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EGE ÜNİVERSİTESİ
FEN BİLİMLERİ ENSTİTÜSÜ
TARLA BİTKİLERİ ANABİLİM DALI
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STUDIES TO DETERMINE APPROPRIATE SELECTION
TECHNIQUES FOR SALT TOLERANCE IN BARLEY AND
RICE GENOTYPES

Ph.D. Thesis

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Teşekkürler

Bu çalışmanın yürütülmesinde maddi olarak sağlayan Ege Üniversitesi, Araştırma Fonu Yöntem Kuruluna en içten teşekkürlerimi sunarken, yardımlarını esirgemeyen, ilgi ve hizmette benzersiz bir örnek oluşturan Tarla Bitkileri Bölümü, Fen Bilimleri Enstitüsü ve Konuk evi personeline teşekkür etmeyi bir borç bilirim.

Mirza Muhammad Ashraf

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ARPA VE ÇELTİKTE TUZA DAYANIKLI GENOTİPLERİN
SELEKSİYONU İÇİN UYGUN YÖNTEM SAPTANMASI
ÜZERİNE BİR ARAŞTIRMA

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tarafından oy birliği ile kabul edilmiştir.

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Abbreviations

AT----->	Application Time (s)
Cm----->	Centimetre
CV----->	Cultivar
Cons.....>	Concentration (s)
da----->	Decare = 0.1 hectare
DAS----->	Days after sowing
DOS----->	Day of sowing
dS/m----->	Deci seimen per metre
E.C----->	Electrical Conductivity
Fig----->	Figure
Geno----->	Genotype
gr/l ----->	Gram per litre
ha ----->	Hectare
kg----->	Kilogram
m----->	metre
mMol----->	Mili Molar
NaCl----->	Sodium Chloride
ppm----->	Parts per million
SEP----->	Seedling Emergence Percentage
Sr. No ----->	Serial Number
S _x ----->	Standard Error

Preface

Salinity is one of the most serious problems that causes reduction in arable land and decreases crop yields. In Pakistan 6.2 million hectares of good agricultural land is affected by salinity to varying degrees. Whereas in Turkey 1.517 million hectares of agricultural land has become barren due to this problem. This area comprises on the most fertile lands of Menemen, Konya and Çumra valleys along with Gediz, Seyhan and Ceyhan river basins. Amongst this area 610,000 hectares is slightly saline, 500,000 hectares is saline, 125,000 is slightly saline sodic, 270,000 hectares is saline sodic and 85,000 hectares is non saline sodic. Crop tolerance to salinity ranges widely from very salt sensitive beans to highly tolerant barley. Besides this rice can be helpful in meeting food grain needs offering dual advantage of reclaiming soil alongwith producing a cash crop. Keeping these facts in view, there is a need to develop techniques for screening salt tolerant varieties of the crops. After that routine screening of existing genotypes can be conducted. Lateron it is convenient to start detailed breeding programs for salt tolerance induction. In these studies methods for screening barley and rice genotypes against salt tolerance were investigated. By applying these methods 144 barley and 132 rice genotypes were screened for their salinity tolerance behaviour. Consequently, it was found that certain barley genotypes having good performance at seedling stage also produced good yield and these genotypes can be succeseully grown on saline soils in Turkey.

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ABSTRAKT

Bu alıřma, arpa ve eltikte tuza dayanıklı genotiplerin saptanması iin uygun yntem belirleyerek bu ynteme gre seleksiyonlara dayanmaktadır. Her iki bitki iin 4' er farklı deneme kurulmuřtur. Denemelerde uygun tuz konsantrasyonu, tuz uygulama zamanı ve, saksı kořullarında tuza dayanıklı genotiplerin seim ve seilen bazı genotiplerin tarla kořullarında verim ve verim geleri gzlenmiřtir. Elde edilen sonulara gre tuz uygulama zamanı ve tuz konsantrasyonu aısından saksı kořullarında ekim ile birlikte arpa iin 180 ve eltik iin 60 mMol tuz konsantrasyonu tuza karřı dayanıklı genotiplerin belirlenmesi saėladıėı saptanmıřtır. Bu bulgulara gre 132 arpa ve 120 eltik materyalinde yapılan seleksiyonlar sonucunda elde edilen 21 arpa ve 20 eltik eřidin verim ve verim geleri tarla kořullarında karřılařtırılarak, bir ok arpa genotipi tuza dayanıklı olarak belirlenmiřtir.

ABSTRACT

These studies were carried out to determine appropriate selection techniques for salt tolerance in barley and rice. In these investigations 8 trials were conducted in two series, 4 trials for barley and 4 for rice. In barley, salt concentration trial included 5 NaCl levels viz., 0, 60, 120, 180 and 240 mMol. While in rice, concentration trial comprised on 3 salt levels; 0, 60 and 120 mMol. For determining an appropriate time of salt application 12 genotypes of both crops were tested against 4 treatments viz., control, application at sowing, application at 10 and 20 days after sowing. Inferences revealed that 180 mMol and 60 mMol NaCl concentrations are suitable for prejudging salt tolerance perspective in barley and rice varieties, respectively. Salt application at the time of sowing showed more distinctive behavior of genotypes. During bulk screening 132 barley and 120 rice genotypes were evaluated against 180 and 60 mMol, respectively. Overall 144 barley and 132 rice genotypes were used in these experiments. Amongst these 21 barley and 20 rice genotypes having better performance under saline conditions during early growth were studied for their yield and yield components. It is concluded that seedling emergence percentage offers a fairly good criteria for selection of barley genotypes. However in rice number of tillers, grain fertility percentage and 1000-grain weight can serve as a guideline for selection among genotypes. On the basis of these criteria remarkable variation were noticed among genotypes for their salinity tolerance perspective. In barley line No 56000/MISC-233 and line No 59888/MISC-221, which were selected on seedling stage gave good performance by producing reasonably good yield.

1. INTRODUCTION

Due to lack of efficient planning commensurate with rising population and increasing pressure on available arable land resources, farmers have attempted to bring under cultivation areas which cannot sustain crops on a long term basis without special management practices. Since often no precautions are taken, large areas are becoming unproductive leading to different types of problem soils. Salinity is one of the most serious problems that hinders in obtaining increased crop yields under irrigated agriculture throughout the world (Abrol et al., 1988). It is estimated that there are about 400 million hectares of salt affected lands in the world (Flowers et al., 1977). Which include more than 65 million hectares in Africa, 50 million hectares in Europe (Kovda and Szabeles, 1979) and 54 million hectares in South and South East Asia (Masoud, 1974). In Pakistan 6.2 million hectares of good agricultural land is affected by salinity to varying degrees, out of which more than one million hectares are under rice cultivation (Quereshi et al., 1990). Whereas in Turkey 1.517 million hectares of agricultural land has become barren due to this problem. This area comprises on the most fertile lands of Menemen, Konya and Çumra valleys along with Gediz, Seyhan and Ceyhan river basins (AÇIKGÖZ and SAATÇILAR, 1976). Amongst this area 610,000 hectares is slightly saline, 500,000 hectares is saline, 125,000 is slightly saline sodic, 270,000 hectares is saline sodic and 85,000 hectares is non saline sodic (Dizdar, 1976). It is obvious that the problem is so wide-spread that almost every part of the world where the crops are grown is facing this problem. The question arises as to how it has occurred and spread the world over.

Salinity has been a problem throughout the world since the advent of irrigation. Moreover monoculture is one of the major reason of salinity. Growing same crop over the years, besides other problems, increases saline areas. Finding solutions for worsening conditions has become complex and expensive. Reclamation of the salt affected wastelands of the world can be accomplished either by adopting reclamation measures involving physical chemical and hydrological methods or through the biological approach involving

development and introduction of salt tolerant plant species of economic importance and use of salt tolerant varieties of the cultivated crops.

A number of institutes in Pakistan and world-over are attempting to develop and apply new physical and chemical methods and techniques for management and reclamation of salt affected soils. The only objective is to minimize the salt level in rhizosphere in order to provide better ecological conditions conducive to plant growth. However the cost involved in terms of money, labour and energy is very high (Sandhu and Qureshi, 1986). It is also of significance that economically feasible engineering schemes may not completely eliminate salinity problem in certain areas. Another strategy available to combat the situation is to select salt tolerant crop species. Crop tolerance to salinity ranges widely from very salt sensitive beans to highly tolerant cotton and barley. Varieties within the same crop species has shown rather large differences in ability to grow under saline conditions.

Rice can be helpful in meeting food grain needs offering dual advantage of reclaiming soil as well as producing a cash crop (AÇIKGÖZ and SAATÇILAR, 1976) where as barley while fulfilling the feed requirements can also serve as a profitable crop for the marginally suitable lands. Keeping this in view it can be said that certain barley and rice varieties may have a potential for successful cultivation under saline condition.

Many Scientists have reported that crops differ in their behaviour to salt stress (Ayers and Hayward, 1948). Species vary widely when grown in a saline media (Gorham 1990). Based on the salinity tolerance crops have been classified into three distinct groups viz., low salt tolerant crops, medium salt tolerant crops and high salt tolerant crops. The crops which can grow successfully only on the soils having an electrical conductivity less than 4 dS/m are termed as low salt tolerant crops, field beans belong to this group. Medium salt tolerant crops are those which can be grown successfully on the soils having an E.C. between 6 and 10 dS/m. This group includes crops like rye, wheat, oat, rice, sorghum, flax, corn, sunflower and castor-beans. However high salt tolerant crops can be grown within a salinity range of 10-16

dS/m. These crops include sugarbeet, cotton and barely. Table 1.1 shows division of different field crops into three groups.

Table 1.1 Relative Tolerance Of Field Crop Plants to Salts

High salt tolerant crops	Medium salt tolerant crops	Low salt tolerant crops
EC= 16 dS/m Barley (grain) Sugar beet Rape Cotton EC= 10 dS/m	EC=10 dS/m Rye (grain) Wheat (grain) Oats (grain) Rice (grain) Sorghum (grain) Corn (field) Flax Sunflower Castorbeans EC= 6 dS/m	EC=4 dS/m Field beans

EC indicates electrical conductivity values of saturation extract in deci-seimen per metre at 25°C associated with 50% decrease in yield.

Barley plant was more effective in removing salts from the surrounding media as compared to wheat (Abdul Aziz et al., 1985). Singh and Rana (1989) revealed that rate of seedling emergence is a good criteria for selection of varietal response to salt stress in cereals. Singh (1989) indicated that productive tillers/plant, and 200-grain weight would be the most useful selection criteria. Soltani et al., (1990) observed that accumulation of Na⁺ and Cl⁻ in the tissues did not appear to be responsible for the reductions in growth and nutrient uptake.

Kuiper et al., (1990) concluded that cytokinin concentrations measured directly after exposure to NaCl form a promising screening method for salt resistance. Aloy et al., (1992) suggested that hydroponics may not be a good screening method for salt tolerance. Grain weight was the yield component most affected by salinity. Royo et al., (1991) found that EC-50, or electrical conductivity at which the studied character is reduced by 50% is the most suitable parameter for the salt tolerance evaluation of the barley cultivars analyzed. Freitas and Camargo (1988) reported that root length was the most useful parameter in evaluating tolerance of salinity. Neimen and Shannon (1976) and Shannon (1984) reported many shortcomings of the methods presently in use. Stavarek and Rains (1985) noticed that, inspite

of the claims of success, techniques like cell culture do not have much promise, as salt tolerance is a whole plant phenomenon. Moreover, in cell, solution, sand and artificially salinized soil culture, some of the problems associated with salinity such as nutrient imbalance, pH and poor aeration etc. are usually eliminated, while screening in naturally saline fields suffers from the lack of control over environments and root zone heterogeneity both in time and space.

A huge amount of foreign exchange is being spent by Turkey on import of rice to meet the demands. It is quite clear that there is a strong need for selecting/evolving promising cereal varieties (rice, barley etc.) which can yield better on salt affected soils. In order to meet the challenge of food and feed shortage for the geometrically increasing population of the world besides the use of marginal lands in an effective and profitable manner. This whole situation necessitates that a suitable, quick and reliable selection method is a need of the time for getting good yield on saline soils. The aim of these studies is to fulfil this need.

2. REVIEW OF LITERATURE

2.0 Salt Concentration Measurements

Before reviewing the effects of salinity, it seems customary to explain different units of measurements used by various workers. For this purpose a table showing different units of measurements regarding salt concentration is reproduced here under.

Table 2.1 Salt Concentration Values In Different Units Of Measurements

E.C.	Molar Cons.		Weight Per Volume	
	dS/m	mMol	ppm	percent
1		11.20	650	0.065
2		22.39	1310	0.131
3		33.42	1950	0.195
4		44.61	2610	0.261
5		55.82	3260	0.326
6		67.00	3920	0.392
7		78.20	4570	0.457
8		89.39	5230	0.523
9		100.42	5880	0.586
10		111.61	6240	0.624
11		122.82	6890	0.689
12		134.00	7550	0.755
13		145.20	8200	0.820
14		156.39	8860	0.886

Note:- dS/m (deci- seimen per metre) and mmhos/cm (milli nhos per centimetre) are used interchangeably.

2.1 General Responses of Plants to Salinity

Different plant species have different degrees of tolerance to salts in the root medium (Flowers et al., 1977). The typical response of plants to salts in the root medium is the growth inhibition (Maas & Hoffman, 1977; Maas & Nieman, 1978; Flowers et al., 1991). As salt concentration increases above a threshold level, both the rate of growth and the vigour of plant species are progressively decreased; shoot growth is more severely affected than root

(Bernstein et al., 1955; Ayers & Eberhard, 1960; Ehlig, 1964; Meiri & Poljakoff-Mayber, 1970; Delane et al., 1982; Weimberg et al., 1984; Sharma, 1986; Lone, 1988; Aslam et al., 1991). Reduction of vegetative growth is not always related to reduction in fruit or seed production. A good example is of rice, where yield was reduced because of salinity without an appreciable effect on straw yield (Akbar & Ponnampereuma, 1982; Aslam et al., 1993c).

2.2. RESPONSES OF BARLEY CROP

2.2.1. Barley Salt Concentration Responses

Barley can avoid injury under saline conditions (Gill and Dutt, 1987). Increase in salinity level from 0 to 5 and 10 dS/m decreased the percentage germination and seedling growth of barley (El-Fawal and El-Nathlawy, 1989). Roots of barley plants decreased with increasing salinity (Al-khafaf et al., 1990). Hunshal et al., (1990) observed the effects of irrigation with saline water of 1 (control), 4, 8 or 12 dS/m on yield of T. dicoccon and barley cv. Karan-4, Karan-18, Karan-19, Karan-19R and Karan-201. T. dicoccon gave the highest grain yield of 150.37 g/m per row as compared with 65.7-79.93 g/m for the barley cultivars. There were no differences in yield at different salinity levels. Total DM yield and number of tillers decreased with increasing salinity for both crops, wheat being more severely affected than barley (Pessarakli et al., (1991). Dunn and Neales (1993) reported that the growth of halophytes, atriplex and barley was reduced by 44 and 51 percent at 400-600 mol NaCl, respectively and net photosynthesis were reduced. Bandyopadhyay and Sen (1993) found that increasing soil water potential decreased oxygen diffusion rate in soil and soil water potential above -0.30 bar decreased plant dry matter yield. They also reported that plant DW decreased and Fe and Mn contents increased with increasing salinity.

2.2.2. Barley Growth Stages Behaviour

Wheat and barley are less tolerant during emergence and seedling stage Mass (1986). Barley as well as other crops differ in their response at different stages of growth Barley cultivar DL-70 showed the highest rate of seedling emergence Singh and Rana (1989). Roth (1989) reported that shoot length was markedly reduced, especially at the higher salinity level. Udovenko and Volkova (1991) reported that the effects of stress at various stages of development were established. Short periods of stress not only caused depression in the yield component that was developing at the given stage of development when stress was applied, but also had complex effects of inhibition, compensation and reduction on grain yield components formed after the cessation of stress and even before its onset.

2.2.3. Barley Varietal Reactions

Number of grains per plant, fertile tillers per plant, grain weight per spike, spike length are among the main components that affect yield in barley (Waltson, 1972). Whereas according to Sip and Skorpik (1984) the most important yield components include grain weight, number of spikes per meter and harvest index. In barley number of grains per plant and number of fertile tillers are major yield components which are to be kept in view while screening for yield (Grigoryon, 1985). Popescu (1985) reported that the 1000-grain weight is a yield component which highly affects yield of barley varieties.

Certain barley varieties have shown high tolerance to salts and produced economically acceptable yield on saline lands (Maity, 1986). Delogu (1987) reported that six rowed barley varieties produced 16% more tillers, 13% more grains per spike and 22 % greater harvest index. Whereas 2 rowed barley varieties have less number of grains per plant but have high grain weight. Crop yields decreased with increase in plant height (50-200) in winter cereals (Kün, 1988). Shoot development for all barley cultivars decreased linearly with increasing salinity at the 2 SAR levels. Each cultivar responded to salinity/sodicity stress in a different manner; shoot development of cv. CR-272 was not affected by solution sodicity, while other cultivars were most sensitive to salinity stress (Abu-Sharar, 1988). Khorikov et al., (1990)

observed that the best forms of the barley collections in terms of yield on solonetz (saline) soils (55-116.8 g/m²) were N5561, Zernogradskii 73, Vympel, Odesskii 36, Omskii 80, Shortandinskii 41, Tselinnyi 213, Dupaglunok, WW6394, Mojar, Karina, K6871, K6868, K19899 and Boing. Slavich et al., (1990) noticed great differences among varieties with respect to their tolerance to saline conditions. Cultivar Forrest and O'Connor ranking more tolerant than California Mariout, Dampier, Weeah and Clipper whilst Triumph and Schooner were less tolerant. The yield reduction/unit increase in electrical conductivity, averaged across sites, varied from 4.7% for Forrest to 6.6% for Schooner and averaged across cultivars. Weltzien and Fischbeck (1990) reported that majority of the landraces significantly outyielded the best controls but at Tel Hadia the control cultivars Beecher, Badia, ER/Apm and Arabie Abied tended to outyield the landraces.

Kalaji and Nalborczyk (1991) revealed that with increasing NaCl concentration (30-170 mol/m³), the growth rate, leaf area, total DM, photosynthetic and transpiration rates of 8 barley cultivars kept in a growth chamber decreased. Using these parameters, the cultivars were classified into 3 groups: tolerant (Aksad 60, Rihane, Furat 1), medium (Ars, Sth 215, Cerice) and sensitive (Arabian Black, Beecher) to salt stress. Ahmed et al., (1993) concluded that saline irrigation reduced fresh and dry weight, plant height, leaf area per plant, 1000-grain weight, biomass production per plant, grain yield per plant, straw yield per plant and harvest index in cereals. Salinity stress increased number of days to heading. Significant differences were exhibited by two barley varieties in their response to salinity stress.

2.2.4. Barley Salinity Tolerance Evaluation Criteria

Singh (1989) indicated that productive tillers/plant, and 200-grain weight would be the most useful selection criteria. Singh and Rana (1989) reported that RSE (rate of seedling emergence) is a better criterion for determining cultivar differences in salt tolerance at germination stage. Soltani et al., (1990) observed that accumulation of Na⁺ and Cl⁻ in the tissues did not appear to be responsible for the reductions in growth and nutrient uptake.

Kuiper et al., (1990) concluded that cytokinin concentrations measured directly after exposure to NaCl form a promising screening method for salt resistance. Royo et al., (1991) found no correlation between salt tolerances at the seedling and adult stages. The EC 50 or saturation extract electrical conductivity at which the value of the character studied was reduced by 50% was the best criteria for salt tolerance evaluation among the varieties.

Aloy et al., (1992) informed that there were few cultivar differences in response to salinity in the field, and suggested that hydroponics may not be a good screening method for salt tolerance. Grain weight was the yield component most affected by salinity. Belkhodja et al., (1994) noticed chlorophyll florescence as a possible tool for screening salinity tolerance in barley.

2.3. RESPONSES OF RICE CROP

2.3.1. Rice Salt Concentration Responses

Salinity reduced plant height, number of mature tillers, panicle length, number of spikelet per panicle, seed setting percentage, grain and straw yield (Akbar et al., 1972 and Akbar and Yabuno, 1975). Reduction in rice yield under salinity was partly due to reduction in Plant height/ growth (Javed and Khan ,1975). Increasing salinity levels decreased growth and yields (Rashid, 1983). Jones and Stenhouse (1983) informed that selection on the basis of early growth with 80 mMol NaCl makes possible determination of salt tolerance in rice genotypes. Jones and Wilkins (1984) applied 60 mMol NaCl after four weeks after sowing and conceived that this method can be helpful in developing and selection of salt tolerance in rice varieties.

Plant height, leaf area, straw and grain yield of rice varieties were decreased under salinity (Verma and Neue, 1984). Grain sterility in all rice varieties was increased with increasing salinity, flowering was only delayed in salt sensitive varieties but not affected in

tolerant rice varieties (Muhammad, 1986). In rice cv. IAC 25 leaf, shoot, root and total DM yields, root volume and transpiration decreased with increasing salinity. The number of tillers/plant decreased with addition of NaCl but differences between salinity levels were not significant. Root length decreased with increasing salinity above - 0.4 MPa. Salinity also resulted in early senescence (Campos et al., 1989). Ahmed et al., (1988) observed that irrigation with saline water applied during the maximum tillering and panicle initiation stages produced greater adverse effects than when applied during the later growth stages. A statistically significant variety X stress interaction was noticed in direct seeded rice varieties (Panaullah et al., 1990). Root length decreased at 2 dS/m or above and no roots were produced in either cultivar at 8 dS/m. Seedling height and plant height decreased significantly at salinity levels above 4 dS/m. (Punyawardena and Dharmasri, 1989). Sajjad and Awan (1989) concluded that salinity reduced productive tillers and yield per plant of rice cultivars but height was not much affected.

Campos and Assuncao (1990) revealed that the main effects (salinity and cultivar) and their interaction both had significant effects on germination and the number of abnormal plants and ungerminated seeds. The effect of salinity was higher than that of cultivar or cultivar X salinity interaction on germination and the number of abnormal plants. Ahmad and Gupta (1991) noticed that germination decreased with increasing salt concentration. Root and shoot length was also markedly reduced in all entries except IR51194-CN930-44-16B. Differences in plant height and rate of DM accumulation were marked. Grain yield was only affected by the 4.0 dS/m treatment where a 20% yield reduction occurred (Beecher, 1991). Ahmed et al., (1993) noticed that emergence and seedling height decreased with increasing salinity levels especially in the range 12-20 dS/m.

2.3.2 Rice Growth Stages Behavior

Salt tolerance in plants changes considerably during their development stages (Maas and Hoffman, 1977). Many salt sensitive species germinate readily in the presence of high

concentrations of salt. This has been documented for corn (Maas et al., 1983) and rice (Maas and Hoffman, 1977). However, tolerance to salinity for rice at germination is usually not of much significance, since in most of rice growing areas, it is grown in nursery in a good soil and then transplanted when seedlings are 20 to 40 days old. In contrast, the most salt tolerant crops like cotton (Shannon and Francois, 1977) and sugarbeet (Ayers and Hayward, 1948) are more salt sensitive during germination than during later stages of development. Similarly, some halophytes whose vegetative growth is often stimulated by salinity, do not appear to be salt-tolerant during germination (Ungar, 1978; Jefferies, 1988).

Kafalioglu (1985) concluded that salt application to the growing media 10 days after sowing made possible to distinguish the response of rice varieties to salt stress. Salt seems to effect rice during pollination and may decrease seed set and grain yield (Mass, 1986). Seedling stage of rice proved to be the most sensitive while it gains tolerance at tillering and vegetative growth stage (Akita, 1986; Aslam, 1993b). Reproductive stage of growth is critical one for about all crop species including wheat, corn, rice and sorghum, and these crops become sensitive to salt to the varying degrees. Salinization showed much more harmful effects on reproductive stage as compared to vegetative growth stage (Akbar et al., 1972). AÇIKGÖZ and GEVREK (1989) noticed a variation in responses of rice mutants when salt was applied on 10 Days after sowing.

Information reported by a number of research workers on the relative tolerance of rice to salinity at various growth stages showed that rice was tolerant during germination, becomes very sensitive during early seedling stage, gains tolerance during vegetative growth, again becomes sensitive at reproductive stage and then becomes increasingly more tolerant at maturity (Yoshida, 1981; Akbar and Ponnampereuma, 1982; Rashid 1983; Jones and Stenhouse, 1983; and Akita, 1986). Jones and Stenhouse (1983) also reported that root length is an important factor in determining differences among rice genotypes while subjected to salinity at germination stage. Salt application at the time of seedling transplanting caused greater reduction in number of tillers and straw yield, while salt applied at the time of panicle

initiation stage caused maximum reduction in paddy yield (Aslam, 1987). Maximum adverse effect on paddy yield was observed when salinity was applied at the panicle initiation stage followed by seedling stage (Aslam et al., 1993a). Yield reductions were greater with salinity imposed at flowering at 0.2-0.6% salinity but were similar for both imposition times at 0.8% salinity (Mancebo (1990).

2.3.3. Rice Varietal Reactios

Intravarietal differences for salt tolerance in rice have been reported by various workers (Flowers and Yeo, 1981; Yeo and Flowers, 1984; Muhammad, 1986; Aslam, 1987, and Yeo et al., 1988). According to Flowers and Yeo (1981) most of the cultivars originating in the tropics were not pure lines for Na⁺ uptake and grain yield on saline and saline-sodic soils. Evidence indicates that intravarietal variation in rice for tolerance to salinity is determined by two factors: a) differential seedling growth caused by difference in embryo weight which is an inevitable intravarietal variation observed even within pure cultivars, b) the genetic impurity, as shown in impure cultivars and lines (Akita, 1986) with reference to the data of individual plants of rice cultivars.

Pandey and Srivastava (1989) rated cv. Damodar and RPA-5929 as tolerant; IET-3359, IR-20, T-26 and Pusa 2-21 as moderately tolerant and CR 10-141, IR-51213, IR-1514 A-E 666, IET-1444 and MI-48 as susceptible. Yeo et al., (1990) studied the overall performance of 200 genotypes. Wide variation^s existed in all the characters studied, but only vigour was strongly correlated with survival. Sajjad (1990) reported that cv. RST24 outyielded Basmati 370 in several quality characters and yield (45.3 vs. 25.5 g/plant). Majumder et al., (1990) noticed that only 33 lines out of 63 lines survived in a field regularly inundated with sea water. Line No. IET11355 and IET11356 performed best. Vorob and Zhurba (1991) noticed a great reduction in 1000-grain weight under salinity stress but they observed that the varietal differences were not marked. Yan and Tan (1991) reported that all varieties grew normally in washed soil but poorly in soil with added NaCl. Liuyou 33,

Mafeizhan, IR36/Meijiangzao 3//Guichao and Pokkali were highly salt tolerant. Ahmed et al., (1993) reported that cv. BR-10, BR-11 and Patnai-23 were more tolerant to salinity than cv. BR-3.

2.3.4. Rice Salinity Tolerance Evaluation Criteria

Plant tolerance to salinity is usually appraised by i) the ability of a plant to survive on saline soils, and ii) by its absolute and relative growth or yield (Nieman and Shannon, 1976; Lauchli, 1984; Shannon, 1984, 1985; Van and Hoffman, 1984; Maas, 1986, 1990; Shannon, 1990). Selection of tolerant plants should be made from young plants with many tillers as against vigorous adult plants having less tillers (Lehman et al., 1984). Tillering capacity could be used as a criteria for salt tolerance evaluation in rice varieties (Aslam, 1987; Nieman and Shannon (1976) and Shannon (1985) described many shortcomings of the tolerance methods presently in use. Starvak and Rains (1985) reported that techniques like cell culture do not have much promise, as salt tolerance is a whole plant phenomenon.

Plant survival, an important ecological criterion, is of little value for evaluating tolerance at commercial production levels. The capability of plants to survive at extreme salinities often does not correlate well with reduction in yield, found at more moderate salinities (Maas, 1990). However, different salt tolerance criteria could be preferred for different species. The choice would depend upon the available facilities, the species involved and the objective of the study (Qureshi et al., 1990). Vorob and Zhurba (1991) found that the most variable traits under saline conditions were grain yield/plant and the percentage of filled and fertile spikelets/ panicle. The 3 traits were found sufficient for use in assessing resistance. Freitas and Camargo (1988) noticed that root length was the most useful parameter in evaluating tolerance of salinity. Aslam et al.,(1993 b) concluded that screening at seedling stage was a convenient practical technique for salt tolerance in a large number of rice genotypes.

3. MATERIALS AND METHODS

In order to determine appropriate selection methods for salt tolerance in barley and rice genotypes, four trials were conducted for each crop. A brief sketch of the schedule of these experiments is given in table-3.1.

Table:-3.1. Schedule of experiments for different trials of salt tolerance studies in barley and rice.

Trial code	Period of experiment	Purpose of study
B-1	Oct, 1992-Dec, 1992.	Determination of appropriate NaCl concentration for genotypical distinction in barley by using 5 different salt concentrations.
B-2	Jan, 1993-Mar, 1993.	Determination of appropriate time of salinization by applying 180 mMol NaCl at 4 different times of early growth of barley plants.
B-3	Oct, 1993-Dec, 1993.	Bulk screening of 132 new barley genotypes were carried out by using 180 mMol NaCl applied at sowing time.
B-4	Dec, 1993-June, 1994.	Field responses of 21 barley genotypes were investigated at two different salinity levels viz., 9 and 17.5 ds/m
R-1	Apr, 1993-June, 1993.	Determination of appropriate NaCl concentration for genotypical distinction in rice by using 3 different salt concentrations.
R-2	June, 1993-Aug, 1993	Determination of appropriate time of salinization by applying 60 mMol NaCl at 4 different times of early growth of rice.
R-3	Aug, 1993-Oct, 1993.	Bulk screening of 120 rice genotypes against 60 mMol NaCl concentration.
R-4	May, 1994-Dec, 1994.	Field responses of 20 rice genotypes were investigated at two different salinity levels viz., 0.4 and 5.5 ds/m

3.1 Materials

During first and second trial of these studies 12 barley and 12 rice genotypes (Table-3.2) were evaluated for their responses to different salt concentrations and salinization times. Third trial of the studies comprised on bulk screening of 132 barley (Appendix -I) and 120 rice (Appendix-II) genotypes. Whereas 21 barley genotypes and 20 rice genotypes (Appendix.III) were tested for their responses to salt stress till maturity, under fourth trial of these studies.

Table 3.2. Barley and rice genotypes used for B-1, B-2, R-1 and R-2 trials.

BARLEY(B-1&B-2)	RICE(R-1&R-2)
1. EFES-2	1. BALDO
2. 87-FA-LDS	2. TOAG-92
3. TOKAK	3. İZ-300
4. EFES-1	4. KROS-424
5. 87-FA-SDS	5. İZ-160/2
6. GEM	6. İZ-43.
7. KAYA	7. CAL/D.BAS
8. ZAFER-160	8. İZ-30
9. YERCİL	9. PALLOGİO-67
10. YESİLKÖY-387	10. M101-İZ-60
11. WI-2198/EMİR	11. NUC/KROS
12. YERLİ	12. ANA/ MAR

3.2 Methods

3.2.1. Methodology For Barley

3.2.1.1. Determination Of Appropriate NaCl Concentration For Selection Among Barley Genotypes (Trial B-1)

In this trial a pot experiment was conducted under glass house conditions at the Department of Field Crops, Ege university, Izmir, Turkey during Oct-Dec-1992. This factorial experiment comprised on two factors viz., salt concentrations and genotypes. First factor included five salt concentration levels i.e., 0, 60, 120 180, and 240 mMol. Salt solution of different concentrations were prepared by dissolving appropriate amount of NaCl in water. Second factor consisted on 12 barley genotypes, listed in table-3.2. A split plot design with three replications was used. For this purpose 180 plastic pots, each filled with 500 gram of sandy loam, non-saline soil ($EC = 0.04$, $pH = 7.1$) were distributed into 3 blocks. Each block represented a replication with 60 pots and further partitioned into five sub- blocks . Each sub block representing a concentration level consisted 12 pots.

Thirty seeds of respective genotypes were sown to each pot. To ensure uniform water availability and to avoid the risk of soil crust formation during emergence fifteen plastic tubs were used, each containing 12 pots in it. Water and other NaCl solutions already prepared, were applied to the pots by maintaining a solution level of 2 cm in each tub. This level was kept constant throughout this trial (40 days) by adding respective solution, every third day. The data on seedling emergence were recorded on 7th and 15th day. However,

shoot and root length of these seedlings were measured on the 40th day of the experimentation.

3.2.1.2. Determination Of Appropriate Time Of Salinization For Selection Of Barley Genotypes.(Trial-B.2)

As a conclusion of the studies conducted during first trial, it was noticed that 180 mMol NaCl has remarkable effects on early growth characteristics of various genotypes. Consequently this concentration can be used for distinguishing the response of genotypes with regard to determining their tolerance ability to salt stress. Here it was worth mentioning that significant interactions between salt concentration and genotypes were noticed in trial b.1, as explained in section 4.1.1. These interactions were significant due to different behaviour of genotypes under control and 60 mMol salt concentration and not due to 180 mMol. Under this concentrations all the barley genotypes ranked at 4th order. Therefore, during this trial responses of twelve barley genotypes, (listed in table-3.2) were tested against four different salinization times. For this purpose 180 mMol NaCl solution; already determined as an appropriate salt concentration for selection of barley genotypes; was applied at following four different times;

1. Normal water application throughout the study period (control).
2. 180 mMol NaCl solution application at sowing till the end of study period .
3. 180 mMol NaCl application at 10 days after sowing till the end of study period (10 DAS)
4. 180 mMol NaCl application at 20 days after sowing till the end of study period (20 DAS).

The trial was conducted during January -March, 1993 by using split plot design design with three replications. For this purpose 144 plastic pots, each filled with 500 gram of sandy loam, non-saline soil (EC = 0.04, and pH=7.1) were distributed equally into 3 blocks. Each block represented a replication. These 3 blocks were further divided into 4 sub blocks,

blocks, each assigned to a specific time of salinization. Rest procedure was similar as given in para 2 of section 3.2.1.1.

3.2.1.3. Bulk Screening Of Barley Genotypes For Salinity Tolerance(Trial-B.3)

As a conclusion of the studies conducted during first and second trial, it was noticed that application of 180 mMol NaCl solution, applied at the time of sowing showed remarkable effects on early growth characteristics of various genotypes. Although there were significant interactions between time of salt application and genotypes in trial b.2, as described in section heading 4.1.2, however significance of these interactions can be attributed to difference in behaviour of genotypes under control and 20 DAS. Regarding application at the time of sowing, all the genotypes ranked at 4th order. Consequently this combination of concentration and application time can be used for distinguishing the response of genotypes with regard to determining their tolerance ability to salt stress. Bulk screening of genotypes on the basis of early growth behaviour, was the aim of the studies conducted during this trial. With this objective in view, an experiment using augmented design with 4 blocks (Petersen, 1985) was conducted during Oct- Dec-1993 in order to screen 132 barley genotypes. Each block consisted on 36 pots 4 check and 32 selection lines (new genotypes). Four check genotypes (GEM, 87-FA-SDS, EFES-2 and YESILKÖY-387) were assigned at random to the pots within each block while the remaining pots of each block were allotted to the new selections under test. Although the check genotypes were replicated, the new selections were not replicated. However these 128 new selection were also assigned randomly. A list of check as well as new selections genotypes is given as Appendix-I. Rest procedure was similar as given in paragraph 2 of section 3.2.1.1.

Agronomic And Morphological Traits Studied

During the above mentioned first three trials of these studies, data on seedling emergence at two different intervals, as well as root and shoot length for both the crops were recorded as follows.

Emergence Percentage: Number of seedlings present in each pot on 7th and 15th day of sowing were counted and percentage emergence was calculated.

Shoot Length: Shoot length was recorded on 40th day of sowing, by placing a meter rod just on the soil surface in the pot, close to the base of the plant and measured up to the tip of the main shoot.

Root Length: For measuring root length, on the final day of experiment the soil around the plants was washed away. Measurements were taken with the help of a meter rod starting from the base of the plant to the tip of the root.

3.2.1.4. Screening Of Barley Genotypes Under Field Conditions (Trial-B.4)

Soil samples from 8 different fields were taken and analysed for E.C and pH. On the basis of these analysis two different fields , both having sandy clay loam soil but differing in their salinity (EC -9 & 17.5 ds/m) were selected. Some physical and chemical properties of these soils are given in appendix IV. These fields were located near Tuzculu (Salt lands) in Menemen region of Izmir province, Turkey. This area has been considered the most suitable area for salt tolerance studies. Twenty one genotypes, listed in Appendix III were sown during second week of December, 1993 using randomized complete block design with three replications at both the locations. Meteorological data of the region for the corresponding period is given as Appendix V.

Fifty Kg N/ha was applied in two split doses, one half at sowing and other half at booting , whereas 80 Kg P₂O₅ / ha was applied as a sole application at the time of sowing.

Howing was done to eradicate the weeds , all other agronomic practices were standard and uniform for all the genotypes. following data were recorded during the course of study.

1. Grain Yield (Kg/da).
2. Emergence percentage
3. Plant height (cm).
4. Sundried Phytomass (kg/ da)
5. Total tillers /m²
6. Fertile tillers /m².
7. In-fertile tillers /m².
8. Spike length (cm).
9. Number of grains / spike
10. Grains weight/ spike.
11. 1000-grain weight (gm).

3.2..2. Methodology For Rice

3.2.2.1. Determination Of Appropriate NaCl Concentration For Selection Among Rice Genotypes (Trial-R.1).

This trial was conducted during April--June, 1993. Similar procedures were done for rice as for barley (trial-b.1) except that:-

- i) There was no germination in higher NaCl concentrations, therefore, only three salt concentrations (0, 60 mMol and 120 m Mol) were taken into account.
- ii) In order to fulfil the water requirement of rice, the solution level in the tubs was maintained as 10 cm.
- iii) Analysis was done by considering three concentration levels.

3.2.2.2. Determination Of Appropriate Time Of Salinization For Selection Of Rice Genotypes (Trial-R.2)

For this portion of the studies all procedures for rice were similar to barley except that the salt concentration applied was 60 mMol and to ensure sufficient water availability to rice plants, solution level in the tubs was maintained as 10 cm.

3.2.2.3. Bulk Screening Of Rice Genotypes For Salinity Tolerance (Trial-R.3)

As a conclusion of the studies conducted during first and second trial, it was noticed that application of 60 mMol NaCl solution, showed remarkable effects on early growth characteristics of various rice genotypes. Consequently this concentration was used for pre-judging the response of rice genotypes with regard to determining their tolerance ability to salt stress. Bulk screening of genotypes on the basis of early growth behaviour, was the aim of the studies conducted during this trial.

This part of studies comprised on the bulk screening of 120 genotypes. The trial was laid out by using Augmented experimental design with 4 blocks. Each block consisted on 33 pots 4 check and 29 selection lines (new genotypes). Four check genotypes (NUC/KROS, BALDO, ANA/MAR, and TOAG-92.) were assigned at random to the pots within each block. The remaining pots of each block were assigned to the new selections, only the check genotypes were replicated quadruplicately. A list of standard as well as new selection genotypes is given in Appendix-II. Rest procedure was similar as given in para 2 of section

3.2.1.1, except that the NaCl solution used was of 60 mMol concentration and solution level was maintained upto 10 cm in each tub by adding water every day throughout this study period. Data related to seedling emergence percentage as well as root and shoot length were recorded as given in section 3.2.3., above.

3.2.2.4. Screening Of Rice Genotypes In Saline Soils For Yield And Yield Component Studies (Trial-R.4)

As cultivation of rice is banned in the farmer's field due to shortage of water in the region, the trial was conducted in the beds specifically prepared for rice in the experimental area of Field Crops Department, Ege University, Bornova, Izmir. This part of studies was conducted during May- November, 1994. Meteorological data for corresponding periods are given in Appendix-6. Two beds lying side by side and measuring, 12.5 m long, 1.25 m wide and 0.54 m deep were used for the trial. These beds were filled with clay loam soil having pH, 7.21, EC, 0.04 dS/m and CaCO_3 as 2.25 percent. E.C. of bed No-2 was increased and maintained as 5.5 ± 0.5 by adding appropriate amount of NaCl. Twenty rice genotypes, showing better performance in third trial of the experiment (Appendix-III) were sown in the nursery in the second week of May, 1994. Seedlings were transplanted in the beds during third week of June. Due to non availability of saline area for cultivation of rice and homogeneity of soil in the beds three rows for each genotypes were grown for the trial.

Water was added every third day, fertilizer was applied at the rate of 150 Kg-N/ha in the form of urea and 50 Kg P_2O_5 / ha in the form of TSP, hoeing was done to maintain a weed free cultivation. Other agronomic practices were normal and uniform for all the treatments. Crop was harvested during the second week of October, 1994. Data were recorded according to the standard evaluation system set forth by International Rice Testing Program (Anonymous, 1988). However yield was estimated / calculated by taking

10 plants for each genotype at both the locations (salinity levels). Following traits were included in the study.

1. Grain yield (kg/ha).
2. Tillers/ plant
3. Days to 50% Flowering .
4. Days to 85% maturity.
5. Plant height (cm) .
6. Panicle length (cm).
- 7.Total number of grains per plant.
8. Filled grains per plant.
9. Empty grains per plant.
10. 1000-grain weight.

3.2.4. Statistical Analysis

All of the data recorded in different study trials on various vegetative and reproductive growth characteristics were analyzed by using TARIST- a Turkish statistical package program (AÇIKGÖZ et al., 1994). Data of trial B-3 and R-3 were analyzed by using Augmented experiment design techniques. However in trial B-4 and R-4 statistical analyses were conducted by using single factor combination with location method. This was done because, these two experiments were conducted at two different locations varying in their salinity levels.

4. RESULTS AND DISCUSSION

4.1. Barley

4.1.1. Salt Concentration Effects on Barley (Trial B-1)

During the first trial of these studies five different salt concentrations were applied to determine an appropriate salt concentration for distinguishing among barley genotypes for their salt tolerance perspective. All the five salt concentrations showed different impacts on barley genotypes regarding their early growth traits. These traits included seedling emergence, shoot and root length. Statistical analysis revealed that there were highly significant interaction between salt concentrations and genotypes, for all the characters studied as shown in table 4.1. below.

Table 4.1 F-ratios for salt concentration effects on barley genotypes

Sources of variation	Seedling emergence (%)		Shoot length (cm)	Root length (cm)
	7th DOS	15th DOS	40th DOS	40th DOS
Concentration	1051.75**	1438.56**	955.94**	1448.99**
Genotype	8.49**	12.22**	2.72**	31.98**
Cons. X Geno.	4.01**	6.77**	2.20**	3.79**

** Significant at 1% level of probability.

4.1.1.1. Salt Concentrations Effects On Seedling Emergence

Seedling emergence seems to be a more dependable measurement regarding the performance of a seed or a variety to tolerate certain environmental stresses. It reflects germination ability as well as seed vigour sufficient to emerge a seedling from the soil surface. F-ratios given in table 4.1 showed highly significant interaction between salt concentrations and genotypes for seedling emergence percentage on 7th day of sowing. Average of the data regarding percentage seedling emergence of barley genotypes recorded on 7th and 15th day of sowing are given in Table- 4.2 and 4.3, respectively.

Table 4.2 Seedling emergence percentage of barley genotypes on 7th day of sowing as affected by different NaCl concentrations (m Mol).

Genotypes	Control	60	120	180	240	Means
GEM	38.9	34.4 ab	33.3	31.1 a	0.0	27.56
YESILKÖY-387	38.9	41.1 ab	33.3	30.0 a	0.0	28.67
87-FA-SDS	42.2	40.0 ab	35.6	28.9 a	0.0	29.33
EFES-2	40.0	42.2 a	33.3	25.6 ab	0.0	28.22
WI-2198/EMIR	35.6	37.8 ab	32.2	18.8 bc	0.0	24.87
ZAFER-160	36.7	36.6 ab	31.1	16.7 cd	0.0	24.20
YERLI	35.6	34.4 b	31.1	16.7 cd	0.0	23.55
KAYA	38.9	34.4 b	32.2	15.6 cde	0.0	24.22
TOKAK	35.3	36.7 ab	33.3	14.4 cde	0.0	23.96
87-FA-LDS	35.6	36.7 ab	34.4	13.3 cde	0.0	24.00
EFES-1	37.8	40.0 ab	31.1	11.1 de	0.0	24.00
YERCIL	37.8	38.9 ab	31.1	8.9 e	0.0	23.34
Means	37.77	37.77	32.69	19.25	0.0	
Sx for Cons.= 0.477		Sx for Geno.=0.739		Sx for Cons.X Geno.= 1.653		

As it is evident from figure-1 that significance of interactions was due to variation in the behaviour of genotypes under control and 60 mMol concentration. Some genotypes showed greater seedling emergence under 60 mMol as compared to control. For example in EFES-2, 87-FA-LDS, TOKAK, EFES-1, YERCIL, YESILKÖY-387, and WI-2198/EMIR showed higher seedling emergence under 60 mMol than under control. Contrary to this 87-FA-SDS, GEM, KAYA, and YERLI gave higher seedling emergence under control and lower under 60 mMol. However under 180 mMol all the genotypes ranked at 4th position regarding their seedling emergence percentage.

From table 4.2 it is evident that increasing salt concentrations substantially decreased emergence percentage of barley seedling from 37.77% (control) to 19.25% (180 mMol). On an average, salt concentrations of 60, 120 and 180 mMol gave 37.77, 32.69 and 19.25 per cent seedling emergence. No seedling emerged under 240 mMol salt concentration. In certain genotypes application of 60 mMol showed a little increase over control. This showed that lower salinity rather favoured seedling emergence in barley. Although Genotypes differed under this concentration yet differences were smaller as compared to 180 mMol salt

concentration. Moreover, genotypes did not differ significantly under control and salt concentrations of 120 mMol. However, salt concentrations of 180 mMol caused significant differences among the genotypes. GEM, YESILKÖY-387 and 87-FA-SDS produced the highest seedling emergence percentage as 31.1 and 30.0 differing significantly from many other genotypes under this concentrations. Lowest emergence (8.9 %) was recorded in YERCIL which was highly affected by salinity. From the table it is also noticeable that 180 mMol salt concentration caused more conspicuous differences among barley genotypes under study.

F-ratios reproduced in table 4.1 also revealed highly significant interactions between genotypes and salt concentrations regarding seedling emergence on 15th day of sowing. As visible from figure-2 significance of interactions can be attributed to the difference in the behaviour of genotypes under control, 60 and 120 mMol concentrations. For example EFES-2, KAYA, and YERLI showed higher seedling emergence under control where as TOKAK, EFES-1 and WI-2198/EMIR gave more seedling emergence under 60 mMol and contrary to this 87-FA-LDS resulted into higher seedling emergence percentage under 120 mMol. However under 180 mMol all the genotypes ranked at 4th position regarding their seedling emergence percentage on 15th day of sowing. Table 4.3 indicates that increasing salt concentrations substantially decreased percentage of emerging barley seedling from 75.83% (control) to 42.31% (180 mMol). Genotypes did not differ among themselves under control, 60 mMol and 120 mMol NaCl concentrations. However 180 mMol NaCl caused a serious reduction in seedling emergence. No seedling emergence was recorded for 240 mMol salt concentration.

Remarkable differences in seedling emergence percentage were recorded only under 180 mMol NaCl. Under this concentration American genotypes 87-Fa-SDS topped the list, by having 71.11 percent emergence and followed by YESILKÖY-387, EFES-2, and GEM that showed 67.78, 64.42 and 58.90 percent seedling emergence, respectively. All these four genotypes did not differ statistically among themselves, but differed from all of the rest genotypes. YERCIL showed lowest performance by having a seedling emergence of 26.67 percent.

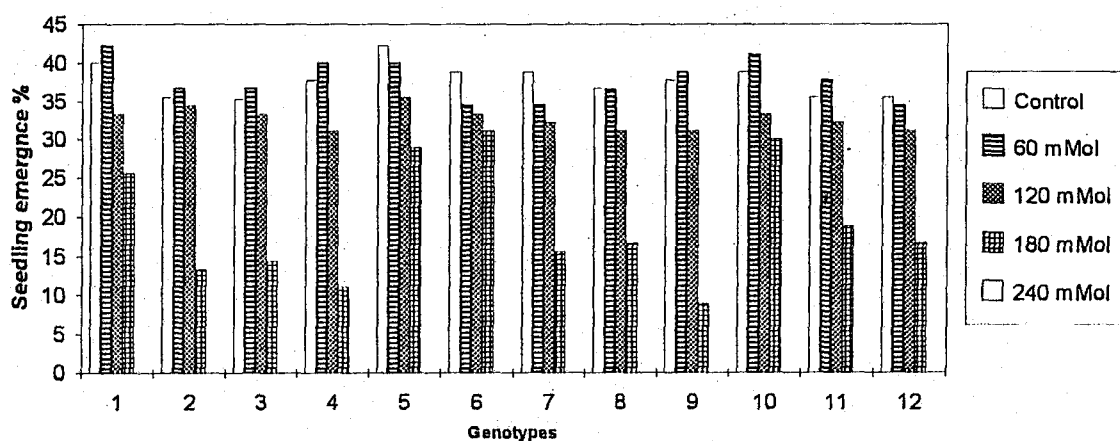


Fig. 1 Graphical presentation of NaCl concentration effects on seedling emergence percentage of barley genotypes (table 3.2) at 7th day of sowing

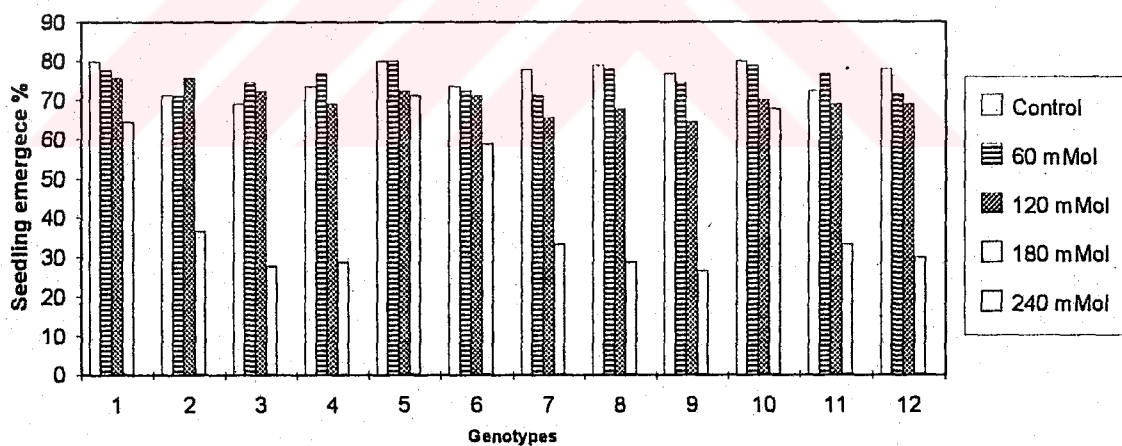


Fig. 2 Graphical presentation of NaCl concentration effects on seedling emergence percentage of barley genotypes (table 3.2) at 15th day of sowing

Table 4.3 Seedling emergence percentage of barley genotypes on 15th day of sowing as affected by different NaCl concentrations (mMol)

Genotypes	Control	60	120	180	240	Means
87-FA-SDS	80.02	80.01	72.21	71.11 a	0.00	60.67
YESILKÖY-387	79.99	78.89	70.01	67.78 a	0.00	59.33
EFES-2	79.90	77.78	75.56	64.42 a	0.00	59.53
GEM	73.33	72.23	71.12	58.90 a	0.00	55.12
87-FA-LDS	71.11	71.13	75.54	36.68 b	0.00	50.89
WI-2198/EMIR	72.22	76.67	68.89	33.33 b	0.00	50.22
KAYA	77.78	71.10	65.57	33.31 b	0.00	49.55
YERLI	77.80	71.47	68.91	30.00 b	0.00	49.64
ZAFER-160	78.89	77.79	7.76	28.87 b	0.00	50.66
EFES-1	73.33	76.67	68.90	28.87 b	0.00	49.55
TOKAK	68.90	74.44	72.22	27.79 b	0.00	48.67
YERCIL	76.68	74.42	64.47	26.67 b	0.00	48.44
Means	75.83	75.22	70.10	42.31	0.00	
Sx for Cons.= 0.857		Sx for Geno.= 1.328		Sx for Cons.X Geno.=2.970		

These results indicated that 180 mMol salt concentrations had remarkable effects on seedling emergence of various genotypes. Consequently this concentrations may be used for distinguishing the responses of barley genotypes to salt stress at seedling emergence stage. Singh and Rana (1989) reported a decrease in seedling emergence of barley under saline conditions. Kumar et al., (1988); El-Fawal and Al-Nathway(1989) and Roth (1989) also reported similar results. None of the previous worker had compared different salt concentrations for their distinctive ability characteristic for barley genotypes on the basis of seedling emergence.

4.1.1.2. Salt Concentration Effects On Shoot Length

Shoot length is a varietal characteristic which can, however, be considerably affected by environmental factors. Figures given in table 4.1 indicated highly significant interaction between salt concentrations and genotypes regarding their shoot length. On closely observing figure-3, it is noticeable that significance of interactions was due to difference in the behaviour of 87-FA-SDS under control and 60 mMol concentration. This genotype showed almost same length under both concentration levels. However under 180 mMol all

the genotypes ranked at 4th position and exhibited clear-cut difference with the other salt concentrations regarding their shoot length.

Average of the data regarding shoot length of different barley genotypes recorded on 40th day of sowing are given in Table-4.4. From the table it is obvious that increasing salt concentrations substantially reduced shoot length of barley plants from 23.21 cm (control) to 10.85 cm (180 mMol). On an average, salt concentrations of 60, 120 and 180 mMol produced shoot length as 18.49, 14.61 and 10.85 cm. Similar results were reported by Al-Khafaf et al., (1990). They reported that maximum reduction in shoot was 70% at the highest salinity level. The relative reductions in shoot due to salinity at the vegetative growth stage were 33% and 46% at the intermediate and highest salinity levels, respectively, as compared with the lowest salinity level.

Table 4.4 Shoot length (cm) of barley genotypes on 40th day of sowing as affected by different NaCl concentrations (mMol)

Genotypes	Control	60	120	180	240	Means
YESILKÖY-387	21.2 ab	17.8 abc	16.7	14.4 a	0.0	14.01
EFES-2	24.8 a	21.1 a	15.3	14.0 ab	0.0	15.06
87-FA-SDS	20.5 b	20.2 abc	15.9	13.8 abc	0.0	14.08
GEM	22.8 ab	19.1 abc	15.6	12.4 abcd	0.0	13.98
87-FA-LDS	23.3 ab	20.8 ab	13.2	10.6 abcde	0.0	13.60
WI-2198/EMIR	22.7 ab	16.4 c	13.8	10.4 abcde	0.0	12.65
KAYA	25.3 a	18.0 abc	12.8	10.1 bcde	0.0	13.22
YERLI	24.0 ab	17.0 abc	13.8	9.7 cde	0.0	12.89
EFES-1	24.4 ab	18.9 abc	13.5	9.2 cde	0.0	13.21
TOKAK	23.5 ab	18.5 abc	13.9	8.9 de	0.0	12.99
ZAFER-160	23.2 ab	17.2 abc	14.7	8.8 de	0.0	12.78
YERCIL	23.0 ab	16.8 bc	16.2	7.7 e	0.0	12.75
Means	23.21	18.49	14.61	10.85	0.0	
Sx for Cons.= 0.285 Sx for Geno.=0.441 Sx for Cons.X Geno.=0.986						

As it is evident from the table 4.4, genotypes differed under all salinity levels except 120 mMol salt concentration. Besides this genotypes also differed under control, but the differences were not as broad as compared to 180 mMol. This salt concentration caused significant and more prominent differences among the genotypes. YESILKÖY-387, EFES-

2, 87-FA-SDS, GEM, 87-FA-LDS, and WI-2198/EMIR produced the greater shoot length of 14.4, 14.0, 13.83, 12.4, 10.6 and 10.4 cm, respectively. These genotypes differed non-significantly among themselves. YERCIL was highly affected and produced a shoot length of 7.7 cm on 40th day of sowing. Abu-sharar(1988) reported that Shoot development for all barley cultivars decreased linearly with increasing salinity and each cultivar responded to salinity stress in a different manner; shoot development of cv. CR-272 was not affected while other cultivars were most sensitive to salinity stress.

Considering concentration effects, it is quite obvious that 180 mMol salt concentration had remarkable effects on shoot length of various genotypes. Accordingly this concentrations can be used for determining the tolerance ability of barley genotypes to salt stress on the basis of shoot length.

None of the previous worker had compared different salt concentrations for their distinctive ability characteristic for barley genotypes on the basis of shoot length.

El-Fawal and Al-Nathway (1989) concluded that increasing salinity level from 0 to 5 and 10 dS/m seedling growth of barley was decreased. Similar results were also reported by Dunn and Neales (1993), who noticed that the growth of halophytes, atriplex and barley, was reduced by 44 and 51 percent at 400-600 mol NaCl, respectively and net photosynthesis were reduced. As salt concentration increases above a threshold level, both the rate of growth and the vigour of plant species are progressively decreased; shoot growth is more severely affected than root (Ayers & Eberhard, 1960; Ehlig, 1964; Meiri & Poljakoff-Mayber, 1970; Mass and Hoffman, 1977; Mass and Nieman, 1978; Delane et al., 1982; Sharma, 1986; Abu-Sharar, 1988; Compos et al., 1989; Lone, 1988; Roth, 1989; Ahmad and Gupta, 1991; Aslam et al., 1991; Flowers et al., 1991; Dunn and N-eales, 1993).

4.1.1.3. Salt Concentration Effects On Root Length

Figures portrayed in table 4.1 described highly significant differences for interactions among genotypes and salt concentrations regarding root length. As exhibited in figure-4 that significance of interactions was due to variation in the behaviour of genotypes under control and 60 mMol concentration. Some genotypes showed greater shoot length under 60

mMol as compared to control. For example in EFES-2, and YESILKÖY-387 showed greater root length under 60 mMol than under control. Contrary to this all other genotypes gave greater root length under control than 60 mMol salt concentration. This gave rise to a significant interaction. On the other hand under 180 mMol all the genotypes ranked at 4th position regarding their root length. Averages of the data regarding root length of different barley genotypes as influenced by NaCl concentrations on 40th day of sowing are given in Table-4.5.

Table 4.5 Root length (cm) of barley genotypes on 40th day of sowing as affected by different NaCl concentrations (mMol).

Genotypes	Control	60	120	180	240	Means
YESILKÖY-387	9.8 ab	10.0 a	9.5a	8.5 a	0.0	7.58
EFES-2	10.0 a	10.2 a	9.3a	8.4 a	0.0	7.62
87-FA-SDS	9.5 abc	9.2 ab	9.1a	8.3 a	0.0	7.24
GEM	9.9 ab	9.2 ab	8.7ab	7.4 a	0.0	7.04
KAYA	8.9 abc	7.4 c	6.9 c	5.5 b	0.0	5.73
TOKAK	9.1 abc	7.6 bc	7.4bc	5.3 b	0.0	5.90
87-FA-LDS	9.0 abc	8.2 bc	7.6bc	5.2 b	0.0	6.02
YERCIL	8.7 abc	7.5 c	6.3 c	5.1 b	0.0	5.50
ZAFER-160	8.3 c	7.3 c	7.4bc	5.0 b	0.0	5.60
EFES-1	8.6 bc	7.4 c	7.3 c	4.9 b	0.0	5.63
YERLI	8.9 abc	8.1 bc	6.7 c	4.9 b	0.0	5.73
WI-2198/EMIR	8.6 bc	7.9 bc	6.7 c	4.4 b	0.0	5.51
Means	9.11	8.35	7.75	6.07	0.0	
Sx for Cons.= 0.096	Sx for Geno.=0.149		Sx for Cons.X Geno.=0.334			

Above table displays that increasing salt concentrations substantially reduced root length of barley seedlings from 9.11 cm (control) to 6.07 cm (180 mMol). On an average salt concentrations of 60, 120 and 180 mMol produced root length as 8.35, 7.75 and 6.07 cm, respectively. Reduction in root growth with increasing salinity may be due to direct contact of roots with toxic ions, present in excessive amount, which decrease water and nutrient availability leading to disturbance of normal metabolism. The typical response of plants to salts in the root medium is the growth inhibition (Maas & Hoffman, 1977; Maas & Nieman, 1978; Flowers et al., 1991).

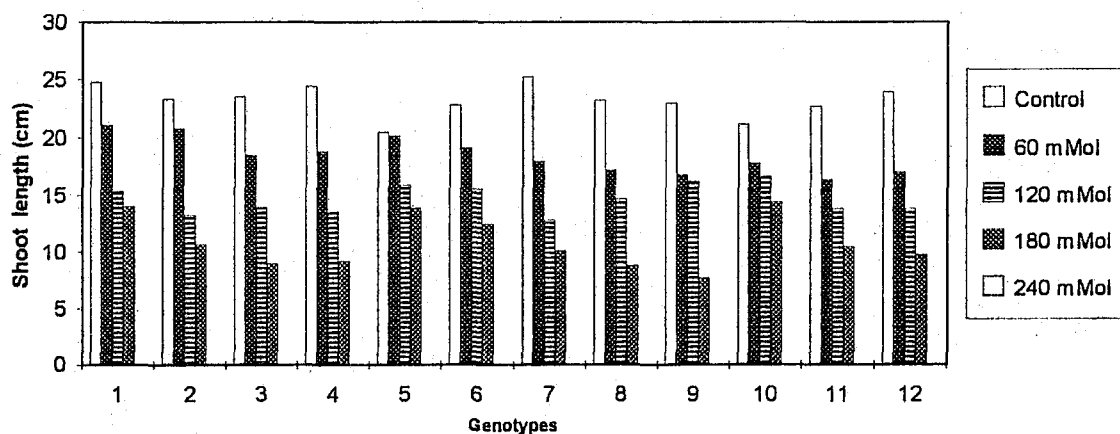


Fig. 3 Graphical presentation of NaCl concentration effects on shoot length of barley genotypes (table 3.2) at 40th day of sowing

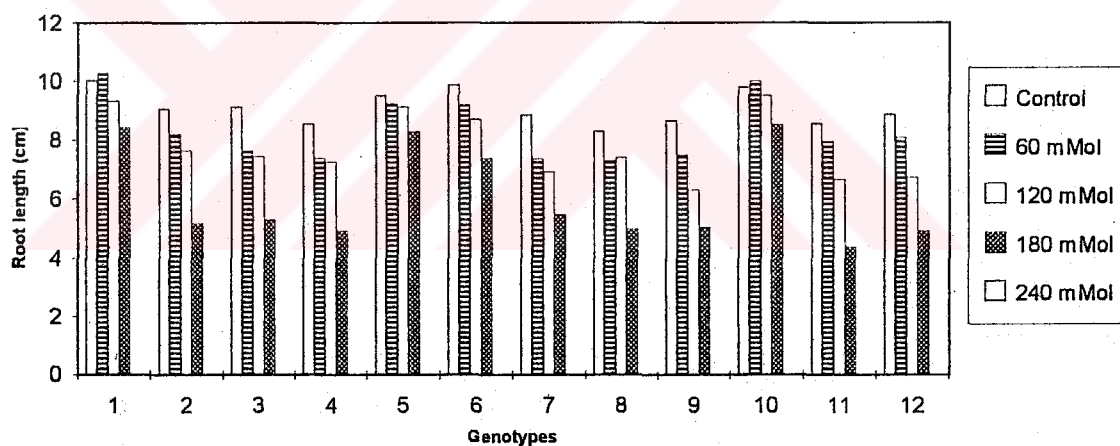


Fig. 4 Graphical presentation of NaCl concentration effects on root length of barley genotypes (table 3.2) at 40th day of sowing

Genotypes differed widely among themselves for all salinity levels except 240 mMol. as there was no seedling emergence and ultimately no root development. Under 180 mMol NaCl application YESILKÖY-387, EFES-2, 87-FA-SDS, and GEM produced a root length of 8.5, 8.4, 8.3, and 7.4 cm, respectively. These genotypes showed notably better performance regarding root growth and remained statistically at par among themselves. However the genotypes differed markedly with YERCIL, ZAFER-160, EFES-1, YERLI and WI-2198/EMIR. YERCIL was highly affected and produced a root length of 4.4 cm on 40th day of sowing.

In case of 60 mMol NaCl concentration EFES-2 and YESILKÖY-387 were totally different in their response as compared to TOKAK, YERCIL, EFES-1, KAYA and ZAFER-160. Statistically different grouping was also noticed under control which indicated that the genotypes included in the trial basically have different root length. These results demonstrated that salt concentrations of 60 mMol, 120 mMol as well as 180 mMol has remarkable effects on root length of various genotypes. However, under 180 mMol NaCl concentration genotypes resulted into two distinct statistical groups regarding their root length. Decisively this concentration can be used for distinguishing the response of genotypes to salt stress on the basis of root length. Freitas and Camargo (1988) reported that root length was a useful criteria in evaluating tolerance to salinity. As salt concentration increases above a threshold level, both the rate of growth and the vigour of plant species are progressively decreased; shoot growth is more severely affected than root (Ayers & Eberhard, 1960; Ehlig, 1964). Kuiper et al., (1990) studied salt resistant and sensitive varieties of wheat and barley, with a greater emphasis to salt resistant barley CV. Featherstone. Growth rates of roots and shoots of hydroponically grown plants of Featherstone decreased rapidly after an exposure to 65 mol NaCl/m³. The results reported above are in good conformity with those recorded in these studies.

All the morphological traits studied above revealed that 180 mMol NaCl has pronounced effects on seedling emergence as well as on shoot and root length. Seedling emergence showed clear difference among genotypes under this concentration. Further to this selection on the basis of seedling emergence is quite easy, time saving, cheap and

reliable, therefore, it may be recommended as a selection criteria. Here it is worth mentioning that although the interaction effects for genotypes X concentrations were significant yet these differences were attributed to the first two concentration levels (control and 60 mMol). However 180 mMol showed no effect which can be considered responsible for presence of interaction. In this way this salt level has been selected as a key concentration for determining the behaviour of genotypes to salt stress. Owing to this 180 mMol salt solution can be used for determining salt tolerance ability of barley genotypes at early stages of growth. Keeping this in view further pot studies were confined to the use of this much salt concentration, for screening of barley varieties.

4.1.2. Times Of Salinization Effects On Barley (Trial-B-2)

As a conclusion of the studies conducted during trial B-1, it was noticed that 180 mMol NaCl has remarkable effects on early growth characteristics of various barley genotypes. Consequently, this concentration may be used for distinguishing the response of genotypes to salt stress. During this trial appropriate time of salt application for distinguishing the behaviour of genotypes will be determined. Keeping this objective in view, application of 180 mMol salt solution was started at 3 different times, in addition to control. Times of salinization showed different effects on barley genotypes regarding their early growth traits. These traits included seedling emergence at two different intervals along with shoot and root length of seedlings. Statistical analysis indicated highly significant interactions for time of salt application and genotypes, for all the characters studied as shown in table 4.6 below.

Table 4.6 F-Ratios For Times Of Salt Application Effects On Barley Genotypes

Sources of variation	<u>Seedling emergence(%)</u>		Shoot length (cm)	Root length (cm)
	7th DOS	15th DOS	40th DOS	40th DOS
Application Times	346.32**	836.96**	1293.37**	169.86**
Genotype	12.88**	14.53**	15.88**	18.86**
A.T. X Geno.	5.09**	9.44**	6.17**	3.48**

** Significant at 1% level of probability.

4.1.2.1. Times Of Salinization Effects On Seedling Emergence

Barley seeds begin to germinate under suitable conditions of temperature, aeration and moisture after they have imbibed sufficient water. The worse the environmental condition is, more time will elapse between germination and emergence. F-ratios given in table 4.6 described highly significant interactions between time of application and genotypes regarding seedling emergence percentage. Average of the data regarding seedling emergence percentage of different barley genotypes as influenced by times of salinization on 7th and 15th day of sowing are given in Table-4.7 and 4.8, respectively.

Table 4.7 Seedling emergence percentage of barley genotypes on 7th day of sowing as affected by different times of NaCl application.

Genotypes	Control	At sowing	10DAS	20DAS	Means
87-FA-SDS	53.3a	40.0a	46.7	47.8	46.94
YESILKÖY387	44.4ab	36.7ab	50.0	44.4	43.88
EFES-2	50.0ab	33.3abc	48.9	45.6	44.45
GEM	43.3ab	30.0abc	45.6	48.9	41.94
87-FA-LDS	50.0ab	25.6bcd	44.4	41.1	40.27
EFES-1	53.3a	24.4bcde	44.4	44.4	41.66
TOKAK	46.7ab	23.3cde	46.7	41.1	39.44
YERLI	46.7ab	17.8de	43.3	7.2	37.22
YERCIL	42.2ab	17.8de	46.7	38.9	36.39
ZAFER-160	47.8ab	15.6de	42.2	43.3	37.22
WI-2198/EMIR	41.1b	15.6de	41.1	45.6	35.83
KAYA	47.8ab	14.4e	44.4	46.7	38.33
Means	47.22	24.54	45.37	44.07	
Sx for application times (AT)= 0.569 Sx for Geno.= 0.986 Sx for AT. X Geno.=1.971					

As obvious from figure-5 significance of interactions can be attributed to the difference in the behaviour of genotypes under control and 10 DAS time of salt application. For example 87-FA-LDS, EFES-1, 87-FA-SDS, and YERLI showed higher seedling emergence percentage under control as compared to 10 and 20 DAS treatments. Contrary to this as GEM, and YESILKÖY-387 gave more seedling emergence percentage under 10 DAS treatment as compared to control. However salt application at sowing did not

contribute to the significance of interaction. Under this application time all the genotypes ranked at 4th position regarding their seedling emergence percentage on 7th day of sowing.

Salinization at sowing produced remarkably significant differences among genotypes and there was a drastic decrease in seedling emergence as compared to control. Under this treatment line No.87-FA-SDS, YESILKÖY-387, EFES-2 and GEM gave higher seedling emergence as 40.0, 36.7, 33.33 and 30.0 percent, respectively, . These genotypes although remained statistically at par but differed significantly from YERCIL, YERLI, ZAFER-160, WI 2198/EMIR and KAYA. Lowest emergence (14.4 %) was recorded in KAYA which was highly affected. It is worth mentioning that genotypes also differed under control yet these differences were smaller as compared to those noticed in case of sowing time treatment.

F-ratios presented in table 4.6 indicated highly significant interactions for times of salinization X genotypes regarding seedling emergence percentage recorded on 15th day of sowing. It can be visualised from figure-6 that significance of interactions was due to variation in the behaviour of genotypes under control and 20 DAS treatment. For example EFES-1, ZAFER-160, and YERLI gave higher seedling emergence percentage under control as compared to 20 DAS treatments. Contrary to this 87-FA-LDS, 87-FA-SDS, GEM, YERCIL, and YESILKÖY-387 resulted into greater seedling emergence percentage under 20 DAS treatment as compared to control. However salt application at sowing can not be stated as responsible toward the significance of interaction. Under this application time all the genotypes ranked at 4th position regarding their seedling emergence percentage on 15th day of sowing. Salinization at the time of sowing produced significant differences among the genotypes. YESILKÖY-387, 87-FA-SDS and EFES-2 showed better performance with 66.7, 61.1 and 56.7 percent seedling emergence, respectively. These genotypes differed significantly from YERCIL, WI-2198/EMIR and ZAFER-160. Lowest emergence percentage (24.4) under this treatment was recorded in case of ZAFER-160 which was most adversely affected. These statistics indicate that salinization at the time of sowing has remarkable effects on seedling emergence of various genotypes. Therefore application of salt at sowing can be used for distinguishing the response of genotypes to salt stress, at seedling emergence stage.

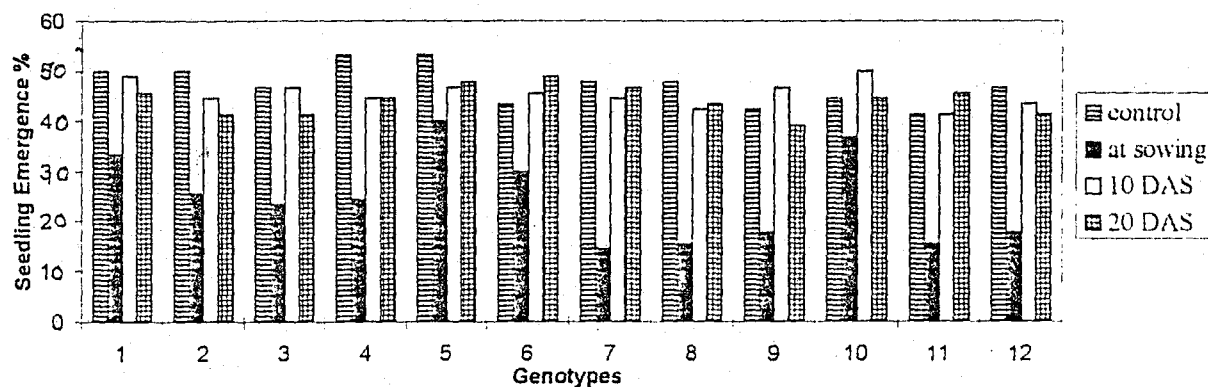


Fig. 5 Graphical presentation of NaCl application times effects on seedling emergence percentage of barley genotypes (table 3.2) at 7th day of sowing

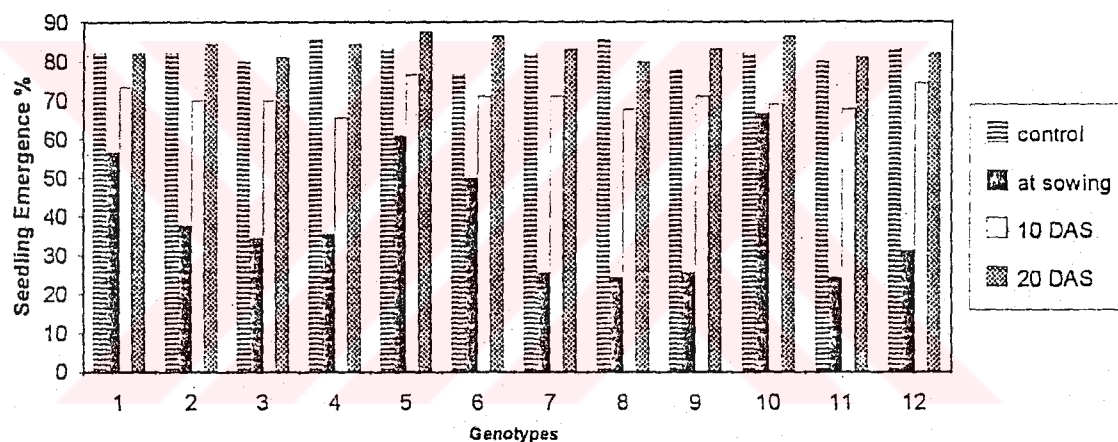


Fig. 6 Graphical presentation of NaCl application times effects on seedling emergence percentage of barley genotypes (table 3.2) at 15th day of sowing

Table 4.8 Seedling emergence percentage of barley genotypes on 15th day after sowing as affected by different times of NaCl application.

Genotypes	Control	At sowing	10DAS	20DAS	Means
87-FA-SDS	83.3	61.1a	76.7	87.8	77.22
YESILKÖY387	82.2	66.7a	68.9	86.7	76.11
EFES-2	82.2	56.7a	73.3	82.2	73.61
GEM	76.7	50.0ab	71.1	86.7	71.11
87-FA-LDS	82.2	37.8bc	70.0	84.4	68.61
EFES-1	85.6	35.6bcd	65.6	84.4	67.78
YERLI	83.3	31.1cd	74.4	82.2	67.78
TOKAK	80.0	34.4cd	70.0	81.1	66.39
KAYA	82.2	25.6cd	71.1	83.3	65.55
ZAFER-160	85.6	24.4d	67.8	80.0	64.45
YERCIL	77.8	25.6cd	71.1	83.3	64.44
WI-2198/EMIR	80.0	24.4d	67.8	81.1	63.33
Means	81.76	39.44	70.65	83.61	
Sx for application times (AT)= 0.706 Sx for Geno.= 1.223 Sx for AT. X Geno.=2.447					

None of the previous investigators had conducted trial for determining varietal behaviour by applying salt at different times as investigated in these studies. However many Scientist reported that crops differ in their responses to salinity stress when applied at different stages of growth. Mass (1986) informed that wheat and barley were less tolerant during emergence and seedling stage. Udovenko and Volkova (1989) reported that the effects of stress at various stages of development were established. The results achieved are quite in line with those reported by above scientists.

4.1.2.2. Times Of Salinization Effects On Shoot Length

Data regarding shoot length of different barley genotypes as influenced by times of salinization were recorded on 40th day of sowing. F-ratios given in table 4.6 revealed highly significant interactions between times of salinization and genotypes regarding shoot length of barley seedlings. On closely observing figure-7, it is noticeable that significance of interactions was due to difference in the behaviour of EFES-1 under 10 and 20 DAS times of salt application. This genotype produced almost same length under both treatments, while other genotypes attained more length under 20 DAS treatment as compared to 10 DAS

treatment. This phenomenon lead to a significant interaction among the treatments and genotypes. However salt application at sowing did not contribute to the significance of interaction. Under this application time all the genotypes ranked at 4th position regarding their shoot length. Averages of the data regarding shoot length of different barley genotypes as influenced by times of salinization on 40th sowing are given in Table-4.9.

Table 4.9 Shoot length (cm) of barley genotypes on 40th day of sowing as influenced by times of NaCl application.

Genotypes	Control	At sowing	10DAS	20DAS	Means
87-FA-SDS	21.4bc	13.4a	16.5ab	18.3a	17.39
EFES-2	24.7a	13.3ab	17.8a	18.9a	18.65
YESILKÖY387	24.9a	12.3abc	15.1ab	18.5a	17.69
GEM	24.9a	12.0abc	15.0ab	16.6ab	17.12
TOKAK	23.5abc	9.8bcd	14.4b	16.4ab	16.04
EFES-1	22.4abc	9.4cd	14.6b	14.8b	15.27
YERCIL	20.9c	9.1cd	14.7b	18.4a	15.78
WI-2198/EMIR	23.9ab	8.7d	14.6b	16.8ab	16.00
87-FA-LDS	24.1ab	8.3d	16.3ab	18.0a	16.68
KAYA	21.6bc	8.0d	14.7b	17.1ab	15.35
YERLI	23.5abc	7.6d	16.8ab	18.2a	16.52
ZAFER-160	22.2abc	7.4d	15.5ab	17.0ab	15.50
Means	23.15	9.93	15.50	17.42	
Sx for application times (AT)= 0.152 Sx for Geno.= 0.263 Sx for AT. X Geno.=0.525					

Earlier salinization (at sowing) indicated more adverse effects on shoot length as compared to other times of sowing. Genotypes differed for their shoot length under all salinization times. However, these differences were highly striking when salinization was done at the time of sowing. Genotypes also differed under control, expressing that besides environment genetic make-up also plays a remarkable role in determining shoot length.

It is also evident from Table 4.9 that when salt solution was applied at sowing 87-FA-SDS, EFES-2, YESILKÖY-387 and GEM were less affected and produced shoot length of 13.4, 13.3, 12.3, and 12.0 cm, respectively and remained at par among themselves. On the other hand under same treatment KAYA, YERLI and ZAFER-160 were affected more adversely and obtained a shoot length of 8.0, 7.6 and 7.4 cm, respectively. Mass (1986)

reported that barley is less tolerant during emergence and seedling growth stage. Reduction in shoot length at higher salinity was also reported by Roth (1989) and Abu-Sharar (1988) who concluded that shoot development for all barley cultivars decreased linearly with increasing salinity levels.

4.1.2.3. Times Of Salinization Effects On Root Length

Root development mainly depends on ecological conditions it may be slow under unfavourable physical conditions and may grow fast if the conditions are more conducive. Data regarding root length of different barley genotypes as influenced by NaCl times of salinization were recorded on 40th day of sowing. Statistical analysis showed highly significant interactions for genotypes and times of salinizations regarding root length (table 4.6). Significance of interaction can be attributed to variation in the behaviour of genotypes under control and 20 DAS time of salt application. For example YERCIL, showed more root length under 20 DAS than under control. Contrary to this all other genotypes gave greater root length under control than 20 DAS treatment. Another source of interaction is the in behaviour of certain genotype under 10 and 20 DAS treatments. EFES-2 can be quoted as a reference which produced more root length under 10 DAS as compared to 20 DAS. This gave rise to a significant interaction. On the other hand all the genotypes ranked at 4th position regarding their root length when salt was applied at the time of sowing (Fig.8)

Averages of the data for genotypes and times of sowing are given in Table-4.10. Genotypes did not exhibited any differences where salinization was done at 20 DAS. All other treatments as well as control caused marked variations among genotypes. These differences were more pronounced in case of treatment when salinization was done at the time of sowing. Under this treatment 87-FA-SDS, YESILKÖY-387, EFES-2 and GEM occupied the same statistical group by producing root length as 8.4, 8.1, 7.7, and 7.5 cm, respectively. These genotypes differed significantly from YERLI, YERCIL, ZAFER-160 and KAYA. Cultivar KAYA was highly affected and produced a root length of 4.7 cm only on 40th day of sowing. These results demonstrate that salinization at the time of sowing produced more noticeable effects on root length of various genotypes as compared to other

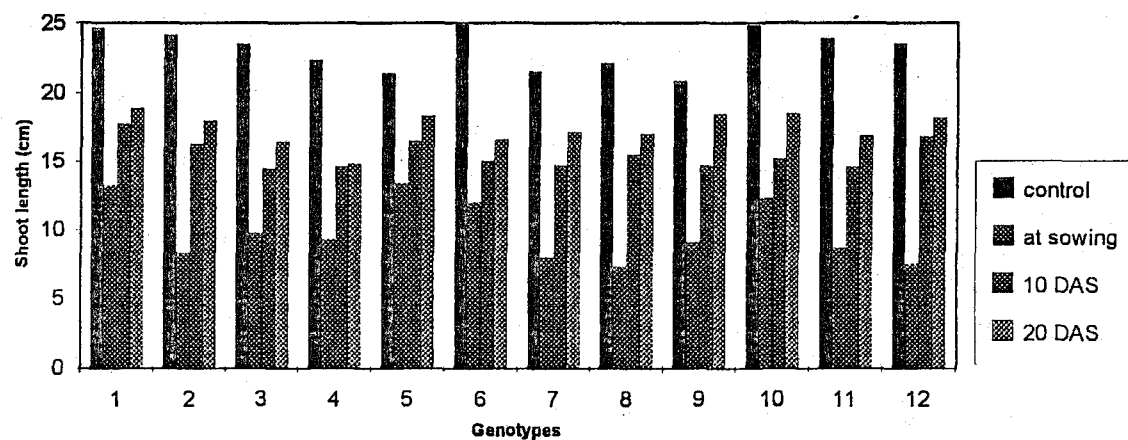


Fig. 7 Graphical presentation of NaCl application times effects on shoot length of barley genotypes (table 3.2) at 40th day of sowing

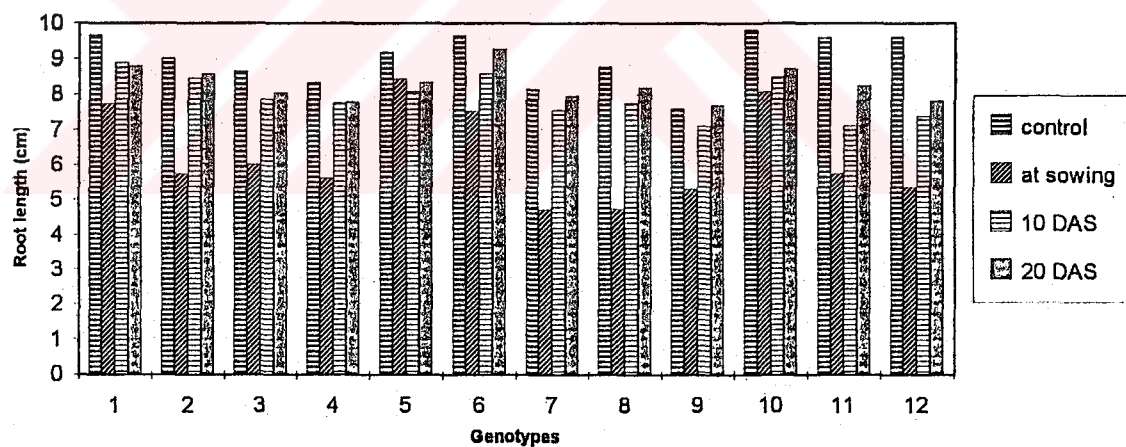


Fig. 8 Graphical presentation of NaCl application times effects on root length of barley genotypes (table 3.2) at 40th day of sowing

times of salinization. Ultimately salt application at sowing time can be used for distinguishing the response of barley genotypes to salt stress on the basis of root length.

Table 4.10 Root length (cm) of barley genotypes on 40th day of sowing as influenced by times of NaCl application.

Genotypes	Control	At sowing	10DAS	20DAS	Means
EFES-2	9.7a	7.7ab	8.9a	8.8	8.78
87-FA-LDS	9.0ab	5.7cd	8.4ab	8.6	7.95
TOKAK	8.6ab	6.0bcd	7.9ab	8.0	7.64
EFES-1	8.3ab	5.6d	7.8ab	7.8	7.38
87-FA-SDS	9.2ab	8.4a	8.1ab	8.3	8.51
GEM	9.7a	7.5abc	8.6ab	9.3	8.76
KAYA	8.2ab	4.7d	7.5ab	8.0	7.10
ZAFER-160	8.8ab	4.7d	7.7ab	8.2	7.37
YERCIL	7.6b	5.3d	7.1b	7.7	6.94
YESILKÖY387	9.8a	8.1ab	8.5ab	8.7	8.78
WI-2198/EMIR	9.6a	5.7cd	7.1b	8.2	7.67
YERLI	9.6a	5.4d	7.4ab	7.8	7.55
Means	9.01	6.25	7.92	8.29	
Sx for application times (AT)= 0.090 Sx for Geno.= 0.155 Sx for AT. X Geno.=0.311					

On an average, salinization at the time of sowing, 10 DAS and 20 DAS produced root length as 6.25, 7.92 and 8.29 cm, respectively. Roth (1989) reported similar results about shoot and root length however, according to him, shoot length was more markedly affected. Inferences drawn above revealed that salinization at the time of sowing has pronounced effects on seedling emergence as well as on shoot and root length. Owing to this, salinization of the growth media at the time of sowing can be used for distinguishing the response of barley genotypes to salt stress at early stages of growth. Keeping in view the above findings, further pot studies for screening barley genotypes were confined only to the application of 180 mMol NaCl at the time of sowing.

All the three traits studied above indicated that interaction for these traits is due to varying responses of genotypes under control, 10 and 20 DAS treatments. However the effect of sowing time treatment was stable. Further to this it was noticed that seedling

emergence at 15th day of sowing showed more clear differences among genotypes when salt application was done at sowing. It is also quite obvious that selection on the basis of seedling emergence is quite easy, time saving, cheap and reliable, therefore, it may be recommended as a selection criteria. Here it is worth mentioning that although the interaction effects for genotypes X times of salt application were significant yet these differences were attributed to the first (control), third (10 DAS) and fourth (20 DAS) treatments. However second treatment (sowing time application) showed no effect that can be considered as responsible for presence of interaction. In this way this time of salt application occupies a key position. Owing to this, application of 180 mMol salt solution at the time of sowing can be used for determining salt tolerance ability of barley genotypes at early stages of growth. Keeping this in view further pot studies for screening of barley varieties were conducted by using this combination of time and salt concentration. The results are quite similar to the studies conducted by previous workers. Singh and Rana (1989) studied germination response of 40 genotypes, barley CV. DL 70 showed the highest rate of seedling emergence closely followed by wheat CV. Kharchia 65. Rate of Seedling Emergence differed among different cultivars of even the same group of tolerance. He indicated that Rate of Seedling Emergence is a better criterion for determining cultivar differences in salt tolerance at germination stage.

4.1.3. Bulk Screening Of Barley Genotypes (Trial. B-3)

As a conclusion of the studies conducted during trial B-1 and B-2, it was noticed that application of 180 mMol NaCl solution, at the time of sowing showed remarkable effects on early growth characteristics of various genotypes. Consequently, this combination of concentration and time of application can be used for distinguishing the response of barley genotypes to salt stress. In this trial combination of these two treatments i.e., 180 mMol NaCl and its application at the time of sowing was used for bulk screening of barley genotypes. For this purpose, an experiment using augmented design with 4 blocks was

conducted to screen 132 barley genotypes. Results achieved from the data recorded on the early growth traits are discussed below.

4.1.3.1. Seedling Emergence.

Statistical grouping of the data regarding seedling emergence percentage of 132 barley genotypes on 7th and 15th day of sowing are given in Table- 4.11. Names of the genotypes are given in Appendix-I. This table displays a complete picture of variations among the genotypes for seedling emergence. From the table it is evident that the genotypes showed various divisions in the form of statistically different groups. Table also indicated wide differences among the genotypes. Zarza"S" CMB 84-1170 (Sr. No. 63) showed the best performance having 79.58% seedling emergence on 7th day of sowing. Contrary to this CI 73793 / CI 9870(Sr.No.74) had the lowest value 2.08%.

Similar results were also revealed for seedling emergence percentage recorded on 15th day of sowing. Identical to 7th day Zarza"S" CMB 84-1170 (Sr. No.63) was at the top of the list by having 100.54% statistically adjusted value for seedling emergence. On the other hand Ca 33787 (Sr. No.122)produced the minimum seedling 14.54.% . Similar results have been reported by Khorikov et al.,(1990) who declared that barley lines / varieties differed in their response under saline conditions. Singh and Rana(1989) also concluded that barley cultivars varied in seedling emergence. These results are quite in line with those drawn in the present study.

4.1.3.2. Shoot Length (cm)

Statistical grouping of the data regarding shoot length of different barley genotypes recorded on 40th day of experimentation are given in Table-4.12. The table shows that there were highly significant differences among the genotypes.

Table 4. II Statistical grouping of seedling emergence percentage (SEP) of 132 barley genotypes as influenced by salinity on 7th and 15th day of sowing .

7th Day of Sowing
Sr. No: SEP Statistical grouping

63 78.303	.....
51 64.253	.....
44 64.253	.....
73 45.421	.....
86 65.421	.....
91 45.421	.....
17 40.413	.....
42 55.303	.....
98 57.913	.....
10 37.003	.....
8 56.665	.....
72 55.421	.....
87 55.421	.....
47 52.901	.....
47 47.913	.....
110 67.913	.....
120 47.913	.....
8 46.645	.....
39 46.253	.....
46 45.421	.....
0 43.009	.....
1 43.753	.....
2 43.753	.....
29 43.753	.....
23 60.413	.....
8 51.009	.....
26 37.001	.....
30 37.043	.....
41 36.253	.....
46 35.421	.....
69 35.421	.....
71 35.421	.....
75 35.421	.....
90 15.421	.....
7 22.193	.....
12 31.753	.....
19 31.753	.....
23 31.753	.....
31 31.753	.....
C 32.337	.....
41 32.913	.....
43 32.041	.....
46 32.041	.....
70 32.041	.....
79 32.041	.....
85 32.041	.....
89 32.041	.....
93 32.041	.....
115 31.253	.....
9 30.413	.....
13 30.413	.....
16 30.413	.....
19 30.413	.....
20 30.413	.....
21 30.413	.....
22 30.413	.....
36 29.593	.....
50 29.593	.....
54 29.593	.....
76 29.593	.....
81 29.593	.....
86 29.593	.....
92 29.593	.....
95 29.593	.....
101 27.913	.....
106 27.913	.....
112 27.913	.....
117 27.913	.....
118 27.913	.....
118 27.913	.....
32 27.093	.....
36 26.253	.....
37 26.253	.....
40 26.253	.....
56 26.253	.....
90 25.421	.....
92 25.421	.....
93 25.421	.....
94 25.421	.....
94 26.593	.....
111 26.593	.....
3 23.753	.....
25 23.753	.....
30 22.913	.....
42 22.913	.....
59 22.913	.....
77 22.001	.....
101 21.253	.....
104 21.253	.....
108 21.253	.....
114 21.253	.....
125 21.253	.....
126 21.253	.....
129 21.253	.....
14 20.413	.....
29 20.413	.....
45 19.593	.....
51 19.593	.....
52 19.593	.....
60 19.593	.....
100 17.913	.....
114 17.913	.....
123 17.913	.....
4 17.003	.....
5 17.003	.....
8 17.003	.....
46 16.253	.....
56 16.253	.....
57 16.253	.....
102 16.593	.....
103 16.593	.....
109 16.593	.....
121 16.593	.....
124 16.593	.....
127 16.593	.....
26 12.913	.....
43 12.913	.....
70 12.001	.....
94 12.001	.....
117 13.253	.....
19 10.413	.....
33 9.593	.....
44 9.593	.....
47 9.593	.....
104 1.913	.....
66 6.253	.....
122 4.593	.....
35 2.913	.....
43 2.913	.....
76 2.041	.....

15th Day of Sowing
Sr. No: SEP Statistical grouping

63 109.544	.....
73 92.872	.....
91 89.542	.....
13 93.874	.....
17 52.044	.....
39 61.209	.....
42 90.544	.....
64 90.544	.....
8 77.506	.....
44 16.212	.....
58 73.874	.....
87 72.872	.....
110 11.209	.....
18 48.704	.....
91 61.879	.....
0 47.500	.....
72 66.212	.....
120 61.209	.....
68 37.542	.....
A 51.332	.....
67 56.212	.....
72 56.212	.....
C 55.835	.....
F 52.872	.....
71 52.872	.....
86 52.872	.....
74 52.872	.....
7 52.044	.....
27 52.044	.....
29 52.044	.....
30 52.044	.....
20 50.544	.....
41 50.544	.....
51 50.544	.....
61 50.544	.....
70 49.542	.....
76 49.542	.....
83 49.542	.....
89 49.542	.....
89 49.542	.....
1 49.704	.....
3 48.704	.....
13 49.704	.....
19 49.704	.....
23 48.704	.....
24 48.704	.....
26 48.704	.....
41 47.877	.....
56 47.204	.....
50 47.204	.....
52 47.204	.....
60 47.204	.....
80 46.212	.....
70 46.212	.....
73 46.212	.....
55 45.212	.....
68 45.542	.....
8 45.374	.....
20 45.374	.....
21 45.374	.....
28 45.374	.....
31 45.374	.....
32 45.374	.....
105 44.539	.....
107 44.539	.....
115 44.539	.....
121 44.539	.....
37 43.874	.....
49 43.874	.....
42 43.874	.....
43 43.874	.....
44 43.874	.....
54 43.874	.....
59 43.874	.....
45 42.872	.....
66 42.872	.....
75 42.872	.....
77 42.872	.....
79 42.872	.....
92 42.872	.....
11 42.044	.....
12 42.044	.....
14 42.044	.....
19 42.044	.....
22 42.044	.....
94 41.209	.....
107 41.209	.....
112 41.209	.....
114 41.209	.....
117 41.209	.....
125 41.209	.....
126 41.209	.....
44 40.544	.....
47 40.544	.....
48 40.544	.....
55 40.544	.....
56 40.544	.....
2 30.704	.....
14 30.704	.....
101 37.879	.....
104 37.879	.....
113 37.879	.....
116 37.879	.....
46 37.204	.....
61 16.212	.....
44 16.212	.....
4 35.374	.....
103 34.539	.....
127 34.539	.....
34 33.874	.....
35 33.874	.....
39 33.874	.....
43 33.874	.....
57 33.874	.....
26 32.044	.....
100 31.209	.....
102 31.209	.....
114 31.209	.....
123 31.209	.....
124 31.209	.....
70 29.542	.....
108 21.879	.....
126 27.879	.....
33 27.204	.....
76 26.212	.....
4 25.374	.....
10 25.374	.....
3 22.044	.....
104 21.209	.....
113 21.209	.....
4 18.704	.....
122 14.539	.....

Note:- Any two entries having a common line do not differ significantly
Names of entries/ genotypes are given in Appendix-I

Maximum shoot length (20.32 cm) was achieved by Baladi-16/CJ 5328 (Sr. No.62) which was closely followed by Zarza"S" CMB 84-1170(Sr. No.63) and German line No.56000 (Sr. No.120) having shoot length as 19.28 and 18.52 cm however, all the three genotype belonged to same statistically group. Gida "S" CMB 79-376-1Y-1B-2Y-0B (Sr. No.10) was most adversely affected and produced minimum shoot length (7.9 cm) while remaining statistically at par with Masurka(Sr. No.116), KYM (Sr. No.4) and Birka (Sr. No.12) which yielded shoot length as 8.5, 8.5, and 8.6 cm, respectively. Abu-Sharar (1988) reported similar findings. He stated that each cultivar respond to salinity in a different manner. Slavich et al., (1990) also noticed similar results and informed that there were great differences among varieties with respect to their salt tolerance.

4.1.3.3. Root Length (cm)

Data regarding root length of different barley genotypes recorded on 40th day of experimentation are given in Table-4.12. The table shows that there were highly significant differences for root development among the genotypes. Maximum root length (9.52 cm) was recorded in case of Zarza"S" CMB 84-1170 (Sr. No.63) which was closely followed by Baladi-16/CJ 5328(Sr. No.62), Gerbel (C) (Sr. No.64) and ARAR (Sr. No.110) having root lengths as 8.94, 8.86, and 8.86 cm, respectively. All these four genotype belonged to same statistically group. ESP/1808-44//W.W(Sr. No.35) was most adversely affected and produced minimum root length (3.1 cm) and differed statistically from all other genotypes included in the study. Many scientists have reported decrease in root length of crop varieties. Akbar and Yabuno (1975), Verma and Neue (1984) and Ahmed and Gupta (1991) reported reduction in root length with higher salinities.

Table 4.12 Statistical grouping regarding shoot and root length (cm) of 132 barley genotypes as influenced by salinity on 40th day of sowing .

Shoot length (SL)

Sr. No: SL Statistical grouping

67	26.321
12	19.281
128	18.321
118	17.841
73	16.996
79	16.993
87	16.616
13	16.321
91	16.194
66	16.021
18	15.765
17	15.701
96	15.316
77	15.301
86	15.196
72	15.236
9	14.875
A	14.870
17	14.836
127	14.801
21	12.097
16	13.613
41	13.623
49	13.326
33	13.361
1	13.201
26	13.103
13	13.091
29	12.941
94	12.876
52	12.941
9	12.901
28	12.901
56	12.901
42	12.761
45	12.761
50	12.761
37	12.701
29	12.421
24	12.601
8	12.565
14	12.565
124	12.663
43	12.436
66	12.261
51	12.361
19	12.361
61	12.213
94	12.276
31	12.201
69	12.181
13	12.161
96	12.161
124	12.121
94	12.101
46	12.041
73	12.036
90	11.976
128	11.971
47	11.901
59	11.891
34	11.861
103	11.813
64	11.836
76	11.836
25	11.801
3	11.641
123	11.641
78	11.536
43	11.516
87	11.476
63	11.476
58	11.476
70	11.436
49	11.421
89	11.416
122	11.341
8	11.301
73	11.291
2	11.261
42	11.261
105	11.223
11	11.201
25	11.201
121	11.201
101	11.041
65	10.936
49	10.921
71	10.876
111	10.821
6	10.801
90	10.736
79	10.696
126	10.651
125	10.641
9	10.601
20	10.601
112	10.561
52	10.476
59	10.526
7	10.359
51	10.361
102	10.301
77	10.435
32	10.441
81	10.436
19	10.301
108	10.293
113	10.281
39	10.276
114	10.161
109	10.161
107	10.061
24	10.036
115	10.021
111	9.901
117	9.821
25	9.781
65	9.736
119	9.641
120	9.601
37	9.613
69	9.433
7	9.401
22	9.461
107	9.261
27	9.201
56	8.851
12	8.601
4	8.501
116	8.501
10	8.301

Root length (RL)

Sr. No: RL Statistical grouping

43	9.520
42	8.760
64	8.860
110	8.860
99	8.520
73	8.505
18	8.413
17	8.355
52	8.160
87	8.145
67	7.945
58	7.900
91	7.955
120	7.960
72	7.845
A	7.295
84	7.225
D	7.175
8	7.170
97	7.140
12	7.135
71	7.065
13	7.075
91	7.040
66	7.025
41	7.000
20	6.975
60	6.780
96	6.765
8	6.955
45	6.915
70	6.945
64	6.905
69	6.905
1	6.975
98	6.845
26	6.815
74	6.875
29	6.875
79	6.805
90	6.645
7	6.635
75	6.645
10	6.575
54	6.520
30	6.525
105	6.500
107	6.540
25	6.520
95	6.465
59	6.460
128	6.460
19	6.435
40	6.420
115	6.420
21	6.415
7	6.410
119	6.400
27	6.375
111	6.360
9	6.315
16	6.315
19	6.315
127	6.300
119	6.290
42	6.240
7	6.235
73	6.235
50	6.220
104	6.220
52	6.200
116	6.200
124	6.200
3	6.175
95	6.145
23	6.160
118	6.190
22	6.135
56	6.120
102	6.100
20	6.075
104	6.060
49	6.020
113	6.040
125	6.270
23	5.755
2	5.735
48	5.700
64	5.875
11	5.875
21	5.555
46	5.840
16	5.805
12	5.775
103	5.740
4	5.715
71	5.665
14	5.655
61	5.615
12	5.615
121	5.640
47	5.620
4	5.615
82	5.385
123	5.390
70	5.310
105	5.340
74	5.323
80	5.205
63	5.300
92	5.275
101	5.270
116	5.250
47	5.225
124	5.140
33	5.190
55	5.100
41	5.020
91	5.040
20	5.015
74	5.005
117	5.000
53	4.975
28	4.847
57	4.770
64	4.660
79	4.575
104	4.520
109	4.570
79	4.310
122	4.420
35	3.160

Note:- Any two entries having a common line do not differ significantly
Names of entries/ genotypes are given in Appendix-I

All the three character investigated for 132 barley genotypes were taken into consideration and performance of these genotypes was evaluated. Consequently 21 barley genotypes namely 56000/MISC-233, 55988/MISC-221, LIGNEE-640, MENTA"S" ZARZA"S", YESILKÖY-387, 55989/MISC-221, 87-FA-SDS, SOUFARA, GEM, 56001/MISC-234, ZEYPHER, CI- 13575, BALADI- 16/CJ, GIDA"S", ROHO/DELISA, ALOE "S", ARAR, IRANIA/LIGNEE 131, WI-2291/WI-2269 and GERBEL having comparatively better performance were selected for evaluating their reproductive behaviour to salt stress under field conditions.

From the above results it is quite obvious that different genotypes showed different degree of tolerance to 180 mMol salt concentration, when applied at the time of sowing. These findings proved that above concentration as well as time of sowing is an effective criteria for selection of salt tolerance in barley varieties. More over seedling emergence is a recommendable tool for distinguishing salt tolerance among the barley crop varieties.

4.1.4. Effects of Salinity On Yield And Yield Components Of Barley (Trial B-4)

As a result of bulk screening of genotypes under 3rd trial of these studies, 21 genotypes (Appendix-III) showing better performance at early growth stages were selected for further studies under field conditions. During this part of studies a field trial was conducted at Tuzculu (Salt land) situated near Menemen town of Izmir Province, Turkey. This area is considered most suitable for salinity tolerance studies. In order to examine the production potential of these genotypes, two different fields (A & B) having sandy clay loam soil but varying in their salinity, were chosen for this experiment. Initial salinity of field A and B was measured as 9 and 17.5 dS/m respectively. A randomised complete block design with three replications was used to test the performance of the genotypes. Data on some vegetative and reproductive traits were recorded. Statistical analysis of the data was carried out and results drawn are discussed below. No interaction was found among salinity levels and genotypes for the characters studied as shown in table 4.13.

Table 4.13 F-ratios related to yield and yield components in barley grown under different salinity levels.

Growth Traits	Salinity levels	Sources of Variation	
		Genotypes	Interactions
Yield	1.07 ^{ns}	80.24**	0.18 ^{ns}
Emergence percentage	7.87*	11.69**	0.66 ^{ns}
Plant height	0.03 ^{ns}	80.39**	0.78 ^{ns}
Phytomass	5.34 ^{ns}	321.67**	0.59 ^{ns}
Total tillers /m ²	0.16 ^{ns}	49.25**	0.40 ^{ns}
Fertile tillers / m ²	0.45 ^{ns}	84.03**	0.86 ^{ns}
Spike length	2.12 ^{ns}	43.90**	0.49 ^{ns}
Grains/ spike	0.06 ^{ns}	221.82**	0.36 ^{ns}
Grain weight / spike	0.18 ^{ns}	440.07**	0.75 ^{ns}
1000-grain weight	0.28 ^{ns}	137.92**	0.51 ^{ns}

ns - Non significant

* - Significant at 5% level of probability

** - Significant at 1% level of probability

From the above table it is obvious that salinity levels did not affect the yield and yield components. This was due to high rainfall during the whole growing season which resulted into extensive leaching of salts from the rhizosphere. S analysis showed that

the electrical conductivity of the field A and B decreased and at the end of growing season it was noted as 3.5 dS/m and 4.5 dS/m, respectively. Keeping in view this situation, it is concluded that salt tolerance evaluation studies may not be carried out under field conditions.

4.1.4.1. Grain Yield (Kg/da).

Grain yield (kg/da) was recorded by taking three samples of 1 m² from each plot of 10 m². Statistical analysis of the data indicated that neither salinity levels nor their interactions with the genotypes showed any significant differences. However, there were highly significant differences among genotypes (Table -4.13). Average values pertaining to different barley genotypes are presented in table 4.14.

Table-4.14 Mean grain yield of barley genotypes as affected by two different salinity levels .

Barley Genotypes	Mean grain yield (kg/da)*
56000/MISC-233	420.00 a
55988/MISC-221	406.88 a
LIGNEE-640	321.77 b
MENTA"S"	306.83 bc
ZARZA"S"	279.58 cd
YESILKÖY-387	251.07 de
55989/MISC-221	242.45 ef
87-FA-SDS	238.58 efg
SOUFARA	224.58 efgh
GEM	215.30 fghi
56001/MISC-234	213.93 fghi
ZEYPHER	211.13 ghi
CI- 13575	209.33 ghij
BALADI- 16/CJ	207.43 hij
GIDA"S"	205.73 hij
ROHO/DELISA	198.58 hij
ALOE "S"	193.38 ij
ARAR	191.78 ij
IRANIA/LIGNEE 131	179.67 jk
WI-2291/WI-2269	152.85 kl
GERBEL	129.32 l
Mean	238.11
S _x for Genotype = 8.214	

*- Means having similar letter (s) differ non-significantly.

Regarding the overall efficiency of genotypes, it was noticed that line No.56000/MISC-233 produced the highest grain yield (420 kg/da) . This was closely followed by Line No.55988/MISC-221 with a grain yield of 406.88 kg/da. Both the genotypes remained statistically at par with each other. GERBEL produced minimum grain yield (129.32 kg/da) and also remained statistically at par with WI-2291/WI-2269 that yielded 152.85 kg/da. It is also noticeable that, generally six rowed barley gave higher yield than two rowed barley. Dolugo et al., (1987) also noted that new varieties of six rowed barley have higher yield due to more grains per spike as compared to two rowed barley.

Moreover it is also noticeable that there are highly striking differences for grain yield among the genotypes. The reason is that the genotypes were collected from different institutes and their adaptability to Aegean ecological conditons was not determined before. Non-significant differences for salinity levels are attributed to a number environmental factors including precipitation. High rainfall during the whole growing season resulted into extensive leaching of salts from the rhizosphere. Ultimately the electrical conductivity of the field A and B decreased and at the end of growing season it was noted as 3.5 and 4.5dS/m, respectively.

Results obtained by Maity (1986) are quite similar to those explained above. He said that certain varieties of barely e.g., Karen -16 has shown economically acceptable yield on saline lands. These results are also matching with those drawn by Hunshal et al., (1990). They noticed no differences in yield at different salinity levels up to 12 dS/m. However inferences drawn by Udovenko and Volkova (1991) were not in agreement with those reported above. They said that varietal differences in yield within each species were not great, probably owing to the absence of appreciable genotype differences. In this respect it is conceived that barley is an oldest species of the world which has been evaluated for different purposes and time to time selection has been done for too many characters. Therefore the above point of view may not be generalised for barley.

4.1.4.2. Seedling Emergence Percentage

Under favourable conditions, seeds of barley start to germinate after they have imbibed sufficient amount of water. More the conditions are favourable, less the time will be taken between germination and emergence. However, if the conditions are highly adverse, the seed reserves will be depleted, before plant can start photosynthesis, ultimately leads to reduced vigour of the seedling or even its inability to become established. Table 4.15 gives a comparison of the genotypes as well as salinity levels.

Table-4.15 Seedling emergence percentage of barley genotypes as affected by two different field salinity levels.

Barley Genotypes	ECe-9dS/m*	ECe-17.5dS/m	Mean
56000/MISC-233	93.33	92.67	93.00 a
55988/MISC-221	91.33	92.00	91.67 ab
LIGNEE-640	84.33	82.33	83.33 bc
MENTA"S"	82.66	83.66	83.17 c
55989/MISC-221	76.66	82.33	79.50 cd
YESILKÖY-387	77.33	76.00	76.67 cde
SOUFARA	75.00	75.00	75.00 cdef
IRANIA/LIGNEE	71.00	79.00	75.00 cdef
GIDA"S"	71.33	75.66	73.50 defg
87-FA-SDS	72.00	74.33	73.17 defg
ZARZA"S"	71.66	72.33	72.00 defg
ROHO/DELISA	71.00	73.00	72.00 defg
BALADI- 16/CJ	68.66	74.66	71.67 defg
ALOE "S"	68.00	75.33	71.67 defg
ARAR	72.00	70.33	71.17 defg
CI- 13575	70.33	69.33	69.83 efg
56001/MISC-234	64.00	74.00	69.00 efg
GERBEL	68.00	67.66	67.83 fg
ZEYPHER	66.33	68.00	67.17 fg
WI-2291/WI-2269	66.33	65.33	65.83 g
GEM	61.66	68.66	65.17 g
Mean	73.48 b	75.79 a	
S _x for Salinity = 0.584		S _x for Genotype = 2.242	

*- Means having similar letter (s) do not differ significantly.

F-ratios given in table 4.13 regarding emergence percentage showed that besides salinity levels, there were significant differences for emergence percentage among genotypes. However, non-significant interactions for salinity X genotypes were noticed. Seedling emergence percentage was little higher (75.79 %) under high salinity level as compared to low salinity level (73.48%). This phenomenon can be attributed to the

occurrence of frequent rainfalls during the season and lower salinity rather favoured the germination and ultimately emergence. Regarding mean values for genotypes, line No. 56000/MISC-233 revealed highest seedling emergence (93.00%). This was closely followed by line No.55988/MISC-233 showing a seedling emergence percentage of 91.67%. Both these genotypes remained statistically at par with each other. Lowest emergence was recorded in case of cv. GEM (65.17 %) which was also statistically similar to many other genotypes. It was also noticed that inspite of having low emergence GEM produced reasonably good yield. This can be attributed to high number of grains per spike produced by this cultivar. Waltson (1972) reported similar results and informed that number of grains per spike is one of the main component that affects yield.

4.1.4.3. Plant Height (cm).

Data on plant height was collected at physiological maturity of the crop. Statistical analysis of the data revealed that the differences for plant height between the two salinity levels as well as interactions between the genotypes X salinity were non significant. However there were significant differences for final plant height among the genotypes (Table 4.13). Average plant height of different genotypes as influenced by salinity levels is given in table 4.16. Regarding mean differences among the genotypes line No. 56000/MISC-233 showed the maximum plant height of 97.39 cm and differed from all other genotypes significantly. However this was followed by line No. 55988/MISC-221 which attained a mean plant height of 89.25 cm. The mean minimum plant height of 49.92 cm was recorded in case of ARAR which was statistically at par with ROHO / DELISA, YESILKÖY and GIDA "S" having a plant height of 55.0, 55.50 and 55.52 cm, respectively

On closely observing the table it is noticed that almost all the varieties attained low height. This may be due to the fact that genotypes are already selected against certain criteria. KÜN (1988) reported that crop yields decreased with increase in plant height (50-200 cm). In these studies some genotypes do not truly hold the above findings. The reason to this lies in the fact that all the genotypes expressed themselves as short or medium stature. No lodging was observed in case of any genotype. Yield in tall varieties normally decreases due to lodging. Kula (1992) reported the highest yield in barley

cultivar GEM with an average plant height of 121 cm under his studies. Whereas none of the genotype under these studies produced height more than 98 cm.

Table-4.16 Mean plant height of barley genotypes as affected by two different field salinity levels .

Barley Genotypes	Mean plant height (cm)*
56000/MISC-233	97.39a
55988/MISC-221	89.25 b
GEM	88.52 bc
MENTA"S"	87.84 bc
IRANIA/LIGNEE 131	86.34 bc
55989/MISC-221	82.90 cd
BALADI- 16/CJ	78.58 de
ALOE "S"	75.84 ef
SOUFARA	74.29 ef
56001/MISC-234	70.44 fg
87-FA-SDS	68.52 gh
GERBEL	65.03 ghi
LIGNEE-640	63.94 hij
WI-2291/WI-2269	63.73 hij
CI- 13575	63.22 hij
ZEYPHER	60.15 -ijk
ZARZA"S"	59.10 jk
GIDA"S"	55.52 kl
YESILKÖY-387	55.50 kl
ROHO/DELISA	55.00 kl
ARAR	49.92 l
Mean	70.99
S_x for Genotype = 1.524	

*- Mean having similar letter (s) differ non- significantly.

4.1.4.4. Sundried Phytomass(Kg /da)

Phytomass is an important criterion in barley because the crop is used for feeding as well forage purposes besides its use in malting industry. Statistical analyses of the data described that interactions among genotypes and salinity levels for phytomass were non significant. However, there were significant differences for phytomass among the genotypes (Table 4.13). Average phytomass yield of different genotypes is given in table

4.17. Overall results regarding the performance of genotypes indicated that Line No. 55988/MISC-221 gave maximum average phytomass of 1089.17 kg/da and remained statistically different from all of the rest genotypes. However, This was followed by line No. 56000/MISC-233 that produced a phytomass of 863.33 Kg /da. It was noticed that there were highly striking variations among the genotypes under study. The reason is that the genotypes were collected from different institutes and comprised on a variety of genetic materials.

Table-4.17 Mean phytomass of barley genotypes as affected by two different field salinity levels.

Barley Genotypes	Mean Phytomass (kg/da)*
55988/MISC-221	1089.17 a
56000/MISC-233	863.33 b
55989/MISC-221	801.67 c
SOUFARA	694.17 d
YESILKÖY-387	650.00 e
GIDA"S"	636.67 ef
CI- 13575	612.50 fg
ARAR	596.67 gh
BALADI- 16/CJ	593.33 gh
LIGNEE-640	592.50 gh
56001/MISC-234	592.50 gh
MENTA"S"	574.17 h
ZARZA"S"	564.17 hi
GEM	537.50 ij
ROHO/DELISA	504.17 jk
87-FA-SDS	502.50 jk
IRANIA/LIGNEE 131	500.00 k
WI-2291/WI-2269	458.34 l
ZEYPHER	397.50 m
ALOE "S"	351.67 n
GERBEL	299.17 o
Mean	591.03
S _x for Genotype = 9.74	

The mean minimum phytomass of 299.17 kg/da was recorded in case of Gerbel. It is also noticed that cultivar YESILKÖY-387 inspite of having low plant height produced comparatively better phytomass yield. This was due to the contribution of heavier spikes produced by the variety.

4.1.4.5. Total Tillers /m²

The amount of tillering depends on heredity and environmental factors. Favourable temperature, ample moisture and high levels of nitrogen, can all increase the amount of tillering considerably. Contrary to that unfavourable soil and moisture conditions reduce the tillering capacity of a grain crop plant. The data regarding total tillers/ m² were recorded at booting stage. Similar to other traits , statistical analysis of the data illustrated that the differences for total tillers/ m² between the salinity levels as well as interaction between genotypes X salinity were non significant. However, there were significant differences for total tillers/ m² among the genotypes (Table 4.13). Averages of the data belonging to total tillers for different genotypes are given in table 4.18.

Table-4.18 Mean total tillers of barley genotypes as affected by two different field salinity levels.

Barley Genotypes	Mean total tiller/ m ²
SOUFARA	383.17 a
56000/MISC-233	366.83 ab
87-FA-SDS	356.34 bc
CI- 13575	342.84 bc
GIDA"S"	336.34 bc
IRANIA/LIGNEE 131	328.50 c
ROHO/DELISA	316.17 cd
BALADI- 16/CJ	314.67 cd
ZARZA"S"	292.00 de
MENTA"S"	283.83 def
ARAR	282.17 efg
ZEYPHER	279.50 efg
55988/MISC-221	266.67 fgh
LIGNEE-640	259.00 fghi
ALOE "S"	253.00 ghi
YESILKÖY-387	251.84 ghi
WI-2291/WI-2269	239.67 hi
55989/MISC-221	234.17 hi
56001/MISC-234	223.50 ij
GERBEL	195.33 j
GEM	147.50 k
Mean	283.48
S _x for Genotype = 8.289	

As it is evident from the table cv. SOUFARA with the maximum number of total tillers (383.17) remained statistical at par with line No. 56000/ MISC-233 that produced 366.83 total tillers/m². These were followed by 87-FA-SDS, CI- 13575, and GIDA"S" that produced 356.34, 342.84 and 336.34 tillers/m² and differed non-significantly with each other. Minimum total tillers/ m² (147.5) were produced by GEM cultivar, which statistically differed from all the rest genotypes. Inspite of having minimum tillers GEM produced reasonably good yield. This was due to more grain weight per spike produced by the cultivar. Kula (1992) concluded that high yield produced by GEM was mainly due to its heavier grains.

4.1.4.6. Fertile Tillers / m².

Statistical analysis of the data indicated that neither salinity levels nor their interactions with the genotypes showed any significant differences. However, there were highly significant differences for fertile tiller among the genotypes (Table 4.13). Averages of the data pertaining to fertile tillers for different genotypes are given in table 4.19.

Overall results indicated that line No.56000/MISC-233 produced the maximum (345.84) fertile tillers/ m² and differed statistically with all other genotypes. This was followed by SOUFARA, 87-FA-SDS, GIDA "S" and ROHO/DELISA that produced 309, 305.34 301.84 and 298.34 fertile tillers/ m², respectively. GEM produced minimum fertile tillers/ m² (128.67) and remained statistically at par with line No. 56001/MISC-234 having fertile tillers as 145.17/ m².

The differences among the varieties were highly conspicuous. This was due to the fact that varieties included in the study were collected from different sources having great diversity in their genetic make-up. It was also noticed that line No 56000/MISC-233 which produced the highest fertile tillers also resulted into maximum yield. Similar findings were reported by Singh (1989), who stated that productive tillers per plant would be the most useful selection criteria towards high yield. Grigoryon (1985) also reported that in barley number of fertile tillers is one of the major component which is to be kept in view while selecting for yield.

Table-4.19 Mean fertile tillers of barley genotypes as affected by two different salinity levels.

Barley Genotypes	Mean fertile tiller/ m ² *
56000/MISC-233	345.84 a
SOUFARA	309.00 b
87-FA-SDS	305.34 b
GIDA"S"	301.84 bc
ROHO/DELISA	298.34 bc
BALADI- 16/CJ	279.33 cd
ARAR	260.50 de
IRANIA/LIGNEE 131	259.00 de
ZEYPHER	257.34 de
CI- 13575	256.00 de
ZARZA"S"	251.17 e
55988/MISC-221	248.84 e
LIGNEE-640	241.34 e
MENTA"S"	241.00 e
YESILKÖY-387	212.84 f
55989/MISC-221	202.50 fg
WI-2291/WI-2269	179.67 gh
GERBEL	165.67 hi
ALOE "S"	153.00 i
56001/MISC-234	145.17 ij
GEM	128.67 j
Mean	240.11
S _x for Genotype = 6.491	

*- Means having similar letter (s) differ non- significantly.

4.1.4.7. Spike Length (cm)

As it is evident from the F-ratios given in table 4.13, salinity levels as well as their interactions with genotypes were non significant for spike length of barley plants. On the other hand highly significant differences were found among the genotypes. Data regarding average spike length (cm) are presented in table 4.20.

As far as performance of genotypes is concerned, cultivar ZEPHYR proved better with respect to spike development. This variety produced the maximum spike length of 9.66 cm and remained statistically at par with BALADI-16/CJ, IRANIA/LIGNEE-131 and GIDA "S" having spike lengths as 9.52, 9.27 and 9.13 cm, respectively.

Table-4.20 Mean spike length of barley genotypes as affected by two different field salinity levels.

Barley Genotypes	Mean spike length (cm)*
ZEYPHER	9.66 a
BALADI- 16/CJ	9.52 a
IRANIA/LIGNEE 131	9.27 ab
GIDA"S"	9.13 ab
CI- 13575	8.78 bc
MENTA"S"	8.17 cd
SOUFARA	8.12 cd
ROHO/DELISA	7.96 d
ARAR	7.75 de
87-FA-SDS	7.58 de
56000/MISC-233	7.49 def
WI-2291/WI-2269	7.11 efg
55989/MISC-221	7.10 efg
GERBEL	6.86 fgh
56001/MISC-234	6.75 ghi
55988/MISC-221	6.29 hij
ZARZA"S"	6.23 hij
ALOE "S"	6.22 hij
LIGNEE-640	6.10 ij
YESILKÖY-387	6.03 j
GEM	5.93 j
Mean	7.53
S _x for Genotype = 0.184	

*- Means having similar letter (s) differ non-significantly.

GEM produced minimum spike length (5.93 cm) and also remained statistically at par with some other genotypes included in the study. The differences among the genotypes were highly prominent. This was due to the fact that varieties included in the study were collected from different institutes and probably have great diversity in their genetic make-up. It was also noted that two rowed barley generally have greater spike length as compared to six rowed barley. But inspite of having longer spikes two rowed barley could not produce high yield as the number of grains per spike was smaller as compared to other group (6 rowed). Delogu (1987) also noticed that low yield in certain two rowed barley varieties was due to less number of grains per spike inspite of having longer spikes.

4.1.4.8. Number of grains per spike.

Non significant differences were recorded for salinity levels and their interactions with the genotypes for the character under study. However, there were highly significant differences among genotypes (Table 4.13). Number of grains/spike were averaged by counting grains of ten spikes for each genotype, mean values are given in table 4.21.

Table-4.21 Number of grains per spike of barley genotypes as affected by two different field salinity levels.

Barley Genotypes	Mean grains per spike
55988/MSc-221	41.97 a
ALOE "S"	40.55 ab
GEM	40.48 ab
56001/MSC-234	39.42 b
55989/MISC-221	38.80 bc
56000/MISC-233	38.50 bc
LIGNEE-640	37.10 c
ZARZA"S"	36.83 c
GERBEL	34.02 d
YESILKÖY-387	31.82 e
GIDA"S"	25.83 f
MENTA"S"	25.53 f
SOUFARA	23.72 fg
ZEYPHER	23.22 gh
WI-2291/WI-2269	22.90 gh
ARAR	22.47 gh
IRANIA/LIGNEE 131	21.28 hi
CI- 13575	19.90 ij
87-FA-SDS	19.27 ij
BALADI- 16/CJ	19.05 j
ROHO/DELISA	18.87 j
Mean	29.60
S_x for Genotype = 0.578	

*- Means having similar letter (s) differ non-significantly.

Overall results regarding the efficiency of genotypes, indicated that line No.55988/MISC-221 topped the list and produced the maximum number of grains/spike (41.97). This line remained statistically at par with ALOE "S" and GEM those produced 40.55 and 40.48 grains/ spike, respectively. ROHO/DELISA produced minimum

grains/spike (18.87) and also remained statistically at par with BALADI-16/CJ and 87-FA-SDS that yielded 19.05 and 19.27 grains per spike. The differences among genotypes for grains/spike were highly striking. These variations can be attributed to the fact that six rowed barley generally have more grains per spike than two rowed barley. Ultimately this led to greater variations. It was noticed that line No 55988/MISC-221 which produced maximum number of grains per spike also produced high yield. Similar results were reported by Grigoryon (1985) who explained that number of grains per spike or per plant is one of the main component that affected yield.

4.1.4.9. Grain Weight Per Spike (gm)

As in case of a number of other traits, F-ratios given in table 4.13 indicated that neither salinity levels nor their interactions showed any significant differences. However, there were significant differences among genotypes under study. Grain weight of 10 spikes was recorded for each genotype and mean values are given in table 4.22.

Regarding mean grain weight/ spike, it was noticed that cultivar GEM produced the highest grain weight/ spike (2.11 gm). This cultivar differed significantly from all other genotypes included in this study. This was followed by cultivar ALOE "S" and Line No.55988/MISC-221, that yielded 2.01 and 1.98 grams mean grain weight/spike, respectively and remained statistically at par with each other. CI-13575 produced minimum grain weight/spike (0.76 g) and also remained statistically at par with ROHO/DELISA that yielded 0.77 gram grain weight per spike as a mean value.

The differences among the genotypes for grain weight/spike were highly noticeable. As explained for other components this was mainly due to the fact that besides genetic variations six rowed barleys owing to their greater number of grains per spike showed more grain weight per spike as compared to two rowed barleys. It was also noticed that varieties having higher grain weight per spike showed comparatively better yield. Sip and Skorpik (1984) achieved similar results and informed that the most important of the yield components for barley cultivars is the grain weight per spike.

Table-4.22 Mean grain weight per spike of barley genotypes as affected by two different field salinity levels.

Barley Genotypes	Mean grain weight per spike(gm) *
GEM	2.11 a
ALOE "S"	2.01 b
55988/MISC-221	1.98 b
56001/MISC-234	1.70 c
YESILKÖY-387	1.62 d
LIGNEE-640	1.61 d
ZARZA"S"	1.60 d
55989/MISC-221	1.42 e
56000/MISC-233	1.40 e
GERBEL	1.20 f
WI-2291/WI-2269	1.11 g
MENTA"S"	1.04 h
SOUFARA	1.00 h
GIDA"S"	0.98 h
IRANIA/LIGNEE 131	0.89 i
ARAR	0.89 i
ZEYPHER	0.88 i
BALADI- 16/CJ	0.88 i
87-FA-SDS	0.87 i
ROHO/DELISA	0.77 j
CI- 13575	0.76 j
Mean	1.273
S_x for Genotype = 0.021	

*- Means having similar letter (s) differ non-significantly.

4.1.4.10. 1000-Grain Weight (gm).

Data regarding 1000-grain weight (gm) were recorded by weighing three samples in each case, mean values for each genotype are given in table 4.23. Statistical analyses of the data described non significant differences for salinity levels and their interactions with genotypes . Opposite to this, there were significant differences among the genotypes for the character under study (see table 4.13). Overall results regarding the performance of genotypes indicated that WI-2291/WI-2269 (51.61 gm), GEM (51.55 gm) and YESILKÖY-387 (51.09 gm) gave higher 1000-grain weight and remained statistically at par with each other.

Table-4.23 1000-grain weight of barley genotypes as affected by two different field salinity levels.

Barley Genotypes	Mean 1000-grain weight (gm) *
WI-2291/WI-2269	51.61 a
GEM	51.55 a
YESILKÖY-387	51.09 a
55988/MISC-221	48.29 b
SOUFARA	46.28 c
ZARZA"S"	45.75 cd
87-FA-SDS	45.39 cd
IRANIA/LIGNEE 131	45.37 cd
BALADI- 16/CJ	45.36 cd
ROHO/DELISA	45.35 cd
56001/MISC-234	44.66 de
ALOE "S"	44.62 de
LIGNEE-640	43.82 e
MENTA"S"	43.37 e
GIDA"S"	43.29 e
CI- 13575	41.18 f
55989/MISC-221	39.82 fg
ZEYPHER	39.47 g
ARAR	38.91 g
56000/MISC-233	38.68 g
GERBEL	31.67 h
Mean	44.07
S _x for Genotype = 0.405	

Lowest efficiency was noticed in case of Gerbel, that attained 31.67 grams 1000-grain weight and statistically differed from all of the rest genotypes. On examining the table it is quite evident that genotypes showed prominent variations among themselves. Like other characters under study the variations may be due to high genetic diversity among the genotypes, as these were obtained from a number of different institutes. It was also noticed that comparatively high yield of line No. 55988/MISC-221, cv. GEM and YESILKÖY-387 was due to their higher 1000-grain weight. Popescu (1985) also achieved similar results and reported that the 1000-grain weight is a yield component which highly affects the yield of barley varieties.

4.2. Rice

4.2.1. Salt Concentration Effects on Rice(Trial-R.1)

During this trial, performance of 12 rice genotypes (Table 3.2) were evaluated against three different salt concentrations viz., control, 60 and 120 mMol. The behaviour of different rice genotypes were determined for distinguishing their salt tolerance attitude at early growth stage. Data on seedling emergence were recorded at 7th and 15th day of sowing. Whereas root and shoot length were measured at 40th day. All the 3 salt concentrations showed different impacts on seedling emergence as well as on root and shoot lengths of genotypes under study. Statistical analysis revealed that there were highly significant interactions among salt concentrations and genotypes, for all the characters studied, as shown in table 4.24. below.

Table 4.24 F-ratios for salt concentration effects on rice genotypes

Sources of Variation	Seedling emergence(%)		Shoot length (cm)	Root length (cm)
	7th DOS	15th DOS	40th DOS	40th DOS
Concentration	1903.24**	9139.20**	6989.23**	8125.39**
Genotype	4.10**	19.37**	16.98**	7.24**
Cons. X Geno.	2.92**	14.21**	5.58**	3.17**

** Significant at 1% level of probability.

4.2.1.1. Salt Concentrations Effects On Seedling Emergence

Seedling emergence is a reasonably good index of germination ability as well as seed vigour. Analysis of the variance of the data showed that there were highly significant interaction effects between salt concentrations and genotypes for seedling emergence percentage of rice at 7th day of sowing (Table 4.24). Average figures regarding percentage seedling emergence of different rice genotypes as influenced by NaCl concentrations on 7th day of sowing are given in table- 4.25.

As it is evident from figure-9, that genotypes differed in their responses under control and 60 mMol NaCl concentration. However significance of interactions can be mainly attributed to analogous behaviour of genotypes under salt concentrations of 120

mMol. Under this concentration there was no emergence at all, thus showing a totally different response of genotypes as compared to other concentrations. On the other hand 60 mMol salt concentration remarkably decreased emergence percentage of rice seedling from 53.80 percent (control) to 45.65 percent (for 60 mMol). Genotypes differed in their behaviour under control as well as under 60 mMol. Besides this, striking differences were noticed among genotypes under 60 mMol. Under this concentration, division of genotypes in three different groups can be visualised from the table (4.25). NUC/KROS, TOAG-92 and ANA/MAR showed seedling emergence percentage greater than 50 percent. BALDO, and KROS-424, although remained statistically at par with the above mentioned three genotypes, but seedling emergence was less than 50 percent. CAL/D.BAS, IZ-300 and PALLOGIO-67 gave lowest performance under 60 mMol salt concentrations.

Table 4.25 Seedling emergence percentage of rice genotypes at 7th day of sowing as affected by different NaCl concentrations (mMol).

Genotype	Control	60m Mol	120 mMol	Average
NUC/KROS	53.33 ab	55.55 a	0.00	36.29
TOAG-92	60.00 a	54.44 a	0.00	38.14
ANA/MAR	50.00 b	51.11 ab	0.00	33.70
BALDO	61.11 a	48.89 abc	0.00	36.67
KROS-424	48.89 b	47.78 abc	0.00	32.22
IZ-160/2	46.67 b	44.44 bc	0.00	33.70
IZ-43.	55.55 ab	42.22 bc	0.00	32.59
IZ-30	50.00 b	42.22 bc	0.00	30.74
M101-IZ-60	47.77 b	41.11 c	0.00	29.62
IZ-300	56.67 ab	40.00 c	0.00	32.22
PALLOGIO-67	50.00 b	40.00 c	0.00	30.00
CAL/D.BAS	55.55 ab	39.99 c	0.00	31.85
Average	53.80	45.65 c	0.00	
Sx for Sal.= 0.665	Sx for Geno.=1.329	Sx for Sal. X Geno.= 2.302		

Statistical analysis of the data regarding seedling emergence percentage recorded at 15th day of sowing also showed similar trend. F-ratios given in table 4.24 revealed highly significant interactions among salt concentrations and genotypes. From the fig.10 it is noticeable that there were obvious differences in the response of different genotypes

to different salinity levels. However significance of interaction is mainly due to similar behaviour of all genotypes at 120 mMol as compared to significant differences at other concentrations. Under this concentration there was no seedling emergence at all, thus indicating a totally different response of genotypes. Seedling emergence percentages of various genotypes under different salt concentrations on 15th day of sowing are given in table 4.26.

Data given in the table indicated that 60 mMol salt concentrations remarkably reduced seedling emergence. Although genotypes differed under control yet the differences were smaller as compared to 60 mMol NaCl. Even the lowest seedling emergence percentage (85.56) recorded in control was higher than the highest seedling emergence percentage (83.33) recorded in 60 mMol NaCl. Salt application at 60 mMol concentration revealed clear cut differences among genotypes. TOAG-92, BALDO, ANA/MAR and NUC/KROS, showed high performance by having a seedling emergence of 83.33, 81.11, 80.00 and 76.67 percent respectively. All other genotypes differed significantly. IZ-300, KROS-424, IZ-43, IZ-160/2, and CAL/D.BAS remained intermediate in their performance.

Table 4.26 Seedling emergence percentage of rice genotypes at 15th day of sowing as affected by different NaCl concentrations (mMol).

Genotype	Control	60 mMol	120 mMol	Average
TOAG-92	90.00 ab	83.33a	0.00	57.78
BALDO	93.33 ab	81.11a	0.00	58.15
ANA/MAR	93.33 ab	80.00a	0.00	57.78
NUC/KROS	92.22 ab	76.67a	0.00	56.30
IZ-300	95.55 a	66.67b	0.00	54.07
IZ-43	92.22 ab	60.00c	0.00	50.74
IZ-160/2	91.11 ab	60.00c	0.00	50.37
KROS-424	86.67 ab	60.00c	0.00	48.89
M101-IZ-60	90.00 ab	57.77c	0.00	49.26
CAL/D.BAS	93.33 ab	55.99cd	0.00	51.11
IZ-30	91.11 ab	54.44cd	0.00	48.51
PALLOGIO-67	85.55 b	50.00d	0.00	45.19
Average	91.20	65.83	0.00	
Sx for Sal.= 0.492	Sx for Geno.0.985	Sx for Sal. X Geno.= 1.705		

Lowest seedling emergence percentage (50) was given by PALLOGIO-67. Intravarietal differences for salt tolerance in rice have been reported by various workers (Flowers and Yeo, 1981; Yeo and Flowers, 1984; Muhammad, 1986; Aslam, 1987, and Yeo et al., 1988).

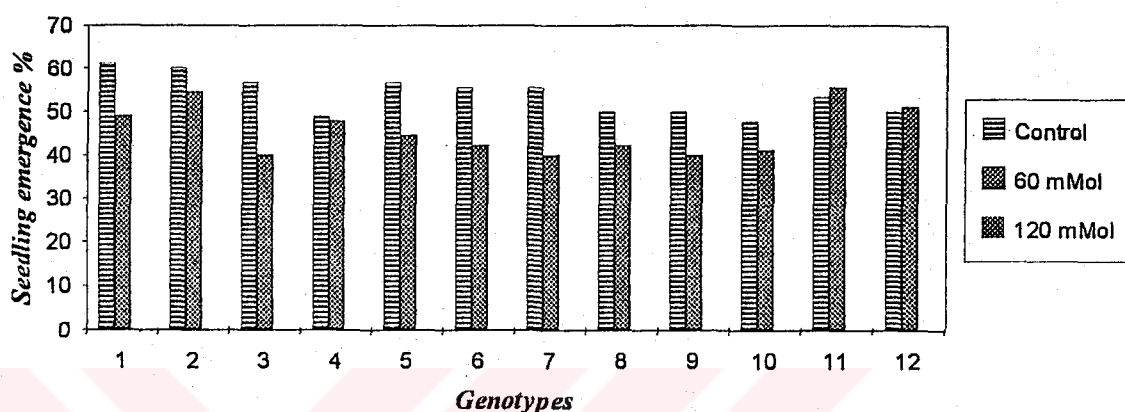


Fig. 9 Graphical presentation of NaCl concentration effects on seedling emergence percentage of rice genotypes (Table 3.2) on 7th day of sowing

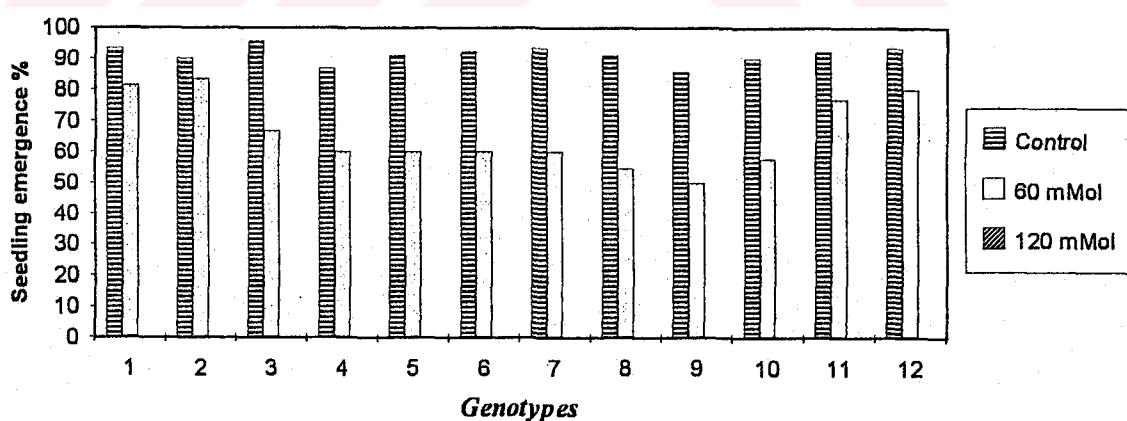


Fig. 10 Graphical presentation of NaCl concentration effects on seedling emergence percentage of rice genotypes (Table 3.2) on 15th day of sowing

Similar results were also reported by many other scientists. Campos and Assuncao (1990) revealed that the main effects (salinity and cultivar) and their interaction both had significant effects on germination and seedling emergence, number of abnormal plants and ungerminated seeds. The effect of salinity was higher than that of cultivar or cultivar X salinity interaction on germination and the number of abnormal plants. However, tolerance to salinity for rice at germination is usually not of much significance, since in most of rice growing areas, it is grown in nursery in a good soil and then transplanted when seedling are 20 to 40 days old. In contrast to this, the most salt tolerant crops like cotton (Shannon and Francois, 1977; Kent and Lauchli, 1985) and sugarbeet (Ayers and Hayward, 1948) are more salt sensitive during germination than during later stages of development. Decrease in seedling emergence with salinity was also observed by Ahmad and Gupta 1991 and Ahmed et al., 1993.

These results indicated that rice genotypes showed remarkable differences regarding seedling emergence percentage at 60 mMol NaCl concentration. Due to differential behaviour of 60 mMol on rice genotypes, this concentration can be used for distinguishing the seedling emergence percentage behaviour of rice genotypes against salinity stress. Similar results were reported by Aslam et al., (1993 b). They concluded that screening at seedling stage was a convenient practical technique for salt tolerance in a large number of rice genotypes. Jones and Wilkins (1984) conceived that selection of salt tolerance rice varieties can be conducted with 60 mMol NaCl.

4.2.1.2. Salt Concentration Effects On Shoot Length

Although shoot length is a varietal character, which is mostly controlled genetically, yet environmental factors also affect it considerably. Data related to shoot length of different rice genotypes were recorded on 40th day of sowing . Statistical analysis of the data revealed highly significant interactions for salt concentrations and

genotypes (Table 4.24). From fig.11 it is noticeable that genotypes differed under control as well as 60 mMol, however there was no emergence under 120 mMol salt concentration. This response of genotypes under of 120 mMol concentration lead to a significant interaction. It is worth mentioning that significance of interaction between the two factors under study was not due to 60 mMol salt concentration.

Average shoot length of the genotypes under different salinity levels are given in table 4.27. From the table it is evident that KROS-424 produced maximum shoot length (42.27 cm) under control. However this remained statistically at par with many other genotypes. Under control minimum shoot length (28.93 cm) was recorded in case IZ-43. Salt concentrations of 60 mMol seriously reduced shoot length. Under this concentration NUC/KROS, BALDO, ANA/MAR, TOAG-92 and PALLOGIO-67 attained a shoot length of 28.67, 28.53, 27.80, 27.67 and 25.93 cm. All these genotypes did not differ statistically among themselves. IZ-43 again produced the minimum shoot length (19.87 cm) under 60 mMol. Shoot length decreased with increasing salinity (Campos et al., 1989). Seedling height decreased with increasing salinity levels especially in the range 12-20 dS/m (Ahmed et al.,1993). Many other workers reported that shoot growth is more severely affected than root (Ayers & Eberhard, 1960; Ehlig, 1964; Meiri & Poljakoff-Mayber, 1970; Delane et al., 1982; Sharma, 1986; Lone, 1988; Aslam et al., 1991). Seedling height decreased significantly at salinity levels above 4 dS/m. (Punyawardena and Dharmasri 1989) Plant becomes stunted because of reduced cell division than cell expansion (Maas & Nieman, 1978). Dunn and Neales (1993), noticed that the growth of halophytes, atriplex and rice was reduced by 44 and 51 percent at 400-600 mol NaCl, respectively. The results reported by the above scientists are in corroboration with those achieved in this study.

It is noticed that 60 mMol salt concentration showed considerable differences among rice genotypes for their shoot length. Jones and Wilkins (1984) and AÇIKGOZ and GEVREK (1989) reported a distinctive response of rice genotypes with 60 mMol and 4 dS/m salt concentration . Keeping in view these findings it can be said that 60

mMol concentration may be successfully used for determining varietal responses against salinity on the basis of shoot length.

Table 4.27 Shoot length (cm) of rice genotypes at 40th day of sowing as effected by different NaCl concentrations (mMol).

Genotype	Control	60m Mol	120 mMol	Average
NUC/KROS	41.73 ab	28.67 a	0.00	23.47
BALDO	41.00 abc	28.53 a	0.00	23.18
ANA/MAR	41.87 ab	27.80 a	0.00	23.22
TOAG-92	40.53 abc	27.67 ab	0.00	22.73
PALLOGIO-67	39.80 abc	25.93 abc	0.00	21.91
IZ-160/2	39.13 abc	25.60 bc	0.00	21.58
M101-IZ-60	40.20 abc	25.47 abc	0.00	21.89
KROS-424	42.27 a	25.00 abc	0.00	22.42
IZ-300	39.53 abc	24.47 bc	0.00	21.33
IZ-30	37.60 bc	24.00 c	0.00	20.53
CAL/D.BAS	37.07 c	23.67 c	0.00	20.24
IZ-43.	28.93 d	19.87 d	0.00	16.26
Average	39.14	25.56	0.00	
Sx for Sal.= 0.238		Sx for Geno.=0.475	Sx for Sal. X Geno.= 0.823	

4.1.1.3. Salt Concentration Effects On Root Length

Root growth has a strong relation with edaphic factors and is seriously influenced by adverse soil conditions. Data about root length was recorded on 40th day of sowing. Statistically significant differences were noticed ^{for} interactions among salt levels and genotypes (Table 4.24). On closely observing fig.12 it is noticeable that genotypes differed under control as well as 60 mMol, however all the genotypes showed a decrease in their root length under higher concentration. But it was also noted that there was no emergence under 120 mMol salt concentration. This effect of 120 mMol concentration was the total cause for making the interaction significant and there was no role of 60 mMol towards a significant interaction. Root length of different rice genotypes as influenced by NaCl concentrations is given in table-4.28.

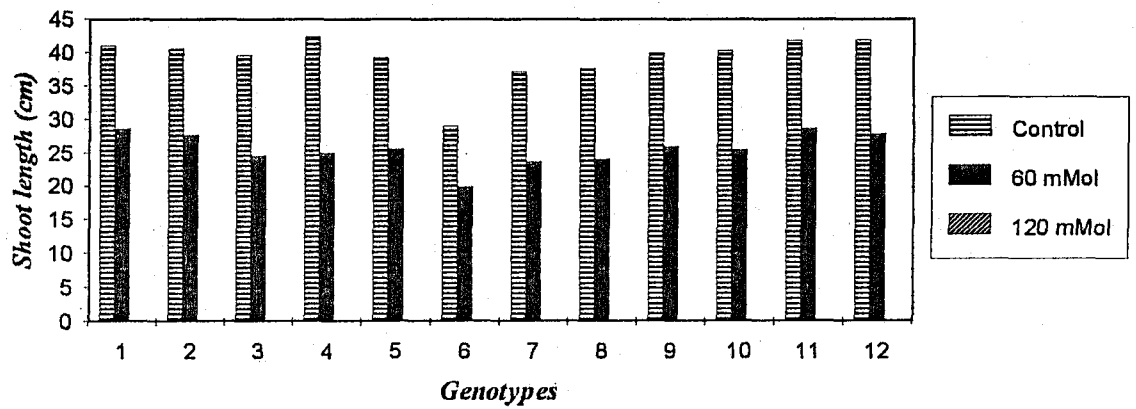


Fig. 11 Graphical presentation of NaCl concentration effects on shoot length of rice genotypes (Table 3.2) on 40th day of sowing

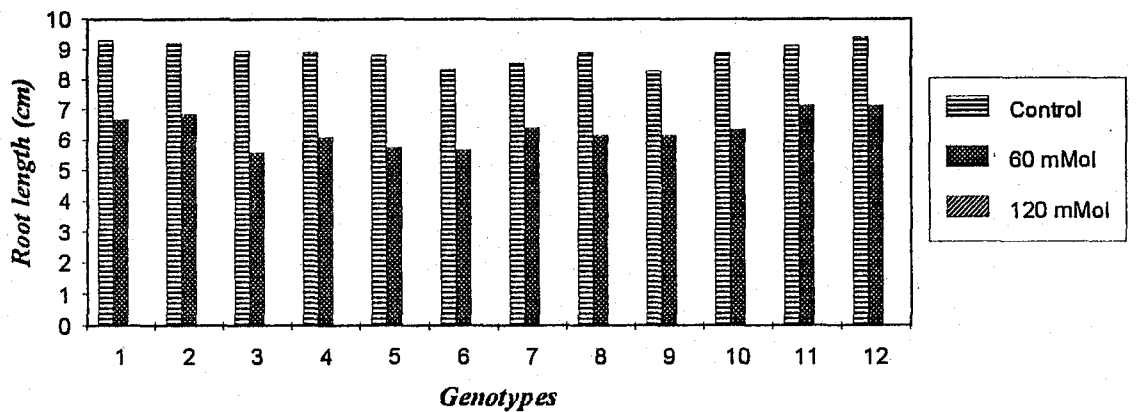


Fig.12 Graphical presentation of NaCl concentration effects on shoot length of rice genotypes (Table 3.2) on 40th day of sowing

Table 4.28 Root length (cm) of rice genotypes at 40th day of sowing as effected by different NaCl concentrations (mMol).

Genotype	Control	60m Mol	120 mMol	Average
ANA/MAR	9.40 a	7.13 a	0.00	5.51
NUC/KROS	9.13 ab	7.13 a	0.00	5.42
TOAG-92	9.20 ab	6.83 ab	0.00	5.34
BALDO	9.30 a	6.66 abc	0.00	5.32
CAL/D.BAS	8.53 bc	6.40 bcd	0.00	4.98
M101-IZ-60	8.87 abc	6.33 bcd	0.00	5.06
IZ-30	8.90 abc	6.13 bcd	0.00	5.01
PALLOGIO-67	8.26 c	6.13 bcd	0.00	4.80
KROS-424	8.90 abc	6.06 cd	0.00	4.99
IZ-160/2	8.80 abc	5.73 d	0.00	4.84
IZ-43	8.33 c	5.66 d	0.00	4.67
IZ-300	8.93 abc	5.56 d	0.00	4.83
Average	8.89	6.31	0.00	
Sx for Sal.= 0.051		Sx for Geno.=0.102	Sx for Sal. X Geno.= 0.176	

Table 4.28 describes that the increasing salt concentrations decreased root length of rice plants from 8.89 cm (control) to 6.31 cm (60 mMol). Genotypes differed significantly under control as well as under 60 mMol salt concentrations. Under control maximum root length (9.41 cm) was again recorded in case of ANA/MAR. This was closely followed by BALDO, which attained a root length of 9.30 cm. Wide differences were recorded in root length under 60 mMol. Under this salt concentration ANA/MAR, NUC/KROS, TOAG-92 and BALDO produced root length as 7.13, 7.13, 6.83 and 6.66 cm and remained statistically at par with each other. IZ-160/2, IZ-43, and IZ-300 showed lower performance by having a root length of 5.73, 5.66 and 5.56 cm, respectively. These genotypes remained statistically at par with each other. Salt concentration of 60 mMol caused greater statistical differences among genotypes. Root length decreased with increasing salinity (Campos et al., 1989). Punyawardena and Dharmasri (1989) reported that Root length decreased at 2 dS/m or above and no root was produced in either cultivar at 8 dS/m. Ahmed and Gupta (1991) noticed that root length was markedly reduced in all entries except IR51194-CN930-44-16B. Reduction in root growth with

increasing salinity may be due to direct contact of roots with toxic ions, present in excessive amount, which decrease⁵ water and nutrient availability leading to disturbance of normal metabolism.

The typical response of plants to salts in the root medium is the growth inhibition (Maas & Hoffman, 1977; Maas & Nieman, 1978; Flowers et al., 1991).

From the results explained above it is obvious that 60 m Mol salt concentration can differentiate among rice varieties for their root length. Therefore, this salt concentrations proved to be useful for evaluating genotypical responses against salt stress with regard to root length in rice. Many scientists explicated similar results. Freitas and Camargo (1988) noticed that root length was the most useful parameter in evaluating tolerance to salinity. Jones and Stenhouse (1983) measured root length on 13th and 17th days after seedling emergence and inferred that root length is an important factor in determining differences among rice genotypes.

All the morphological traits studied above revealed that; 1) there were statistically significant differences among genotypes under saline as well as control conditions. 2) These differences were more conspicuous under 60 m Mol salt concentration for seedling emergence as well as for root length. 3) Interaction effect was mainly due to the response of genotypes to 120 mMol as compared to others. 4) Salt concentration of 60 mMol did not show any contribution toward significance of interaction for shoot or root length. 5) Rice genotypes can be differentiated for their early growth responses to salinity at 60 m Mol NaCl salt concentrations.

4.2.2. Times Of Salinization Effects On Rice (Trial R-2)

It is concluded in trial R.1 that 60 mMol NaCl is an appropriate salt concentration for selection of rice genotypes. It is worth mentioning that significant interactions were present among genotypes and concentrations. However the interaction effects were mainly due to the response of genotypes to 120 mMol salt concentration. More over it is

also noticed that 60 mMol did not show any contribution toward significance of interaction for shoot or root length. During this trial (R-2) appropriate time of salt application to distinguish among rice genotypes was determined. With this objective 60 m-Mol salt solution was applied at 3 different times, in addition to control. Salt applications were done at sowing, 10 days after sowing (10DAS) and 20 days after sowing (20DAS). Data on early growth traits were recorded. These traits included seedling emergence percentage at 7th and 15th day of sowing as well as shoot and root length at 40th day of sowing. Statistical analysis revealed significant interaction between genotypes and time of salinization for shoot length as shown in table 4.29.

Table 4.29 F-ratios for times of application effects on rice genotypes

Sources of variations	Seedling emergence (%)		Shoot length (cm)	Root length (cm)
	7th DOS	15th DOS	40th DOS	40th DOS
Genotype (G)	8.163**	8.23**	6.72**	1.07 ^{ns}
ApplicationTimes (AT)	259.70**	5.62**	301.95**	74.35**
G X AT.	1.05 ^{ns}	0.43 ^{ns}	2.03**	0.35 ^{ns}

ns- Non-significant

** -Significant at 1% level of probability.

4.2.2.1 Times Of Salinization Effects On Seedling Emergence

Statistical analysis of the data on seedling emergence percentage at 7th day of sowing revealed highly significant differences among genotypes as well as salt application times. However non- significant differences were noticed for interactions of these two factors (Table 4.29). Average values about percentage seedling emergence at 7th day of sowing, as influenced by time of salt application, are given in Table- 4.30.

As an average effect of salt application times, BALDO (59.72%) ANA/MAR (54.45%) and TOAG-92, having seedling emergence percentage as 54.45 showed better performance and remained statistically at par with each other. Minimum seedling

emergence was recorded as 31.95 per cent in case of CAL/D.BAS. Regarding application times, salt application at sowing seriously reduced the seedling emergence percentage (Fig.13) and significantly differed from control. Nevertheless other two treatments, i.e., 10 days after sowing and 20 days after sowing remained statistically at par with control. This indicated that salt application at the time of sowing may help to determine salinity tolerance at early stages of growth.

Table 4.30 *Seedling emergence percentage of rice genotypes at 7th day of sowing as affected by different times of NaCl application.*

Genotype	Control	At sowing	10 DAS	20DAS	Average
BALDO	68.89	25.56	68.89	75.56	59.72 a
ANA/MAR	76.67	14.45	58.89	67.78	54.45 ab
TOAG-92	68.89	12.22	68.89	55.56	51.39 abc
NUC/KROS	56.67	12.22	63.33	57.78	47.50bcd
KROS-424	61.11	6.67	57.78	54.45	45.00 bcd
M101-İZ-60	56.67	5.56	57.78	56.67	44.17 bcd
PALLOGİO-67	61.11	8.89	44.45	60.00	43.61cd
İZ-30	58.89	4.45	50.00	57.78	42.78cd
İZ-300	55.56	6.67	51.11	55.56	42.22bcd
İZ-43.	45.56	4.45	56.67	55.56	40.56cde
İZ-160/2	48.89	5.56	47.78	55.56	39.45 de
CAL/D.BAS	40.00	7.78	41.11	38.89	31.95 e
Average	58.24 a	9.54 a	55.56 a	57.59 b	
Sx for Geno.=2.561 Sx for TS.=1.478 Sx for Geno.X TS= 5.121					

Data about seedling emergence percentage recorded on 15th day of sowing showed similar trend. Statistical analysis of the data revealed highly significant differences among genotypes and application times. However, interaction effects of genotypes X times of application remained non significant (Table 4.29). Data regarding seedling emergence percentage of rice genotypes on 15th day of sowing are portrayed in table 4.31. As an average effect of application times, wide differences were noticed among genotypes. On 15th day of sowing BALDO (82.50%), TOAG-92 (80.56%), ANA/MAR (78.61%) and NUC/KROS (73.33%) gave better performance and remained statistically at par with each other. CAL/D.BAS showed lowest performance with 48.61 percent seedling emergence.

Table 4.31 Seedling emergence percentage of rice genotypes at 15th day of sowing as affected by different times of NaCl application.

Genotype	Control	At sowing	10 DAS	20DAS	Average
BALDO	94.45	74.45	78.89	82.22	82.50 a
TOAG-92	84.45	78.89	81.11	77.78	80.56 a
ANA/MAR	91.11	75.56	67.78	80.00	78.61 ab
NUC/KROS	71.11	75.56	72.22	74.45	73.33 abc
İZ-30	71.11	57.78	65.56	75.56	67.50 bc
KROS-424	67.78	67.78	64.45	67.78	66.95 bc
M101-İZ-60	68.89	54.45	64.45	72.22	65.00 c
PALLOGİO-67	71.11	57.78	61.11	67.78	64.44 c
İZ-43.	68.89	57.78	64.45	64.45	63.89 c
İZ-300	71.11	58.89	58.89	65.56	63.61 c
İZ-160/2	68.89	58.89	57.78	62.22	61.95 c
CAL/D.BAS	52.22	41.11	52.22	48.89	48.61d
Average	73.43a	63.24a	65.74a	69.91b	
Sx for Geno.=3.291	Sx for TS.=1.900		Sx for Geno.X TS= 6.582		

Concerning times of application, significant reduction was recorded when salt application was done at the time of sowing (Fig.14). By considering mean values Control gave 73.43 percent seedling emergence, whereas salt application at sowing resulted into 63.24 percent seedling emergence. Results demonstrate by Akita (1986) and Aslam (1993b) are in partial agreement with those reported above. According to them seedling stage of rice proved to be the most sensitive, while it gains tolerance at tillering and vegetative growth stage. Ahmed et al., (1988). observed that irrigation with saline water applied during the tillering and panicle initiation stages produced greater adverse effects than when applied during the later growth stages. Increasing salinity levels decreased growth and yields. Mass (1984) informed that wheat and rice are less tolerant during emergence and seedling stage. He further said that salt seems to affect rice during pollination and may decrease seed set and grain yield.

From the above results it is obvious that there was a wide variation among rice genotypes when salt application was done at sowing. Thus, this technique may be used for salt tolerance evaluation in rice varieties.

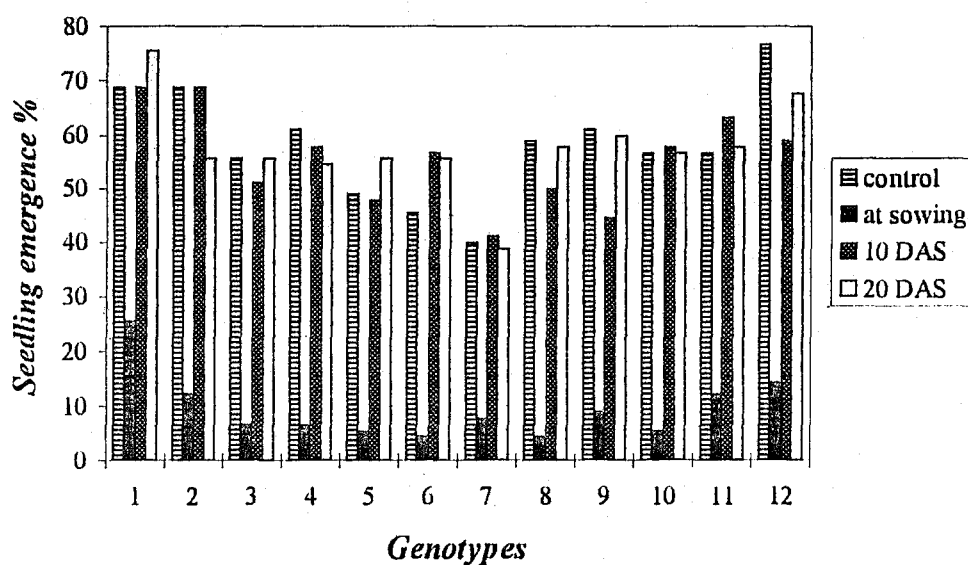


Fig.13 Graphical presentation of NaCl application times effects on seedling emergence percentage of rice genotypes at 7th day of sowing

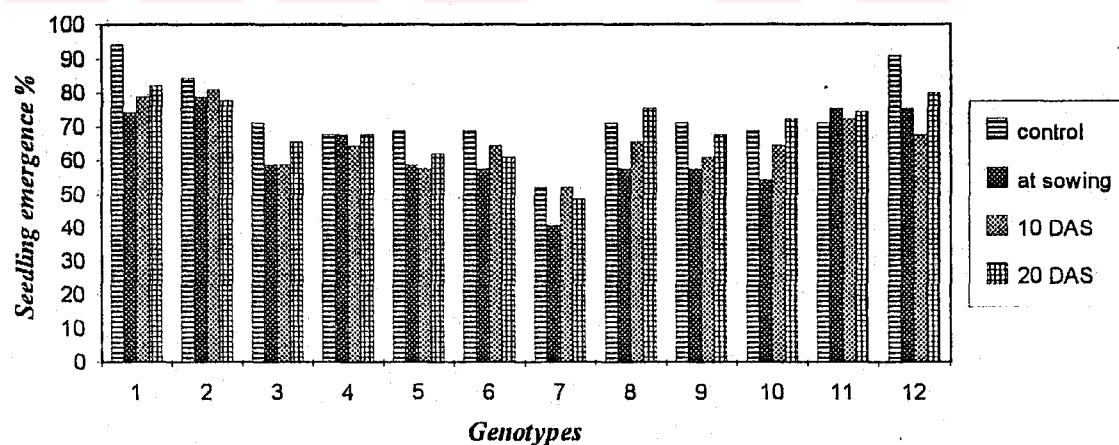


Fig.14 Graphical presentation of NaCl application times effects on seedling emergence percentage of rice genotypes at 15th day of sowing

KAFLIOĞLU (1985) concluded that salt application on 10th day after sowing is better as compared to salt application at 20 DAS to distinguish the responses of rice varieties with respect to their salt tolerance. Under his experimental conditions there was total death of emerging seedlings, when salt was applied at sowing so it was not possible for him to see differences among varieties under this treatment. According to these inferences earlier application showed more clear differences among the varieties, if they survived. The results achieved in this study are also in line with those cited above.

4.2.2.2. *Times of Salinization Effects On Shoot Length*

Statistical analysis of the data regarding shoot length collected on 40th day of sowing showed highly significant interactions for genotype X times of salt application (Table 4.29). As evident from fig. 15 significance of interaction can be attributed to the variation in the behaviour of certain genotypes under control and 20 DAS application. For example ^{12-160/2} *L* showed greater shoot length under 20 DAS application time as compared to control. Whereas other varieties had smaller shoot length under this treatment as compared to control. This was the major contribution towards a significant interaction. Mean shoot length values for different times of applications and genotypes are given in table -4.32. Earlier salinization had more adverse effects on shoot length of rice plants. Salt application at the time of sowing showed a remarkable decrease in this regard.

Interaction among genotypes X times of salt application depicted different responses with regard to shoot length. Genotypes showed statistically significant differences under all times of salt applications as well as control. Variation among genotypes under control indicated that the material has genetic variability. Ahmed et al., (1988) observed that irrigation with saline water applied during tillering and panicle initiation stages produced greater adverse effects than when applied during the later growth stages. Increasing salinity levels decreased growth and yields.

Table 4.32 Shoot length (cm) of rice genotypes at 40th day of sowing as influenced by times of NaCl application.

Genotype	Control	At sowing	10 DAS	20 DAS
TOAG-92	38.97ab	27.87 a	33.63 abc	37.23 ab
PALLOGIO-67	40.40ab	26.93 ab	30.65 abc	35.94 abc
ANA/MAR	39.80ab	26.65 ab	33.10 abc	36.90 ab
İZ-30	39.50ab	25.91 ab	29.53 bc	36.37 ab
M101-İZ-60	41.07ab	25.85 ab	36.50 a	39.55 ab
İZ-43	35.67b	25.70 ab	31.01 abc	33.60 bc
KROS-424	40.60ab	25.43 ab	32.52 abc	38.91 ab
İZ-160/2	39.43ab	25.42 ab	35.39 ab	40.70 a
İZ-300	40.23ab	25.24 ab	34.58 ab	39.45 ab
NUC/KROS	39.73ab	25.17 ab	33.71 abc	38.80 ab
BALDO	41.50a	25.07 ab	32.67 abc	37.31 ab
CAL/D.BAS	40.67ab	22.67 b	27.67 c	29.58 c
Average	39.80	25.66	32.58	37.03
Sx for Geno.=0.615	Sx for TS.=0.354		Sx for Geno.X TS= 1.2296	

Information reported by a number of research workers on the relative tolerance of rice to salinity at various growth stages showed that rice was tolerant during germination and becomes very sensitive during early seedling stage.(Yoshida, 1981; Akbar and Ponnampurna, 1982; Jones and Stenhouse, 1983; Rashid 1983; Akita, 1986). Reduction in shoot length was also reported by Ahmad and Gupta (1991), when salinity was applied during early stage of growth. On closely observing the two way table it was noticed that TOAG-92 though topped the list by having shoot length of 27.87 yet remained statistically at par with many others except CAL/D.BAS when salt was applied at sowing. Both Under 10 DAS and 20 DAS application times, many varieties remained at par with each other. It is quite obvious that rice genotypes invariably differed under all application times for their shoot length. From the above results, although it is difficult to select a single treatment being most appropriate, yet it is quite obvious that earlier application is helpful in distinguishing responses of rice genotypes. AÇIKGOZ and GEVREK (1989) also noticed variation in plant height of rice mutants when salt was applied on 10th day after sowing.

4.2.2.3. Times Of Salinization Effects On Root Length

Root length data were recorded on 40th day of sowing. Statistical analysis of this data showed non significant differences among genotypes. However significant differences were noticed for times of salt application. Besides this, the interaction for genotypes X application times were non significant (Table 4.29). Average root length of different genotypes as influenced by time of salt application is given in table 4. 33.

While comparing the treatments salt application at sowing drastically reduced the root length (Fig.16). Average root length for this treatment was 5.97cm as compared to 8.63 cm for control. Salt application at 20 DAS remained statistically at par with control. However, salt application at 10 DAS significantly differed from the other treatments, and produced an average root length as 7.55.

Table 4.33 Root length (cm) of rice genotypes at 40th day of sowing as influenced by times of NaCl application.

Genotype	Control	At sowing	10 DAS	20 DAS	Average
ANA/MAR	9.10	6.40	7.80	8.90	8.05
NUC/KROS	8.80	6.47	8.20	8.43	7.97
KROS-424	8.67	5.87	7.27	8.13	7.83
İZ-30	9.10	6.27	7.33	8.10	7.70
TOAG-92	8.70	6.43	7.57	7.83	7.63
BALDO	8.20	5.87	7.57	8.50	7.53
M101-İZ-60	8.77	5.97	7.33	8.07	7.53
İZ-43	8.27	5.80	7.50	8.43	7.50
İZ-300	8.73	5.60	7.33	7.93	7.40
İZ-160/2	8.50	5.87	7.13	8.03	7.38
CAL/D.BAS	8.43	5.80	7.67	7.60	7.37
PALLOGİO-67	8.33	5.33	7.90	7.67	7.31
Average	8.63 a	5.97 c	7.55 b	8.14a	
Sx for Geno.=0.232		Sx for TS.=0.134		Sx for Geno.X TS= 0.464	

From the above results it was noticed that salt application at sowing and 10 DAS affected root length and remarkable differences among genotypes were present under both the time of sowing. Jones and Stenhouse (1983) started application of 0 and 80 mMol NaCl at the time of sowing and noted that root length is an important factor in determining salt tolerance in rice varieties.

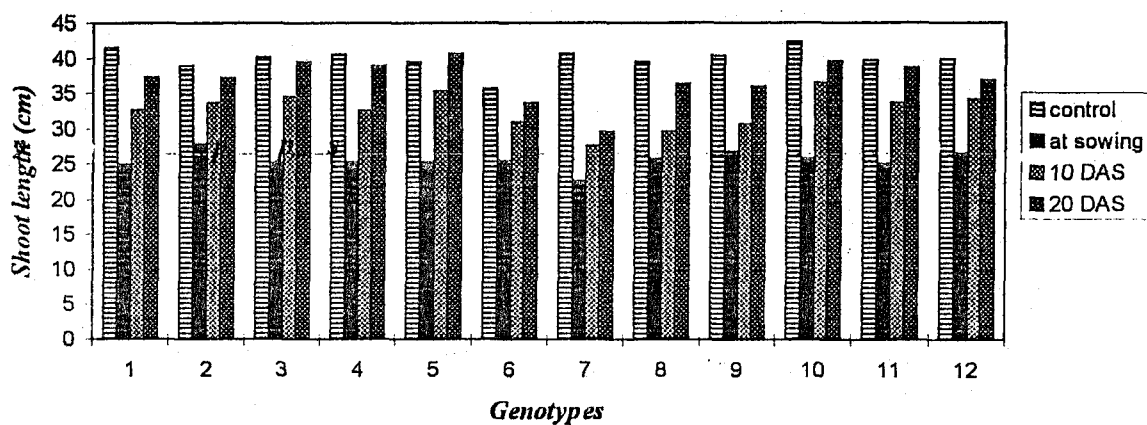


Fig. 15 Graphical presentation of NaCl application times effects on shoot length of rice genotypes (table 3.2) at 40th day of sowing

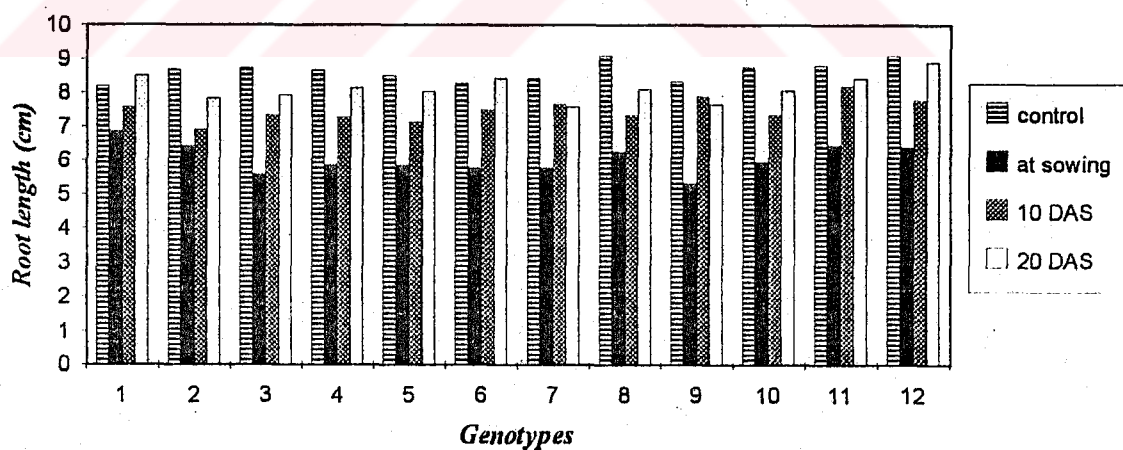


Fig. 16 Graphical presentation of NaCl application times effects on root length of rice genotypes (table 3.2) at 40th day of sowing

On considering above three traits together it can be inferred that rice genotypes were more distinguishable in their response to salinity when salt was applied at sowing. However, genotypes showed almost similar responses to all application times regarding their shoot length. On the other hand seedling emergence on 15th day of sowing exhibited more conspicuous differences in the genotypes under study. Whereas root length responses of different varieties were equally distinctive to salt application at sowing as well as 10 DAS. Keeping in view these conclusions, during further studies seedling emergence and root length were considered the major tools in determining differences among rice genotypes when subjected to salt application at sowing. Aslam et al., (1993) concluded that screening at seedling stage was a convenient practical technique for salt tolerance in a large number of rice genotypes. Keeping all these findings and discussion in view it was concluded that 60 mMol NaCl at the time of sowing is an excellent combination for distinguishing rice varieties to salt stress at early stage. Consequently further pot studies were conducted using this combination for bulk screen of rice genotypes.

4.1.3. Bulk Screening Of Rice Genotypes (Trial. R-3)

From the studies conducted so far on rice, it is concluded that 60 mMol NaCl concentration and salinization at the time of sowing is an effective combination for pre judging salt tolerance behavior of rice genotypes. Besides this it was also noted that seedling emergence at 15th day of sowing is a good criterion for selection of rice genotypes to salt stress at seedling stage. Consequently, this concentration was used for mass screening of rice genotypes against salt stress at early growth stage. To accomplish this aim an augmented experimental design with 4 blocks was used. In all 120 rice genotypes (4 check and 116 new selections) were tested during this trial. Data on seedling emergence, shoot and root length recorded during these studies were subjected to statistical analysis. Results drawn after appropriate statistical analysis are discussed here under.

4.1.3.1. Seedling Emergence.

Statistical grouping of the data regarding seedling emergence percentage of 120 rice genotypes on 7th and 15th day of sowing are given in Table- 4.34. This table gives complete illustration of variations among the genotypes for seedling emergence. From the table it is evident that the genotypes showed various divisions in the form of statistically different groups. (Names of the genotypes are given in appendix-II) Table 4.34 indicated wide differences among the genotypes. MERIC.(Sr. No.94) showed the best performance having 86.06% seedling emergence on 7th day of sowing. As it is obvious from the table this genotype remained statistically at par with 23 other genotypes. However it was closely followed by ALTINYAZI (Sr. No.18) and M-101/IZ-68 (Sr. No.59), both showed 80.21 percent seed-ling emergence. Contrary to this, 33 other genotypes did not show any seedling emergence. Here it is worth mentioning that in the table no entry has 0 % value against it. This phenomenon is due to addition or subtraction of adjustment factor for the enteries present in different blocks.

Identical results were also obtained for seedling emergence percentage recorded on 15th day of sowing. BALDO*IZ-30 (Sr. No.3) was at the top of the list by having 105.00% statistically adjusted value for seedling emergence. This was followed by ALTINYAZI (Sr. No.18) , 8217-TR-427-1-1-1 (Sr. No.77), TIT/IZ-43 (Sr. No.8) and BELLOMENT*IZ-68. (Sr. No.21). All the five genotypes remained statistically at par with each other. However no seedling emergence was recorded in 32 genotypes. On closely observing the table it was noticed that most of the rice seeds germinated during first week of sowing. Moreover, most of the seedlings emerged during first week normally continued their growth and there were a very few chances of mortality under this concentration.

Table 4.34 Statistical grouping of seedling emergence percentage (SEP) of 120 rice genotypes as influenced by salinity on 7th and 15th day of sowing .

7th Day of Sowing		15th Day of Sowing	
Sr. No:	SEP Statistical grouping	Sr. No:	SEP Statistical grouping
94	86.063	3	105.438
19	80.213	18	96.738
59	80.213	77	89.362
89	79.363	6	85.438
3	76.913	21	85.438
6	76.913	53	83.762
83	76.913	86	82.962
90	76.913	0	80.000
71	75.913	10	78.738
56	73.513	11	78.738
77	73.513	22	76.738
86	73.513	26	76.738
46	70.213	89	77.938
C	67.500	112	77.938
10	66.913	74	76.262
11	66.913	85	76.262
26	66.913	6	75.438
53	66.913	20	75.438
58	66.913	94	74.538
62	66.913	5	72.138
74	66.913	9	72.138
76	66.913	14	72.138
78	66.913	95	71.238
81	66.913	8	70.875
102	66.063	56	70.392
8	65.000	60	69.562
D	65.000	67	69.562
8	62.513	75	69.562
12	63.513	76	69.562
16	63.513	81	69.562
40	63.513	A	69.175
A	63.350	15	68.738
97	62.662	72	66.262
9	60.213	73	66.262
14	60.213	83	66.262
22	60.213	104	64.537
79	60.213	68	62.962
65	60.213	87	62.962
67	60.213	12	62.138
83	60.213	C	61.650
13	56.913	58	60.362
44	56.913	59	59.562
75	56.913	63	59.562
89	56.913	78	59.562
112	56.031	80	59.562
15	53.513	84	59.562
20	53.513	14	58.738
70	53.513	64	56.262
84	53.513	7	55.338
5	50.213	2	55.438
108	49.363	38	53.762
38	46.913	71	52.962
72	46.913	13	52.138
87	46.913	17	52.138
95	46.063	25	52.138
2	43.513	65	49.562
7	43.513	67	49.562
34	43.513	70	49.562
69	43.513	79	49.562
79	43.513	19	48.738
19	40.213	42	47.062
42	40.213	66	46.262
45	40.213	106	44.537
92	39.363	92	41.238
104	39.363	33	40.362
113	39.363	34	40.362
13	36.913	49	39.562
68	36.913	24	35.438
71	36.913	97	34.537
24	33.513	113	34.537
33	33.513	90	31.237
43	30.213	93	31.237
73	30.213	37	30.362
41	26.913	61	27.062
37	23.513	43	27.062
29	20.213	39	23.762
90	19.363	45	23.762
92	19.363	29	22.138
39	16.913	30	17.062
44	12.513	44	13.762
30	10.213	48	13.762
101	9.363	101	11.237
105	9.363	54	10.362
31	6.913	102	10.237
1	3.513	1	8.738
99	2.662	99	7.937
103	2.662	31	7.062
4	0.213	32	7.062
23	0.213	35	7.062
27	0.213	36	7.062
28	0.213	40	7.062
32	0.213	46	7.062
35	0.213	47	7.062
36	0.213	49	7.062
40	0.213	50	7.062
46	0.213	51	7.062
47	0.213	52	7.062
48	0.213	55	7.062
49	0.213	57	7.062
50	0.213	4	5.438
51	0.213	23	5.438
52	0.213	27	5.438
54	0.213	28	5.438
55	0.213	105	1.237
57	0.213	61	-3.738
61	0.213	82	-3.738
82	0.213	103	-5.462
88	-0.637	88	-8.763
91	-0.637	91	-8.763
96	-0.637	96	-8.763
98	-0.637	98	-8.763
100	-0.637	100	-8.763
106	-0.637	106	-8.763
107	-0.637	107	-8.763
109	-0.637	109	-8.763
110	-0.637	110	-8.763
111	-0.637	111	-8.763
114	-0.637	114	-8.763
115	-0.637	115	-8.763
116	-0.637	116	-8.763

Note:- Any two entries having a common line do not differ significantly
Names of entries/ genotypes are given in Appendix-II

Intravarietal differences for salt tolerance in rice have been reported by various workers (Flowers and Yeo, 1981; Yeo and Flowers, 1984; Muhammad, 1986; Aslam, 1987, 1990b; Yeo et al., 1988).

4.1.3.2. Shoot Length (cm)

Statistical grouping of the data regarding shoot length of different rice genotypes recorded on 40th day of experimentation are given in Table-4.35. This table indicates that there were highly significant differences among the genotypes. Maximum shoot length (29.72cm) was recorded in case of 83030-TR648-4-2-1-1(Sr. No.95) which remained at par with IZ-300-1 (Sr. No.112) and IPSALA. (Sr. No.102) having shoot lengths as 28.72 and 28.17. As noticed for seedling emergence, none of the seeds of 35 genotypes produced any shoot. This indicated that the seeds of three genotypes could not continue their apical growth and thus failed to produce any shoot. Similar results were also reported by Yeo et al., (1990). They noticed wide variation among rice genotypes for all the characters studied.

4.1.3.3. Root Length (cm)

Statistical analysis of the data regarding root length recorded on 40th day of sowing showed great variations among the rice genotypes. A complete description of these variations may be seen in table 4.35. Maximum root length (9.97 cm) was recorded in case of IPSALA (Sr. No.102) that remained statistically at par with 22 other genotypes. However this genotype was closely followed by BAL/ SOLNEYS (Sr. No.97) that produced a root length of 9.63 cm. Similar to seedling emergence 32 genotypes could not attain any measurable root length. Yan and Tan (1991) reported that rice varieties showed differences in their root length when grown in soil with added NaCl. These results are quite in line with those drawn in present studies.

Table 4.35 Statistical grouping regarding shoot and root length (cm) of 120 rice genotypes as influenced by salinity on 40th day of sowing.

Shoot length (SL)

Sr. No: SL Statistical grouping

95	29.719
112	29.719
102	29.719
9	27.329
10	27.029
92	27.019
59	26.399
63	26.399
3	26.629
20	26.229
47	26.264
15	26.179
20	26.064
77	25.949
26	25.829
77	25.769
22	25.629
50	25.416
12	25.029
90	24.989
12	24.769
8	24.629
89	24.369
17	24.229
106	24.219
53	24.214
84	24.189
11	23.029
94	23.769
10	23.629
74	21.599
49	23.499
113	21.369
25	23.229
74	21.029
62	22.999
75	22.999
64	22.789
72	22.789
83	22.549
17	22.079
41	21.999
A	21.990
7	21.929
14	21.879
67	21.819
63	21.789
66	21.789
10	21.789
84	21.789
71	21.689
106	21.669
8	21.229
70	21.089
8	20.899
14	20.879
19	20.789
101	20.729
C	19.515
60	19.529
81	19.189
64	19.149
74	18.749
1	18.679
56	18.614
103	18.019
71	17.629
17	17.329
5	14.789
99	13.549
41	14.064
70	13.519
87	12.399
45	10.674
54	10.614
48	10.214
41	10.214
37	9.414
39	9.394
73	9.329
34	8.714
39	8.159
19	7.429
105	6.719
33	6.714
28	3.464
88	0.569
11	0.569
94	0.569
98	0.569
100	0.569
106	0.569
107	0.569
109	0.569
110	0.569
111	0.569
114	0.569
115	0.569
116	0.569
31	0.214
32	0.214
33	0.214
34	0.214
35	0.214
36	0.214
37	0.214
38	0.214
39	0.214
40	0.214
41	0.214
42	0.214
43	0.214
44	0.214
45	0.214
46	0.214
47	0.214
48	0.214
49	0.214
50	0.214
51	0.214
52	0.214
53	0.214
54	0.214
55	0.214
56	0.214
57	0.214
58	0.214
59	0.214
60	0.214
61	0.214
62	0.214
63	0.214

Root length (RL)

Sr. No: RL Statistical grouping

102	9.968
97	9.628
9	9.625
3	9.601
A	9.550
C	9.500
89	9.398
2	9.371
13	9.371
7	9.331
8	9.328
18	9.301
104	9.258
6	9.271
101	9.156
86	9.116
3	9.071
77	8.874
22	8.601
95	8.568
10	8.501
83	8.474
8	8.411
14	8.431
90	8.338
108	8.328
74	8.201
9	8.071
20	8.071
87	8.004
17	7.911
38	7.894
58	7.874
85	7.874
11	7.871
24	7.871
25	7.701
31	7.471
74	7.406
53	7.358
80	7.304
81	7.304
16	7.301
15	7.201
19	7.201
71	7.144
84	7.144
42	7.054
94	6.899
37	6.894
56	6.894
84	6.874
97	6.844
113	6.844
70	6.844
73	6.844
78	6.844
34	6.574
45	6.534
79	6.544
62	6.374
75	6.374
76	6.304
12	6.301
41	6.224
40	6.204
72	6.204
93	6.164
67	6.144
65	6.144
97	6.029
89	5.964
112	5.968
43	5.894
64	5.874
34	5.724
48	5.404
1	5.301
31	5.224
39	5.224
57	5.144
29	5.131
99	4.928
48	4.924
105	4.478
102	3.958
30	3.894
4	0.301
23	0.301
27	0.301
20	0.301
88	-0.002
91	-0.002
96	-0.002
98	-0.002
100	-0.002
106	-0.002
107	-0.002
109	-0.002
110	-0.002
111	-0.002
114	-0.002
115	-0.002
116	-0.002
61	-0.024
82	-0.024
31	-0.274
32	-0.274
35	-0.274
36	-0.274
40	-0.274
44	-0.274
46	-0.274
47	-0.274
49	-0.274
50	-0.274
51	-0.274
52	-0.274
54	-0.274
57	-0.274

Note:- Any two entries having a common line do not differ significantly
Names of entries/ genotypes are given in Appendix-II

All the three character for 120 genotypes were taken together and performance of the genotypes, under study, was evaluated. It was noticed that MERIC and M-101/IZ-68 though showed higher seedling emergence on 7th day of sowing yet they remain low in other traits studied during the course of this trial. Consequently 20 rice genotypes namely 83030-TR648-4-2-1-1, BALDO*IZ-30, ALTINYAZI, PALLOGIO-67, 84017-TR745-12-1, TIT/IZ-43, BELLOMENT*IZ-30, IPSALA, 83030-TR621-2-1-1-1, IZ-30*KROS, BELLOMENT*IZ-68, KROS424, BAL / KROS, NUC/KROS, 84027-TR755-2-1, TRAKYA, ROCCO, BAL/SZISKIY, BALDO, TOAG-92, having comparatively better performance, were selected for comparison among their yield and yield components under saline conditions.

.2.4. Effects Of Salinity On Yield And Yield Components Of Rice (Trial-R.4)

Twenty rice genotypes having better performance under pot trials were selected for further experimentation. As cultivation of rice is banned in the farmers' field in the vicinity of izmir, the trial was conducted in specially prepared cemented beds. These beds were prepared in the Department of Field Crops, Faculty of Agriculture, Ege University, Bornova, İzmir, Turkey. Meteorological data pertaining to growing seasons is given in Appendix-V. EC. of bed No.1 was kept normal (0.04 dS/m) while the EC. of bed No.2 was increased and maintained at 5.5 ± 0.5 dS/m. This was achieved by adding appropriate amounts of NaCl or water as required. Data on various vegetative and reproductive traits of rice genotypes were recorded. Appropriate statistical analyses were carried out and results are given here under.

Table 4.36 F-ratios related to yield and yield components in rice grown under different salinity levels

Growth Traits	Salinity levels	Sources of Variation	
		Genotypes	Interactions
Yield	24740**	8.15**	3.42**
Tillers/ plant	118.94**	23.19**	1.67 ^{ns}
Days to 50% Flowering	54.77**	34.09**	8.15**
Days to 85% Maturity	100.75**	3.01**	1.91*
Plant height	311.69**	243.40**	8.36**
Panicle length	630.65**	11.95**	3.53**
Total grains / plant	237.3**	9.65**	4.08**
Grain fertility percentage	13319**	6.50**	6.20**
1000-grain weight	307.91**	80.15**	3.05**

ns - Non significant

* - Significant at 5% level of probability

** - Significant at 1% level of probability

4.2.4.1. Grain Yield (Kg/da)

Statistical analysis of the data about yield (kg/da) revealed significant interaction among salinity levels (locations) and genotypes as it is evident from F-ratios given in Table 4.36 Interaction was significant mainly due to the fact that cv. TRAKYA showed higher grain yield than cv. ALTINYAZI under control whereas under saline conditions cv. TRAKYA produced less grain yield than cv. ALTINYAZI. Besides this, some varieties e.g., PALLOGIO-67 and line No. 84017-TR745-12-1 while remaining at par with each other for yield under saline conditions, differed significantly among themselves under control. Average yield produced by various rice genotypes under control and saline conditions are given in Table 4.37.

Table-4.37 Grain yield (kg/ da) of rice genotypes as affected by two different salinity levels.

Genotypes	Control	5.5 dSm ⁻¹
83030-TR648-4-2-1-1	352.33 bcd	168.82 a
BALDO*IZ-30	374.73 abcd	168.00 a
ALTINYAZI	330.75 cde	167.53 a
PALLOGIO-67	349.53 bcde	166.02 a
84017-TR745-12-1	486.85 a	164.27 a
TIT/IZ-43	481.83 a	163.10 a
BELLOMENT*IZ-30	444.62 ab	150.03 ab
IPSALA	483.93 a	144.78 ab
83030-TR621-2-1-1-1	344.75 bcde	133.47 ab
IZ-30*KROS	347.90 bcde	130.78 ab
BELLOMENT*IZ-68	342.07 bcde	129.85 ab
KROS424	338.22 cde	118.42 ab
BAL / KROS	271.48 e	108.03 ab
NUC/KROS	341.02 bcde	103.95 ab
84027-TR755-2-1	377.30 abcd	102.43 ab
TRAKYA	411.95 abc	99.63 ab
ROCCO	301.35 de	99.17 ab
BAL/SZISKIY	316.17 cde	88.67 ab
BALDO	285.25 de	85.75 ab
TOAG-92	334.25 cde	68.95 b
Means	365.81	128.08
Sx for Sal.=0.338 Sx for Geno.=14.911 Sx for Sal. X Geno.= 21.088		

*: Means having different letters differ significantly.

It is evident from the table that line No. 84017-TR745-12-1 gave highest yield (486.85 kg/da) under control conditions. This was followed by IPSALA with a yield of 483.93 kg/da, and remained statistically at par with each other. Some other genotypes including TIT/IZ-43, BELLOMENTx IZ-30, TRAKYA, 84027-TR755-2-1 and BALDO x IZ-30 also occupied same statistical group. Lowest yield under control was given by BAL/KROS (271.48 kg/da) and this genotype also remained statistically at par with many other genotypes. Under saline conditions line No. 83030-TR648-4-2-1-1 produced maximum yield (168.82 Kg/da). This genotype did not differ significantly with all other genotypes except TOAG-92. Minimum yield under saline conditions was recorded in case of TOAG-92 (68.95 kg/da). Regarding locations (saline and control), Control gave higher average yield (365.81 kg/da), as compared to saline conditions (128.08 kg/da).

Similar results were narrated by many scientists (Akbar et al.,1972; Akbar and Ponnampurna, 1982, Rashid, 1983 and Verma and Neue ,1984). Beacher(1991) reported that grain yield was only affected by 4.0 dS/m treatment. Panaullah et al.,(1990) noted a significant variety X stress interaction. Ahmed et al., (1988). observed that increasing salinity levels decreased growth and yield. Mancebo (1990) noticed that grain yield decreased with increasing salinity. Intravarietal differences for salt tolerance in rice have been reported by various workers (Flowers and Yeo, 1981; Yeo and Flowers, 1984; Muhammad, 1986; Aslam, 1987; Yeo et al., 1990). Sajjad (1990) reported that cv. RST24 out yielded Basmati 370 in several quality characters and yield.

4.2.4.2. Tillers Per Plant

Tillering capacity generally depends upon genetic make-up and its interaction with the environment. Edaphic factors play an important role in determining the tillers produced by a crop plant. Data on tillering were recorded by counting tillers of 10 plants at panicle initiation stage. Statistical analysis was done by taking mean values. Significant

differences among rice genotypes and salinity levels were noticed. However interactions of both these factors were found non-significant (Table 4.36).

Table-4.38 Total tillers per plant of rice genotypes as affected by two different salinity levels.

Genotypes	Control	5.5 dSm ⁻¹	Means*
84017-TR745-12-1	5.22	4.33	4.78 a
BELLOMENT*IZ-30	5.11	3.78	4.45 ab
ALTINYAZI	4.67	3.78	4.22 ab
BALDO*IZ-30	5.00	3.44	4.22 ab
KROS424	4.67	3.78	4.22 ab
TIT/IZ-43	4.89	3.56	4.22 ab
PALLOGIO-67	5.00	3.33	4.17 ab
83030-TR621-2-1-1-1	4.55	3.78	4.17 ab
IZ-30*KROS	4.55	3.67	4.11 abc
IPSALA	4.33	3.56	3.94 abc
BELLOMENT*IZ-68	4.44	3.11	3.78 bcd
NUC/KROS	4.11	3.11	3.61 bcd
83030-TR648-4-2-1-1	4.00	2.56	3.28 cde
BAL / KROS	3.22	2.89	3.06 def
TRAKYA	3.44	2.67	3.06 def
BALDO	3.22	2.33	2.78 efg
84027-TR755-2-1	2.89	2.55	2.72 efg
BAL/SZISKIY	2.67	2.11	2.39 fg
TOAG-92	2.56	2.22	2.39 fg
ROCCO	2.45	2.11	2.28 g
Means	4.05a	3.13b	
Sx for Sal.= 0.0594 Sx for Geno.=0.162 Sx for Sal. X Geno.= 0.229			

*: Means having different letters differ significantly.

Number of tillers produced by various rice genotypes under control and saline conditions along with their averages are given in Table 4.38. From the table it is evident, that line No. 84017-TR745-12-1 gave highest average tillers per plant (4.78). This remained statistically at par with BELLOMENTx IZ-30, ALTINYAZI, KROS-424, TIT/IZ-43, BALDO x IZ-30, PALLOGIO-67, 83030-TR621-2-1-1-1, IZ-30 x KROS and IPSALA. But differed significantly with many other genotypes. Minimum numbers of tillers (2.28) were noticed in case of ROCCO. This genotype also differed non-significantly with BAL/SZISKIY, TOAG-92, 84027-TR755-2-1, and BALDO.

BAL/SZISKIY, and TOAG-92 produced same number of tillers per plant (2.39) whereas 84027-TR755-2-1, and BALDO gave 2.72 and 2.78 tillers per plant, respectively. These results are quite in line No. with those reported by Maas and Hoffman, 1977; Yeo and Flowers, 1984). These researchers appraised a serious reduction in number of tillers of rice genotypes. Maas and Hoffman, 1977; Flowers et al., 1991 also reported that decrease in tillers is probably due to inhibition of growth under saline conditions.

Both locations (control and saline) differed in producing total tillers per plant. Control gave higher numbers of tillers per plant (4.05) Whereas average number of tillers per plant under saline conditions were recorded as 3.13. These results are in accordance with Aslam, (1987). However, the resulted reported by Campos et al., (1989) and Akita (1986) are in partial agreement with those illustrated above. They said that number of tillers per plant decreased with addition of NaCl but differences were not significant. Lehman et al., (1984) pointed out that selection of tolerant plants should be made from young plants with many tillers as against vigorous adult plants having less tillers. Correlation analysis (Appendix-VI) revealed that total tillers play prominent role in obtaining high yield under saline conditions. These findings are quite in line with those cited above. ACIKGÖZ and GEVREK (1989) showed variations in rice genotypes for tillers produced, while subjected to salt stress at 10 days after sowing.

4.2.4.3. Days To 50 Percent Flowering

F-ratios regarding 50 percent flowering, given in table 4.36 revealed significant interaction among salinity levels (locations) and genotypes for days to 50 percent flowering in rice. The Interaction was significant mainly due to the fact that variety BAL/SZISKIY showed more days to 50 percent flowering than cv. PALLOGIO-67 under control whereas under saline conditions BAL/SZISKIY showed less days to 50 percent flowering than PALLOGIO-67. Besides this, some varieties e.g., ROCCO and BALDO while remaining at par with each other for number of days to 50 percent

flowering under saline conditions differed significantly among themselves under control. Number of days to 50 percent flowering taken by different genotypes under control and saline conditions are given in table 4-39.

Table-4.39 Number of days to 50 percent flowering of rice genotypes as affected by two different salinity levels.

Genotypes	Control	5.5 dSm ⁻¹
ROCCO	100.67 a	98.67 a
BALDO	93.33 b	92.67 ab
IPSALA	91.67 abcd	92.33 abc
84017-TR745-12-1	94.00 b	90.67 bcd
TRAKYA	94.67 ab	89.67 bcde
BELLOMENT*IZ-68	93.00 bc	89.67 bcde
83030-TR648-4-2-1-1	90.33 bcde	89.33 bcdef
ALTINYAZI	95.33 ab	88.67 bcdefg
84027-TR755-2-1	92.67 bc	87.33 bcdefg
BELLOMENT*IZ-30	86.67 cde	86.67 bcdefgh
TIT/IZ-43	89.67 bcde	86.00 cdefgh
BAL / KROS	90.67 bcde	85.67 defgh
NUC/KROS	90.67 bcde	85.67 defgh
83030-TR621-2-1-1-1	90.33 bcde	83.67 efgh
KROS424	85.00 e	83.33 efgh
TOAG-92	85.67 de	83.00 fgh
BALDO*IZ-30	89.67 bcde	82.33 gh
IZ-30*KROS	85.00 e	80.67 h
PALLOGIO-67	74.33 f	68.33 i
BAL/SZISKIY	89.33 bcde	60.00 j
Means	90.13	85.22
Sx for Sal.= 0.47 Sx for Geno.= 1.085 Sx for Sal. X Geno.= 1.535		

*: Means having different letters differ significantly.

From the two way table, it is noticed that ROCCO took more days to 50 percent flowering under control as well as under saline conditions. Under control this genotype took 100.67 days and was followed by many other genotypes. Whereas, under saline conditions this was followed by BALDO and IPSALA having 92.67 and 92.33 average numbers of days to 50 percent flowering. All the three genotypes remained statistically at par with each other but differed significantly with many other genotypes. Minimum days

to 50 percent flowering (60.00) were noticed in case of BAL/SZISKIY. This genotype differed significantly with all others included in the study.

Significant differences for both the locations (control and saline) for days to 50 percent flowering were also recorded. Under control genotypes took more days to 50 percent flowering (90.13) as compared to saline conditions (85.22). From the above table it is also clear that although genotypes differed under both the conditions yet the differences under saline conditions were wider as compared to control. Results reported above revealed that salinity caused earliness in flowering behaviour of genotypes. AÇIKGÖZ and GEVREK (1989) also reported similar variations in rice mutants when subjected to salt stress. Contrary to above findings Muhammad, (1986) reported that flowering was only delayed in salt sensitive varieties but not affected in tolerant rice varieties. Non-significant behaviour of genotypes noted by him may be due to less genetic diversity in the material used for the experiment.

4.2.4.4. Days to 85 Percent Maturity

Statistical analysis of the data about days to 85 percent maturity revealed significant interaction among salinity levels and genotypes as evident from F-ratios given in Table 4.36. The interaction was significant mainly due to the fact that ALTINYAZI showed more days to 85 percent maturity than 84017-TR745-12-1 under control whereas under saline conditions ALTINYAZI took less days to 85 percent maturity than 84017-TR745-12-1. This and similar phenomena gave rise to a significant interaction. Besides this, some varieties e.g., ALTINYAZI and ROCCO while remaining at par with each other for number of days to 85% maturity under control differed significantly among themselves under saline condition. Number of days to 85 percent maturity taken by different rice genotypes under control and saline conditions are given in table 4.40.

From the table, it is obvious that ALTINYAZI took more days (126.33) to 85 percent maturity under control as compared to other genotypes. However under saline condition ALTINYAZI took fewer days (113.67) to mature. The longest period (124.67 days) to 85 percent maturity under saline conditions was taken by ROCCO. Under these conditions this was followed by 84017-TR745-12-1, BALDO x IZ-30 and TRAKYA having average number of days to 85 percent maturity as 120, 117.67, and 116.67 days, days. IPSALA and IZ-30xKROS also took same number of days (116) to complete 85 percent maturity. All these six genotypes remained statistically at par with each other but differed significantly with many other genotypes. Under control although ALTINYAZI and KROS424 differed significantly, however, none of the other genotypes differed statistically with each other.

Table-4.40 *Number of days to 85 percent maturity of rice genotypes as affected by two different salinity levels.*

Genotypes	Control	5.5 dSm ⁻¹
ROCCO	125.67ab	124.67a
84017-TR745-12-1	123.67 ab	120.00ab
BALDO*IZ-30	118.33 ab	117.67abc
TRAKYA	121.67 ab	116.67abcd
IPSALA	117.00 ab	116.67abcd
NUC/KROS	119.00 ab	116.33abcde
IZ-30*KROS	117.67 ab	116.33abcde
BALDO	119.67 ab	116.00abcde
TIT/IZ-43	123.67 ab	115.67abcde
TOAG-92	122.33 ab	115.67abcde
BAL / KROS	124.33ab	115.33abcde
84027-TR755-2-1	120.33 ab	114.67 bcde
BELLOMENT*IZ-68	116.67 ab	114.67 bcde
83030-TR648-4-2-1-1	123.33 ab	114.33 bcde
ALTINYAZI	126.33 a	113.67 bcde
BELLOMENT*IZ-30	120.33 ab	113.33 bcde
83030-TR621-2-1-1-1	118.67 ab	111.67 bcde
PALLOGIO-67	123.33 ab	109.00 cde
BAL/SZISKIY	124.33 ab	107.67 de
KROS424	114.67 b	106.67 e
Means	121.05	114.83
Sx for Sal.= 0.438 Sx for Geno.=1.663 Sx for Sal. X Geno.= 2.352		

*: Means having different letters differ significantly.

Minimum days to 85 percent maturity (114.67) and (106.67) were noticed in case of KROS424 under control and saline conditions, respectively. Under control, genotypes on an average took more days to 85 percent maturity (121.05) as compared to saline conditions/ location (114.83). From the above table it is also evident that although genotypes differed under both the conditions yet the differences under saline conditions were wider as compared to control. Besides this, under saline conditions genotypes were more widely distributed to different statistical groups.

4.2.4.5. Plant Height (cm)

F-ratios reproduced in table 4.36 related to plant height revealed significant interaction among salinity levels (locations) and rice genotypes. The interaction was significant mainly due to the fact that cv. BALDO resulted into more plant height than cv. ROCCO under control whereas under saline conditions cv. BALDO showed less plant height than cv. ROCCO. Besides this, some varieties e.g., BALDO and KROS424 while remaining at par with each other for plant height under control differed significantly among themselves under saline condition. Plant heights achieved by different rice genotypes under control and saline conditions are given in table 4.41

It is evident from the two way table that BALDO resulted into maximum plant height of 80.37 cm under control conditions. This was followed by KROS424, ALTINYAZI and TRAKYA that gave plant height as 79.97, 79.50 and 79.40 cm. All the four genotypes remained statistically at par with each other but differed significantly with many other genotypes. Under saline conditions maximum plant height (79.53 cm.) was achieved by TRAKYA. This was however, followed by ALTINYAZI and ROCCO that attained plant height as 77.73 and 76.56 cm. These three genotypes were also statistically non-significantly with each other. Minimum plant height (51.07 cm) was recorded in case of TIT/IZ-43 under saline conditions. Whereas under control TIT/IZ-43 attained a plant height of 56.8 cm and also stood at the lowest position

Both the locations (Saline and control) also differed significantly in their effect on plant height. Control gave greater average plant height (69.03 cm) as compared to that of saline conditions (66.13 cm). Reduction in plant height under saline conditions has been observed in various rice varieties by many investigators (Akbar et al., (1972); Javed and Khan (1975); Maas and Hoffman (1977); Yeo and Flowers (1984); Ahmed et al., (1988); Panyawardena and Dharmasry (1989); and Ahmad and Gupta(1991). This inhibition in growth may be due to osmotic effect, specific ion toxicity and nutritional imbalance (Maas and Hoffman, 1977 and Flowers et al., 1991). On comparing yield and plant height it was noticed that genotypes having smaller plant height produced more grain yield. Similar results were also noticed by ACIKGÖZ and GEVREK (1989).

Table-4.41 Plant height (cm) of rice genotypes as affected by two different salinity levels.

Genotypes	Control	5.5 dSm ⁻¹
TRAKYA	79.40 abc	79.53 a
ALTINYAZI	79.50 abc	77.73 ab
ROCCO	74.90 de	76.57 abc
IPSALA	76.93 bcd	75.33 bcd
84017-TR745-12-1	73.93 de	73.83 cd
KROS424	79.97 ab	73.23 d
84027-TR755-2-1	76.57 cd	72.80 de
83030-TR648-4-2-1-1	69.20 fg	72.40 de
BALDO	80.37 a	69.87 e
83030-TR621-2-1-1-1	71.97 ef	66.00 f
BELLOMENT*IZ-68	67.07 g	65.40 fgh
NUC/KROS	68.17 g	62.87 fgh
BAL / KROS	66.93 g	62.63 ghi
BAL/SZISKIY	62.60 hi	60.27 hij
BELLOMENT*IZ-30	62.60 hi	59.60 ij
IZ-30*KROS	59.50 ij	58.93 j
TOAG-92	63.50 h	58.07 jk
PALLOGIO-67	56.37 jk	54.87 k
BALDO*IZ-30	54.30 k	51.50 l
TIT/IZ-43	56.80 jk	51.07 l
Means	69.03	66.12
Sx for Sal.= 0.116 Sx for Geno.= 0.55 Sx for Sal. X Geno.= 0.778		

*: Means having different letters differ significantly.

4.2.4.6. Panicle Length (cm)

Data on panicle length (cm) was recorded by measuring the length of 10 panicles. Statistical analysis of the data revealed highly significant interaction among salinity levels (locations) and genotypes as evident from F-ratios given in Table 4.36 The interaction was significant mainly due to the fact that line No 84017-TR745-12-1 produced greater panicle length than cv. ROCCO under control whereas under saline conditions line No 84017-TR745-12-1 showed smaller panicle length than cv. ROCCO. Besides this, some varieties e.g., TOAG-92 and BAL/KROS while remaining at par with each other for panicle length under control differed significantly among themselves under saline conditions. Panicle lengths produced by various rice genotypes under control and saline conditions are given in Table 4.42.

Table-4.42 Panicle length of rice genotypes as affected by two different salinity levels.

Genotypes	Control	5.5 dSm ⁻¹
KROS424	16.33 cdefg	16.53a
ROCCO	16.70 bcdef	16.50a
TOAG-92	18.20 ab	15.83ab
83030-TR648-4-2-1-1	17.23 abcde	15.80ab
IPSALA	17.23 abcde	15.40abc
TRAKYA	16.93 bcde	15.40abc
PALLOGIO-67	15.93 defg	15.33abcd
BELLOMENT*IZ-68	18.87 a	15.06abcde
BALDO	17.93 abc	14.77abcdef
ALTINYAZI	18.27 ab	14.73abcdef
83030-TR621-2-1-1-1	16.93 bcde	14.73abcdef
84017-TR745-12-1	18.06 abc	14.63 bcdef
BAL/SZISKIY	15.60 defg	14.47 bcdefg
BALDO*IZ-30	17.37 abcd	13.97 cdefgh
BAL / KROS	17.27 abcd	13.93 cdefgh
IZ-30*KROS	15.27 efg	13.57 defgh
84027-TR755-2-1	16.30 cdefg	13.27 efgh
BELLOMENT*IZ-30	15.17 efg	13.06 fgh
NUC/KROS	15.06 fg	12.77 gh
TIT/IZ-43	14.63 g	12.20 gh
Means	16.76	14.60
Sx for Sal.= 0.061 Sx for Geno.=0.306 Sx for Sal. X Geno.= 0.433		

*: Means having different letters differ significantly.

It was observed from the table that BELLOMENTx IZ-68 gave maximum panicle length (18.87 cm) under control and remained statistically at par with ALTINYAZI, TOAG-92, 84017-TR745-12-1, BALDO, BALDO*IZ-30, BAL / KROS, 83030-TR648-4-2-1-1, and IPSALA. Under saline conditions KROS424 produced maximum panicle length (16.53 cm). This genotype also differed non-significantly with some other genotypes including ROCCO, TOAG-92 and 83030-TR648-4-2-1-1, having panicle length of 16.5, 15.83 and 15.80 cm respectively. TIT/ IZ-43 produced minimum panicle length under control (14.63 cm) as well as under saline conditions (12.2 cm). Moreover, on closely observing the above table it is noticed that though genotypes differed under both salinity levels, yet differences under saline conditions were more marked as compared to control. It was also noticed that certain genotypes having larger panicle length under control were more affected by salinity as compared to those having smaller panicle length.

Regarding locations (control and saline), control gave higher average panicle length (16.77 cm). Whereas average panicle length under saline conditions was recorded as 14.60 cm. Similar results were also enlightened by Akbar et al., (1972); and Akber and yabuno (1975). They were of the view that reduction in panicle length might be due to restricted growth caused by ion toxicity.

4.2.4.7. Total Number Of Grains Per Plant

Data on number of grains/plant was recorded by counting grains of 10 plants and taking their average for variance analysis. Statistically analysis revealed significant interaction among salinity levels and genotypes as evident from F-ratios given in table 4.36. The interaction was significant mainly due to the fact that cv. IPSALA showed higher total number of grains per plant than line No 83030-TR648-4-2-1-1 under control whereas, under saline conditions cv. IPSALA showed lower total number of grains per plant than line No 83030-TR648-4-2-1-1. Besides this, some varieties e.g. TIT/IZ-43

and line No 84017-TR745-12-1 while remaining at par with each other under saline conditions differed significantly among themselves under control. Number of grains /plant produced by various rice genotypes under control and saline conditions are given in Table 4.43.

Table-4.43 Total number of grains per plant of rice genotypes as affected by salinity levels.

Genotypes	Control	5.5 dSm ⁻¹
TIT/IZ-43	392.00 a	261.00 a
PALLOGIO-67	285.67 cdefg	257.67 ab
BALDO*IZ-30	327.33 bcd	256.33 abc
BELLOMENT*IZ-30	372.33 ab	250.33 abc
83030-TR648-4-2-1-1	251.00 fgh	240.33 abc
IZ-30*KROS	309.00 cde	236.67 abcd
84017-TR745-12-1	330.00 bc	235.00 abcd
ALTINYAZI	250.00 fgh	228.33 abcd
83030-TR621-2-1-1-1	251.67 fgh	226.33 abcd
KROS424	314.33 cde	225.00 abcd
BAL / KROS	240.33 gh	220.67 abcd
NUC/KROS	301.67 cdef	219.33 abcd
BELLOMENT*IZ-68	268.67 efgh	212.00 abcd
BAL/SZISKIY	252.67 fgh	211.33 abcd
TOAG-92	302.67 cdef	207.67 abcd
TRAKYA	299.00 cdef	206.00 abcd
IPSALA	331.00 bc	202.67 bcd
ROCCO	273.00 defgh	200.67 cd
84027-TR755-2-1	302.67 cdef	200.33 cd
BALDO	217.67 h	183.67 d
Means	293.63	224.07
Sx for Sal.= 3.193 Sx for Geno.=9.435 Sx for Sal. X Geno.= 13.343		

*: Means having different letters differ significantly.

On viewing the table, it was noticed that, TIT/IZ-43 and BELLOMENT* IZ-30 gave higher number of grains/ plant as 392 and 372.33 under control remaining statistically at par with each other. Under saline conditions although TIT/IZ-43 produced the maximum grains (261) but it did not differ significantly with many varieties. At this location BALDO produced minimum number of grains per plant (183.67). This genotypes also differed non-significantly with some other genotypes including 84027-

TR755-2-1 and ROCCO having 200.33 and 200.67 grains per plant, respectively. Moreover, on closely observing the table, it is also noticed that although genotypes differed under both salinity levels, yet differences under control were much narrow as compared to saline conditions. This indicates that genotypes having higher number of total grains under control were more affected by salinity as compared to those having less number of total grains.

Regarding locations, as noticed for all other characters control gave higher average number of grains per plant (293.63) Whereas average number of grains/ plant under saline conditions were recorded as 224.07. The results explained above are quite in harmony with those reported by Akbar et al., (1972) and Akbar and Yabuno, (1975). They also informed that decrease in number of grains caused by salinity was due to reduction in panicle length.

4.2.4.8. Grain Fertility Percentage

Statistical analysis of the data showed significant interaction among salinity levels (locations) and genotypes as evident from F-ratios given in Table 4.36 for the character under study. The interaction was significant mainly due to the fact that variety BAL/SZISKIY gave higher grain fertility percentage than variety BALDO*IZ-30 under control whereas under saline conditions variety BAL/SZISKIY showed lower grain fertility percentage than variety BALDO*IZ-30. Besides this, some varieties e.g., BALDO*IZ-30 and TOAG-92 while remaining at par with each other for grain fertility percentage under control differ^{ed}/significantly among themselves under saline condition. Grain fertility percentage calculated for various rice genotypes under control and saline conditions are given in table 4.44. It is evident from the table that TIT/IZ-43 gave highest grain fertility percentage (92.15) under control conditions. This variety remained statistically at par with 11 other genotypes. However it was closely followed by BAL/SZISKIY having grain fertility percentage as 91.57.

Under saline conditions PALLOGIO-67 produced highest grain fertility percentage (52.45) and this remained statistically at par with many other genotypes including BALDO x IZ-30, TIT/IZ-43 and ALTINYAZI having 51.59, 50.95 and 50.95 grain fertility percentage, respectively. Minimum grain fertility percentage (30.15) was recorded in case of TOAG-92 under saline conditions. This genotype also differed non-significantly with some other genotypes including BALDO, TRAKYA and BAL/SZISKIY having 37.83, 36.07 and 35.58 grain fertility percentage, respectively. It is crystal clear that although there was a serious reduction in all yield components yet some genotypes e.g. PALLOGIO-67, BALDO x IZ-30, TIT/IZ-43 and ALTINYAZI showed more than 50% grain fertility. These varieties also produced comparatively better yield under saline conditions.

Table-4.44 Grain fertility percentage of rice genotypes as affected by two different salinity levels.

Genotypes	Control	5.5 dSm ⁻¹
PALLOGIO-67	85.98 abc	52.45 a
BALDO*IZ-30	85.21 abc	51.59 a
TIT/IZ-43	92.15 a	50.95 ab
ALTINYAZI	86.63 abc	50.95 ab
BELLOMENT*IZ-30	87.46 abc	49.53 ab
BELLOMENT*IZ-68	82.47 bc	48.16 abc
BAL / KROS	86.44 abc	47.62 abc
IPSALA	87.43 abc	47.12 abcd
83030-TR648-4-2-1-1	84.92 abc	46.63 abcd
84017-TR745-12-1	85.70 abc	46.36 abcd
KROS424	89.57 ab	46.23 abcd
IZ-30*KROS	86.40 abc	45.54 abcde
83030-TR621-2-1-1-1	90.00 ab	43.51 bcdef
ROCCO	82.03 bc	40.85 cdef
84027-TR755-2-1	85.58 abc	40.55 cdef
NUC/KROS	84.61 abc	39.32 def
BALDO	80.89 c	37.83 efg
TRAKYA	88.50 abc	36.07 fg
BAL/SZISKIY	91.57 a	35.58 fg
TOAG-92	87.13 abc	30.15 g
Means	86.55	44.35
Sx for Sal.= 0.259 Sx for Geno.=1.353 Sx for Sal. X Geno.= 1.913		

*: Means having different letters differ significantly.

Moreover, on closely observing the above table it was also noticed that although genotypes differed under both conditions (locations), yet differences under control were less prominent as compared to saline conditions. AÇIKGÖZ and GEVREK (1989) also noticed a variation in fertility percentage of different rice mutants. Vorob and Zhurba (1991) found that the most variable traits under saline conditions were grain yield/plant and the percentage of filled and fertile spikelets/ panicle. These traits were found sufficient for use in assessing resistance. Above results also showed that salinity affected grain fertility percentage (number of filled grains/ number of total grains X100) more intensively and this character has more prevalent effects in determining salt tolerance of rice genotypes.

4.2.4.9. 1000-Grain Weight

Statistical analysis of the data was done after taking 1000-grain weight of three samples for each genotype. taking average of these values. Significant interaction were noticed among salinity levels (locations) and genotypes for 1000-grain weight as it is evident from F-ratios given in Table 4.36. The interaction was significant mainly due to the fact that that cv. BALDO showed higher 1000-grain weight than cv. ALTINYAZI under control whereas under saline conditions cv. BALDO showed lower 1000-grain weight than cv. ALTINYAZI. Besides this, some genotypes e.g., line No 84017-TR745-12-1 and BALDO while remaining at par with each other for 1000-grain weight under control differ significantly among themselves under saline condition. Two way table (4.45) describes 1000-grain weight achieved by various rice genotypes under control and saline conditions.

A perusal of the table, revealed that line No 84017-TR745-12-1 gave maximum 1000-grain weight as 35.97 and 34.40 gram under control and saline conditions, respectively. Under control this was followed by BALDO, 83030-TR648-4-2-1-1 and IPSALA that produced 1000-grain weight as 35.63, 34.87 and 34.80 grams, respectively

and remained statistically at par with each other. Under saline conditions this line (line No 84017-TR745-12-1) was followed by Line No 83030-TR648-4-2-1-1 and IPSALA that were also statistically at par with it and gave 33.87 and 33.60 gram 1000-grain weight, respectively.

Table-4.45 1000-grain weight of rice genotypes as affected by two different salinity levels.

Genotypes	Control	5.5 dSm ⁻¹
84017-TR745-12-1	35.97 a	34.40 a
83030-TR648-4-2-1-1	34.87 ab	33.87 ab
IPSALA	34.80 abc	33.60 abc
ALTINYAZI	32.73 cd	32.07 bcd
TRAKYA	32.90 bcd	31.57 cd
BALDO	35.63 a	31.23 d
83030-TR621-2-1-1-1	32.27 d	30.67 d
84027-TR755-2-1	31.33 d	28.53 e
ROCCO	28.57 e	28.03 ef
BELLOMENT*IZ-68	32.47 d	27.90 efg
BELLOMENT*IZ-30	28.77 e	27.70 efg
PALLOGIO-67	29.03 e	27.63 efg
BAL/SZISKIY	29.03 e	27.50 efgh
BALDO*IZ-30	28.30 e	27.07 efgh
IZ-30*KROS	27.93 e	26.20 fgh
TIT/IZ-43	27.93 e	26.13 fgh
NUC/KROS	28.10 e	25.93 gh
TOAG-92	27.03 ef	25.53 h
KROS424	25.70 f	25.43h
BAL / KROS	27.00 ef	22.90i
Means	30.52	28.69
Sx for Sal.= 0.073 Sx for Geno. =0.351 Sx for Sal. X Geno.= 0.496		

*: Means having different letters differ significantly.

Minimum 1000-grain weight under control was obtained by KROS 424 (25.70 gm). Whereas under saline conditions BAL/ KROS produced the minimum 1000-grain weight (22.90 gm). Salinity levels also caused remarkable variations in 1000- grain weight. Control gave markedly higher mean 1000-grain weight (30.52 gm) as compared to saline conditions (28.69 gm). A decrease in 1000-grain weight of cereals under saline conditions was also recorded by Ahmed et al., (1993)

5. CONCLUSIONS AND SUGGESTIONS

During these studies 8 trials; 4 for barley and 4 for rice, were conducted for determining appropriate method to evaluate salt tolerance perspective in these crops. Results drawn led to following conclusions

1. Increasing salt concentrations showed substantial decrease in seedling emergence percentage, as well as root and shoot length of barley plants. Amongst the five salt concentration applied 180 mMol NaCl revealed highly significant differences among the barley genotypes for all the characters studied. Seedling emergence percentage recorded at 15th day of sowing showed more conspicuous differences among barley genotypes under 180 mMol NaCl as compared to other salt concentrations.

2. Amongst the times of salinization, it was concluded that NaCl application at sowing has pronounced effects on emergence as well as on shoot and root length. Salt application at the time of sowing proved to be more effective in distinguishing the responses of barley genotypes to salt stress.

3. Above findings indicated that 180 mMol NaCl application at the time of sowing has discriminate effects on early growth of barley genotypes. Consequently, this concentration was used for screening barley genotypes against salt stress. Data recorded on 132 barley genotypes against 180 mMol revealed large variations, among genotypes, for their emergence percentage as well as shoot and root growth. Resultantly 21 genotypes having comparatively better performance were selected for evaluating their reproductive behaviour to salt stress under field conditions.

4. Data recorded on different yield and yield components indicated that field salinity levels showed non-significant differences for most of the characters studied. This can be attributed to high rainfall during the growing season and leaching of the salts from

the rhizosphere. However, statistically high/significant differences were noticed among the genotypes for all the characters under study.

5. Screening methodology developed for barley with respect to its salt tolerance behaviour gave excellent results. Salt concentration of 180 mMol provides an exact medium for selection of barley genotypes, when application is done at sowing time. The screening may be done by using this method in pots under controlled conditions. This provides a time saving, cheap and reasonably good technique for the purpose. The method also facilitates to compare large number of genotypes in a short span of time. On the other hand studies for evaluation of salt tolerance in barley can not be recommended in the field because environmental control is not possible and leaching of salts due to rains is not measurable.

6. In rice, none of the seedling of any genotype emerged at 120 mMol salt concentration. On the other hand wider variations among genotypes were noticed for emergence as well as for root and shoot length under 60 mMol as compared to control.

7. Regarding times of salinization, rice genotypes differed significantly for their emergence percentage under all times of salt applications as well as under control. However these differences were more conspicuous when salt application was done at sowing.

8. As noticed above 60 mMol NaCl application showed prejudging differences among rice genotypes, this concentration was used for bulk screening of 120 rice varieties. Statistical analysis showed large variations among genotypes for their salt tolerance at seedling stage. On the basis of these results, 20 rice genotypes having comparatively better performance were selected for comparison among their yield responses to salinity.

9. Data recorded on yield and yield components of rice showed significant differences for genotypes, salinity levels and their interactions. correlation studied revealed that tillering capacity, number of filled grains and 1000-grain weight have higher correlation coefficient with yield under saline conditions as compared to normal growth conditions.

Keeping in view the above conclusions it is suggested that ;

i). Large number of barley genotypes can be fairly judged for their salt tolerance perspective by their seedling emergence percentage behaviour against 180 mMol NaCl concentration. This offers a good criteria for selection of barley genotypes against salt stress.

ii). In rice mass screening for survival of genotypes against salinity stress may be carried out by using 60 mMol NaCl at germination. However, while selecting for high yield under saline conditions three yield parameters viz., number of tillers , number of filled grains and 1000-grain weight can serve as a criterion for selection among rice genotypes.

iii) Salt tolerance evaluation studies for barley can not be recommended in the field because environmental control is not possible and leaching of salts due to rains is not measurable.

iv) These studies may be conducted in pots by using soil taken from the saline fields. In this way we can check the environmental effects while conducting studies on naturally occurring soils.

6..SUMMARY

To improve crop production in salt affected soils, selection of a crop variety having high salt tolerance seems to be a pre-requisite. Present studies were envisaged to determine appropriate selection techniques for ascertaining salt tolerance in barley and rice genotypes, on the basis of their growth behaviour. For this purpose, eight different trials were conducted. Data on different traits related to crop growth were recorded. All the data collected were statistically analyzed and results obtained are summarized below.

In barley, besides control four salt concentrations viz, 60, 120, 180, and 240 mMol were used to evaluate varietal behaviour to salt stress. It was noticed that 180 mMol NaCl revealed highly significant differences among barley genotypes for all the characters studied. Highest seedling emergence on 15th day of sowing and maximum shoot length on 40th day under this concentration was recorded as 71.11% and 14.4 cm for 87-FA-SDS and YESILKÖY, respectively. This concentration showed more conspicuous differences among barley genotypes and thus 180 mMol NaCl may be used for determining salt tolerance in barley genotypes. Amongst the times of salinization, NaCl application at sowing has pronounced effects on emergence as well as on shoot and root length. Highest and lowest seedling emergence under this treatment, on 15th day of sowing were recorded as 61.1 and 24.4 percent. Salt application at the time of sowing proved to be more effective in distinguishing the responses of barley genotypes to salt stress. Above findings indicated that 180 mMol NaCl application at the time of sowing has discriminate effects on early growth of barley genotypes. Consequently, this concentration was used for screening barley genotypes against salt stress. Data recorded on 132 barley genotypes against 180 mMol revealed large variations among genotypes for their emergence percentage as well as shoot and root growth. Resultantly, 21 genotypes namely, 56000/MISC-233, 55988/MISC-221, LIGNEE-640, MENTA"S", ZARZA"S", YESILKÖY-387, 55989/MISC-221, 87-FA-SDS, SOUFARA, GEM, 56001/MISC-234, ZEYPHER, CI- 13575, BALADI- 16/CJ, GIDA"S",

ROHO/DELISA, ALOE "S", ARAR, IRANIA/LIGNEE 131, WI-2291/WI-2269 and GERBEL having comparatively better performance were selected for evaluating their reproductive behaviour to salt stress under field conditions. Data recorded on different yield and yield components indicated that there were significant differences among genotypes for most of the characters studied. However non-significant differences were recorded for salinity levels. This can be attributed to high rainfall during the growing season and leaching of the salts from the rhizosphere. German line No. 56000/MISC-233 gave best performance by producing grain yield as 424.1 and 415.9 kg/ da under lower and higher salinity, respectively.

In rice, besides control 60 and 120 mMol salt concentrations were used to evaluate varietal behaviour to salt stress. None of the seedling of any genotype emerged at 120 mMol salt concentration. On the other hand, significant differences were recorded under control and 60 mMol NaCl concentration. Wider variations among genotypes were noticed for emergence as well as for root and shoot length under 60 mMol as compared to control. Under this concentration, maximum and minimum seedling emergence on 15th day of sowing was recorded as 83.33 and 50.00 percent for TOAG-92 and PALLOGIO-67, respectively. Regarding the times of salinization, rice genotypes differed significantly for their emergence percentage under all times of salt applications as well as control. However, non significant interactions were recorded for times of salinizations and genotypes. This indicates that though salt application affected growth, yet *earlier* time of application has distinguishing effects among rice genotypes at early growth stage. Obviously, 60 mMol NaCl application showed prejudging differences among rice genotypes, this concentration was used for bulk screening of 120 rice varieties. Statistically different behaviour of genotypes towards salt stress was noticed. On the basis of these results, 20 rice genotypes namely, 83030-TR648-4-2-1-1, BALDO*IZ-30, ALTINYAZI, PALLOGIO-67, 84017-TR745-12-1, TIT/IZ-43, BELLOMENT*IZ-30, ISPALA, 83030-TR621-2-1-1-1, IZ-30*KROS, BELLOMENT*IZ-68, KROS424, BAL / KROS, NUC/KROS, 84027-TR755-2-1,

TRAKYA, ROCCO, BAL/SZISKIY, BALDO, TOAG-92, having comparatively better performance were selected for comparison among their yield responses to salinity. Data recorded on yield and yield components showed significant differences for genotypes, salinity levels and their interactions. Line 84017-TR745-12-1 gave highest yield (486.85 kg/da) under control whereas, under saline conditions line 83030-TR648-4-2-1-1 produced maximum yield (168.82 Kg/da). Correlation studies revealed that number of tillers, grain fertility percentage and 1000-grain weight have higher correlation coefficient with yield under saline conditions as compared to control. From the above results, it is concluded that seedling emergence percentage against 180 mMol NaCl (applied at sowing time) offers a fairly good criteria for selection of barley genotypes against salt stress. In rice, mass screening of genotypes against salinity stress may be carried out by using 60 mMol NaCl at germination. However, number of tillers, grain fertility percentage and 1000-grain weight can serve as a criterion for selection of rice genotypes towards high yield at a field salinity of 5.5 dS/m.

Screening methodology developed for barley with respect to its salt tolerance behaviour gave excellent results. Salt concentration of 180 mMol provides an exact medium for selection of barley genotypes, when application is done at sowing time. The screening may be done by using this method in pots under controlled conditions. This provides a time saving, cheap and reasonably good technique for the purpose. The method also facilitates to compare large number of genotypes in a short span of time. On the other hand studies for evaluation of salt tolerance in barley can not be recommended in the field because environmental control is not possible and leaching of salts due to rains is not measurable. It is also suggested that these studies may be conducted in pots by using soil taken from the saline fields. In this way we can check the environmental effects while conducting studies on naturally occurring soils.

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Appendix-I

List of barley genotypes used for salinity tolerance evaluation in bulk screening trial.

1	SOUFARA 03	55	ROHO / MASURKA	110	ARAR
2	KERVANA/MASURKA	56	BOWMAN	111	APIZACA
3	Ca 347317KETI	57	ANAMIR	112	NO.55997
4	KYH	58	NO.56001	113	WI 2197(MASURKA)
5	YSIMSIZ	59	HARMA.02	114	BARBAROUSSE
6	DEVATARDAN	60	CI 3909.2//M66/157 HANKAR CMB-78..	115	SALHAS
7	TRIUMPH X TYRA Ca-706192	61	NO.56010	116	MASURKA
8	ROHO X JULIA	62	BALADI 16/ CJ 5328	117	ROHO /MASURKA
9	LIGNEE 121	63	ZARZA"S" CMB 84-1170..	118	TERAN-78
10	GIDA"S"CMB 79-376-1Y-1B-2Y-1B-	64	GERBEL (c)	119	NO.55994
11	MONTANA-85	65	NO.56007	120	NO.56000
12	BIRKA	66	BOR-92	121	AROPO "S"
13	Ca 709413	67	NO.55989	122	Ca 33787
14	KAYA	68	YESILKOY	123	KARPATHOS
15	CI-10035/CI1042//KAYA	69	NO.55995	124	Ca 709413
16	NO.55999	70	ENELDA"S" CMB 84A-1651...	125	MW 267
17	NO.55988	71	CI 08887/CI05761//LIGNEE 640..	126	BIRKA
18	SOUFARA 03	72	IRANIA/LIGNEE131 ICB 82-0717..	127	NO.55990
19	Ca-37906	73	WI 2291/WI 2269 ICB78...	128	PATTY (A)
20	AGHTA/P 12300	74	CI 73797/CI9870//...	A	GEM
21	CR 259/36	75	M 10080	B	87-FA-SDS
22	Ca-923908	76	HJA"S" CMB 85A-772-S..	C	EFES-2
23	SOUFARA"S" SEL-YEAP-OAP	77	P 71318	D	YESILKOY-387
24	CHICU /AN 57//ALBERT	78	NO.88039		
25	ZAFAR	79	CARDO "S" CMB 85A-1200-C..		
26	Ca-40925	80	NO.56011		
27	NO.55998	81	TINTERN		
28	ROHO / MASURKA	82	NO.56004		
29	FAIZ	83	M 97246		
30	GEM	84	MENTA"S"CMB 84A-1767..		
31	COGBAR	85	Ca-917177		
32	AS 46/ATH 2	86	BARAKA		
33	WI 2274 (CI 3576 X UNION)	87	EGNEE 640 (MONTPELLIER)		
34	KERVANA /MASURKA	88	GIDA"S"CMB 79-376-1Y-1B-2Y-1B-2Y-0B		
35	ESP/1808-44//W.W..	89	BEECHER		
36	ATEM	90	BARLEY 5681		
37	PI 00505	91	ALOE"S" CMB 84A-1663-E..		
38	Ca 709503	92	M 9878		
39	LIGNEE 131	93	DC 640		
40	Ca 709503	94	CARINA		
41	CASSACK	95	YERCIL		
42	CUNHILD	96	TOKAK		
43	ACK X (BUPAL X ANT13-13) Ca-00	97	ZEPHYR		
44	WI 2291	98	DEFRA		
45	VALERIANA "S"	99	CI 13575		
46	KASAS	100	NO.55996		
47	Ca 923908	101	NO.56003		
48	NO.56009	102	TUMBO "S"		
49	TRUMPH/HENNET	103	CUMHURIYET		
50	BONITA	104	MELLE"S"		
51	IDEAL	105	NO.55991		
52	WI 2198/EMIR	106	UNION		
53	ROHO/DELISA	107	HB 42 (ETHIOPIA)		
54	NO.56008	108	TINTERN		
		109	WI 2274 (CI3576 X UNION)..		

Appendix-II

List of rice genotypes used for salinity tolerance evaluation in bulk screening trial.

1	IR.19729-67-3	60	83036-TR621-2-1-1-1
2	890197-TR-635-1-1-2-	61	K-333
3	BALDO * IZ-30	62	KROS424
4	INDIO	63	DINAR
5	KROS*TOYGIN	64	8341-TR659-7-1-1-1
6	ZEM*TOY	65	TIT/IZ-10
7	SK/BAL	66	84037-TR765-6
8	TIT/IZ-43	67	84008-TR736-6-5-1
9	83093-TR711-2-1-1-1-1	68	SOMAR
10	IZ-30*KROS	69	8336-TR-654-9-1-1
11	84027-TR755-2-1	70	88G-326
12	83026-TR643-1-1-1-1	71	8265-TR-475-4-1-1-1-1
13	BELLOMENT*KROS	72	SERHAT-92
14	VENERIA	73	RIBE
15	CAL/D.BAS	74	83030-TR648-4-2-1-1
16	84017-TR745-2-1-1-1	75	LIDO
17	M101*TONGPINLUE	76	BAL/SZISKIY
18	ALTINYA 21	77	8217-TR-427-1-1-1-1
19	M101*SOLNECYI	78	82125-TR-535-2-1-1-2
20	M101*IZ-68	79	REA
21	BELLOMENT*IZ-68	80	F-38
22	IZ-30	81	TRAKYA
23	3283	82	IZ-43
24	IDRA	83	83051-TR669-2-1-1-1
25	83036-TR654-9-1-2-1	84	PRIMOJ-2*SUKOF-6
26	BELLOMENT*IZ-30	85	MAR-TIT
27	BALILLA*SALONA	86	PALLOGIO-67
28	ONDA	87	84030-TR758-2-1
29	KROSNODARMEX-313	88	ROSA-MATCHETTI
30	DEMO	89	BAL/KROS
31	ARBORIO-PROCOCE	90	8214-TR424-12-1-1-1
32	ZENIT	91	SZARVASI-CARSU
33	ALFA	92	BAL/PAL-67
34	SIRELLE	93	83050-TR668-7-1-1-1
35	AIRONE	94	MERIC
36	SIRIO	95	83031-TR621-2-1-1-1
37	DENIAS	96	ROMEO
38	PADONA	97	BAL/SOLNEYS
39	REDI	98	1979/46-1
40	ISKRA	99	CHIRNOGI
41	CASTELO	100	KALROSE-76
42	SLAVA	101	CRISTAL
43	RUBINO	102	IPSALA
44	CALLUSA	103	M-101
45	ROMENICA	104	ERGENE
46	SHIMOKITA	105	S-101
47	RAFAELLO	106	GRITNA
48	CAROLLO	107	3263
49	DONZKOF-63	108	ROMA
50	HAKKARI	109	BONENT-BEL
51	YUHARE	110	BALILLA-28
52	TKM9	111	UNCI
53	ROCCO	112	IZ-300-1
54	IR10154-88-11	113	CRM-3-CRIPTO
55	CARNORALLI	114	DERVIS
56	BAL/IZ-45	115	3280
57	CHINC-SHAV	116	3257
58	TIT/IZ-10		A NUC/KROS
59	M101/IZ-68		B BALDO
			C ANA/MAR
			D TOAG-92

Appendix-III

List of barley and rice genotypes grown under field conditions for salinity tolerance evaluation.

A) Barley

No	FULL NAME
1	87-FA-SDS
2	No.56001/Misc-234-R.T.Remage AP Bulk3-10AP-
3	YESILKOY-387
4	GEM
5	No.56000/Misc-233-R.T.Remage AP Bulk3-8AP-
6	NO.55989/Misc-221
7	GERBEL (c)
8	IRANIA/LIGNEE131 ICB 82-0717-6AP-0AP
9	ALOE"S" CMB 84A-1663-E-2M-3Y-1B-1Y-0M
10	BALADI 16/ CJ 5328
11	CI 13575
12	ZEPHYR
13	SOUFARA 03
14	ARAR
15	WI 2291/WI 2269 ICB78.0594-8AP-1AP-0AP
16	ZARZA"S" CMB 84-1170.1-12Y-18-1Y-10B-1Y-0B
17	GIDA"S"CMB 79-376-1Y-3B-2Y-1B-2Y-0B
18	MENTA"S"CMB 84A-1767.Z-3M-1Y-1B-0Y
19	LIGNEE 640 (MONTPELLIER)
20	ROHO/DELISA
21	NO.55988/Misc-221

B) Rice

1	ALTINYAZL
2	BAL/KROS
3	BALDO * IZ-30
4	BELLOMENT * IZ-68
5	PALLOGIO-67
6	ROCCO
7	IZ-30 * KROS
8	BELLOMENT * IZ-30
9	84027-TR755-2-1
10	83030-TR648-4-2-1-1
11	TRAKYA
12	KROS424
13	BAL/SZISKIY
14	ISPALA
15	TOAG-92
16	BALDO
17	TIT/IZ-43
18	84017-TR745-12-1
19	83030-TR621-2-1-1-1
20	NUC/KROS

Appendix-IV

Some physical and chemical properties of soil samples (0-20 cm) taken from the field used for barley crop.

Soil properties	Field "A"		Field "B"	
Soil Texture	Sandy Loam		Sandy Loam	
	15-11-93	10-6-94	15-11-93	10-6-94
pH	7.5	7.3	7.8	7.3
E.C. (dS/m)	9.0	3.5	17.5	4.5
CaCO ₃	7.87	7.62	7.52	7.33
Total N (%)	0.11	0.92	0.21	0.84
Available P(ppm)	4.75	4.84	5.60	4.32
Available K(ppm)	220	340	270	320

APPENDIX: V

A):-Meterological Data For Growing Season Of Barley Crop (1993-94) Pertaining to Menemen Region.

	DEC.,93	JAN.,94	FEB.,94	MAR.,94	APR.,94	MAY ,94
Average Temperature °C	13.10	11.60	10.50	12.70	18.90	23.20
Total Precipitation (mm)	70.70	52.70	87.30	49.50	22.80	19.00
Total Evaporation	91.80	82.00	72.00	122.80	195.60	276.30
Relative Humidity (%)	72.40	67.30	59.10	61.90	58.10	53.70
Soil Temp. °C (10 cm)	10.10	9.30	8.50	12.10	18.20	23.20
Soil Temp. °C (5 Cm)	9.90	9.20	8.50	12.40	18.60	23.50
Average Radiation	141.10	127.60	240.90	369.40	467.10	515.60
Sunshine Hours	121.90	119.30	129.00	227.40	249.60	314.10

B):-Meterological Data For Growing Season Of Rice Crop (1994) Pertaining to Bornova Region.

	MAY ,94	JUNE,94	JULY,94	AUG.,94	SEP.,94	OCT. ,94
Average Temperature °C	21.50	25.20	28.40	28.70	25.70	20.50
Total Precipitation (mm)	32.60	2.70	0.00	3.50	0.00	61.50
Total Evaporation	179.80	267.00	306.00	316.20	216.00	136.40
Relative Humidity (%)	54.00	45.00	44.00	42.00	54.00	68.00
Soil Temp. °C (10 cm)	25.10	29.20	33.70	33.50	30.90	23.00
Soil Temp. °C (5 Cm)	25.80	30.90	35.40	34.50	31.20	22.60
Average Radiation	450.70	502.20	502.60	462.20	378.60	240.90
Sunshine Hours	316.00	333.30	366.00	368.90	318.00	207.70