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Effects of Selecting for K^+/Na^+ and Grain Yield on Salinity Tolerance in Spring Wheat

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Abstract
Twelve S, selection, four from each of the three wheat varieties (Alexandria, Kharchia-65 and KRL1-4) were made on the bases of high and low K^+/Na^+ ratio and yield. These were tested to know the effects of selecting for these traits. The S, lines A-1 and A-24 which were selected on the basis of high and low K^+/Na^+ ratio were found significantly different for IC K^+/Na^+ ratio. Similarly, Kh-1 (high K^+/Na^+ ratio) and Kh-5 (low K^+/Na^+ ratio) were also found significantly different for K^+/Na^+ ratio. On the other hand, S, lines which were selected on the basis of high and low grain yield showed non significant differences. However, it is concluded from the results that high K^+/Na^+ ratio may be used as selection criteria for salt tolerance in wheat. Grain yield per plant and its components, showed no significant differences between plants with and without fourth leaf. It is suggested from these results that sampling of fourth leaf have no effects on the grain yield per plant and these can be included with plant without fourth leaf in yield comparison.

Introduction
Early screening of wheat genotypes, germinability at high salt concentrations (Roy, 1991) and seedling dry and fresh weight at different levels of salinity (Prakash and Sastry, 1992) along with Na^+ and K^+ contents are useful criteria for salt tolerance. Ashraf and McNeilly (1988) proposed a general selection criterion for splt tolerance as they suggested the use of whole plant performance for assessment of salt tolerance in wheat.

An enhanced K^+/Na^+ ratio is associated with increased salt tolerance in crap plants (Gorham, 1990; Gorham *et al*., 1991; Subbarao *et al*., 1990). In view of above evidence the current study was planned to compare selections with already existing three wheat varieties for low and high ratio and grain yield to determine the effects of selecting for these traits. And also to determine that or high yield can be used as useful selection criteria for increasing salt tolerance of wheat. The second objective of this experiment was to compare plants with and without fourth leaf to investigate effects of sampling on yield.

Materials and Methods
This experiment was conducted in glass-house at College Farm, Aber, University of Wales, Bangor, UK., during January to May, 1995. .The temperature of the glass-house was not controlled and natural day light was supplemented by mercury vapour bulbs (model 3808 MP) to give a photoperiods of 16 hrs. Average temperature in the glasshouse was $16.4 + 0.44$°C.

Twelve S, selections (produced by selfing S_0 selections) and their parents (Table 1) were evaluated to determine the effects of selecting for K^+/Na^+ ratio and grain yield. The seeds were grown in the growth-room set at 20°C on capillary matting starting on January 13, 1995. The light intensity in the growth-room was 200-300 μ mol m^2 S^1 PAR at leaf surface. Seedlings were transplanted into hydroponic culture on January 22, 1995. There were 10 plants (1 row) per selection and 20 plants (2 rows) per parents in each of three replicates. The plants were grown in 6 pots. The size of the pot was 52 x 35 x 16 cm. The pots were well aerated. The plant-to-plant and row-to-row distance was 3.5 and 6.0 cm respectively. Salt stress (100 mol m NaCl) was introduced in three increments over a period of five days starting from January 28, 1995. Phostrogen (0.5 g 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.

Youngest fully-expanded fourth leaves from three plants per selection and five plants per parents per replication were sampled on February 16, 1995 (replication 1) and February 17, 1995 (replications 2 and 3). 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, Cell sap was extracted by following the method (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 Laboratory) and K^+/Na^+ ratio was determined. All plants (those with the fourth leaf intact and fourth leaf detached) were separately harvested at maturity on May 15, 1995 (replications 2 and 3) and on May 16, 1995 (replication 1). Threshing was done by hand and main tiller height (cm), straw weight per plant (g), fertile spikelets per spike, number of grains per plant, number of grains per spike and grain weight per plant (g) 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 selections and parents. Where differences between means were found to he significant ($p = 0.05$) an LSD test was applied at 5 percent level of significance. The means of plants with the fourth leaf either intact or detached were also compared using Students t test.

Table 1: Twelve S_1 selections, their source and used selection criteria

Source	Selections	Selection criteria
Alexandria	A-1	High K^+/Na^+ ratio
	A-24	Low K^+/Na^+ ratio
	A-3	High yield per plant
	A-14	Low yield per plant
Kharchia-65	Kh-1	High K^+/Na^+ ratio
	Kh-5	Low K^+/Na^+ ratio
	Kh-4	High yield per plant
	Kh-17	Low yield per plant
KRL1-4	KRL-24	High K^+/Na^+ ratio
	KRL-21	Low K^+/Na^+ ratio
	KRL-26	High yield per plant
	KRL-3	Low yield per plant

Results and Discussion

There was significant differences ($p<0.05$) in K^+/Na^+ ratio between A-1 (high K^+/Na^+ - ratio) and A-24 (low K /Na ratio). This is because, these S_l lines were selected on the bases of high and low K^+/Na^+ ratio. There were no significant differences ($p<0.05$) in Na^+, K^+ and K^+/Na^+ ratio between Alexandria parent and selections. There were also no significant differences ($p<0.05$) in grain yield per plant between the Alexandria parent, A-3 (high yield) and A-14 (low yield) and no significant differences ($p<0.05$) for any other parameter (Table 2).

In case of S_i selections from within Kharchia-65 parent. Kh-1 (high K^+/Na^+ ratio) had significantly higher (p<0.05E K uptake and K^+/Na^+ ratio than Kh-5 (low K^+/Na^+ ratio). There were also significant differences ($p<0.05$) in K^+/Na^+ ratio between Kharchia-65 parent and selections (K11-1, Kh-5). Kh-4 (high yield) had a higher grain weight per plant than Kh-17 (low yield) and the parent Kharchia-65 but differences were not significant ($p = 0.05$). There were no significant differences ($p<0.05$) in any indicated parameter between KRL1-4 parent and S, selections (KRL-26, KRL-3 KRL-24 and KRL-21) (Table 2). Different workers have also reported different responses to selection from within varieties. Joshi (1992) reported highly significant differences in grain yield and its attributes under saline conditions in Kharchia collections. However Weltzien and Fischbeck (1990) tested homozygous lines of barley under drought and dry land salinity stress and reported greater variation among yield components between than within populations.

It is generally concluded from the performance of selfed generation of Alexandria, Kharchia-65 and KRL1-4 that there is genetic variation in K^+/Na^+ ratio within these three wheat varieties under saline conditions. Therefore, there is possibility to select lines from within these varieties with high K^+/Na^+ ratio.

Table 2: Means ± S.E. of fourth leaf ion contents (mol m ^{3}), K^+/Na^+ ratio and grain yield per plant (g) of three wheat varieties (Alexandria, Kharchia-65 and KRL1-4) and selections from within these varieties

Trait	Parent	Selections				
	Alexandria	A-1	A-24	A-3	A-14	LSD
Na^+	248.0±10.4	254.0±10.9	249.0±11.7	205.0±8.9	254.0±13.7	NS
K^+	125.0±7.6	122.0±5.2	112.0±5.40	139.0±7.4	113.0±8.6	NS
K^+/Na^+	0.5±0.04	0.5±0.03	0.5±0.03	0.7±0.1	0.4±0.03	0.1
Grain yield (g)	0.09±0.04	0.09±0.01	0.08±0.01	0.20±0.05	0.07±0.02	NS
	Kharchia-65	Kh-1	Kh-5	Kh-4	Kh-17	
Na^+	197.0±9.4	186.0±13.8	179.0±8.1	181.0±6.0	217.0±11.6	NS
K^+	139.0±8.0	151.0±6.9	155.0±10.1	157.0±11.9	128.0±4.1	13.8*
K^+/Na^+	0.7±0.1	0.8±0.1	0.9±0.1	0.9±0.1	0.6±0.03	0.1
Grain yield (g)	0.24±0.09	0.39±0.13	0.34±0.16	0.36±0.12	0.23±0.1	NS
	KRL1-4	KRL 24	KRL-21	KRL-26	KRL-3	
Na^+	204.0±9.5	184.0±8.4	218.0±10.4	189.0±9.6	177.0±12.2	NS
K^+	149.0±9.2	167.0±11.9	122.0±6.5	152.0±10.6	145.0±7.9	NS
K^+/Na^+	0.7±0.05	0.9±0.1	0.6±0.1	0.8±0.1	0.9±0.1	NS

Grain yield (g)	0.37±0.04	0.44±0.01	0.28±0.08	0.42±0.04	0.48±0.06	NS

NS= $p>0.05$, * = $p<0.05$

Table 3: Means±S.E. for yield and yield components of plants with and without fourth leaf in Alexandria, Kharchia-65, KRL1-4 and selections from within these varieties

Trait	Detached Means±S.E	Undetached Means±S.E	t test	df
	Alexandria parent and selections			
Grain weight per plant (g)	0.12±0.02	0.11±0.01	0.19^{NS}	43
Main tiller height (cm)	48.2±2.1	52.2±1.1	-1.95^{NS}	52
Straw weight per plant (g)	0.6±0.01	0.7±0.03	-0.34^{NS}	40
Fertile spikelets per spike	11.8±0.5	11.7±0.3	0.11^{NS}	64
Grains per spike	11.4±1.6	11.6±0.9	-0.15^{NS}	55
Grains per plant	13.3±2.3	12.5±1.0	0.31^{NS}	44
	Kharchia-65 parent and selections			
Grain weight per plant (g)	0.31±0.03	0.30±0.03	0.29^{NS}	107
Main tiller height (cm)	65.8±1.8	66.8±1.2	-0.49^{NS}	92
Straw weight per plant (g)	0.8±0.1	0.8±0.1	-0.32^{NS}	98
Fertile spikelets per spike	9.5±0.2	9.4±0.2	0.08^{NS}	138
Grains per spike	13.5±0.9	13.4±0.5	0.04^{NS}	82
Grains per plant	23.9±2.4	24.8±1.7	-0.31^{NS}	96
	KRL1-4 parent and selections			
Grain weight per plant (g)	0.35±0.02	0.34±0.02	0.27^{NS}	94
Main tiller height (cm)	65.4±1.2	66.6±0.9	-0.82^{NS}	97
Straw weight per plant (g)	0.6±0.03	0.7±0.02	-2.02^{NS}	115
Fertile spikelets per spike	11.1±0.3	11.0±0.2	0.13^{NS}	102
Grains per spike	23.8±1.6	23.1±1.1	0.34^{NS}	88
Grains per plant	25.5±1.5	26.7±1.2	-0.65^{NS}	102

NS= $p>0.05$, * - $p<0.05$

Differences between plants with and without fourth leaf showed no significant differences for grain yield per plant and yield components except straw weight per plant in KRL1-4, which is not directly related to yield (Table 3). However, it is suggested from the results that plants from which leaves have been sampled can be included with plants from which leaves have not been sampled for yield comparison.

References

Ashraf, M. and T. McNeilly, 1988. Variability in salt tolerance of nine spring wheat cultivars. J. Agron. Crop Sci., 160: 14-21.

Gorham, J., 1990. Salt tolerance in the triticeae: K/Na discrimination in synthetic hexaploid wheats. J. Exp. Bot., 41: 623-627.

Gorham, J., A. Bristol, E.M. Young and R.W. Jones, 1991. The presence of the enhanced K/Na discrimination trait in diploid *Triticum* species. Theor. Applied Genet., 82: 729-236.

Gorham, J., E. McDonnell and R.G.W. Jones, 1984. Pinitol and other solutes in salt-stressed *Sesbania aculeata*. Zeitschrift Pflanzenphysiologie, 114: 173-178.

Hewitt, E.J., 1966. Sand and Water Culture Methods Used in the Study of Plant Nutrition. 2nd Rev. Edn., Farnham Royal Commonwealth Agricultural Bureau, UK., Pages: 547.

Joshi, P., 1992. Genetic variability in Kharchia wheat (*Triticum aestivum*) from salt affected areas in Rajasthan. Ann. Arid Zone, 31: 103-106.

Prakash, V. and E.V.D. Sastry, 1992. Effects of salinity on germination and seedling growth in wheat. Ann. Arid Zone, 31: 71-72.

Roy, P.K., 1991. Effect of salinity on variability and correlation in wheat seedlings. Ann. Arid Zone, 30: 61-63.

Subbarao, G.V., C. Johansen, J.V.D.K. Rao and M.K. Jana, 1990. Salinity tolerance in F_1 hybrids of pigeonpea and a tolerant wild relative. Crop Sci., 30: 785-788.

Weltzien, E. and G. Fischbeck, 1990. Performance and variability of local barley landraces in near-eastern environments. Plant Breed., 104: 58-67.