

Salt Tolerance in Indian Mustard (*Brassica juncea* (L.) Czern and Coss)

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Abstract: Relative salt tolerance potential of ten Indian mustard (*Brassica juncea* (L.) Czern and Coss) genotypes assessed at salinity levels of 2.1 (control), 6.8 and 10.5 dS m⁻¹ revealed that seed yield with 61.3% reduction at the highest salinity over control was severely affected. However, 1000-seed weight with 22.6% reduction at the same salinity level was the most resistant trait under such conditions. Amongst the genotypes, SAL-3 with minimum reduction in seed yield at the highest salinity over control (54%) and the highest mean susceptibility index (MSI) value (7.0) was the most tolerant. On the contrary, CSTR-338-1 with maximum seed yield reduction (74%) at the highest salinity over control and least MSI (5.2) value was the most sensitive. Tolerant genotypes were typically characterized by several fold wider K/Na ratio at the salinity level of 10.5 dS m⁻¹ over its preceding EC level of 6.8 dS m⁻¹. Our results revealed that salt tolerant genotypes could be conveniently screened by a proportion of wider K/Na ratio at the threshold salinity over its preceding salinity level.

Key words: Indian mustard, salt tolerance, K/Na ratio.

Soil salinity is a problem associated with the irrigated agriculture in many parts of semi-arid and arid regions of the world. In arid regions, due to high evapotranspiration and low precipitation, the salinity is causing serious concern for successful crop harvest. Thus, arid saline lands require more attention compared to other regions as far as management of saline soils is concerned (Tanji, 1990). Amongst the management options, identification of salt tolerant genotypes is the most convenient approach. In spite of great progress in screening Indian mustard genotypes for their tolerance to salinity, till date we have quite limited genotypes which can resist diversified and complex saline situations. Cultivation of mustard crop on large area with poor quality underground water warrants the screening of genotypes which excel in yield and other economic traits over the existing ones (Kumar, 1984).

In view of this, present investigation with ten promising genotypes of Indian mustard was undertaken to identify a promising salt-tolerant genotype.

Materials and Methods

A field experiment on salt tolerance of ten promising Indian mustard genotypes (BIO-902, CS-52, CSTR-338-1, CZM-2, Kranti, NDR-8604, NDR-9501, RH-30, SAL-2 and SAL-3) was conducted adopting split plot design with three replications. The salinity levels (2.1 (control), 6.8 and 10.5 dS m⁻¹) were adjusted in main plots. Genotypes in 4 m long paired rows were in sub-plots. Fixed number of seeds were sown and after 20 days of planting 28 to 30 plants were maintained in each sub-plot. Recommended agronomic practices were adopted. The main plots were separated by stone slabs inserted upto 90 cm depth to

avoid lateral movement of salts. This is a standard practice and we have been using it (Kumar and Tarafdar, 1989). Irrigations were given after 25, 45, 75, and 100 days of planting. Thus, in all five irrigations (including pre-sowing) were applied with the natural saline water of EC 6.5 dS m⁻¹. The experiments on this site were in progress for almost a decade. Hence, micro-plots had salt build up in subsurface of the soil (0-30 cm). Soil samples from 2 to 3 sites in each of the nine micro-plots were drawn at 0 to 15 and 15 to 30 cm depths at pre-sowing and at harvest time of the crop. Results are discussed with reference to average salinity (dS m⁻¹) at sowing and at harvest of the crop.

The data on plant height, main shoot length, number of pods on main shoot and number of pods/plant were recorded on 5 random plants in each of the treatments, whereas 1000-seed weight was recorded on whole plot basis. Seed yield was recorded on paired row basis. Tolerance of genotypes was assessed in respect of mean absolute yield, magnitude of yield reduction and MSI values (Giriraj *et al.*, 1976). Mean susceptibility index (MSI) was calculated using the following formula:

$$\text{MSI} = \frac{\sqrt{\text{Mean seed yield across salinity levels}}}{\text{Yield of control}} \times 100$$

The accumulation of Na and K ions was assessed by the method of Richards (1954) in leaf tissues at 70 days after sowing (which is active growth stage).

Results and Discussion

Mean seed yield and its components in general exhibited varied response to rise in salinity levels. For instance, seed yield that was reduced to 61.3% at the highest salinity level of 10.5 dS m⁻¹ over control was the most severely affected trait under arid saline situation (Table 1). On the contrary, reduction in other traits ranged from 22.6% (1000-seed weight) to 36.8% (number of pods/plant) at the same level of salinity. As far as the yield components are concerned, 1000-seed weight was the most resistant to salt stress. However, the main shoot length and the number of pods/plant, that registered 35% reduction, seemed to be responsible for yield reduction in Indian mustard. The reduction in plant height and number of pods on main shoot was moderate. The seed weight showed resistance to a greater extent, but the same was neutralized by considerable reduction

Table 1. Effect of salinity on seed yield and its components in Indian mustard genotypes

Salinity levels (dS m ⁻¹)	Plant height (cm)	Main shoot length (cm)	Number of pods on main shoot	Number of pods plant ⁻¹	1000-seed weight (g)	Seed yield (g plot ⁻¹)
2.1	171.0	64.3	45.8	213.8	4.2	441.3
6.8	145.2	50.6	38.7	185.7	3.0	310.5
10.5	118.3	41.6	31.2	135.1	3.2	170.5
Reduction at 10.5 dS m ⁻¹ over control	30.8	35.3	31.7	36.8	22.6	61.3
CD 5%	36.3	7.5	7.5	65.8	0.51	60.1

Table 2. Relative salt tolerance potential of Indian mustard genotypes

Genotype	Seed yield* (g plot ⁻¹)	Yield reduction at 10.5 dS m ⁻¹ over control	Mean susceptibility index	Rating
SAL-3	347.2	54.0	7.3	T
SAL-2	330.5	54.6	7.2	T
CS-52	348.3	55.0	7.0	T
RH-30	272.7	57.1	5.9	MT
CZM-2	196.1	55.7	6.0	MT
NDR-8604	283.3	58.5	5.6	MT
KRANTI	294.4	62.4	5.6	MT
BIO-902	261.1	67.6	5.3	S
NDR-9501	315.1	65.1	5.3	S
CSTR-338-1	325.0	74.0	5.2	S

* Seed yield across salinity levels, T: Tolerant, MT: Moderately tolerant; and S: Sensitive.

in number of pods per plant and the main shoot. These results are in conformity with those of Kumar (1984) and Uma *et al.* (1992) in Indian mustard.

Relative salt tolerance potential of the genotypes was assessed *vis-à-vis* absolute seed yield, and magnitude of per cent yield reduction (MSI). The mean seed yield in tolerant genotypes (SAL-3, SAL-2 and CS-52) was 340 g plant⁻¹. These genotypes showed 54% reduction in seed yield at salinity level of 10.5 dS m⁻¹ over control and showed appreciably high MSI (7.2). On the contrary, genotypes of susceptible group (BIO-902, NDR-9501 and CSR-33-1) showed comparatively lower absolute seed yield (300 g plot⁻¹). Reduction in seed yield at the aforesaid salinity level was considerable (70%) and the MSI values were low (5.2). Thus, the genotypes included in this study could be classified in discrete tolerant and susceptible groups. Three genotypes, RH-30, CZM-2 and NDR-8604, were considered to be moderately tolerant to the salinity. However, genotypes SAL-3 and CSTR-338-1

were the most tolerant and susceptible, respectively (Table 2).

Salt tolerance in crop plants, including Indian mustard, is a phenomenon of salt selectivity or salt avoidance (Kumar, 1984, Ashraf and McNeilly, 1990; Ashraf and Naqvi, 1992; Maas, 1996). Thus, to understand genotypic differences in salt tolerance, the Na and K concentration in whole plant was studied 70 days after planting the crops. Na concentration sharply increased in sensitive than in tolerant genotypes over the control values (Table 3). The response of K was, however, not so clear in two groups of genotypes and both had comparable concentration at the highest salinity level (10.5 dS m⁻¹).

It is worth mentioning that magnitude of reduction in K:Na ratio at salinity level of 10.5 dS m⁻¹ over its preceding level of 6.8 dS m⁻¹ was only 3.55% in the tolerant genotypes, whereas in sensitive genotypes this rate was much higher (41.7%). Thus, salt tolerance in Indian mustard appears to be determined principally by the lesser

Table 3. Relationship between seed yield and accumulation of K and Na cations on Indian mustard genotypes at 70 days of sowing

Groups of genotypes	Salinity levels (dS m ⁻¹)	Seed yield (g)	Reduction of seed yield over control (%)	K (%)	Na (%)	K:Na ratio
Tolerant						
SAL-3	2.1*	445.5	-14.8	0.92	0.24	3.31
SAL-2	6.8	379.4	-54.8	0.61	0.54	1.12
CS-52	10.5	201.1		0.60	0.65	0.92
Mean		342.0		0.71	0.47	1.78
Sensitive						
CSTR-338-1	2.1*	464.9	-30.2	0.80	0.18	4.44
BIO-902	6.8	324.4	-67.8	0.78	0.52	1.34
and Kranti	10.5	149.4		0.63	0.80	0.78
Mean		312.9		0.73		2.18

* = control.

accumulation of Na, thereby giving wider K:Na ratio only at the salinity level of 10.5 dS m⁻¹ over its preceding level of 6.8 dS m⁻¹ in both the groups of genotypes. To be precise, the ratio was manifold wider in tolerant genotypes. Similar results were also reported by many workers in Indian mustard (Kumar, 1984; Sharma and Gill, 1995; Porcell *et al.*, 1995) and this phenomenon is operating in other field crops also.

Present study reveals that the salt tolerance in Indian mustard genotypes can be conveniently and readily assessed by difference in K:Na values at the threshold salinity value >8 dS m⁻¹, which is known to be the tolerance limit of this crop on light textured arid soils.

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