplantandexposedtoredlightthen1Rlightinshortdayperiod theplantremainsvegetativeduringlongdayperiodtheplantproducedflower.

 1RR 1RR

|  |  |
| --- | --- |
| White | Black |

|  |  |
| --- | --- |
| White | Black |

S.D Vegetative L.D

Flowering

Borthwickconcludedthatonlyquantityoflightisimportantbutqualityalsoimportant.

Temperature:

Thedegreeofheatpresentinasubstanceespeciallyexpressedbyacomparativescaleona thermometer.

Temperatureisanabioticfactorwhichwedefinedas“Thenegativeimpactofnonlivingfactoronlivingorganisminaspecificenvironment.”

EffectofTemperatureonPlant:

Theoptimumtemperatureforplantgrowthis25-30°c.Ifthetemperatureincreasefrom theoptimalvaluetheyhavenegativeeffectonplantandalsoiftemperaturedecrease fromnormalvalueeffecttheplant. HighTemperatureEffect:

1.Highmaycauseinjurytochloroplastby:

i.DisturbingThyloKoidstructure

ii.Swellingofgrana

iii.Effectgranastockingability.

2.Hightemperatureincreasefluidityoflipidduetowhichkineticenergyof membraneincreaseandthemoleculerandomlymove.

3.Hightemperaturealsodecreaseshydrogenbondingandelectro-static interactionb/wpolargroupsofproteinwithintheaqueousphaseofthe membrane.

4.Hightemperaturemodifiesmembranecompositionandstructureandcauseleakage ofions.

5.Photo-Synthesisandrespirationarebotheffectedbyhightemperature.

6.Chloroplastenzymesbecomeunstablebyhightemperatureandbeganto denatureandloseactivity.Becauseenzymesareproteininnatureandinthehigh temperature,theylosetheirthree-dimensionalstructure.

TolerancetohighTemperature:

Whentemperatureishightheplantdevelopssomemethodtoprotectitselffromhightemperature.

1.Highexpressionofanti-oxidantenzymelikecatalyze,peroxidase,glutathione,reductase.

2.Plantproduceanti-oxidantmetabolitelikeascorbatecaroteneetc.

3.Expressionofheatshockprotein(heatshockproteinsareafamilyofprotein thatareproducedbycellsinresponsetoexposuretostressfulcondition.)

PreventiontohighTemperature:

1.Whentemperatureishighthenstomataautomaticallyclosedtoconservewater.

2.Xylemtransportlittlewatertoconservewaterwhentemperatureishigh.

3.Walycuticlealsopreventswaterlossathightemperaturethisisthe adaptationwhichovercomethehightemperature.

4.Rollingofleafbladderwherevertheyusedrollingofleafbladderthereisless surfaceforthereductionofwater.

LowTemperature:

1.ChillingStressTemperature0-15°ccausechillingstress(whenplantexposed toalowtemperatureabovethe0°cthisiscalledchillingstress).

2.FreezingStressWhenplantisexposedtoalowtemperaturebelowzerodegree causefreezingstress.

Thesetwoconditionsareshownbytheplantoftropicalarea.

EffectofColdTemperatureonPlant:

1.Discolorationofleaves:Whentemperatureislowtheleaveshaschanged colorintothewhitish,yellowishorbronzeandalsoprematureleaffallalsooccur. Thisdiscolorationalsooccursduetothedeficiencyofnutrient.

2.Delayedtransitionoffloweringandplantgrowth.

3.PollenSterility:Pollensterilityisalsocausedbylowtemperature.

“Pollensterilitymeanthefailureofplanttoproducepollenormalegametes”

4.Waterpotentialinsidethecellalsoeffectedbylowtemperaturebecauseatlow temperaturewaterconvertintoicewhicheffectenzymesandionschannel. AdaptationtoLowTemperature:

1.NeedlelikeleafstructurewhichpresentfreezingandtranspirationofH2Oduetolow surfacearea.Theyalsohaveterpenesandalcoholwhichareanti-freezingfactor.

2.Terminationofgrowthactivityduringwinter.

3.Coldareaplantsanti-freezingproteinwhichintheRyeplant.