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RESPONSE OF MORPHOLOGICAL AND YIELD OF DIFFERENT LINSEED (*LINUM USITATISSIMUM* L.) GENOTYPE UNDER SALINITY STRESS

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Abstract

The present investigation was conducted at the Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Pryagraj to explore the effect of different concentrations of NaCl on morphological and yield parameters of different linseed genotype. The study was laid out in FRBD (4x9 Factorial), having three levels each of Nacl (100mM, 150mM and 200mM) and nine varieties viz., SHA1, SHA2, SHA3, SHA4, SHA5, SHA6, SHA7, SHA8 and SHA9, making a total of 36 treatment combinations with control, each replicated three times. NaCl affects the plant height, number of primary branches plant^{-1}, days to maturity, number of capsules plant^{-1}, number of seeds capsule^{-1}, test weight, and seed yield plant^{-1}. Whereas the minimum days to 50% flowering (62.42) was recorded in variety SHA5 and the maximum days to 50% flowering (79.00) was found in variety SHA3 and plant height (cm) days to maturity, number of capsules plant^{-1}, number of seeds capsule^{-1}, test weight (g) and seed yield plant^{-1} (g) was recorded in SHA7 genotype. Thus it shows that SHA7 genotype are more potential in saline soil. The research will provide useful leads in the planned development of linseed cultivars having increased salt tolerance.

Keywords : Salinity stress**,** linseed, yield

Introduction

Linseed (*Linum usitatissimum* L.; n=15) has a place with family Linaceae represented by around 14 genera and more than 200 species, which are broadly spread in mild and subtropical territories of the world (Tadesse *et al*., 2010). Out of all the species *Linum usitatissimum* L. is the only cultivated species both for oil and fiber. Linseed is used in treatment of some inflammatory human and animal diseases and its oil is mainly utilized in the preparation of printing ink, paint and several innumerable by-products. Linseed is significant as its oils is having 51.9% to 55.2% α-linoleinic acids, which is helpful in cardiovascular illnesses and bringing down cholesterol. Because of the fantastic acceptability of linseed cake it is better quality enhancement for steers. It contains 3% oil and 36% protein and fills in as nutritious feed for dairy cattle. It is also a good source of phosphorus (370 mg/100g), manganese, calcium (170 mg/100g), potassium etc. There is reliable need to increment hereditary seed yield potential to expand the interest of linseed. Recombination of favorable genes is one of the ways to increase seed yield potential and related traits. In Egypt, flax is cultivated as a dual purpose (seeds for oil and stems for fiber). The cultivated area through the last 20 years was decreased from 60.000 to 30.000 feddan due to the great competition of other economic winter crops resulting in a gap between production and consumption. Therefore, it is necessary to increase flax productivity per unit area which could be achieved by using high yielding cultivars and improving the agricultural treatments (Hussein, 2007 and Ibrahim, 2009). One of these treatments is the use of mineral fertilizers which are important factors for vigorous growth and consequently higher yield of different plant species. However, repeated application of mineral fertilizers may lead to increase in the salinity of the soil.

Salinity adversely reduces the overall productivity of plants including crops by inducing numerous abnormal morphological, physiological and biochemical changes that cause delayed germination, high seedling mortality, poor crop stand, stunted growth and lower yields. Germination and seedling growth under saline environment are the screening criteria which are widely used to select the salt tolerant genotype (Ashraf & Tufail, 1995). Linseed being also used as a medicinal plants for treating various human ailments, so such medicinal plants are important source of medicines and livelihood. They are either collected from natural habitat or imported. Salted soils that cannot support crops might be used for medicinal plants as novel crops. The present study therefore tries to study the morphological and yield of different linseed (*Linum usitatissimum* L) genotype under salinity stress and tries to evaluate how it performance under field condition with respect to growth, uniform crop stand and its yield.

Materials and Method

The present study entitled "Estimation of heterosis and physiological variation in some economic Traits in elite Linseed (*Linum usitatissimum* L.) genotypes under salinity stress", was conducted in the Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Pryagraj. The climate of Prayagraj city is subtropical. The winter season is very cold (temperature reaching as low as 2.5^{o}C and in summer season temperature reaching up to 48^{o}C. The study was laid out in FRBD (4x9 Factorial), having three levels each of Nacl (100mM, 150mM and 200mM) and nine different genotypes viz., SHA1, SHA2, SHA3, SHA4, SHA5, SHA6, SHA7, SHA8 and SHA9, making a total of 36 treatment combinations with control, each replicated three times. Observations for all the traits was recorded on five randomly selected plants for each replication and for each plot. The observations were taken on different plant characters *viz.,* days to 50% flowering, plant height (cm), number of primary branches plant^{-1}, days to maturity, number of capsules plant^{-1}, number of seeds capsule^{-1}, test weight (g) and seed yield plant^{-1} (g) of linseed. The analysis of variance was worked out to test the significance of F tests. It was carried out according to the procedure of factorial randomized block design for each character as per methodology advocated (Fisher, 1936).

Results and Discussion

Effect of different levels of NaCl on growth and yield of Linseed

Observations regarding the response of different levels of NaCl on plant height (cm), number of primary branches plant^{-1}, days to maturity, number of capsules plant^{-1}, number of seeds capsule^{-1}, test weight (g) and seed yield plant^{-1} (g) of linseed as influenced by different levels of NaCl and different nine varieties and their interaction is presented in table 1. Growth and yield was found to be significant among the treatments. The maximum plant height (78.84cm), number of primary branches plant^{-1} (3.26), days to maturity (125.00), number of capsules plant^{-1} (68.07) number of seeds capsule^{-1} (7.44) test weight (7.88g) and seed yield plant^{-1} (4.97g) was recorded in control and minimum plant height (76.89cm), number of primary branches plant^{-1} (2.04), days to maturity (122.96), number of capsules plant^{-1} (64.30) number of seeds capsule^{-1} (4.59) test weight (5.43g) and seed yield plant^{-1} (4.68g) was found in 200mM of linseed. Whereas Salt stress reduces plant growth and productivity by affecting morphological, characteristics yield of crop and Disturbed water and nutritional balance of plants may cause reduced crop yield in saline soil (Rizwan *et al*., 2015). Reduced plant height and other morphological characters are the most distinct and obvious effects of salt stress. Depressed growth due to high salinity is attributed to several factors such as, water stress, specific ion toxicity and ion imbalance stress or induced nutritional deficiency (Ma *et al*., 2011).

Effect of NaCl on different genotype with respect to growth and yield of Linseed

The NaCl is found to influence the flowering which is directly related to the yield of the crop. Days to 50% flowering as influenced by different levels of NaCl on nine different genotype and their interaction is presented in table 1. The Days to 50% flowering was found to be significant among the treatments. The minimum days to 50% flowering (67.59) was recorded in 200mM and maximum 50% flowering (72.44) was found in Control. Whereas the minimum days to 50% flowering (62.42) was recorded in variety SHA5 and the maximum days to 50% flowering (79.00) was found in variety SHA3. The plant height (cm), number of primary branches plant^{-1}, days to maturity, number of capsules plant^{-1}, number of seeds capsule^{-1}, test weight (g) and seed yield plant^{-1} (g) of linseed as influenced by NaCl on the nine different varieties and their interaction is presented in table 1. Growth and yield was found to be significant among the treatments. The maximum plant height is recorded in SHA7 (94.63), number of primary branches plant^{-1} in SHA1 (4.00), days to maturity in SHA3 (133.58), number of capsules plant^{-1} in SHA7(75.42), number of seeds capsule^{-1} in SHA7 (7.83), test weight in SHA8 (8.42), seed yield plant^{-1} in SHA7 (7.49), minimum plant height in SHA1(52.43), number of primary branches plant^{-1} in SHA6 (1.67). The number of branching/tillering gradually decreased with increasing salt concentration and days to maturity in SHA1 (116.83), number of capsules plant^{-1} in SHA3 (56.33) number of seeds capsule^{-1} in SHA6 (4.75), test weight in SHA2 (4.55g) and seed yield plant^{-1} in SHA3 (3.05g) was found in these linseed genotype under salanity stress. Whereas the reduced plant height might be attributed to the direct effect of excess salt on plant tissues and poor intake of minerals. Reduced plant height and day to maturity under saline conditions has been observed in *Linum usitatissimum* (Singh & Singh, 1991; Kheir *et al*., 1991). Number of seeds capsule-1 did not vary significantly among different genotypes and their interaction. Non-significant variation in number of seeds capsule-1 may be attributed to same potential of genotypes for producing number of seeds capsule-1. The observed reduced degree of branching at higher salt concentration directly affects the productivity, and seed yield. Decreased branching due to salt stress in different o linseed genotype has been also been reported and our results are in consonant with them (Singh *et al*., 1988; Narash *et al*., 1993; Mensah *et al*., 2006; Sadat-Noori, 2006).

Table 1: Effect of NaCl and varieties on growth and yield of linseed *(Linum usitatissimum L.)*

Treatments	Parameters							
	Days to 50% flowering (Days)	**Plant height (cm)**	**Number of primary branches plant^{-1}**	**Days to maturity (Days)**	**Number of capsules plant^{-1}**	**Number of seeds capsule^{-1}**	**Test weight (g)**	**Seed yield plant^{-1} (g)**
Level of NaCl								
Control	72.44	78.84	3.26	125.00	68.07	7.44	7.88	4.97
100mM	71.30	78.29	2.85	124.04	65.04	6.33	6.98	4.76
150mM	69.63	77.75	2.44	123.67	65.33	5.26	6.20	4.72
200mM	67.59	76.89	2.04	122.96	64.30	4.59	5.43	4.68
F-test	S	S	S	S	S	S	S	S
C.D. at 0.5%	0.571	0.449	0.284	0.249	N/A	0.461	0.186	0.004
S.Ed. (±)	0.286	0.225	0.142	0.147	1.570	0.230	0.093	0.002
Varieties								
SHA1	69.08	52.43	4.00	116.83	66.58	6.25	6.14	3.27
SHA2	72.08	72.04	3.50	123.75	58.50	6.17	4.55	3.95
SHA3	79.00	80.90	2.75	133.58	56.33	5.67	5.16	3.05
SHA4	64.75	65.30	3.17	120.08	68.08	5.67	5.48	4.04
SHA5	62.42	70.00	2.17	120.67	72.00	4.83	7.03	5.09
SHA6	70.08	82.07	1.67	121.83	57.92	4.75	7.32	3.43

SHA7	71.83	94.63	2.00	126.92	75.42	7.83	8.10	7.49
SHA8	69.67	92.84	2.75	126.08	72.75	7.08	8.42	6.99
SHA9	73.25	91.29	1.83	125.50	63.58	4.92	7.41	5.75
F-test	S	S	S	S	S	S	S	S
C.D. at 0.5%	0.857	0.673	0.427	0.441	4.707	0.691	0.280	0.006
S.Ed. (±)	0.429	0.337	0.214	0.221	2.355	0.346	0.140	0.003

Interaction (NaCl x Varieties

S. No.	Treatment	Days to 50% flowering	Plant height (cm)	Number of primary branches plant^{-1}	Days to maturity	Number of capsules plant^{-1}	Number of seeds capsule^{-1}	Test weight (g)	Seed yield plant^{-1} (g)
T1	**SHA1+ (Untreated)**	70.33	53.12	4.67	118.33	67.67	7.67	7.08	3.33
T2	**SHA2+ (Untreated)**	73.00	72.89	4.33	124.33	64.67	7.67	5.60	4.04
T3	**SHA3+ (Untreated)**	80.00	81.42	3.33	134.00	57.67	7.00	6.47	3.10
T4	**SHA4+ (Untreated)**	66.33	66.53	3.67	120.67	70.00	7.00	6.74	4.10
T5	**SHA5+ (Untreated)**	65.33	70.92	2.67	121.67	74.67	6.33	8.39	5.17
T6	**SHA6+ (Untreated)**	71.33	83.06	2.33	122.67	59.67	6.67	8.39	3.50
T7	**SHA7+ (Untreated)**	72.67	95.57	2.67	128.00	78.33	10.00	9.55	7.54
T8	**SHA8+ (Untreated)**	70.67	93.76	3.00	128.33	74.33	8.00	9.85	7.03
T9	**SHA9+ (Untreated)**	74.00	92.32	2.67	127.00	65.67	6.67	8.84	6.94
T10	**SHA1 +100mM**	70.00	52.69	4.33	117.33	66.67	6.67	6.52	3.28
T11	**SHA2+100mM**	71.67	72.33	3.67	123.33	45.00	6.67	4.98	3.96
T12	**SHA3+100mM**	78.67	80.99	2.67	133.33	56.67	5.67	5.83	3.08
T13	**SHA4+100mM**	64.33	65.74	3.33	120.00	68.67	6.00	5.78	4.06
T14	**SHA5+100mM**	63.33	70.43	2.33	120.67	73.67	5.33	7.45	5.11
T15	**SHA6+100mM**	71.00	82.73	2.00	122.33	59.00	5.00	7.74	3.46
T16	**SHA7+100mM**	71.33	94.64	2.33	127.33	77.33	8.67	8.81	7.50
T17	**SHA8+100mM**	70.00	93.29	2.67	126.33	73.33	8.67	8.15	7.02
T18	**SHA9+100mM**	74.33	91.76	2.33	125.67	65.00	4.33	7.58	5.41
T19	**SHA1+150mM**	68.67	52.21	3.67	116.33	66.33	5.67	6.04	3.24
T20	**SHA2+150mM**	71.33	71.79	3.33	124.00	62.67	5.67	4.27	3.92
T21	**SHA3+150mM**	77.67	81.14	2.67	133.67	56.00	5.33	4.33	3.01
T22	**SHA4+150mM**	63.67	65.20	3.00	120.33	67.33	5.33	4.90	4.02
T23	**SHA5+150mM**	61.33	69.69	2.00	120.33	70.33	4.33	6.53	5.05
T24	**SHA6+150mM**	69.33	81.78	1.33	121.67	57.00	4.00	7.17	3.39
T25	**SHA7+150mM**	72.33	94.39	1.67	126.33	73.67	6.67	7.57	7.47
T26	**SHA8+150mM**	68.33	92.51	3.00	125.33	72.33	6.00	8.26	6.98
T27	**SHA9+150mM**	73.33	91.06	1.33	125.00	62.33	4.33	6.74	5.36
T28	**SHA1+200nM**	65.33	51.68	3.33	115.33	65.67	5.00	4.91	3.22
T29	**SHA2+200nM**	69.00	71.16	2.67	123.33	61.67	4.67	3.36	3.87
T30	**SHA3+200nM**	74.33	80.04	2.33	133.33	55.00	4.67	4.01	3.00
T31	**SHA4+200nM**	61.67	63.72	2.67	119.33	66.33	4.33	4.50	3.99
T32	**SHA5+200nM**	59.33	68.96	1.67	120.00	69.33	3.33	5.76	5.03
T33	**SHA6+200nM**	68.00	80.70	1.00	120.67	56.00	3.33	5.99	3.37
T34	**SHA7+200nM**	70.33	93.92	1.33	126.00	72.33	6.00	6.47	7.43
T35	**SHA8+200nM**	65.33	91.81	2.33	124.33	71.00	5.67	7.40	6.94
T36	**SHA9+200nM**	72.33	90.02	1.00	124.33	61.33	4.33	6.47	5.29
	F-test	S	S	S	S	S	S	S	S
	C.D. at 0.5%	N/A	N/A	0.859	0.882	N/A	N/A	0.559	0.012
	S.Ed. (±)	0.857	0.676	0.426	0.441	4.710	0.691	0.280	0.006

Conclusion

The current investigation is carried out to assess nine genotype of linseed for salt stress tolerance. The investigation showed a gradual increase in the amplitude of salt stress exert differential response in all the nine linseed genotypes. Findings of the present investigation suggest that SHA7 genotype showed a higher level of salt tolerance, and it might be attributed through the increased potential. Moreover, it could be hypothesized that SHA7 cultivar of linseed could be used to minimize the yield loss of linseed crop due to salt stress.

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