Screening and Stability Analysis For Salinity Tolerance in Sorghum [*Sorghum bicolor (L.)* Moench] ”

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by

PRADEEP SINGH KULHARI

2004

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, UDAIPUR
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CERTIFICATE – I

Dated: /10/2004

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This is to certify that, this thesis entitled "**Screening and Stability Analysis for Salinity Tolerance in Sorghum [*Sorghum bicolor* (L.) Moench]"** submitted for the degree of **Master of Science in Agriculture** in the subject of **Plant Breeding & Genetics,** embodies bonafide research work carried out by **Mr. Pradeep Singh Kulhari** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The advisory committee also approved the draft of this thesis on 12th October 2004.

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Screening and Stability Analysis for Salinity Tolerance in Sorghum [*Sorghum bicolor* (*L*.) Moench]

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ABSTRACT

Present investigation entitled "Screening and Stability Analysis for Salinity Tolerance in Sorghum [*Sorghum bicolor* (*L*.) Moench]" was carried out with 100 genotypes of sorghum collected over the different agroclimatic zones of Rajasthan which were evaluated on different salinity levels in CRD. The four salinity levels of 0 dSm^{-1}, 3 dSm^{-1}, 6 dSm^{-1} and 9 dSm^{-1} were prepared by supplementing Hoagland's solution with different salts such as NaCl, $MgSO_4$, $CaCl_2$ and $NaHCO_3$ in different ratio. 20 seeds of each genotype were sown in petridishes and irrigated with 5 ml of test solution after draining the previous day's solution for the first five days, which was later, increased to 10 ml.

Observations were recorded for nine characters viz. germination percentage, seedling height, coleoptile length, fresh weight of shoot per seedling, fresh weight of root per seedling, dry weight of shoot per seedling, dry weight of root per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots.

The analysis of variance for all the traits revealed considerable variability in the experimental material and environments. Environment S_0 was identified as most favourable environment and the mean values showed reduction along the salinity gradient. Genotype Raj 42 and Raj 36 exhibited higher mean performance for a number of attributes at varied salinity levels. Dry weight of roots per seedling showed high estimate of GCV, heritability and genetic gain in all the four salinity levels. Hence, it was concluded that experimental material possess potential for improvement in this trait.

The correlation among all the characters was found generally to be highly significant and positive. Based upon this, correlation between fresh weight of shoot per seedling with fresh weight of root per seeding, dry weight of shoot per seedling, ratio of dry weight of shoots to dry weight of roots and ratio of fresh weight of shoots to fresh weight of roots should be used as a criterion for selection of salt tolerance particularly for germination and seedling establishment.

Analysis of variance for stability parameters showed significant difference among genotypes and considerable G x E interaction. Genotypes Raj-21, Raj-29, Raj-

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34, Raj-48, Raj-49, Raj-57, Raj-60, Raj-61, Raj-65, Raj-68, Raj-79, Raj-80 and Raj-86 for germination percentage, Raj-51 for seedling height and Raj-7 for ratio of dry weight of shoots to dry weight of roots showed stability under wider salinity levels. Genotypes Raj 27, Raj 30 and Raj 4 were found promising for salinity tolerance. Further, evaluation of genotype Raj 42 is also suggested**.**

1. INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] popularly known as jowar is an often cross-pollinated crop. It belongs to genera sorghum and family poaceae. It is an important cereal crop of the country primarily grown for food, feed, forage and industrial raw material. It is extensively grown in tropical and subtropical environments with high temperature and low rainfall. In semi-arid areas, under rainfed condition no other cereal can beat sorghum with respect to productivity. Sorghum has potential to emerge as a bio-energy crop in near future since it is efficient in conversion of cultural energy and accumulation of high levels of sugar.

Introduction of high value crops such as soybean has led to change in traditional cropping system. In context to sorghum, it was cultivated in an area of 18.5 mha during late sixties, which has declined to 10 mha in 2001-02 (Govt. of India 2001-02) with production and productivity of 7.7 mt and 772 kg/ha respectively. In Rajasthan also, the area has reduced from 9.3 lac ha (1990-91) to 6.15 lac ha (2001-02) with the production and productivity of 2.54 lac tonnes and 413 kg/ha respectively (Vital Ag. Stat., Govt. of Raj. 2003).

In India, nearly 10-mha areas is salt affected, out of which 17,8716 ha area is in Rajasthan (Govt. of India 2002-03). Soil salinity in arid and semi arid regions of the world, is a major detrimental factor for crop production. Millions of hectares of non-productive saline land exists throughout the world and is still increasing. The problem is increasing day by day because of faulty soil management practices like shallow ploughing, low organic matter, increased use of ground water for irrigation and poor water drainage system. Salinity affects the physiology of plants in numerous ways viz. excessive uptake of ions, toxicity of ions, water deficit, adverse effect on plant metabolism, nutritional deficiency, decrease in growth and decrease in CO_2 fixation (Levitt, 1980).

Plant resistance in context of salinity is not a simple reaction but it is a complex interaction between the plant and operating soil stress factors. Thus, its exploitation depends on numerous variables relating to soil conductions and plant itself viz. genotype, ploidy level, growth stage, maturity period etc. In this light, two approaches can be suggested to tackle the problem of salinity, first, the modification of the environment that is suitable for plants, and second, the genetic manipulation of plants to suit the stress. Now, regarding the first approach i.e. modification of environment it would mean the reclamation of saline soils through desalinization but escalating costs of reclamation or drainage or water control make these means non attractive for the government. So, the second approach i.e. breeding of salt tolerant varieties, seems to be more appealing. Breeding of salt tolerant crop varieties for such soils, as proposed by Epstein *et al.* (1989) is an attractive possibility in combination with appropriate management programmes and only this could allow exploitation of saline soils for agriculture.

Breeding of salt tolerant varieties needs information on various aspects viz., genotypic differences in plants in context to salinity, stage of plant which is most adversely affected and different traits which help in screening of salt tolerant lines. In case of sorghum, seedling stage is most adversely affected by the salts. Estimation of early seedling traits and their establishment helps in selecting the plant at an early stage, cutting down the entries to a manageable number for further evaluation and screening for yield; also knowledge of genetics of tolerance at the early stage i.e. seedling stage and establishment will help in breeding varieties, which will be tolerant to salinity at the early stage.

So, the present investigation was undertaken with the following objectives:

(i) To study the variability in germination and seedling traits at various levels of salinity.

(ii) To identify sorghum genotypes for tolerance to salinity at germination and seedling stage.

(iii) To identify stable sorghum genotypes at varying salinity levels.

2. REVIEW OF LITERATURE

Stress, in simple term, is set of condition that leads to aberrant change in metabolic process causing injury to organism. Stress may either be 1) Abiotic i.e. not involving or produced by organism e.g. water deficit/excess, salinity temperature etc or ii) Biotic, i.e. involving or produced by organism. Environmental stress markedly limits the potential of crop in agriculture system. Water (drought) and salinity stress especially harmful to food production in all arid and semiarid regions. Modifying the environment is central to the alleviation of environmental stress in the current crops management practices. (Arkin & Taylor, 1983)In many cases it may not be possible to modify the environmental but the genetic modification of plants to successfully grow in stress condition is feasible or atleast has been demonstrated to be feasible. Plant breeders have been developing plant varieties tolerant to specific environmental stress for a long time, without being always aware of the selective effects of environmental under which the selection are made (Blum, 1986).

The genetic improvement of yield is primarily concerned with two major parameters, yield potential and yield stability over different environments, yield stability is controlled by the complex response to interaction with environment (Saeed & Francis, 1983).

Due to both genetic and environmental consideration, yield is a poor selection index for tolerance to complex environmental stress. The initial vigour of the seedlings determine the yield potential of the variety thus, the germination, plant straw and early seedling vigour should all be considered while selecting superior yielding genotype. In almost all the stress, germination percentage and early seedling vigour are affected (Levitt, 1972).

SALINITY

According to Mass and Nieman (1978) salinity stress has been defined as presence of excessive concentration of soluble salts, which suppress plant growth. Agrawal *et al.* (1979) classified salt affected soil into three types viz. saline (EC more than 4 dSm^{-1} and pH less than 8.5) sodic/ alkali (EC more than 4 dSm^{-1} and pH less than 85) and saline sodic (Ec more than 4 dSm-1 and pH more than 8.5), based on electrical conductivity of saturation extract and pH levels.

Ratavodilk *et al.* (1978) were observed that germination indices in laboratory were correlated with both percentage emergence and early height growth rate. They also reported that moderate to high broad sense heritability estimates were obtained for shoot length and root length. They revealed that germination percentage were more precise selection indices for salt tolerance during germination and the seedling stage than shoot or root growth rate.

Weinberg (1987) stated that 'salt tolerance' is a term, which semi-quantitatively express the ability of plant species to survive and grow in saline environments.

Simpson *et al.* (1979) reported that in general, further improvement in any species rests on the variability available for various traits. In case of salinity resistance, there are a number of attributes in plants that confer both survival and productivity to plant at different stages of life cycle under different level of salinity.

Spivakav-MS (1990) studied the genetic nature and degree of inheritance of salt tolerance in Sorghum and concludes that salt resistance was inherited mainly along the male line and was controlled by several non-allelic genes, which conditioned dominated or over dominance expression of resistance.

Major difficulty with the evaluation to salinity in plants is the method adopted and also the stage at which the tolerance estimated. As mentioned else where, the age and physiology are important in determining the tolerance. Garg *et al.* (2000) reported that sorghum crop is relatively more tolerant to salinity at germination than other stages, being most sensitive at the vegetative stages.

The reduction in plant growth in response to salinity may be a consequence of change in plant water relation, ion allocation, photosynthesis, respiration and other biochemical reaction or combination of all these.

So, an attempt has been made to review the available literature on effects of salinity on sorghum and related crops at the seedling stage.

EFFECT OF SALINITY ON SEED GERMINATION AND SEEDLING CHARACTERISTICS

Taylor *et al*. (1975); observed that there is substantial genotypic difference exist among various cultivar of sorghum in growth response to saline condition.

Ogra and Baijal (1978) assessed that root and coleoptile length of 22 varieties grown under salt stress at 4, 8, 12 and 16 mMhos/cm EC. Growth was progressively reduced with an increase in salinity level, with coleoptile growth being more adversely affected than root growth, although the varieties differed significantly in their ability to growth under high salt condition.

Ratavodilk *et al.* (1978) were observed that germination indices in laboratory were correlated with both percentage emergence and early height growth rate. They also observed that moderate to high broad sense heritability estimates were obtained for shoot length and root length. Their studied revealed that germination percentage were more precise selection indices for salt tolerance during germination and the seedling stage then shoot or root growth rate.

Mass *et al.* (1983) studied the relative salt tolerance of maize at different growth stages from germination to maturity and showed that maize was relatively tolerant during germination and seedling growth was much more sensitive to salinity at maturity than seed germination.

Reddy and Vora (1983) observed the salt tolerance capacity of *P. typhoides* (*P. americanum*) at different level of KCl, NaCl, K2SO4 and Na2SO4 during early seedling growth. Germination was generally not affected except that it delayed. Root and shoot length decreased considerably.

Francois *et al*. (1984) concluded that grain sorghum was significantly affected by salt at germination stage than the later stages of growth.

Pan (1984) observed that there is significant differences in germination and growth were seen among 86 inbred lines grown for 15 day in nutrient containing 150 mM NaCl, the growth of salt tolerant lines decreased with increasing salt concentration, while little growth was observed in sensitive lines in the presence of NaCl.

Verma and Yadav (1985) assessed germination in 8 cultivar at 6 salt concentrations from zero to 200 mill equivalent (ml/liter). They confirmed that as salinity concentration increased there is decreased in germination and seedling growth in Sorghum. In IS3383 and IS3193-1, germination was unaffected at 40 me/lit. And at high concentration, IS3193-1 was lest sensitive. When both germination and seedling growth taken in account IS3193-1, IS3199-1 and IS3353 were the most tolerant.

Bliss *et al.* (1986) evaluated that salt stress inhibit growth throughout the plant life cycle in general, but seed germination is the most sensitive.

Prakash (1988) and Muralia (1989) confirmed that germination is delayed by salinity. Morozova (1979), Dutta & Paradhan (1981), Prakash and Shastry (1992), Sharma and Shastry (1992), Naryana, (1993), and Kumari (1993) were concluded that main reason for poor seedling establishment under salinity is the slow growth of coleoptile. Due to slow growth of coleoptile, the emergence and establishment of seedlings of susceptible genotypes is appreciably affected by salinity. Poorly established seedlings perform poorly in biomass production.

Boursier and Lauchli (1990) studied the effects of moderate level of salinity on growth, assimilate partitioning, and mineral nutrient relations of sorghum and they confirmed that DM production decreased substantially in response to moderate increased in soil electrical conductivity (2.1-5.9 dsm^{-1}). Total shoot and root dry weight of green house grown plants decreased to a greater extent by moderate (-0.2 and –0.4 MPa) addition of isosmatic concentration of NaCl and Na_2SO_4.

Jiging Peng *et al.* (1990) evaluated one hundred and twenty three Chinese sorghum cultivars for tolerance to salinity and observed that the higher salinity content in top 10 cm of soil seriously reduced both the SGR and PSR in each cultivar group and also conform that salinity damage the sorghum cultivar much more seriously in the seedling emergence stage than any other stage.

Boursier and Lauchli (1990) observed that sorghum dry matter production decreased substantially in response to a moderate increase in soil electrical conductivity (2.1 to 5.9 dsm^{-1}). Overall, total shoot and root dry weight of green house growth plants decreased to a greater extent by moderate (-0.2 and –0.4 MPa) addition of isosmotic concentration of NaCl that Na_2SO_4. However, at higher salinity level (-0.6 MPa), growth was more inhibited by Na_2SO_4.

Prakash and Shastry (1992); Sharma and Shastry (1992) also observed that the fresh weight and dry weight of seedling is affected by salinity. Reduction in fresh and dry weight of seeding is because of less biomass production.

Allberico and Cramer (1993) conducted a research for preliminary screening of seven cultivar for salinity tolerance in maize and they observed that salinity significantly reduced total dry weight, leaf area and shoot and root dry weight below control level.

Ismaeil *et al.* (1993) observed that salinity decreased both germination rate and percentage in Sudan grass (*Sorghum Sudanese*). However, CCC (Chlormequat) counter act the highest level of 6000 ppm. They also observed that growth characters including plant fresh weight, dry weight, shoot height, leaf area, number of leaves and number of tiller were decreased by salinity but generally increased by seed treatment.

Igartua *et al.* (1994) studied the response of grain sorghum to salinity in germination & emergence stages. Twelve inbred lines and 18F_1 hybrids were tested for germination and emergence in folder paper at 10 salt concentrations from 1.8 to 36 dSm^{-1}. The mean EC_{50} (the electrical conductivity at which the variable score decline by 50%) for emerged seedling production was 21.2 dSm^{-1}. Large genotypic difference was observed for salt tolerance at germination and emergence stage, which were not related to the variability of seed and poorly related to seed weight (considered as an estimate of intrinsic seed vigour).

Maiti *et al.* (1994) evaluated 25 sorghum genotype for salinity tolerance at different levels of sodium chloride and observed a highly significant difference for variables with an increases in salt concentration, shoot and root dry weight, seedling height and root length decreased.

El-Tayes (1995) observed that seed germination of sorghum plants were significantly lowered with increasing salinity level using NaCl.

Kebebew and McMeilly (1995) studied the variation in response of miner millets, *Pennisetum americanum* (L.), *Leeke* (Pearl millet) and *Eleusine coracena* (L.), *Gaertn* (Finger millet) and *Elagrostis tef* (Zucc.), *Trotter* (tef.) to salinity in early seedling growth. After, 14 days, seeding were evaluated for the length of longest root and they observed that with increasing NaCl concentration significantly reduced seedling root length, there was considerable variation within and between accessions with in each species.

Kulhari and Katewa (1995) studied effect of sodium salt on early seedling growth of sorghum sudenese and observed wide variation in tolerance toward soil salinity.

Macharia *et al.* (1995) observed that seed germination, seedling root and shoot extension of 4 sorghum cultivars decreased with increased salinity. The decrease in seed germination and shoot/root extension was attributed largely to ionic toxicity rather than osmotic factor. Root extension was more sensitive to salinity stress than shoot extension.

Marambe, B., Ando-T (1995) studied that seed germination of sorghum was not effected by NaCl concentration less then 100 nm (0.46 Mpa). Germination was reduced by 50% at 300 4m NaCl (1.31 Mpa) and completely inhibited at 500 nm.

Suchato *et al.* (1995) observed that salinity delayed germination and germination percentage gradually decreased as salinity increased.

Rosa *et al.* (1995) studied seventeen glossy sorghum genotypes in pots filled with perlite to determine their resistance to salinity stress, using 0.25 m sodium chloride solution for salinity treatment and distilled water for the control for a period of 25 days after emergence. The variable measured were seedling height, root length and root, shoot and total dry mass of plant. Highly significant differences were found among genotypes and among treatments for all these traits.

Singhania *et al.* (1995) observed that fresh weight and dry weight of seedling is also affected by salinity.

Azar & Khan (1997) examined the salinity response of nine sorghum accession under hydroponics condition and measured maximum shoot length and total plant dry weight for comparing accession responses to increasing salinity and results that characters were significantly affected due to increase NaCl concentration in nutrient media.

Kumari *et al.* (1997) studied graded level of soil salinity on sorghum and showed that the total dry matter production (DMP = root + shoot + grain), decreased with increased in salinity levels from 0.8 to 10 dsm^{-1}.

Nadeem *et al.* (1997) observed that plant height and fresh and dry shoot weight reduced while concentration of N, P, Ca, Mg, Na and Cl in shoot increased with increased salinity level.

Azar *et al.* (1998) revealed highly significant difference in root length among 12 sorghum genotypes, four NaCl solution and genotype environment interaction.

Clark (1999) observed that sorghum aerial part and root production decreased with increasing salinity.

Lu Yuan Fang (1999) observed that plant height decreased in all PP333 treatment but particularly under salinity, leaf growth was inhibited and leaf area was decreased, but chlorophyll and proline content increased.

Mehdi & Aksan (2000) studied genetic coefficient of variation, relative expected genetic advance and inter-relationship in maize for green fodder purpose at seedling stage and observed that higher value of GCV were found for fresh shoot and dry root weight. Moderate broad sense heritability estimates were found for fresh shoot weight, dry root weight and fresh shoot length. Fresh shoot weight was phenotypically, highly significant and positive correlated with other indicated traits.

Garg and Gupta (2000) observed that sorghum crop is relatively more tolerant to salinity at the germination than other stages, being most sensitive at the vegetative stage.

Iqbal *et al.* (2000) was observed that increased salinity level had significantly reduced fresh weight, shoot dry weight and shoot K^+ concentration at 15 & 30 days after salt application.

Azhar (2001) showed that the roots of accession were reduced more in mixture of salts than in single salt.

Azhar and McMeilly (2001) conducted an experiment on 51 accessions from different countries grown as seedling in culture solution for 14 days with NaCl concentration 0-200mN, variance due to accession, concentration and the accession X concentration interaction was significant for shoot length, root length and total plant dry weight. Increased in NaCl concentration resulted in decreases in the value of these three characters, but accession response were not uniform. It is suggested that recurrent selection offers the possibility of improving salt tolerance in Sorghum.

Kachapur M.D. *et al.* (2001) studied 40 pop sorghum cultivars and exhibited significant tolerance to moderately higher salinity stress (8ds/m) with respect to germination, seedling height & vigour index.

Khalvati *et al.* (2001) were grown nine maize cultivars in water culture (hydroponics) with 25, 50, 75 and 100 m Mol NaCl concentration and tested for salt tolerance during germination, emergence and early growing stages. The germination rate, coleoptile length and root length and plant height, number of leaves and stem diameter in addition to the leaf, stem and root dry matter yields were observed. There was significant variation among the cultivars in term of salt tolerance. Salt concentration at 25 m Mol was not harmful for the genotypes, whereas 100 m Mol salinity was highly determined, also lethal for some cultivars.

Khan *et al.* (2003) assessed the root growth response of 10 days old seedling of 100 maize accession at, 0 mM, 60mM, 80mM and 150mM NaCl concentration in solution culture. The non-linear least sequence method was used to quantify the salt tolerance of maize accessions. The estimated salinity threshold, Ct, the NaCl concentration at which root growth start to decrease, C0, and C50, the concentration at which roots stop growing and 50 per cent of its control value revealed considerable difference between the accession. No general consistency for tolerance was however, found between the estimates of Ct and C50. Both Ct and C50 appeared to quantify accession tolerance and the expression of root growth as a function of NaCl concentration provides a useful guideline for slat tolerance.

The above studies also showed a linear negative response of the growth to increasing salinity gradient.

On the contrary, Carmer *et al.* (1986) observed that the root growth of cotton seedling was stimulated by low NaCl concentration through at high NaCl concentration root growth of seedling was inhibited, the concentration at which this occurred depend upon the calcium content.

3. MATERIALS AND METHODS

3.1 EXPERIMENTAL MATERIAL

Seeds of 100 germplasm of sorghum (*Sorghum bicolor*), collected from different agroclimatic zones of Rajasthan were evaluated in four environments, created by four salinity levels (0 dSm^{-1}, 3 dSm^{-1}, 6 dSm^{-1} & 9 dSm^{-1}).

3.2 EXPERIMENTAL METHODOLOGY

The germplams were evaluated for germination and early seedling growth in petridishes in laboratory. Borosil's, petridishes of size 10 cm were selected for the evaluation of the germplam. Twenty seeds of each germplasm were surface sterilized with 0.1% $HgCl_2$ solution for 5 minutes followed by atleast three washings with distilled water. After which the seeds were sown in the previously autoclaved petridishes. The whole experiment was replicated three times. The petridishes were irrigated with 5 ml of sterile test solution after draining out the previous day's solution, during the first five days. After 5^{th} day each petri dish was irrigated with 10 ml of the test solution. All the petri dishes were kept in dark for 72 hours, later the dishes were exposed to artificial light (10 hrs/day) achieved by the use of florescent lamps and incandescent bulb.

3.3 CREATION OF ENVIRONMENTS

The test solution representing different salinity levels were prepared as described below:

The four test solutions were prepared by supplementing Hoagland's solution (Table 3.1) with different salts such NaCl, $MgSO_4$, $CaCl_2$, $NaHCO_3$ in different ratios (the ratio of solution of salt given in table 3.1). Four types of test solution having salinity levels 0, 3, 6, 9 dSm^{-1} were prepared artificially by the addition of requisite amount of NaCl, $CaCl_2$, $MgSO_4$ & $NaHCO_3$ to Hoagland solution and used for irrigating the test crops as per need arise.

Table 3.1 Composition of Hoagland's Solution (Epstein, 1972)

Compound	Molecular weight	Concentration of stock solution (g/litre)	Volume of stock solution per litre of final solution (ml)
Macro-nutrients			
KNO_3	101.10	101.10	6.4
$Ca(NO_3)_2 \cdot 4H_2O$	236.16	236.16	4.0
$NH_4H_2PO_4$	115.08	115.08	2.0
$MgSO_4 \cdot 7H_2O$	246.49	246.49	1.0
Micro-nutrients			
KCl	74.55	3.728	
H_3BO_3	61.84	1.546	1.0
$MnSO_4 \cdot H_2O$	169.01	0.338	
$ZnSO_4 \cdot 7H_2O$	287.55	0.575	
$CuSO_4 \cdot 5H_2O$	249.71	0.125	

H_2MOO_4 (85% MOO_3)	161.97	0.081	
Fe-EDTA**	346.08	6.922	1.0

*** A combined stock solution is made up containing all micro-nutrients except iron**

**** Ferrous dihydrogen ethylenedimine tetracetic acid**

Table 3.2 Details of ingredients needed for the formulation of irrigation water

S.No.	Symbol	EC	mel^{-1} of various salts			
			NaCl	$CaCl_2$	$MgSO_4$	$NaHCO_3$
1.	S0	0				
2.	S1	3	7	3	5	5
3.	S2	6	26	9	15	10
4.	S3	9	44	13.5	22.5	10

$CaCl_2$ = mixed in the last to avoid precipitation

3.4 OBSERVATIONS RECORDED ON SEEDLING

On the 11th day, the seedlings were harvested from each of the petridish and following observations were recorded.

3.4.1 Germination percentage

The total number of germinated seeds were counted and expressed as germination percentage over total number of seeds planted. A seed was considered to have germinated which produced a coleoptile of 0.5 cm length.

3.4.2 Seedling height (cm)

The length of each seedling was measured from the base of the coleoptile to the tip of the seedling in centimeters and averaged to obtain seedling height.

Each seedling, after measuring the seedling height was washed in distilled water to remove any traces of filter paper attached. The shoots and roots of all seedlings of a petridish were separated and kept in self-sealing polyethene bags separately to record the following observations.

3.4.3 Coleoptile length (cm)

The coleoptile length of germinated seedlings was measured in centimeters and averaged to obtain coleoptile length.

3.4.4 Fresh weight of shoot per seedling (g)

The fresh weight of shoots of all seedlings in a petriplate was weighed on a sensitive electronic balance and averaged to obtain fresh weight of shoot per seedling.

3.4.5 Fresh weight of root per seedling (g)

The fresh weight of root of all seedlings in a petriplate was weighed on a sensitive electronic balance and averaged to obtain fresh weight of root per seedling.

After recording the observations of fresh weight of shoot and root of all the seedlings in a petridish, they were kept in an oven at 60^0C for 3 days. After which the following observations were recorded.

3.4.6 Dry weight of shoot per seedling (g)

The dried shoots in each petridish were weighed on a sensitive electronic balance and averaged to obtain dry weight of shoot per seedling.

3.4.7 Dry weight of root per seedling (g)

The dried roots of seedlings in a petridish were weighed on a sensitive electronic balance and averaged to obtain dry weight of roots per seedling.

3.4.8 Ratio of fresh weight of shoots to fresh weight of roots

The ratio between fresh weight of shoots and fresh weight of roots was obtained.

3.4.9 Ratio of dry weight of shoots to dry weight of roots

The ratio between dry weight of shoots and dry weight of roots was obtained.

3.5 STATISTICAL METHODOLOGY

Data on different characters were subjected to the following statistical analysis.

3.5.1 Analysis Of Variance

In the present investigation the experiment was laid in Completely Randomized Block Design (CRD) with 3 replications ANOVA of this design is as follows:

Table 3.3: Skeleton of ANOVA for CRD

S.No.	Source of variance	d.f.	SS	MS	EMS
1.	Genotype	g-1	$\sum_{i=1}^{g}\left(\sum_{j=1}^{r} x\,ij\right)^2 / r - \left(\sum_{i=1}^{g}\sum_{j=1}^{r} x\,ij\right)^2 / rg$	MSg	$\sigma^2 + r\,\sigma^2 g$
2.	Error	g (r-1)	Total SS-Genotypes SS	MSg	σ^2
	Total	r g-1	$\sum_{i=1}^{g}\sum_{j=1}^{r} x_{ij}^2 - \left(\sum_{i=1}^{g}\sum_{j=1}^{r} x\,ij\right)^2 / rg$		

Table 3.4: Skeleton of analysis of variance for CRD over salinity levels

S.No.	Source of variance	d.f.	SS	MS	F
1.	Genotypes (G)	g-1	$\frac{1}{sr}\sum_{i=1}^{g}\left[\sum_{j=1}^{s}\sum_{k=1}^{r} x_{ijk}\right]^2 - \frac{1}{gsr}\left[\sum_{i=11}^{g}\sum_{j=1}^{s}\sum_{k=1}^{r} x_{ijk}\right]^2$	$\frac{SSG}{g-1}$	$\frac{MS_g}{MS_e}$
2.	Salinity (s)	s-1	$\frac{1}{gr}\sum_{j=1}^{s}\left[\sum_{i=1}^{g}\sum_{k=1}^{r} x_{ijk}\right]^2 - \frac{1}{gsr}\left[\sum_{i=11}^{g}\sum_{j=1}^{s}\sum_{k=1}^{r} x_{ijk}\right]^2$	$\frac{SSG}{s-1}$	$\frac{MS_s}{MS_e}$
3.	Genotype x Salinity (G x s)	(g-1) (S-1)	$\frac{1}{r}\sum_{i=1}^{g}\sum_{j=1}^{s}\left[\sum_{k=1}^{r} x_{ijk}\right]^2 - \frac{1}{gsr}\left[\sum_{i=1}^{g}\sum_{j=1}^{s}\sum_{k=1}^{r} x_{ijk}\right]^2$	$\frac{SSGxS}{(g-1)(s-1)}$	$\frac{MS_{gxs}}{MS_e}$
4.	Error		$\sum_{j=1}^{s} SSE_i$		MS_e
	Total	gsr-1	$\sum_{i-1}^{g}\sum_{j-1}^{s}\sum_{k-1}^{r} x_{ijk}^2 - \frac{1}{gsr}\left[\sum_{i-1}^{g}\sum_{j-1}^{s}\sum_{k-1}^{r} x_{ijk}\right]^2$		

Where

g = Number of genotypes

s = Number of salinity levels

r = Number of replication

Coefficient of variance (CV)

$$CV = \frac{\sqrt{MS_e}}{\overline{X}} X100$$

Where

MS_e = Error mean square

X = General mean i.e. $\left[\sum_{i-1}^{s} \sum_{j-1}^{g} \sum_{k-1}^{r} x_{ijk} \right]$ / gsr

TesT of dif ference beTween Two means

Critical difference was calculated
SE_m (Standard error difference of means) = $\sqrt{2MSe / r}$

Critical difference, $CD_{5\%} = SE_d$ x t

Where

MSe = Error mean square

r = No. of replication

t = t-value for error degrees of freedom at 5% level of significance

3.5.2 Estimation of variability parameters

The magnitude of variation existing in a character was estimated by the formula given by Burton (1952).

Genotypic coefficient of variation (GCV): $= \frac{\sqrt{V_g}}{\bar{x}} \times 100$

Phenotypic coefficient of variation (PCV) $= \frac{\sqrt{V_p}}{\bar{x}} \times 100$

Heritability

Heritability in the broad sense was calculated by using the formula proposed by Burton and Devane (1953).

$$h^2 = \frac{V_g}{V_p} \times 100$$

Where,

h^2	=	Heritability (Broad sense)
V_g	=	Genotypic variance and
V_p	=	Phenotypic variance

Expected genetic advance

Expected genetic advance was measured by the formula proposed by Lush (1949).

$$GA = \frac{V_g}{V_p} \times \sqrt{V_p} \times k$$

Genetic gain (in percent of mean):

Genetic gain was calculated by using the formula suggested by Johnson *et al.* (1955).

$$Genetic\ gain = \frac{GA}{\overline{X}} \times 100$$

Where,

Vg	=	Genotypic variance
Vp	=	Phenotypic variance
$\overline{X}$	=	General mean of the character under study
k	=	Selection differential (constant) i.e. 2.06 at 5% selection intensity (Allard, 1960)

3.5.2 Association analysis

Genotypic and phenotypic correlation coefficients were calculated using the genotypic and phenotypic variances and covariance in the formula suggested by Fisher (1954) and Al-Jibouri *et al.* (1958).

Genotypic correlation coefficient

$$r(xy)_{(g)} = \frac{CoV(xy)_{(g)}}{\sqrt{Vx_{(g)}\ Vy_{(g)}}}$$

Phenotypic correlation coefficient

$$r(xy)_{(p)} = \frac{CoV(xy)_{(p)}}{\sqrt{Vx_{(p)}\ Vy_{(p)}}}$$

Where,

$r\ (xy)_{(g)}$	=	Genotypic correlation coefficient between a pair of characters *viz.*, x and y.
$r\ (xy)_{(p)}$	=	Phenotypic correlation coefficient between a pair of characters *viz.*, x and y.
$CoV(xy)_{(g)}$	=	Genotypic covariance for a pair of characters *viz.*, x & y.
$CoV(xy)_{(p)}$	=	Phenotypic covariance for a pair of characters *viz.*, x & y
$Vx_{(g)}$	=	Genotypic variance for character x
$Vy_{(g)}$	=	Genotypic variance for character y
$Vx_{(p)}$	=	Phenotypic variance for character x
$Vy_{(p)}$	=	Phenotypic variance for character y

The significance of correlation was tested using the formula:

$$t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

Where,

r = Correlation coefficient, and

n = Number of observations.

The calculated values of t were tested against the table values of t with (n-2) d.f at 5 and 1 per cent levels of significance.

3.5.4 STABILITY ANALYSIS

Stability parameters were estimated using the model proposed by Eberhart and Russell (1966). The model provides estimates of desirable stability by calculating the regression of each genotype in the experiment on an environment index and a function of the squared deviation from this regression. Accounting to this model, a desirable variety with good stability should have high mean (μ), unit regression coefficient ($b_i = 1$) and the deviation from regression as small as possible ($S^2di = 0$).

Eberhrt nd Ruell (1966) ued the folloing model to tudy the tbility of vrietie under different environment

$$Y_{ij} = \mu_i + b_i I_j + \delta_{ij}$$

Where,

Y_{ij}	=	mean of the i^{th} genotype at the j^{th} environment
μ_i	=	mean of the i^{th} genotype over all environment
b_i	=	regression coefficient that measure the response of the i^{th} genotype to varying environment
δ_{ij}	=	the deviation from regression of the i^{th} genotype at the j^{th} environment
I_j	=	the environmental index is defined as the deviation of all the genotypes at a given environment from the over all mean.

$$I_j = \left(\sum_{i=1}^{g} Y_{ij}\right) / g - \left(\sum_{i=1}^{g}\sum_{j=1}^{s} Y_{ij}\right) / gs$$

With

$$\sum_{j=1}^{s} I_j = 0$$

$$CF = \left(\sum_{j=1}^{s}\sum_{i=1}^{g}\sum_{k=1}^{r} Y_{ijk}\right)^2 / sgr$$

Where,

g = Number of genotype

s = Number of environment and

r = Number of replications

$$\delta_i^2 = \left[\sum_{j=1}^{s}\left(\sum_{k=1}^{r} Y_{ijk}\right)^2 / r - \left(\sum_{j=1}^{s}\sum_{k=1}^{r} Y_{ijk}\right)^2 / sr\right] - \left[\sum_{j=1}^{s}\left(\left(\sum_{k=1}^{r} Y_{ijk} / r\right) I_j\right)^2 / \sum_{j=1}^{s} I_j^2\right]$$

3.5.1 Test of significance

The significance of genotype x environment (G x E), environment + (genotype x environment) and pooled deviation was tested against pooled error i.e. MS_3/MS_8, MS_4/MS_8 and MS_7/MS_8. The significance of genotype (G) and environment (E) was tested against genotype x environment (G x E) i.e. MS_1/MS_3 and MS_2/MS_3. Similarly if pooled deviation is significant, then environmental linear (E-lin.) and genotype x environment linear (G x E-lin.) is tested against pooled deviation else tested against pooled error.

(1) Regression coefficient (b_i)

The regression coefficient (b_i) was estimated as,

$$b_i = \sum_{j=1}^{s}\left((Y_{ijk} / r) I_j\right) / \sum_{j=1}^{s} I_j^2$$

The significance of b_i was tested as

$$t = \frac{b_i}{S.E.(bi)}$$

Where,

$$S.E.(bi) = \frac{\sqrt{\delta_i^2 / (s-2)}}{\sum_{j=1}^{s} I_j^2}$$

(II) Deviation from linear regression (S^2di)

It is another stability parameters which was estimated as follows:

$$S^2di = \left[\delta_i^2 / (s-2)\right] - M_8 / r$$

The test of deviation from regression for each genotype was obtained as

$$F = \delta_i^2 / (S-2) / M_8 .$$

A stable genotype is one which has $b_i = 1$ and $S^2di = 0$.

4. EXPERIMENTAL RESULTS

The results of the present investigation entitled **“Screening and Stability Analysis for Salinity Tolerance in Sorghum (*Sorghum bicolor L.*)”** are presented under following heads:

4.1 ANALYSIS OF VARIANCE AND MEAN PERFORMANCE

4.2 VARIABILITY PARAMETERS

4.3 CHARACTER ASSOCIATION

4.4 STABILITY PARAMETERS

4.1 ANALYSIS OF VARIANCE AND MEAN PERFORMANCE

Replication wise mean values of all the nine characters viz. germination percentage, coleoptile length, seedling height, fresh weight of shoot per seedling, fresh weight of root per seedling, dry weight of shoot per seedling, dry weight of root per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots, were subjected to analysis of variance.

Mean squares due to genotypes were significant for all the characters at all the salinity levels (Table 4.1). Similarly difference among salinity levels and interaction of genotypes with environments were also significant for all the characters. The mean performance of characters was as follows.

4.1.1. Germination percentage

At salinity level S_0, genotype Raj11 (96.33) exhibited highest germination percentage followed by Raj 5 (93.33), Raj 85 (93.33), Raj 7 (91.66), Raj 27 (91.66), Raj 31 (91.66), Raj 36 (91.66) and Raj 42 (91.66); these eight genotypes were statistically at par (Table 4.1.1). Lowest germination percentage was recorded in Raj 93 (55.00). Whereas, on mean basis 80.00 % germination was found.

The range for germination percentage at salinity level S_1 was 45.00 (Raj 93) to 91.66 (Raj 11). Genotypes Raj 27 (90.00), Raj 31 (90.00), Raj 42 (90.00), Raj 45 (88.33), Raj 48 (88.33), Raj 65 (88.33) and Raj 99 (88.33) had germination percentage at par to Raj 11. The average germination percentage was 76.03.

Genotype Raj 11 (90.00) also exhibited highest germination percentage at salinity level S_2 followed by Raj 31 (86.60), Raj 5 (85.58), Raj 27 (86.66) and Raj 44 (86.66) which were statistically at par to Raj 11 while genotype Raj 93 (46.6) had lowest germination percentage. Whereas, on mean basis 70.61 % germination was found.

At salinity level S_3 germination percentage ranged from 56.60 (Raj 93) to 83.33 (Raj 5). Genotypes Raj 31 (83.33), Raj 42 (83.33), Raj 66 (83.33), Raj 36 (80.00), Raj 39 (78.33), Raj 45 (80.00) and Raj 59 (78.33) had germination percentage at par to Raj 5. The average germination percentage was 61.51.

4.1.2. Seedling height (cm)

At salinity level S_0, genotype Raj 29 (22.34) exhibited maximum seedling height whereas minimum seedling height was recorded in Raj 72 (8.52) (Table 4.1.1). None of the genotype was at par to Raj 29 and average seedling height was 14.79.

The range for seedling height at salinity level S_1 was 7.05 (Raj 88) to 17.18 (Raj 42). Genotypes Raj 26 (16.81), Raj 56 (16.25), Raj 77 (16.20), Raj 47 (16.08), Raj 38 (16.05), Raj 45 (16.04), Raj 61 (16.01) and Raj 29 (15.97) had seedling height at par to Raj 42.Whereas mean seedling height was 13.73.

Genotype Raj 29 (15.30) exhibited maximum seedling height at salinity level S_2 followed by Raj 38 (15.18), which was statistically at par to Raj 29 while genotype Raj 88 had minimum seedling height (7.05). At salinity level S_3 seedling height ranged from 1.53 (Raj 52) to 14.02 (Raj 69) and none of the genotype was at par to Raj 69. Average seedling height was 9.96 at S_2 and 7.01 at S_3 salinity level.

4.1.3. Coleoptile length (cm)

The range for coleoptile length at salinity level S_0 was 4.05 (Raj 5) to 11.29 (Raj 42). Genotypes Raj 64 (11.12), Raj 54 (11.07) and Raj 52 (10.08) had coleoptile length at par to Raj 42, whereas mean value was 8.10 (Table 4.1.1).

At salinity level S_1, genotype Raj 73 (9.29), exhibited maximum coleoptile length followed by Raj 52 (8.99), which was statistically at par to Raj 73. Minimum coleoptile length was recorded in Raj 25 (3.85) and mean was 6.13.

At salinity level S_2, genotype Raj 73 (7.32) exhibited maximum coleoptile length while genotype Raj 35 (1.42) had the minimum value. Genotype Raj 73 (6.63) also exhibited maximum coleoptile length at salinity level S_3 followed by Raj 42 (6.44), Raj 4 (6.34) and Raj

89 (6.32), which were statistically at par to Raj 73 where as minimum coleoptile length was recorded in Raj 18 (1.34) and mean value was 4.64 at S_2 and 3.95 at S_3 salinity level.

4.1.4 Fresh weight of shoot per seedling (g)

At salinity level S_0, genotype Raj 36 (2.20) exhibited highest fresh weight of shoot per seedling followed by Raj 42 (2.18), where as lowest fresh weight of shoot per seedling was recorded in Raj 49 (0.52) and average value was 1.12 (Table 4.1.2).

The range for fresh weight of shoot per seedling at salinity level S_1 was 0.50 (Raj 13) to 1.95 (Raj 36) and Raj 42, whereas mean value was 1.00.

Genotype Raj 36 (1.80) exhibited highest fresh weight of shoot per seedling at salinity level S_2 followed by Raj 42 (1.79), which was statistically at par to Raj 36 while genotype Raj 13 (0.43) had lowest fresh weight of shoot per seedling. At salinity level S_3 fresh weight of shoot per seedling ranged from 0.41 (Raj 13) to 1.73 (Raj 42). The average value was 0.92 at S_2 and 0.83 at S_3 salinity level.

4.1.5 Fresh weight of root per seedling (g)

The range of fresh weight of root per seedling at salinity level S_0 was 0.04 (Raj 26) to 0.63 (Raj 91) (Table 4.1.2). At salinity level S_1, genotype Raj 37 (0.62) exhibited highest fresh weight of root per seedling while lowest value was recorded in Raj 0.41 (0.04). Genotype Raj 90 (0.55) exhibited highest fresh weight of root per seedling at salinity level S_2 while Raj 93 (0.03) was lowest in performance. Maximum and minimum fresh weight of root per seedling was in the same genotypes i.e. 0.52 and 0.05 at salinity level S_3 respectively. None of the genotype was at par to maximum value in any salinity level.

The mean fresh weight of root per seedling was 0.20 at S_0, 0.19 at S_1, 0.17 at S_2 and 0.16 at S_3 salinity level.

4.1.6 Dry weight of shoot per seedling (g)

Genotype Raj 42 exhibited highest dry weight of shoot per seedling (0.52) at salinity level S_0 where as genotype Raj 38 (0.05) had lowest dry weight of shoot per seedling (Table 4.1.2). The range of dry weight of shoot per seedling at salinity level S_1 was 0.04 (Raj 38) to 0.93 (Raj 76). At salinity level S_2, genotype Raj 94 (0.69) exhibited highest dry weight of shoot per seedling while, lowest value was exhibited by Raj 68 (0.03). At salinity level S_3, highest dry weight of shoot per seedling was recorded in Raj 33 (0.52) while lowest in Raj 91 (0.02). None of the genotype was at par to genotype exhibiting maximum dry weight.

The average dry weight of shoot per seedling was 0.14 at S_0, 0.13 at S_1, 0.12 at S_2 and 0.10 at S_3 salinity levels.

4.1.7 Dry weight of root per seedling (g)

The range for dry weight of root per seedling at salinity level S_0 was 0.01 (Raj 93) to 0.53 (Raj 15) (Table 4.1.3). At salinity level S_1, highest dry weight of root per seedling was recorded in genotype Raj 59 (0.61) while lowest in Raj 46 (0.03). Genotype Raj 59 (0.45) exhibited highest dry weight of root per seedling at salinity level S_2 while Raj 93 (0.01) exhibited the lowest value. At salinity level S_3, dry weight of root per seedling ranged from 0.002 (Raj 92) to 0.35 (Raj 59). None of the genotype was at par to the genotype having maximum dry weight.

The average dry weight of root per seedling was 0.04 at S_0 and S_1 and 0.03 at S_2 and S_3 salinity levels.

4.1.8 Ratio of fresh weight of shoots to fresh weight of roots

At salinity level S_0, genotype Raj 93 (22.24) exhibited highest ratio of fresh weight of shoots to fresh weight of roots followed by Raj 82 (22.17), which was statistically at par (Table 4.1.3). Lowest ratio of fresh weight of shoots to fresh weight of root was recorded in Raj 91 (2.49).

The range of ratio of fresh weight of shoots to fresh weight of roots at salinity level S_1 was 2.01 (Raj 91) to 59.23 (Raj 53), at S_2 was 1.20 (Raj 37) to 28.30 (Raj 41) and at S_3 1.40 (Raj 91) to 38.40 (Raj 42) and none of the genotype was at par to genotypes having highest ratio.

Mean value of ratio of fresh weight of shoots to fresh weight of roots was 8.53 at S_0, 7.53 at S_1, 6.00 at S_2 and 5.43 at S_3 salinity levels respectively.

4.1.9 Ratio of dry weight of shoots to dry weight of roots

The range of ratio of dry weight of shoots to dry weight of roots at salinity level S_0 was 0.34 (Raj 15) to 30.59 (Raj 36), at S_1 was 0.18 (Raj 59) to 39.56 (Raj 53), at S_2 was 0.20 (Raj 59) to 22.80 (Raj 94) and at S_3 was 0.23 (Raj 59) to 23.98 (Raj 17) (Table 4.1.3). None of the genotype was statistically at par to maximum value.

Mean value of ratio of dry weight of shoots to dry weight of roots was 4.45 at S_0, 4.96 at S_1, 4.18 at S_2 and 3.93 at S_3 salinity levels respectively.

4.2 VARIABILITY PARAMETERS

4.2.1 Genetic Coefficient of variation (GCV)

The perul of dt (Tble 4.2.1) reveled tht high GCV oberved for dry eight of root per eedling (118.99), rtio of dry eight of hoot to dry eight of root (79.83) nd dry eight of root per eedling t $_{0}$ linity level. At linity level $_{1}$ high GCV observed for rtio of dry eight of hoot to dry eight of root (102.03), dry eight of root per eedling (146.31) nd dry eight of hoot per eedling (89.89). At $_{2}$ linity level, dry eight of root per eedling (116.79) nd t $_{3}$ linity level, dry eight of root per eedling (103.45), rtio of freh eight of hoot to freh eight of root (85.47) nd rtio of dry eight of hoot to dry eight of root (85.63) exhibited high GCV.

Characters such as fresh weight of roots per seedling (57.47) and ratio of fresh weight of shoots to fresh weight of roots exhibited medium GCV at S_0 salinity level. Ratio of fresh weight of shoots to fresh weight of roots (62.40) and fresh weight of root per seedling (58.55) exhibited medium GCV at S_1 salinity level. Ratio of dry weight of shoots to dry weight of roots (75.45), dry weight of shoot per seedling (75.17) ratio of fresh weight of shoots to fresh weight of roots (64.14) and fresh weight of root per seedling (55.84) exhibited medium GCV at S_2 salinity level. Dry weight of shoot per seedling (64.81), fresh weight of root per seedling (53.37) and seedling height (39.85) exhibited medium GCV at S_3 salinity level.

Low GCV was observed for coleoptile length (29.31), fresh weight of shoot per seedling (26.67), seedling height (19.27) and germination percentage (10.87) at S_0 salinity level. At S_1 salinity level characters such as coleoptile length (23.56), fresh weight of shoot per seedling (27.64), seedling height (17.19) and germination percentage (11.86) exhibited low GCV. At S_2 salinity level fresh weight of shoot per seedling (29.29), seedling height (22.17), coleoptile length (20.27) and germination percentage (12.84) exhibited low GCV and at S_3 salinity level fresh weight of shoot per seedling (29.29), coleoptile length (24.13) and germination percentage (18.06) exhibited low GCV.

4.2.2. Phenotypic Coefficient of Variation (PCV)

The perusal of data (Table 4.2.1) revealed that high PCV was observed for dry weight of root per seedling at S_0 salinity level. At S_1 salinity level, dry weight of root per seedling (146.31) and ratio of dry weight of shoots to dry weight of roots exhibited high PCV. Dry weight of root per seedling (116.80) at S_2 salinity level and dry weight of root per seedling (103.47), ratio of fresh weight of shoots to fresh weight of root and ratio of dry weight of shoots to dry weight of roots (84.63) at S_3 salinity level exhibited high PCV.

Medium PCV was observed for ratio of dry weight of shoots to dry weight of roots (79.86), dry weight of shoot per seedling (72.65), fresh weight of root per seedling (57.48) and ratio of fresh weight of shoots to fresh weigh of roots (53.57) at S_0 salinity level. At S_1 salinity level, medium PCV was recorded for dry weight of shoot per seedling (89.89), ratio of fresh weight of shoots to fresh weight of roots (62.40) and fresh weight of root per seedling (58.59). At S_2 salinity level, medium PCV was recorded in ratio of dry weight of shoots to dry weight of roots (75.53), dry weight of shoot per seedling (75.17), ratio of fresh weight of shoots to fresh weight of roots (64.14) and fresh weight of root per seedling. At S_3 salinity level, medium PCV was exhibited by dry weight of shoot per seedling (64.81) and fresh weight of root per seedling (53.37).

Low PCV was observed for coleoptile length (29.71), fresh weight of shoot per seedling (26.68), seedling weight (19.34) and germination percentage (11.25) at S_0 salinity level. At S_1 salinity level, characters such as fresh weight of shoot per seedling (27.65), coleoptile length (23.75), seedling height (17.77) and germination percentage (12.23) exhibited low PCV. At S_2 salinity level, seedling height (39.91), fresh weight of shoot per seedling (31.72), coleoptile length (24.19) and germination percentage (18.49) exhibited low PCV and at S_3 salinity level low PCV was recorded for seedling height (39.91), fresh weight of shoot per seedling (31.72), coleoptile length (24.19) and germination percentage (18.48).

4.2.3 Heritability

The perusal of data (Table 4.2.1) revealed that high heritability was observed for fresh weight of root per seedling (100.00), dry weight of root per seedling (100.00), ratio of fresh weight of shoots to fresh weight of roots (99.99), fresh weight of shoot per seedling (99.93), dry weight of shoot per seedling (99.85), ratio of dry weight of shoots to dry weight of roots (99.93) and seedling height (99.25) at S_0 salinity level. At S_1 salinity level, high heritability was exhibited by fresh weight of root per seedling (100.00), dry weight of shoot per seedling (100.00), dry weight of root per seedling (99.99), ratio of fresh weight of shoots to fresh weight of roots (99.99) and fresh weight of shoot per seedling (99.95). At S_2 salinity level, high heritability was recorded for fresh weight of root per seedling (100.00), dry weight of shoot per seedling (100.00), ratio of fresh weight of shoots to fresh weight of roots (99.99), dry weight of root per seedling (99.98), fresh weight of shoot per seedling (99.93), seedling height (99.83) and ratio of dry weight of shoots to dry weight of roots (99.00). At S_3 salinity level high heritability was recorded in fresh weight of root per seedling (100.00), dry weight of shoots per seedling (100.00), ratio of fresh weight of shoots to fresh weight of roots (99.99), dry weight of root per seedling (99.96), fresh weight of shoot per seedling (99.94), seedling height (99.72) and ratio of fresh weight of shoots to fresh weight of roots (97.65).

The medium heritability was recorded for coleoptile length (97.28) at S_0 salinity level, ratio of dry weight of shoots to dry weight of roots (98.15) and coleoptile length (97.28) at S_1 salinity level, coleoptile length (97.32) at S_2 salinity level and ratio of dry weight of shoots to dry weight of roots (97.65) at S_3 salinity level.

Traits such as germination percentage (93.95) at S_0 salinity level, germination percentage (94.15) and seedling height (93.76) at S_1 salinity level, germination percentage (93.76) at S_2 salinity and germination percentage (95.78) at S_3 salinity level exhibited low PCV.

4.2.4 Genetic Gain

The perusal of data (Table 4.2.1) revealed that high genetic gain was recorded for dry weight of root per seedling (245.11) at S_0 salinity level, dry weight of root per seedling (301.28) and ratio of dry weight of shoots to dry weight of roots (208.23) at S_1 salinity level, dry weight of root per seedling (240.56) at S_2 salinity level and dry weight of root per seedling (213.07) at S_3 salinity level.

Medium genetic gain was observed for ratio of dry weight of shoots to dry weight of roots (164.39), dry weight of shoot per seedling, fresh weight of root per seedling (118.40) and ratio of fresh weight of shoots to fresh weight of roots (110.34) at S_0 salinity level. At S_1 salinity level, medium genetic gain was observed for dry weight of shoot per seedling (185.17), ratio of fresh weight of shoots to fresh weight of root (128.53) and fresh weight of roots per seedling (120.69). At S_2 salinity level, medium genetic gain was observed for ratio of dry weight of shoots to dry weight of roots (155.29), dry weight of shoot per seedling (154.85) ratio of fresh weight of shoots per to fresh weight of root (132.11) and fresh weight of root per seedling (115.04). Ratio of fresh weight of shoots to fresh weight of roots (176.08), ratio of dry weight of shoots to dry weight of roots (170.25), dry weight of shoot per seedling (133.51) and fresh weight of root per seedling (109.95) exhibited medium genetic gain at S_3 salinity level.

Low genetic gain was recorded for coleoptile length (59.54), fresh weight of shoot per seedling (54.92), seedling length (39.54) and germination percentage (21.63) at S_0 salinity level. At S_1 salinity level low genetic gain was observed for fresh weight of shoot per seedling (56.93), coleoptile length (48.13), seedling weight (34.27) and germination percentage (23.72). Whereas fresh weight of shoot per seedling (60.31), seedling height (45.62), coleoptile length (41.19), and germination percentage (25.62) at S_2 salinity level and fresh weight of shoot per seedling (65.31), seedling height (81.98), coleoptile length (49.56) and germination percentage (36.33) at S_3 salinity level exhibited low genetic gain.

4.3 CHARACTER ASSOCIATION

The correlation coefficients at both genotypic and phenotypic level were worked out between different characters in each environment, and are presented in table 4.3.1-4.3.4. The genotypic correlation coefficients were higher than phenotypic correlation coefficients in all the salinity levels.

Perusal of the table 4.3.1 indicated that at S_0 salinity level, significant and positive association was observed for germination percentage with seedling height, fresh weight of shoot per seedling with fresh weight of root per seedling, dry weight of shoot per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots; fresh weight of root per seedling with dry weight of shoot per seedling and ratio of fresh weight of shoots to fresh weight of roots with ratio of dry weight of shoots to dry weight of roots . While significant and negative association was observed for germination percentage with seedling height; seedling height with coleoptile length, fresh weight of root per seedling and ratio of fresh weight of shoots to fresh weight of roots and dry weight of root per seedling with ratio of dry weight of shoots to dry weight of roots.

At S_1 salinity level, positive and significant association was observed for germination percentage with seedling height and coleoptile length; fresh weight of shoot per seedling with fresh weight of root per seedling, dry weight of shoot per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots; fresh weight of root per seedling with dry weight of shoot per seedling and ratio of fresh weight of shoots to fresh weight of roots with ratio of dry weight of shoots to dry weight of roots (Table 4.3.2). While negative and significant association was observed for seedling height with coleoptile length; fresh weight of root per seedling with ratio of fresh weight of shoots to fresh weight of roots and dry weight of root per seedling with ratio of dry weight of shoots to dry weight of roots.

Perusal of the table 4.3.3 indicated that at S_2 salinity level, positive and significant association was observed for germination percentage with fresh weight of shoot per seedling; seedling height with fresh weight of shoot per seedling and ratio of fresh weight of shoots to fresh weight of roots; fresh weight of shoot per seedling with dry weight of shoot per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots; dry weight of shoot per seedling with ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots; and ratio of fresh weight of shoots to fresh weight of roots with ratio of dry weight of shoots to dry weight of root per seedling . While negative and significant association was observed for seedling height with coleoptile length, fresh weight of root per seedling with ratio of fresh weight of shoots to fresh weight of roots and dry weight of root per seedling with ratio of dry weight of shoots to dry weight of roots.

At S_3 salinity level, positive and significant association was observed for germination percentage with fresh weight shoot per seedling, dry weight of shoot per seedling and dry weight of root per seedling; fresh weight of shoot per seedling with dry weight of root per seedling , ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots and dry weight of shoots per seedling with ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots (Table 4.3.4). Negative and significant association was observed for seedling height with coleoptile length; fresh weigh of root per seedling with ratio of fresh weight of shoots to fresh weight of roots and dry weight of root per seedling with ratio of dry weight of shoots to dry weight of roots.

4.4 STABILITY ANALYSIS

Analysis of variance for stability analysis (Eberhart and Russell, 1966) revealed significant mean square due to all sources viz., environment, genotype, environment + genotype x environment, G x E linear and pooled deviation (Table 4.4.1).

In the present investigation, model proposed by Eberhart and Russell (1966) was used for analysis of G x E interaction. It considered both linear (bi) and non-linear (S^2di) components of G x E interaction for the prediction of performance of the individual genotype. The parameters are presented in table 4.4.2 to 4.4.4. The linear regression coefficient (bi) was considered as a measure of responsiveness and deviation from regression (S^2di) as a measure of stability. The analysis of variance revealed significant difference among genotypes, bi and S^2di for all the characters. The characters wise results are as follows:

4.4.1. Germination percentage

Out of total 100 genotypes non-significant deviation from regression was observed in 46 genotypes (Table 4.4.2). Among these genotypes mean germination percentage over the different salinity levels was above average in Raj 4, Raj 6, Raj 7, Raj 21, Raj 26, Raj 27, Raj 29, Raj 30, Raj 34, Raj 35, Raj 38, Raj 40, Raj 45, Raj 48, Raj 49, Raj 57, Raj 60, Raj 61, Raj 65, Raj 66, Raj 68, Raj 74, Raj 75, Raj 79, Raj 80, Raj 81, Raj 86, Raj 90, Raj 95 and Raj 99. Out of these thirty genotypes, twenty six genotypes were having non-signficant b_i, out of these thirteen genotypes *viz*., Raj 21, Raj 29, Raj 34, Raj 48, Raj 49, Raj 57, Raj 60, Raj 61, Raj 65, Raj 68, Raj 79, Raj 80 and Raj 86 were having regression coefficient around unity (bi≃1), eight genotypes viz. Raj 7, Raj 26, Raj 38, Raj 40, Raj 45, Raj 81, Raj 95 and Raj 99 were having regression coefficient greater than unity (b>1) and three genotype viz; Raj 4, Raj 27 and Raj 30 were having regression coefficient less than unity (b<1).

4.4.2. Seedling height (cm)

A perusal of data (Table 4.4.2) for this character revealed that out of total 100 genotypes, non-significant deviation from regression was exhibited by seven genotypes. Among these genotypes mean seedling height over the different salinity levels was above average in Raj 15, Raj 51, Raj 78, Raj 85 and Raj 91. Among these only one genotype Raj 51 was having regression coefficient around unity (bi≃1), two genotypes viz. Raj 78 and Raj 85 were having regression coefficient greater than unity (bi>1) and two genotypes Raj 15 and Raj 91 having regression coefficient less than unity (b<1).

44.3. Coleoptile length (cm)

The estimates of stability parameters for this trait revealed that deviation from regression (S^2di) was non-significant for eight genotypes (Table 4.4.2). Among these genotypes mean coleoptile length over the different salinity levels was above average in Raj 32, Raj 75 and Raj 82 and three genotypes viz. Raj 32, Raj 76 and Raj 82 were having regression coefficient greater than unity (b>1).

4.4.4. Fresh weight of shoot per seedling (g)

A perusal of stability parameters for this trait revealed that out of 100 genotypes, only four genotypes exhibited non-significant deviation from regression (S^2di), but none of these had fresh weight of shoot per seedling above mean over environments (Table 4.4.3).

4.4.5. Fresh weight of root per seedling (g)

The estimates of stability parameters for this trait revealed that not a single genotype was having non-significant deviation from regression (S^2di) (Table 4.4.3).

4.4.6. Dry weight of shoot per seedling (g)

Out of total 100 genotypes non-significant deviation from regression was observed in 11 genotypes (Table 4.4.3). Among these mean dry weight of shoot per seedling over the different salinity levels was above average in Raj 16 and Raj 75. Both these genotypes were having regression coefficient less than unity.

4.4.7. Dry weight of root per seedling (g)

A perusal of data for this character revealed that 19 genotype had non-significant deviation from regression (S^2di) (Table 4.4.4). Among these genotypes, mean dry weight of root per seedling over all the different salinity levels was above average in Raj 24, Raj 49 and Raj 86. Genotype Raj 49 was having regression coefficient greater than unity (bi>1) while the genotype Raj 86 was having regression coefficient less than unity (bi<1).

4.4.8. Ratio of fresh weight of shoots to fresh weight of roots

The estimates of stability parameters for this trait revealed that out of 100 genotypes, only one exhibited non significant deviation from regression whereas 91genotype had lower mean ratio of fresh weight of shoots to fresh weight of roots than population mean (Table 4.4.4).

4.4.9. Ratio of dry weight of shoots to dry weight of roots

Out of total 100 genotypes, non-significant deviation from regression was observed in 41 genotypes (Table 4.4.4). Among these genotypes, mean dry weight of shoots per dry weight of roots over the different salinity levels was above average in Raj 2, Raj 6, Raj 7, Raj 26, Raj 44, Raj 52, Raj 54, Raj 71, Raj 79, Raj 82 and Raj 84.

Only one genotype Raj 7 was having regression coefficient around unity (bi≃1) along with mean value higher than population mean. Two genotypes viz., Raj 2 and Raj 84 were having regression coefficient less than unity (b<1).

5. DISCUSSION

Sorghum is an important dry land crop grown for its utility as food, feed, forage and industrial raw material. Research efforts are being focused on it with the objective of improvement in higher yield potential. With the release of first sorghum hybrid CSH-1 in 1964, there was a rapid increase in productivity of sorghum in India. This was followed by the release of 17 more hybrids, including the popular CSH-5 and CSH-6 in the mid seventies and the subsequent release of widely adopted hybrids like CSH-9 in the eighties. Similarly, many popular varieties e.g. CSV-4, CSV-10, CSV-11, CSV-12, CSV-13 and CSV-15 have also been released. However, a critical overview of the present scenario reveals a stagnation in the yield potential and reduction in the area of sorghum from 18.5 mha in late sixties to 10 mha in 2000-01. The area of sorghum reduced on account of its competition with more remunerative crops. For sustainability of yield level and boosting the production, there is need to look at the possibility of exploiting marginal environments such as area affected by drought and salinity. Soil salinity in arid and semiarid regions, is a major detrimental factor for crop production. In India, around 10 mha of area is affected by salinity, out of which 17,8716 ha area is in Rajasthan. Exploitation of these soils can be done either by reclamation or by use of salt tolerant varieties. The reclamation of saline soil is possible to an extent but it is not economic. Until now, neither promising salt tolerant varieties are available nor much work has been done in this direction. In view of above facts 100 elite genotypes of sorghum collected from all over the Rajasthan were evaluated under four salinity level viz. 0, 3, 6, 9 dSm^{-1}. The results obtained are discussed as below:

The analysis of variance revealed significant difference among the genotypes for all the characters in all the salinity levels. Variation for germination percentage and seedling characteristics at different salinity level is also widely reported (Taylor, 1975; Kulhari, 1995; Kebebew and Mcmelly, 1995, Rosa, 1995, Azar *et al*., 1998; Kalavati, Aucioge and Demiroglu 2001 and Khan 2003).

The salinity gradient adversely affected the mean value of all the characters. The *per se* performance decreased with increasing the salinity. Such effects were also noticed by (Orga and Baijal, 1978, Verma and Yadav, 1985, Alberico and Carmey, 1993, Igartua, 1994; Macharia *et al*., 1995 and Kumari and Pillai 1997).

Comparison of mean performance of genotypes in different salinity levels revealed that genotype Raj 42 exhibited higher values for various traits viz., germination percentage, coleoptile length and fresh weight of shoot per seedling . Similarly Raj 36 showed higher mean values for germination percentage and fresh weight of shoot per seedling.

With respect to individual traits, genotype Raj 5 and Raj 31 for germination percentage, Raj 69 for seedling height, Raj 73 for coleoptile length, Raj 42 for fresh weight of shoot per seedling, Raj 90 for fresh weight of root per seedlings, Raj 33 for dry weight of shoot per seedlings, Raj 59 for dry weight of root per seedlings, Raj 42 for ratio of fresh weight of shoots to fresh weight of roots, and Raj 17 for ratio of dry weight of shoots to dry weight of roots were tolerant to salinity levels upto 9 dSm^{-1} as they exhibited higher mean performance for these traits.

To start any breeding programme first of all breeder should assess the presence of variability in the population under study, its nature and heritability. In present investigation the magnitude of PCV was higher than GCV in all the four salinity levels for all the characters, however, magnitude of both moved together. This indicates the importance of environment in the expression of characters.

In present study, high GCV was observed for dry weight of root per seedling and ratio of dry weight of shoots to dry weight of roots in all the four salinity levels. Besides these traits, some characters had high GCV in specific environment like dry weight of shoot per seedling in S_0 and S_1 and ratio of fresh weight of shoots to fresh weight of roots in S_3.Similar type of results of high GCV for one or other aforesaid character were reported by Mehdi and Ahsan (2002).

The efficiency with which genotypic variability can be utilized in breeding programme depends upon its heritability. In present study, heritability was high for fresh weight of root per seedling, dry weight of root per seedling, fresh weight of shoot per seedling and ratio of fresh weight of shoots to fresh weight of roots in all the four salinity levels. It indicated that heritability of these characters was less affected by salinity levels. Whereas, some characters had high heritability in specific environment such as seedling height in S_0, S_1 and S_3 and for ratio of dry weight of shoots to dry weight of roots in S_0 and S_2 which indicated that the inheritance of these traits was affected by salinity. These results were in accordance with the finding of Maiti *et al.* (1994).

The ultimate aim of studying the variability and heritability of any trait is to have an idea about the efficiency with which it can be improved by selection. The improvement in the mean performance of selected families over the base population is known as genetic advance. Genetic advance, when expressed as per cent of mean is called genetic gain. The genetic gain was high for dry weight of root per seedling in all the four salinity levels. Whereas, it was high for ratio of dry weight of shoots to dry weight of roots in S_1.

On the basis of above discussion about GCV, heritability and genetic gain it can be concluded that the experimental material of this study possess potential for improvement in dry weight of root per seedling as the estimates of GCV, heritability and genetic gain were high in this character in all the four salinity levels. Therefore selection is amicable in all the four salinity levels. Whereas, for ratio of dry weight of shoots to dry weight of roots it is amicable only in S_1 as estimates of these three parameters viz., GCV, heritability and genetic gain were higher in S_1 salinity level only.

Salinity tolerance, being complex character, is difficult to improve by direct selection. The efficiency of selection can be increased by simultaneous selection for few correlated characters. In present study the trend of genotypic and phenotypic correlation was similar between different characters. However, the genotypic correlation coefficients were slightly higher than the corresponding phenotypic correlation coefficients. This indicates role of environment on the association between characters.

The establishment of seedling determines the establishment of the plants in field. Parameters like germination percentage (Levitt, 1972 and Macharia *et al.* 1995), fresh weight of shoot per seedling (Prakash and shastry 1992; Sharma and shastry 1992;and

Ismariel *et al*. 1993) and dry weight of shoot per seedling (Azar and Mc Meilly, 1978 Prakash and Shastry 1992; Sharma and Shastry 1992, Allberico and Cramer 1993; Maiti *et al*., 1994 and Iqbal *et al*., 2000) could be used as reliable indicators of salinity resistance.

Germination percentage was positively and significantly correlated with fresh weight of shoot per seedling in all the salinity levels and with seedling height in S_1 salinity level Fresh weight of shoot per seedling was positively correlated with fresh weight of root per seedling, dry weight of shoot per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots in all the four salinity levels except with fresh weight or root per seedling in S_2 and S_3. Dry weight of shoot per seedling was having positive and significant correlation with ratio of dry weight of shoots to dry weight of roots in all salinity levels; with ratio of fresh weight of shoot to dry weight of roots at S_2 and S_3 salinity levels; and with fresh weight of root at S_0 and S_1 salinity levels. Among mutual correlations, ratio of dry weight of shoot to dry weight root was positively and significantly correlated with ratio of fresh weight of shoot to fresh weight of roots at S_0, S_1, and S_2 salinity levels.

The genotype having good performance at high salinity is assumed to have good performance at low salinity level but it is not necessary that it may have good performance in normal condition. Further, the trend to performance may not be linear therefore to identify genotypes suitable for different as well as for all salinity levels, study of G x E interaction in useful. The non-significance of pooled deviation suggests absence of non-linear variance where as significance of linear G x E suggests difference in response of genotypes. Significance of both the components for all the characters suggests that b_i and pooled deviation varied with the genotypes, therefore, need to study these parameter for different genotypes and characters.

In the present investigation, model proposed by Eberhert and Russell (1966) was used for the analysis of G x E interaction. It considers both linear (b_i) and non-linear (S^2di) component of G x E interaction for the prediction of performance of individual genotype.

According to this model an ideal stable variety is that which has zero deviation from regression i.e. S^2di non-significantly deviating from zero ($S^2di=0$), unit regression coefficient (b=1) and high per se performance. In this model regression coefficient is considered as a parameter of response and deviation from regression (S^2d) as a parameter of stability. Breese (1969) and Jatasra and Paroda (1979) also emphasized that ‘b_i’ could simply be regarded as a measure of response, where as S^2di is the most suitable measure of stability.

In present study, mean squares due to genotypes, environment, G x E and pool deviation were significant for all the traits. Thus, it is evident that sufficient variability among genotypes was present for all the characters, and that genotypes interacted considerably with the salinity levels.

Per se performance for all the traits was higher in normal conditions i.e. S_0 and was reduced with increasing the salinity level. Therefore, best environment for all the characters was S_0 and poorest was S_3. The magnitude of G x E (linear) was higher than the G x E (non linear) for all the characters. Therefore, prediction of performance is possible for all the traits.

The genotypes having S^2di around zero and mean performance higher than the population mean were classified into three categories for each of the characters. These categories are average responsive having wide adoption (b=1), genotypes suitable to poor environment (b<1) and genotypes suited to favourable environments (b>1). A perusal of table 5.1 indicated that genotypes *viz*. Raj 21, Raj 29, Raj 34, Raj 48, Raj 49, Raj 57, Raj 60, Raj 61, Raj 65, Raj 68, Raj 79, Raj 80 and Raj 86 exhibited wider adaptability for germination percentage where as genotypes *viz*. Raj. 4, Raj 27 and Raj 30 were identified for poor environment and genotypes Raj 7, Raj 26, Raj 38, Raj 40, Raj 45, Raj 81, Raj 95 and Raj 99 were identified for favourable environment. Likewise, for seedling height and ratio of dry weight of shoots to dry weight of roots, genotype Raj 51 and Raj 7 respectively were identified for varied environments. Whereas genotypes Raj 15 and Raj 9, and Raj 2 and Raj 84 respectively were identified for poor environment, however, for favourable environment Raj 78 and Raj 85 were identified for seedling height where as no genotype could be identified for ratio of fresh weight of shoots to fresh weight of roots.

Two other genotypes viz. Raj 16 and Raj 75 were identified for poor environment for dry weight of shoot per seedling. Where as some genotypes viz., Raj 32, Raj 76 and Raj 82 for coleoptiles length and Raj 49 and Raj 86 for dry weight of root per seedling were identified for favourable environments.

On the basis of above discussion it can be concluded that sufficient variability existed among the genotypes for all the characters at all the salinity levels. For salinity tolerance two type of characters are important, one is germination and another is seedling establishment. Among seedling establishment characters fresh weight of shoot per seedling and dry weight of shoot per seeding are most important. In present investigation, correlation between germination percentage and fresh weight of shoot was positive in all the salinity levels. Further Raj 42 and Raj 36 showed constant superiority over various salinity levels for both the characters. Study of GCV, PCV, heritability and genetic gain revealed that the experimental material possessed potential for improvement in traits viz., dry weight of root per seedling and ratio of dry weight of shoots to dry weight of roots. However, dry weight of shoot per seedling was positively correlated with germination percentage at S_3 level and had moderate genetic gain at all the salinity levels. Whereas, Raj 33 had highest dry weight of shoot but had germination of only 61.67 per cent but Raj 42 had high dry weight of shoot per seedling, therefore, Raj 42 can be selected. Further none of the genotype was stable for more which one character except Raj 7 that was stable and suitable for germination in good environment and for ratio of dry weight of shoots to dry weight of roots, it was average performer. For germination percentage, maximum genotypes having per se performance above average were stable where as for fresh weight of shoot per seedling, fresh weight of root per seedling and ratio of fresh weight of shoots to fresh weight of roots none of such genotype were stable. For germination percentage Raj 27, Raj 30 and Raj 4 having b<1 and germination percentage 81.67, 78.67 and 75.00 respectively could be identified for high salinity conditions.

Table 5.1: Sorghum genotypes classified with respect to their adoptability in difference types of salinity levels

CharaCters	b_i =1 Suited for varying environment	b_i <1 Suited for poor environment	b_i >1 Suited for favorable environment
Germination percentage	Raj 21, Raj 29, Raj 34, Raj 48, Raj 49, Raj 57, Raj 60, Raj 61, Raj 65, Raj 68, Raj 79, Raj 80, Raj 86	Raj 4, Raj 27, Raj 30	Raj 7, Raj 26, Raj 38, Raj 40, Raj 45, Raj 81, Raj 95, Raj 99
Seedling height	Raj 51	Raj15, Raj 91	Raj 78, Raj 85
Coleoptile length			Raj 32, Raj 76, Raj 82
Dry weight of shoot per seedling		Raj16, Raj 75	
Dry weight of root per seedling			Raj 49, Raj 86
Ratio of dry weight of shoots to dry weight of roots	Raj 7	Raj 2, Raj 84	

6. SUMMARY

The present investigation entitled **"Screening and stability analysis for salinity tolerance in Sorghum [*Sorghum bicolor* (L.) Moench]"** was an attempt to identify suitable genotypes for both salt affected soil and normal conditions through variability parameters, correlation and stability analysis.

The experimental material comprised of 100 elite genotypes of sorghum collected from different sorghum growing districts of Rajasthan. These genotypes were evaluated in CRD with three replications in four environments, created by four salinity levels (induced by supplementing different salts viz., NaCl, $MgSo_4$, $CaCl_2$ and $NaHCO_3$ to the medium) viz., control 0 dSm^{-1} (S_0), 3 dSm^{-1} (S_1), 6 dSm^{-1} (S_2) and 9 dSm^{-1} (S_3). Twenty seeds of each genotype were sown per petridish. Each petridish was irrigated with 5 ml of test solution during the first 5 days and with 10 ml of test solution after 5th day after draining out previous days solutions. The petridishes were placed in an environmental chamber at 25^0 C temperature. For the first three days, complete darkness was maintained and later on 14 hrs dark and 10 hrs lights was maintained. Exposure of light was achieved by tube lights and incandescent bulbs. The observations were recorded for nine characters *viz*., germination percentage, seedling height, coleoptile length, fresh weight of shoot per seedling, fresh weight of root per seedling, dry weight of shoot per seedling, dry weight of root per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots. The data were subjected to statistical analysis. The results of this study are as follows:

i. Analysis of variance exhibited presence of considerable variability in the genotypes for all the characters in all salinity levels.

ii. Pooled analysis of variance indicated significant difference among genotypes, salinity levels as well as the interaction between genotypes x salinity level indicating differential response of genotypes in different salinity gradient for all the traits.

iii. Mean performance of genotypes for all the characters was higher in normal conditions i.e. S_0 and decreased with increasing salinity levels.

iv. Comparison of mean performance of genotypes in various salinity levels revealed that genotype Raj 42 exhibited higher values for various traits *viz*., germination percentage, coleoptile length, ratio of fresh weight of shoots to fresh weight of root and fresh weight of shoot per seedling. Similarly Raj 36 showed higher mean values for germination percentage and fresh weight of shoot per seedling. Only one genotype Raj 42 exhibited higher mean performance in all the salinity levels for fresh weight of shoot per seedling. All other genotypes showed varied mean performance in different salinity levels. Whereas, genotypes *viz*., Raj 5 and Raj

31 for germination percentage, Raj 69 for seedling height, Raj 73 for coleoptile length, Raj 42 for fresh weight of shoot per seedling, Raj 90 for fresh weight of root per seedlings, Raj 33 for dry weight of shoot per seedlings, Raj 59 for dry weight of root per seedlings, Raj 42 for ratio of fresh weight of shoots to fresh weight of roots and Raj 17 for ratio of dry weight of shoots to dry weight of roots were higher in performance at highest level of salinity.

v. The genotypic coefficient of variation was higher for dry weight of root per seedling and ratio of dry weight of shoots to dry weight of roots in all the four salinity levels. The heritability was high for fresh weight of root per seedling, dry weight of shoot per seedling, dry weight of root per seedling, fresh weight of root per seedling and ratio of fresh weight of shoots to fresh weight of roots in all the four salinity levels. The expected genetic gain was high for dry weight of root per seedling in all the four salinity levels. Thus, the estimates of GCV, heritability and genetic gain were of higher order for dry weight of root per seedling in all the four salinity levels.

vi. Genotypic and phenotypic correlation coefficients depicted almost the same trend. However, the genotypic correlation was in general, higher than the corresponding phenotypic correlations. Significant and positive association was observed between the characters like fresh weight of shoot per seedling with fresh weight of root per seedling, dry weight of shoot per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots and dry weight of shoot per seedling with ratio of dry weight of shoots to dry weight of roots in all the four salinity levels. Mutual association of germination percentage and fresh weight of shoot per seedling was positive in all the four salinity levels.

vii. The analysis of variance for stability parameters revealed significant difference among genotypes for all the characters and considerable interaction of genotypes with environments. Genotypes viz. Raj 21, Raj 29, Raj 34, Raj 48, Raj 49, Raj 57, Raj 60, Raj 61, Raj 65, Raj 65, Raj 68, Raj 79, Raj 80 and Raj 86 for germination percentage, Raj 51 for seedling height and Raj 7 for ratio of dry weight of shoots to dry weight of roots showed stability under varying levels of salinity conditions.

viii. Three genotypes viz., Raj 27, Raj 30 and Raj 4 could be identified for salinity tolerance as they were stable having b_i>1 and high germination percentage at highest (S_3) salinity level. Though, genotype Raj 42 was not stable but it exhibited higher mean performance in all salinity levels for fresh weight of root per seedling and for coleoptile length, germination percentage and ratio of fresh weight of shoots to fresh weight of roots, so it is suggested that this genotype could be further tested for yield and other important attributes at varied salinity levels.

Table 3.5 : Analysis of variance for phenotypic stability parameters (Eberhart and Russell, 1966)

Source of variation	**d.f.**	**S.S.**	**M.S.**
Genotypes (G)	(g-1)	$\sum_{i=1}^{g}\left(\sum_{j=1}^{s}\sum_{k=1}^{r}Y_{ijk}\right)^2 / sr - CF$	M_1
E + (G x E)	g (s-1)	$\sum_{i=1}^{g}\sum_{j=1}^{s}\left(\sum_{k=1}^{r}Y_{ijk}\right)^2 / r - \sum_{i=1}^{g}\left(\sum_{j=1}^{s}\sum_{k=1}^{r}Y_{ijk}\right)^2 / sr$	M_4
Environment (Linear)	1	$\left(\sum_{i=1}^{s}Y_{.j.}I_j\right)^2 / \left(\sum_{j=1}^{s}I_j^2\right) / g$	M_5
Genotype x Environment (Linear)	(g-1)	$\sum_{j=1}^{s}\left[\sum_{j=1}^{s}\left(\sum_{k=1}^{r}Y_{ijk}\right)^2 r / \left(\sum_{j=1}^{s}I_j^2\right)\right] - environment\ linear\ SS$	M_6
Pooled deviation	g(s-2)	$\sum_{i=1}^{g}\left(\delta_i^2\right)$	M_7
Pooled error	s(r-1)(g-1)	$\sum_{j=1}^{s}Se_j$	M_8

Table 4.1.1 Mean values of genoTypes in differenT saliniTy levels for germination percentage, seedling height and coleoptile length

Genotypes/Salinity level	Germination percentaGe				Seedling height (cm)				Coleoptile length (cm)			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 1	80.00	78.33	66.67	55.00	12.65	12.64	12.60	12.63	7.53	5.85	4.55	4.14
Raj 2	81.67	85.00	76.67	56.67	11.31	11.31	11.28	11.30	8.13	5.09	5.08	5.50
Raj 3	86.67	85.00	86.67	70.00	12.17	12.19	12.08	12.15	8.70	6.49	5.38	5.10
Raj 4	75.00	73.33	73.33	75.00	11.94	11.95	11.93	11.94	8.70	7.09	6.52	6.34
Raj 5	93.33	85.00	85.00	83.33	11.70	11.69	11.67	11.69	4.06	4.09	2.98	3.30
Raj 6	70.00	68.33	63.33	53.33	11.13	11.15	11.17	11.15	9.79	6.76	3.48	3.40
Raj 7	91.67	85.00	70.00	53.33	14.59	14.49	14.47	14.52	7.86	6.13	6.26	5.47
Raj 8	75.00	73.33	68.33	68.33	16.59	16.49	16.47	16.52	9.90	7.79	5.15	3.90
Raj 9	86.67	88.33	71.67	56.67	10.54	10.51	10.46	10.50	10.00	6.29	3.78	5.47
Raj 10	85.00	70.00	75.00	45.00	19.45	19.46	19.49	19.47	5.63	4.49	2.28	3.97
Raj 11	96.67	91.67	90.00	75.00	14.60	14.58	14.59	14.59	9.70	6.29	4.52	3.64
Raj 12	78.33	71.67	76.67	48.33	14.35	14.39	14.44	14.40	9.24	7.16	6.29	3.97
Raj 13	65.00	65.00	70.00	61.67	13.54	13.44	13.41	13.46	6.50	8.09	5.92	5.70
Raj 14	78.33	80.00	73.33	60.00	13.38	13.43	13.46	13.43	7.93	5.55	3.65	4.44
Raj 15	83.33	86.67	76.67	60.00	13.50	13.47	13.45	13.47	5.28	4.75	3.55	2.47
Raj 16	83.33	86.67	81.67	68.33	17.41	17.43	17.40	17.41	5.26	4.85	4.12	3.17
Raj 17	86.67	76.67	76.67	63.33	11.32	11.37	11.31	11.33	5.96	4.42	2.08	5.30
Raj 18	56.67	55.00	50.00	48.33	11.29	11.28	11.27	11.28	5.63	4.39	4.35	1.34
Raj 19	80.00	81.67	65.00	48.33	9.60	12.80	12.32	11.57	6.10	4.89	3.18	3.30
Raj 20	71.67	71.67	55.00	40.00	17.37	17.39	17.44	17.40	5.30	4.09	3.92	3.84
Raj 21	86.67	80.00	76.67	66.67	13.28	13.26	13.27	13.27	6.83	5.25	3.30	3.60

Genotypes/Salinity level	Germination percentage				Seedling height (cm)				Coleoptile length (cm)			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 22	85.00	83.33	80.00	63.33	14.36	14.39	14.44	14.40	7.57	4.59	3.62	3.57
Raj 23	81.67	70.00	71.67	50.00	17.42	17.51	17.61	17.51	10.61	7.45	5.75	4.24
Raj 24	86.67	80.00	78.33	78.33	17.08	17.10	17.06	17.08	6.20	5.65	4.45	4.57
Raj 25	76.67	65.00	63.33	50.00	13.58	13.58	13.57	13.58	5.10	3.85	4.12	3.24
Raj 26	86.67	81.67	70.00	51.67	19.26	19.35	19.28	19.29	8.14	6.25	3.85	3.47
Raj 27	91.67	90.00	86.67	81.67	16.70	16.63	16.52	16.62	9.81	6.02	4.98	4.24
Raj 28	70.00	63.33	56.67	33.33	18.45	18.45	18.41	18.44	9.41	6.37	4.42	2.74
Raj 29	80.00	80.00	73.33	70.00	22.34	22.35	22.34	22.34	10.40	6.55	5.38	2.84
Raj 30	85.00	83.33	81.67	78.33	17.67	17.66	17.64	17.65	5.63	5.92	4.55	3.14
Raj 31	91.67	90.00	81.67	83.33	17.74	17.71	17.67	17.71	4.43	4.59	4.32	2.44
Raj 32	65.00	61.67	50.00	46.67	11.11	11.14	11.16	11.14	10.83	8.26	6.29	5.64
Raj 33	75.00	76.67	73.33	61.67	14.65	14.57	14.48	14.57	9.66	8.52	6.08	4.07
Raj 34	85.00	83.33	80.00	68.33	14.18	14.22	14.22	14.20	7.60	6.62	5.32	4.27
Raj 35	68.33	68.33	65.00	61.67	12.90	13.12	13.42	13.15	4.73	4.79	1.42	3.97
Raj 36	91.67	85.00	80.00	80.00	14.63	14.58	14.51	14.57	5.60	4.33	3.91	4.03
Raj 37	68.33	65.00	63.33	61.67	15.32	15.37	15.31	15.33	6.90	5.39	4.35	2.38
Raj 38	88.33	85.00	81.67	73.33	17.23	17.15	17.20	17.20	10.12	5.05	4.55	3.26
Raj 39	78.33	58.33	76.67	78.33	13.50	13.44	13.50	13.48	10.30	5.39	5.23	4.42
Raj 40	86.67	80.00	73.33	61.67	12.31	12.26	12.26	12.28	8.13	5.67	5.77	4.05
Raj 41	80.00	70.00	73.33	68.33	16.51	16.35	16.36	16.41	5.18	3.96	3.08	1.83
Raj 42	91.67	90.00	81.67	83.33	18.41	18.41	18.42	18.41	11.30	7.02	5.59	4.33
Raj 43	76.67	71.67	70.00	60.00	15.61	15.52	15.42	15.52	8.96	5.96	4.26	2.96
Raj 44	90.00	83.33	86.67	71.67	14.51	14.46	14.40	14.46	8.18	6.87	4.55	4.05
Raj 45	88.33	88.33	83.33	80.00	18.44	18.51	18.50	18.49	5.66	4.93	3.56	1.94
Raj 46	78.33	78.33	70.00	68.33	14.34	14.32	14.34	14.33	8.99	5.58	4.16	3.95
Raj 47	66.67	63.33	61.67	56.67	17.38	17.30	17.31	17.33	9.08	6.68	4.95	2.95
Raj 48	88.33	88.33	80.00	73.33	18.76	18.76	18.69	18.74	8.97	5.97	4.13	2.98
Raj 49	83.33	76.67	71.67	58.33	12.08	12.08	12.01	12.06	9.93	6.30	5.75	6.44

Genotypes/Salinity level	Germination percentage				Seedling height (cm)				Coleoptile length (cm)			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 50	80.00	75.00	68.33	56.67	14.69	14.69	14.62	14.67	10.36	6.94	4.50	4.15
Raj 51	78.33	71.67	66.67	51.67	16.72	16.72	16.65	16.70	6.51	5.04	3.96	3.78
Raj 52	70.00	70.00	63.33	63.33	10.01	10.01	9.94	9.99	10.89	8.54	6.25	5.61
Raj 53	83.33	70.00	73.33	68.33	15.73	15.73	15.66	15.71	7.76	6.02	4.38	3.14
Raj 54	83.33	71.67	70.00	61.67	14.96	14.96	14.89	14.94	11.08	7.96	6.35	5.58
Raj 55	78.33	76.67	68.33	60.00	14.45	14.45	14.38	14.43	4.78	4.35	5.27	5.39
Raj 56	80.00	80.00	61.67	51.67	17.00	17.00	16.93	16.98	5.76	4.27	3.25	1.48
Raj 57	83.33	80.00	73.33	61.67	0.36	0.36	0.29	0.34	10.45	6.07	4.77	4.36
Raj 58	78.33	70.00	66.67	53.33	13.55	13.55	13.48	13.53	9.13	6.93	5.06	5.50
Raj 59	90.00	80.00	78.33	78.33	12.89	12.89	12.82	12.87	5.49	6.90	3.75	2.43
Raj 60	85.00	81.67	80.00	70.00	17.24	17.24	17.17	17.22	8.53	7.44	5.53	4.46
Raj 61	86.67	80.00	78.33	66.67	15.28	15.28	15.21	15.26	7.03	6.09	3.89	3.67
Raj 62	73.33	70.00	70.00	60.00	18.47	18.47	18.40	18.45	5.78	4.38	3.74	3.45
Raj 63	85.00	83.33	56.67	60.00	16.05	16.05	15.98	16.03	9.89	7.17	4.64	3.34
Raj 64	71.67	70.00	68.33	60.00	17.57	17.57	17.50	17.55	11.13	7.33	6.92	3.27
Raj 65	90.00	88.33	80.00	68.33	17.19	17.19	17.12	17.17	10.36	6.80	3.80	3.14
Raj 66	86.67	86.67	83.33	83.33	15.08	15.08	15.01	15.06	8.74	7.64	4.99	4.90
Raj 67	76.67	76.67	71.67	60.00	17.10	17.10	17.03	17.08	9.24	4.32	5.42	2.70
Raj 68	90.00	85.00	73.33	63.33	17.51	17.51	17.44	17.49	7.11	6.49	4.18	2.15
Raj 69	60.00	66.67	60.00	43.33	12.36	12.36	12.29	12.34	10.80	8.49	6.95	4.84
Raj 70	73.33	81.67	71.67	53.33	13.47	13.47	13.40	13.45	9.03	6.21	3.94	4.94
Raj 71	76.67	71.67	70.00	55.00	12.60	12.60	12.53	12.58	9.45	5.86	5.81	3.28
Raj 72	65.00	58.33	56.67	56.67	8.52	8.52	8.45	8.50	6.58	6.39	5.98	5.59
Raj 73	75.00	58.33	63.33	66.67	11.10	11.10	11.03	11.08	10.53	9.29	7.32	6.80
Raj 74	75.00	76.67	70.00	66.67	15.75	15.75	15.68	15.73	8.36	7.11	5.75	4.59
Raj 75	78.33	75.00	75.00	73.33	14.73	14.73	14.66	14.71	5.39	4.44	3.42	2.71
Raj 76	88.33	78.33	75.00	68.33	14.80	14.80	14.73	14.78	10.10	7.22	5.02	4.34
Raj 77	90.00	86.67	76.67	71.67	19.70	19.70	19.63	19.68	6.75	4.82	4.10	2.67

Genotypes/Salinity level	Germination percentaGe				Seedling height (cm)				Coleoptile length (cm)			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 78	86.67	68.33	76.67	61.67	17.10	17.10	17.03	17.08	8.53	5.89	3.52	2.67
Raj 79	85.00	81.67	73.33	63.33	16.67	16.67	16.60	16.65	9.13	7.73	5.86	3.27
Raj 80	81.67	80.00	75.00	66.67	16.70	16.70	16.63	16.68	9.76	7.52	4.12	3.77
Raj 81	90.00	85.00	76.67	60.00	15.12	15.12	15.05	15.10	8.33	6.85	5.78	2.78
Raj 82	70.00	70.00	51.67	46.67	14.64	14.64	14.57	14.62	10.26	7.51	5.76	4.80
Raj 83	68.33	63.33	55.00	51.67	11.18	11.18	11.11	11.16	5.10	4.42	4.12	4.88
Raj 84	83.33	81.67	66.67	63.33	13.76	13.76	13.69	13.74	8.30	6.67	3.42	4.94
Raj 85	93.33	80.00	75.00	61.67	16.81	16.81	16.74	16.79	10.06	7.58	4.72	3.63
Raj 86	76.67	76.67	70.00	66.67	13.63	13.63	13.56	13.61	10.50	7.22	4.33	6.21
Raj 87	68.33	66.67	60.00	56.67	13.97	13.97	13.90	13.95	6.40	5.06	3.11	3.69
Raj 88	71.67	61.67	58.33	58.33	13.28	13.28	13.21	13.26	8.00	6.03	4.34	4.17
Raj 89	65.00	68.33	63.33	50.00	13.51	13.51	13.44	13.49	8.53	6.79	3.94	6.32
Raj 90	75.00	76.67	75.00	73.33	14.51	14.51	14.44	14.49	7.75	6.69	5.27	4.45
Raj 91	71.67	66.67	55.00	60.00	14.79	14.79	14.72	14.77	6.69	6.01	4.32	3.98
Raj 92	68.33	66.67	53.33	40.00	15.29	15.29	15.22	15.27	8.28	7.35	6.46	5.55
Raj 93	55.00	45.00	46.67	26.67	15.99	15.99	15.92	15.97	5.56	4.47	4.38	3.81
Raj 94	73.33	66.67	53.33	45.00	12.27	12.27	12.20	12.25	10.15	6.36	5.39	5.30
Raj 95	86.67	83.33	73.33	56.67	14.84	14.84	14.77	14.82	10.33	7.49	4.41	4.66
Raj 96	81.67	75.00	66.67	55.00	17.08	17.08	17.01	17.06	8.46	6.39	4.43	2.76
Raj 97	83.33	76.67	66.67	58.33	16.48	16.48	16.41	16.46	5.50	4.42	4.33	2.02
Raj 98	88.33	83.33	66.67	46.67	16.67	16.67	16.60	16.65	6.03	5.39	3.63	2.47
Raj 99	95.00	88.33	75.00	60.00	12.51	12.51	12.44	12.49	10.50	6.99	5.76	4.09
Raj 100	73.33	73.20	65.00	60.00	14.13	14.13	14.06	14.11	9.88	7.49	5.08	4.04
Mean	80.00	76.03	70.61	61.51	14.79	13.73	9.96	7.01	**8.10**	**6.132**	**4.64**	**3.95**
CD at 5%	**3.72**	**3.60**	**3.75**	**3.92**	0.39	0.91	0.14	0.24	**0.31**	**0.22**	**0.33**	**0.23**
CD at 1%	**4.91**	**4.75**	**4.92**	**5.17**	0.52	1.21	0.19	0.31	**0.41**	**0.30**	**0.44**	**0.31**

Table 4.1.2 Mean values of genotypes in different salinity levels for fresh weight of shoot per seedling, fresh weight of root per seedling and dry weight of shoot per seedling

Genotypes/Salinity level	Fresh weight oF shoot per seedling (g)				***Fresh weight of root per seedling (g)***				***Dry weight of shoot per seedling (g)***			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 1	0.74	0.72	0.66	0.62	0.09	0.07	0.06	0.06	0.11	0.11	0.10	0.09
Raj 2	1.15	1.14	1.00	0.93	0.11	0.09	0.09	0.08	0.14	0.12	0.11	0.10
Raj 3	1.33	1.15	0.93	0.90	0.23	0.21	0.20	0.20	0.15	0.13	0.10	0.09
Raj 4	1.42	1.32	1.29	1.28	0.24	0.17	0.14	0.12	0.17	0.16	0.16	0.16
Raj 5	1.51	1.33	1.30	1.29	0.24	0.22	0.19	0.18	0.21	0.20	0.20	0.20
Raj 6	0.79	0.75	0.70	0.66	0.12	0.12	0.10	0.09	0.16	0.15	0.12	0.10
Raj 7	1.05	0.98	0.96	0.82	0.16	0.15	0.20	0.24	0.14	0.13	0.10	0.07
Raj 8	1.34	1.25	1.23	1.19	0.18	0.20	0.20	0.22	0.15	0.14	0.13	0.13
Raj 9	0.63	0.61	0.60	0.58	0.08	0.07	0.07	0.06	0.11	0.10	0.09	0.09
Raj 10	0.67	0.68	0.60	0.59	0.13	0.12	0.10	0.09	0.10	0.10	0.09	0.07
Raj 11	1.42	1.29	1.11	0.92	0.18	0.16	0.15	0.13	0.18	0.16	0.14	0.11
Raj 12	0.96	0.76	0.66	0.53	0.06	0.07	0.07	0.08	0.16	0.14	0.14	0.09
Raj 13	0.55	0.50	0.43	0.41	0.10	0.09	0.08	0.07	0.13	0.11	0.09	0.08
Raj 14	0.83	0.73	0.65	0.54	0.06	0.07	0.08	0.10	0.10	0.09	0.08	0.07
Raj 15	1.42	1.32	1.23	1.11	0.20	0.18	0.17	0.15	0.18	0.16	0.15	0.15
Raj 16	1.25	0.98	0.99	0.93	0.22	0.20	0.19	0.16	0.14	0.13	0.12	0.11

Genotypes/Salinity level	Fresh weight oF shoot per seedling (g)				Fresh weight of root per seedling (g)				Dry weight of shoot per seedling (g)			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 17	1.28	1.14	1.08	1.06	0.15	0.13	0.09	0.09	0.15	0.13	0.13	0.11
Raj 18	1.46	1.40	1.30	1.26	0.17	0.15	0.15	0.12	0.20	0.19	0.19	0.19
Raj 19	1.15	1.12	1.02	0.98	0.13	0.11	0.09	0.08	0.13	0.11	0.10	0.10
Raj 20	0.97	0.57	0.55	0.46	0.13	0.11	0.09	0.08	0.10	0.10	0.09	0.10
Raj 21	1.12	0.99	0.92	0.86	0.12	0.09	0.06	0.09	0.15	0.13	0.11	0.11
Raj 22	1.33	1.15	0.93	0.90	0.16	0.15	0.14	0.12	0.14	0.14	0.10	0.10
Raj 23	0.76	0.65	0.59	0.56	0.29	0.27	0.25	0.22	0.09	0.09	0.09	0.08
Raj 24	1.08	1.00	0.96	0.92	0.39	0.37	0.35	0.31	0.16	0.15	0.15	0.15
Raj 25	0.95	0.73	0.68	0.62	0.06	0.08	0.09	0.27	0.06	0.05	0.04	0.03
Raj 26	1.12	0.91	0.83	0.71	0.05	0.09	0.11	0.18	0.13	0.12	0.10	0.09
Raj 27	1.13	1.12	0.99	0.98	0.18	0.16	0.14	0.13	0.10	0.09	0.09	0.06
Raj 28	0.98	0.92	0.65	0.44	0.14	0.14	0.12	0.09	0.16	0.15	0.15	0.01
Raj 29	1.72	1.68	1.62	1.52	0.16	0.15	0.13	0.11	0.25	0.23	0.20	0.20
Raj 30	0.93	0.92	0.87	0.75	0.19	0.18	0.17	0.15	0.22	0.21	0.21	0.21
Raj 31	1.32	1.30	1.20	1.11	0.15	0.12	0.11	0.09	0.15	0.14	0.14	0.13
Raj 32	0.97	0.92	0.91	0.86	0.13	0.12	0.09	0.06	0.09	0.09	0.09	0.08
Raj 33	1.33	0.79	0.70	0.68	0.24	0.23	0.09	0.21	0.13	0.09	0.09	0.52
Raj 34	1.21	1.12	1.01	0.95	0.24	0.24	0.24	0.23	0.14	0.13	0.12	0.12
Raj 35	0.84	0.80	0.64	0.60	0.26	0.24	0.23	0.22	0.09	0.09	0.05	0.05
Raj 36	2.21	1.95	1.82	1.65	0.09	0.17	0.35	0.43	1.02	0.92	0.61	0.13
Raj 37	1.13	0.71	0.70	0.76	0.06	0.62	0.09	0.20	0.14	0.11	0.09	0.10
Raj 38	0.62	0.59	0.52	0.48	0.08	0.07	0.07	0.07	0.05	0.04	0.04	0.03
Raj 39	1.26	1.12	1.03	0.96	0.21	0.20	0.18	0.16	0.12	0.12	0.11	0.09
Raj 40	0.78	0.71	0.68	0.61	0.13	0.12	0.10	0.08	0.08	0.08	0.07	0.05
Raj 41	1.50	1.25	1.19	1.00	0.05	0.04	0.47	0.08	0.16	0.15	0.15	0.15
Raj 42	2.10	1.83	1.79	1.73	0.05	0.07	0.08	0.10	0.52	0.48	0.42	0.37

Genotypes/Salinity level	Fresh weight oF shoot per seedling (g)				Fresh weight of root per seedling (g)				Dry weight of shoot per seedling (g)			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 43	0.91	0.83	0.71	0.65	0.15	0.14	0.13	0.11	0.10	0.09	0.09	0.05
Raj 44	1.29	1.16	0.98	0.92	0.24	0.21	0.19	0.18	0.15	0.14	0.11	0.10
Raj 45	1.32	1.39	1.25	1.11	0.24	0.22	0.20	0.19	0.24	0.20	0.19	0.19
Raj 46	1.26	1.15	0.95	0.91	0.19	0.17	0.17	0.16	0.14	0.13	0.12	0.11
Raj 47	1.20	1.09	0.98	0.75	0.15	0.12	0.10	0.06	0.14	0.13	0.12	0.10
Raj 48	1.40	1.25	1.16	1.00	0.16	0.15	0.14	0.09	0.16	0.15	0.14	0.14
Raj 49	0.53	0.68	0.52	0.43	0.16	0.15	0.10	0.13	0.12	0.11	0.09	0.05
Raj 50	0.96	0.76	0.66	0.53	0.20	0.25	0.18	0.16	0.16	0.13	0.13	0.13
Raj 51	1.48	1.27	1.15	0.95	0.18	0.17	0.16	0.14	0.22	0.20	0.20	0.17
Raj 52	0.95	0.77	0.69	0.59	0.12	0.12	0.10	0.07	0.10	0.09	0.09	0.08
Raj 53	1.25	1.19	1.15	0.95	0.13	0.13	0.04	0.10	0.16	0.12	0.12	0.12
Raj 54	1.41	1.36	1.30	1.25	0.32	0.30	0.17	0.29	0.18	0.16	0.15	0.15
Raj 55	1.36	1.25	1.17	1.13	0.26	0.24	0.23	0.22	0.15	0.14	0.13	0.13
Raj 56	0.95	0.73	0.63	0.53	0.25	0.24	0.21	0.20	0.13	0.11	0.09	0.08
Raj 57	1.01	0.99	0.97	0.85	0.13	0.12	0.12	0.10	0.13	0.12	0.10	0.10
Raj 58	0.99	0.86	0.78	0.69	0.14	0.14	0.12	0.07	0.12	0.10	0.10	0.09
Raj 59	1.18	1.05	0.93	0.89	0.16	0.13	0.13	0.10	0.13	0.11	0.09	0.08
Raj 60	0.69	0.64	0.60	0.53	0.20	0.18	0.16	0.15	0.09	0.08	0.05	0.04
Raj 61	1.53	1.43	1.40	1.32	0.45	0.39	0.33	0.30	0.24	0.23	0.23	0.22
Raj 62	0.83	0.84	0.76	0.71	0.29	0.26	0.25	0.22	0.14	0.14	0.13	0.13
Raj 63	0.96	0.87	0.79	0.76	0.23	0.22	0.19	0.17	0.16	0.12	0.12	0.10
Raj 64	0.93	0.92	0.87	0.75	0.19	0.18	0.16	0.14	0.10	0.09	0.06	0.05
Raj 65	1.05	0.98	0.96	0.82	0.20	0.16	0.15	0.13	0.14	0.12	0.10	0.08
Raj 66	0.75	0.70	0.96	0.62	0.15	0.13	0.12	0.11	0.11	0.09	0.09	0.07
Raj 67	0.81	0.75	0.71	0.66	0.16	0.14	0.14	0.11	0.10	0.08	0.08	0.07
Raj 68	0.95	0.92	0.87	0.76	0.21	0.20	0.19	0.18	0.16	0.12	0.11	0.09

Genotypes/Salinity level	Fresh weight oF shoot per seedling (g)				Fresh weight of root per seedling (g)				Dry weight of shoot per seedling (g)			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 69	0.78	0.73	0.95	0.56	0.14	0.12	0.13	0.10	0.09	0.07	0.06	0.04
Raj 70	0.95	0.74	0.65	0.52	0.15	0.13	0.15	0.09	0.09	0.08	0.07	0.05
Raj 71	0.72	0.64	0.51	0.45	0.32	0.28	0.26	0.23	0.12	0.10	0.10	0.09
Raj 72	0.95	0.87	0.73	0.65	0.15	0.12	0.09	0.06	0.11	0.09	0.08	0.05
Raj 73	1.22	1.22	1.21	1.11	0.49	0.48	0.47	0.47	0.18	0.17	0.16	0.16
Raj 74	1.21	0.93	0.85	0.81	0.28	0.27	0.11	0.22	0.14	0.12	0.11	0.10
Raj 75	1.39	1.30	1.29	1.18	0.38	0.37	0.35	0.33	0.16	0.16	0.15	0.14
Raj 76	1.26	1.15	0.96	0.81	0.30	0.28	0.27	0.25	0.11	0.93	0.08	0.05
Raj 77	1.35	1.26	1.13	1.11	0.27	0.25	0.24	0.23	0.14	0.14	0.13	0.13
Raj 78	1.15	1.11	0.96	0.85	0.25	0.22	0.17	0.20	0.09	0.07	0.06	0.04
Raj 79	1.16	1.10	0.85	0.81	0.22	0.20	0.19	0.16	0.12	0.11	0.10	0.09
Raj 80	0.95	0.65	0.62	0.59	0.08	0.12	0.11	0.15	0.08	0.05	0.04	0.04
Raj 81	1.15	1.12	1.02	0.98	0.17	0.15	0.14	0.14	0.13	0.11	0.10	0.10
Raj 82	1.19	0.95	0.83	0.62	0.12	0.10	0.10	0.05	0.07	0.07	0.07	0.05
Raj 83	1.28	1.21	1.02	0.97	0.16	0.14	0.11	0.08	0.10	0.08	0.08	0.07
Raj 84	1.64	1.41	1.23	1.11	0.37	0.33	0.07	0.32	0.15	0.13	0.12	0.10
Raj 85	1.01	0.98	0.97	0.85	0.29	0.29	0.27	0.25	0.13	0.12	0.10	0.10
Raj 86	0.96	0.84	0.75	0.63	0.14	0.14	0.06	0.12	0.13	0.11	0.10	0.10
Raj 87	0.65	0.62	0.52	0.51	0.16	0.14	0.11	0.08	0.10	0.09	0.09	0.09
Raj 88	1.14	0.95	0.86	0.73	0.28	0.28	0.25	0.24	0.10	0.09	0.07	0.07
Raj 89	0.82	0.73	0.70	0.66	0.22	0.19	0.19	0.15	0.09	0.08	0.07	0.07
Raj 90	1.43	1.23	1.20	0.95	0.62	0.59	0.56	0.53	0.16	0.15	0.13	0.12
Raj 91	1.30	1.12	0.93	0.89	0.63	0.58	0.55	0.52	0.12	0.11	0.10	0.09
Raj 92	1.43	1.35	1.17	1.15	0.21	0.20	0.16	0.15	0.09	0.08	0.05	0.02
Raj 93	1.15	0.97	0.83	0.75	0.12	0.09	0.03	0.05	0.09	0.07	0.05	0.03
Raj 94	1.06	0.93	0.90	0.78	0.24	0.25	0.19	0.17	0.08	0.07	0.69	0.06

Genotypes/Salinity level	Fresh weight oF shoot per seedling (g)				Fresh weight of root per seedling (g)				Dry weight of shoot per seedling (g)			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 95	1.39	1.16	1.00	0.93	0.16	0.15	0.13	0.12	0.14	0.12	0.11	0.07
Raj 96	1.22	1.12	0.93	0.83	0.27	0.26	0.25	0.22	0.10	0.09	0.09	0.08
Raj 97	0.83	0.72	0.65	0.60	0.30	0.26	0.24	0.21	0.09	0.07	0.07	0.06
Raj 98	0.95	0.82	0.70	0.69	0.35	0.34	0.32	0.28	0.08	0.08	0.07	0.06
Raj 99	0.89	0.80	0.69	0.62	0.27	0.25	0.23	0.21	0.07	0.07	0.07	0.06
Raj 100	0.86	0.75	0.70	0.69	0.33	0.29	0.28	0.27	0.08	0.07	0.07	0.06
Mean	1.12	1.00	0.92	0.83	0.201	0.19	0.17	0.16	**0.14**	**0.13**	**0.12**	**0.10**
CD at 5%	**0.013**	**0.008**	**0.009**	**0.010**	0.0008	0.0008	0.0002	0.0003	**0.001**	**0.0003**	**0.0003**	**0.003**
CD at 1%	**0.016**	**0.012**	**0.013**	**0.013**	0.001	0.001	0.0003	0.0005	**0.002**	**0.0005**	**0.0005**	**0.0005**

Table 4.1.3 Mean values of genotypes in different salinity levels for dry weight of root per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots

Genotypes/Salinity level	Dry weight of root per seeDling (g)				***Ratio of fresh weight of shoots to fresh weight roots***				***Ratio of dry weight of shoots to dry weight of roots***			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 1	0.02	0.02	0.01	0.01	11.66	11.24	10.08	6.93	5.65	5.88	6.69	7.98
Raj 2	0.02	0.02	0.02	0.02	13.61	12.96	10.89	8.81	5.55	5.72	5.43	5.27
Raj 3	0.03	0.03	0.03	0.02	6.74	5.79	4.41	4.00	4.49	4.49	3.60	3.74
Raj 4	0.02	0.04	0.05	0.06	12.18	9.63	7.83	5.37	7.83	3.85	3.10	2.83
Raj 5	0.03	0.04	0.04	0.05	8.19	6.87	5.87	5.49	6.08	5.31	4.94	4.32
Raj 6	0.02	0.02	0.02	0.02	8.83	7.67	6.08	5.38	7.36	7.60	6.63	5.71
Raj 7	0.03	0.03	0.02	0.02	4.41	4.90	6.41	5.12	4.53	5.10	4.09	3.47
Raj 8	0.04	0.03	0.03	0.02	6.02	6.25	6.24	6.70	3.56	4.50	3.85	5.79
Raj 9	0.05	0.04	0.04	0.04	9.71	8.57	8.07	7.31	2.15	2.34	2.29	2.25
Raj 10	0.03	0.03	0.02	0.02	7.02	6.89	5.21	4.47	3.00	3.69	4.05	4.68
Raj 11	0.02	0.03	0.03	0.03	10.55	8.53	6.85	5.26	7.28	5.58	5.62	4.41
Raj 12	0.02	0.02	0.02	0.02	11.87	10.42	9.49	9.30	8.43	9.17	7.32	4.21
Raj 13	0.02	0.02	0.01	0.01	7.97	6.09	4.93	4.18	7.07	6.85	6.44	5.36
Raj 14	0.02	0.03	0.02	0.03	8.42	8.80	9.31	8.69	4.56	3.45	3.57	2.52
Raj 15	0.53	0.04	0.03	0.03	9.31	8.00	6.95	5.72	0.34	3.85	5.20	5.58
Raj 16	0.04	0.04	0.03	0.02	7.69	5.28	5.10	4.35	3.23	3.32	3.87	5.50

Genotypes/Salinity level	Dry weight of root per seeDling (g)				Ratio of fresh weight of shoots to fresh weight roots				Ratio of dry weight of shoots to dry weight of roots			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 17	0.04	0.04	0.04	0.00	14.74	12.23	8.67	6.98	3.56	3.39	3.55	23.99
Raj 18	0.03	0.03	0.02	0.02	11.85	9.62	8.52	7.62	6.89	7.15	8.45	8.78
Raj 19	0.01	0.01	0.01	0.01	14.11	12.03	9.06	7.40	12.00	9.45	8.22	8.45
Raj 20	0.02	0.02	0.02	0.03	12.14	6.08	4.88	3.64	4.23	4.33	3.71	3.81
Raj 21	0.03	0.02	0.03	0.07	12.48	16.78	10.21	7.52	4.65	6.04	3.89	1.69
Raj 22	0.02	0.02	0.02	0.02	10.81	8.17	6.09	5.55	8.53	8.30	6.28	6.01
Raj 23	0.12	0.05	0.01	0.01	3.40	2.59	2.22	1.92	0.78	1.96	7.56	6.15
Raj 24	0.05	0.05	0.05	0.05	3.43	2.86	2.58	2.35	3.40	3.27	3.22	3.21
Raj 25	0.03	0.05	0.04	0.02	3.49	7.92	8.19	10.01	2.05	1.04	1.16	1.98
Raj 26	0.03	0.03	0.02	0.02	6.07	8.18	9.76	15.61	4.77	4.19	4.26	4.28
Raj 27	0.02	0.02	0.02	0.02	8.59	7.94	6.14	5.34	4.11	3.98	4.48	2.87
Raj 28	0.05	0.04	0.04	0.03	10.38	8.00	4.82	3.10	3.13	3.37	4.23	0.58
Raj 29	0.03	0.03	0.03	0.10	15.40	13.44	11.10	9.28	8.19	7.70	7.88	1.93
Raj 30	0.03	0.02	0.02	0.02	6.07	5.31	4.73	3.97	7.65	9.40	10.32	10.21
Raj 31	0.02	0.02	0.04	0.05	14.72	11.48	10.03	7.69	8.50	6.34	3.94	2.90
Raj 32	0.04	0.03	0.03	0.03	16.21	10.21	7.58	6.73	2.28	2.58	2.91	3.22
Raj 33	0.04	0.03	0.03	0.03	6.20	8.70	3.11	2.81	3.47	2.89	2.98	19.86
Raj 34	0.04	0.03	0.03	0.03	5.17	4.66	4.19	3.95	3.47	3.70	3.84	4.61
Raj 35	0.04	0.03	0.03	0.02	3.74	3.49	2.67	2.32	2.29	2.76	1.85	2.11
Raj 36	0.03	0.03	0.03	0.04	5.15	5.57	10.71	18.97	30.59	27.41	18.34	3.26
Raj 37	0.02	0.03	0.06	0.08	5.59	8.18	1.12	12.90	6.80	3.30	1.67	1.28
Raj 38	0.11	0.10	0.09	0.06	8.85	8.30	7.12	6.25	0.47	0.42	0.43	0.54
Raj 39	0.02	0.02	0.01	0.01	7.65	6.12	5.28	4.53	6.52	7.44	7.86	6.83
Raj 40	0.04	0.03	0.03	0.03	9.25	7.38	5.92	4.63	2.02	2.27	2.23	1.66
Raj 41	0.08	0.16	0.04	0.04	18.31	2.67	28.32	22.20	1.92	0.96	3.80	4.15
Raj 42	0.05	0.04	0.04	0.05	21.97	22.82	25.58	38.45	9.49	12.35	9.94	8.19

Genotypes/Salinity level	Dry weight of root per seeDling (g)				*Ratio of fresh weight of shoots to fresh weight roots*				*Ratio of dry weight of shoots to dry weight of roots*			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 43	0.03	0.02	0.02	0.02	8.10	6.29	5.11	4.49	3.44	3.85	4.45	2.54
Raj 44	0.02	0.02	0.02	0.02	6.98	6.00	4.63	3.93	6.63	6.90	5.81	6.01
Raj 45	0.05	0.06	0.07	0.08	6.89	6.93	5.66	4.74	4.62	3.22	2.65	2.32
Raj 46	0.16	0.09	0.06	0.05	7.71	6.82	5.50	4.93	0.84	1.42	2.04	2.35
Raj 47	0.03	0.04	0.04	0.04	20.14	11.48	7.98	4.95	3.97	2.87	2.86	2.87
Raj 48	0.05	0.04	0.04	0.06	14.73	9.27	7.93	6.15	3.13	3.30	3.36	2.29
Raj 49	0.07	0.06	0.05	0.05	4.04	6.75	3.62	2.65	1.82	1.92	1.66	1.17
Raj 50	0.05	0.05	0.05	0.04	5.89	4.17	2.61	2.62	3.11	2.82	2.81	2.96
Raj 51	0.03	0.03	0.03	0.03	10.61	7.85	6.70	5.26	6.96	6.86	6.45	5.63
Raj 52	0.02	0.02	0.02	0.02	14.41	7.81	6.04	4.77	5.19	4.91	4.93	4.72
Raj 53	0.03	0.00	0.04	0.04	12.67	29.23	9.22	7.22	4.90	39.56	3.19	3.30
Raj 54	0.03	0.03	0.03	0.03	4.80	8.10	4.29	3.88	5.41	5.42	5.08	5.54
Raj 55	0.06	0.01	0.06	0.06	6.11	5.40	4.86	4.30	2.47	10.90	2.07	2.09
Raj 56	0.04	0.04	0.05	0.05	4.66	3.44	2.70	2.12	3.26	2.56	2.02	1.51
Raj 57	0.07	0.07	0.06	0.06	9.60	8.57	8.16	6.46	1.80	1.76	1.59	1.61
Raj 58	0.10	0.05	0.07	0.02	14.86	7.42	5.79	4.97	1.26	2.11	1.39	4.51
Raj 59	0.10	0.25	0.45	0.35	11.96	8.40	7.08	5.71	1.26	0.00	0.20	0.23
Raj 60	0.09	0.08	0.07	0.06	4.55	3.92	3.35	2.73	1.02	1.04	0.70	0.67
Raj 61	0.03	0.03	0.03	0.08	5.11	4.40	3.57	2.93	6.85	6.76	7.60	2.93
Raj 62	0.04	0.03	0.03	0.07	3.77	3.34	2.89	2.43	3.43	3.90	4.00	1.80
Raj 63	0.06	0.05	0.04	0.03	5.70	4.52	3.69	3.29	2.65	2.37	2.72	3.77
Raj 64	0.02	0.02	0.02	0.02	6.45	5.67	4.97	3.97	4.54	4.68	2.96	2.62
Raj 65	0.01	0.01	0.01	0.01	7.82	6.45	5.93	4.21	9.06	8.88	6.76	5.70
Raj 66	0.05	0.04	0.04	0.04	7.06	5.71	7.25	4.12	2.27	2.05	2.11	1.86
Raj 67	0.06	0.05	0.05	0.05	7.34	5.53	5.04	4.06	1.65	1.59	1.44	1.43
Raj 68	0.02	0.02	0.02	0.02	5.28	4.79	4.35	3.57	7.04	6.19	5.46	5.12

Genotypes/Salinity level	Dry weight of root per seeDling (g)				Ratio of fresh weight of shoots to fresh weight roots				Ratio of dry weight of shoots to dry weight of roots			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 69	0.03	0.02	0.02	0.02	7.65	5.53	7.85	3.96	3.39	3.02	2.71	1.94
Raj 70	0.04	0.04	0.05	0.02	10.91	4.79	4.94	3.57	2.23	1.98	1.29	2.53
Raj 71	0.02	0.02	0.02	0.02	3.14	2.44	1.82	1.41	5.04	5.29	5.20	5.57
Raj 72	0.01	0.01	0.02	0.03	15.96	9.61	6.10	4.34	7.96	7.15	4.05	1.99
Raj 73	0.07	0.07	0.07	0.07	2.62	2.60	2.53	2.27	2.42	2.39	2.32	2.22
Raj 74	0.03	0.03	0.03	0.03	5.62	8.26	3.14	2.88	4.66	4.08	3.74	3.35
Raj 75	0.09	0.08	0.08	0.04	4.17	3.69	3.49	3.10	1.78	1.87	2.03	3.48
Raj 76	0.05	0.05	0.04	0.04	5.02	4.23	3.42	2.75	2.21	19.43	1.87	1.28
Raj 77	0.02	0.02	0.04	0.04	5.83	5.26	4.56	4.08	6.49	6.08	3.69	3.14
Raj 78	0.05	0.05	0.04	0.03	5.74	6.65	4.33	3.39	1.82	1.60	1.70	1.59
Raj 79	0.02	0.02	0.02	0.02	7.14	5.72	4.21	3.77	5.63	5.64	4.94	5.01
Raj 80	0.06	0.06	0.06	0.06	6.44	5.76	5.09	7.38	1.36	0.75	0.72	0.67
Raj 81	0.05	0.04	0.04	0.04	8.31	8.05	6.74	5.92	2.58	2.50	2.40	2.73
Raj 82	0.01	0.01	0.01	0.01	22.18	10.00	8.14	5.40	5.47	5.67	5.31	4.48
Raj 83	0.02	0.02	0.02	0.02	15.19	10.79	7.56	5.97	4.16	3.89	4.13	3.47
Raj 84	0.03	0.02	0.02	0.02	5.20	20.08	3.77	3.00	5.34	5.60	5.17	5.01
Raj 85	0.05	0.05	0.05	0.04	4.01	3.61	3.41	2.92	2.49	2.58	2.19	2.25
Raj 86	0.05	0.04	0.04	0.04	7.83	14.85	5.56	4.41	2.74	2.56	2.41	2.39
Raj 87	0.02	0.01	0.02	0.04	7.75	5.64	3.85	3.25	4.77	9.04	4.24	2.44
Raj 88	0.08	0.06	0.06	0.05	4.79	3.76	3.12	2.60	1.28	1.39	1.20	1.32
Raj 89	0.04	0.04	0.04	0.04	5.34	3.95	3.64	2.99	2.06	2.01	1.83	1.85
Raj 90	0.04	0.04	0.04	0.03	2.72	2.21	2.03	1.53	3.72	3.81	3.42	3.76
Raj 91	0.05	0.04	0.04	0.02	2.49	2.02	1.60	1.41	2.48	2.67	2.70	4.26
Raj 92	0.03	0.02	0.02	0.00	9.79	8.33	6.02	5.51	3.49	4.03	2.65	10.25
Raj 93	0.01	0.01	0.01	0.01	22.24	28.24	9.22	6.10	8.42	7.26	4.84	2.96
Raj 94	0.03	0.03	0.03	0.03	6.11	4.82	3.55	3.23	2.40	2.31	22.81	2.42

Genotypes/Salinity level	Dry weight of root per seeDling (g)				Ratio of fresh weight of shoots to fresh weight roots				Ratio of dry weight of shoots to dry weight of roots			
	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3	S_0	S_1	S_2	S_3
Raj 95	0.03	0.02	0.02	0.02	11.87	9.24	6.53	5.77	5.03	4.91	4.99	3.47
Raj 96	0.06	0.06	0.06	0.05	5.44	4.41	3.55	3.07	1.70	1.61	1.59	1.56
Raj 97	0.02	0.02	0.02	0.02	3.91	2.98	2.48	2.04	4.04	3.62	3.59	3.71
Raj 98	0.03	0.03	0.02	0.02	3.34	2.56	2.05	1.96	2.59	2.64	3.28	4.02
Raj 99	0.05	0.04	0.04	0.04	4.24	3.45	2.77	2.28	1.43	1.56	1.54	1.52
Raj 100	0.03	0.03	0.02	0.02	3.21	2.66	2.42	2.14	2.60	2.38	3.45	3.02
Mean	0.046	0.04	0.038	0.036	8.53	7.53	6.00	5.43	**4.45**	**4.96**	**4.18**	**3.93**
CD at 5%	**0.003**	**0.006**	**0.008**	**0.001**	0.06	0.007	0.068	0.063	**0.15**	**1.10**	**0.22**	**0.821**
CD at 1%	**0.005**	**0.009**	**0.001**	**0.001**	0.082	0.114	0.090	0.090	**0.20**	**1.47**	**0.30**	**1.08**

Table 4.2.1 Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (H) and genetic gain (GG) for different characters in sorghum

S.No	Characters	Salinity level	GCV	PCV	H^2	GG
1	Germination percentage	S_0	10.87	11.25	93.35	21.63
		S_1	11.86	12.23	94.15	23.72
		S_2	12.84	13.27	93.76	25.62
		S_3	18.06	18.49	95.38	36.33
2	Seedling height (cm)	S_0	19.27	19.34	99.25	39.54
		S_1	17.19	17.77	93.59	34.27
		S_2	22.17	22.19	99.83	45.62
		S_3	39.85	39.91	99.72	81.98
3	Coleoptile length (cm)	S_0	29.31	29.71	97.28	59.54
		S_1	23.56	23.75	98.35	48.13
		S_2	20.27	20.54	97.32	41.19
		S_3	24.13	24.19	99.45	49.56
4	Fresh weight of shoot per seedling (g)	S_0	26.67	26.68	99.93	54.92
		S_1	27.64	27.65	99.95	56.93
		S_2	29.29	29.30	99.93	60.31
		S_3	31.72	31.72	99.94	65.31
5	Fresh weight of root per seedling (g)	S_0	57.47	57.48	100.00	118.40
		S_1	58.59	58.59	100.00	120.69
		S_2	55.84	55.84	100.00	115.04
		S_3	53.37	53.37	100.00	109.95
6	Dry weight of shoot per seedling (g)	S_0	72.60	72.65	99.85	149.44
		S_1	89.89	89.89	100.00	185.17
		S_2	75.17	75.17	100.00	154.85
		S_3	64.81	64.81	100.00	133.51
7	Dry weight of root per seedling (g)	S_0	118.99	118.99	100.00	245.11
		S_1	146.31	146.31	99.99	301.38
		S_2	116.79	116.80	99.98	240.56
		S_3	103.45	103.47	99.96	213.07
8	Ratio of fresh weight of shoot to fresh weight of root	S_0	53.57	53.57	99.99	110.34
		S_1	62.40	62.40	99.99	128.53
		S_2	64.14	64.14	99.99	132.11
		S_3	85.47	85.47	99.99	176.06
9	Ratio of dry weight of shoot to dry weight of root	S_0	79.83	79.86	99.93	164.39
		S_1	102.03	102.99	98.15	208.23
		S_2	75.45	75.53	99.80	155.27
		S_3	83.63	84.63	97.65	170.25

Table 4.3.1 Genotypic and phenotypic correlation coefficient between seedling characters in sorghum at salinity level S_0

S.No	Character	r	Germination percentage	Seedling height	Coleoptile length	Fresh weight of shoot per seedling	Fresh weight of root per seedling	Dry weight of shoot per seedling	Dry weight of roots per seedling	Ratio of fresh weight of shoot to fresh weight of root	Ratio of dry weight of shoot to dry weight of root
1.	Germination percentage	g	-	0.26*	-0.24*	0.01	0.01	0.01	0.13	-0.19	-0.15
		p	-	0.15	-0.15	0.01	0.01	0.01	0.08	-0.11	-0.09
2.	Seedling height (cm)	g		-	-0.48**	0.14	0.09	0.10	-0.04	-0.07	0.06
		p		-	-0.47**	0.14	0.09	0.10	-0.04	-0.07	0.06
3.	Coleoptile length (cm)	g			-	-0.12	0.00	-0.06	-0.12	0.03	-0.05
		p			-	-0.12	0.00	-0.06	-0.12	0.03	-0.06
4.	Fresh weight of shoot per seedling (g)	g				-	0.31**	0.63**	0.06	0.25*	0.48**
		p				-	0.31**	0.63**	0.06	0.25*	0.48**
5.	Fresh weight of root per seedling (g)	g					-	0.27**	0.05	-0.70**	0.07
		p					-	0.26**	0.05	-0.70**	0.07
6.	Dry weight of shoot per seedling (g)	g						-	0.02	0.06	0.79**
		p						-	0.02	0.06	0.79**
7.	Dry weight of root per seedling (g)	g							-	-0.06	-0.32**
		p							-	-0.06	-0.32**
8.	Ratio of fresh weight of shoot to fresh weight of root	g								-	0.20*
		p								-	0.20*
9.	Ratio of dry weight of shoot to dry weight of root	g									-
		p									-

Table 4.3.2 Genotypic and phenotypic correlations between seedling characters in sorghum at salinity level S_1

S.No	Character	r	Germination percentage	Seedling height	Coleoptile length	Fresh weight of shoot per seedling	Fresh weight of roots per seedling	Dry weight of shoot per seedling	Dry weight of root per seedling	Ratio of fresh weight of shoot to fresh weight of root	Ratio of dry weight of shoot to dry weight of root
1.	Germination percentage	g	-	0.33**	-0.16	0.21*	-0.00	0.19	0.07	-0.09	0.02
		p	-	0.31**	-0.16	0.20*	-0.00	0.18	0.07	-0.09	0.02
2.	Seedling height (cm)	g		-	-0.40**	0.21*	0.11	0.15	0.09	-0.00	0.06
		p		-	-0.37**	0.20*	0.11	0.15	0.09	-0.00	0.06
3.	Coleoptile length (cm)	g			-	-0.04	-0.00	-0.03	-0.11	-0.04	-0.02
		p			-	-0.03	-0.00	-0.03	-0.11	-0.04	-0.02
4.	Fresh weight of shoot per seedling (g)	g				-	0.26**	0.53**	0.02	0.27**	0.38**
		p				-	0.26**	0.52**	0.02	0.27**	0.38**
5.	Fresh weight of root per seedling (g)	g					-	0.22*	0.08	-0.62**	-0.08
		p					-	0.22*	0.08	-0.62**	-0.08
6.	Dry weight of shoot per seedling (g)	g						-	-0.01	0.03	0.58**
		p						-	-0.01	0.03	0.58**
7.	Dry weight of root per seedling (g)	g							-	-0.09	-0.23*
		p							-	-0.09	-0.23*
8.	Ratio of fresh weight of shoot to fresh weight of root	g								-	0.45**
		p								-	0.45**
9.	Ratio of dry weight of shoot to dry weight of root	g									-
		p									-

Table 4.3.3 Genotypic and phenotypic correlations between seedling characters in sorghum at salinity level S_2

S.No	Character	r	Germination percentage	Seedling height	Coleoptile length	Fresh weight of shoot per seedling	Fresh weight of root per seedling	Dry weight of shoots per seedling	Dry weight of root per seedling	Ratio of fresh weight of shoots to fresh weight of roots	Ratio of dry weight of shoots to dry weight of rootss
1.	Germination percentage	g	-	0.14	-0.06	0.26**	-0.05	0.09	0.14	0.12	-0.01
		p	-	0.14	-0.06	0.25*	-0.05	0.08	0.14	0.12	-0.01
2.	Seedling height (cm)	g		-	-0.42**	0.22*	-0.03	0.10	0.04	0.20*	-0.01
		p		-	-0.41**	0.22*	-0.03	0.10	0.04	0.20*	-0.01
3.	Coleoptile length (cm)	g			-	-0.08	0.10	-0.10	0.05	-0.17	-0.08
		p			-	-0.08	0.09	-0.10	0.05	-0.17	-0.07
4.	Fresh weight of shoot per seedling (g)	g				-	0.14	0.54**	0.03	0.42**	0.35**
		p				-	0.14	0.54**	0.03	0.42**	0.35**
5.	Fresh weight of root per seedling (g)	g					-	0.06	0.02	-0.58**	-0.07
		p					-	0.06	0.02	-0.58**	-0.07
6.	Dry weight of shoot per seedling (g)	g						-	-0.02	0.26**	0.83**
		p						-	-0.02	0.26**	0.83**
7.	Dry weight of root per seedling (g)	g							-	-0.00	-0.28**
		p							-	-0.00	-0.28**
8.	Ratio of fresh weight of shoot to fresh weight of root	g								-	0.21*
		p								-	0.22*
9.	Ratio of dry weight of shoot to dry weight of root	g									-
		p									-

Table 4.3.4 Genotypic and phenotypic correlations between seedling characters in sorghum at salinity level S_3

S.No	Character	r	Germination percentage	Seedling height	Coleoptile length	Fresh weight of shoot per seedling	Fresh weight of root per seedling	Dry weight of shoot per seedling	Dry weight of root per seedling	Ratio of fresh weight of shoots to fresh weight of roots	Ratio of dry weight of shoots to dry weight of roots
1.	Germination percentage	g	-	0.02	-0.03	0.47**	0.15	0.37**	0.33**	0.19	-0.02
		p	-	0.02	-0.03	0.46**	0.15	0.37**	0.32**	0.19	-0.02
2.	Seedling height (cm)	g		-	-0.43**	0.19	0.05	0.14	0.21*	0.16	-0.04
		p		-	-0.42**	0.19	0.05	0.14	0.21*	0.16	-0.04
3.	Coleoptile length (cm)	g			-	-0.15	-0.05	-0.06	-0.11	-0.01	-0.08
		p			-	-0.15	-0.05	-0.06	-0.12	-0.01	-0.08
4.	Fresh weight of shoot per seedling (g)	g				-	0.19	0.50**	0.15	0.44**	0.20*
		p				-	0.19	0.50**	0.15	0.44**	0.20*
5.	Fresh weight of root per seedling (g)	g					-	0.11	0.02	-0.52**	-0.02
		p					-	0.11	0.02	-0.52**	-0.02
6.	Dry weight of shoot per seedling (g)	g						-	0.11	0.34**	0.51**
		p						-	0.11	0.34**	0.50**
7.	Dry weight of root per seedling (g)	g							-	0.05	-0.32**
		p							-	0.05	-0.32**
8.	Ratio of fresh weight of shoot to fresh weight of root	g								-	0.12
		p								-	0.12
9.	Ratio of dry weight of shoot to dry weight of root	g									-
		p									-

Table 4.1 Mean squares for different characters in different salinity levels in sorghum

S.No	Characters	Env	Genotype [99]	Error [200]
1	Germination percentage	S_0	232.15**	5.33
		S_1	248.98**	5.00
		S_2	252.29**	5.42
		S_3	376.27**	5.92
2	Seedling height (cm)	S_0	24.42**	0.06
		S_1	14.63**	0.32
		S_2	14.66**	0.01
		S_3	23.44**	0.02
3	Coleoptile length (cm)	S_0	4.08**	0.04
		S_1	3.60**	0.02
		S_2	4.68**	0.04
		S_3	11.48**	0.02
4	Fresh weight of shoot per seedling (g)	S_0	0.27**	6.433e-05
		S_1	0.23**	3.633e-05
		S_2	0.22**	4.934e-05
		S_3	0.21**	4.234e-05
5	Fresh weight of root per seedling (g)	S_0	0.03**	3.45e-07
		S_1	0.03**	4.15e-07
		S_2	0.03**	2.5e-08
		S_3	0.03**	6.5e-08
6	Dry weight of shoot per seedling (g)	S_0	0.03**	1.633e-05
		S_1	0.05**	6.5e-08
		S_2	0.02**	6.5e-08
		S_3	0.01**	6.5e-08
7	Dry weight of root per seedling (g)	S_0	0.01**	6.5e-08
		S_1	0.02**	2.65e-07
		S_2	0.01**	4.15e-07
		S_3	0.01*	5.2e-07
8	Ratio of fresh weight of shoot to fresh weight of root	S_0	62.69**	0.001
		S_1	66.24**	0.002
		S_2	44.54**	0.001
		S_3	64.78**	0.001
9	Ratio of dry weight of shoot to dry weight of root	S_0	37.91**	0.01
		S_1	77.32**	0.48
		S_2	29.86**	0.02
		S_3	32.72**	0.26

* Significant at 5 percent level
** Significant at 1 percent level

Table 4.4.1 Analysis of variance for stability parameters of over four salinity levels in sorghum (Eberhart and Russel, 1966)

S.No	Characters	Genotype [99]	E+(G x E) [300]	E (L) [1]	G x E (L) [99]	Pool dev. [200]	Pool Err [800]
1	Germination percentage	286.69**	91.40**	19180.94**	54.04**	14.44**	1.806
2		17.36**	14.16**	3419.31**	4.67**	1.82**	0.03449
3	Seedling height (cm)	5.05**	4.33**	1010.54**	1.79**	0.55**	0.01003
4		0.29**	0.02**	4.43**	0.01**	0.00**	1.603e-05
5	Coleoptile length (cm)	0.04**	0.00**	0.08**	0.00**	0.00**	7e-08
6		0.02**	0.01**	0.11**	0.01**	0.00**	1.377e-06
7	Fresh weight of shoot per seedling (g)	0.01**	0.00**	0.01**	0.00**	0.00**	1.05e-07
8		54.57**	10.20**	600.2**	13.44**	5.65**	0.0006322
9	Fresh weight of root per seedling (g)	30.12**	9.81**	58.14**	17.16**	5.94**	0.06376

* Significant at 5 percent level
** Significant at 1 percent level

Table 4.4.2 Estimates of stability parameters for germination percentage, seedling height and coleoptile length (Eberhart and Russel, 1966)

Genotype	Germination percentage			Seedling height			Coleoptile length		
	μ	b_i	S^2Di	μ	b_i	S^2Di	μ	b_i	S^2Di
Raj 1	70.00	1.43*	3.539	9.45	0.97**	0.1433**	5.52	0.83**+	-0.0036
Raj 2	75.00	1.48	30.74**	8.51	0.55	5.098**	5.95	0.65	1.079**
Raj 3	82.08	0.88	22.28**	8.51	1.09**	0.2335**	6.42	0.88*	0.0794**
Raj 4	74.17	-0.02++	-0.482	8.59	0.78*	0.324**	7.16	0.57*+	0.0694**
Raj 5	86.67	0.44	10.37**	9.32	0.85*	0.8596**	3.61	0.25+	0.1454**
Raj 6	63.75	0.93*	-0.14	6.95	1.37*	1.035**	5.86	1.64*	0.2933**
Raj 7	75.00	2.12**+	1.65	9.57	1.30**+	0.1092*	6.43	0.51	0.2164**
Raj 8	71.25	0.38+	2.014	11.39	0.92	5.608**	6.68	1.45**	0.1749**
Raj 9	75.83	1.79*	20.01**	8.04	1.07	2.869**	6.38	1.28	1.988**
Raj 10	68.75	1.96	65.32**	12.29	1.56	5.309**	4.09	0.59	1.122**
Raj 11	88.33	1.13*	5.448*	8.75	1.51**+	0.2483**	6.04	1.45**+	0.0831**
Raj 12	68.75	1.52	66.73**	10.60	0.84*	0.63**	6.66	1.14*	0.6014**
Raj 13	65.42	0.15	13.84**	8.29	1.18	5.257**	6.55	0.27	1.381**
Raj 14	72.92	1.08	10.28**	12.15	0.49*+	0.3984**	5.39	0.96	0.571**
Raj 15	76.67	1.40	21.98**	11.48	0.51**++	0.03509	4.01	0.65	0.248**
Raj 16	80.00	0.90	17.08**	13.74	0.84*	0.4496**	4.35	0.46	0.1596**
Raj 17	75.83	1.15*	9.637**	11.27	0.41	2.969**	4.44	0.46	3.232**
Raj 18	52.50	0.47*+	0.4505	8.51	0.47	1.497**	3.93	0.83	1.537**
Raj 19	68.75	1.88*	20.82**	13.55	0.43	0.5976**	4.37	0.74*	0.1176**
Raj 20	59.58	1.86*	14.88**	14.22	0.74*	0.2548**	4.29	0.35+	0.0779**
Raj 21	77.50	1.03**	0.09034	10.55	0.86**	0.2022**	4.74	0.86*	0.2037**
Raj 22	77.92	1.19*	10.53**	9.97	1.12*	0.8437**	4.84	0.98*	0.3974**
Raj 23	68.33	1.57	26.02**	12.43	1.07*	1.968**	7.01	1.48**+	0.0759**
Raj 24	80.83	0.38	7.896**	14.05	0.68*	0.5088**	5.22	0.44*+	0.0748**
Raj 25	63.75	1.32*	10.07**	11.05	0.65**+	0.02002	4.08	0.37+	0.1862**
Raj 26	72.50	1.94**+	0.2125	14.76	1.21**	0.1594**	5.43	1.18**	0.1051**
Raj 27	87.50	0.55**++	-1.747	12.60	1.25*	0.7927**	6.26	1.31*	0.4339**
Raj 28	55.83	1.97*+	7.548**	13.65	1.23**	0.07934*	5.73	1.55**+	0.0882**

Genotype	Germination percentage			Seedling height			Coleoptile length		
	μ	b_i	S^2Di	μ	b_i	S^2Di	μ	b_i	S^2Di
Raj 29	75.83	0.60*	1.435	16.38	1.20	4.046**	6.29	1.68*	0.615**
Raj 30	82.08	0.36**++	-1.804	13.23	0.97	1.906**	4.81	0.56	0.8031**
Raj 31	86.67	0.50	10.66**	12.92	1.18**	0.381**	3.94	0.36	0.8544**
Raj 32	55.83	1.05	11.09**	7.64	1.10*	0.6851**	7.75	1.27**+	0.0027
Raj 33	71.67	0.78	9.597**	8.68	1.34*	1.463**	7.08	1.30*	0.874**
Raj 34	79.17	0.92*	2.381	10.44	1.06*	0.5106**	5.95	0.78*	0.1419**
Raj 35	65.83	0.39*++	-1.144	10.42	1.05	2.849**	3.73	0.48	2.568**
Raj 36	84.17	0.59	10.85**	10.45	1.26**	0.3541**	4.47	0.40+	0.0946**
Raj 37	64.58	0.33+	-0.339	10.82	0.93	1.894**	4.75	0.99*	0.4578**
Raj 38	82.08	0.80**+	-1.47	14.63	0.88	1.834**	5.74	1.56*	1.252**
Raj 39	72.92	-0.40	125.4**	10.56	1.10	3.439**	6.33	1.35	1.563**
Raj 40	75.42	1.33**+	-1.322	9.71	0.69**++	-0.01732	5.90	0.85	0.5498**
Raj 41	72.92	0.48	15.82**	12.52	1.08**	0.2645**	3.51	0.75*	0.1431**
Raj 42	86.67	0.50	10.66**	15.22	1.01*	0.5104**	7.06	1.63*	0.3562**
Raj 43	69.58	0.86*	0.5668	11.62	1.14**	0.3541**	5.53	1.41**+	0.0379**
Raj 44	82.92	0.89	17.36**	8.98	1.61*	0.9788**	5.91	1.04*	0.1818**
Raj 45	85.00	0.49*+	-0.2124	14.83	0.86*	0.6641**	4.02	0.83	0.4947**
Raj 46	73.75	0.61	5.218*	10.75	1.19*	0.8835**	5.67	1.24*	0.3582**
Raj 47	62.08	0.52**+	-1.345	13.40	1.16*	0.7978**	5.91	1.40*	0.2952**
Raj 48	82.50	0.88*	2.401	13.37	1.57*	1.504**	5.51	1.42**+	0.0117
Raj 49	72.50	1.32**	-0.6239	9.14	1.05	2.72**	7.10	0.89	1.407**
Raj 50	70.00	1.26**++	-1.813	11.46	1.05*	1.006**	6.49	1.55**+	0.1491**
Raj 51	67.08	1.41**	0.1085	13.31	0.95**	0.006776	4.82	0.68**+	0.0142
Raj 52	66.67	0.41	3.9*	6.52	1.10*	0.4871**	7.82	1.30**+	0.024*
Raj 53	73.75	0.62	28.95**	12.00	0.91*	0.4025**	5.32	1.08**	0.095**
Raj 54	71.67	1.05	12.86**	11.77	1.13*	1.256**	7.74	1.32**	0.074**
Raj 55	70.83	1.04*	0.4736	12.94	0.45*+	0.1872**	4.95	-0.18+	0.176**
Raj 56	68.33	1.69*	21.85**	14.09	0.88*	0.603**	3.69	0.94*	0.3415**
Raj 57	74.58	1.19**	-1.14	8.17	-0.57	46.79**	6.41	1.47*	0.7259**
Raj 58	67.08	1.28*	2.08	10.49	0.92*	0.3454**	6.65	0.97*	0.314**

Genotype	Germination percentage			Seedling height			Coleoptile length		
	μ	b_i	S^2Di	μ	b_i	S^2Di	μ	b_i	S^2Di
Raj 59	81.67	0.52	19.56**	11.29	0.55	2.323**	4.64	0.77	2.731**
Raj 60	79.17	0.79*	0.7575	12.59	1.05*	1.005**	6.49	0.97*	0.234**
Raj 61	77.92	1.02*	2.167	13.79	0.63	1.095**	5.17	0.87*	0.2296**
Raj 62	68.33	0.69*	2.947	14.15	0.96*	0.9793**	4.34	0.56**+	0.01793
Raj 63	71.25	1.55	106.2**	11.98	1.13**	0.2036**	6.26	1.57**+	0.045**
Raj 64	67.50	0.63*	0.4111	10.17	1.92*	1.754**	7.16	1.65	1.789**
Raj 65	81.67	1.23**	0.9295	10.23	2.05**+	1.229**	6.02	1.79**+	0.071**
Raj 66	85.00	0.21+	-0.3928	11.70	0.97**	0.2383**	6.57	1.01*	0.359**
Raj 67	71.25	0.95*	4.195*	11.53	1.46*	2.39**	5.42	1.33	2.657**
Raj 68	77.92	1.48*	2.527	11.63	1.50**+	0.3348**	4.98	1.14	1.134**
Raj 69	57.50	1.05	40.71**	10.61	-0.15	15.25**	7.77	1.34*	0.3751**
Raj 70	70.00	1.28	54.64**	10.91	1.05	3.137**	6.03	1.13	0.8614**
Raj 71	68.33	1.13*	5.448*	8.23	1.15*	1.815**	6.10	1.30	1.08**
Raj 72	59.17	0.38	7.896**	6.86	0.59	0.6444**	6.13	0.23++	0.0224*
Raj 73	65.83	0.20	68.01**	7.74	0.93*	0.3499**	8.48	0.93*	0.108**
Raj 74	72.08	0.53	3.006	11.87	0.89*	0.5411**	6.45	0.88*	0.1308**
Raj 75	75.42	0.23+	-0.29	11.73	0.84**	0.1109*	3.99	0.63*+	0.0339*
Raj 76	77.50	0.99	8.679**	11.27	1.11*	0.4401**	6.67	1.41**+	0.0123
Raj 77	81.25	1.03*	4.868*	15.03	1.12**	0.3817**	4.58	0.90*	0.1713**
Raj 78	73.33	1.07	64.31**	12.47	1.32**+	0.02778	5.15	1.43**++	0.0057
Raj 79	75.83	1.21**	-0.8458	11.58	1.15*	1.207**	6.50	1.30	1.074**
Raj 80	75.83	0.84**	-0.9886	11.54	1.07	2.322**	6.29	1.54*	0.335**
Raj 81	77.92	1.64**+	-0.3746	12.02	0.73*	0.278**	5.93	1.17	1.373**
Raj 82	59.58	1.41	29.49**	10.71	1.16**	0.3727**	7.08	1.30**+	0.0014
Raj 83	59.58	0.91*	6.104*	9.35	0.62*	0.2396**	4.63	0.11+	0.2184**

Genotype	Germination percentage			Seedling height			Coleoptile length		
	μ	b_i	S^2Di	**μ**	b_i	S^2Di	**μ**	b_i	S^2Di
Raj 84	73.75	1.19	20.06**	10.79	0.74	2.446**	5.83	1.03	1.347**
Raj 85	77.50	1.60*	10.86**	11.62	1.43**++	-0.02307	6.50	1.57**+	0.1094**
Raj 86	72.50	0.60*	1.435	8.85	0.75	6.206**	7.06	1.26	2.025**
Raj 87	62.92	0.67*	1.027	11.14	0.79**	0.1219*	4.56	0.76	0.3158**
Raj 88	62.50	0.62	20.71**	7.63	1.07	4.326**	5.63	0.97**	0.0515**
Raj 89	61.67	0.90	17.08**	10.26	1.13*	1.296**	6.39	0.79	2.174**
Raj 90	75.00	0.13++	-0.5649	11.67	0.72*	0.1952**	6.04	0.79*	0.0809**
Raj 91	63.33	0.66	37.04**	12.47	0.63**+	0.03527	5.25	0.69*	0.1432**
Raj 92	57.08	1.63*	5.582*	10.77	1.08*	0.4466**	6.91	0.63*	0.0726**
Raj 93	43.33	1.41	21.88**	13.24	0.54	0.8267**	4.55	0.38*+	0.0541**
Raj 94	59.58	1.56*	9.272**	9.06	1.05*	1.991**	6.80	1.18*	0.7384**
Raj 95	75.00	1.67**+	1.517	10.03	1.55*	1.07**	6.72	1.49*	0.4093**
Raj 96	69.58	1.44**+	-1.054	11.49	1.34*	0.6329**	5.51	1.32*	0.2149**
Raj 97	71.25	1.36*	3.444	12.41	1.03**	0.108*	4.07	0.68	0.8676**
Raj 98	71.25	2.34**+	4.119*	10.72	1.43*	0.8181**	4.38	0.84	0.3778**
Raj 99	79.58	1.93**+	0.7402	8.25	1.36*	1.01**	6.83	1.46*	0.2457**
Raj 100	67.08	0.72**	-1.006	9.78	1.32*	0.9344**	6.62	1.42**+	0.0409**
PM (X)	72.03			11.38			5.70		

,* **Significant deviation from zero at 5% and 1% level respectively**
+, ++ **Significantly deviating from unity at 5% and 1% respectively**

Table 4.4.3 Estimates of stability parameters for fresh weight of shoot per seedling, dry weight of root per seedling and dry weight of shoot per seedling (Eberhart and Russel, 1966)

Genotype	Fresh weight of shoot per seedling			Fresh weight of root per seedling			Dry weight of shoot per seedling		
	μ	b_i	S^2Di	μ	b_i	S^2Di	μ	b_i	S^2Di
Raj 1	0.68	0.44*+	0.0003329**	0.07	0.58	0.0001022**	0.10	0.42*++	6.881e-07
Raj 2	1.06	0.86	0.002273**	0.09	0.48	2.253e-05**	0.12	0.82*	3.387e-05**
Raj 3	1.08	1.61*	0.003622**	0.21	0.75*	2.227e-05**	0.12	1.29*	8.117e-05**
Raj 4	1.33	0.51	0.0006382**	0.16	2.96	0.0006527**	0.16	0.32	3.134e-05**
Raj 5	1.36	0.77	0.003261**	0.21	1.43**+	2.557e-06**	0.20	0.33+	2.468e-05**
Raj 6	0.72	0.45**++	8.106e-06	0.11	0.95**	2.597e-06**	0.13	1.42**	1.968e-05**
Raj 7	0.95	0.75	0.00153**	0.19	-2.27+	0.0003797**	0.11	1.61**+	2.007e-05**
Raj 8	1.25	0.51*+	0.0002769**	0.20	-0.99+	0.0001141**	0.13	0.45+	1.635e-05**
Raj 9	0.60	0.18**++	-9.716e-06	0.07	0.34+	7.372e-06**	0.10	0.58	2.164e-05**
Raj 10	0.63	0.32+	0.001026**	0.11	1.00*	2.211e-05**	0.09	0.73*	5.326e-06**
Raj 11	1.19	1.77*	0.001665**	0.16	0.99*	4.139e-05**	0.15	1.53*	3.783e-05**
Raj 12	0.73	1.50**+	0.0001528**	0.07	-0.57+	2.333e-05**	0.13	1.57	0.000207**
Raj 13	0.47	0.51*+	0.0001365**	0.08	0.69	3.097e-05**	0.10	1.22*	6.074e-05**
Raj 14	0.69	1.02**	0.0002628**	0.08	-0.95*++	2.903e-05**	0.08	0.53*+	2.707e-06
Raj 15	1.27	1.07**	0.000255**	0.17	1.05*	3.899e-05**	0.16	0.70	8.567e-05**
Raj 16	1.04	1.04	0.006988**	0.19	1.23	9.741e-05**	0.12	0.54*+	2.223e-06
Raj 17	1.14	0.77*	0.001101**	0.11	1.82*	4.82e-05**	0.13	0.80*	2.121e-05**
Raj 18	1.35	0.73*	0.0002547**	0.15	0.98	8.177e-05**	0.19	0.27+	1.125e-05**
Raj 19	1.07	0.66*	0.00059**	0.11	1.33*	2.59e-05**	0.11	0.73	9.529e-05**
Raj 20	0.64	1.72	0.01167**	0.10	1.20*	2.045e-05**	0.10	0.13+	2.36e-05**
Raj 21	0.98	0.91**	0.0002415**	0.09	0.98	0.0003926**	0.13	0.86	0.0001158**
Raj 22	1.08	1.61*	0.003622**	0.14	0.96	4.882e-05**	0.12	1.23	0.0001018**
Raj 23	0.64	0.70*	0.0003827**	0.26	1.69	0.0001469**	0.09	0.28*++	4.188e-07
Raj 24	0.99	0.55**++	4.124e-05*	0.36	1.90	0.0002086**	0.15	0.27+	1.602e-05**
Raj 25	0.75	1.13*	0.002486**	0.13	-4.41	0.006252**	0.04	0.57**+	1.914e-06
Raj 26	0.89	1.42**	0.0007193**	0.11	-3.26	0.0008849**	0.11	0.91*	3.075e-05**
Raj 27	1.06	0.62	0.001585**	0.15	1.36*	3.021e-05**	0.09	0.89	5.636e-05**

Genotype	Fresh weight of shoot per seedling			Fresh weight of root per seedling			Dry weight of shoot per seedling		
	μ	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**
Raj 28	0.75	1.97*	0.00789**	0.12	1.27*	5.026e-05**	0.12	3.18	0.001556**
Raj 29	1.64	0.69*	0.0008213**	0.14	1.38*	2.498e-05**	0.22	1.28	0.0002079**
Raj 30	0.87	0.59	0.002133**	0.17	0.89	6.489e-05**	0.21	0.33+	8.009e-06**
Raj 31	1.24	0.75*	0.001282**	0.12	1.26	0.0001379**	0.14	0.46*+	5.625e-06**
Raj 32	0.92	0.36*++	8.593e-05**	0.10	1.81*	0.000122**	0.09	0.27*++	9.193e-07
Raj 33	0.87	2.27	0.02852**	0.19	2.43	0.004758**	0.21	-8.86	0.02097**
Raj 34	1.07	0.95**	0.0002707**	0.24	0.14++	3.569e-06**	0.13	0.44*+	9.18e-06**
Raj 35	0.72	0.92*	0.001854**	0.24	0.88	3.872e-05**	0.07	1.04	9.354e-05**
Raj 36	1.91	1.93**++	0.0003622**	0.26	-9.57**++	0.0002364**	0.67	20.62**++	0.001603**
Raj 37	0.82	1.28	0.02832**	0.24	3.62	0.0958**	0.11	0.97	0.0002729**
Raj 38	0.55	0.50*+	0.0002954**	0.07	0.18++	1.817e-06**	0.04	0.43+	1.242e-05**
Raj 39	1.09	1.05**	0.0002903**	0.19	1.19*	5.456e-05**	0.11	0.74*	1.628e-05**
Raj 40	0.70	0.59**+	0.0001032**	0.11	1.24*	2.184e-05**	0.07	0.72*	1.722e-05**
Raj 41	1.23	1.66*	0.001693**	0.16	-6.70	0.04645**	0.15	0.26+	1.298e-05**
Raj 42	1.86	1.27	0.005003**	0.07	-1.21+	8.706e-05**	0.45	3.39*+	0.0002097**
Raj 43	0.77	0.93*	0.0004823**	0.13	0.78	6.918e-05**	0.08	1.07	0.00011**
Raj 44	1.09	1.36*	0.001214**	0.21	1.32*	4.351e-05**	0.12	1.11*	4.278e-05**
Raj 45	1.27	0.77	0.008247**	0.21	1.18**	9.437e-06**	0.20	0.92	0.0003087**
Raj 46	1.07	1.31*	0.002307**	0.17	0.52	2.043e-05**	0.12	0.63*	9.877e-06**
Raj 47	1.01	1.51*	0.003755**	0.11	2.32*	0.0001821**	0.12	0.81*	1.101e-05**
Raj 48	1.20	1.35**	0.0004147**	0.13	1.56	0.0002766**	0.15	0.44	2.579e-05**
Raj 49	0.54	0.42	0.01151**	0.13	1.31	0.0003643**	0.09	1.66**++	-1.212e-06
Raj 50	0.73	1.50**+	0.0001528**	0.20	1.65	0.001084**	0.14	0.67	0.0001483**
Raj 51	1.22	1.82**+	0.0005186**	0.16	0.99	7.798e-05**	0.20	0.99*	1.531e-05**
Raj 52	0.75	1.24**	0.0004181**	0.10	1.41	0.0001636**	0.09	0.47*+	8.106e-06**
Raj 53	1.14	0.97	0.004024**	0.10	1.86	0.001185**	0.13	0.71	0.0002515**
Raj 54	1.33	0.55**++	3.481e-05*	0.27	2.54	0.004864**	0.16	0.66	4.61e-05**
Raj 55	1.23	0.83**	0.0002804**	0.24	0.98	6.021e-05**	0.13	0.43+	1.412e-05**
Raj 56	0.71	1.46**	0.0009009**	0.23	1.29*	1.379e-05**	0.10	1.26*	4.766e-05**
Raj 57	0.95	0.49	0.001834**	0.12	0.63	3.145e-05**	0.11	0.82	4.63e-05**

Genotype	Fresh weight of shoot per seedling			Fresh weight of root per seedling			Dry weight of shoot per seedling		
	μ	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**
Raj 58	0.83	1.05**	1.708e-05	0.11	1.73	0.0004353**	0.10	0.62	5.428e-05**
Raj 59	1.02	1.07*	0.0006296**	0.13	1.29	0.0001541**	0.10	1.11	8.436e-05**
Raj 60	0.62	0.56**+	9.42e-05**	0.17	1.12*	1.795e-05**	0.07	1.25*	7.342e-05**
Raj 61	1.42	0.72**	0.0001907**	0.37	4.08*+	0.000189**	0.23	0.36+	2.102e-05**
Raj 62	0.78	0.47	0.001017**	0.26	1.62	0.0001999**	0.13	0.33*+	4.117e-06*
Raj 63	0.85	0.71**	0.0001865**	0.20	1.63*	7.002e-05**	0.12	1.28	0.0002577**
Raj 64	0.87	0.59	0.002133**	0.17	1.12*	4.961e-05**	0.07	1.34*	6.237e-05**
Raj 65	0.95	0.75	0.00153**	0.16	1.41	0.0001561**	0.11	1.40*	2.148e-05**
Raj 66	0.76	0.13	0.0301**	0.13	1.05	6.354e-05**	0.09	0.78	7.628e-05**
Raj 67	0.73	0.54**++	-3.786e-06	0.14	1.14	0.0001397**	0.08	0.58	5.88e-05**
Raj 68	0.88	0.66	0.00134**	0.20	0.77*	2.134e-05**	0.12	1.37	0.0003004**
Raj 69	0.76	0.43	0.03402**	0.12	0.69	0.0002534**	0.07	0.98*	4.408e-05**
Raj 70	0.71	1.46**	0.0005051**	0.13	0.92	0.001021**	0.07	0.89*	1.72e-05**
Raj 71	0.58	0.98*	0.0004622**	0.27	2.17	0.0002408**	0.10	0.53*	1.413e-05**
Raj 72	0.80	1.10*	0.0005468**	0.11	2.30*	0.000131**	0.08	1.20*	3.467e-05**
Raj 73	1.19	0.33	0.001643**	0.48	0.64*	6.89e-06**	0.17	0.55*	1.374e-05**
Raj 74	0.95	1.40	0.005605**	0.22	3.58	0.003874**	0.12	0.85*	4.079e-05**
Raj 75	1.29	0.68*	0.0008697**	0.36	1.25*	4.438e-05**	0.15	0.52*+	1.768e-06
Raj 76	1.05	1.61*	0.001809**	0.27	1.04	7.662e-05**	0.29	10.57	0.209**
Raj 77	1.21	0.91*	0.0009303**	0.25	0.98	7.216e-05**	0.13	0.39*+	3.137e-06*
Raj 78	1.02	1.10*	0.002116**	0.21	1.83	0.0005166**	0.07	1.13*	3.317e-05**
Raj 79	0.98	1.37	0.004846**	0.19	1.22	0.0001418**	0.10	0.84*	2.739e-05**
Raj 80	0.71	1.22	0.008337**	0.12	-1.31	0.0004632**	0.05	0.74	0.0002773**
Raj 81	1.07	0.66*	0.00059**	0.15	0.73*	1.629e-05**	0.11	0.73	9.529e-05**
Raj 82	0.90	1.96**+	0.0005818**	0.09	1.36	0.0003043**	0.06	0.51*+	6.923e-06**
Raj 83	1.12	1.19*	0.002224**	0.12	1.94*	0.0001223**	0.08	0.49	3.422e-05**
Raj 84	1.35	1.88**+	0.0006074**	0.27	4.76	0.01852**	0.12	0.99*	2.38e-05**
Raj 85	0.95	0.49	0.001775**	0.28	1.03	6.697e-05**	0.11	0.82	4.63e-05**
Raj 86	0.79	1.14**	0.0001167**	0.11	1.52	0.001412**	0.11	0.70	3.957e-05**
Raj 87	0.57	0.55*	0.0006766**	0.12	1.88*	7.904e-05**	0.09	0.19++	4.801e-06*

Genotype	Fresh weight of shoot per seedling			Fresh weight of root per seedling			Dry weight of shoot per seedling		
	μ	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**
Raj 88	0.92	1.42**+	0.0003649**	0.26	1.20*	1.802e-05**	0.08	0.77*	3.045e-05**
Raj 89	0.73	0.53*+	0.0001323**	0.19	1.53	0.0002369**	0.08	0.48*+	4.317e-06*
Raj 90	1.20	1.57*	0.003897**	0.57	2.49*	0.0001185**	0.14	0.97*	3.279e-05**
Raj 91	1.06	1.50*	0.002097**	0.57	2.74*	0.0003088**	0.10	0.81*	1.939e-05**
Raj 92	1.28	1.06*	0.002141**	0.18	1.76**+	1.413e-05**	0.06	1.62**++	4.736e-07
Raj 93	0.93	1.44**	0.0005818**	0.07	2.28	0.0002735**	0.06	1.27**	1.369e-05**
Raj 94	0.92	0.93*	0.0006107**	0.22	2.21	0.0002205**	0.23	-2.50	0.1402**
Raj 95	1.12	1.63*	0.001824**	0.14	1.32**+	1.045e-06**	0.11	1.43*	6.018e-05**
Raj 96	1.03	1.43*	0.001207**	0.25	1.08	0.0001346**	0.09	0.50*+	8.388e-06**
Raj 97	0.70	0.82**	0.0001631**	0.25	2.00	0.0001784**	0.07	0.55	4.667e-05**
Raj 98	0.79	0.98*	0.001431**	0.33	1.67	0.0001995**	0.07	0.49**++	7.369e-07
Raj 99	0.75	0.98**	0.0001592**	0.24	1.54*	7.008e-05**	0.07	0.33**++	-1.115e-06
Raj 100	0.75	0.58	0.0008014**	0.29	1.35	0.0001783**	0.07	0.36+	1.547e-05**
PM (X)	0.968			0.183			0.12		

,* **Significant deviation from zero at 5% and 1% level respectively**

+, ++ **Significantly deviating from unity at 5% and 1% respectively**

Table 4.4.4 Estimates of stability parameters for dry weight of root per seedling, ratio of fresh weight of shoots to fresh weight of roots and ratio of dry weight of shoots to dry weight of roots (Eberhart and Russel, 1966)

Genotype	Dry weight of root per seedling			Ratio of fresh weight of shoots to fresh weight of roots			Ratio of dry weight of shoots to dry weight of roots		
	μ	b_i	S^2Di	μ	b_i	S^2Di	μ	b_i	S^2Di
Raj 1	0.02	0.75*	9.791e-07**	9.98	1.32	1.641**	6.55	-1.93	0.5136**
Raj 2	0.02	0.53*+	1.915e-07	11.57	1.47*	0.5523**	5.49	0.43*++	-0.06276
Raj 3	0.03	0.70*	5.236e-07**	5.23	0.89**+	0.002744**	4.08	0.88	0.0469
Raj 4	0.04	-3.08*+	1.964e-05**	8.75	1.98*	0.5563**	4.40	1.53	7.385**
Raj 5	0.04	-0.91*++	1.518e-06**	6.61	0.84*	0.06116**	5.16	0.99	0.4688**
Raj 6	0.02	0.41*++	3.024e-08	6.99	1.10**+	0.001965*	6.83	1.76	0.1129
Raj 7	0.02	0.89**	9.793e-08	5.21	-0.41+	0.5937**	4.30	1.54*	-0.03927
Raj 8	0.03	1.50	2.062e-05**	6.30	-0.17++	0.03354**	4.42	-0.88	1.184**
Raj 9	0.04	1.31*	3.666e-06**	8.41	0.69*	0.09303**	2.25	0.07+	-0.05564
Raj 10	0.02	1.71**+	1.496e-06**	5.90	0.86*	0.1541**	3.85	-0.97	0.4036**
Raj 11	0.03	0.07	4.955e-06**	7.80	1.59*	0.1783**	5.72	1.09	1.673**
Raj 12	0.02	-0.17	6.191e-06**	10.27	0.80*	0.1251**	7.28	4.37	1.535**
Raj 13	0.02	0.44*+	2.261e-07*	5.79	1.14*	0.1516**	6.43	1.31	0.2948**
Raj 14	0.02	-0.52+	6.002e-06**	8.81	-0.15+	0.1384**	3.53	0.80	0.7903**
Raj 15	0.16	44.16	0.02986**	7.49	1.06*	0.122**	3.74	-2.23	7.011**
Raj 16	0.03	1.98*	1.345e-05**	5.60	0.92	0.6288**	3.98	-1.89	0.5644**
Raj 17	0.03	3.06	0.0001492**	10.66	2.47**++	0.02052**	8.62	-15.91	83.76**
Raj 18	0.02	0.78*	5.846e-07**	9.40	1.26*	0.2726**	7.82	-1.74	0.3698**
Raj 19	0.01	-0.05++	1.798e-07	10.65	2.11**++	0.05178**	9.53	1.51	3.783**
Raj 20	0.02	-0.14+	1.886e-06**	6.69	2.43	3.573**	4.02	0.60	-0.02943
Raj 21	0.04	-2.71	0.0003254**	11.75	1.99	11.21**	4.07	3.93*	0.411**
Raj 22	0.02	0.10*++	-8.244e-08	7.65	1.66*	0.2939**	7.28	2.50	0.7304**
Raj 23	0.05	10.19	0.0005136**	2.53	0.44*+	0.03736**	4.11	-5.32	7.614**
Raj 24	0.05	0.13++	1.365e-07	2.81	0.32*++	0.018**	3.28	0.08+	-0.05491
Raj 25	0.03	1.15	0.0002266**	7.40	-1.76+	2.157**	1.56	-0.64	0.2374**
Raj 26	0.03	0.63	5.011e-06**	9.91	-2.60	4.915**	4.37	-0.02	0.04301

Genotype	Dry weight of root per seedling			Ratio of fresh weight of shoots to fresh weight of roots			Ratio of dry weight of shoots to dry weight of roots		
	μ	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**
Raj 27	0.02	0.41+	9.687e-07**	7.00	1.06**	0.05428**	3.86	0.70	0.5145**
Raj 28	0.04	2.39*+	5.836e-06**	6.58	2.29**++	0.04639**	2.83	1.82	2.667**
Raj 29	0.05	-5.33	0.001093**	12.31	1.88**+	0.1486**	6.42	4.45	7.735**
Raj 30	0.02	0.83	3.151e-06**	5.02	0.61*	0.04865**	9.40	-1.15	1.828**
Raj 31	0.03	-2.59*+	9.65e-06**	10.98	2.02*	0.8142**	5.42	3.75	5.275**
Raj 32	0.03	1.45**+	2.532e-07*	10.18	2.87	2.753**	2.75	-0.64	0.06235
Raj 33	0.03	1.05**	5.318e-07**	5.20	1.53	4.605**	7.30	-13.04	55.8**
Raj 34	0.03	1.24*	1.792e-06**	4.49	0.38**++	0.003702**	3.90	-0.78	0.1239
Raj 35	0.03	1.39*	2.309e-06**	3.06	0.47*++	0.01429**	2.25	0.76	-0.01037
Raj 36	0.04	-0.52	8.437e-06**	10.10	-4.07	12.17**	19.90	22.15	82.33**
Raj 37	0.05	-5.05*++	1.858e-05**	6.95	-0.83	34.32**	3.26	2.55	7.559**
Raj 38	0.09	4.77	0.0001366**	7.63	0.81*	0.05847**	0.47	-0.09++	-0.06232
Raj 39	0.02	0.53*+	1.915e-07	5.90	0.93*	0.1152**	7.16	0.21	0.4673**
Raj 40	0.03	0.94*	9.018e-07**	6.80	1.39*	0.132**	2.04	0.45	-0.005692
Raj 41	0.08	7.12	0.003204**	17.87	-4.09	129.6**	2.71	-3.33*+	0.1891*
Raj 42	0.05	0.79	5.165e-05**	27.20	-4.39	30.16**	9.99	3.70	0.502**
Raj 43	0.02	0.89*	1.401e-06**	6.00	1.10*	0.137**	3.57	0.76	0.7292**
Raj 44	0.02	0.48*+	1.411e-07	5.38	0.97**	0.005283**	6.34	1.03	0.01931
Raj 45	0.07	-2.70**++	4.59e-07**	6.06	0.70	0.2067**	3.20	1.06	1.161**
Raj 46	0.09	10.78*+	0.00028**	6.24	0.89**+	0.0005773	1.66	-1.00	0.3214**
Raj 47	0.04	-0.02	3.757e-05**	11.14	4.46*	4.904**	3.14	0.14	0.3796**
Raj 48	0.05	-0.57	8.46e-05**	9.52	2.45	2.533**	3.02	0.73	0.1468*
Raj 49	0.06	2.13**++	-2.707e-08	4.26	0.69	3.192**	1.64	0.65	-0.02409
Raj 50	0.05	0.85*	8.686e-07**	3.82	1.07*	0.2034**	2.93	-0.07+	-0.03586
Raj 51	0.03	0.06++	1.129e-07	7.60	1.55*	0.4932**	6.48	1.11	0.1304*
Raj 52	0.02	0.26*++	-2.767e-08	8.26	2.81	3.904**	4.94	0.17	-0.01599
Raj 53	0.03	-1.17	0.0003386**	14.58	3.61	111.5**	12.74	36.33	96.88**
Raj 54	0.03	0.53*	7.804e-07**	5.27	0.66	4.276**	5.36	0.03	-0.005161
Raj 55	0.05	-1.38	0.000798**	5.17	0.54*+	0.02478**	4.39	8.82	5.687**

Genotype	Dry weight of root per seedling			Ratio of fresh weight of shoots to fresh weight of roots			Ratio of dry weight of shoots to dry weight of roots		
	μ	b_i	S^2Di	μ	b_i	S^2Di	μ	b_i	S^2Di
Raj 56	0.05	-0.80*++	8.748e-07**	3.23	0.76*	0.06314**	2.34	1.08	0.4374**
Raj 57	0.07	1.25*	1.005e-06**	8.20	0.85	0.3955**	1.69	0.18+	-0.05682
Raj 58	0.06	5.72	0.0005563**	8.26	2.88	5.753**	2.32	-1.71	2.506**
Raj 59	0.38	-18.21	0.05782**	8.29	1.82*	0.8608**	0.47	0.09	0.3538**
Raj 60	0.08	2.74**++	1.603e-06**	3.63	0.54*+	0.02719**	0.86	0.40	-0.05114
Raj 61	0.04	-2.99	0.0003836**	4.00	0.67**+	0.0167**	6.04	2.68	4.514**
Raj 62	0.04	-2.12	0.0003118**	3.11	0.40*++	0.01355**	3.28	1.53	0.8193**
Raj 63	0.05	3.20*	2.015e-05**	4.30	0.74*	0.05115**	2.88	-1.17	0.1061
Raj 64	0.02	0.41*+	2.068e-07	5.27	0.72*	0.08984**	3.70	2.17	0.2567**
Raj 65	0.01	0.14++	5.162e-08	6.10	0.99	0.3944**	7.60	3.21	0.9944**
Raj 66	0.04	0.97**	3.727e-07*	6.04	0.53	2.302**	2.07	0.15	-0.02796
Raj 67	0.05	0.95	8.931e-06**	5.49	0.92*	0.2743**	1.53	0.18+	-0.05648
Raj 68	0.02	0.42*+	4.714e-07**	4.50	0.49*+	0.06282**	5.95	1.19	0.6164**
Raj 69	0.02	0.40*+	3.715e-07*	6.25	0.63	3.966**	2.76	0.98	0.2224*
Raj 70	0.04	1.28	0.0001873**	6.05	1.96	4.77**	2.01	-0.15	0.3437**
Raj 71	0.02	0.58*	7.188e-07**	2.20	0.53**++	0.01014**	5.27	-0.21	-0.00387
Raj 72	0.02	-1.18+	7.699e-06**	9.00	3.52*	2.158**	5.29	5.16	3.735**
Raj 73	0.07	0.46+	6.721e-07**	2.51	0.09++	0.01082**	2.34	0.16+	-0.05995
Raj 74	0.03	0.02++	-6.103e-08	4.98	1.30	4.387**	3.96	0.75	0.2394**
Raj 75	0.07	4.42	0.0001585**	3.61	0.30*++	0.02162**	2.29	-1.31	0.4009**
Raj 76	0.05	1.14**	5.005e-07**	3.86	0.69**+	0.02252**	6.20	17.98	22.95**
Raj 77	0.03	-1.86+	1.216e-05**	4.93	0.54**++	0.007493**	4.85	3.15	1.306**
Raj 78	0.04	2.44*	1.099e-05**	5.03	0.87	0.8918**	1.68	-0.00+	-0.04734
Raj 79	0.02	0.41*+	2.068e-07	5.21	1.08**	0.03684**	5.30	0.73	0.001655
Raj 80	0.06	0.10+	1.475e-06**	6.17	-0.10	1.405**	0.87	0.15	0.08717
Raj 81	0.04	1.41*	1.265e-06**	7.26	0.77*	0.1027**	2.55	-0.14+	-0.04054
Raj 82	0.01	0.18++	8.329e-08	11.43	4.73	15.11**	5.23	1.02	0.04371
Raj 83	0.02	0.29+	8.748e-07**	9.88	2.84*+	0.6561**	3.91	0.27	0.06712
Raj 84	0.02	0.63*+	3.487e-07*	8.01	2.35	81.64**	5.28	0.58**++	-0.06398

Genotype	Dry weight of root per seedling			Ratio of fresh weight of shoots to fresh weight of roots			Ratio of dry weight of shoots to dry weight of roots		
	μ	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**	**μ**	**b_i**	**S^2Di**
Raj 85	0.05	0.86*	8.65e-07**	3.49	0.31*++	0.02777**	2.38	0.38+	-0.05277
Raj 86	0.04	0.64**++	-3.376e-08	8.16	1.91	21.88**	2.53	0.21	-0.03783
Raj 87	0.02	-1.46	9.301e-05**	5.12	1.42*	0.1336**	5.12	6.23*+	0.3812**
Raj 88	0.06	2.44*+	6.628e-06**	3.57	0.65*	0.0451**	1.29	0.11+	-0.05826
Raj 89	0.04	0.57	1.549e-06**	3.98	0.66	0.1674**	1.94	0.19+	-0.05502
Raj 90	0.04	1.01*	2.77e-06**	2.12	0.33*+	0.03425**	3.68	0.16	-0.0267
Raj 91	0.04	2.53*	1.855e-05**	1.88	0.34**++	0.004414**	3.03	-1.25	0.5063**
Raj 92	0.02	1.92	3.649e-05**	7.41	1.41**+	0.02191**	5.10	-4.38	12.47**
Raj 93	0.01	-0.01++	-8.75e-08	16.45	6.41	42.54**	5.87	4.30	3.567**
Raj 94	0.03	0.73	2.501e-06**	4.43	0.92**	0.04414**	7.49	-7.18	141.4**
Raj 95	0.02	0.64**++	-3.376e-08	8.35	1.95**+	0.1472**	4.60	1.09	0.4415**
Raj 96	0.06	0.90*	1.074e-06**	4.12	0.73**	0.02582**	1.62	0.06++	-0.06011
Raj 97	0.02	0.49*+	6.978e-07**	2.85	0.56*+	0.04383**	3.74	-0.00	-0.001741
Raj 98	0.02	1.59*	6.352e-06**	2.48	0.43*+	0.03743**	3.13	-1.29	0.1274*
Raj 99	0.04	1.14*	8.789e-07**	3.18	0.60**+	0.01481**	1.51	0.02++	-0.05929
Raj 100	0.03	1.13	6.017e-06**	2.61	0.31*++	0.01749**	2.86	-0.84	0.06891
PM (X)	0.04			6.88			4.30		

,* **Significant deviation from zero at 5% and 1% level respectively**

+, ++ **Significantly deviating from unity at 5% and 1% respectively**

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