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Relative salt tolerance of Indian mustard (*Brassica juncea*) genotypes in relation to germination, growth and seed yield

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Abstract

Effect of salinity on germination percentage, dry matter per plant, number of siliqua per plant, 1000-seed weight and seed yield per plant of Indian mustard [*Brassica juncea* (L.) Czern & Coss] was studied (2008-09 & 2009-10). Five genotypes (Urvashi, Basanti, Varuna, Rohini and Ashirwad) were evaluated at five levels of salinity viz. normal, 3, 6, 9 and 12 dSm^{-1}. All the five mustard genotypes showed increasing trend with respect to all above mentioned crop parameters with 3 dSm^{-1} salinity over normal water, but further increase in irrigation water salinity above 3 dSm^{-1} reduced all parameters significantly with each increase in salinity upto 12 dSm^{-1}. Among genotypes, Urvashi showed best performance with respect to above mentioned characters at higher levels of 6, 9 and 12 dSm^{-1} salinity, while Ashirwad performed poorest. Thus, Urvashi genotypes proved to be more tolerant to salinity than other genotypes.

***Key words**: Indian mustard, genotypes, salinity, irrigation water, germination, seed yield*

Introduction

Indian mustard [*Brassica juncea* (L.) Czern & Coss] is an important *rabi* oilseed crop grown in across the Northern plains of India. The maximum area is centered in North-West agro-climatic zone, where majority of ground water is highly saline and has medium to high sodicity problems. Under such condition, seed germinability, growth and finally seed yield of mustard is adversely affected. Higher salinity levels reduce the seed germination and seedling growth. There was also reduction in root/shoot elongation and dry matter accumulation in Indian mustard (Mishra and Anju, 1996). Hence, there is need to enhance crop productivity under saline conditions. Selection of salt tolerant genotypes holds great promise in this respect. The information on salt tolerance of recently developed mustard genotypes is meager; therefore, present study was undertaken with five genotypes of mustard at different levels of irrigation water salinity and showed that variation in relation to germination, growth and yield.

Materials and Methods

An experiment was conducted in earthen pots of 25 cm (diameter) in the Department of Crop Physiology, C.S. Azad University of Agriculture and Technology, Kanpur during *rabi* 2008-09 and 2009-10. The five mustard genotypes viz. Urvashi, Basanti, Varuna, Rohini and Ashirwad were sown during first week of October in each year with five irrigation water salinity levels of ECiw in 3, 6, 9 and 12 dSm^{-1} and normal (0.4 dSm^{-1}). The soil used in experiment was sandy loam in texture having pH 7.8, ECe 0.33 dSm^{-1}, ESP 8.2 per cent, CEC 18.9 cmol $(p+)kg^{-1}$and organic carbon 0.52 per cent. Irrigation water of different salinity levels was prepared in laboratory by adding required quantity of NaCl and $CaCl_2$ (4:1). Tap water was used for water treatment. The treatments were replicated four times and five plants in each pot were grown. A uniform dose of 120 kg N, 60 kg P and 60 kg K/ha was applied through urea, DAP and MOP, respectively to each pot. Light and frequent irrigations were given to keep the salt distribution

ever in pots. The experiment carried out in Completely Randomized Design. The observations on seed germination, dry matter per plant, number of siliqua per plant, test weight and seed yield per plant were recorded during both years.

Results and Discussion

Germination of seed

The increase in salinity levels beyond 3dSm^{-1} significantly decreased seed germination in all the genotypes (Table 1). It might be due to higher osmotic pressure build up at higher salt concentration resulting into restricted flow of water and ultimately limited seed germination. Higher salinity levels aggravates delay in emergence of emergence and finally reduced germination per cent (Ayers and Hayward, 1948). Das *et al.* (2004) also reported similar results in mustard.

Among genotypes, Urvashi recorded significantly higher germination per cent than rest of the genotypes except Varuna, which was at par with it. The genotypes other than Urvashi were found at same bar of significance. Such differences in genotypes seem to be due to their genetic makeup against salinity condition. Those results corroborate to the findings of Das *et al.* (2004).

Dry matter per plant

The data on dry matter/plant recorded at 70 days after sowing (Table 2) revealed significant decrease in dry weight with enhancing levels of salinity beyond 3 dSm^{-1} level. The rate of reduction in dry matter at 6, 9 and 12 dSm^{-1} levels of salinity as compared with 3 dSm^{-1} level were found to be 7.6, 15.6 and 22.7% in first year and, 12.0, 17.7 and 24.7% in second year. The reduced plant growth restricts

Table 1: Effect of saline irrigation water on germination (%) of Indian mustard genotypes

Treatments / Varieties	Salinity levels dSm^{-1}					
	Normal	3 EC_{iw}	6 EC_{iw}	9 EC_{iw}	12 EC_{iw}	Mean
	Rabi-2008-09					
Urvashi	86.0	87.0	84.3	82.8	80.5	84.1
Basanti	83.8	84.8	82.5	80.8	79.3	82.2
Varuna	85.8	86.3	83.0	81.5	80.0	83.3
Rohini	84.3	85.5	82.8	81.0	79.8	82.9
Ashirwad	84.5	85.5	82.0	81.3	79.8	82.9
Mean	84.9	85.8	83.3	81.7	79.9	83.1
		V	S		V x S	
S.E.(d) ±		0.57	0.57		1.28	
C. D. at 5%		1.14	1.14		N.S.	
	Rabi-2009-10					
Urvashi	86.3	86.7	85.8	82.5	81.0	84.4
Basanti	83.3	85.0	82.3	80.0	79.5	82.1
Varuna	85.0	85.3	83.5	81.3	80.0	83.0
Rohini	84.5	85.0	82.0	81.0	79.0	82.8
Ashirwad	84.0	85.3	82.5	80.5	78.3	82.1
Mean	84.7	85.7	83.3	81.2	79.5	82.9
		V	S		V x S	
S.E.(d) ±		0.51	0.51		1.14	
C. D. at 5%		1.02	1.02		N.S.	

Table 2: Effect of saline irrigation water on dry matter per plant (g) of Indian mustard genotypes at 70 DAS

Treatments / Varieties	Salinity levels dSm^{-1}					
	Normal	3 EC_{iw}	6 EC_{iw}	9 EC_{iw}	12 EC_{iw}	Mean
			Rabi-2008-09			
Urvashi	4.87	5.03	4.67	4.02	3.80	4.46
Basanti	4.65	4.67	4.50	4.07	3.67	4.31
Varuna	4.75	4.82	4.37	3.85	3.55	4.25
Rohini	4.75	4.77	4.22	4.12	3.67	4.31
Ashirwad	3.72	3.85	3.62	3.50	3.30	3.65
Mean	4.58	4.63	4.28	3.91	3.58	4.20
		V	S		VxS	
S.E.(d) ±		0.08	0.08		0.18	
C. D. at 5%		0.16	0.16		N.S.	
			Rabi-2009-10			
Urvashi	4.95	5.10	4.43	4.10	3.72	4.46
Basanti	4.73	4.80	4.32	3.97	3.65	4.29
Varuna	4.83	4.80	4.35	3.78	3.52	4.29
Rohini	4.76	4.78	4.21	4.01	3.55	4.26
Ashirwad	4.08	4.20	3.56	3.43	3.26	3.70
Mean	4.65	4.74	4.17	3.90	3.57	4.21
		V	S		VxS	
S.E.(d) ±		0.05	0.05		0.12	
C. D. at 5%		0.11	0.11		N.S.	

assimilate production because of shrinkage in photosynthetic surface available per plant. Thus, dry weight/plant was adversely affected by increasing levels of salinity in irrigation water. Ramesh *et al.* (2004), Kuhad *et al.* (2005) and Hayat *et al.* (2007) also observed similar effect of salinity on *B. juncea*.

In case of genotypes, Urvashi produced significantly highest dry matter per plant, while lowest was produced in Ashirwad. Other three genotypes remained at par with each other. Genotypic growth potential of different varieties might have caused the variation in dry matter accumulation. Das *et al.* (2004) also observed such variations among mustard genotypes.

Number of siliquae per plant

Number of siliquae (Table 3) reduced significantly with each increase in salinity level beyond 3 dSm^{-1} with the margins of 5.8, 11.2 and 22.0% during 2008-09 and; 6.9, 12.5 and 22.8% during the year 2009-10 at salinity levels of 6, 9 and 12 dSm^{-1}, respectively. Such reduction might be associated with increased salts concentrations in soil solution which restricted the absorption of water and nutrients thereby reduction in photosynthetic surface and rate of photosynthesis. Hence, sufficient photosynthate could not form and translocate towards reproductive organs and decreased the number of siliquae/plant. Among genotypes, Urvashi produced maximum and Ashirwad produced significantly

Table 3: Effect of saline irrigation water on number of siliqua per plant of Indian mustard genotypes at harvest stage

Treatments / Varieties	Salinity levels dSm^{-1}					
	Normal	3 EC_{iw}	6 EC_{iw}	9 EC_{iw}	12 EC_{iw}	Mean
	Rabi-2008-09					
Urvashi	179.8	182.5	175.0	171.0	152.8	172.2
Basanti	178.8	181.3	172.2	162.3	141.5	167.2
Varuna	176.3	180.3	172.8	162.0	138.5	166.0
Rohini	178.8	180.5	169.3	157.0	139.0	164.9
Ashirwad	108.0	109.0	96.0	88.0	79.3	96.1
Mean	164.4	166.7	157.0	148.1	130.1	153.3
		V	S		V x S	
S.E.(d) ±		2.65	2.65		5.94	
C. D. at 5%		5.29	5.29		N.S.	
	Rabi-2009-10					
Urvashi	181.3	181.5	175.8	164.3	150.0	170.6
Basanti	176.3	181.0	171.3	161.5	139.0	165.8
Varuna	173.8	179.0	170.8	159.5	137.8	164.2
Rohini	172.5	176.0	160.5	155.5	137.3	160.3
Ashirwad	110.0	113.5	96.3	86.0	77.8	96.7
Mean	162.8	166.2	154.8	145.4	128.4	151.5
		V	S		V x S	
S.E.(d) ±		2.56	2.56		5.73	
C. D. at 5%		5.11	5.11		N.S.	

minimum number of siliquae per plant, while remaining genotypes remained at par with each other. It might be due varying siliquea bearing capability of different genotypes. These results corroborate to the findings of Thakral *et al.* (1996), Javed *et al.* (2002). The salinity level of 3 dSm^{-1} showed numerical increase in number of siliquae over normal salinity in all genotypes.

1000-seed weight

1000-seed weight showed significant reduction with increase in salinity beyond 3 dSm^{-1} level upto the level of 12 dSm^{-1} (Table 4) in all genotypes of mustard. It might be attributed to disturbed absorption of moisture and nutrients, limited formation of photosynthates and their lesser translocation towards seeds. resulting reduction in 1000-seed weight. Among genotypes, Urvashi maintained significantly highest 1000-seed weight followed by Varuna. Genotypes Rohini and Basanti being at par registered lowest test weight. The boldness of seed is a varietal character governed by genetic makeup of a genotype. These results confirm the findings of Tahkral *et al.* (1996).

1000-seed weight was influenced significantly by interaction effect of salinity **x** genotypes during 2009-10 (Table 4). The rate of reduction in test weight due to increasing levels of salinity was lowest in Urvashi and highest in Ashirwad. It might

Table 4: Effect of saline irrigation water on test weight (g) of mustard genotypes

Treatments / Varieties	Salinity levels dSm^{-1}					
	Normal	3 EC_{iw}	6 EC_{iw}	9 EC_{iw}	12 EC_{iw}	Mean
			Rabi-2008-09			
Urvashi	4.8	4.9	4.6	4.4	4.1	4.6
Basanti	4.1	4.0	3.9	3.7	3.2	3.8
Varuna	4.8	4.9	4.5	4.1	3.8	4.4
Rohini	3.9	3.9	3.7	3.5	3.3	3.7
Ashirwad	4.1	4.2	4.1	3.8	3.5	3.9
Mean	4.3	4.4	4.2	3.9	3.6	4.1
		V	S		V x S	
S.E.(d) ±		0.06	0.06		0.13	
C. D. at 5%		0.12	0.12		N.S.	
			Rabi-2009-10			
Urvashi	4.8	4.9	4.6	4.2	4.0	4.5
Basanti	4.0	4.1	3.8	3.6	3.1	3.7
Varuna	4.8	4.9	4.5	4.1	3.6	4.4
Rohini	3.9	3.9	3.7	3.3	3.2	3.6
Ashirwad	4.2	4.2	4.0	3.7	3.4	3.9
Mean	4.3	4.4	4.1	3.8	3.5	4.0
		V	S		V x S	
S.E.(d) ±		0.04	0.04		0.09	
C. D. at 5%		0.08	0.08		0.18	

be due to salt tolerance capacity of Urvashi and susceptibility of Ashirwad at higher salinity levels. Dhawan (1985) also reported similar results.

Seed yield

The seed yield per plant increased significantly with 3 dSm^{-1} salinity over normal treatment (Table 5). But beyond 3 dSm^{-1} level of salinity, seed yield reduced progressively at 6, 9 and 12 dSm^{-1} levels by the margins of 12.9, 21.3 and 28.3% during 2008-09 and; 11.4, 21.9 and 27.8% during 2009-10, respectively over 3 dSm^{-1} salinity. Such yield reductions might be attributed to poor yield attributes viz., siliquae/plant and 1000-seed weight which also behaved in a similar way at increasing salinity levels. It may be ascribed due to reduction in dry weight/plant, poor photosynthetic rate, lesser accumulation of assimilates and their translocation from source to sink. These results are in accordance to those of Thakral *et al.* (1996), Sharma and Gill (1995).

Among genotypes, Urvashi yielded significantly highest followed by Varuna and Basanti. Ashirwad produced significantly lowest yield. The variation in yield is attributed to number of siliqua per plant and upto some extent by 1000-seed weight. The interaction affect of salinity x genotypes was not found significant on seed yield.

Table 5: Effect of saline irrigation water on seed yield per plant (g) of mustard genotypes

Treatments / Varieties	Salinity levels dSm^{-1}					
	Normal	3 EC_{iw}	6 EC_{iw}	9 EC_{iw}	12 EC_{iw}	Mean
			Rabi-2008-09			
Urvashi	6.3	6.7	6.1	5.6	5.2	6.1
Basanti	6.1	6.3	5.5	5.1	4.4	5.4
Varuna	6.1	6.6	5.6	5.1	4.4	5.5
Rohini	5.6	5.7	4.8	4.4	4.2	4.9
Ashirwad	5.0	5.3	4.6	4.2	3.9	4.36
Mean	5.8	6.1	5.3	4.8	4.4	5.3
		V	S		V x S	
S.E.(d) ±		0.12	0.12		0.27	
C. D. at 5%		0.24	0.24		N.S.	
			Rabi-2009-10			
Urvashi	6.2	6.7	6.1	5.5	5.0	6.1
Basanti	6.1	6.3	5.8	4.8	4.4	5.5
Varuna	6.2	6.4	5.6	4.9	4.4	5.5
Rohini	5.5	5.7	4.8	4.4	4.2	4.9
Ashirwad	5.0	5.3	4.6	4.1	3.9	4.6
Mean	5.9	6.1	5.4	4.7	4.4	5.3
		V	S		V x S	
S.E.(d) ±		0.08	0.08		0.18	
C. D. at 5%		0.16	0.16		N.S.	

References

Damodaram, T. and Hegde, D.M. 2010. Oil seeds situation: A statistical compendum publishers. Directorate of Oil Seeds Research Hyderabad pp. 36-60.

Das, G.G., Ouddus, M.A. and Kabir, M.E. 2004. Hetosis in inter specific *Brassica* hybrids grown under saline condition. *J Biol Sci* **4** (5): 664-667.

Dhawan, R.S. 1985. Response of some *Brassica* varieties to salt stress. Proceedings: *National Seminar on Plant physiology* held in the Department of Genetics, Haryana Agricultural University, Hisar, pp. **56**.

Hayat, S., Ali, B., Aiman H.S., Hayat Q. and Ahmad, A. 2007. Effect of 28-Homobrassinolide on salinity induced changes in growth, ethylene and seed yield of mustard. *Indian J. Pl. Physio.* **12** (2): 207-211.

Javed Akhter, Tanveer-ul-Huq and Khalid, M. 2002. Effect of salinity on yield, growth, oil content of four *Brassica* spp. *Pakistan J Agri Sci,* **39** (2): 76-79.

Kuhad, M.S.; Goyal, V. and Kumar, R. 2005. Influence of fertility-salinity interactions on growth, water status and yield of Indian mustard (*B. juncea). Indian J Pl Physiol.* **10** (2): 139-144.

Mishra, S.N. and Anju C. 1996. Nitrate and ammonium effect on Indian mustard seedling grown under salinity stress. *Indian J Pl Physiol.*, **1** (2): 93-97.

Ramesh, V., Razai, A. and Saaidi, G. 2004. Study of salinity tolerance in rapeseed. *Soil Science and Plant Analysis* **35** (19-20): 2849-2866.

Sharma, P.C. and Gill, K.S. 1995. Performance and ionic accumulation in *B. juncea and B. carinata* genotypes under salinity. *Plant Physiol Biochem.* **22** (2): 154-158.

Thakral, N.K. Hari, Singh, Chhabra, M.L. and Singh, H. 1996. Effect of salinity on seed yield, its component characters and oil content in Ethiopian Mustard. *Crop Improvement* **23** (1): 131-134.