INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2004/06–4–665–668
http://www.ijab.org

Some Growth Related Characteristics in Canola (*Brassica napus* L.) Under Salinity Stress

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ABSTRACT

Some growth related characteristics such as plant biomass relative growth rate (RGR), plant height, stem diameter, and time taken to flower initiation of eight lines of canola (*Brassica napus* L.) were studied in soil-sand (2:1) culture salinized with different concentrations of NaCl. Root and shoot lengths were recorded up to five sequential harvests with an interval of 10 days after the application of salt treatment. Plant height, stem diameter and time taken to flower initiation were also noted at maturity of the crop. Plant height and flower initiation were significantly depressed with increase in salt concentration of the growth medium. Maximum plant height and stem diameter were found in cvs. DGL and Dunkeld; whereas, cv. Cyclon followed by Rainbow were the lowest in plant height. Time taken to flower initiation in canola increased with increase in salinity of the growth medium. In conclusion, salinity caused a significant reduction in growth rate and flower initiation in canola.

Key Words: Canola; Salinity; Growth rate

INTRODUCTION

The most common adverse effect of salinity on the crop of *Brassica* is the reduction in plant height, size and yield as well as deterioration of the quality of the product (Kumar, 1995). Inter-specific differences occur among the species at different salinity levels. For instance, reduction in growth of *B. napus* was related to relative growth rate (RGR) linked with reduction in leaf area ratio (LAR).

It is now well evident that salt tolerance of most crops varies with the stage of their life cycle (Akbar & Yabuno, 1974; Kingsbury & Epstein, 1984; Ashraf, 1994). In contrast, other studies have revealed that in some species degree of salt tolerance is considerably maintained at different growth stages i.e. as in alfalfa (Noble *et al*., 1984) in three leguminous forage species (Ashraf *et al*., 1986b) and in four grass species (Ashraf *et al.*, 1986a). It has been stated (Blum, 1985) that selection for salt tolerant species can be employed at any stage, if it has consistent pattern of salt tolerance at all growth staged, however, it becomes more tedious for otherwise situation. Canola (B*rassica napus* L.) has some potential to cope with the toxicity of salts (Francois, 1984) so it can be successfully grown on salt affected soils. The present study was undertaken to assess the effect of salt stress on different growth attributes of some genetically diverse lines of canola at different growth stages.

MATERIALS AND METHODS

The experiment was conducted in a glasshouse at Ayub Agricultural Research Institute, Faisalabad, in glazed pots (26 cm diameter and 32 cm depth) containing 14 kg soil-sand culture (2:1). Twenty seeds of eight lines/cultivars of canola were sown in each pot. At the seedling stage (20 days after germination), salt treatment was applied by adding appropriate amount of NaCl in distilled water. The EC of the soil was 2.4 dS m^{-1}, that was considered as control and the other treatments were 4, 8 and 12 dS m^{-1}. The salt was applied gradually in aliquot of 4 dS m^{-1} every day. After the start of experiment, two plants from each pot were harvested after every 10 day interval. At each harvest, the plants were separated into shoots, roots and length of each plant was recorded. Finally, plant height, stem diameter and time taken (number of days) to flower initiation were recorded. The relative growth rate (RGR) was determined with the following formula (Shennan *et al.*, 1987).

$$RGR(gg^{-1}\,day^{-1}) = \frac{1}{w} \times \frac{dw}{dt}$$

Where

w	=	dry weight of shoot at the initial harvest.
dw	=	dry weight of shoot at final harvest dry weight of shoot at initial harvest
dt	=	number of days between initial harvest and the final harvest

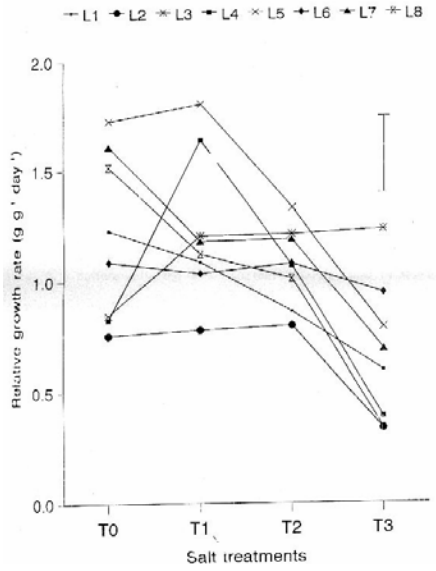
RESULTS AND DISCUSSION

The results (Table I, II) show that NaCl adversely affected the seedling growth. It is clear that both roots and shoot lengths decreased significantly with increase in salt concentration particularly at the higher salinity level at later growth stage. However, at the initial developmental stages, the effect of salt was not so much conspicuous in plant growth. The data showed that cv. Dunkeld was the highest

Table I. Root length (cm) in canola (*Brassica napus*) at five sequential harvests at an interval of 10 days after the application of salt treatment

Lines/ Salinity levels	Harvest I	Harvest II	Harvest III	Harvest IV	Harvest V
DGL					
2.4 dS m^{-1}	4.63	6.33	6.75	6.62	9.43
4.0 dS m^{-1}	3.93	4.63	5.81	6.62	8.18
8.0 dS m^{-1}	3.37	4.40	6.43	6.56	6.62
12.0 dS m^{-1}	4.60	4.72	5.31	7.00	5.93
CON-II					
2.4 dS m^{-1}	3.87	4.32	5.06	7.06	8.18
4.0 dS m^{-1}	3.61	4.32	4.93	7.81	7.37
8.0 dS m^{-1}	4.18	5.45	6.43	8.82	6.81
12.0 dS m^{-1}	3.28	5.18	5.31	5.93	5.55
CON-III					
2.4 dS m^{-1}	4.30	4.70	6.68	6.56	8.56
4.0 dS m^{-1}	3.43	4.57	6.56	6.75	7.82
8.0 dS m^{-1}	3.23	4.35	4.37	7.81	7.75
12.0 dS m^{-1}	3.41	4.03	5.50	4.87	5.56
Rainbow					
2.4 dS m^{-1}	2.57	4.98	4.94	5.87	6.10
4.0 dS m^{-1}	5.10	3.51	5.12	6.68	7.68
8.0 dS m^{-1}	4.76	4.06	5.61	5.31	7.48
12.0 dS m^{-1}	3.71	5.12	5.41	4.16	6.87
Oscar					
2.4 dS m^{-1}	3.11	4.37	6.78	5.91	8.06
4.0 dS m^{-1}	2.52	5.18	5.43	5.35	7.77
8.0 dS m^{-1}	3.24	3.76	7.06	6.43	7.82
12.0 dS m^{-1}	2.78	4.90	6.62	7.18	7.77
Excel					
2.4 dS m^{-1}	2.70	4.16	5.71	5.45	9.41
4.0 dS m^{-1}	3.83	5.18	6.35	6.98	9.32
8.0 dS m^{-1}	2.67	3.28	5.50	5.90	8.80
12.0 dS m^{-1}	4.51	4.95	5.53	5.22	8.97
Dunkeld					
2.4 dS m^{-1}	3.98	5.45	6.50	10.35	10.28
4.0 dS m^{-1}	4.45	4.71	5.53	5.60	10.01
8.0 dS m^{-1}	4.01	5.37	5.73	6.68	9.15
12.0 dS m^{-1}	4.77	4.96	5.98	6.62	7.40
Cyclon					
2.4 dS m^{-1}	2.73	3.13	4.87	6.48	8.06
4.0 dS m^{-1}	3.08	4.45	5.37	6.73	7.37
8.0 dS m^{-1}	2.37	3.50	3.78	6.60	7.49
12.0 dS m^{-1}	3.17	3.36	4.08	4.80	5.68

Fig. 1. Relative growth rates of eight lines of canola (*B. napus*) at different harvests at varying salt treatments



pronounced at higher salinity levels (8.0 and 12.0 dS m^{-1}), Con-II, followed by DGL, was less affected under saline treatments as compared to other cultivars; whereas, the effect of salinity on Rainbow followed by Con-III and Cyclon was pronounced in plant height.

Varying salt treatments significantly reduced the stem diameter of al the lines of canola. Each line showed similar response to salt at different salinity levels. Con-III had the highest stem diameter (3.02 cm) of all the lines at all salinity levels; whereas, the lowest diameter was found on Cyclon (Table IV).

The lines also showed a great magnitude of variation in the rate of germination (Table V). For instance, Con-III and Rainbow had the highest rate of germination among all the lines. In contrast, Cyclon and AC-Excel were the lowest in the rate of germination. Similar results showing variation in the rate of germination have been earlier reported in pigeon pea (Ashraf, 1994), and maize (Ashraf & McNeilly, 1989).

Variation in salt tolerance among the lines was also observed at the vegetative stage based on data for shoot

Table II. Shoot length (cm) in canola (*Brassica napus*) at five sequential harvests at an interval of 10 days after the application of salt treatment

Lines/ Salinity levels	Harvest I	Harvest II	Harvest III	Harvest IV	Harvest V
DGL					
2.4 dS m^{-1}	3.78	5.17	7.62	10.18	14.80
4.0 dS m^{-1}	4.21	4.91	6.18	10.75	14.37
8.0 dS m^{-1}	3.88	5.00	7.75	10.75	12.75
12.0 dS m^{-1}	3.80	5.29	6.56	9.31	11.43
CON-II					
2.4 dS m^{-1}	4.10	3.27	6.43	10.25	10.16
4.0 dS m^{-1}	3.37	4.63	6.12	10.25	11.31
8.0 dS m^{-1}	3.58	4.55	6.13	7.50	9.93
12.0 dS m^{-1}	3.50	4.50	4.25	7.06	8.00
CON-III					
2.4 dS m^{-1}	3.58	6.07	7.12	12.25	15.75
4.0 dS m^{-1}	3.73	4.92	6.31	10.87	12.25
8.0 dS m^{-1}	3.52	4.77	5.78	8.37	9.37
12.0 dS m^{-1}	3.40	4.66	4.33	5.15	8.62
Rainbow					
2.4 dS m^{-1}	2.21	2.92	3.37	4.93	5.81
4.0 dS m^{-1}	2.42	3.08	3.25	4.96	6.00
8.0 dS m^{-1}	2.40	3.42	2.77	3.41	5.77
12.0 dS m^{-1}	2.35	3.05	3.34	4.28	3.50
Oscar					
2.4 dS m^{-1}	3.31	3.42	3.95	6.13	7.87
4.0 dS m^{-1}	3.67	3.88	3.65	6.17	7.93
8.0 dS m^{-1}	3.01	3.47	3.55	5.25	7.17
12.0 dS m^{-1}	3.00	3.25	3.27	4.13	5.22
Excel					
2.4 dS m^{-1}	4.16	5.46	6.77	14.20	11.40
4.0 dS m^{-1}	3.77	4.80	6.17	9.73	10.37
8.0 dS m^{-1}	3.87	3.66	4.23	11.21	9.57
12.0 dS m^{-1}	2.96	3.54	3.55	5.90	6.81
Dunkeld					
2.4 dS m^{-1}	3.12	3.23	3.82	6.22	10.25
4.0 dS m^{-1}	2.97	2.88	3.81	4.77	7.93
8.0 dS m^{-1}	2.83	3.42	3.72	3.81	7.25
12.0 dS m^{-1}	2.80	3.46	4.17	4.21	7.37
Cyclon					
2.4 dS m^{-1}	3.24	3.15	4.68	5.75	8.93
4.0 dS m^{-1}	3.91	3.37	3.73	4.96	7.68
8.0 dS m^{-1}	2.53	3.07	3.57	4.10	5.81
12.0 dS m^{-1}	2.50	2.65	3.18	3.59	3.87

Table III. Analysis of variance (mean squares) of data for percent germination and days to 50% germination of eight lines of canola (*B. napus*) under different NaCl treatments

Source of variation	Degree of freedom	Percent seed germination	Days to 50% germination
Salt Treatments (T)	3	429.341***	1.026***
Lines (L)	7	27.767***	0.866***
T x L	21	19.895***	0.042***
Error	96	3.508	0.140

Table IV. Effect of different NaCl treatments on stem diameter (cm) of eight lines of canola (*B. napus*) at maturity of the crop

Lines	NaCl concentration (dS m^{-1})			
	2.4 (control)	4.0	8.0	12.0
DGL	1.07	1.00	1.05	0.98
Con-II	1.03	1.13	1.13	0.99
Con-III	3.78	2.96	3.01	2.32
Rainbow	0.85	0.83	0.91	0.84
Oscar	1.03	1.04	0.91	0.85
AC Excel	1.19	0.98	1.00	0.95
Dunkeld	1.28	1.05	1.06	1.21
Cyclon	1.01	0.84	0.66	0.66

Interaction term, Lines x Treatments = NS

Table V. Effect of different NaCl treatments on days to 50% germination of eight lines of canola (*B. napus).*

Lines	NaCl concentration (dS m^{-1})			
	2.4 (control)	4.0	8.0	12.0
DGL	1.38b	1.64b	1.54de	1.57b
ConII	1.32c	1.35cd	1.78bc	1.60b
ConIII	1.12c	1.20d	1.44c	1.58b
Rainbow	1.14c	1.31cd	1.52de	1.56b
Oscar	1.31b	1.38cd	1.62cde	1.74b
AC Excel	1.69a	1.81a	1.89b	2.20a
Dunkeld	1.40b	1.43c	1.63cd	1.57b
Cyclon	1.64a	1.87a	2.09a	2.21a

Table VI. Effect of different NaCl treatments on plant height (cm) of eight lines of canola (*B. napus*) at maturity of the crop

Lines	NaCl concentration (dS m^{-1})			
	2.4 (Ccontrol)	4.0	8.0	12.0
DGL	98.25 b	109.25 a	94.00 a	81.25 a
Con-II	103.25 ab	107.50 a	93.75 a	82.75 a
Con-III	94.00 b	103.75 a	`76.75 a	53.75 bc
Rainbow	60.75 c	67.00 b	42.75 b	40.25 c
Oscar	95.75 b	97.25 a	89.00 a	67.00 ab
AC Excel	119.25 a	96.25 a	86.00 a	75.75 a
Dunkeld	94.25 b	71.00 b	79.50 a	72.00 ab
Cyclon	99.25 b	105.25 a	77.50 a	56.50 bc

Means with the same letters in each column do not differ significantly at the 5% level; *** = Significant at 0.05, 0.01 and 0.001 levels, respectively

biomass and RGR. For instance, Dunkeld was the highest, and Cyclon the lowest followed by Rainbow in shoot biomass of all the lines (Table VI). It may be concluded that response of canola plant varies from line to line at varying salt treatments with respect to different parameters.

CONCLUSION

The lines can be categorized into salt tolerant and salt sensitive groups based on their performance at different growth stages under saline conditions. DGL (non-canola) and Dunkeld were found to be salt tolerant and Cyclon and, Rainbow the salt sensitive; whereas, the remaining four lines were intermediate in salt tolerance.

REFERENCES

Akbar, M. and T. Yabuno, 1974. Breeding for saline resistant varieties of rice. I. Comparative performance of some rice varieties to salinity during early developmental stages. *Japan J. Breed.*, 24: 176–81

Ashraf, M. and T. McNeilly, 1989. Effect of salinity on some cultivars of maize. *Maydica*, 34: 179–89

Ashraf, M., 1994. Salt tolerance of pigeon pea (*Cajanus cajan* L. Mill sp.) at three growth stages. *Ann. Apple. Boil.*, 124: 153–64

Ashraf, M., T. McNeilly and A.D. Bradshaw, 1986a. The response of selected salt tolerant and normal lines of four grass species to NaCl in sand culture. *New Phytologist*, 104: 453–61

Ashraf, M., T. McNeilly and A.D. Bradshaw, 1986b. Response and ion uptake of selected salt tolerant and unselected lines of three legume species. *New Phytologist*, 104: 463–72

Blum, A., 1985. Breeding crop varieties for stress environments. *CRC Critical Rev. in Pl. Sci.*, 2: 199–38

Francois, L.E., 1984. Salinity effects on germination, growth, and yield of turnips. *Hort. Sci.*, 19: 82–4

Kingsbury, R.W. and E. Epstein, 1984. Selection for salt-resistant spring wheat. *Crop Sci.*, 24: 310–24

Kumar, D., 1995. Salt tolerance in oilseed Brassicas – present status and future prospects. *Plant Breed. Abst.*, 65: 1438–47

Noble, C.L., G.H. Halloran and D.W. West, 1984. Identification and selection for salt tolerance in Lucerne (*Medicago sativa* L.). *Australian J. Agric. Res.*, 35: 239–52

Shennan, C., R. Hunt and E.A.C. Macrobbie, 1987. Salt tolerance in *Aster tripolium* L. I. The effect of salinity on growth. *Plant Cell Environ.*, 10: 59–65

Stebbins, G.L., 1966. Chromosomal variations and evolution. *Sci.*, 152: 1463–9

Swaminatha, M.S., 1967. The significance of polyploidy in the origin of species and species groups. *In: Genetic Resources in Plants their Exploration and Conservation.* Blackwell Scientific Publications, Oxford, UK

(Received 15 March 2003; Accepted 25 January 2004)