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SCREENING OF CULTIVARS OF *BRASSICA NAPUS* AND *B. COMPESTRIS* FOR SALT TOLERANCE GROWN UNDER CONTROLLED CONDITION

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ABSTRACT

Six *Brassica napus* genotypes Salam, Altex, Ganyou-5, PR-7, Marnoo, NARC-82, and four *Brassica Compestris* genotypes Desi, Tobin, Torch and Span were screened for salt tolerance under glasshouse conditions at maturity stages. Two levels of salinity i.e; 7.5 and 15 $dS.m^{-1}$ were induced in soil under test along with control (EC 1.2 $dS.m^{-1}$). Root zone salinity reduced plant height, stem diameter, biological and grain yield significantly over control. Cumulative varietal means showed that relative yield was higher in NARC-82 and Desi as compared with other cultivars. K^+/Na^+ ratio decreased with increasing root zone salinity. Relatively, salt tolerant cultivars appeared to exclude Na^+ and maintain K^+ and K^+/Na^+ ratio higher than the sensitive cultivars.

Key words: *Brassica* (*napus* & *compestris),* Cultivars, Salt tolerance

INTRODUCTION

Pakistan is situated in arid and semi arid region of the world having 6.67 million hectare salt affected (Khan, 1998). The salt affected areas are one of the major factors for low soil productivity in Pakistan. Although some crops are moderately tolerant to saline conditions, many other are adversely affected by even low level of salt (Greenway and Munns, 1980). Selection of such salt tolerance plants has immense importance in agriculture. At present Pakistan is a major importer of edible oils. The major oil seed crops include cottonseed, rapeseed/mustard, sunflower and canola etc. The total consumption of edible oils in 2004-2005 was 2.764 million tons. The local production was 0.857 million tons, which accounts for 31% of total consumption while the remaining 69% was made available through imports (Anonymous. 2004-2005). Screening of *Brassica* cultivars for salt tolerance will help to identify the salt tolerant cultivars. Cultivation of such cultivars on marginal land can boost up edible oil production. The present study has been undertaken to explore the salt tolerance in cultivars of *Brassica napus* & *B. compestris).*

MATERIALS AND METHODS

The salt tolerance studies were carried out in net-house of NWFP Agricultural University, Peshawar. Six Brassica *napus* genotypes Salam, Altex, Ganyou-5, PR-7, Marnoo, NARC-82, and four *Brassica Compestris* Desi, Tobin, Torch and Span were tested at two levels of induced salinity i.e., 7.5 $\pm$ 0.04 and 15 $\pm$ 0.05 along with control (1.2 $dS\ m^{-1}$). The cultivars were sown in soil culture in plastic containers (diameter 50 cm, depth 22 cm). The containers were filled with 40 kg air-dried and sieved surface soil. Twelve containers were placed in 2 factor factorial split plot design, with four replications and have three salt levels of 1.2 (control), 7.5 and 15 $dS.m^{-1}$ at the main level and cultivars at sublevel. The soils were salinized with NaCl + $CaCl_2$ solution to the levels of 7.5 and 15 $dS.m^{-1}$ electrical conductivity of saturation extract in four installments within two weeks. Later on, containers were irrigated with tap water as desired. A basal dose of 60 $\mu g\ g^{-1}$ N and 30 $\mu g\ g^{-1}$ P in the form of urea and DAP, respectively was applied to all the pots. All of required P was applied at the time of sowing whereas corresponding N was applied in two equal splits i.e., at sowing, while remaining half before flowering. Before sowing soil was irrigated to field capacity and than 8 seeds of each cultivar were sown in line equally spaced arranging from center. Seedlings in each container were thinned at eight leaf stage to two of each cultivar. Fully expanded leaves from each plant were collected for Na^+ and K^+ determination. Yield and yield parameters were recorded at maturity (78-85 days).

RESUTS AND DISCUSSION

PLANT HEIGHT: The data pertaining to plant height of *Brassica* cultivars have been presented in Table-1 the impact of salinity was pronounced as it reduced plant height significantly over control the mean reduction in plant height was 20 and 43% at 7.5 and 15.0 dS.m^{-1} respectively over control. Cumulative mean height of Brassica cultivars was also significantly different among the cultivars. Plant height in all cultivars decreased due to salt addition in soil as reported by Kumar, 1995, Dhawan *et al*., 1987 and Kumar & Kumar, 1990.

Table 1. Effect of Salinity on Plant height of cultivars of *Brassica napus & B. compestris.* (Average of Four replicates).

Cultivars	Salinity levels dS.m^{-1}				
	1.2 dS.m^{-1} (Control)	7.5 dS.m^{-1}		15 dS.m^{-1}	
	Plant height (cm)				
Salam	83.5 ± 0.91	73.5 ± 1.21	(88.0)*	31.0± 0.79	(37.1)*
Altex	126.7 ± 2.92	104.2 ± 1.39	(82.2)	71.0 ± 1.75	(56.0)
Ganyou-5	122.5 ± 1.75	82.5 ± 1.43	(67.3)	62.5 ± 0.91	(51.0)
PR-7	128.2 ± 1.41	85.2 ± 1.05	(64.4)	54.2 ± 1.26	(42.3)
Desi	124.5 ± 1.40	108.5 ± 1.72	(87.1)	84.7 ± 0.84	(68.0)
Marnoo	44.5 ± 1.06	27.0 ± 0.72	(60.5)	25.0 ± 0.95	(56.0)
NARC-82	153.2 ± 0.98	127.0± 1.86	(82.8)	96.0 ± 1.09	(62.6)
Tobin	118.0 ± 1.55	108.0 ± 1.17	(91.5)	75.5 ± 1.12	(63.9)
Torch	121.0 ± 0.86	102.7 ± 1.07	(84.9)	69.5 ± 1.51	(57.4)
Span	131.0 ± 1.59	110.2 ± 1.24	(84.1)	88.2 ± 0.88	(67.3)
Mean	115.3 ± 1.50	92.9 ± 1.30	(80.5)	65.7 ± 1.15	(56.9)

*, percent proportion of control.

SILIQUA NUMBER:

Data regarding siliqua number per plant have been given in Table-2. Number of pods was significantly reduced by salinity as compared to control. Mean reduction of pods number was 57 and 74 % at 7.5 and 15 dS.m^{-1}. Cumulative varietal mean showed that the NARC-82, Altex and Desi have maximum number of pods per plant while Marnoo and Salam the least number at both salinity levels. The similar results were also reported by Kumar, 1995 and Kumar & Kumar, 1990.

Table 2. Effect of Salinity on number of Siliqua of various cultivars of *Brassica napus* and B. *compestris.* (Average of Four replicates).

Cultivars	Salinity levels dS.m^{-1}				
	1.2 dS.m^{-1} (Control)	7.5 dS.m^{-1}		15 dS.m^{-1}	
	Number of Siliqua per plant				
Salam	90 ± 1.78	44 ± 1.58	(48.8) *	28 ± 1.78	(30.8) *
Altex	289 ± 1.83	82 ± 0.91	(28.3)	48 ± 1.78	(16.6)
Ganyou-5	244 ± 1.68	87 ± 1.68	(34.0)	57 ± 1.78	(23.1)
PR-7	162 ± 1.47	89 ± 1.29	(55.0)	38 ± 1.78	(23.5)
Desi	217 ± 1.22	118 ± 1.29	(54.3)	67 ± 1.78	(30.8)
Marnoo	79 ± 1.08	37 ± 0.91	(47.0)	23 ± 1.78	(29.0)
NARC-82	343 ± 2.20	128 ± 1.58	(37.1)	86 ± 1.78	(25.0)
Tobin	215 ± 0.71	85 ± 1.08	(39.5)	56 ± 1.78	(25.9)
Torch	168 ± 1.83	102 ± 1.47	(60.4)	57 ± 1.78	(34.0)
Span	199 ± 1.87	104 ± 1.58	(52.2)	63 ± 1.78	(31.4)
Mean	**201 ± 1.54**	**87 ± 1.31**	**(43.6)**	**52 ± 1.36**	**(25.9)**

*, Percent proportion of control.

BIOLOGICAL YIELD:

The biological yield data presented in Table-3, indicated that salinity effect on cultivars and their interaction on biological yield were highly significant and reduction in dry matter yield was 32 and 58% at both salinity levels. Cumulative varietal means showed that the performance of NARC-82, Desi and Altex in term of biological yield was better as compared with the performance of Salam, Marnoo and Span at both salinity levels. The behavior of same cultivars like Altex and Tobin was in consistent. Low biological yield has also been reported by Kumar, 1995 and Dhawan *et al.*, 1987.

GRAIN YIELD:

Grain yield data of Brassica cultivar have been depicted in (Table-4). The data revealed that progressive addition of induced salinity reduced the grain yield of all the cultivars significantly. Average grain yield was 4.40, 1.80 and 1.0 g per plant at control, 7.5 and 15 dS.m^{-1} salinity levels respectively. At low salinity level the reduction in yield ranged between 2.83 to 0.72 whereas at high level it ranged between 1.61 to 0.60 g.plant^{-1}. The NARC-82 and Desi proved to be tolerant as they gave maximum grain yield, while Marnoo and Salam gave minimum grain yield as they were very sensitive to salinity at both level of salinity. Similar results of decreasing effect of salinity on grain yield of brassica reported by (Dhawan et al 1987, Rizk et al 1979, Kumar 1995 and Kumar and Kumar 1990 also have been noted in a number of crops Makhdum and Muhammad 1971 in sunflower, Shannon *et al.* 2000. in vegetable and Zeng *et al*. 2003 in rice.

Table 3. Effect of induced Salinity on Biological yield of *Brassica* (*napus* & *compestris)* Cultivars (Average of Four replicates).

Cultivars	**Salinity levels dS.m^{-1}**				
	1.2 dS.m^{-1} (Control)	**7.5 dS.m^{-1}**		**15 dS.m^{-1}**	
	Biological Yield (g)				
Salam	12.64 ± 0.70	6.39 ± 0.75	(50.6)	3.60 ± 0.11	(28.5)
Altex	28.25 ± 1.47	6.07 ± 0.38	(77.4)	9.35 ± 0.42	(37.2)
Ganyou-5	23.89 ± 1.27	14.42 ± 0.37	(85.8)	9.36 ± 0.51	(39.1)
PR-7	19.45 ± 1.18	14.24 ± 0.57	(86.7)	8.40 ± 0.57	(43.2)
Desi	24.53 ± 1.08	20.16 ± 0.90	(92.5)	12.62 ± 0.86	(51.4)
Marnoo	9.56 ± 0.71	6.01 ± 0.41	(90.5)	3.15 ± 0.39	(35.9)
NARC-82	31.57 ± 0.69	21.97 ± 0.54	(86.7)	15.23 ± 0.52	(48.2)
Tobin	19.10 ± 1.10	14.69 ± 1.04	(94.3)	10.13 ± 0.62	(53.1)
Torch	23.96 ± 0.73	15.06 ± 0.54	(87.5)	8.54 ± 0.43	(35.6)
Span	14.43 ± 0.51	9.35 ± 0.48	(95.9)	4.41 ± 0.27	(35.4)
Mean	20.45 ± 0.97	12.83 ± 0.58	(67.6)	8.48 ± 0.51	(41.6)

Table 4. Effect of Salinity on Grain yield of cultivars of *Brassica napus* and B. *compestris.* (Average of Four replicates).

Cultivars	**Salinity levels dS.m^{-1}**					
	1.2 dS.m^{-1} (Control)		**7.5 dS.m^{-1}**		**15 dS.m^{-1}**	
	Absolute Grain Yield (g)					
	g.plan^{-1}	Rank	g.plan^{-1}	Rank	g. plan^{-1}	Rank
Salam	2.94 ± 0.27	9	1.06 ± 0.09	9	0.60 ± 0.08	9
Altex	8.26 ± 0.44	1	1.88 ± 0.05	7	1.07 ± 0.08	4
Ganyou-5	5.32 ± 0.24	3	1.93 ± 0.12	5	1.38 ± 0.11	2
PR-7	3.39 ± 0.30	6	1.37 ± 0.08	8	0.84 ± 0.11	8
Desi	5.01 ± 0.23	4	2.54 ± 0.07	2	1.30 ± 0.11	3
Marnoo	1.63 ± 0.12	10	0.72 ± 0.03	10	0.51 ± 0.09	10
NARC-82	7.01 ± 0.37	2	2.82 ± 0.14	1	1.61 ± 0.10	1
Tobin	3.31 ± 0.15	7	2.23 ± 0.09	3	1.06 ± 0.06	6
Torch	4.90 ± 0.14	5	1.91 ± 0.11	6	1.07 ± 0.09	5
Span	2.56 ± 0.20	8	2.06 ± 0.12	4	0.98 ± 0.11	7
Mean	4.41 ± 0.25	-	1.85 ± 0.09	-	1.07 ± 0.09	-

LEAF POTASSIUM CONTENTS:

Potassium concentration data are presented in (Table 5). It is clear from the statistical analysis that leaf potassium was significantly reduced by salinity especially at 15 dSm^{-1} level, but there was no significant reduction at 7.5 dSm^{-1} over control. The mean potassium reduction was 28 42% over control at both salinity level. In all treatments, Desi NARC-82 and Span has higher potassium concentration, while Salam and Marnoo have comparatively lower contents at both salinity levels. Grain yield and leaf potassium content have positive correlation. This indicated that higher yield cultivars under salt stress conditions attempted to maintain their potassium status.

LEAF SODIUM CONTENTS:

Leaf sodium contents of *Brassica* (*napus* & *compestris)* cultivars are presented in (Table-6). Sodium content of leaf increased significantly over control with salinization of ECe 7.5 and 15 dSm^{-1} low leaves sodium contents were noted in span, Desi and NARC-82, while higher sodium accumulation occurred in leaves of Salam and Marnoo at while higher sodium accumulation occurred in leaves of Salam and Marnoo at both salinity levels. Grain yield and leaf sodium showed a strong negative relationship at medium and high salinities, it may be concluded that growth reduction in *Brassica* (*napus* & *compestris)* cultivars in saline condition was due to "ion excess" caused by enhanced Na^+ accumulation in mature tissue.

Table 5. Effect of NaCl plus $CaCl_2$ Salinity on Leaf potassium contents of *Brassica* (*napus* & *compestris)* Cultivars (Average of Four replicates).

Cultivars	**Salinity levels $dS.m^{-1}$**		
	1.2 $dS.m^{-1}$ (Control)	**7.5 $dS.m^{-1}$**	**15 $dS.m^{-1}$**
	Leaf potassium content (meq. $100g^{-1}$)		
Salam	82.83 $\pm$ 1.91	63.93 $\pm$ 1.51	41.7 $\pm$ 0.87
Altex	90.50 $\pm$ 0.45	46.05 $\pm$ 1.08	43.9 $\pm$ 0.81
Ganyou-5	85.27 $\pm$ 1.87	67.80 $\pm$ 0.98	53.0 $\pm$ 0.86
PR-7	77.87 $\pm$ 1.15	67.80 $\pm$ 1.88	47.1 $\pm$ 1.37
Desi	102.65 $\pm$ 1.05	82.50 $\pm$ 1.23	68.8 $\pm$ 0.96
Marnoo	73.85 $\pm$ 1.85	55.55 $\pm$ 1.36	43.8 $\pm$ 1.70
NARC-82	111.00 $\pm$ 1.55	77.85 $\pm$ 1.35	60.9 $\pm$ 1.90
Tobin	103.87 $\pm$ 0.31	72.05 $\pm$ 1.44	58.5 $\pm$ 1.38
Torch	105.55 $\pm$ 1.48	72.15 $\pm$ 1.27	54.1 $\pm$ 1.19
Span	112.22 $\pm$ 1.12	76.00 $\pm$ 1.82	63.2 $\pm$ 0.77
Mean	**94.56 $\pm$ 1.27**	**68.17 $\pm$ 1.39**	**53.5 $\pm$ 1.18**

Table 6. Effect of NaCl plus $CaCl_2$ Salinity on Leaf Sodium contents of cultivars of *Brassica napus* and B. *compestris.* (Average of Four replicates).

Cultivars	**Salinity levels $dS.m^{-1}$**		
	1.2 $dS.m^{-1}$ (Control)	**7.5 $dS.m^{-1}$**	**15 $dS.m^{-1}$**
	Leaf Sodium content (meq.100 g^{-1})		
Salam	3.8 $\pm$ 0.68	31.9 $\pm$ 1.64	52.3 $\pm$ 1.48
Altex	2.7$\pm$ 0.26	28.8 $\pm$ 1.57	43.9 $\pm$ 0.60
Ganyou-5	2.6$\pm$ 0.32	29.5 $\pm$ 0.79	44.0 $\pm$ 1.17
PR-7	3.3$\pm$ 0.41	30.8 $\pm$ 0.87	47.0 $\pm$ 0.66
Desi	2.9$\pm$ 0.26	28.4 $\pm$ 1.39	43.0 $\pm$ 1.16
Marnoo	3.5$\pm$ 0.19	39.6 $\pm$ 0.21	62.2 $\pm$ 1.86
NARC-82	2.5$\pm$ 0.36	27.8 $\pm$ 1.68	24.4 $\pm$ 1.98
Tobin	2.8$\pm$ 0.35	28.7 $\pm$ 1.78	45.0 $\pm$ 1.27
Torch	2.9$\pm$ 0.25	27.7 $\pm$ 1.12	45.0 $\pm$ 1.47
Span	2.9$\pm$ 0.23	27.1 $\pm$ 1.12	42.0 $\pm$ 1.51
Mean	**2.9$\pm$ 0.33**	**30.1 $\pm$ 1.22**	**47.6 $\pm$ 1.32**

LEAF POTASSIUM/ SODIUM RATIO:

The data regarding K^+/Na^+ ratio have been shown in Table-7. Salinity significantly reduced K^+/Na^+ ratio of *Brassica* (*napus* & *compestris)* cultivars and mean reduction was 93 and 96% at both levels of salinity. Those cultivars which excluded sodium have high K^+/Na^+ ratio and those which included Na^+ have low K^+/Na^+ ratio. Correlation between grain yield and leaf K^+/Na^+ ratio of Brassica cultivars at both was showed positive. This indicated that higher yielding cultivars in saline conditions maintained K^+/Na^+ ratios at somewhat higher level than the salt sensitive cultivars. These results are similar to Makhdum and Muhammad (1971).

Table 7. Effect of Salinity on Leaf Potassium / Sodium ratio of cultivars of *Brassica napus* and *B. compestris).* (Average of Four replicates).

Cultivars	**Salinity levels dS.m^{-1}**		
	1.2 dS.m^{-1} (Control)	**7.5 dS.m^{-1}**	**15 dS.m^{-1}**
	Leaf K^+/Na^+ ratio		
Salam	21.8 b	2.0 b	0.8 c
Altex	33.5 ab	1.6 c	1.0 b
Ganyou-5	32.8 ab	2.3 b	1.2 a
PR-7	23.6 c	2.2 b	1.0 b
Desi	35.4 a	2.9 a	1.6 a
Marnoo	21.1 c	1.4 c	0.7 c
NARC-82	44.4 a	2.8 a	1.5 a
Tobin	37.1 a	2.6 ab	1.3 a
Torch	36.4 a	2.6 ab	1.2 a
Span	38.7 a	2.8 a	1.5 a
Mean	**32.5 a**	**2.3 b**	**1.2 c**

Mean values followed by different letters in the same column are significantly different from each other at $p < 0.05$ by DMR test.

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