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THE IMPROVEMENT OF SALT TOLERANCE IN FIVE VARIETIES F_2 GENERATION MATERIAL OF WHEAT

Ass.Prof.Ibrahim, I. H. Al-Mashhadani * Ass.Prof.Saif, A. Salim **
*Directorate of Agricultural research and Food Technology – Ministry of Science and Technology
**University of Anbar - Center of Desert Studies

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Abstract

Improving crop tolerance of salinity is one way to maximize production on irrigated land in arid and semiarid areas where the salinity of soils and irrigarion water are problems.

A screening and selection techniques were used to examine variability to NaCl tolerance and to improve salt tolerance in five population material. A total of 4-6 of individuals were obtained from 5,000 seeds of each of the five F_2 population sample with improved salinity tolerance in a sand experiment in which samples of the progenies of selected individuals were grown at 100 and 175 mM NaCl. There were differences between individuals in the five F_2 populations and between selected wheat lines in their overall sensitivities to salinity. The progeny of those individals selected and seedling produced significantly higher total dry weight and in all cases except one were superior in yield at maturity when compare to the yield of the F_2 controls.

تحسين تحمل الملوحة لخمسة تراكيب وراثية F_2 من الحنطة

إبراهيم إسماعيل حسن المشهداني* سيف الدين عبد الرزاق سالم**
* دائرة البحوث الزراعية وتكنولوجيا الغذاء - وزارة العلوم والتكنولوجيا
** جامعة الانبار – مركز دراسات الصحراء

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المستخلص

يعد تحسين مقدرة تحمل النباتات للملوحة احد الطرق المتبعة لزيادة الإنتاج في المناطق المروية من المناطق الجافة وشبه الجافة، والتي تكون فيها ملوحة التربة ومياه الري احد المعوقات الرئيسة.
استخدمت الغربلة والانتخاب لاختبار مقدار التغاير في ملح كلوريد الصوديوم لمقدرة تحمل خمسة مواد وراثية من الحنطة.
تم الحصول على ٤ - ٦ تراكيب فردية من أصل ٥٠٠٠ بذرة لكل خمسة عينة سكانية من الجيل الثاني F2 المتحملة للملوحة من خلال زراعة عينات من الجيل المتحصل عليه في وسط زرعي رملي تراوح تركيز ملح NaCL من ١٠٠ إلى ١٧٥ مليمول. تم الحصول على اختلافات بين أفراد خمسة عينات من الجيل الثاني F2 وبين كل خطوط الحنطة المنتخبة والحساسة للملوحة. تفوقت بادرات الأجيال الجديدة المنتخبة فرديا معنويا في الوزن الجاف الكلي وفي كل الحالات ما عدا جيل واحد والذي تفوق في الحاصل في مرحلة النضج عندما تمت مقارنته مع حاصل الجيل الثاني من الشاهد.

Introduction

The breeding of salt tolerance crop variaties is an attractive possibility since it provided an efficient and economic strategy for overcoming salinity problems (Epstein *et al*, 1980).

The possibility of improving salt tolerance in plant depends upon the breeder detecting variability in tolerance species, and devising a screening procedure capable of identifying tolerant genotypes (Muhammad Ashraf, 2004; Shannon, 1978). Epstein and Nolyn (1977) were able to select strains of barley that could be grown satistfactorily on sand bebs watered with sea water. From the study of variability for salt tolerance in *Sorghum bicolor* L. Moench, Azhar and McNeilly (1987) showed clear differences in response to NaCl in that species and they concluded that the development in NaCL tolerance in this species through recurrent selection was possible. Variation in NaCl tolerance was also found in seedlings of four of wheat genotypes Hassan et al ,(2000) and forage species Ashraf, McNeilly and Bradshow, (1987) and there were significant responses to selecting for seedling NaCl tolerance Akbar *et al* (1977) and Akbar and Yabuno (1977) reported that the variation in an F_2 generation of rice was greater than in the parents, and tolerant progenies could be selected from F_3 and F_4 generation, Kingsbury and Epstein (1984) identified 29 salt-tolerant lines of 5,000 wheat accessions. Genetic and agronomic manipulation of plants for increasing salt tolerance and improving wheat yield thus seem possible.

The present work was conducted, using sand culture for screening the possibility of selecting plants for enhanced salinity tolerance in seedlings of F_2 generation of wheat A sand culture experiment was therefore undertaken to assess performance of samples of the progeny of the selected material at later growth stages.

Materials and Methods

Experiment 1:
Screening for tolerance to NaCl:

Five screening experiments were carried out separately to screen five samples of F_2 generation wheat seeds foe NaCl tolerance 5,000 seeds of each F_2 population were allowed to germinate in sand treated with NaCl.

Surviving individuals were selected after different times from sowing (Table-A) due to differences in the impact of selection on the different F2 materials. They were then planted into standard potting compost and grown to maturity in a heated glasshouse. The seeds produced from each selected individual were kept separately for further experimentation.

Experiment 2:

The growth of samples of the progeny of selected and unselected plants of the three F_2 generation (F_2A, F_2B, F_2C) were examined in a sa sand culture experiment having treatments of 0,100 and 175mM NaCl in standard nutrient solute-ion. The experiment was carried out in containers, 60 cm diameter and 40 cm deep, setup in a glasshouse in a completely randomized design with three replications.

The plastic containers were filled to depth of 30 cm with washed sand, and the glasshouse was maintained at 23.7^0C with 16 hours daylength, the seeds were germunated on moist filter paper in peteridishes 5 day-old seedlings were transplanted into the containers. However, seedlings of F_2C were transplanted into the sand one week after those of F_2A and F_2B. Each container contained 12 rows each 10 plants, made up as follows:

1. F_2A five rows; 1 row representing the unselected control, and 4 rows each of the progeny of one of 4 randomly chosen selected individuals (F_2A1-4).
2. F_2B four rows; 1 row control, plus 2 wach of the progeny of one of 3 randomly chose selected individuals (F_2B103).
3. F_2C three rows; 1 row of control, plus 2 rows of progeny randomly chose selected individuals (F_2C1-2).

   The plants of all three F_2 selected and unselected lines were harvested 82 days after the start of the salt treatments and the characters were measured are:

1. Total plant dry weigh(mg/plant)
2. Seeds yield per plant (mg).

   The data for each character were subjected to analysus of variance.

Results

Experiment 1:

Individual variation was very apparent. It was possible to select surviving individuals after exposure to 350 nM NaCl from samples of 5,000 sedd of all five F_2 populations used, the numbers of surviving seedlings decreased with increasing time of exposure to salinity (Table-A) Some selected plants were died subsequently after transplanting into pootting compost.

Experiment 2:
Total plant dry weight:

The results of analysis of variance for these data are given in\Table1,and revealed that the treatments X selected and unselected lines (TxS) interaction was significant for the means (P 0.01) This reflects the differences between selected and unselected lines particularly the mean F_2A response to increasing NaCl concentrations (Fig.1A).The mean dry weights of the selected lines ar all salinity levels.At 175 nM NaCl, Total dry weight of the means of the selected lines in F_2A (164.4 mg/plant) and in F_2B (145.0 mg/plant), differed sigificantly from the overall mean of unselected lines (Fig. 1A).There were also marked differences in responses of the selected and unselected lines in F_2A(P 0.01). In F_2B and F_2C the interaction (treatments x selected vs unselected) is non- significantly showing that mean total plant dry weights of selected and unselected controls declined in a similar way with increasing NaCl concentration.

The treatments x lines (S) within selected materials interaction was significant (P 0/001) for F_2A and F_2C and at P 0.01 for F_2B, reflecting the fact that the selected lines within each F_2 differed in their response to increasing NaCl concentration. For the two selected lines F_2AS1, and F_2AS2 total plant dry weight increased at 175 nM NaCl, whilst it decreased in F_2AS3 and F_2AS4 (Fig. 1B). For F_2BS2, the reduction in total dry weight of F_2BS1, and F_2BS3 was greater then that of F_2BS2 (Fig. 1C). The selected lines of F_2C differed significantly in total dry weight only at 0 nM B NaCl (Fig. 1D).

Grain yield per plant

The interaction term, treatments x selected vs unselected materials (TxS) was significant for the F_2 means and for F_2A ($P < 0.001$), and for F_2B (P, 0.001) (Table 2). This reflects the large difference between the selected and unselested llines at all NaCl concentration. Mean seed yield (mg/plant) of the selected lines of F_2A and F_2B (70.90 and (51.7)at 100 nM, and (61.9) and (33.5) at 175 nM NaCl respectively were significantly greater than those of the mean of the unselected lines (Fig. 2A).for the mean of the selected lines in F_2A and F_2B, seed yield descreased significantly compared to mean at 0 mM NaCl.

As for the data for total plant dry weight, the response of the selected materials from the three F_2 population to increasing NaCl concentration were different (Treatments x lines within selected material significant at $P < 0.001$ for F_2A, F_2B, and at $P<0.01$ for F_2C).Witjin F_2A the two selected lines F_2AS1 and F_2AS2, seed yield increased at 175mM NaCl. Whilst F_2AS3 and F_2AS4 it decreased at this NaCl (Fig. 2B).At 100 mM NaCl, the grain yield of F_2CS1 increased whilst that of F_2CS2 decreased slightly, At this concentrarion, in F_2BS3, the seed yild increased significantly, whilst in F_2BS1 it was less affected compared to that at 0 mM NaCl (Fig,2C).

The selected lines of F_2B differed in the time of seed maturity. The relatively low yield of F_2BS2 compared to unselectted material was almost certainly due to their differing times of maturity.

Discussion

The experiments reported in this paper have examined this possibility in genetically variable F_2 material derived from a commercial wheat breeding programme the frequency of occurrence of these more tolerant individuals (confirmed by experiment 2) is of the order of 0.1% in the F_2 populations examined here. This compares with frequencies of 3 – 8% in four forage (Ashraf *et al*. 1987).

The result from experment 1 showed that variation in salt tolerance, as measured by survival in saline conditions, doed in fact exist in all five F_2 populations examined. From each screening the numbers of survivrs were very small; just 4-6 individuaks after 3-7 weeks treatment. It is possible that different survival times of individuals in the five F_2 populations may indicate difference in their overall sensitivities to NaCl. In a similar experiment, Noble, *et al.*, (1984) found variation Lucerne (*Medicago sativa* L) cultivars in shoot number and length, and leaf damaged, when plants were grown for 70 days in 250 mM NaCl Variability on salt tolerance among species and even cultivars within a species has been reported by a number of workers in a number of species, Hassan *et al*, (2000) in wheat genotype ; Dewey (1962) in wheatgrass; Shannon (1978) in tall wheat grass; Rush and Epstein (1976) in tomato; Greenway (1962) in barley. Differences in salt-tolerance have also been found between populations within species. Hannon and Bradshow (1968) reported significant variation in salt tolerance between different genotypes of (*Festuca rubra* and *Agrostis stolonifera)*.

In wheat the seedling stage has been considered as being more sensitive to NaCl than the adult stage (Hoffman, 1977; Ashour, Abdel-Halime, Raafat and Nourt, 1977). Clearly seed germination under saline conditions is of prime importance in breeding for salinity tolerance in any plant species. However, it is possible that tolerance at germination and at different growth stages of the plant may not necessarily be correlated (Shannon, 1979)

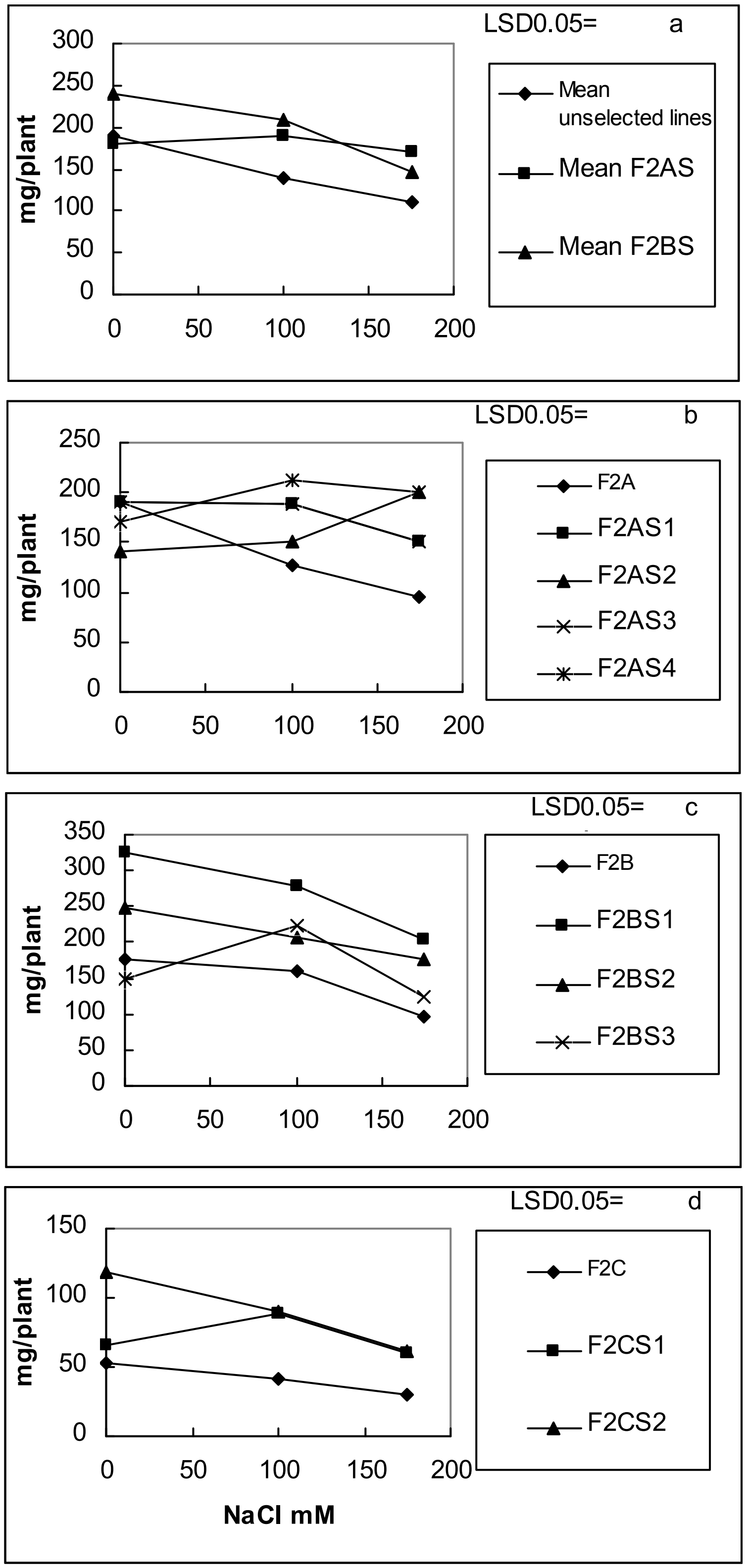

Fig.1: The effect of NaCl on total plant dry weight per plant of selected and unselected lines Derived from three F_2 wheat populations grown in sand culture at three NaCl concentration

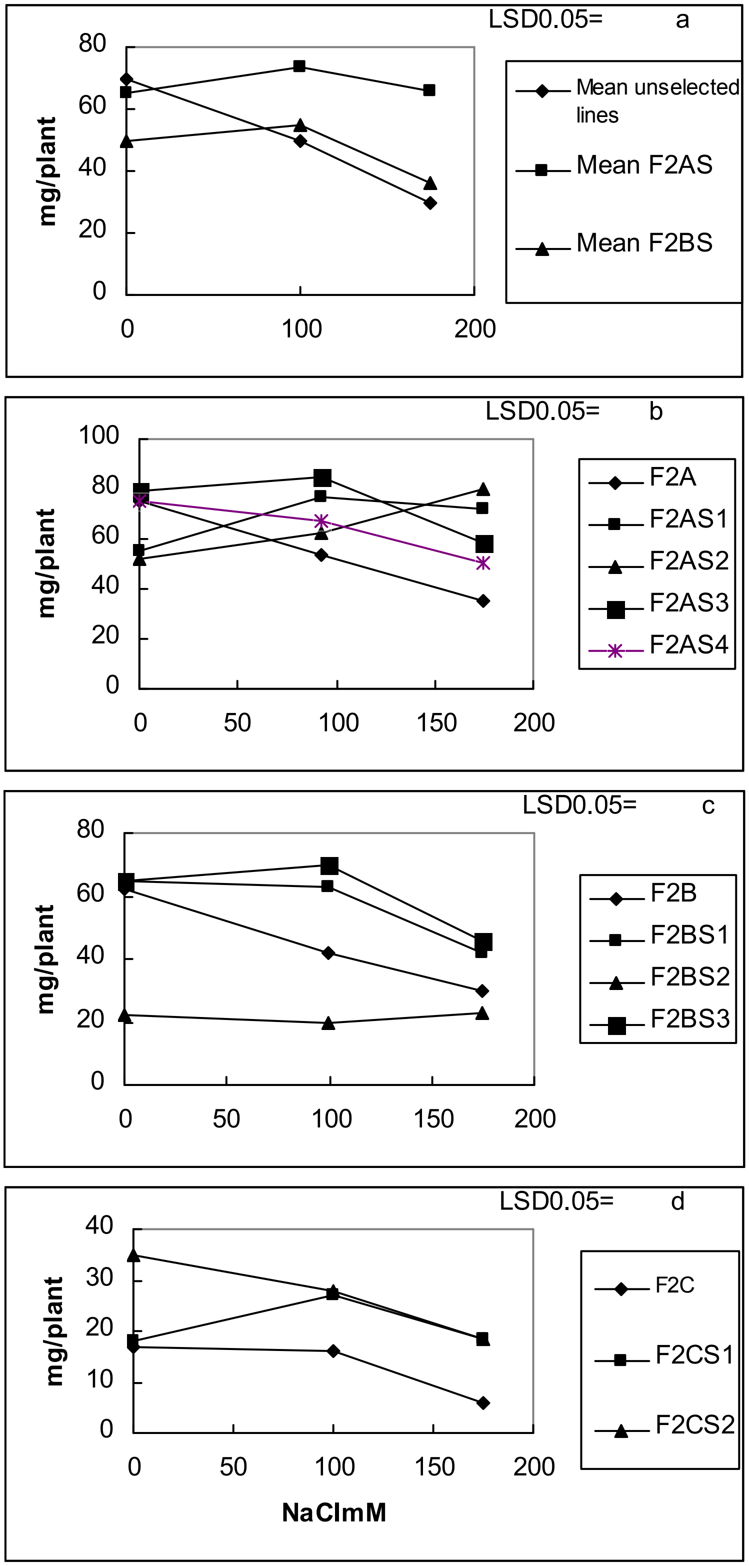

Fig.2. The effect of NaCl on yield per plant of selected and unselected lines derived from three F2 wheat populations grown in sand cultureat three NaCl concentrations

In this some selected lines had more than twice the seed yield obtained from unselected lines out 175 mM NaCl, and their seed yield was also significantly higher than at zero mM NaCl. Nobel et al.(1984) reported similar differences in response to NaCl in selected salt tolerant lines of lucerne. Similar results to those reported here for wheat have been found in barly (Richars, 1983). Pasternak *et al.* (1979) found a high correlation under saline conditions between early development and yield at maturity of tomato, confirming that seedling performance of tomato plants can provide a good pointer to adult performance in that species also.

The progeny of some of the selected lines superior unselected lines not only under saline conditions. This soils is not uniform spatially, but patchy. Hence tolerant material must be able to give acceptable yields on non – saline as well as saline soils for effective use in saline areas. This evidence for the absence of any yield penalty in the selected lines in this important.

There is, as would be expected from theoretical considerations, (Allard, (1966) considerable variation within the selected material, since the selected individuals were heterozygotes (F_2).This is reflected in the variation in the reponse of the individual lines within F_2A and F_2B to incersing salinity.An F_2 generation generally contains a much wider range of genetic variation than the original parents (Akbar et *al*, 1977); Akbar and Yabano, (1977); Ashraf and McNeilly (1991). The interesting point about the differences between the lines examined her is not that it exists; se would expect that bwcause we are looking in this experiment at the porgenies of a heterozygous group of individuals whose progeny will therefore, upon selfing, show a spectrum of salt tolerance, unless tolerance is controlled by a major gene which seem unlikely for such complex character and from data for salt tolerance in Sorgham (Azhar and McNeilly, 1987).This variation is sufficient to allow further of selection on the progeny to be carried out with no need yet for further crossing to increase variation. Since the plants grown were derived from seed produced by plants selected in experiment 1, the improvement in salinity tolerance is clearly inherited, although the precise nature of this inheritance is not yet known.

It is interesting to note that as a consequence of the commencement of salt treatments of F_2C on just one week pld seedling, caused by a design constraint in the experiment, performance of the population and its selected lines was consistently poorer than corresponding F_2A or F_2B lines. This confirms the increased sensitivity of younger seedlings to NaCl, and suggests that this difference cqan be manifest iver a very short period of time. It may have considerable implications for field growth of crops under saline soil conditions where irrigation with unsalinized water for a after which growth may proceed adequately irrigated with salne water.

It is important to bear in mind that the significant impoovement achieved in some lines which is the product of just a single cycle of selection. There is then a strong possibolity that further increases in tolerance may be obtantable through further cycles of selections.

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