EFFECTS OF SALTSTRESS ONGERMINATION, GROWTH,YIELDAND IONS CONTENT OFTWO MUSTARD VARIETIES

A

Thesisby

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EFFECTS OF SALTSTRESS ONGERMINATION, GROWTH,YIELDAND IONS CONTENT OFTWO MUSTARD VARIETIES

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Dedicated

toMy

Beloved Parents

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EFFECTSOFSALTSTRESSONGERMINATION,GROWTH,YIELDANDIONSCONTENTOFMUSTARD

ABSTRACT

Apotexperimentwasconductedatthenethouseof AgroEnvironmentalChemistryLaboratoryofthe DepartmentofAgriculturalChemistry,Sher-e-BanglaAgriculturalUniversity,Dhaka-1207.TheexperimentwascarriedoutinpotsduringNovember,2019toFebruary2020toobservethe effectsofsaltstressongermination,growth,yieldandionscontentofmustard.Theexperimentwaspe rformedusingtwocultivars(SAUSarisha-1andBARISarisha9) and fivesalinitylevels(0,3,6, 9 and12dSm^{-1}).The experimentwasset inCompletelyRandomizedDesign(CRD)havingtwofactorswiththreereplications.Themaximu mgerminationpercentageof seedsand plantpopulationper potwasfoundinBARISarisha 9.The tallestplantwasfound inBARISarisha 9.BARISarisha 9achievedmaximumbranchesplant^{-1},totaldrymatter,siliquaeplant^{-1},lengthofsiliqua,numberofseedssiliqua^{-1}.Betweenthetwovarieties,thehigherseedyield(4.69gpot^{-1})wasfoundinBARISarisha9. Indifferentsalinitylevels,highestgrowthandyieldcontributingcharacterswerefoundat0dSm^{-1}.Thehighestseedyield(6.13gpot^{-1})wasalsorecordedatcontroltreatment.Whencombinedeffectsofvarietiesandsalinitylevelswereconsidered,highestseedyield(6.29gpot^{-1})wasfoundinBARISarisha9with0dSm^{-1}levelandat3,6,9and12dSm^{-1}salinitylevels,itperformedbetterthanSAUSarisha-1.TheKcontentwashigherinBARISarisha9thanSAUSarisha-1.TheKcontentdecreasedsignificantlywithincreasing thesalinitylevel.NacontentwashigherinSAUSarisha-1thanBARI Sarisha9.Nacontentinthevarietiesincreasedsignificantlywiththeincreasingsalinitylevel.ThevarietyBARISarisha9showedbettermorphological,yieldandyieldcontributingcharactersthanthose ofSAUSarisha-1.

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LISTOFABBREVIATIONANDACRONYMS

AEZ	=	Agro-EcologicalZone
BARI	=	BangladeshAgriculturalResearchInstitute
HRC	=	HorticultureResearchCentre
BBS	=	BangladeshBureauofStatistics
FAO	=	FoodandAgriculturalOrganization
N	=	Nitrogen
etal.	=	Andothers
TSP	=	TripleSuperPhosphate
MOP	=	MuriateofPotash
RCBD	=	RandomizedCompleteBlockDesign
DAT	=	DaysafterTransplanting
ha^{-1}	=	Perhectare
g	=	gram(s)
kg	=	Kilogram
SAU	=	Sher-e-BanglaAgriculturalUniversity
SRDI	=	SoilResourcesandDevelopmentInstitute
wt	=	Weight
LSD	=	LeastSignificantDifference
^0C	=	DegreeCelsius
NS	=	Notsignificant
Max	=	Maximum
Min	=	Minimum
%	=	Percent
NPK	=	Nitrogen,PhosphorusandPotassium
CV%	=	PercentageofCoefficientofVariance

Chapter 1

Introduction

CHAPTERI

INTRODUCTION

MustardbelongstothefamilyCruciferaeorBrassicaceae,isoneofthemostimportantoilcropsoftheworldaftersoybeanandgroundnut(FAO,2012).*Brassicanapus*,*B.campestris*and*B.juncea*arethethree species ofmustardthoseproduceedible oil.Itisoneof themostimportantandwidelygrownoilseedcropsinBangladeshwhichoccupying0.483million hectareoflandandin2012thetotalproductionwas0.525millionmetricton(AIS,2013).Vegetableoilsandfats(lipids)constituteanimportantcomponentofhumandietandoilsofplantorigin arenutritionallysuperiortothatofanimalorigin(Singh,2000).Itisnotonlyahighenergyfoodbutalsoacarrieroffat-solublevitaminsincludingvitaminA,D,EandKinthebody.InBangladeshitisanimportantsourceofcookingoilthatmeettheonethirdofedibleoilrequirementofthecountry(Ahmed,2008).Cumilla,Tangail,Jeshore,Faridpur,Pabna,Rajshahi,Dinajpur,Kushtia,Kishoregonj,Rangpur andDhakadistrictsarethemajormustardgrowingdistrictsofBangladesh(BBS,2011).Bangladeshhasbeenfacingacuteshortageofedibleoilforthelastseveraldecades.Forthatitneedstoimportoilandoilseedstomeetupthedeficitofedibleoil.Ourinternalproductioncanmeetonlyabout21%ofourconsumptionwhichcanmeetonlyafractionofthecookingoil,requirementofthecountryandtherest79%isneededtoimport(Begum*etal*.,2012).Duetoinsufficientoilproduction, ahugeamountofforeignexchangeinvolvingover160millionUS$isbeingspenteveryyearforimportingedibleoilsinBangladesh(Rahman,2002).Mustardseedcontainsabout40-45% oilandbyincreasing productionofmustardwecanmeetuptheshortageofedibleoil.Theaverageyieldofmustard(1,087kgha^{-1})inourcountryisalarminglyverypoorcomparedtotheadvancedcountrieslikeGermany,France,UKandCanada.Atpresenttheworldaverageyieldofmustardis1,575kgha^{-1}(FAO,2012). Brassica(genus ofmustard)has threespeciesthatproduceedibleoil,theyare *B.napus*, *B. campestris*and*B.juncea*.Amongthem,*B.napus*and*B.campestris*areofthegreatestimportanceintheworld'soilseedtrade.Inthissubcontinent,*B.juncea*isalsoanimportantoilseedcrop. Untilrecently,mustardvarietiessuchasTori-7,Sampad(*Brassicacampestris*)and Doulat (*Brassica juncea*)were mainlygrowninthis country.

RecentlyseveralvarietiesofhighyieldingpotentialcharacteristicshavebeendevelopedbyBangladeshAgriculturalResearchInstitute(BARI).

Seedyieldandotheryieldcontributingcharacterssignificantlyvariedamongthevarietiesofrapeseedandmustard(BARI,2001).Uddin*etal*.(1987)reportedthattherewasasignificantyielddifferenceamongthevarietiesofrapesandmustardwiththesamespecies.Singh*etal*.(1999)foundoilcontentvariationduetodifferentvarietiesanddifferentmethod.Theyestimatedoilcontentofdifferentvarietiesfromdifferentspeciesandhighestoilcontent(44.3%)fromvarietyPYS841(*B.campestris*)andlowest(40.8%)fromKranti(*B.juncea*)bySoxhletmethod.Inboldpercolationmethod,theyfoundhighestoilcontent(44%)inthevarietyPYS841(*B.campestries*)andlowest(40%)inPBC221(*B.carinata*).JahanandZakaria(1997)observedtheperformanceofsevenlocalandthreeearlyvarietiesofrapeseed,mustardandcanola.Thevarieties differedwithrespect tooil contentofseeds.Ingeneral, localvarieties hadhigheroilcontentcomparedtoexoticvarieties.Thehigheroilcontentof41.85%wasfoundinSonalisarishawhichwasidenticaltothatfoundinSampad.Thelowestoilcontentof30.90%wasfoundinBLN-900.Itiswellknownthatvarietyplaysanimportantroleinproducinghighyieldofmustardbecausedifferentvarietiesperformdifferentlyfortheirgenotypiccharacters.Improvedvarietyisthefirstandforemostrequirementforinitiationandacceleratedcropproductionprogram.TherearesomeHYVsofmustard,whichhavebeenreleasedbytheSher-e-BanglaAgriculturalUniversity(SAU),BangladeshAgriculturalResearchInstitute(BARI)andBangladeshInstituteofNuclearAgriculture(BINA).Yieldcontributingcharactersandyieldofdifferentvarietyvariedsignificantly(Mamun*etal*.2014,BARI,2001).TheyieldofmustardinBangladeshhasbeenincreasedobviouslywiththeintroductionofhighyieldingvarietiesandimprovementofmanagementpractices.
Salinityistheprocessofaccumulationofsolublesalts,bywhichsalinesoilsareproduced.Soilsalinityisamajorconcerntotheagricultureinaridandsemi-aridregions.Accordingtoanestimationonethirdoftheworld’slandsurfaceisaridorsemi-arid(4.8×109ha.),outofwhichone-halfisestimatedtobeaffectedbysalinity.Highsaltcontentinthesoilaffectsthesoilporosityandalsodecreasesthesoilwaterpotentialthat results inaphysiologicaldrought.Theproblemsofsalinization areincreasing,eitherduetobadirrigationdrainageoragriculturepractices.Despiteitsrelativelysmallarea,irrigatedlandisestimatedtoproduceone-thirdoftheworldfood.

Highsalinitylowerswaterpotentialandinducesionicstress,andresultsinsecondaryoxidativestress.ItseverelylimitsgrowthanddevelopmentofplantsbyaffectingdifferentmetabolicprocessessuchasCO_2assimilation,oilandproteinsynthesis.Thecompositionofsaltsinlargeamountsmostlyissodium,calciumandmagnesiumchlorideandsulfateionsandinrelativelysmallamountsarepotassium,carbonates,bicarbonates,borateandlithiumsalts.Whenplantsareexposedtosaltstress,theyadapttheirmetabolisminordertocopewiththechangedenvironment.

Salinityisoneofthemajorenvironmentalstressesaffectingplantgrowthanddevelopmentandresultsinsevereagriculturallosses.Itaffectsnutrientuptake(Varshney*etal*.1998)andmetabolicactivitiesinplants(Singhet*al*.,2001).Activeosmoticadjustment causes positive effect on growthprocesses(Turner, 1981).

Osmoticadjustmenthelpsintwowaysundersalinecondition;i)tomakeplantscapabletouptakewaterundersalineconditionandii)tokeepstomataopenbymaintainingturgidoftheplantcell:Themagnitudeoftheeffectofsalinityvariedwiththeplantspecies,typeandlevelofsalinity(Bishnoi*etal*.,1987).So,plantspecies/varietiestoleranttohighlevelofsaltareessentialfortheutilizationofthehighlysaltaffectedsoils.

InBangladesh,over30%ofcultivatedareasareinthecoastalbelt.Outof2.85millionhectaresoflandonly0.88millionhectaresarearablelands,whichconstituteabout52.8%ofthecultivableareas.Thisareaisaffectedbyvaryingdegreeofsoilsalinity(Karim*etal*.,1990).Moreover,thesaltaffectedareaisincreasingdaybyday.Butsalinityaffects growthand yieldattributesof*Brassicaspecies*(Javaid*etal*.2002).

Therefore, therewasagreatopportunitytoadoptthe salttolerantrapeseed andmustardvarietiesinthecoastalbelt.Amongtheoilseedcrops*B.Juncea*and*B.napus*aretheamphibiandiploidinorigin.Thisexperimentwasconductedtoidentifythebettervarietiesofrapeseedandmustardtoleranttodifferentsalinitylevelsconsideringyieldandcomponentcharacters.

Therefore,keepingtheabovepointsinview,thepresentworkwasundertaken:

I. toobservetheeffectofsalinityongerminationandgrowthperformanceofmustardatdifferentstages,
II. toobservethebio-massandseedyieldofmustard,
III. tostudytheionicbalanceinplantsand
IV. toselectcomparativelymoresalttolerantmustardvariety.

Chapter 2

Review of literature

CHAPTERII

REVIEWOFLITERATURE

Mustardand rapeseed areimportant oilcropof Bangladesh which contributestoalargeextentinthenationaleconomy.Buttheresearchworksdoneonthiscropwithrespecttoagronomicpracticesareinadequate.Itsgrowthandyieldaredeterminedbyvariousfactorsofwhichsalinityisoneofthemostimportant.Averylimitedworkshasbeendoneinvolvingthesalinitywiththemustard(rapeseed)varieties.Someoftheworkapplicabletothepresentstudyhasbeenreviewedbelow:

2.1 Effectofvarietyondifferentcropcharacters

2.1.1 Plantheight

Ahmed*etal*.(1999)statedthatthetallestplant(102.56cm)wasrecordedonthevarietyDaulat.Nosignificantdifferencewasobservedonplantheightbetween DhaliandNap-8509.

ZakariaandJahan(1997)observedthatDhaligavethetallestplantheight(142.5cm)whichwassimilarwithSonali(139.5cm)andJaprai(138.6cm).TheshortestplantheightwasobservedinTori-7(90.97cm)whichwassignificantlyshorterthanothervarieties.

AnexperimentwasconductedattheRegionalAgriculturalResearchStation(RARS),Jeshore(AEZ-11,HighGangesRiverFloodplain)during2003-2006toevaluatetheresponseofdifferentvarietiesofmustardtoboronapplication.Boronapplicationwasmade at0and1kg ha^{-1}. Thevarietieschosenfrom*B.campestris*wereBARISarisha6,BARISarisha9andBARISarisha12.The*B.napus*varietieswereBARISarisha7,BARISarisha8andBARISarisha13.Amongthevarieties,BARISarisha10andBARISarisha11werefromthe*B.juncea*group.Theseedyieldwaspositivelyandsignificantlycorrelatedwiththeyieldcontributingcharactersviz.podsplant^{-1},seedspod^{-1},and1000-seedweight,butnotwithplantheightandpodlength(Hossain*etal*.,2012).

Hossain*etal*.(1996)observedthatthehighestplantwasinNarenda(175cm),whichwasidenticalwithAGA-95-21(166cm).TheshortestvarietywasTori-7.

Mondaletal.(1992)reportedthatvarietyhadsignificanteffectonplantheight.Theyfoundthehighestplantheight(134.4cm)inthevarietyJ-5004,whichwasidenticalwithSS-75andwassignificantlytallerthanJS-72andTori-7.

Yadav*et al*. (1994)suggested that the plantheight wasgreaterin cv.Vaibhav (167cm)ascomparedtocv.Varuna(158cm).InJodhpur,India,Singh*etal*.(2001)observedthat thelocalcultivarwastallerascomparedtocultivarT-59(158cm).RanaandPachuari(2001)quotedthatplantheightwasrecordedsignificantly higherincv.TERI(OE)M21(177cm)ascomparedtocv.TERI(OE)R15(129cm).

ShahandRahman(2009)observedthatsignificantlyhigherplantheightinrapeseedgenotypeRM-159-2(180.8cm)ascomparedtogenotypeRM-152-2(180.7cm),Pak-Cheen(177.1cm)andRM-182(176.0cm).Lallu*etal*.(2010)atKanpur(U.P)observedthatamongdifferentmustardgenotypes,plantheightofgenotypeRGN-152wassignificantlyhigher(184.7cm)ascomparedtoothergenotypesinnormalsowingandinlatesownconditioncv.RGN-145exhibitedsignificantlyhigher(118.5cm)plantheight.

Rashid*etal*.(2010)inafieldexperimentobservedthatthevarietyBARISharisa-15wasofthetallplanttypeandthatotherswereofintermediateandshortstructureinplantheight. Afroz*etal*.(2011)observedthatcv.BARISarisha-6exhibitedsignificantlyhigherplantheight(96.7cm)ascomparedtocv.BARISarisha-9(84.9cm).Kumari*etal*.(2012)observedthathybridDMH-1recordedsignificantlyhigherplantheight(212cm)overcv.Kranti(203cm) andhybridNRCHB-506(196cm).

2.1.2 Branchesplant^{-1}

Theyieldcontributingcharacterssuchasnumberofprimary,secondaryandtertiarybranchesareimportantdeterminantoftheseedyieldofrapeseedandmustard.VarietiesamongBrassicaspeciesshowedamarkedvariationinthearrangementofthebranchesandtheirnumberperplant.

AliandRahman(1998)foundsignificantvariationinplantheightofdifferentvarietiesofrapesandmustard.

BARI(2001)foundthatthenumberofprimary branchesperplantwashigher(4.02)inthe variety SS-75 andlower(2.1) in the variety BARISharisa-5 underpoor managementundermediummanagement,thehighernumberofprimarybranchesplant^{-1}wasfoundin BARISharisha-6(5.5)andlowerinBARISharisa-8underhighermanagement.Thehighest numberofprimarybranchesplant^{-1}waswithBARISharisha-6(5.9) and lower (3.0) withNap-248.

Hossain*etal*.(1996)statedthatthevarietieswerestatisticallydifferentwithrespecttonumber ofprimary branches.ThemaximumnumberofprimarybrancheswasrecordedintheHyola-401(5.0)andtheminimumnumberwasrecordedinSemu-249/84.

ZakariaandJahan(1997)foundthatthelocalvarietiesTori-7andSampadproducedthehighestnumberofprimarybranchesplant^{-1}(4.07)whichwasatparwithBLN-900.Theminimumnumberofprimarybranchesplant^{-1}(2.90)wasfoundinJataraiwhichwasidenticaltothosefoundinHhole-401andBARIsarisha-8varieties.

Mamun*etal*.(2014)conductedafieldexperimenttoevaluatetheeffectofvarietyanddifferentpl antdensitiesongrowthandyieldofrapeseedmustardduringRabi2011-12underrain-fedconditionsatSher-e-BanglaAgriculturalUniversity,Dhaka,Bangladesh.Fourvarieties(BARISarisha-13,BARISarisha-15,BARISarisha-16andSAUSarisha-3)andfourplantdensities.BARISarisha-13producedthehighestnumberofbranchesplant^{-1}(6.14)whichwas33.77%higher(4.59)thanBARISarisha-15.

Sultana*etal*.(2009)carriedoutanexperimenttoevaluatetheeffectofirrigationandvarietyonyie ldandyieldattributesofrapeseed.SAUSarisha-1producedthehighestnumberof branches perplant (5.43) which wassignificantlyhigher thankollania(4.80)andImprovedTori-7(4.40).

MondalandIslam(1993)reportedthatvarietyhadsignificanteffectonplantheight.Theyfoundt hehighestplantheight(134.4cm)onthevarietyJ-5004,whichwasidenticalwithSS-75andwassignificantlytallerthanJS-72andTori-7.

Yadav*etal*. (1994) reported thatthenumberofprimaryand secondarybranchesplant^{-1}wasrecordedhigherincv.Vaibhav(5.9and13.7)ascomparedtocv.Varuna(5.3and13.0).Divy aexhibitedsignificantlyhighernumberofprimarybranches(4.7plant^{-1})overcv.Kunthi(4.0plant^{-1}).Singh*etal*.(2001)observethatthenumberofprimarybranchesplant^{-1}wererecordedhigher

incv.PusaBold(5.63)compared
tolocalcultivar(4.67).RanaandPachauri(2001)quotedthatcv.TERI(OE)M21recorded

highernumberofprimarybranches(6.8plant^{-1})ascomparedtocv.Bio-902(6.2plant^{-1}).

Kumar*etal*.(2008)reportedthatthenumberofbranchesinBrassicaspecieswassignificantlygreaterin*B.juncea*cv.Kranti(14.8plant^{-1})ascomparedto*B.junceacv*.Urvarshi(14.6plant^{-1}),*B.napus*cv.GSL-1(11.9plant^{-1}),*B.napus*cv.Hyola-401(8.5plant^{-1}),*B.carinata*cv.Kiran(5.42plant^{-1})and *B.campestris*cv.NDYS-2(5.2plant^{-1}).

Afroz*etal*.(2011)observedthatcv.BARISarisha-9exhibitedsignificantlyhighernumberofbranches(3.30plant^{-1})ascomparedtocv.BARISarisha-6(1.59plant^{-1}).Kumari*etal*.(2012)observedthathybridDMH-1recordedsignificantlyhigherprimaryandsecondarybranches(7.6,18.5plant^{-1})overhybridNRCHB-506(7.2,17plant^{-1})andcv.Kranti(6.5,15.7plant^{-1}).

2.1.3 Numberofsiliquaeplant^{-1}

Sultana*etal*.(2009)showedthatKollaniaproducedthehighestnumberofsiliquaeplant^{-1}(94.96)whichwas significantlyhigherthanSAUSarisha-1and ImprovedTori-7(89.97and78.28)respectively.

Mamun*etal*.(2014)conductedanexperimentandfoundthatmaximumsiliquaplant^{-1}(126.90)wasobtainedinBARISarisha-13whichwasmorethanthreetimeshigherthantheminimumnumberofsiliquaplant^{-1}(50.10)producedbySAUSarisha-3.

Hossain*etal*.(2012)foundthatBARI Sarisha11producedthehighestnumberofpodsplant-1followedbyBARISarisha10.BARISarisha7,BARISarisha8,andBARISarisha13produced statisticallysimilarnumberofpodsplant-1inthecontrolplots.

JahanandZakaria(1997) reported thatin caseofnumberof siliquaeplant^{-1},thehighestnumberwasrecordedinBLN-900(130-9)whichwasidenticalwiththatobservedinDhali(126.3).Tori-7hadthelowest(46.3)numberofsiliquaeplant^{-1}.

Mondal*etal*.(1992)statedthatmaximumnumberofsiliquaeplant^{-1}wasinthevarietyJ-5004whichwasidenticalwiththevarietyTori-7.Thelowestnumberofsiliquaeplant^{-1}(45.9)wasfoundinthevarietySS-75.

Sharma(1992)atGwalior(ModhaProdesh,India)observedsignificantlyhighernumberofsili
quaeincv.Kranti(281.9plant^{-1})ascomparedtocv.Varun(226.7plant^{-1}).

SimilarlyYadav*etal*.(1994)alsoquotedthatnumberofsiliquaeplant^{-1}washigherincv.Vaibhav(363)ascomparedtocv.Varuna(257).Divyarecordedsignificantlyhighernumberofsiliquae(132plant^{-1})overcv.GM-2(97plant^{-1}).Sharma*etal*.(1997)emphasizedthatmustardcv.RH-819exhibitedsignificantlyhighernumberofsiliquae(421.3plant^{-1})overRH30(348.9plant^{-1}).

LaxminarayanaandPoornachand(2001)observed thatcv.Krantirecordedsignificantlyhighernumberofsiliquae(260plant^{-1})overcv.Divya(208plant^{-1}).Singh*etal*.(2001)observedthatnumberofsiliquae(plant^{-1})wassignificantlyhigherincv.PusaBold (257)ascomparedtocv.TS9(198).RanaandPachauri(2001)quotedthatnumberofsiliquaeplant^{-1}wererecordedsignificantlyhigherincv.TERI(OE)R15(285)ascomparedtocv.Bio902(238).

Kumar*etal*.(2008)suggestedthatthenumberofsiliquaeplant^{-1}in*Brassica*speciesweresignificantlyhigherin*B.carinata*cv.Kiran(277)ascomparedto*B.napus*cv.GSL-1(219),*B.juncea*cv.Kranti(215),*B.juncea*cv.Urvarshi(206),*B.napus*cv.Hyola-401(131),and*B.campestris*cv.NDYS-2(66).InMymensingh(Bangladesh),Afroz *et al*.(2011) observedsignificantlyhigher number ofsiliquaeplant^{-1}in cv. BARISarisha-9(153.3)ascomparedtocv.BARISarisha-6(138.8).Kumari*etal*.(2012)observedthathybridDMH-1recordedsignificantlyhighernumberofsiliquae(342plant^{-1})overhybridNRCHB-506 (286plant^{-1})and cv.Kranti(235plant^{-1}).

2.1.4 Siliqualength

Theshortestpodlength(4.62cm)wasfoundinthehybridSemu-249/84whichwasidentical tothose ofSemu-DNK_89/218, AGH-7and Tori-7.The longestpod (8.07cm)wasfoundinBLN-900andHyola-401(JahanandZakaria,1997).

Masood*etal*.(1999)foundsignificantgeneticvariationinpodlengthamongsevengenotypes of*B.campestris*andacultivarof*B.napus*. Similar resultforpod length wasobservedbyLebowitz (1989)andOlsson(1990).

Akhter(2005)reportedthatthevarietyBARIsarisha-8showedlongestsiliqualength(7.30cm)withharvestingat100dayswhichwassimilarwiththesamevarietyharvestedat90days(7.13cm).

Hossain*etal*.(1996)statedthatthevarietiesofrapeseeddifferedsignificantlyinrespectofsiliqualength.ThelongersiliquawasfoundinhybridBGN-900(7.75cm)thatwassimilartoHyole-101,Sampad,DhaliandHyola-51.

2.1.5 Numberofseedssiliqua^{-1}

Akhter(2005)reportedthatvariationsinnumberofseedssiliqua^{-1}amongthevarietieswerefoundstatisticallysignificant.Thehighestnumberofseedssiliqua-1(23.80)wasfoundfromBARISarisha-8andthelowestwasrecordedas10.78fromBARIsarisha-11.ThevarietyBARISarisha-10andBARIsarisha-7showedthenumberofseedssiliqua^{-1}as12.64and22.03respectively.

Mamun*etal*.(2014)foundthatthenumberofseedssiliqua^{-1}contributesconsiderablytowards the finalseedyield. Thenumberofseedssiliqua^{-1}differed significantlyamongvarietiesbutnotforplantdensities,whiletheinteractioneffectofvariety×plantdensitywassignificant.Highestnumberofseedssiliqua^{-1}(25.36)wasobtainedfromBARISarisha-13andBARISarisha-16obtainedthelowest(14.95).

Hossain*etal*.(2012)foundthatthenumberofseedspod^{-1}alsovariedsignificantlyamongthevarietiesduetoboron(B)application.Theaveragenumberofseedspod^{-1}rangedfrom12.00to20.67and13.22to27.44intheBuntreatedandtreatedplots,respectively.Themaximumnumberofseedspod^{-1}(27.44)wasrecordedinBtreatedBARISarisha-8.

Sharma(1992)observedthatnumberofseedssiliqua^{-1}recordedsignificantlyhigherincv.Kranti(15.0)overcv.Krishna(11.8).Tyagietal.(1995)reportedthatcv.Laxmiproducedsignificantlyhighernumberofseeds(12 siliqua^{-1})followed bycv.RH-30 andVarunaYadav*etal*.(1994)revealedthatnumberofseeds(siliqua^{-1})recordedsignificantlyhigherincv.Rohini(14.6)comparedtocv.Vardan(13.5).Sharma*etal*.(1997)observedthatnumberofseedssiliqua^{-1}recordedsignificantlyhigherincv.RH819(12.5)overRH30(11.3).Singh*etal*.(2001)reportedthatamongthecultivarstested,cv.PusaBoldrecordedhighernumberofseeds(14.0siliqua^{-1})ascomparedtoLocalcultivar(11.2siliqua^{-1}).

RanaandPachauri(2001)quotedthatthecv.TERI(OE)R15exhibitedsignificantlyhighernumberofseeds(18.0siliqua^{-1})ascomparedtocv.Bio902(13.7siliqua^{-1}).Singh *etal*.(2002)reportedthatcv.Laxmirecordedsignificantlyhighernumberofseeds(13siliqua^{-1})overcv.BSH1(11siliqua^{-1}).

Kumar*et al.* (2008)reported thatthenumberofseedssiliqua^{-1}in*Brassica*species werefoundsignificantlygreaterin*B.campestris*cv.NDYS-2(24)ascomparedto*B.napus*cv.Hyola-401(21),*B.napus*cv.GSL-1(14),*B.carinata*cv.Kiran(12)and*B.juncea*cv.Kranti(11),*B.juncea*cv.Urvarshi(11).Afroz*etal*.(2011)conductedafieldexperimentandobservedthatsignificantlyhighernumberofeffectiveseedssiliqua^{-1}werefoundincv.BARISarisha-6(20.6)ascomparedtocv.BARISarisha-9(13.5).Kumari*etal*.(2012)observedthathybridDMH-1recordedsignificantlyhighernumberofseeds(13.8siliqua^{-1})overhybridNRCHB-506 (13.6siliqua^{-1})andcv.Kranti(11.7siliqua^{-1}).

2.1.6 1000-seedweight

MondalandWahab(2001)foundthatweightof1000seedsofrapeseedandmustardvariedfrom variety tovarietyandspeciestospecies.Theyfoundthousandseedweight2.50-2.65g incaseofimprovedTori-7(*B.campestris*)and1.50-1.80g incaseofRai5(*B.napus*).

Yeasmin(2013)studiedthatthesignificantlyhighestyieldwasshowedbyBARISarisha-9(1448.20kgha^{-1}).Thesignificantly lowestyieldwaswithBARISharisa–15(1270.10 kgha^{-1})

Karim*etal*.(2000)reportedthatthevarietiesshowedsignificantdifferenceinweightofthousandseeds.Theyfoundhigherweightof1000seedinJ-4008(3.50g),J-3023(3.43g), J. -3018 (3.42g).

Akhter(2005)reportedthatthehighestweightof1000seeds(3.8g)wasrecordedfromBARIsarisha-7withharvesting thecropat90days.The lowest1000seedweight(2.63 g)wasrecordedfromBARIsarisha-10withharvestingat100days,whichwassimilarwiththesamevarietyharvestingat90and110days.

Sharma(1992)observedthat1000-seedsweightwassignificantlyhigherincv.PusaBold(6.31g)overcv.Varuna(5.26g).Yadav*et al*.(1994)quotedthat1000-seedweightrecordedhigherincv.Rohini(4.9g)comparedtocv.Vaibhav(4.6g).Tyagi*etal*.(1995)revealedthatcv.RH-30exhibitedsignificantlyhigher1000-seedsweight

(6.5g)followedbycv.Varuna(5.6g)andLaxmi(5.3g).Sharma*etal*.(1997)concludedthat1000-seedsweightrecordedsignificantlyhigherincv.RH30(6.66g)overcv.RH-819 (4.70g).RanaandPachauri(2001)suggested thatcv.Bio 902recordedhigher1000-seedsweight(3.16g)comparedtocv.TERI(OE)R15(2.18g).Singh*etal*.(2001)observedthatthecv.PusaBoldrecordedhigher1000-seedsweight(4.48g)ascomparedtolocalcultivar(3.55g).Similarly,Singh*etal*.(2002)recordedsignificantlyhigher1000-seedsweightincv.RH30(6.2g)over cv.Varuna(5.6g).

Kumar*etal*.(2008)reportedthat1000-seedsweightin*Brassica*specieswerefoundsignificantlygreaterin*B.juncea*cv.Urvarshi(4.57g)ascomparedto*B.carinata*cv.Karan(4.43g),*B.juncea*cv.Kranti(3.88g),*B.campestris*cv.NDYS-2(3.78g).*B.napus*cv.Hyola-401(3.36g)and*B.napus*cv.GSL-1(2.91g).Afroz*etal*.(2011)observedsignificantlyhigher1000-seedsweightincv.BARISarisha-9(2.76g)ascomparedtocv.BARISarisha-6(2.68g).Kumari*etal*.(2012)revealedthathybridDMH-1recordedsignificantlyhigher1000-seedsweight(4.11g)overhybridNRCHB-506 (3.82 g)and cv.Kranti(3.52 g)

2.1.7Seedyield

Yadav*etal*.(2018)conductedduringrabiseasonof2014onthetopicentitled“Effectofplanting geometryongrowthandyieldofmustard[*Brassicajuncea*(L.)]Varieties”insandyloamsoilof N.D.UniversityofAgricultureandTechnology,Kumarganj,Faizabad(UttarPradesh,India).Theexperimentalcomprisedofthreeplantinggeometryviz.,40×15cm,40×20cm,40×25cmand threevarietiesviz.,Varuna,VardanSandNDR-8501.Resultsrevealedthatplantinggeometryof40×15cmproducedsignificantlyhigheryield.

Akhter(2005)conductedanexperimentattheAgronomyField,Sher-e-BanglaAgriculturalUniversity,Dhaka,fromNovember2004toFebruary2005toobservetheeffectofharvestingtimeonshattering,yieldandoilcontentofrapeseedandmustard.Thehighestseedyield(1.78tha^{-1})wasrecordedfromBARISarisha-7with100daysofharvestingthatwassimilar(1.57tha^{-1})withBARISarisha-11harvestedon110days.Thelowestyield(1.04tha^{-1})wasshownbyBARISarisha-8thatharvestedearlier.

Rahman(2002)statedthatyieldvariationexistedamongthevarietieswhereasthehighestyield wasobservedinBARISarisha-7,BARISarisha-8andBARISarisha-11(2.00-2.50tha^{-1})andthelowestyieldinvarietyTori-7(0.95-1.10tha^{-1}).

IslamandMahfuza(2012)conductedanexperimentattheresearchfieldofAgronomyDivision, BARI,Joydebpur,Gazipurduringrabiseasonof2010-2011.BARISarisha-11producedthehighestseedyield(1472kgha^{-1})whileBARISarisha-14thelowest(1252 kg ha^{-1}).The highestseedyieldwasrecordedatmaturitystage (1480kg ha^{-1})anddecreasedtowardsgreensiliquestage.

Mamun*etal*.(2014)conductedanexperimentandtheyindicatedtheresultthatvariety,plantdensityandtheirinteractionhadsignificanteffectonseedyield.Meanscomparisonshowedthatthe most(1.35tha^{-1})andtheleastseedyield(0.92tha^{-1})werebelongedtotheplotshavingBARISarisha-13andBARISarisha-15,respectively.

Mendham*et al.*(1990) showed that seedyield was variabledueto varietaldifferenceinspeciesof*B.napus*.SimilarfindingswerenoticedbyChayandThurling(1989),andSharaanandGowad (1986).

Afroz*etal*. (2011)conductedanexperimentatthe AgronomyField,BangladeshAgriculturalUniversity,Mymensingh duringthe periodfromNovember2007toMarch2008tostudythe effect ofsowingdate and seedrateon theyieldandyield componentsoftwomustardvarieties.Thehighestseedyield(1.53tha^{-1})wasrecordedin10Novembersowingandthelowestonewasachievedin30Novembersowing.Seedratehadalsosignificanteffectonplantheight,branchesplant^{-1},podsplant^{-1},effectivepodsplant^{-1},podlength,numberofseedspod^{-1}andseed yield.

2.2Saltstressinrelationtogrowth,yield andyieldattributes

SharmaandSingh(1993)conductedafieldexperimenton*Brassicajuncea*andobservedthatoneirrigationattherossettestagegavesignificantlygreaterrelativegrowthrate,branchesandpods/plantandseedandstrawyieldscomparedwithoneirrigationatpodformationstageandunirrigatedtreatments.

Ashraf*etal.*(2002) conducteda fieldexperimenton*Brassicajuncea*andobservedthatcultivarsSheiralle,Peelaraya,Chakwaliraya andRL-18producedsignificantlygreater plantheight,highernumberofpodsonthemainbranchandyieldperplotthanothercultivarsund erallsalinitytreatments.

KumarandRathore(2002)revealedthattheseedyield61.3%andtestweight22.6%reduceat10. 5dSm^{-1}salinitylevel.

Verma*etal*.(2003)conductedafieldexperimenttostudytheyieldandyieldcontributingcharact ersofmustardcultivarsPusaBold,T-59,PCR-7,Kranti,Bio-902andRS-30underdifferentsalinitylevel(0.25,2.50,5.00,7.50and10.00dSm^{-1})ofirrigationwater.ThehighestseedyieldwasrecordedinKranti,T-59showedthehighestmeansalinityindexandhighelectricalconductivityvalueand50%yieldr eduction.

Das*etal*.(2004)reportedthatathighersalinitylevel,germinationpercentage,plantheightandse edyieldperplantdecreased.Daystogermination,daystofloweringanddaystomaturityalsodec reased.Itwasfurtherobservedthattheeffectofsalinitywasmoreprominentuptothefloweringst age,butgraduallydecreased.

HumariaandRafiqAhmad(2004)observedthatplantheight,numberof leaves,numberofbranchesperplant,siliquaweight,numberandweightofseedperplantdecrea sedbyincreasingsalinitylevelofirrigationwater.

Muhammad*etal*.(2004)observedthatplantheightandflowerinitiationweresignificantlydecr easedwithincreaseinsaltconcentration.

Ahuja*et al*. (1989) reportedthatoilcontentofmatureseeds decreasedsteadilywith theincreaseinthelevelsofsalinityinallthe*Brassica*species.

Hasni*etal*.(1995)reportedthatthesalinityincreasedNa,Cl,KandMgcontentsbutdecreasedCa andPcontents.

Mishra*etal*.(1995)concludedpotexperimenton*B.juncea*andobservedthatproteincontentins eeddecreasedbysalinity.

Porcelli*etal*. (1995)reportedthatassoilsodium absorptionratioincreasedK:Narationin*B.napus*plantsdecreasedandplantscouldnotmaintai ntheircalciumconcentrationathighsalinity.

Gundalia*etal*.(1995)observedthattheplantheight,strawandgrainyieldaswellasNaandKcont entandNa/Kratiowereseverelyaffectedbysalinitylevels.LowNacontentsandNa/Kratiowere associatedwithhighsalinitytolerance.

Thakral*etal*.(1998)evaluatedthatK:Naratio decreased andprotein content increasedundersaltstresscomparedtocontrolsin*B.juncea*.

Garg*etal*.(1999)observedthatgenotypessensitivetosaltstresshadhigherconcentrationsofNa andlowconcentrationKin Indianmustard.

Kwon*etal*. (1999)concludedthatsalinitytolerancewasassociatedwithNa^+exclusion,theselectiveuptake ofK^+overNa^+andthemaintenanceofhigherK:Naratiosingrowingleavesandstems.

JamilandRha,(2013)conductedanexperimenttoseedgerminationandearly seedlinggrowth,photosynthesisandproteinactivityofmustardwereinvestigatedundersaltstr ess.TheNaClconcentrationsinHoaglandsolutionwere0(control),50,100and150mM.Percen tageofseedgermination,germinationrate,length,andfreshweightoftheseedlingsdecreasedsi gnificantlyundersalinity.Saltconcentrationssignificantlyreducedleafareaandnumberofleav eswhilesalinityshowedanon- significanteffectonleafwatercontent.Chlorophyllcontentenhancedconsiderablywiththeinc reasingNaClconcentration.Incontrast,non- photochemicalquenchingcoefficientincreasedsignificantlywithincreasingNaClconcentrat ion.NetCO_2assimilation,stomatalconductance,transpirationrate,andintrinsicwater- useefficiencydecreasedremarkablywithincreasingNaClconcentrationwhilewateruseeffici encyincreasedat50mMNaClbutthenreduced.Therewasanincreaseintheconcentrationoftot alproteincontentwiththecorrespondingincreaseinNaCllevelupto100mM.

Sharma*etal*.(2013)carriedoutinordertotesttheeffectofsalinityongerminationtraitsandseedli nggrowthin25Indianmustard(*Brassicajuncea*)genotypes.Theresults revealed statisticallysignificanteffects ofsalinity(EC12dSm^{-1})on germinationtraitsaswellasgrowthcharacteristicsofseedlings.Genotypicresponsesweresigni ficantforgerminationpercentage,speedofgermination,germinationindex,andrelativegermi nationrate,whichwereallgenerallyregardedbysaltstress. However,themeangerminationtimeincreasedundersalineconditions.Declineinroot/shootra tioanddrymatterofseedlingswasobservedundersalinity.Sixmustardgenotypeswere characterizedbysignificantlyhighertoleranceindexforrootgrowth.Significantcorrelationexistedbetweentoleranceindexandshootlength,drymatterandalsosalttoleranceefficiency.Basedontheresults,thegenotypesRB-10andPR-2004-2wereidentifiedashighlytolerantandNDR-05-01,PBR-300,RK-05-01,NPJ-93,PDR-1188andRGN-145asmoderatelytoleranttosaltstress.

Uddin*etal.*(2005)carriedoutattheBangladeshInstituteofNuclearAgriculture(BINA),Mymensingh,toevaluatesalinity toleranceofmustard/rapeseedcultivarsviz.,Binasarisha-5,Binasarisha-6andSafalduringOctober2003toJanuary2004.Salinitylevelswere4,6,8and10dSm^{-1}withacontrol(0.43dSm^{-1}).Plantheight,leafarea,totaldrymatter,numberofsiliquaperplant,numberofseedspersiliqua,1000-seedweightandharvestindexweredecreasedwiththeincreaseofsalinitycomparedtocontrol. Na^+contentinleavesincreasedbutK^+contentdecreasedwiththeincreaseofsalinity.Binasarisha-6showedthehighestnumberofsiliqua,seedyieldperplant,harvestindex,higherNa^+andmediumK^+contentinleavesandBinasarisha-5showedthehighestnumberofseedspersiliqua,1000-seedweight,lowerNa^+andhigherK^+contentinleavesunderthesalinitylevels.Ontheotherhand,Safalshowedthelowestnumberof seedspersiliqua,seedyield,higherNa^+andthelowestK^+contentinleaves.Binasarisha-6andBinasarisha-5werefoundtobetolerantandSafalwaslesstoleranttoimposedsalinity.

Hossain*etal*.(2020)conductedandexperimenttoinvestigatetheidentificationofsalttolerantmustardgenotypesandbetterunderstandingthemechanismofsalinitytolerance.Saltstressessignificantlyreducedrelative watercontent(RWC),chlorophyll(Chl)content,K^+andK^+/Na^+ratio,photosyntheticrate(PN),transpirationrate(Tr),stomatalconductance(gs),intercellularCO_2concentration(Ci) andincreasedthelevelsofproline(Pro)andlipidperoxidation(MDA)contents,Na^+,superoxideandhydrogenperoxide(H_2O_2)inbothtolerantandsensitivemustardgenotypes.Thetolerantgenotypesmaintainedhigherproteinandlowerlipidper-oxidationcontentthanthesaltsensitivegenotypesunderstresscondition.The activities ofsuperoxidedismutase(SOD),catalyst(CAT),peroxidase(POD),glutathioneperoxidase(GPX),monodehydroascorbatereductase(MDHAR)anddehydroascorbatereductase(DHAR) wereincreasedwithincreasingsalinityinsalttolerantgenotypes, BJ-1603,BARISarisha-

11andBARISarisha-

16,buttheactivitieswereunchangedinsaltsensitivegenotype,BARISarisha-

14.Besides,theincrementofascorbateperoxidase(APX) activitywashigherinsaltsensitivegenotypeascomparedtotolerantones.However,theactivitiesofglutathionereductase(GR)andglutathioneS-transferase(GST)wereincreasedsharplyatstressconditionsintolerantgenotypesascomparedtosensitivegenotype.Higheraccumulationofproteinalongwithimprovedphysiologicalandbiochemicalparametersaswellasreducedoxidativedamagebyup-regulationofantioxidantdefensesystemarethemechanismsofsalttoleranceinselectedmustardgenotypes,BJ-1603andBARISarisha-16.

Kumar*etal*.(2005)carriedoutwith*Brassicajuncea*cv.RH-30tostudytheeffectofsalinityonvariousphysiologicalcharacteristicsanduseofphosphaticandsulphurfertilizertomitigatethesalinityeffects.Undersalineirrigation,plantheightanddryweightofleavesdeclinedovernon-salinecontrol.Fertilizerappliedincombinedform(60kgPha^{-1}+30kgSha^{-1})exhibitedmaximumalleviationoftheadverseeffectsofsalinity.Saltstressshowedsignificantreductioninplantwaterstatusintermsofrelativewatercontent,waterpotentialandosmoticpotential.Applicationofbothphosphorusandsulphurimprovedthewaterstatusbutthehigherlevelofsulphur(30kgSha^{-1})showedpoorresponse.Yieldanditsattributesadversely affectedbysalinity.Bothphosphorusandsulphurimprovedtheyieldundersalinityuptosomeextenthoweverthecombinationoftwofertilizersprovedbetterinrevivingtheyieldcharacters.

Chapter 3

Materials and Methods

ChapterIIIMATERIALS ANDMETHODS

Theexperimentwasundertakenin November,2019toFebruary2020atthenethouseofAgroEnvironmentalChemistryLaboratoryofAgriculturalChemistryDepartment,Sher-e-BanglaAgriculturalUniversity,Dhaka,Bangladeshtostudytheeffectsofsaltstressongermination,growth,yieldandionscontentofmustard.Thematerialsandmethodsfollowedduringentireperiodoftheexperimentaredescribedinthischapter.

3.1 Siteoftheexperiment

Itislocatedat90^{0}22$'$Elongitudeand23°4l$'$Nlatitudeatanaltitudeof8.6metersabovethesealevel.ThelandbelongstoAgro-ecologicalzoneofModhupurTract,AEZ-28whichisshowninAppendixI

3.2 Materials

3.2.1 Seed

ThehighyieldingvarietiesofmustardareSAUSarisha-1andBARISarisha9developedbySher-e-BanglaAgriculturalUniversity,DhakaandtheBangladeshAgriculturalResearchInstitute(BARI),Joydebpur,Gazipur,respectivelyandwereusedasanexperimentalplantingmaterial.TheseedswerecollectedfromSher-e-BanglaAgriculturalUniversity(SAU),DhakaandBangladeshAgriculturalResearchInstitute(BARI),Joydebpur,Gazipur.

3.2.2 Fertilizers

TherecommendeddosesofureaasasourceofNitrogen(N),Triplesuperphosphate(TSP)asasourceofphosphorus(P),MuriateofPotash(MoP)asasourceofPotash(K),GypsumasasourceofSulpher(S)andBoricacidasasourceofBoron(B)wereaddedtothesoilofexperimentalpots.

3.3 Experimentaldesign

TheexperimentwassetinCompletelyRandomizedDesign**(**CRD)havingtwofactorswiththreereplications.

Factor1: Varieties-2(V_1-SAUSarisha-1and V_2-

BARISarisha9)Factor2:Salinitylevels-5(0,3,6,9 and12dSm^{-1})

Replication:3

Thetwovarieties incombinationwithfivesalinitylevelswererandomlyassignedto30experimentalpots.

3.4 Salinitytreatments

Thefivesalinitytreatmentswere0 (control),3,6,9and12dSm^{-1}.Thedifferentsalinitylevelswereobtainedbydissolvingcommercialsalt(NaCl)attherateof640mgperliterdistilledwaterfor1dSm^{-1}salinitylevel.Thecontrol*i.e.*0wasmaintainedusingdistilledwateronly.

3.5 Collectionandpreparationofsoil

ThesoilsoftheexperimentwerecollectedfromSher-e-BanglaAgriculturalUniversity(SAU)farm.Thesoilwasnon-calcariousRedBrownTerracesoilwithloamytexturebelongingtotheAEZ28 (Madhupur Tract).The collectedsoil waspulverizedand inertmaterials,visibleinsectpestandplantpropaguleswereremoved.Thesoilwasdriedinthesun,crushed carefullyandthoroughlymixed.

3.6 Potpreparation

Anamountof8kgsoilwastakenineachpot.Therequirednumberofplasticpotshaving24cmtop,18cmbottomdiameterand22cmdepthwerecollectedfromthelocalmarketandcleanedbeforeuse.Therewerealtogether30potscomprising5salinitylevelstotwomustardcultivarswith3replications.FertilizerandNaClsaltapplication tosoilwasdone beforefillingthepots. Waterwasaddedtothepottobringthesoiluptosaturation.

3.7 Sowing ofseeds

Thechemicalfertilizers*i.e.*,25gUrea,19gTripleSupperPhosphate(TSP),19gMuriateofPotash(MoP),16gGypsumand5gBoricacidwereaddedforN,P,K,SandBineachpot.ThewholeamountofTSP,MoP,Gypsum,Boricacidand1/3rdofureawereappliedbeforethefinalpreparationofthepots.Todevelop0,3,6,9and12dSm^{-1}salinity0g,1.92g,3.84g,5.76gand7.68gNaCldissolvingperliterwaterwereappliedtoeveryplot.Thereafterthepotscontainingsoilweremoistenedwithwater.

Mustardseedsweresowingon08November2019inpots.Theelectricconductivity(EC)ofeach potwasmeasuredeverydaywithanECmeterandnecessaryadjustmentsweremadebyaddingw ater.Theremaining2/3[rd]ureaweretopdressedattwoequaldivisionsafter20and 45 days ofseed sowing.

3.8 Irrigation

Watergivenwhennecessarytomaintainthesoilmoistureatzoecondition.

3.9 Cropsamplinganddatacollection

Cropsamplinganddatacollectionweredonebeforeandafterharvestingtheplants

3.10 Harvestingandthreshing

Toanalyzetheyieldandyieldcontributingcharacters,cropwasharvestedwhen80%ofthesiliqu aeinterminalracemeturnedcreamy whiteincolor.Harvesting wasstartedonFebruary18andcompletedonFebruary21,2020.Foryieldcalculationperpotwa sselectedforharvesting.Theharvestedcropsweretiedintobundlesandcarriedtothethreshingfl oor.Thecropbundlesweresundriedbyspreadingthoseonthethreshingfloor.Theseedswerese paratedfromtheplantsbybeatingthebundleswithbamboosticks.

3.11 Dryingandweighing

Seedsandstovesthuscollectedweredriedinthesunforacoupleofdays.Driedseedsandstovesof eachpotwereweighed.

3.12 Datacollection

Somedatawerecollectedaftergrowingseed,somedatawerecollectedatharvestingstageandfin aldatacollectionwasdoneafterharvesting.Thesampleplantswereuprootedpriortoharvestand driedproperly inthesun.Theseedyieldandstovesyieldperpotwererecordedaftercleaninganddryingthosepr operlyinthesun.Datawerecollectedonthefollowingparameters:

3.12.1 Germinationpercentage

Germinationpercentagewasdeterminedbythefollowingformula:Germinationperc entage(G%)=n/N×100,

Wherenisthenumberofgerminatedseedatthefourthday;Nisthen umberoftotalseeds

3.12.2 Populationdensity

The dataonpopulationdensitywerecollectedfromeachpot.The numberwascountedpopulationofmustard.

3.12.3 Plantheight

Plantheightincmwasmeasuredatharvest.Theheightoftheplantwasmeasuredbyscaleconsideringthedistancefromthesoilsurfacetothetipoftherandomlytenselectedplantsandmeanvalue wascalculatedforeachtreatment.

3.12.4 Branchesplant^{-1}

Branchesplant^{-1}wascountedatharvestofmustardplants.Meanvalueofdatawerecalculatedandrecorded.

3.12.5 Totaldrymatter

Totaldrymaterofplantat harvestwas calculatedbyaggregatingthedrymatterweightofleaves,stems,roots,siliquaecoverandotherimmaturereproductiveparts.

3.12.6 siliquaeplant^{-1}

Numberoftotalsiliquae**Cropsamplinganddatacollection**oftenplantsfromeachunitplotwasnotedandthemeannumberwasexpressedasperplantbasis.

3.12.7 Lengthofsiliqua

Thelengthof10siliquaefromeachsamplewascollectedrandomlyandthemeannumberwasexpressedaspersiliquabasis(cm).

3.12.8 Numberof seedssiliqua^{-1}

Numberoftotalseedsoftenrandomlysampledsiliquaefromeachplotwasnotedandthemeannumberwasexpressedaspersiliquabasis.

3.12.9 SeedYield

Afterthreshing,cleaninganddrying,totalseedfromharvestedpotswererecordedasgm/pots.

3.13 Analysisofdifferentchemicalconstituentsof mustard plantsamples

i)Grinding: Oven-driedofplantsampleswereGroundinaWileyHammerMill,passedthrough40meshscreens,mixedwelland storedinplasticvials.

ii.DigestionofplantsampleswithsulphuricacidforN

Forthedeterminationofnitrogenanamountof0.5govendry,groundsampleweretakeninamicrokjeldahlflask.1gcatalystmixture(K_2SO_4:$CuSO_4$5H_2O:Seinthe ratio of100:10: 1), and10mLconc. H_2SO_4wereadded. The flasks wereheatedat 160^0Candadded2mLH_2O_2thenheatingwascontinuedat360^0Cuntilthedigestsbecomecleara ndcolorless.Aftercooling,thecontentwastakenintoa100mLvolumetricflaskandthevolume wasmadeuptothemarkwithde-ionizedwater.Areagentblankwaspreparedinasimilarmanner.Nitrogeninthedigestwasestim atedbydistillingthedigestwith10NNaOHfollowedbytitrationofthedistillatetrappedin H_3BO_3indicatorsolutionwith0.01NH_2SO_4.

TheamountofNwascalculatedusingthefollowingformula:

%N=(T-B)×N ×0.014×100/ S

Where,

T=Sampletitration(ml)valueofstandardH_2SO_4B=B

lanktitration(ml)valueofstandardH_2SO_4N=Strengt

hofH_2SO_4

S=Sampleweightin gram

iii)DeterminationofNaandK

1govendry,groundsampleofmustardplantwasanalyzedtodeterminetheamountofNaandKco ntentstherein.NaandKcontentsanalyseswereconductedonDi-acidmixture(Conc.HNO_3:60%$HClO_4$=2:1)throughwetoxidationmethod.Thenthecontents ofNaandKweremeasuredbyFlamePhotometer(JENWAY,PFP7).

3.14 Statisticalanalysis

ThecollecteddatawereanalyzedstatisticallyfollowingCRDdesignbyMSTAT-Ccomputerpackageprogramsdevelopedby Gomez,K.A.andGomez,A.A.(1986).Thetreatm entmeanswerecomparedbyDuncan'sMultipleRangeTest(DMRT)andregressionanalysisw ereperformed asandwherenecessary.

Chapter 4

Results and Discussion

CHAPTERIVRESULTS

ANDDISCUSSION

Twomustardvarieties(SAUSarisha-1andBARISarisha9)havebeenselectedforpresentexperimentinordertoobservetheeffectsofsaltstressongermination,growth,yieldandionscontentofmustard.Thelevelsofsalinity0,3,6,9and12dS m^{-1}werechoseninordertogetmorefrequencyforhavingapreciseeffectofsalinitylevels.

4.1 Germinationpercentageofseeds

Therewassignificantdifferenceamongthevarietiesofmustardinthegerminationpercentageofseeds.Thegerminationpercentageofseeds(86.80%)wasfoundinvarietiesofmustardBARISarisha9(V_2)andthegerminationpercentageofseedling(80.93%)wasfoundinvarietiesofmustardSAUSarisha-1 (V_1)(Table1).

Therewassignificantvariationingerminationpercentageofseedsduetodifferentlevelsofsalinity.Themaximumgerminationpercentageofseedlings(91.67%)wasrecordedfrom0dSm^{-1}. Theminimumgerminationpercentageof seedlings(77.33%)was recorded12dSm^{-1}(Table1).Salinitypreventswaterimbibition,therebyinhibitingtheinitialprocessofseedgermination(Othman2005).

Thecombinedeffectofdifferentvarietiesandlevelsofsalinityongerminationpercentageofseedlingswasfoundtobesignificant.DatainTable1Showsthat,thegerminationpercentageofseedswasmaximum(96.005)inBARISarisha9with0dSm^{-1},whileitwasminimum(71.33%)inSAUSarisha-1with12dSm^{-1} levelsofsalinity.

4.2 Populationdensity

Significantvariationwasobservedonpopulationdensitythroughoutthegrowing periodfordifferentvarietaltreatments(Table1).Thehighestplantpopulation(14.67)wasobservedinBARISarisha 9.The lowestnumber of plantpopulation(12) wasobservedinSAUSarisha-1.

Therewas significant variation observed on population densityperpotdueto salinitylevels(Table1).Thehighestplantpopulation(19.17)wasrecordedat0dSm^{-1}anditgraduallydecreasedwithincreasingthesalinitylevelat12dSm^{-1}andlowestplantpopulation(6.45)wasobserved at 12dSm^{-1}.

Table1.Effectofmustardvarietiesanddifferentsalinitylevelswiththeirinteractionongerminationpercentageandplantpopulation ofmustard

Variety	Salinitylevels (dSm^{-1})	Germination%		Plantpopulationpot^{-1}	
Effectofvariety					
SAUSarisha-1		80.93		12.00	
BARISarisha9		86.80		14.67	
CV(%)		9.75		5.82	
Effectofsalinity					
	0	91.67	a	19.17	a
	3	86.33	ab	17.39	ab
	6	82.67	bc	14.00	bc
	9	81.33	bc	9.67	cd
	12	77.33	c	6.45	d
Levelofsignificance		*		*	
$LSD_{(0.05)}$		5.86		4.70	
CV(%)		9.75		5.82	
Interactioneffectofvarietyandsalinity					
SAUSarisha-1	0	87.33	ab	18.67	ab
	3	80.00	bc	16.67	abc
	6	86.00	ab	13.00	bcd
	9	80.00	bc	7.67	de
	12	71.33	c	4.00	e
BARISarisha9	0	96.00	a	19.67	a
	3	92.67	ab	18.11	ab
	6	79.33	bc	15.00	abc
	9	82.67	abc	11.67	cd
	12	83.33	abc	8.90	de
Levelofsignificance		*		*	
$LSD_{(0.05)}$		13.92		5.86	
CV(%)		9.75		5.82	

Inacolumn, means havingsimilarletter(s)arestatisticallyidenticalandthosehavingdissimilarletter(s)differsignificantlyasper0.05levelof probability

*5%levelofSignificance

Theinteractioneffectofvariety andsalinity onnumberofplantpopulationwasstatisticallysignificant(Table 1).Themaximumplantpopulation(19.67)wasfoundfrom BARISarisha9 with0dSm^{-1}levelsof salinityandminimumnumber of plantpopulation(4.00) fromSAUSarisha-1with12dSm^{-1} levelsofsalinity.

4.3 Plantheight

Plantheightwasinfluencedbyvariety.Thetallestplant(77.57cm)wasfoundinvarietiesSAUSarisha-1andtheshortest(61.19cm)plantwasinBARISarisha9(Appendix-IIfordata).Probablythegeneticmakeupofvarietieswasresponsibleforthevariationinplantheight. ThisconfirmsthereportsofBINA(1992),Shamsuddin*etal*.(1988)wasfoundthatplantheightdifferedduetovarietalvariation.AliandRahman(1988)andMondal*etal*.(1992)alsoobservedthatsignificantvariationinplantheightofdifferentvarietiesofrapesandmustard.

Theplantheightofthemustardwassignificantlyinfluencedbydifferent salinitylevels.Thehighestplantheight(76.13cm)wasobservedat0dSm^{-1}anditgraduallydecreasedwithincreasingthesalinitylevel(Figure2).Theshortestplant(60.54)was foundin12dSm^{-1}(Appendix-IIfordata).Salinitymightbeledtoosmoticinhibition,toxiceffectofionsandnutritionalimbalanceofelementsbyloweringdowntheuptakeofessentialnutrientelementsandfinallyculminatesindecreasedgrowth(Levitt,1992).TheresultsareinalsoinaccordancewiththefindingsofStrogonov(1964), Poljakoff-MayberandGale(1975),AshrafandRasul(1988).

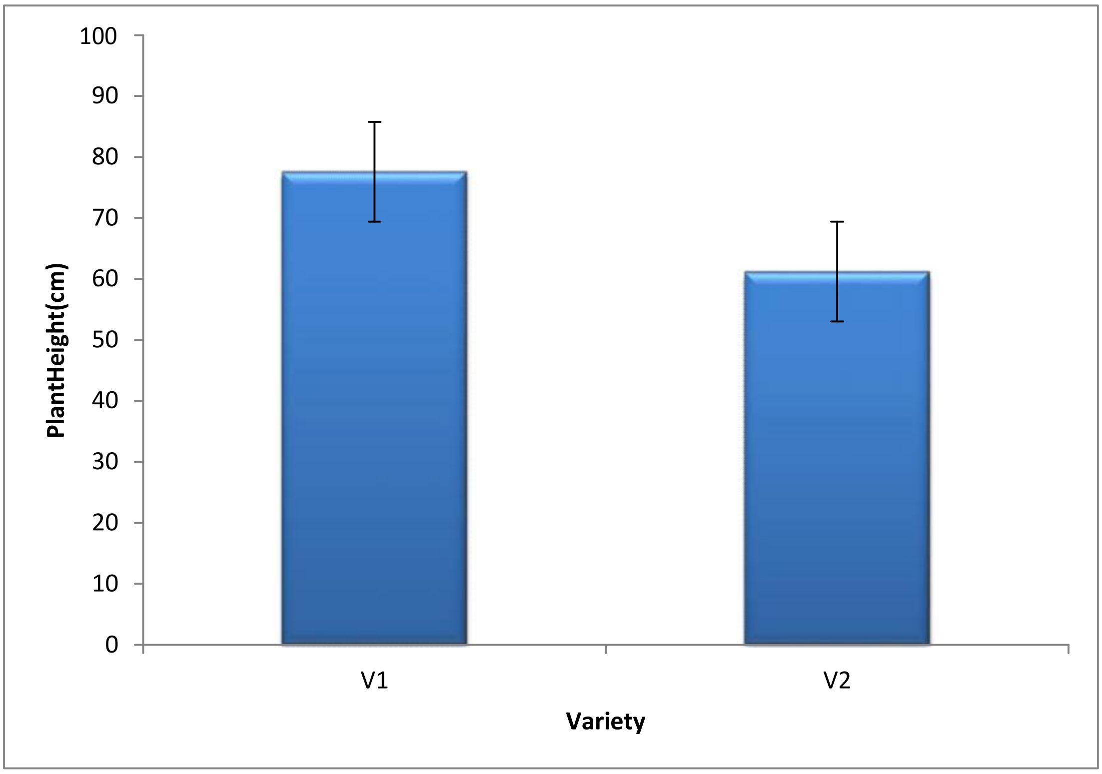

Figure1.**Effectof varietiesontheplantheightofmustard**

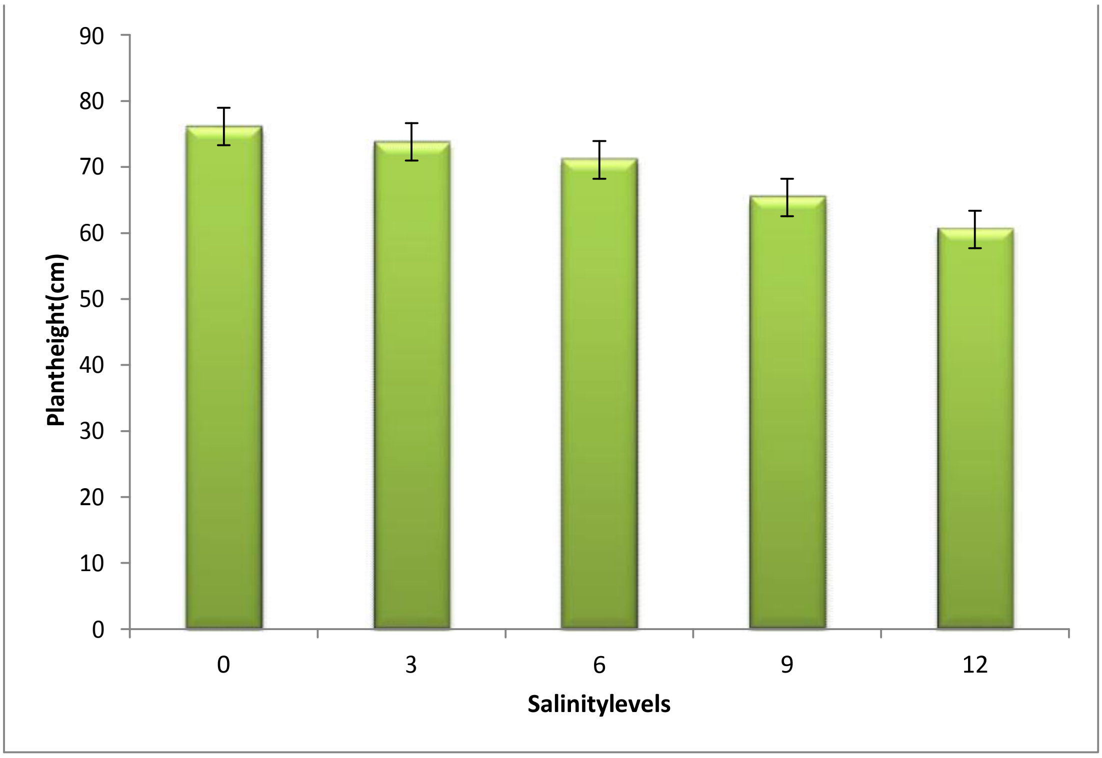

Figure2.**Effectofdifferentsalinitylevelsontheplantheightofmustard**

Incombinedeffectofvarietiesandsalinitylevelswassignificantlyinfluencedonplantheight.Theplantheightofdifferentmustardvarietiessignificantlydecreasedwithincreasingthesalinitylevels(Table2).Thehighestplantheight(85.60cm)wasfoundinSAUSarisha-1with0dSm^{-1}andthelowestplantheight(52.83cm)wasfoundinBARISarisha9with12dSm^{-1} levelsofsalinity.Reducedplantheightundersalinitymightbeduetoinhibitedcelldivisionandcellenlargement Javaid*etal.*(2002)reportedthatplantheightofmustardgenotypeswasdecreasedbyhigherlevelofsalinity.Choi*etal.*(2003)observedthattheplantheightdecreasedinthe0.5%salinewaterinthesoil.Khan*etal.*(1997)conductingapotexperimentwiththreemustardvarietiesreportedthatplant heightwasseriously decreasedbysalinity.Duringvegetativeperiod,thesalinity effectwasstuntingofplantgrowth,whereasleafwitheringwaslessapparent(Alam *etal*.,2001).

4.4Numberofbranchesplant^{-1}

Thenumberof branchplant^{-1}wasinfluenced byvariety. Varietaleffects ontheformation oftotalnumberofbranchesareshownin Figure3.BARISarisha9 achievedmaximum branch(1.98),whereastheminimumbranch(1.45)productionwasobservedinSAUSarisha-1(Appendix-IIfordata).Mamun*etal.*(2014)reportedthatBARISarisha-15performedwellintermsofbranches plant^{-1}(6.14).

Numberofbranchplant^{-1}wassignificantlyinfluencedby differentsalinitylevel(Figure4).Themaximumnumberofbranchplant^{-1}(3.78)wasproducedat0dSm^{-1}andtheminimumnumber ofbranchesplant^{-1}(0.22)wasproducedat12dSm^{-1}salinitylevels(Appendix-IIfordata).Thenumberofbranchesplant^{-1}graduallydecreasedwithincreasingthesalinitylevel.

Thecombinedeffectofvarietyanddifferentsalinitylevelswerestatisticallysignificantatharvest(Table2).Themaximumtotalnumberofbranchesplant^{-1}(3.78)wasfoundfromBARI Sarisha9at0dSm^{-1}andminimumtotalnumberofbranchesplant^{-1}(0.33)fromSAUSarisha-1at12dSm^{-1}salinitylevel.

Table2.Combinedeffectofmustardvarietiesanddifferentsalinitylevelsonplanth eightandnumberof branch andtotaldrymatterof mustard

Variety	Salinitylevels (dSm^{-1})	Plant height(cm)		Numberof branchperplant		Totaldrymatter (g)	
SAU Sarisha-1	0	85.60	a	3.75	a	18.67	ab
	3	82.25	b	2.11	bc	18.00	abc
	6	78.43	c	0.67	de	15.33	bcd
	9	73.33	d	0.67	de	13.33	bcd
	12	68.25	e	0.33	e	9.33	d
BARI Sarisha9	0	66.65	ef	3.78	a	24.00	a
	3	65.33	fg	2.78	ab	18.67	ab
	6	63.70	g	1.78	bc	17.33	abc
	9	57.42	h	1.11	cd	15.33	bcd
	12	52.83	i	0.44	de	11.33	cd
Levelofsignificance		*		*		*	
LSD(0.05)		2.07		1.07		6.70	
CV(%)		6.75		6.62		5.38	

Inacolumn, means havingsimilarletter(s)arestatisticallyidenticalandthose havingdissimilarletter(s)differsignificantlyasper0.05levelofprobability

*5%levelofSignificance

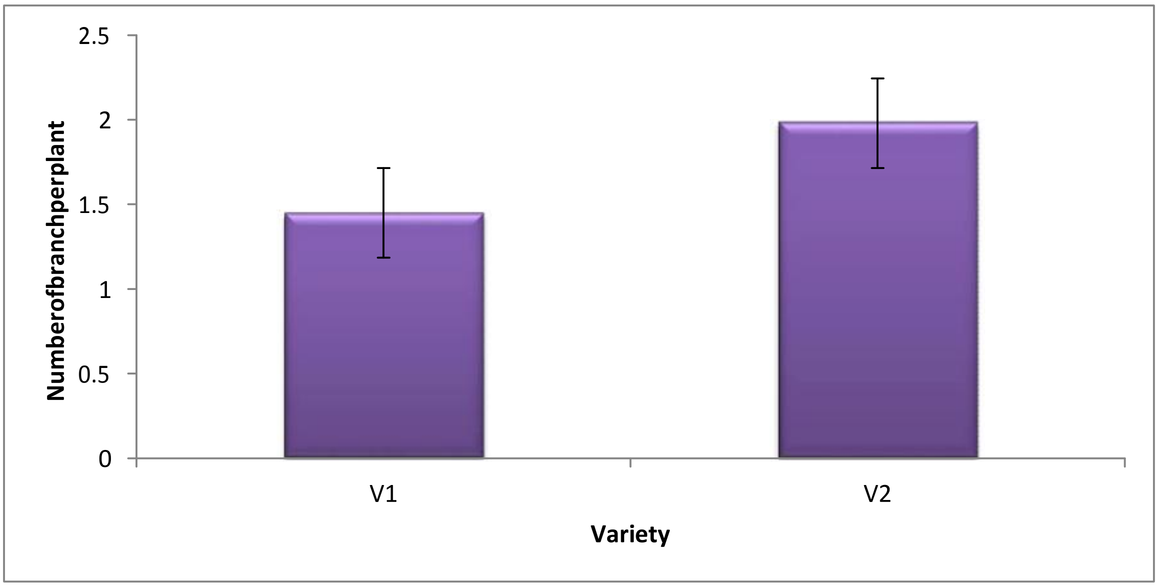

Figure3.Effectof varietiesonthenumberof branchesperplantof mustard

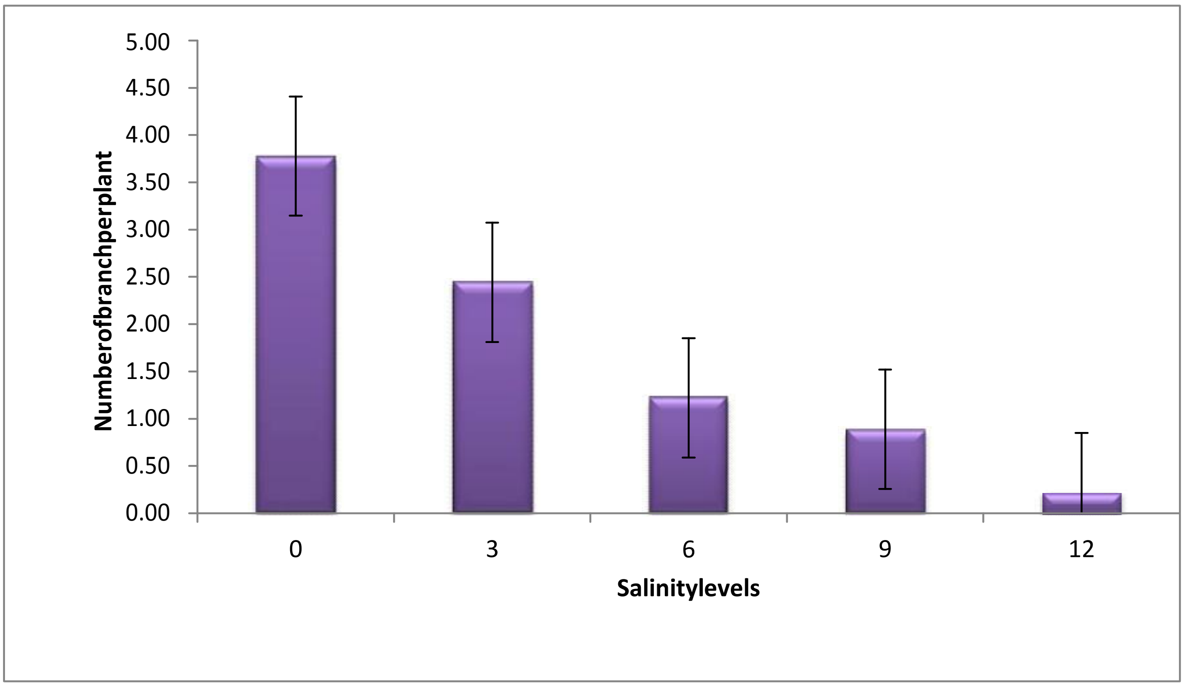

Figure4.Effectofdifferentsalinitylevelsonthe numberofbranchesofmustard

4.5 TotalDryMatterplant^{-1}

TotalDrymatter(g)productionwassignificantlyinfluencedbyvarietythroughoutthelifecycle(Fig.5).Themaximumtotaldrymatter(17.33g)wasgainedatBARISarisha9andminimumdrymatterweight(14.93g)wasrecordedatSAUSarisha-1(Appendix-IIfordata).

Theresultpresentedinfigure6showedthattotaldrymaterproductionsignificantlydecreasedwithincreasingthesalinitylevels.Thehighesttotaldrymatter(21.33gplant^{-1})wasfoundat0dSm^{-1}andthelowest(10.33gplant^{-1})wasat12dSm^{-1}levelofsoilsalinity(Appendix-IIfordata).Drymatterproductioninplantsatlowwaterpotentialinducedbysalinitystressisexpectedtodecreasebecauseofsuppressingthenetassimilationrates(Levitt,1992).

TotalDrymatter(g)wassignificantlyinfluencedbytheinteractionofvarietyandsalinitylevels(Table2).Themaximumtotaldrymatter(24.00g)accumulationwasrecordedatthecombinationofBARISarisha9at0dSm^{-1}levelofsoilsalinityandminimumdrymatter(9.33g)accumulationwasobservedatthecombinationofSAUSarisha-1at12dSm^{-1}levelofsoilsalinity.

4.6 Siliquaeplant^{-1}

Therewasasignificantdifferenceamongthevarietyinthenumberofsiliquaeperplant(Table3).Themaximumnumberofsiliqueperplant (26.62)was producedinBARISarisha9andtheminimumnumberofsiliquaeperplant(24.18)wasproducedinSAUSarisha-1.Hossain*etal*.(1996)andJahanandZakaria(1997)alsostatedthattherewasmarkedstatisticalvariationinnumberofsiliquaeplant^{-1}.

Numberofsiliquaeperplantisoneofthemostimportantyieldcontributingcharactersinmustard.Theeffectofsalinity showedsignificantly variationinthenumberofsiliquaeperplant(Table3).Themaximumnumberofsiliquaeperplant(35.55)wasproducedby0dSm^{-1}levelofsoilsalinityand12dSm^{-1}levelofsoilsalinitytreatmentproducedtheminimumnumberofsiliquaeperplant(18.44).

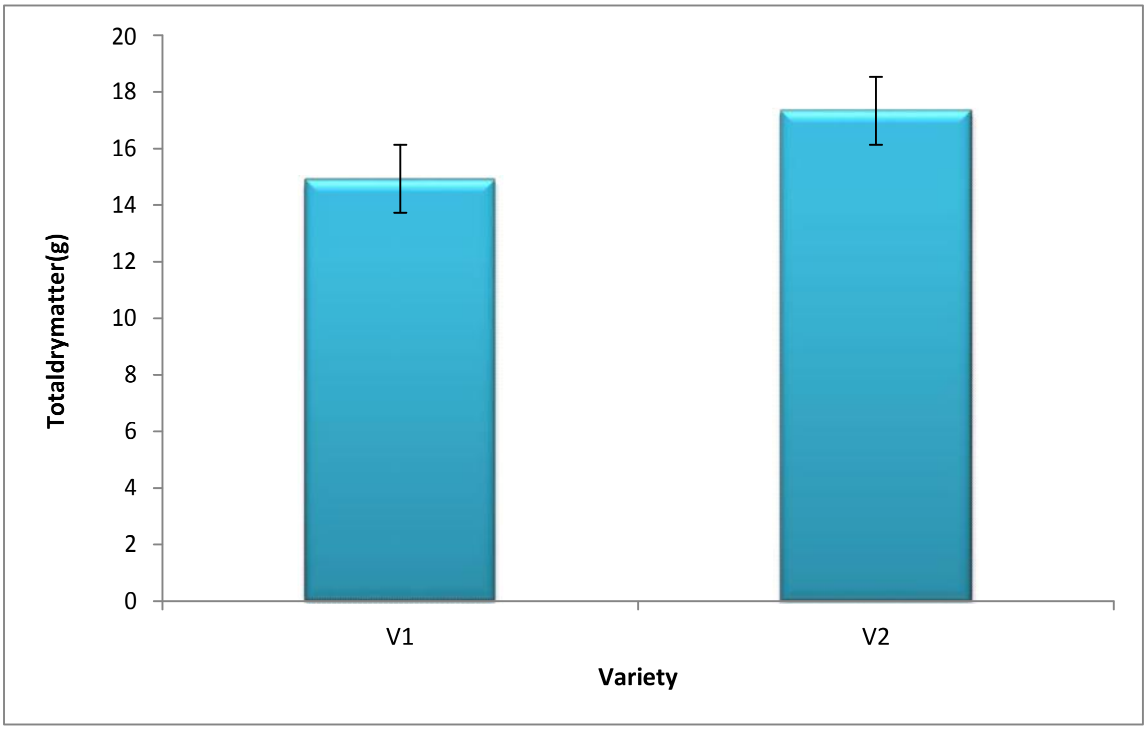

Figure5.Effectof varietiesonthenumberoftotaldrymatterof mustard

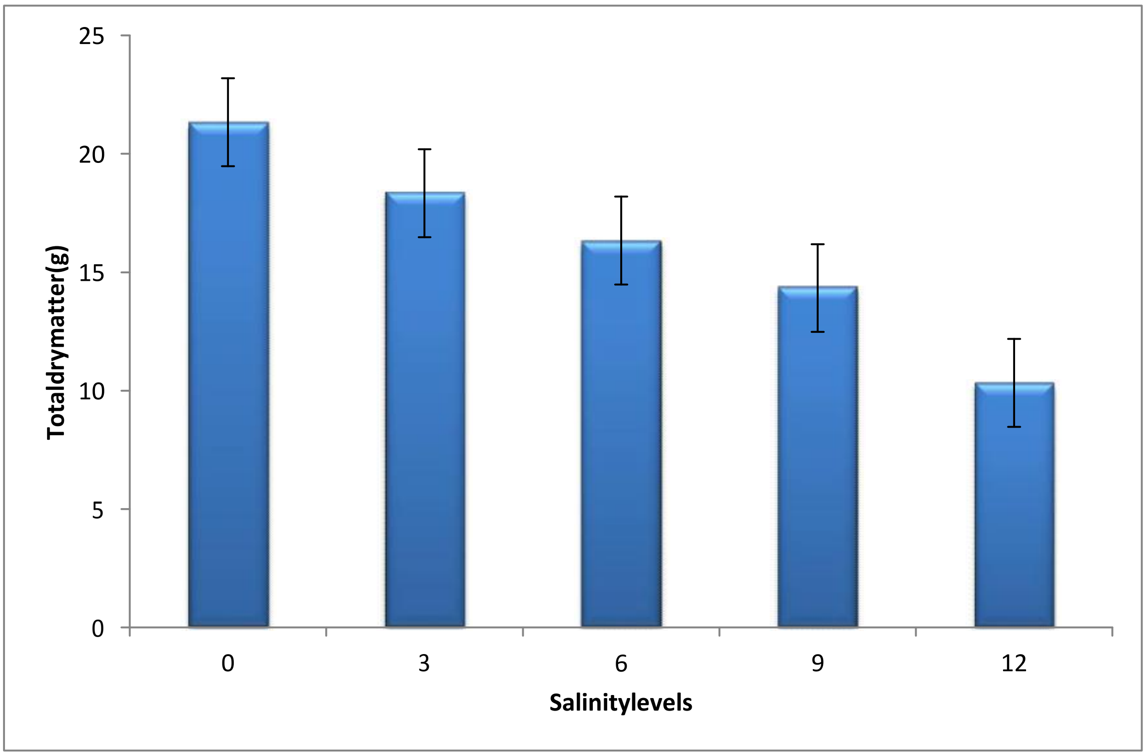

Figure6.Effectofdifferentsalinitylevelsonthetotaldry matterof mustard

Table3.Effectofmustardvarietiesanddifferentsalinitylevelswithinteractiononyieldan dyieldcontributingcharacters ofmustard

Variety	Salinitylevels (dSm^{-1})	Siliqua plant^{-1}		Lengthof siliquae (cm)		Seed siliqua^{-1}		Seedyield (g)	
Effectofvariety									
SAUSarisha-1		24.18		3.51		15.58		3.84	
BARISarisha9		26.62		3.94		16.07		4.69	
CV(%)		5.27		6.72		5.24		5.82	
Effectofsalinity									
	0	35.55	a	4.21	a	20.83	a	6.13	a
	3	29.22	ab	3.85	ab	17.06	b	5.56	ab
	6	24.18	bc	3.71	ab	15.50	bc	4.48	bc
	9	19.61	c	3.53	b	13.39	cd	3.09	cd
	12	18.44	c	3.30	b	12.34	d	2.06	d
Levelofsignificance		*		*		*		*	
LSD$_{(0.05)}$		7.58		0.61		2.99		1.51	
CV(%)		5.27		6.72		5.24		5.82	
Interactioneffectofvarietyandsalinity									
SAU Sarisha-1	0	35.38	a	4.04	abc	20.45	a	5.97	ab
	3	28.70	b	3.62	cde	16.11	bc	5.33	abc
	6	23.59	bc	3.55	de	15.67	bcd	4.16	bcd
	9	18.33	cd	3.32	ef	13.11	cd	2.45	de
	12	14.89	D	3.00	f	11.78	d	1.28	e
BARI Sarisha9	0	35.72	A	4.38	a	21.22	a	6.29	a
	3	29.74	ab	4.08	ab	18.00	ab	5.79	ab
	6	24.78	bc	3.87	bcd	15.33	bcd	4.80	abc
	9	20.89	cd	3.75	bcd	13.67	cd	3.73	cd
	12	22.00	C	3.61	de	12.89	cd	2.85	de
Levelofsignificance		*		*		*		*	
LSD$_{(0.05)}$		6.61		0.43		4.11		1.88	
CV(%)		5.27		6.72		5.24		5.82	

Inacolumn, means havingsimilarletter(s)arestatisticallyidenticalandthosehavingdissimilarletter(s)differsignificantlyasper0.05levelo fprobability

**5%levelofSignificance

Asignificantvariationwasfoundinthetreatmentcombinationsofvarietyandlevelofsalinityonnumberofsiliquaeperplant(Table10).Themaximumnumberofsiliquaeperplant(35.72)wasfoundinBARISarisha9with0dSm^{-1}levelofsoilsalinity,whichwasstatisticallysimilarwithSAUSarisha-1with0dSm^{-1}levelofsoilsalinity,whereastheminimumnumberofsiliquaeperplant(14.89)wasfoundinSAUSarisha-1with12dSm^{-1}levelofsoilsalinity.TheresultsareinaccordancewiththefindingofAshraf*etal.*(1999)whofoundreducedyieldparametersandyieldintwelvevarietiesfrom*Brassicanapus*,*B.carinata*,*B.campestris, B.juncea*and*Raphanusraphanistrum*withtheseverityofsalinity.

4.7 Lengthofsiliqua

Therewasasignificantdifferenceamongthevarietyinthelengthofsiliqua(Table3).Themaximumlengthofsiliqua(3.94cm)wasproducedinBARISarisha9.Theminimumlengthofsiliqua(3.51cm) wasproducedinSAUSarisha-1.Hussain*etal.*(2008)reportedthatBARIsharisha-8performedbetterintermsofsiliqualength.Hossain*etal*.(1996)observedthelongestsiliqua(8.07cm)in BLN-900 andtheshortest(4.83cm)inHyola-401.

The levelofsalinitywasshowedsignificantvariation inthelength ofsiliqua(Table3).Themaximumlengthofsiliqua(4.12cm)wasproducedby0dSm^{-1}levelofsoilsalinity,whereas12dSm^{-1}levelofsoilsalinityproducedtheminimumlengthofsiliqua(3.30cm),whichwasstatisticallysimilarwith9dSm^{-1}levelofsoilsalinity.

Lengthofsiliquaindicatedasignificantvariationamongthetreatmentcombinationsofvariety andlevelofsalinity(Table3).Themaximumlengthofsiliqua(4.38cm)wasfoundinBARISarisha9at0dSm^{-1}levelofsoilsalinity,whereastheminimumlengthofsiliqua(3.00cm)was foundSAUSarisha-1at12dSm^{-1}levelofsoilsalinity.

4.8 Seedpersiliqua^{-1}

Therewasasignificantdifferenceamongthevarietyinthenumberofseedpersiliqua(Table3).Themaximumnumberofseedpersiliqua(16.07)was producedin BARISarisha 9.Theminimumnumberofseedpersiliqua(15.58)wasproducedinSAUSarisha-1.Mondal*etal*.(1992)andHossain*etal*.(1996)alsoreportedthattherewassignificantdifferenceamongthevarietieswithrespecttonumberofseedssiliqua^{-1}.

Thelevelofsalinityshowedvariationinthenumberofseedpersiliqua(Table3).Themaximumnumb erofseedspersiliqua(20.83)wasproducedby0dSm^{-1} levelofsoil salinity,whereas12dSm^{-1}levelof soilsalinityproducedtheminimumnumber of seedspersiliqua(12.34).

Numberofseedpersilliquaindicatedasignificantvariationamongthetreatmentcombinationsofvarietyandlevelofsalinity(Table3).Themaximumnumberofseedpersiliqua(21.22)wasfoundinBARISarisha9with0dSm^{-1}levelofsoilsalinity,whichwasstatisticallysimilarwithSAUSarisha-1with0dSm^{-1}levelofsoilsalinitywhereastheminimumnumberofseedpersiliqua(11.78)wasfoundinSAUSarisha-1with12dSm^{-1}levelofsoilsalinity.

4.9 Seedyield

Seedyieldisafunctionofinterplayofvarious yieldcomponentssuchasnumberofproductivebranches,seedsiliqua^{-1}.Theseedyieldpot^{-1}oftwoselectedmustardvarietiesdiffereddueto themeaneffectofdifferentsalinitytreatments(Table3).Thehighestseedyieldpot^{-1}(4.69gpot^{-1})wasfoundincultivarBARISarisha9andthelowestyield(3.84gpot^{-1})wasrecordedinSAUSarisha-1.Seedyielddifferencesduetovarietieswerereportedby Hossain*etal*.(2012).Sarkees(2013)alsoreportedthatvarietieshadsignificantinfluenceonseed yield.

Ahighlysignificantvariationinseedyieldpot^{-1}ofmustardvarietieswasobservedduetothedifferentsalinitylevels(Table3)**.**Thehighestseedyield(6.13gpot^{-1})wasrecordedatcontroltreatmentanditwaslowest(2.06gpot^{-1})at12dSm^{-1}levelofsalinity(Table3).Thesowingofseedsundersalineconditionsignificantlydecreasedthenumberofsiliquaperplant,numberofseedspersiliqua,seedyieldascompared tonormal condition. Thedecreaseinnumberofsiliquaperplant,numberofseedspersiliquaowingtolessnumberoffruitingnodes,flowers, comparativelypoorsettingandless decompositionofmetabolitesinseed.Similar,resultshavealsobeenreportedbyKumarandRathore(2002)inIndianmustardandMurmukarandChavan(1986).

Itwasevidentfromthetable3thatinteractionofvarietyanddifferentsalinitylevelssignificantlyaffectedtheseedyield.Thehighestseedyield(6.29gpot^{-1})wasfoundinBARISarisha9at0dSm^{-1}levelofsoilsalinity,andthelowestyield(1.28gpot^{-1})wasobtainedinSAUSarisha-1at12dSm^{-1}levelofsalinity.Seedyieldisthefunctionofnumberofsiliquaplant^{-1},numberofseedsiliqua^{-1}.Alltheyieldcontributingcharacterscontributedfortheyieldreductionpot^{-1}undersalineconditions;contributionoftheseriouslyaffectednumberofseedssilliqua^{-}

[1]wasthehighest.Theresultsareinconformity

withSharma*etal.*(1997)whoobservedreducedseedyieldof9.2%,26.08%and50.4%inDIRA337, RYS80andVarungenotypes(*Brassicajuncea*),respectively,underdifferentvariedsalinitylevels(10 dSm^{-1},15dSm^{-1}).

4.10 Nitrogenconcentrationinmustardplant

TheeffectofvarietyshowedvariationintheNconcentrationinmustardplant(Table4).ThetotalNcontentofmustardplantvariedfrom0.42%to0.46%.ThehighesttotalNcontent(0.422%)wasobservedinmustardcultivarofSAUSarisha-1.ThelowestvalueofN(0.412%)wasobservedunderBARISarisha9.

TheeffectofdifferentlevelsofsalinityshowedastatisticallysignificantvariationintheNconcentrationinmustardplant(Table4).ThetotalNcontentofthemustardplantvariedfrom0.351to0.520.Amongthedifferentlevelsofsalinity,12dSm^{-1}showedthehighestNconcentration (0.520) inplant. Thelowestvalue(0.351) wasunder controltreatment 0dSm^{-1}salinitylevel.

InteractioneffectofdifferentlevelsofsalinityandvarietyontheNconcentrationwasobservedsignificantinmustardplant(Table3).ThehighestconcentrationofNinmustardplant(0.520%)wasrecordedinSAUSarisha-1at12dSm^{-1}salinitylevel,whichwasstatistically similarwithBARI Sarisha9with12dSm^{-1}levelofsalinity.Ontheotherhand,thelowestNconcentration(0.338%)wasfoundinBARISarisha 9with0dSm^{-1}levelofsalinity.

Table4.Effectofmustardvarietiesanddifferentsalinitylevelswithinteractiononcontent ofN, K, Na onplantof mustard

Variety	Salinitylevels(dSm^{-1})	N (%)		K (%)		Na(%)	
Effectofvariety							
SAUSarisha-1		0.422		0.203		0.046	
BARISarisha9		0.412		0.225		0.042	
CV(%)		8.890		9.830		7.910	
Effectofsalinity							
	0	0.351	c	0.254	a	0.031	d
	3	0.376	bc	0.232	ab	0.039	c
	6	0.413	bc	0.216	b	0.045	bc
	9	0.432	b	0.192	c	0.050	ab
	12	0.520	a	0.174	c	0.054	a
Levelofsignificant		*		*		*	
LSD$_{(0.05)}$		0.072		0.023		0.007	
CV(%)		8.890		9.830		7.910	
Interactioneffectofvariety	andsalinity						
	0	0.364	cd	0.244	b	0.034	bc
	3	0.366	cd	0.224	c	0.039	abc
SAUSarisha-1	6	0.415	bc	0.201	d	0.047	abc
	9	0.446	b	0.184	d	0.053	ab
	12	0.520	a	0.161	e	0.057	a
	0	0.338	d	0.264	a	0.028	c
	3	0.385	cd	0.241	bc	0.039	abc
BARISarisha9	6	0.418	bc	0.231	bc	0.044	abc
	9	0.411	bc	0.201	d	0.047	abc
	12	0.510	a	0.187	d	0.050	ab
Levelofsignificant		*		*		*	
LSD$_{(0.05)}$		0.054		0.017		0.017	
CV(%)		8.890		9.830		7.910	

Inacolumn, means havingsimilarletter(s)arestatisticallyidenticalandthosehavingdissimilarletter(s)differsignificantlyasper0.05levelof probability

**5%levelofSignificance

4.11 Potassium(%)

Itappearsfromtheresultspresentedintable4thattherewasavariationinpotassium(%)contentintwo selectedmustardvarietiesundermeaneffectofdifferentsalinity levels.ThehighestKcontent(0.225%)inplantwasfoundinBARISarisha9andthelowest(0.203%) wasobservedinSAUSarisha-1.

ThePotassium(K)contentsinplantofmustardalsosignificantlyvariedduetotheeffectofdifferentsalinitylevels;wheretheKcontentdecreasedwiththeincreasinglevelofsalinityinplant(table4).ThehighestKcontentinplant(0.254%)wasrecordedin0dSm^{-1}anditwaslowest(0.174)in12dSm^{-1}salinitylevel,whichwasstatisticallysimilarwith9dSm^{-1}salinitylevel.

Thecombinedeffectsofsalinityandvarietyoncontentof K(%)inplantweredifferedsignificantly.ThecontentofKinplantoftwoselectedvarietiesprogressivelydecreasedwithincreasingthesalinitylevels.ThehighestKcontent(0.264%)inplantwasfoundinBARISarisha9with0dSm^{-1}levelofsoilsalinityanditwaslowest(0.161%)forSAUSarisha-1at12dSm^{-1}(Table4).TheresultsareinanagreementwiththefindingofTanveer*etal*. (2002)foundhighK^+in*B.napus*and lowin*B.campestris.*

4.12 Sodium(%)

Thepercentcontentofsodium(Na)inplantoftheentiretwoselectedmustardvarietiesvariedgrownat differentlevelsofsalinity.Itscontentinplantwashighest(0.046%)inSAUSarisha-1andlowest(0.042%)inBARISarisha9(Table4).

Thesodium(Na)contentinplantofmustardsignificantlyvariedduetotheeffectofdifferent salinitylevels;where the Nacontent inplantincreasedwiththe increasing level ofsalinity. ThehighestNacontent(0.054%)inplant wasrecordedin12dSm^{-1}levelofsalinityandthelowest(0.031%) wasin0dSm^{-1}(Table4).

Thecombinedeffectofsalinityandvarietyoncontentof Na(%)inplantwasfoundsignificant.TheNa contentincreasedwiththeincreasinglevelsofsalinityinbothplantofallvarieties(table4).ThehighestNacontent(0.057%)inplantwasfoundinSAUSarisha-1with12dSm^{-1}levelofsoilsalinityanditwaslowest(0.028%)inthecultivarBARISarisha9at0dSm^{-1}salinitylevels.Ashraf*etal.*(2004)foundthatappliedNaClenhancedNa^+concentrationintissuesoffourmustardvarieties(twosaltsensitiveandtwosalt-tolerant).

Chapter 5

Summary and Conclusion

CHAPTERV

SUMMARYAND CONCLUSIONS

Apotexperimentwasconductedatthenethouseof AgroEnvironmentalChemistryLaboratoryof thedepartmentofAgriculturalChemistry,Sher-e-BanglaAgriculturalUniversity,Dhaka-1207undertheexperimentwasconductedinpotsduringNovember,2019toFebruary2020toeffectsofsaltstressongermination,growth,yieldandioncontentofmustard.Theexperimentwasconductedusingtwovarieties(SAUSarisha-1andBARISarisha9)andfivesalinitylevels(0,3,6,9and12dSm^{-1}).TheexperimentwassetinCompletelyRandomizedDesign**(**CRD)havingtwofactorswiththreereplications.

Theresultsontheeffectofcharactersindicatedthatgerminationpercentageofseed,populationdensity,plant height,branchesplant^{-1},total drymatter,siliquae plant^{-1},lengthofsiliqua,numberofseedssiliqua^{-1},seedyieldwereinfluencedbythevariety.Themaximumgerminationpercentageofseeds(86.80%)wasfoundinvarietiesofmustardBARISarisha9.Thehighestplantpopulation(14.67)wasobservedinBARISarisha9.Thetallestplant(77.57cm)wasfoundinvarietySAUSarisha-1.BARISarisha9achievedmaximumbranch(1.98).Themaximumweight(17.33g)wasgainedatBARISarisha9.Themaximumnumberofsiliquaeperplant(26.62)wasproducedinBARISarisha9.Themaximumlengthofsiliqua(3.94cm)andnumberofseedspersiliqua(16.07)wereproducedinBARI Sarisha9.Thehighestseedyieldpot^{-1}(4.69g pot^{-1})wasfound invarietyBARISarisha9andthelowestyield(3.84g pot^{-1}) wasrecordedinSAUSarisha-1.

Therewasasignificantvariationinpotassium(%)contentintwoselectedmustardvarietiesunder differentsalinity levels.ThehighesttotalNcontent(0.422%)wasobservedinmustardvarietyofSAUSarisha-1.ThehighestKcontent(0.225%)inplantwasfoundinBARISarisha 9.Itscontentinplantwashighest(0.046%)inSAUSarisha-1.

Allparameterswerestatisticallyinfluencedbydifferentsalinitylevels.Themaximumgerminationpercentageofseeds(91.67%)wasrecordedfrom0dSm^{-1}.Thehighestplant population(19.17)wasrecordedat0dSm^{-1}.Atharvestingofmustardplant,thehighestplantheight(76.13cm)wasobservedin0dSm^{-1}.Themaximumnumberofbranchesplant^{-1}(3.78),totaldrymaterwashighest(21.33gplant^{-1}),numberofsiliquaeperplant(35.55),lengthofsiliqua(4.12cm),numberofseedspersiliqua(20.83)wereproducedfrom 0dSm^{-1}.Thehighestseedyield(6.13 gpot^{-1}) wasrecordedat controltreatmentanditwaslowest(2.06 gplant^{-1})at12dSm^{-1}levelofsalinity.12dSm^{-1}showedthehighestNconcentration(0.520%)inplant.ThehighestKcontentinplant(0.254%)wasrecordedin0dSm^{-1}.ThehighestNacontent(0.054%)inplantwasrecordedin12dSm^{-1}levelofsalinity.

Incombinedeffectofvarietiesandsalinitylevels,allparametersweresignificantlyinfluenced. Thegerminationpercentageofseedswas maximum(96.01) inBARISarisha9with0dSm^{-1}.Themaximumtotalnumberofplantpopulation(19.67)wasfoundfromBARISarisha9at0dSm^{-1}levelsofsalinity.Thehighestplantheight(85.60cm)wasfoundinSAUSarisha-1at0dSm^{-1}.Themaximumtotalnumberofbranchplant^{-1}(3.78),totaldrymatter(24.00g),lengthofsiliqua(4.38cm),numberofseedspersiliqua(16.07)werefoundfromBARISarisha9with0dSm^{-1}.Thehighestseedyield(6.29gpot^{-1})wasfoundinBARISarisha9with0dSm^{-1}levelofsoilsalinity,andthelowestyield(1.28gpot^{-1})wasobtainedinSAUSarisha-1at12dSm^{-1}levelofsalinity.

ThehighestconcentrationofNinmustardplant(0.520)wasrecordedinSAUSarisha-1at12dSm^{-1}salinitylevel.ThehighestKcontent(0.264%)inplantwasfoundinBARISarisha9at0dSm^{-1}levelofsoilsalinity.ThehighestNacontent(0.057%)inplantwasfoundinSAUSarisha-1 with12dSm^{-1}levelofsoilsalinity

Basedontheaboveresultsthefollowingconclusionsandrecommendationmaybemade

- ThevarietyBARISarisha9hadbetterexpressionofmorphological,yieldandyieldcontributing charactersthanthoseofSAUSarisha-1inallcasesexceptplantheight.
- SalinityincreasedthecontentofNa^+anddecreasedK^+contentindifferentplanttissuesofthevarieties.
- ThetolerantvarietyshowedlowerNa^+concentrationreflectingthedilutioneffect,thetolerant mechanism.
- Basedontheaboveconclusionsplantbreedermayadaptthetechniqueofselectionorscreeningthegenotypesanddevelopsalttolerantmustardvarieties.

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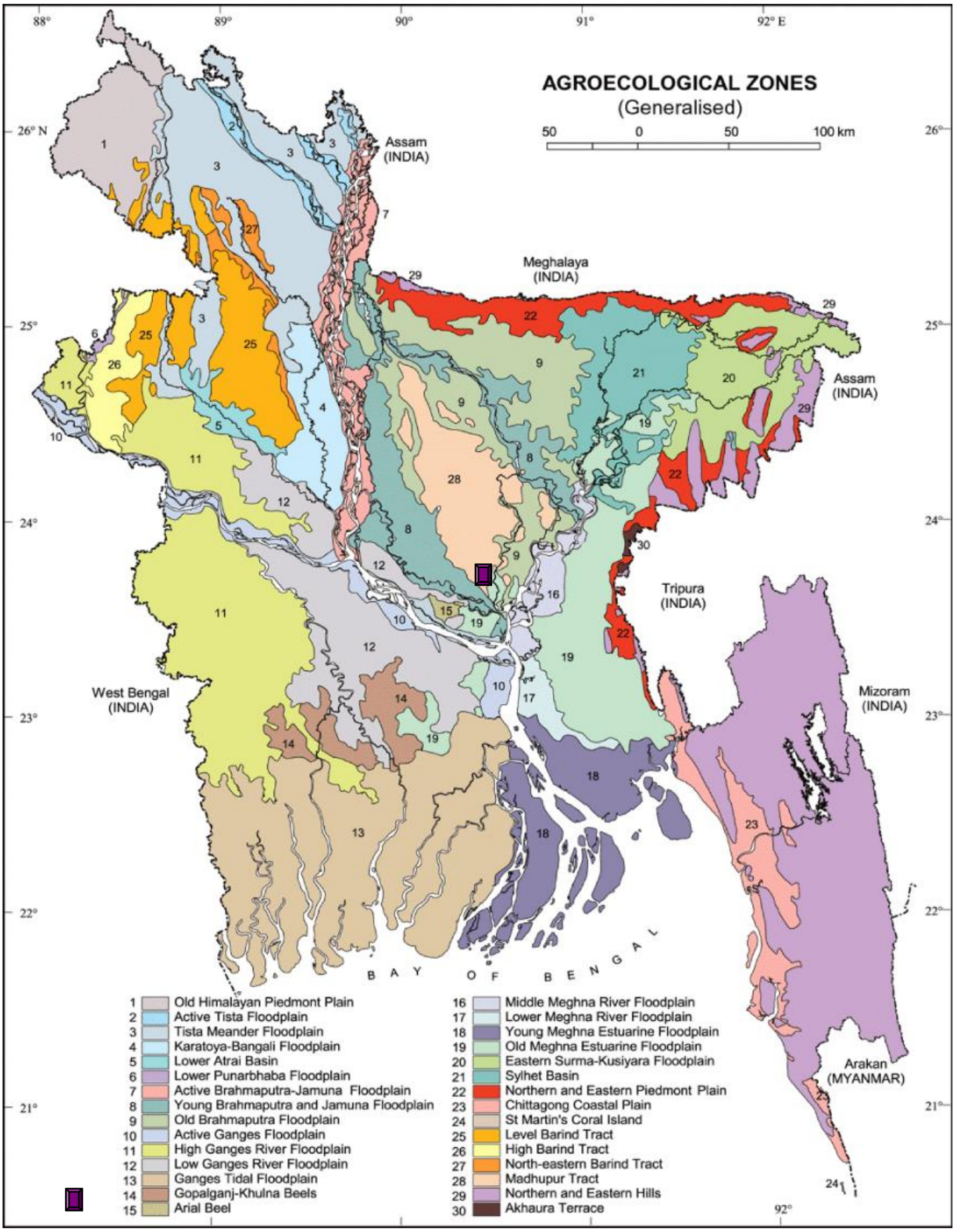
Appendices

APPENDICES

AppendixI.Mapshowingtheexperimentalsitesunderstudy



AppendixII.Effectofmustardvarietiesanddifferentsalinitylevelsonplant heightandnumberof branchandtotaldrymatterof mustard

Variety	Salinity levels (dSm^{-1})	Plantheight(cm)		Numberofbranchperplant		Totaldrymatter(g)	
Effectofvariety							
V_1		77.57		1.45		14.93	
V_2		61.19		1.98		17.33	
CV(%)		6.75		6.62		5.38	
Effectofsalinity							
	0	76.13	a	3.78	a	21.33	a
	3	73.79	ab	2.44	b	18.33	ab
	6	71.07	b	1.22	c	16.33	b
	9	65.38	c	0.89	cd	14.33	bc
	12	60.54	d	0.22	d	10.33	c
Levelofsignificant		*		*		*	
$LSD_{(0.05)}$		4.551		1.00		4.837	
CV(%)		6.75		6.62		5.38	