Integratedeffectof*Trichodermaharzianum* withselectedbotanicalsextractsonAlternaria leafspotofbroccoli(*Brassicaoleraceavar. italica*)causedby*Alternariabrassicae*(Berk.) Sacc.

ABSTRACT

Broccoli (*Brassicaeoleracea*var. *italica*) is an important cole crop vegetable, belongtofamilyBrassicaceae.Alternarialeafspotcausedby*Alternariabrassicae*is one of the serious diseases in broccoli. *In vitro* and *in vivo* experiment were conducted at the research plot of the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh in *Rabi* season 2023-2024, to evaluate *Trichodermaharzianum*andbotanicalson Alternarialeafspot of broccolicausedby*A.brassicae*. *Invitro*condition,fivebotanicalextractsweretakenattheconcentration10%and*T.harzianum*at 10% and Mancozebat 0.2% (treated check). *In vivo* condition, eight treatments were taken and all seedlings were treated with *T.harzianum*at 10%, Mancozebat0.2% and foliar spray of botanical extracts@10%exceptT_0 – control(untreatedcheck)and(treatedcheck).*Invitro* condition, among the treatments Neem leaf extract at10% were observed effectiveinthepercentdiseaseinhibition(%)(79.77)followedbyEucalyptusleaf extract at 10% (75.69). Among the treatments, under *In vivo* condition, T_3- *T. harzianum*(S.T.)+Neemleafextract(F.S.)wasobservedminimum disease intensity (16.59, 19.85 and23.28 %) at 45,60 and 75 DAT, respectively. Maximum plant height (9.78, 23.84 and 36.66cm) at 30,60 and 90 DAT, number of leaves per plant (9.36, 17.26 and 28.00), head weight (0.38 kg) and yield (9.68 t/ha) were found in T_3-*T.harzianum*(S.T.) and Neemleaf extract (F.S.) when compared to treated T_7- mancozeb (treated check) and T_0- Control (untreated check).

*Keywords:*Alternarialeafspot,*Alternariabrassicae*,botanicalsplantextracts, broccoli,*Trichodermaharzianum.*

1.INTRODUCTION

Broccoli(*Brassicaoleracea*var.*italica*)isanimportantcolecropvegetable,belongto Brassicaceaefamilyoriginatedfromltalyaboutmorethan2000yearsago**(Buck,1956).** BroccoliisnativetotheeasternMediterraneanandAsiaminor,broccoliwascultivatedinItaly inancientromantimes.ItwasintroducedtoEnglandinthe18thcenturyandbecame popular intheUnitedStatesinthe20thcentury(**Morenoetal.,2007**).ThecommonEnglishname broccoli'isderivedfromthe Italianword'broccolo',meaning'thefloweringcrestofacabbage'. Freshbroccoliisdarkgreenincolourwithfirmstalksandcompactbudclusters.Asa vegetable,itisgrownforitsedibleflowerbudsandstalk(**Dasetal.,2021**).

Broccoliisabiennialplant belongingtothe Brassicaceae familythat is eatenasavegetable throughouttheworld.Theedibleplantpartsarethestalkandlargefloweringhead.Broccoliis arichsourceofvitaminCandvitaminK.Broccolibecameoneofthefavouritefoodsduetoits highnutrientandfibercontent.Broccolialsocontainsnumerousphytochemicals,suchas polyphenols,namelykaempferol,quercetinglucosides,isorhamnetin,glucosinolates,and theirderivatives.Theseareresponsibleforitsantioxidantandanticancerpropertiesandother healthbenefits.(**Nagrajetal.,2020**).

Broccoliis consideredacoolseasoncrop,whichhasnowbeendistributedtobothtropicaland subtropicalareas**(Shivakumaretal.,2022).**Thiscropcanbecultivatedinvariouspartsof Indiaduringthewinterseason,especiallyinregionswhererainfallisnotexcessive.Areaswith moderaterainfallandcoolertemperaturesaregenerallysuitableforbroccolifarming.Beinga coolseasoncrop,itrequires15-20°Ctemperatureforheadcreation.Temperatureabove25° Cisn'tfavourableforitsdevelopmentandcancauseslackeninganddartingofheads**(Kumar *etal*., 2021).**

Theglobalproductionofbroccoliandcauliflowerwas25,531,274tonsfromanareaof 1,357,186ha,inwhichEuroperanksthird(afterChinaandIndia)andcontributes9.5and 10.5%inproductionandarea,respectively**(Siomosetal.,2022).**Thisvegetable,closely resemblingcauliflowerbutusuallygreenincolor,introducedinIndiamanyyearsaftercabbage andcauliflowerandhasgainedpopularity inshortspanoftime.Now,Indiastandsatsecond positionforcauliflowerandbroccoliproductionwithanannualproductionof6.7milliontonnes **(Tejaswinietal., 2018).**ItismostlycultivatedinhillyareasofHimachalPradesh,Uttar Pradesh,JammuandKashmir,NilgiriHillsandNorthernplainsofIndia**(Meenaetal.,2020**).

Therearemanydiseasesandpestscollectivelythatlowertheyieldandqualityofbroccoli crops.Broccoliisinfectedbyvarioustypesofpathogensincludingbacteria,fungi,andviruses, whichleadtoreductionofyieldandquality**(Zhangetal.,2022).**Amongallthediseases Alternarialeafspotdiseasecausedby*Alternaria*sp.isthemostimportantmajordiseasewhich resultedsignificantdeclineintheyieldofallcultivars **(Lafietal.,2022).**

Amongthedifferentdiseasescausedbythegenus*Alternaria,*Alternarialeafspotdisease ismostdominantonethatcausesaverageyieldlossintherangeof32-57%**(Singhetal., 2015).**During2017and2018,severesymptomsofdarkspotsonleaveswereobservedon broccoliplants(*Brassicaoleracea*L.var.*italica*) cultivarwith 45to37% diseaseincidenceand 70%yieldloss**(DeBrittoetal.,2020).**

Forthemanagementofthisdiseasefungicideshavebeenrecommendedtomanagethe disease,butpresent-dayfarmerperceptionsandenvironmentalhazardsarecompellingto searchforalternativeeco-friendlydiseasemanagementstrategies**(Sakhareetal.,2021)**So thissituationcompelstofocusondiseasemanagementbyutilizingbiologicalagents,plant extractsandfungicidesinlowestconcentration.Applicationofbiologicalagentsandextractis

eco-friendlyandasustainableapproachapartfrombeingapromisingalternativetofungicide application. Inthepresentstudyamongtheplantextracts,*Lantana camara*wasfoundtobe effectiveinmanagingtheAlternariablightinfectioninthefield(71.92%reductionindisease severityand68.18%increaseinyield)incomparisontobio-agent(*Trichodermaviride*)36.27% reductionindiseaseseverityrespectively.**(AhmadandAshraf,2016).**

2.MaterialsandMethods

TheexperimentwasconductedattheresearchplotoftheDepartmentofPlantPathology, CentralResearchField,SamHigginbottomUniversityofAgriculture,TechonologyAnd Sciences,Prayagrajduringthe*Rabi*seasonof2023-2024.Fieldexperimentwaslaidoutin RandomizedBlockDesignwitheighttreatmentshavingthreereplications.

2.1Isolationandidentificationofpathogen

Theleaveswerecollectedfrominfectedplantsbearingcharacteristicsymptomsof*Alternaria* leafspotofbroccoli.Theleaveswerethoroughlywashedunderrunningtapwater.The symptomsonleavesaftermountingonslidewereexaminedundermicroscopetoconfirmthe presenceof*Alternaria*sp.Theinfectedleafpartsalongwiththehealthyportionwascut into smallpiecesunderasepticconditionsandsurfacesterilizedwith1%sodiumhypochlorite (NaOCl)solutionfor1minuteandwashedthreetimeswithsteriledistilledwatertoremove anytracesofsodiumhypochlorite(NaOCl)adheredwithleafbits.Thentheywereplaced on filterpapersothatextrawatergetsabsorbed.Afterthatfiveleafbitsweretransferredon PDA media**(Tuite,1969)**containedinsterilizedpetriplateswiththehelpofforceps.Toavoid bacterialcontaminationstreptomycin@100ppm,wasaddedinthemediumatlukewarm stagebeforepouringPDAintoPetriplates.ThenPetriplateswerewrappedandincubatedat 27±2°CinBOD,after3daysmycelia growthwasobservedaroundleaf bits.With thehelp of corkboreraportionfromtheperipheryhavingsinglehyphaltipfromthiscolonygrowthwas separatedandtransferredtootherpetriplateshavingmediumtogetpureculture and identificationofthepathogenwasrecordedbyobservingthemorphologicalfeaturesofcolony, sporecharacteristicsandreferringtherelevantliterature**(BarnettandHunter,1972)**.

2.2Evaluationofbotanicalextractsand*Trichodermaharzianum*against Alternarialeafspotofbroccoli

2.2.1*Invivo*evaluation

Botanicalextractswerepreparedusingmethodofstandardproceduregivenby**Mahapatra andDas(2013).**Maturedleavesandotherbotanicalswerecollectedandsterilizedwithdistilled water,theleaveswerehomogenizedinapestleandmortar,sterilizeddistilledwater.Aqueous extractofthisbotanical(1%w/v)werepreparedbymixing100gfreshleaves/botanicalsof plantwith100mlofsteriledistilledwaterandcrushinginwarringblender.Theextractwas filteredthroughfourlayersofmoisturemuslincloth.Thefiltratethusobtainedwasconsidered asstocksolution.Thephyto-extractsweresprayed@10%preparedfromstandardsolution, Mancozebat aratio 0.2%,fungalbio-agent*T.harzianum*werealsosprayed @10% aftertheappearanceofthefirstsymptomsinthefieldatthirtydaysaftertransplanting(DAT), thefoliarsprayofbotanicals,mancozebandT.harzianumwasappliedthreetimes atfifteendaysinterval.Unsprayedplotswerekeptascontrol.

2.2.2DiseaseIntensity

Theintensityofdiseasewasvisuallyassessedinalltheplotsatweeklyintervalfromfirst appearanceofdiseaseforeachtreatment.Diseaseintensitywascalculatedusingtheformula givenby**Wheeler(1969)**.

$$\text{DiseaseIntensity}(\%)=\frac{\text{Sumofalldiseaseratings}}{\text{Totalnoofratings}\times\text{Maximumdiseasegrade}}\times 100$$

2.2.3*Invitro*evaluation

Cultureof*T.harzianum*

Onegofproductwas takenandmixedinninemlofsterilizeddistilledwaterina cleanand sterilizetesttubetomake10^{-1}dilution(1:10)shakenwellandonemlofthesuspensionofnine mlofsterilizewaterwastakeninatubetomake10^{-2}dilution(1:100).Similarly,fourmore serialdilutioninthesamewaywasdonetoget10^{-6}dilutionandtransferredonemlofthis suspensiontosterilepetriplatecontaining15-20mlofsterilizedmeltedandcooledPDAmedia theplateswererotatedgentlyandallowedtosolidify.Thepetriplateswereincubatedin BOD incubatorat25+2°Cforfivetosevendays.Thedevelopmentoftypicalcolonyof *T.harzianum*wasobserved.

Preparationofplantextracts

Thebotanicalsusedfortheexperimentwere Neem,Blacknightshade,Eucalyptus,Datura, Lantana.Thebotanicalpartusedforthetreatmentwere Neemleafextract10%,Blacknight shadeleaf extract 10%,Eucalyptusleaf extract10%,Daturaleafextract10%, Lantana leaf extract10%.Aqueousplantextractswere obtained asperthemethoddescribedby**Bhatti, (1988).**A100-gramsampleofeachfreshleaveswere gently washunderrunningtapwater andagainwashitinsteriledistilledwater.Theneachsamplewasgrindseparatelybyusing sterilepestleandmortalwith100mlsteriledistilledwater.Theextractofeach sample thusobtainedwasfilteredseparatelythroughasterilizeddoublelayeredmuslinclothto removethebitsofplantmaterialisfiltrate.Thenextractwasagainfilteredthroughafilterpaper (WhatmanNo.1).Thisformedthestandardplantextractssolution(100%). All theglassware used inthestudy weresterilizedbeforeuse.All theplantextractsweretested at10percent concentrationagainstthetestpathogenusingPDAasabasalmedium.Toobtain10percent concentrationofplantextracts,100mloflukewarmPDAwasmixedwith10mlofstandard plantextractsin250mlconicalflask,separatelyandthenitwasstirredwelltoobtain homogenizedmixture.

2.2.4DualCultureTechnique

Twentymlofsterilizedandcooledpotatodextroseagarmediumwaspouredintosterilized petriplates.Fungalantagonistswereevaluatedbyinoculatingapathogenatonesideof the petriplateandtheantagonistatexactlyoppositesideofthesameplatebyleavingaspaceof 4cm.Afterrequiredperiodofincubationi.e.,whenthegrowthincontrolplaterecords90mm indiameter,theradialgrowthofthepathogenswasmeasured**(Vincent,1947)**.

Percentageinhibitionofmyceliagrowthoftestpathogenwascalculatedusingtheformula:

$$I = \frac{C - T}{C} x100$$

Where,

I=Percentreductioningrowthoftestpathogen

C=Radialgrowth(mm)incontrol

T=Radialgrowth(mm)intreatment

2.2.5Poisoned foodtechnique

Fivemmdiameterofculturediscof*A.brassicae*wasbekeptatthecenterofeachpetri platecontainingthebotanicalsofrequiredconcentrationdissolvedinPDA.Threereplications weremaintained.Theplateswereincubatedat27±2˚Cforsevendaysandcolonydiameter wasrecorded**(Vincent,1947).**

Percentinhibitionofmycelialgrowthwascalculatedbyusingtheformula:

$$I = \frac{C - T}{C} x100$$

Where,

I=Percentinhibition

C=Growth(mm)oftestfungusinuntreatedcontrol plate

T=Growth(mm)oftestfungusintreatedplate

3.RESULTSAND DISCUSSION

3.1Effectofplantextractson*A.brassicae*bypoisonfoodtechnique

Radialgrowth(mm)of*A.brassicae*

Thedata presented intable1,depictedrevealsignificantreductionin T_3-Neem leafextract (18.20mm)followedbyT_2–Eucalyptusleafextract(21.87mm),T_5–Blacknightshadeleaf extract(23.83mm),T_4–Lantanaleafextract(26.00mm),T1-Daturaleafextract (26.98mm)ascomparedtomancozeb(treatedcheck)-(2.50mm)anduntreatedcheck controlT_0 -(90mm).

Percentinhibitionofmyceliagrowth

The datapresentpresentedintable1andfigure1reveal thattherewassignificantincrease inT_3-Neemleafextractat 10%(79.77%)followedbyT_2–Eucalyptusleafextractat 10% (75.7%),T_5–Blacknightshadeleafextractat 10%(73.52%),T_4–Lantanaleafextractat 10% (71.11%),T_1-Daturaleafextractat 10%(70.02%)ascomparedtoT_7-mancozeb(treated check)(97.21%)anduntreatedcheckcontrolT_0-(0%).Theprobablereasonforsuchfindings maybeduetothefactthatNeemleafcontainsactivecompoundssuchasazadirachtinaswell assalanin,nimbim.Constituentssuchasnimbim,nimbidin,limonoidswhichdisruptsthecell ofthepathogenandrestrictstheperformanceofsomeenzymesthatareimportanttoproliferate fungiinnatureandleadstotheirdeath.Thecurrentfindingsareconsistingwiththeresearch conductedby**Vijaykumar*etal*.(2022)andKumar*etal*.(2007)**whotestedtheeffectiveness ofdifferentphytoextractsagainst*A.brassicae*andfoundthattheantifungalactivity andpotentialityofnimbicidinandNeemleafextracthavebeenprovedsuccessfullyagainst the causal fungus..

3.2Effectoftreatmentsondiseaseintensityof Alternarialeafspotofbroccoli causedby*A.brassicae*

Thedatapresentedin theTable(2)revealthatthediseaseintensity(%)onbroccoli significantly reducedbyT_3–*T.harzianum*+Neemleafextractat 10%(23.28%)followedbyT_6-(*T.harzianum*at 10%(26.31%),T_5–(*T.harzianum*+Blacknightshade leafextractat 10%(30.26%),T_4-(*T.harzianum*+Lantanaleafextractat10% (32.56%),T_2–*T.harzianum*+Eucalyptusleafextractat 10%(36.83%),T_1-(*T.harzianum*+Daturaleafextractat 10%(37.28%)ascomparedtotheT7–mancozebat0.2%(treatedcheck)(18.96%)aswellas(T_0)–control(untreatedcheck) (40.64%).Similarfindingshavebeenreportedby**AnshikaandZacharia(2023)**and**Ravella *etal*.(2023)**Theprobablereasonforthisresultmaybeduetothe Neemhavinganti-microbial activity.Neemhasreportedtoexhibitantifungal,antibacterialandinsecticidalproperties.The ethanolicextractofNeemleavesstopsthegrowthoffungi.*T.harzianum*hasshown significantresultsondiseaseintensityandyieldattributes,whereasyieldhasbeen significantlyincreasedanddecreaseddiseaseintensity whichmaybeduetothemycoparasite

natureand abilitytogeneratevolatileandnon-volatilecompoundsagainstpathogenwithgreat anti-microbialactivity.

3.3Effectoftreatmentsonplantheight(cm)ofbroccoli

The datapresentedintheTable(3)revealthattheplantheight(cm)onbroccoli significantly increasedplantheightinT_3–(*T.harzianum*+Neemleafextractat 10%(36.66 cm)followedbyT_6-(*T.harzianum*at 10%(33.70cm),T_5–(*T. harzianum*+Blacknightshadeleafextract@10%(31.10cm),T_2-(*T.harzianum* +Eucalyptusleaf extractat 10%(29.93 cm),T_4–(*T.harzianum*+Lantanaleaf extractat 10%(28.41cm),T_1-(*T.harzianum*+Daturaleafextractat 10%(27.78 cm)ascompared totheT7–Mancozebat0.2%(treatedcheck)(39.47cm)aswellas(T_0) –control(untreatedcheck)(23.01cm).Theprobablereasonforthisresultmaybedueto Neemaqueousextractshowedapromotiveeffectonshootlengths,branchesandleaves numbers.Thebio-efficacyofNeemextractoverpathogenscanbeattributedtothefactthat Neemhasactivecompoundssuchasazadirachtin,nimbin,nimbidin,nimbineneand azadironewhichareantifungal, anti-bacterialandanti-insecticidalinnature**Nahak*etal*. (2015).***Trichoderma*strainscolonies plantroots,establishingchemicalcommunicationand systemicallyalteringtheexpressionofnumerousplantgenesthatalterplantphysiology. Applicationof*T.harzianum*significantlyincreasedcurdcircumferencelength,the diameterofthestem**Rosa*etal*.(2019).**

3.4Effectoftreatmentsonnumberofleavesperplantofbroccoli

ThedatapresentedinTable(4)revealthatnumberofleavessignificantlyincreasedinT3– (*T.harzianum*+Neemleafextractat 10%(28.00)followedbyT6-(*T. harzianum*at 10%(25.20),T5–(*T.harzianum*+Blacknightshadeleafextract at 10%(23.40),T2-(*T.harzianum*+Eucalyptusleaf extractat10%(21.13),T4 –(*T.harzianum*+Daturaleafextractat 10%(20.66),T1-(*T.harzianum*+Lantana leafextractat 10%(20.40)ascomparedtotheT7–Mancozebat 0.2%(treatedcheck)(31.53)aswellas(T0)control(untreatedcheck)(16.00).Theprobable reasonforthisresultmaybedueto Neemaqueousextractshowedapromotiveeffecton shootlengths,branchesandleavesnumbers.Thebio-efficacyofNeemextractover pathogenscanbeattributedtothefactthatNeemhasactivecompoundssuchas azadirachtin,nimbin,nimbidin,nimbineneandazadironewhichareantifungal,antibactrial andanti-insecticidalinnature**Nahak*etal*.(2015).***Trichoderma*strainscoloniseplantroots, establishingchemicalcommunicationandsystemicallyalteringtheexpressionofnumerous plantgenesthatalterplantphysiology.Applicationof*T.harzianum*significantly increasedcurdcircumferencelength,thediameterofthestem,andtheleafgreennessindex value**Rosa*etal*.(2019).**

3.5Effectoftreatmentsonheadweight(kg)ofbroccoli

ThedatapresentedinTable(5)andFigure(3)revealthatheadweight(kg)ofbroccoli significantlyincreasedinT3–*T.harzianum*+Neemleafextractat 10%(0.38kg) followedbyT6-*T.harzianum*at 10%(0.35kg),T5–*T.harzianum*+ Blacknightshadeleafextractat 10%(0.304kg),T4-*T.harzianum*+Lantanaleaf extractat10%(0.301kg),T2–(*T.harzianum*+Eucalyptusat 10%(0.21),T1- *T.harzianum*+Daturaleafextractat 10%(0.20kg)ascomparedtotheT7– Mancozebat0.2%(treatedcheck)(0.40kg)aswellas(T0)–control(untreatedcheck) (0.16kg).Theprobablereasonforsuchfindingsmaybethatthe Trichodermaandplant interactionproducethesecondarymetabolitessuchasauxin-likecompoundsorauxin-

inducingsubstances thatresultedin improvedgrowth,head diameter andyield**Tanwar*et al*.(2013).**Neemextractiscomposedofantimicrobialingredientssuchasalkaloids, glycosides,flavonoids,andsaponins,whicharecommonantibioticsfoundinplants.At concentrationsof0.1and0.4gmL^{-1},Neemextractinhibitedthegrowthofsoil microorganisms**Sarawaneeyaruk*etal*.(2015).**

3.6Effectoftreatmentsonyield(t/ha)ofbroccoli

Thedatapresentedin Table(6)andFigure(4)revealedthatyieldofbroccolisignificantly increasedheadweightT3–*T.harzianum*+Neemleafextractat 10%(9.68 t ha^{-1})followedbyT6-*T.harzianum*at 10%(7.92t/ha),T5–(*T. harzianum*+Blacknightshadeleafextractat 10%(6.81t ha^{-1}),T4-(*T.harzianum* +Lantanaleafextractat10%(6.50t ha^{-1}),T4–(*T.harzianum*+Eucalyptusleaf extract at 10%(6.19t ha^{-1}),T1-(*T.harzianum*+Daturaleafextract@10%(5.68 tha^{-1})ascomparedtotheT7–Mancozebat0.2%(treatedcheck)(11.55th^{-1})aswellas (T0)–control(untreatedcheck)(3.85t/ha).Theprobablereasonforthisresultmaybedue totheproductionofsecondarymetabolitessuchasantibiotics,isocyanide,acidsandcellwall degradingenzymeswhichareimplicatedinthegrowthinthegrowthinhibitionofmany phytopathogenicfungi**Supriya*etal*.(2022).***T.viride***hasshownsignificant resultsonyieldattributes,theyieldhasbeensignificantlyincreasedwhichmaybealtributed tothemycoparasiticnatureandabilitytogeneratevolatileandnon-volatilecompounds againstpathogenwithgreatanti-microbialactivity**(Ravella*etal*.,2023).**

Table1.Effectofselectedplantextractsonradialgrowth(mm)of*A. brassicae*

Sr.No.	Treatments	Concentration	Meancolony diameter(mm)	Percent inhibition
T0	Control(untreatedcheck)	-	90.00	0.00
T1	Daturaleafextract	10%	26.98[a]	70.02
T2	Eucalyptusleafextract	10%	21.87	75.69
T3	Neemleafextract	10%	18.20	79.77
T4	Lantanaleafextract	10%	26.00[a]	71.10
T5	Blacknightshadeleafextract	10%	23.83	73.51
T6	Mancozeb	0.2%	2.50	97.21
S.Em.(+)			0.51	0.57
C.D (5%			1.59	1.76

Figure1:-Efficacyofplantextractonpercentmycelial inhibitionof*A.brassicae*bypoisonedfood technique.**

Table2.Percentdiseaseintensity(%)at45,60and75DATasaffectedbytreatments

Sr.No.	Treatments	45DAT	60DAT	75DAT
T_0	Control(untreatedcheck)	25.98	33.83	40.64
T_1	*T.harzianum*10%(S.T.)+Datura leafextract10%(F.S.)	23.40	29.88	37.28
T_2	*T.harzianum* 10% (S.T.) + Eucalyptus leaf extract 10%(F.S.)	22.50	29.55	36.83
T_3	*T.harzianum*10%(S.T.)+Neem leaf extract 10%(F.S.)	16.59	19.85	23.28
T_4	*T.harzianum*10%(S.T.)+ Lantana leafextract10%(F.S.)	21.34	27.51	32.56
T_5	*T.harzianum*10%(S.T.)+Black night shade leaf extract 10%(F.S.)	20.28	25.64	30.26
T_6	*T.harzianum* 10% (S.T.) + *T.harzianum*10%(F.S.)	18.26	22.36	26.31
T_7	Mancozeb(treatedcheck)0.2%(S.T.+F.S.)	11.66	15.90	18.96
S.Em.(+)		0.36	0.30	0.34
C.D(5%		1.09	0.92	1.03

Table3.Effectoftreatmentsonplantheight(cm)ofbroccoli at30,60and90DAT

Sr.No.	Treatments	30DAT	60DAT	90DAT
T_0	Control(untreatedcheck)	6.92	15.40	23.01
T_1	*Trichodermaharzianum*10% (S.T.) + Datura leaf extract 10%(F.S.)	7.46	17.06	27.78
T_2	*Trichoderma harzianum* 10% (S.T.) + Eucalyptus leaf extract 10%(F.S.)	8.96	19.16	29.93
T_3	*Trichodermaharzianum*10%(S.T.)+Neem leaf extract 10%(F.S.)	9.78	23.84	36.66
T_4	*Trichodermaharzianum*10%(S.T.)+Lantana leaf extract 10%(F.S.)	8.21	18.28	28.41

T_5	*Trichodermaharzianum*10%(S.T.)+Black nightshadeleafextract10%(F.S.)	9.64	20.12	31.10
T_6	*Trichoderma harzianum* 10% (S.T.) + *Trichodermaharzianum*10%(F.S.)	10.43	21.37	33.70
T_7	Mancozeb(treatedcheck)0.2%(S.T.+F.S.)	12.72	26.43	39.47
S.Em.(+)		0.17	0.40	0.45
C.D(5%		0.53	1.23	1.31

Table4.Effectofselectedtreatmentsonnumberofleavesperplantofbroccoliat 30,60and90DAT

Sr.No.	Treatments	30DAT	60DAT	90DAT
T_0	Control(untreatedcheck)	7.73	10.46	16.00
T_1	*Trichodermaharzianum*10%(S.T.)+Datura leafextract10%(F.S.)	8.16	12.40	20.66
T_2	*Trichoderma harzianum* 10% (S.T.) + Eucalyptus leaf extract 10%(F.S.)	8.93	13.40	21.13
T_3	*Trichodermaharzianum*10%(S.T.)+Neem leaf extract 10%(F.S.)	9.36	17.26	28.00
T_4	*Trichodermaharzianum*10%(S.T.)+Lantana leafextract10%(F.S.)	8.46	12.93	20.40
T_5	*Trichodermaharzianum*10%(S.T.)+Black night shade leaf extract 10%(F.S.)	8.86	14.16	23.40
T_6	*Trichoderma harzianum* 10% (S.T.) + *Trichodermaharzianum*10%(F.S.)	9.76	15.73	25.20
T_7	Mancozeb(treatedcheck)0.2%(S.T.+F.S.)	10.13	20.13	31.53
S.Em.(+)		0.11	0.21	0.21
C.D(5%		0.33	0.66	0.64

Table 5.Effectoftreatmentsonheadweight(kg)ofbroccoli

Sr.No.	Treatments	Headweight/kg
T_0	Control(untreatedcheck)	0.16
T_1	*Trichodermaharzianum*10%(S.T.)+Daturaleafextract 10%(F.S.)	0.20
T_2	*Trichodermaharzianum*10%(S.T.)+Eucalyptusleafextract 10%(F.S.)	0.21
T_3	*Trichodermaharzianum*10%(S.T.)+Neemleafextract 10%(F.S.)	0.38
T_4	*Trichodermaharzianum*10%(S.T.)+Lantanaleafextract 10%(F.S.)	0.301
T_5	*Trichodermaharzianum*10%(S.T.)+Blacknightshadeleaf extract10%(F.S.)	0.304
T_6	*Trichodermaharzianum*10%(S.T.)+*Trichodermaharzianum* 10%(F.S.)	0.35
T_7	Mancozeb(treatedcheck)0.2%(S.T.+F.S.)	0.40
S.Em.(+)		0.05
C.D(5%		0.15

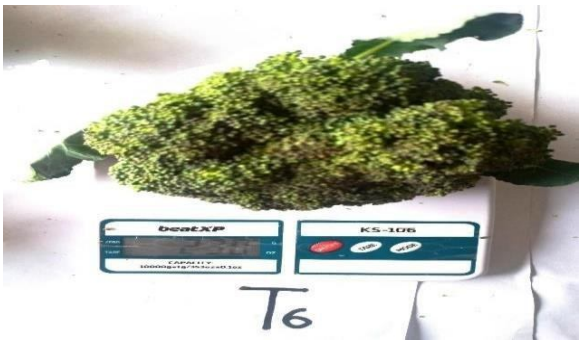

Figure2:-Weighingofbroccoli

Table6.Effectoftreatmentsontotalyield(t/ha)ofbroccoli

Sr.No.	Treatments	Yield(t ha^{-1})
T_0	Control(untreatedcheck)	3.85
T_1	*Trichodermaharzianum*10%(S.T.)+Daturaleafextract 10%(F.S.)	5.68
T_2	*Trichodermaharzianum*10%(S.T.)+Eucalyptusleafextract 10%(F.S.)	6.19
T_3	*Trichodermaharzianum*10%(S.T.)+Neemleafextract 10%(F.S.)	9.73
T_4	*Trichodermaharzianum*10%(S.T.)+Lantanaleafextract 10%(F.S.)	6.50
T_5	*Trichodermaharzianum*10%(S.T.)+Blacknightshadeleaf extract10%(F.S.)	6.81
T_6	*Trichodermaharzianum*10%(S.T.)+*Trichodermaharzianum* 10%(F.S.)	7.35
T_7	Mancozeb(treatedcheck)0.2%(S.T.+F.S.)	11.55
S.Em.(+)		0.12
C.D(5%		0.37

Figure3:-Yieldofbroccoli

4.CONCLUSION

ItcanbeconcludedthatT.*harzianum*andbotanicalsNeemleafextractis significantincontrolling*A.brassicae*inbroccoli.Thisstudycontributesvaluable insightsintosustainablediseasemanagementpracticesbytheusedofbio-controlagent andplantextractsthatcanbenefitbothfarmersandtheagriculturalsector.Itisimportantto notethatthisinvestigationhasbeenconductedinaspecificcroppingseasonwithinthe agro-climaticconditionsofPrayagraj.Furthertrialsindiverselocationsandseasonsare recommendedtoexpanduponthesepromisingresults.

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