

TOLERANCE OF CASTOR TO SOIL SALINITY

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ABSTRACT

Screening of 16 strains of castor (*Ricinus communis* L.) for salt tolerance in micro-plots, filled with naturally salinized soils of different salinity levels, revealed significant adverse effects of increasing salinity on seedling emergence, plant height, cluster length, stem girth, 100-seed weight and seed yield. Emergence and seed yield were the most seriously affected traits, exhibiting a reduction of 85.0 and 90.0% at the salinity of 16.0 and 12.5 dS/m at crop sowing and at maturity, respectively, over the control. Strains VI 9 and 1379 and the hybrid GCH 4 had lesser extent of decrease in yield, and had higher values of Mean Susceptibility Index (MSI). These strains were, therefore, better tolerant than the rest. Tolerant strains were, in general, marked with more contents of Na and Cl in leaf tissue and had lesser reduction of nitrate reductase at ECe 16.0 dS/m corresponding ECe 12.0 dS/m at maturity of the crop.

INTRODUCTION

Salinity is becoming a problem in realizing a satisfactory yield of crops in arid environment. It affects almost all the growth and developmental traits resulting in reduction of yield to a varied extent. Emergence of seedlings is the first seriously affected attribute influencing yield through poor and patchy plant stand (Norlyn and Epstein, 1984).

Castor is an important non-edible oilseed, grown in semi-arid and arid tracts on soils having poor water retention capacity. Its yield potential being very low on salt affected soils (Rana and Singh, 1981; Kumar and Daulay, 1988), an attempt has been made to screen 16 strains for their relative salt tolerance potential on naturally salinized soils.

MATERIAL AND METHODS

Sixteen diverse genotypes (11 varieties and 5 hybrids) of castor were screened for salt tolerance in rainfed conditions during kharif 1988 on a loamy sand soils. A split-plot design with 3 replications was used. Levels of soil salinity (EC 12.5 and 16.0 dS/m) along with control (ECe 2.4 dS/m) in 0-15 cm depth formed the main plots whereas, 3-m long single rows in each main plots formed the sub-plots as reported earlier (Kumar and Tarafdar, 1989). Fifty seeds were sown for each strain

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on July 1, 1988, following a rainfall of 30 mm. No irrigation was applied thereafter. The crop, however, received 260.4 mm total rainfall during cropping period. The crop received usual agronomical operations. After 20 days of sowing, emergence of seedlings was assessed and the equal number of plants were maintained for each strain. Data on plant height (cm), cluster length (cm) stem girth (cm), leaf area (cm²) and 100-seed weight (g) were recorded on 5 random plants from each treatment. Seed yield was assessed on per line basis. Nitrogen (Linder, 1944), nitrate (Cataldo et al., 1975), Na and Cl (Richards, 1954) and nitrate reductase (NR) activity (Jaworski, 1971) were estimated from the fresh leaf tissue of competitive plant of each strain after 50 days of sowing.

Relative salt tolerance of the strains was assessed in terms of the per cent yield reduction at ECe 12.0 dS/m (at harvest) over control and the Mean Susceptibility Index (MSI) values were computed as under :

$$\text{Mean Susceptibility Index (MSI)} = \frac{\sqrt{\frac{\text{Mean seed yield across salinity levels} \times \text{Mean salinity index}}{\text{Control yield}}}}$$

RESULTS AND DISCUSSION

Means for the traits, except for leaf area, decreased significantly with increase in soil salinity registering 90.5, 85.0, 56.6, 52.0, 49.8, 18.0 and 7.0% reduction for seed yield, seedling emergence, cluster length, 100-seed weight, plant height, stem girth and leaf area, respectively, at the soil salinity treatment of ECe 16.0 dS/m, corresponding to ECe 12.0 dS/m at the crop harvest over control (Table 1). These results were in conformity with those of Kumar and Malik (1983) and Kumar (1984) that seed yield was more seriously affected than its components and the growth.

Decrease in yield appeared to be mainly on account of the decrease in cluster length and 100-seed weight (Table 1). Low germination at the salinity levels of

Table 1. Effect of soil salinity on growth and yield of castor

Salinity of the soil extract (dS/m)		Seedling emergence (%)	Plant height (cm)	Cluster length (cm)	Leaf area (cm ²)	Stem girth (cm)	100-seed weight (g)	Seed yield/plot (g)
At sowing	At harvest							
2.4 (control)	2.0	67.4	90.4	15.9	504.6	5.4	11.0	56.7
12.5	7.8	36.9	66.6	10.6	498.8	5.1	9.7	12.5
	Reduction (%)	45.0	26.0	33.0	10.0	5.0	11.0	77.0
16.0	12.0	10.1	45.3	6.9	468.9	4.4	5.3	5.3
	Reduction (%)	85.0	49.0	56.0	7.0	18.0	52.0	90.0
SEm ±		1.64	1.80	0.31	2.01	0.10	0.12	0.72
CD 5%		4.54	4.98	0.86	NS	0.29	0.34	1.99
CD 1%		7.52	8.28	1.43	NS	0.48	0.57	3.31

ECe 12.5 and 16.0 dS/m at crop sowing (37 and 10%, respectively) also may be responsible for yield decrement to a considerable extent. Castor, thus, appeared to be sensitive to salinity for emergence, cluster length and seed weight.

Interaction between the levels of salinity and the varieties was significant for seed yield only, which indicated that it was only JI-35 that resisted salinity to the extent that yield was not reduced at ECe 12.5 dS/m corresponding to ECe 7.8 dS/m at the crop harvest (Table 2). The strain 1379, followed by VI 9, yielded maximum (49.7 and 45.1 g, respectively) across the salinity levels and also at the highest salinity level of ECe 16 dS/m (16.7 and 14.7 g), exhibited least reduction at this salinity over control (63.2 and 84.4%, respectively) and also gave appreciably high values on MSI (3.3 and 3.1, respectively). These varieties, having exhibited contrast and discrete yield responses than rest of the strains are, therefore, rated better tolerant under the existing conditions.

Recently developed hybrid GCH 4, although yielded poor (12.4 g) at the salinity treatment of ECe 16.0 dS/m than the varieties 1379 and VI 9, yet owing to its lower magnitude of decrement at this salinity over control and higher values on MSI (3.1), is also rated tolerant and ranked 3rd (after 1379 and VI 9) in relative tolerance potential. On the other hand the strains, viz., Maru 1, JM 6 and hybrid SH 41 with 100% yield reduction at the highest salinity level and lowest values on MSI (0.8 to 0.9) are rated susceptible. Remaining 11 strains reflected almost the intermediate yield response towards the existing salinity levels. The strain VI 9 had the maximum emergence (28.3 %) at the ECe level of 16.0 dS/m and was followed by SPS-43-3 (21.7 %). Tolerant hybrid GCH 4 however had very low emergence (4%) at the highest salinity level, its yield potential could be enhanced by higher seed rate. Better tolerance of this hybrid appeared to be associated with its bold seedness having 100-seed weight of 10.0 and 9.3 g ECe of 7.8 and 12.0 dS/m at the crop harvest, respectively. Tolerance potential in respect of 1379 appeared to be imparted by the cluster length of 13.8 cm that was maximum at the highest salinity level.

Bio-chemical studies

Activity of leaf nitrate reductase (NR) was inhibited at the salinity level of ECe 16.0 dS/m (Table 3). The reduction in enzyme activity has also been reported by Garg et al. (1986), and Wasnik et al. (1988) in different crop plants. The NR is the key enzyme of nitrogen metabolism and plays vital role in crop production. Lower magnitude of inhibition in tolerant strains under saline condition suggests greater metabolic activities. Differential response of varieties to NR activities has been observed in wheat showing higher activity in 'Kalyan sona' under salt/water stress (Nair and Abrol, 1982). Susceptible strains, on the contrary, appear to undergo greater metabolic impediment which is evident from the considerable reduction in NR activity under salt stress conditions over control. Furthermore,

Table 2. Effect of soil salinity on seed yield of castor cultivars

Treatment ECe (dS/m)	CULTIVARS																	
	At sowing	VI 9	JI 77	Tarai	SA 1	1397	GCH 4	SHB 62	SH 41	SPS 43-3	JM 6	SH 63	SA 2	SH 74	JI 35	Maru-1	Aruna	
2.4	2.0	94.4	64.0	69.6	50.8	45.4	106.6	101.8	30.6	48.1	13.0	73.8	86.6	46.8	20.1	9.0	46.9	
12.5	7.8	26.2	17.7	9.4	3.9	19.6	30.3	10.0	4.6	13.0	3.8	14.1	18.6	2.7	15.6	3.4	6.9	
16.0	12.0	14.7	4.3	1.9	1.5	16.7	12.4	3.4	0.0	5.4	0.0	7.4	6.7	1.3	4.7	0.0	3.4	
Mean yield across salinity levels																		
		45.1	28.6	26.9	18.7	27.2	49.7	38.4	11.7	22.1	5.6	31.7	37.1	16.9	13.4	4.1	19.6	
% Decrease at ECe 16 over control																		
		84.4	93.2	97.2	97.0	63.2	88.3	96.6	100.0	88.7	100.0	89.2	92.2	97.2	76.6	100.0	92.7	
Mean susceptibility index																		
		3.1	2.2	2.8	0.9	3.3	3.1	1.5	0.9	2.0	0.9	2.1	2.3	0.8	2.6	0.8	1.4	

SEm ± 2.52; CD 5% 4.98; CD 1% 6.47

Table 3. Biochemical response of tolerant and susceptible cultivars of castor in saline soils (ECe 16 dS/m)

Strains	N (%)		NO ₃ (mg ⁻¹ g cm)		NA (%)		Cl (%)		NRA (mg NO ₃ g ⁻¹ dw h ⁻¹)	
	Control	Saline	Control	Saline	Control	Saline	Control	Saline	Control	Saline
VI 9	3.97	5.09	1.74	1.65	0.62	2.01	0.38	1.03	110.7	102.1
1379	4.30	4.59	1.99	1.70	0.91	1.95	0.44	0.95	114.6	107.2
Mean	4.13	4.84	1.86	1.67	0.76	1.98	0.41	0.99	112.64	108.15
JI 35	3.93	4.87	1.90	1.48	0.85	1.14	0.45	0.90	120.4	88.3
SH 63	4.27	4.87	1.77	1.50	0.95	2.16	0.55	1.10	115.0	86.9
Mean	4.10	4.87	1.83	1.49	0.90	1.65	0.50	1.00	117.7	87.6
SH 74	4.34	5.01	1.41	1.34	0.51	1.83	0.37	1.00	102.5	84.1
SH 63	4.15	5.03	1.86	1.40	0.75	1.27	0.32	0.62	121.7	71.5
JM 6	4.50	4.57	1.90	1.50	0.48	1.24	0.25	0.68	110.9	79.0
Maru 1	4.11	5.01	1.98	1.58	0.81	1.70	0.38	0.98	128.0	90.0
Mean	4.27	4.90	1.78	1.45	0.63	1.51	0.33	0.82	115.77	81.15

comparatively higher contents of NO_3 in sensitive genotypes under saline conditions over control confirm more inhibition of metabolic activities in these strains.

A perusal of data in table 3 indicates varietal tendency towards more accumulation of Na and Cl salts in their leaf tissues under saline conditions, which probably suggests susceptible nature of this crop. The strains VI 9 and SH 63 accumulated maximum Na and Cl salts at ECe 16 dS/m compared to other strains. These strains, therefore, accumulate toxic ions in their tissues. These strain might have used Na and Cl salts as the osmotic gradients so as to maintain turgor leading to physiological adaptation. The 1379 and JI 35 strains, on the other hand, accumulated more amount of Na salts. Susceptible strains characteristically showed lower accumulation of these salts in their leaf tissues compared to tolerant and moderately tolerant strains.

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