Pak. J. Bot., 35(5): 895-909, 2003.

EFFECT OF NITROGEN FERTILIZER ON GROWTH OF CANOLA (*BRASSICA NAPUS* L.) UNDER SALINE WATER IRRIGATION

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Abstract

Effect of nitrogen fertilizer providing two different doses of urea (@ 150 and 250 kg/ha) were investigated on the growth of canola (*Brassica napus* L. cv. Oscar) under saline water irrigation of different sea salt concentrations. Plants were subjected to control (non-saline), 0.4 % (EC 4.5 $dS.m^{-1}$) and 0.6 % (EC 6.5 $dS.m^{-1}$) of sea salt concentrations with and without N amendment. Vegetative growth was recorded in terms of plant height, number of leaves and branches, fresh and dry shoot biomass per plant, while reproductive growth was noted in terms of number of flowers and siliquae per plant; siliquae weight; seed number and weight per siliquae; seed number and weight per plant. Plant growth on vegetative as well as reproductive phases was found proportionately inhibited with respect of increasing salinity in irrigation water. Amendment of urea @ 150 and 250 kg/ha had beneficial effect in non-saline as well as under saline conditions. The amount of chlorophyll decreased under saline conditions without N amendment while plants supplemented with urea exhibited an increase in chlorophyll. Total sugars and proteins exhibited an increase under N amendment in control as well as in saline conditions. Among mineral composition (Na^+ and K^+), Na^+ showed increase while others exhibited a decrease in different salinity levels with or without N amendment. Reproductive yield was comparatively more in N amended plants whereas it was considerably decreased in plants grown under salinity without N amendment.

Introduction

The production of edible oil in Pakistan is much below our domestic requirements and this shortage is a constant drain on our resources. A huge amount of foreign exchange is being spent annually on the import of edible oils. To minimize this national loss and to meet the demands of ever-increasing population, the production of oil-seeds must be raised. *Brassica napus* (canola), a member of Brassicaceae family is covered with more bloom than other species namely *Brassica campestris* (toria or sarson). Rape and mustard are comparatively salt tolerant crops among oil-seeds grown at marginal soil in Pakistan. It is reported to withstand soil salinity up to 7.9 $dS.m^{-1}$ (Gupta, 1990). Studies have been documented on various aspects of salinity tolerance in *Brassica* species (He and Cramer, 1993a,b,c; Jain *et al.*, 1993; Schmidt *et al.*, 1993; Tyagi & Rangaswamy, 1993; Redmann *et al.*, 1994).

In addition to the presence of high erucic acid content in seed oil, glucosinolates are also present in rapeseed meal. These cause a bad taste and nutritional problem. Such problems were goiters and depressed growth. Because of health concerns with the high erucic acid content of local varieties of *Brassica napus* (Downey, 1976; Thomas, 1986), only small quantities of the oil were utilized as an edible oil in the 1950s. These concerns prompted an intensive breeding program by Canadian scientists, where rapeseed had become a major crop, to develop varieties with low erucic acid content. By 1974, the conversion to low erucic acid varieties in Canada was essentially complete. Canola (Canadian oil, low in acid) is now the world's third largest source of edible oil following soyabean (*Glycine max)* and palm (*Elaeis oleifera*) oils (Nowlin, 1991). To be classified as canola, varieties must have <20 g kg^{-1} erucic acid in the oil and <30 umol of aliphatic glucosinolates g^{-1} in the deffated meal (Campbell, 1986).

Nitrate and ammonium are the major inorganic N sources taken up by the roots of higher plants. Depending on the plant species, development stage and organ, the N content required for optimal growth varies between 2-5 % of the plant dry weight (Marschner, 1986). High rates of N fertilizer are usually applied to oilseed rape crops in order to obtain high seed yields (Mendham *et al.*, 1984; Yau & Thurling, 1987; Malhi *et al.*, 1988; Taylor *et al.*, 1991; Hocking *et al.*, 1997). Although the content of oil per unit seed weight decreases with increasing rate of N application (Holmes, 1980; Barraclough, 1989; Porter, 1993; Yusuf & Bullock, 1993), usually about 50 % of applied fertilizer N is recovered in the harvested seeds (Holmes, 1980; Schjoerring *et al.*, 1995). Drought stress may further reduce the N recovery to values considerably below 50 % (Schjoerring *et al.*, 1995).

Materials and Methods

Plastic buckets containing approximately 18 kg soil each having a basal outlet for drainage were used in this experiment. Organic manure was added in the soil at 9:1 ratio. Sets of 30 buckets each were used for the experiment. Details of the sets are as follows:

1st Set: Without fertilizer comprising non-saline control and two salinity treatments of (0.4 and 0.6 % sea salt dilutions).

2nd Set: Nitrogen provided as urea 2.15 g per bucket (equivalent to 150 kg N per ha), the set comprises non-saline control and two salinity treatments (0.4 and 0.6 % sea salt dilutions).

3rd Set: Nitrogen provided as urea 3.26 g per bucket (equivalent to 250 kg N per hectare), the set comprises of non-saline control and two salinity treatments (0.4 and 0.6 % sea salt dilutions).

Out of 30 buckets in each set, 10 replicates were maintained for each treatment: i) control (non-saline), ii) 0.4 % (EC 4.5 $dS.m^{-1}$), iii) 0.6 % (EC 6.5 $dS.m^{-1}$) sea salt concentrations. Three seeds of canola cv. Oscar were sown in each bucket filled with non-saline soil and irrigation started with non-saline water. Seedlings were thinned to one per bucket after 20 days prior to starting saline water irrigation. Concentration of sea salt was gradually increased in irrigation water till it reached to the desired salinity of each treatment. Each bucket was irrigated with 4 L of tap water / salt solution twice a week. Different doses of N fertilizer were applied monthly in the soil by dissolving in irrigation water only for first four months.

Plant height, leaf area and fresh and dry biomass were recorded in harvested plants. Relative growth rate (RGR) was calculated as outlined by Hunt (1982). Shoot/root ratio was calculated and expressed on dry weight basis at grand period of growth. Number of flowers and siliquae were recorded weekly. Siliquae weight, siliquae length, seed number and weight per plant were recorded at termination of experiment. A total flower shed per plant was calculated as the difference between total flowers and siliquae per plant and expressed as the percentage of total flowers produced per plant. Soil samples collected at each harvest for soil analysis and leaf samples were collected at grand period of growth for biochemical analysis and for the analysis of different cations ($Na^+$and K^+). Samples were dried and 0.5 g of each dry sample was taken for ash weight. Then solution of ash was made in 50 mL of de-ionized water, then dilutions were made in de-ionized water for mineral analysis. Concentration of cations in samples was measured using a Jarrell Ash atomic absorption spectrophotometer.

Statistical analysis of the data was carried out as outlined by Little & Hills (1975) and Gomez & Gomez (1976). Data were analyzed using a computer program Costat 3.03. Mean separation of data was carried out using Duncan's Multiple Range test (Duncan, 1955).

Results and Discussion

Vegetative growth

Fortnightly growth of cv. Oscar in terms of height as affected by irrigation water of different salinity levels as well as different doses of N is presented in Figure 1. The data showed slow growth up to 5th fortnight period and a sudden increase in height started in 5th fortnight period in control and from 6th fortnight under salinity levels. It exhibited a significant ($P<0.001$) decrease under saline treatment, while amendment of N fertilizer exhibited a significant ($P<0.001$) increase in plant height. N amendment @ 150 and 250 kg/ha (sets 2 & 3) exhibited 17 % and 54 % growth enhancement respectively in plant height even at all levels including 0.6 % salinity level. High dose of fertilizer (N @ 250) exhibited low percent reduction (40 %) under 0.6 % salinity level as compared to that without fertilizer (55.4 %) under same salinity level.

Relative growth rate (RGR) calculated from data for plant height (Fig. 1) exhibited high values during 5th fortnight period in sets 1, 2, 3. Statistical analysis exhibited that RGR had significant ($P<0.001$) differences with time while non-significant differences with salinity and fertilizer.

Fresh and dry shoot biomass showed a significant ($P<0.001$) reduction in different salt treatments in all sets (Fig. 2). The effect of N fertilizer is evident in increasing fresh shoot biomass significantly. This increase was more prominent under non-saline (control) condition, although it persisted even under all salinity treatments. Fresh shoot biomass of cv. Oscar produced by irrigation water without any fertilizer and salinity was 47.6 g/plant. When it was subjected to 0.6 % sea salt dilution it was reduced by 58.2 %. Fresh shoot biomass of the cultivar produced by amendment of N (250 kg/ha) was 160.6 g, while irrigated with 0.6 % sea salt dilution caused reduction by 53.5 %. Hence it appears that inhibition effect of 0.6 % sea salt salinity was offset by addition of nitrogen by 4.7%. Hocking *et al.* (1997) reported in negligible vegetative growth in canola after the end of flowering. Approximately, 35 % of the dry matter of canola shoots at anthesis is in the leaves. Over a wide range of applied N rates, dry matter is re-mobilized from canola leaves with about 20 % efficiency.

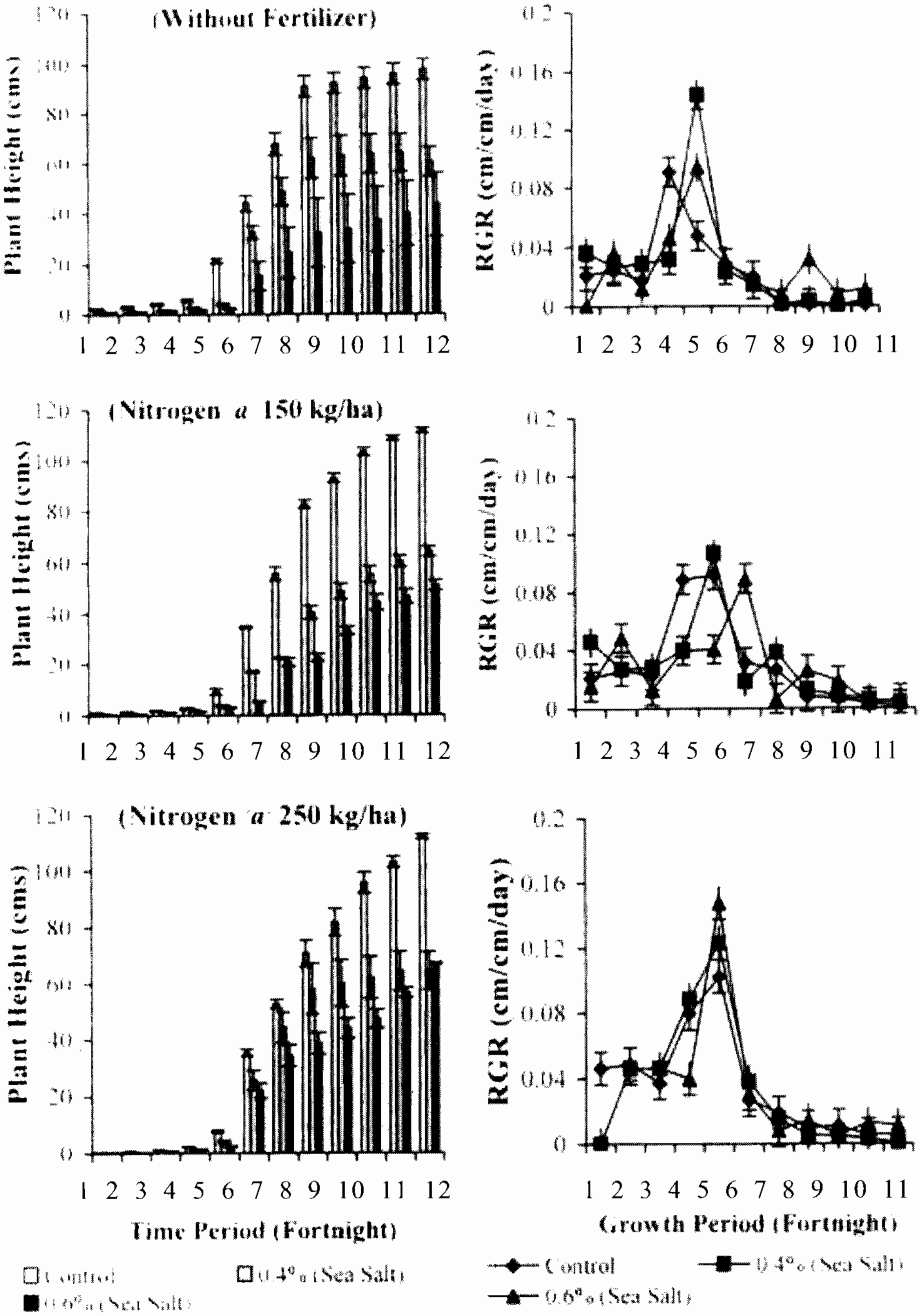

Fig. 1. Effect of irrigation water of different salinity levels on plant height and its RGR of canola cv. Oscar grown in soil amended with nitrogen.

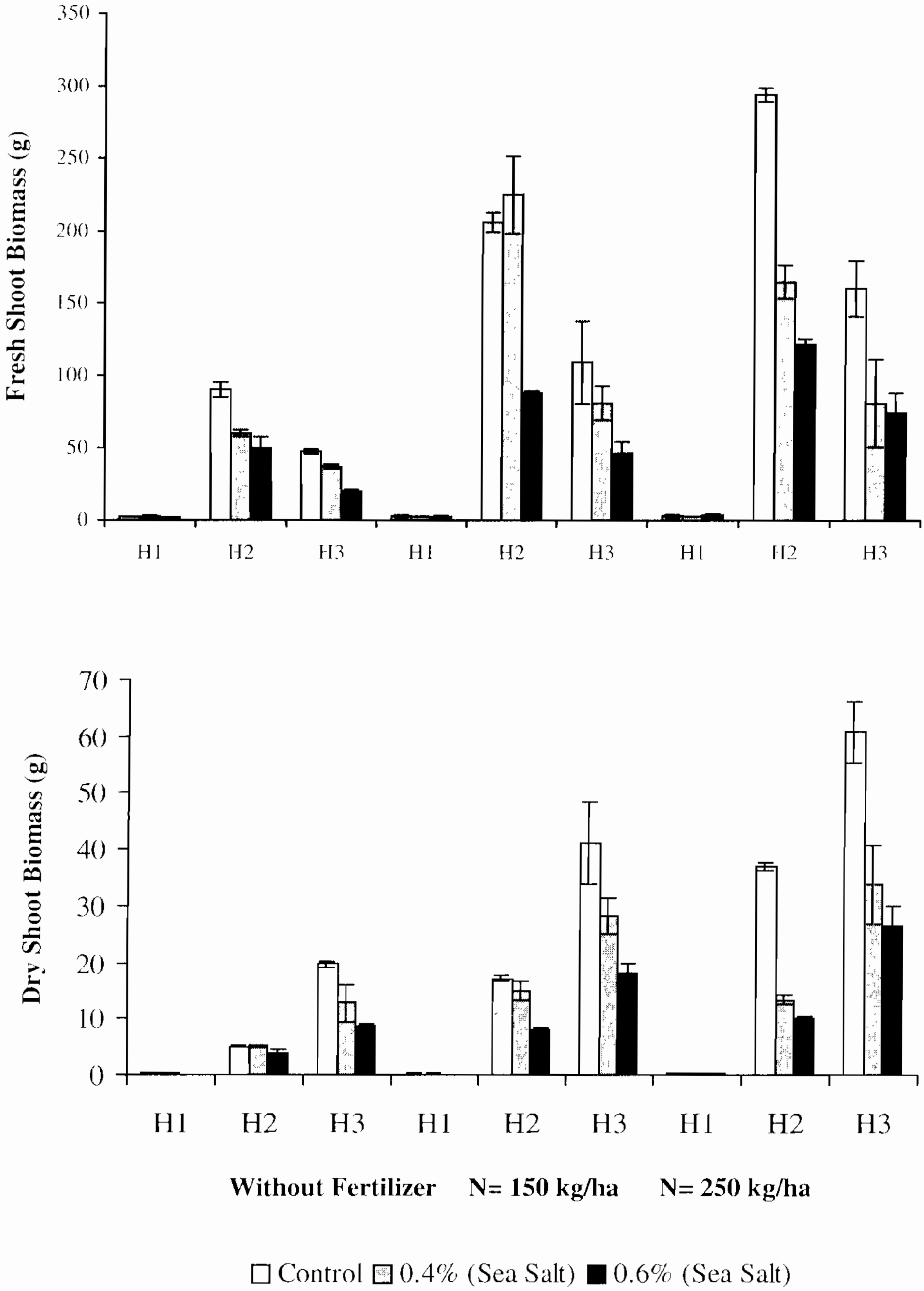

Fig. 2. Effect of irrigation water of different salinity levels on shoot biomass (fresh & dry) of canola cv. Oscar grown in soil amended with nitrogen (H= harvest number).

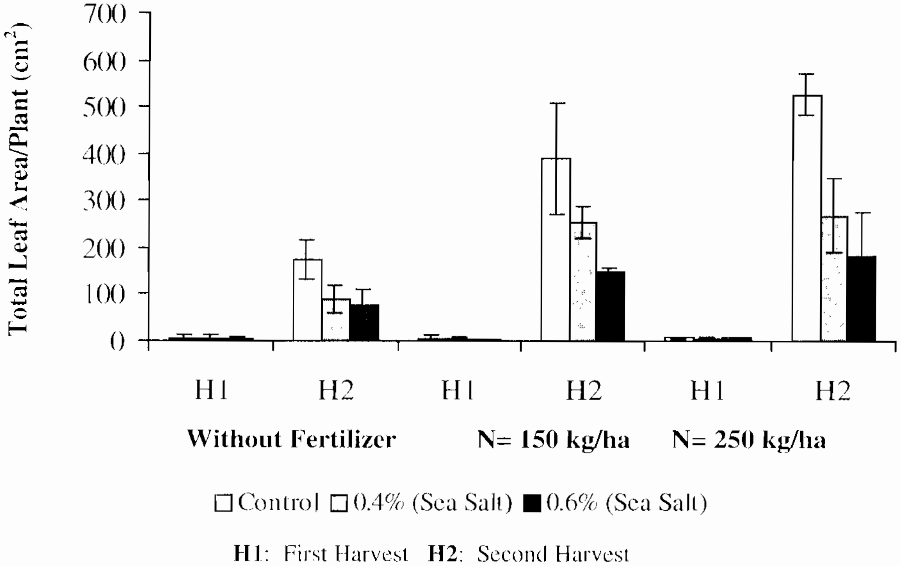

Fig. 3. Effect of irrigation water of different salinity levels on total leaf area per plant of canola cv. Oscar grown in soil amended with nitrogen.

Leaf area increased during the second harvest in all sets (Fig. 3). Since almost all leaves were shed at the third harvest (maturity stage) no values of this parameter appeared on graph. Leaf area significantly ($P<0.001$) decreased in saline treatments as compared to their respective non-saline controls. Plants supplemented with N exhibited significantly ($P<0.001$) higher values for leaf area in non-saline conditions and this effect persisted in urea even under saline conditions. One of the main effects of increasing N status of oilseed rape plants is enhanced leaf expansion (Wright *et al.*, 1988). Increasing N application under conditions without water deficiency enhanced expansion of photosynthetically active leaf surface (Gammelvind *et al.*, 1996).

Shoot/root ratio on dry weight basis in the plants grown under different salinity levels and amended with N fertilizer showed an increase under salinity treatments in all sets (Table 1). Differences in these values are significant at $P<0.05$ level.

Reproductive growth

Plants irrigated with different salinity levels exhibited significant ($P<0.001$) decrease in different reproductive parameters as compared to non-saline control while amendment of N fertilizer showed a significant ($P<0.001$) increase in these parameters over control even under saline conditions (Fig. 4). Shedding percentage showed high values in salinity treated plants as compared to their respective non-saline control in all sets (Table 2). Plants of all sets showed low shedding percentage as compared to set-1 at 0.4 % and 0.6 % salinity treatments as compared to set-1. Differences of shedding percentage and salinity was non-significant when data analyzed statistically.

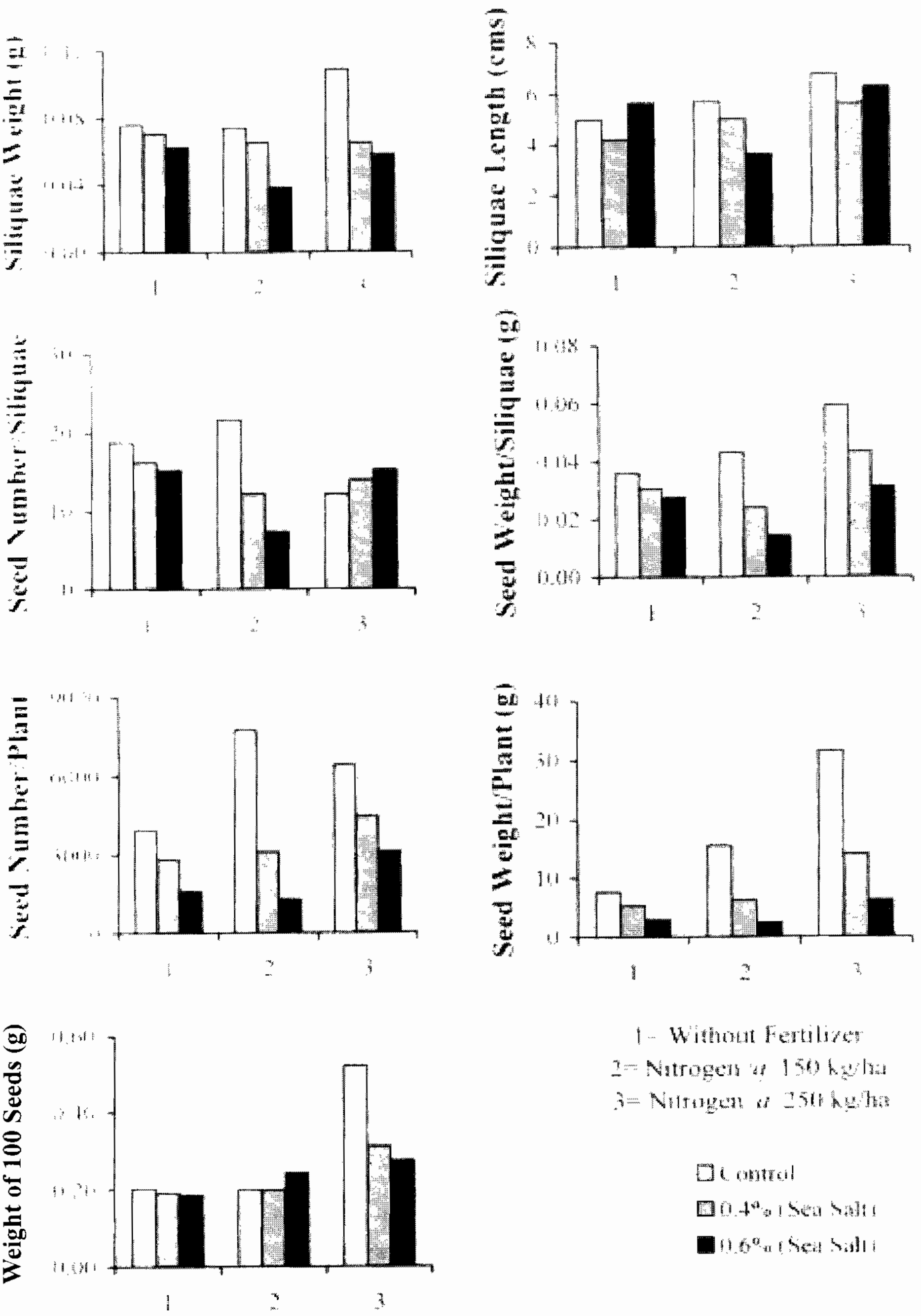

Fig. 4. Effect of irrigation water of different salinity levels on different reproductive parameters of canola cv. Oscar grown in soil amended with nitrogen.

Table 1. Effect of irrigation water of different salinity levels on shoot-root ratio in canola cv. Oscar grown in soil amended with nitrogen at grand period of growth.

Treatment	Shoot Dry Wt. (g)	Root Dry Wt. (g)	Shoot / Root
Without fertilizer			
Control	4.979 a	4.336 a	1.327 b
	±0.275	±1.294	±0.306
0.4% (S.S)	5.074 a	1.471 b	3.552 a
	±0.196	±0.156	±0.505
	(+1.908)	(-66.080)	(+167.622)
0.6% (S.S)	3.898 a	2.094 ab	1.843 b
	±0.584	±0.110	±0.175
	(-21.706)	(-51.711)	(+38.879)
$LSD_{0.05}$	1.349	2.613	1.231
Nitrogen @ 150 kg/ha			
Control	17.154 a	7.642 a	2.504 b
	±0.549	±1.647	±0.631
0.4% (S.S)	14.887 a	2.828 b	5.287 b
	±1.766	±0.280	±0.556
	(-13.218)	(-62.996)	(+111.155)
0.6% (S.S)	8.020 b	0.465 b	19.095 a
	±0.168	±0.088	±4.848
	(-53.245)	(-93.920)	(+662.556)
$LSD_{0.05}$	3.711	3.344	9.830
Nitrogen @ 250 kg/ha			
Control	37.052 a	10.503 a	3.731 b
	±0.667	±1.820	±0.594
0.4% (S.S)	13.405 b	1.685 b	8.046 a
	±0.943	±0.085	±0.908
	(-63.821)	(-83.960)	(+115.666)
0.6% (S.S)	9.993 b	1.071 b	10.018 a
	±0.308	±0.199	±1.864
	(-73.031)	(-89.799)	(+168.512)
$LSD_{0.05}$	5.689	3.662	4.309

Means followed by different letters in the same column differ significantly at 95 % probability level according to New Duncan's Multiple Range Test.
Figures in parentheses indicate % promotion (+) and reduction (-) over control.
S.S = Sea Salt

Canola cv. Oscar when supplemented with 250 kg N per ha (as urea) in non-saline soil showed 74.8, 60.2 and 300 % increase in flowers per plant, seed number per plant and seed weight per plant, respectively. When irrigated with 0.6 % sea salt dilutions without N amendment, 198 flowers, 1585 seeds and 3 g seed weight were produced per plant exhibiting a reduction by 51.7, 59.7 and 62.5 %, respectively. Under the irrigation of 0.6 % sea salt dilution supplemented by 250 kg N per ha (as urea), produced 321 flowers, 3120 seeds and 6 g seed weight per plant, exhibiting an increase by 62, 96.5 and 99.8 %, respectively over the above-mentioned saline water irrigation without nitrogen amendment.

Table 2. Effect of irrigation water of different salinity levels with added N on total flowers, siliquae and flowers shed per plant in canola cv. Oscar grown in soil.

Treatment	Total flowers per plant	Total siliquae per plant	Total flowers shed per plant	Flower shedding (%)
Without fertilizer				
Control	410.000 a	210.333 a	199.667 a	49 a
	+3.464	+5.872	+9.263	
0.4% (S.S)	337.667 b	171.667 b	166.000 b	49 a
	+18.074	+3.564	+14.933	
	(-17.642)	(-18.383)	(-16.861)	
0.6% (S.S)	198.000 c	105.000 c	93.000 c	47 a
	+6.333	+4.910	+2.027	
	(-51.707)	(-50.079)	(-53.422)	
$LSD_{0.05}$	67.351	29.219	3.985	9.900
Nitrogen @ 150 kg/ha				
Control	579.333 a	359.000 a	220.333 a	38 a
	+3.671	+2.848	+1.835	
0.4% (S.S)	367.333 b	203.000 b	164.333 a	45 a
	+3.469	+2.185	+1.710	
	(-36.593)	(-43.454)	(-25.416)	
0.6% (S.S)	262.667 c	169.667 c	93.000 a	35 a
	+4.426	+8.180	+9.527	
	(-54.660)	(-52.739)	(-57.791)	
$LSD_{0.05}$	23.242	30.915	8.683	11.857
Nitrogen @ 250 kg/ha				
Control	717.333 a	538.000 a	179.333 a	25 c
	+13.745	+14.193	+3.237	
0.4% (S.S)	461.667 b	321.333 b	140.333 a	30 b
	+9.833	+6.185	+3.686	
	(-35.641)	(-40.272)	(-21.747)	
0.6% (S.S)	321.667 c	200.333 c	121.333 a	38 a
	+6.577	+5.581	+1.170	
	(-55.157)	(-62.763)	(-32.342)	
$LSD_{0.05}$	62.756	56.950	18.926	2.902

Means followed by different letters in the same column differ significantly at 95 % probability level according to New Duncan's Multiple Range Test.
Figures in parentheses indicate % promotion (+) and reduction (-) over control.
S.S = Sea Salt

Application of N fertilizer in soil has been reported to increase agricultural productivity in different crops (Chauhan *et al.*, 1988; Manchanda & Sharma, 1990; Mor & Manchanda, 1992). In the presence of excessive amount of sodium chloride under saline conditions, the nitrate ion being anions competes with chloride during uptake mechanism and their absorption is adversely affected. Under environmental stress greater competition between developing pod hulls and seeds for photosynthate is reported in rapeseed which could result in pod abortion (Wright *et al.*, 1988). Taylor *et al.* (1991) also found increase in number and weight of seeds with supplement of N fertilizer in canola plant. Increase in yield by the addition of N fertilizer has also been found under saline conditions in different plants by many workers (Mendham *et al.*, 1981; Wright *et al.*, 1988).

Table 3. Cation composition of canola cv. Oscar grown in soil amended with nitrogen fertilizers and irrigated with different salinity levels.

	STEM		ROOT		LEAVES	
	Na^+	K^+	Na^+	K^+	Na^+	K^+
Treatments	------Meq/L--------		------Meq/L-------		------Meq/L--------	
Without fertilizer						
Control	2.608 a	1.703 a	2.893 a	2.593 a	1.739 a	1.534 a
	±0.251	±0.086	±0.146	±0.043	±0.250	±0.147
0.4% (S.S)	8.695 a	1.554 a	5.067 b	1.443 b	4.926 b	1.308 ab
	±0.251	±0.297	±0.384	±0.086	±0.383	±0.267
	(+233.39)	(-8.747)	(+75.110)	(-44.344)	(+183.33)	(-14.732)
0.6% (S.S)	10.376 b	1.443 a	7.960 c	0.978 c	9.847 c	0.682 b
	±1.986	±0.086	±0.800	±0.041	±0.769	±0.112
	(+297.85)	(-15.264)	(+175.11)	(-62.275)	(+466.33)	(-55.562)
$LSD_{0.05}$	4.303	0.643	1.797	0.210	1.789	0.651
Nitrogen @ 150 kg/ha						
Control	3.191 a	2.340 a	2.747 a	2.083 a	2.313 a	1.953 a
	±0.148	±0.185	±0.382	±0.114	±0.143	±0.043
0.4% (S.S)	4.637 ab	1.910 a	3.037 b	1.273 b	5.613 b	1.270 a
	±0.522	±0.072	±0.251	±0.147	±0.974	±0.314
	(+45.325)	(-18.376)	(+10.558)	(-38.880)	(+142.651)	(-34.982)
0.6% (S.S)	6.376 b	1.146 b	5.827 b	1.063 b	12.540 b	1.001 a
	±0.881	±0.264	±0.795	±0.258	±1.560	±0.457
	(+99.811)	(-51.011)	(+112.135)	(-48.976)	(+442.074)	(-48.976)
$LSD_{0.05}$	2.068	0.661	1.833	0.636	3.686	1.113
Nitrogen @ 250 kg/ha						
Control	2.753 a	2.181 a	2.167 a	2.164 a	2.457 a	2.573 a
	±0.383	±0.400	±0.251	±0.213	±0.522	±0.268
0.4% (S.S)	3.913 b	1.461 a	3.907 b	1.690 ab	4.777 b	1.913 b
	±0.664	±0.225	±0.251	±0.420	±0.251	±0.072
	(+42.123)	(-32.986)	(+80.307)	(-21.903)	(+94.436)	(-25.647)
0.6% (S.S)	6.521 b	0.926 a	5.587 c	1.113 b	11.873 b	1.107 c
	±0.753	±0.433	±0.257	±0.078	±2.261	±0.076
	(+136.881)	(-57.520)	(+157.840)	(-48.552)	(+383.310)	(-56.994)
$LSD_{0.05}$	2.147	1.261	0.876	0.954	4.665	0.575

Means followed by different letters in the same column differ significantly at 95 % probability level according to New Duncan's Multiple Range Test.

Figures in parentheses indicate % promotion (+) and reduction (-) over control.

S.S = Sea Salt

Table 4. Effect of different levels of saline water irrigation on chlorophyll, protein and sugar content in canola cv. Oscar grown in soil amended with nitrogen fertilizer.

Treatment	Without fertilizer			N= 150 kg/ha			N= 250 kg/ha		
	Control	0.6% (S.S)	$LSD_{0.05}$	Control	0.6% (S.S)	$LSD_{0.05}$	Control	0.6% (S.S)	$LSD_{0.05}$
Chlorophyll a ($mg.g^{-1}$ fresh weight)	0.409 a ±0.144	0.265 a ±0.054	0.426	0.238 a ±0.09	0.333 a ±0.147	0.477	0.384 a ±0.111	0.149 a ±0.064	0.355
Chlorophyll b ($mg.g^{-1}$ fresh weight)	0.395 a ±0.069	0.354 a ±0.08	0.293	0.597 a ±0.147	0.323 a ±0.113	0.515	0.559 a ±0.119	0.591 a ±0.133	0.496
Total Chlorophyll ($mg.g^{-1}$ fresh weight)	0.804 a ±0.084	0.618 a ±0.035	0.252	0.835 a ±0.091	0.656 a ±0.139	0.462	0.943 a ±0.208	0.740 a ±0.189	0.78
Chlorophyll a/b ratio	1.201	0.891		0.498	1.394		0.704	0.243	
Total Sugars ($mg.g^{-1}$ dry weight)	2.847 a ±0.266	3.761 a ±0.284	1.08	1.987 b ±0.16	4.519 a ±0.49	1.432	2.160 b ±0.421	5.140 a ±0.296	1.429
Total Proteins ($mg.g^{-1}$ dry weight)	13.107 b ±0.761	16.166 a ±0.491	2.516	11.804 a ±1.868	14.292 a ±1.503	6.656	10.566 a ±0.531	15.152 a ±1.774	5.139

Means followed by different letters in the same column differ significantly at 95% probability level according to New Duncan's Multiple Test.
S.S= Sea Salt

Table 5. Electrical conductivity and pH values of soil as a result of salt accumulation during saline water irrigation of different salinity levels and amended with nitrogen fertilizers.

	A		B		C	
Treatment	EC ($dS.m^{-1}$)	pH	EC ($dS.m^{-1}$)	pH	EC ($dS.m^{-1}$)	pH
Without fertilizer						
Control	0.667 c	7.400 a	0.767 c	7.400 a	0.800 c	7.267 a
	±0.176	±0.152	±0.088	±0.173	±0.230	±0.145
0.4% (S.S)	4.600 b	7.200 a	5.067 b	7.567 a	4.667 b	7.667 a
	±0.208	±0.099	±0.290	±0.120	±0.233	±0.145
0.6% (S.S)	6.233 a	7.400 a	8.200 a	7.533 a	7.967 a	7.600 a
	±0.338	±0.057	±0.916	±0.145	±0.536	±0.057
$LSD_{0.05}$	0.815	0.382	1.929	0.511	1.256	0.426
Nitrogen @ 150 kg/ha						
Control	0.967 c	7.800 a	1.233 c	7.300 a	0.967 c	7.200 a
	±0.120	±0.251	±0.202	±0.115	±0.166	±0.199
0.4% (S.S)	4.967 b	7.567 a	5.967 b	7.467 a	5.800 b	7.533 a
	±0.523	±0.088	±1.155	±0.066	±0.493	±0.233
0.6% (S.S)	6.633 a	7.900 a	9.867 a	7.167 a	8.500 a	7.467 a
	±0.317	±0.378	±0.940	±0.240	±0.321	±0.088
$LSD_{0.05}$	1.247	0.925	3.003	0.549	1.222	0.638
Nitrogen @ 250 kg/ha						
Control	0.633 c	7.600 a	1.000 c	7.633 a	0.833 c	7.667 a
	±0.284	±0.152	±0.208	±0.272	±0.233	±0.133
0.4% (S.S)	5.100 b	7.533 a	5.900 b	7.367 a	4.900 b	7.633 a
	±0.251	±0.176	±0.057	±0.120	±0.378	±0.120
0.6% (S.S)	6.700 a	7.200 a	9.267 a	7.333 a	6.600 a	7.567 a
	±0.378	±0.230	±0.635	±0.120	±0.513	±0.133
$LSD_{0.05}$	1.071	0.655	1.341	0.642	1.356	0.446

Means followed by different letters in the same column differ significantly at 95 % probability level according to New Duncan's Multiple Range Test.

A= Before the application of saline water

B= Grand period of growth

C= Termination of experiment

S.S= Sea Salt

Mineral content in plant parts

Mineral composition in plant parts grown under different salinity levels of irrigation water and amended with N fertilizer showed that increase in salinity of irrigation medium enhanced the Na^+ concentration in stem, root and leaves in all sets (Table 3). The high level of Na^+ accumulation found in plant parts indicates that like other Crucifers, canola tends to be Na^+ accumulator (Francois, 1984; Francois & Kleiman, 1990). While increase in Na^+ concentration decreased the K^+ accumulation in different plant parts as compared to their respective non-saline control. He & Cramer (1992) have also observed the reduction in K^+ concentration under salinity. Leidi *et al.* (1991) observed that concentration of K^+ was reduced in wheat by increasing the concentration of NaCl in the solution in shoots. The N amendment exhibited increase in Na^+ and K^+ concentration in leaves as compared to without fertilizer plant in saline or non-saline conditions.

Biochemical analysis

Biochemical analysis performed in the leaf samples exhibited that chlorophyll "a", "b" and total chlorophyll decreased in high salinity (0.6 % sea salt) in all sets, although this decrease was non-significant statistically (Table 4). Plants supplemented with N fertilizer exhibited high values of total chlorophyll as compared to those in set-I. Decrease in chlorophyll "b" and total chlorophyll of *Brassica napus* has been reported under saline conditions (Ashraf & Naqvi, 1992). It is possible that the specific enzyme that is responsible for the synthesis of green pigments may have been drastically affected in *Brassica napus* under saline environment. The ratio of chlorophyll "a" and "b" was increased in saline medium as compared to non-saline control in all sets. Total sugars showed a significant ($P<0.01$) increase in higher salinity (0.6 % sea salt) as compared to non-saline control in all sets. Protein content in the leaves showed an increase in saline medium as compared to non-saline control plants in all sets. Increase in total proteins have played a role in the maintenance of cellular integrity of salinized plants to some extent due to induction of some new enzymatic or structural protein (Abdullah *et al.*, 2002).

Changes in soil characteristics

Changes in electrical conductivity and pH shown of soil irrigated with different salinity levels at different stages of growth have shown that electrical conductivity of the soil enhanced with increase in salinity levels of irrigation water in all sets (Table 5). Electrical conductivity of soil exhibited an increase at grand period of growth and then showed a decrease at final harvest in all sets. The presence of sodium in irrigation water increases the exchangeable sodium in the colloidal system of the soil. This results in the deterioration of soil physical properties and affects the plant growth and productivity (El-Saidi, 1997). The pH of the soil exhibited a slight difference in all salinity levels of all sets. Soil amendment with N fertilizer within the above mentioned range did not exhibit any significant change in the accumulation of salt in the soil.

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