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Inter- and Intra-Varietal Variations in Wheat (*Triticum aestivum* L.) Under Saline Conditions

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Abstract
Three wheat varieties (Kharchia-65, KRL 1-4and Alexandria) were tested for their salt tolerance at 125 mol m^3 NaCl salinity. Inter- and intra-varietal variations in these wheat varieties were also investigated for ion contents (Na^+, K^+, Cl), K^+ /Na^+ ratio, yield and yield components under saline conditions. Although environmental conditions were uniform , but variability within varieties was found to higher than the variability between varieties. KRL1-4 was found salt tolerant than Kharchia-65 and Alexandria under saline conditions. These inter-and intra-varietal variations suggested that improvement for salt tolerance might be achieved through selection from within already existing varieties and, or by crossing salt tolerant and salt sensitive wheat genotypes.

Key words: Wheat, variability, NaCl, ion contents, grain yield

Introduction
Existence of genetic variability is the pre-requisite for any breeding programme to improve crop plants. Vraietal differences in salt tolerance have been reported for many crops including wheat (Ashraf and McNeilly,1988), barley (Epstein *et al.,* 1980; Rawson *et al.,*1988; Jones and Storey, 1978). Varetial differences in foliar uptake of Na^+ in barley have been reported by Papa *et al*., 1993. Inter-varietal variation for salt tolerance has also been reported in rice (Flowers and Yeo, 1981; Yeo *et al.,* 1988) and in wheat (Joshi, 1992).

In view of the previous published research studies, the present study was planned to extend this approach in wheat. The aims of this study were to identify variability in physiological and morphological traits within and between varieties and land race. It is imperative to use near homozygous lines from varieties to generate such information which will give more precise and accurate information about the genetic basis of salt tolerance (Jones and Qualset, 1984). These information could be great value for developing wheat varieties which yield reliably on saline soils.

Materials and Methods
This experiment was conducted in glass-house at College Farm, Aber, University of Wales, Bangor, UK., during March to July 1993. The temperature of the glass-house was not controlled and even supplementary lighting was not used in the experiment.

Three wheat varieties KRL1-4 (a selection from within Kharchia, reported to be more salt tolerance and agronomically superior to Kharchia, Supplied by Dr. S. Quarrie, Cambridge Laboratory, Norwich, UK), Khrachia-65 (salt tolerant) reported by Prakash and Sastry (1992) and Alexandrian (unknown) were evaluated to determine the extent of any inter- and intra-varietal variation in salt tolerance. These three wheat varieties were tested at 125 mol m^3 NaCl. The seeds were grown in the growth room set at 20°C on capillary matting starring on March 18, 1993. The light intensity in the growth-room was 200-300 μ mol m^2 S^1 PAR at leaf surface. Seedling were transplanted into hydroponic culture in three pots on March 26,1993. A total of 45 plants per variety were grown in one pot. The size of pot was $52 \times 35 \times 16$ cm. The pots were well aerated. The plant-to plant and row-to-row distance was 7.0 and 6.0 cm respectively. Salt stress (125 mol m^3 NaCl) was introduced in three increaments over a period of five days starting from April 15,1993. Phostrogen (0.5 g L^{-1} phostrogen Ltd, Corwen, Clwyd, UK) was applied to each pot. Phostrogen is blended 10-10-27 NPK fertilizer with 1.3 percent Mg,0.4 percent Fe and 0.02 percent Mn. A modified Long Ashton Solution (Hewitt, 1966) was used in combination with phostrogen to supply micro-nutrients. The solution in the pots were changed after every 15 days.

The fourth leaf on the main stem of randomly selected 27 plants from each variety was sampled on April 21,1993. The leaves were rinsed quickly in distilled water and blotted dry with tissue paper. The samples were placed in Eppendorf tubes and stored in a freezer set at -10°C. Thereafter, salt stress was removed to allow the plants to recover and produce sufficient quantities of seed to be harvested for further studies. Cell sap was extracted by following the method of Gorham *et al.* (1984). The cell sap was diluted with distilled water. Na^+ and K contents were estimated form diluted cell sap by using the atomic absorption spectrophotometer (Model-151, Instrumentation Labortary) and K^+/Na ratio was determined. All 27 plants from which the fourth leaf has been detached were harvested at maturity. Main tiller height (cm), number of spikes per plant, straw weight per plant (g) were recorded. Threshing was done by hand and grain weight per plant (g), number of grain per spike and average grain weight (mg) were determined. Statistical analysis were performed by using the Minitab, SYSTAT statistical packages. Analyses of variance (ANOVA) were used to assess significant differences ($p < 0.05$) between means of the varieties.

Where differences between means were found to be significant ($p<0.05$) an LSD test applied at 5 percent level of significance.

LSD was calculated as: $\sqrt{2\frac{EMS}{N}}\times t_{df\,5\%}$

Where:
EMS = Error mean square from the analysis of variance.
N = Number of values for each variety.

The coefficient of variation for all parameters were calculated as σ^2/λ.

Where:
σ^2 = Standard deviation
$\bar{x}$ = Trait mean

To test the question of whether intrinsic variation in ion contents, yield and its components varied between genotypes. The coefficients of variation were compared using the procedure of Lewontin (1966).

RESULTS AND DISCUSSION

Inter-varietal variations: There were significant differences found between the varieties in ion uptake (Table,1). KRL 1-4 was found to be salt tolerant and had significantly ($p<0.0.5$) low Na^+, high K^+ and higher K^+/Na^+ ratio than Alexandria and Kharchia-65. Hence these results suggest the possibility in wheat to select salt tolerant genotypes by selecting by these psychological traits. Similar results were reported in clover cultivars by Shannon and Noble (1995) and concluded that improvement in salt tolerance is possible through selection. There weer no significant differences in Na^+, K^+ and K^+/Na^+ ratio between Alexandria and Kharchia-65. These results indicate significant inter-varietal variation for ion contents between KRL 1-4 , Alexandria and Kharchia-65. Similarly, Ashraf and McNeilly (1988) reported significant differences under saline conditions between nine wheat cultivars for Na^+ and K^+ contents. However, in common with the results obtained in his study many other research workers have reported that salt tolerance in wheat also depends on maintaining a high Na^+ ratio (Rana *et al.,* 1980; Rashid, 1986; Shah *et al.,* 1987 and Gorham *et al.*, 1987).

There were also significant differences ($p<0.05$) in grain eight per plant and yield components between varieties (Table 1). Alexandria have significanlty ($p<0.001$) higher rain weight per plant than KRL1-4 and Kharchia-65. Kharchia-65 had significantly ($p<0.001$) more spikes per plant than Alexandria and KRL1-4. But Alexandria had significantly ($p<0.001$) morre spikes per plant and main tiller height than KRL1-4. KRL1-4 was significantly ($p<0.001$) lower in straw weight per plant than Alexandria and Kharchia-65, but Alexandria had significantly($p<0.001$) greater straw weight per plant than Kharchia-65.

There were also significant differences ($p<0.005$) in grain eight per plant and yield components between varieties (Table 1). Alexandria have significantly ($p<0.001$) higher grain weight per plant than KRL1-4 and Kharchia-65.

Table 1: Means ± standard error (S.E) and least significant differences for leaf ion contents (mol m^{-3}), K^+/Na^+ ratio, grain weight per plant and yield components in three wheat genotypes.

Trait	Genotypes			
	KRL1-4	Alexandria	Kharchia-65	LSD
Na^+	137 ±6.6	172 ± 9.8	162 ± 17.3	22.4**
K^+	152±9.6	115±5.3	97 ±4.5	19.2***
K^+,Na'	1.1 +0.05	0.7 ±0.04	0.6 ± 0.03	0.1***
Main tiller height (cm)	66.3 ±0.8	91.6±1.4	77.2 ± 1.3	2.7***
Number of spikes per plant	2.0 ±0.1	3.1 ±0.1	3.9 ±0.3	0.5***
Straw weight per plant (g)	2.1 ±0.1	5.2+0.3	3.0 ±0.2	0.6***
Number of grains per spike	36.3 ±1.2	51.7±1.9	25.3 ±0 8	3.9***
Grain weight per plant (g)	2.2 ±0.2	5.7 ±0.3	3.6 ± 0.4	0.8***
Average grain weight (mg)	29.8 ±1.3	35.5 ±0.8	34.9 ± 1.3	3.0**

** = $p<0.01$, *** = $p<0.001$

Table 2: Coefficients of variation (CV%) and variances of logarithms (s^2_{log}) in parentheses, for leaf ion contents (mol m^{-3}), K^+/Na^+ ratio, grain weight per plant and yield components in three wheat genotypes.

Trait	Genotypes		
	KRL1-4 CV(%)	Alexandria CV(%)	Kharchia-65CV(%)
Na*	25 010.010404)	29.6(0.017636)	23.4(0.010545)
K^-	33.1(0.010384)	24.0(0.009545)	24.0(0.010531)
K' /Na '	25.0(0.012277)	27.7(0.01 3202)	26.1(0.010778)
Main tiller height (cm)	5.9(0.0006676)[a]	3.7(0.000266)a	9.0(0.001685)a
Number of spikes per plant	25.9(0.01 3433)	22.5(0.009643)a	34.6(0.022572)a
Straw weight per plant (g)	28.0(0.026212)	34.0(0.040602)	40.9(0.039351)
Number of grains per spike	17.2(0.005929)	19.5(0.008780)	15.6(0.007265)
Grain weight per plant (g)	39.6(0.035834)	31.6(0.023531)a	51.7(0,065096)a
Average grain weight (mg)	22.6(0.009761)[a]	12.3(0.002851)ab	18.7(0.007813)b

Note: Values with the same letter for a trait are significantly different at 5% level of significance. Values without letters for a trait are not significantly different.

Kharchia-65 had significantly ($p<0.001$) more spikes per plant than Alexandria and KRL1-4. But Alexandria had significantly ($p<0.001$) more spikes per plant and main tiller height than KRL 1-4. KRL1-4 was significantly ($p<0.001$) lower in straw weight per plant than Alexandria and Kharchia-65, but Alexandria had significantly ($p<0.001$) greater straw weight per plant than Kharchia-65.

Intra-varietal variaties: intra-varietal variations found in ion uptake and k^+/Na' ratio within each variety. Differences within varieties were larger than differences between varieties. However overall, variability in Na^+ , and K^+ contents and K^+/Na^+ ratio was found to be similar in KRL1-4, Alexandria and Khachia-65 wheat varieties. Yeo and Flowers (1984) reported high variability in Na^+ and K^+ levels in rich under saline conditions (Table 2).

This is also clear from the coefficients of variability for grain weight per plant and yield components that there was a large amount of variability within KRL1-4, Alexandria and Kharchia -65 for yield and its components, except main tiller height (Table 2). The results of this study provide clear evidence that individual plants of landrance Kharchia-65 were more variable for yield than those of pure breeding genotype (Alexandria and KRL1-4). But variability in ion uptake was found similar in these three varieties. Although it was expected that landrace should have more variability than pure genotypes. These results suggest that there are intra-varietal variations for ion contents, K^+/Na^+, grain weight per plant and yield components. However, there is possibility of a single plant selection with improved salt tolerance from within a wheat veriety. Such variability within wheat varieties have been reported by many research workers, in Blue Silver (Rashid, 1986; Shah, 1987) and in Karchia (Joshi,1992).

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