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THE ROLE OF BENZYLADENINE (BA) ON CANOLA (*Brassica napus* L.) PLANTS GROWING UNDER DIFFERENT NaCl SALINITY LEVELS

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ABSTRACT

The effects of exogenously applied BA (at 50 and 100 ppm) and NaCl salinity (at 0, 2000, 4000 and 6000 ppm) on growth, chemical constituents as well as yield and its components in canola plants were investigated. Canola growth was reduced significantly under NaCl salinity levels as indicated by plant height, number of branches as well as shoot fresh and dry weights. Photosynthetic pigments also showed a similar trend in response to salinity. On the contrary, accumulation of Na^+ and Cl^- ions as well as proline increased with increasing NaCl levels, while K^+ concentration was decreased. Furthermore, canola seed yield and its components were decreased in response to NaCl salinity, as indicated by number of both silquae/plant, seed/siliqua and weight of 100 seeds as well as seed oil yield.

Application of BA to canola plants under normal conditions stimulated plant growth, increased photosynthetic pigments, K^+ concentration as well as yield and its components. While accumulation of Na^+ and Cl^- ions as well as proline were decreased.

Under salinity stress, BA treatment could partially overcome the disturbance occurred in growth, photosynthetic pigments, yield and its components as well as oil seed yield caused by salinity stress.

INTRODUCTION

Canola (*Brassica napus* L.) is one of the oil winter crops, while most of oil crops cultivated in Egypt are summer ones. Canola seed contains 40-44% of excellent edible semi-dry oil.

Salinity is a wide spread phenomenon on the earth and is dominant constraint to successful agriculture in arid and semi-arid regions of the world. Salts have been reported to disturb integrity of cell membranes by inducing changes in the structure, lipid composition and proteins (Hussain *et al.*, 2002). Plant growth declined when exposed to saline conditions. The causes of growth reduction differ.

Different strategies are being employed for attaining optimum growth under saline conditions. One of them is to produce salt tolerant genotypes of different crops (Benzel *et al.*, 1985; Chaudhary *et al*., 1996 and Flowers, 2004). In addition, many other attempts have been made to overcome this disorder, including proper management and exogenous application of plant growth regulators (Mumtaz *et al.*, 1997 and Kaur *et al.*, 2003).

Salinity stress can reduce cytokinin export from the root to the shoot. An adequate cytokinin supply is essential for normal plant development; it can explain why exogenous application of cytokinin can overcome the inhibitory effects of salinity stress on plant growth by regulating various growth processes (Younis *et al*., 2003).

Previous workers revealed that benzyladenine (as a cytokinin) application ameliorated effects of soil salinity on the growth of many plants (Shi Gong *et al.*, 1999; Shadi *et al.*, 2001 and Mitsuya *et al.*, 2003).

The objective of the present work was to study the effects of NaCl salinity on canola growth, photosynthetic pigments as well as yield and its components. In addition, an attempt to counteract the adverse effect of salinity by BA application as a foliar spray.

MATERIALS AND METHODS

Two pot experiments were conducted during the two successive seasons of 2000/2001 and 2001/2002 in the Experimental Farm, Faculty of Agriculture, Mansoura University. The physical and chemical properties of the soil used were recorded in Table 1 (Piper, 1950). Fifty uniform seeds of canola per pot were sown on 15^{th} December in both seasons in 25 cm pot diameter filled with 4.5 Kg loamy clay soil. Tap water was used for irrigation till complete seedling stage, then the plants were thinned to leave three uniform plants/pot. N, P, K fertilizers were added at the recommended rates. The experimental design was factorial experiment with three replicates in complete randomized block design, each replicate contained three pots.

Table (1): The chemical and physical analysis of the soil.

Soil content	%
Mechanical analysis:	
Coarse sand	1.72
Fine sand	27.80
Silt	31.20
Clay	38.50
Chemical analysis:	
Organic matter	1.36
Available nitrogen (ppm)	40.25
EC (mmhos/cm) at 25°C	4.81
PH (Soil reaction)	8.33

Sodium chloride was used as a source of salinity. Four salinity levels, *i.e.*, 0 (control), 2000, 4000 and 6000 ppm were developed by using NaCl and salinization was started 40 days after sowing with an increment of 2000 ppm per irrigation in order to prevent the osmotic shock.

Twenty days after adding salinity (60 days from sowing), each treatment was devided into three groups. The first one was sprayed with distilled water, while the other groups were treated with benzyladenine (BA) at either 50 or 100 ppm. A hand atomizer was used till dripping after adding tween 20 (0.05%) as a surfactant.

Plant samples were taken two weeks after the foliar application of BA (75 days from sowing) at full flowering stage. The following data were recorded: plant height (cm), number of branches/plant as well as shoot fresh and dry weights (g/plant). Samples were collected from the 4^{th} leaf from plant tip to determine photosynthetic pigments. Photosynthetic pigments were extracted from the fresh leaves and determined as mg/g fresh weight

(Mackinny, 1941). Plant materials were oven-dried at 75°C to determine sodium, potassium and chloride concentrations. Na^+ and K^+ were estimated by flame photometer according to Chaudhary *et al.* (1996). While, Cl^- was determined by titration with 0.001 N $AgNO_3$ using potassium dichromate as indicator. In addition, proline concentration was determined in the fresh material by the ninhydrine method of Bates *et al.* (1973).

At harvesting, number of siliquae/plant, number of seeds/siliqua, 100 seed weight and seed yield/plant (g) were recorded. In addition, oil concentration was determined as mg/g dry weight of canola seed according to Folch *et al.* (1957). Oil yield/ plant was calculated from the oil percentage based on seed yield/plant.

Data (average of the two seasons) were statistically analyzed according to Gomez and Gomez (1984) and L.S.D. value was used for comparison.

RESULTS AND DISCUSSION

1) Growth parameters:

Data in tables (2 and 3) show that all NaCl salinity levels (2000, 4000 and 6000 ppm) caused a significant reduction in canola growth expressed as: plant height, number of branches/plant as well as shoot fresh and dry weights as compared to the untreated plants. On the contrary, data in the same tables reveal that exogenous application of BA enhanced the growth parameters. It is also clear that the application of BA to the salinized plants could partially overcome the depressing effect of salinity on canola plant growth.

The depressing effect of salinity on plant height may be a result of reduction in cell size or number of cells per unit area (Strogonov, 1964) and / or an inhibition of cell division, cell elongation and/or inhibited apical growth as well as internal hormone imbalance (Nieman, 1965 and Kurth *et al.*, 1986). Moreover, Kord and Khalil (1995) concluded that salinity reduced hormone delivery from roots to leaves. In addition, Younis *et al.* (2003) found a reduction in IAA, GA_3 and cytokinins contents under salt stress. Meanwhile, ABA was accumulated in shoots of the stressed plants. These changes may contribute a physiological active message that would modify shoot physiology and development. Relative higher uptake of Cl^- could be directly or indirectly responsible for growth depression, either by depressing the uptake of other anions (Ashraf *et al.*, 1998) or by direct osmotic effects of high local concentrations (Khan and Ashraf, 1988). Moreover, Strogonov *et al.* (1970) concluded that absorption of Cl^- salts from saline media and their accumulation up to toxic level may affect the metabolic activity of plant tissues and cause the appearance of some intermediate toxic compounds and consequently a decrease in plant growth. In addition, the decline in plant growth due to salinity stress may be attributed to a reduction in water uptake and/or an inhibition of photosynthetic output and carbohydrate synthesis (Sultana *et al.*, 1999) and/or toxicity and osmotic stress, leading to the generation of reactive oxygen species (ROS) which cause damage to DNA, lipids and proteins. Thus, oxidative stress is one of the major damaging factor in plants exposed to salinity (Rodriguez *et al.*, 2004).

Table (2): Effect of salinity and BA as well as their interactions on plant height and number of branches / plant.

Salinity (ppm)	Plant height (cm)			Salinity average	No of branches / plant			Salinity Average
	BA (ppm)				BA (ppm)			
	0	50	100		0	50	100	
0	88.5	95.2	91.6	91.77	9.8	12.6	10.5	10.93
2000	83.3	86.4	85.2	84.97	8.4	9.0	8.4	8.60
4000	64.4	76.4	75.8	72.20	5.6	6.8	8.0	6.80
6000	38.8	47.5	47.2	44.50	2.8	5.7	3.5	4.00
BA average	68.75	76.38	74.95		6.65	8.53	7.6	
L.S.D 5%	S	B	S x B		S	B	S x B	
	2.765	2.395	4.781		1.005	0.871	1.738	

Table (3): Effect of salinity and BA as well as their interactions on shoot fresh and dry weights (g).

Salinity (ppm)	Shoot fresh weight (g)			Salinity average	Shoot dry weight (g)			Salinity average
	BA (ppm)				BA (ppm)			
	0	50	100		0	50	100	
0	122.6	137.0	127.6	129.07	20.9	29.9	22.3	24.37
2000	103.2	114.9	105.2	107.77	19.4	20.8	20.9	20.37
4000	80.6	94.9	83.3	86.27	15.1	20.2	17.4	17.57
6000	43.5	66.0	49.2	52.90	5.6	10.2	8.5	8.10
BA average	87.48	103.2	91.33		15.25	20.28	17.28	
L.S.D 5%	S	B	S x B		S	B	S x B	
	6.103	5.285	10.55		1.498	1.297	2.589	

The stimulating effect of BA on canola growth may be the result of increasing cell division in the apical meristem (Houssa *et al.*, 1990) due to an increase in the transport of ions and nutrients (Erdei *et al.*, 1989). In addition, Erdei and Matsumoto (1991) stated that BA caused an increase in the transport of Ca^{2+} and concomitant in membrane structure and function.

Evidently, application of BA had a stimulating effect on canola plant growth under NaCl levels as compared to the untreated salinized plants. The obtained results are in agreement with that of Shadi *et al.* (2001) and Younis *et al.* (2003).Das Gupla *et al.* (1994) recorded that foliar application of IAA, GA_3 and kinetin helped to re-establish water content in mung bean plants which had been retarted by severe water deficits.

The role of growth substances in overcoming the effects of salinity on growth may be due to changes in endogenous cytokinins, which affect plant water balance and/or decrease root resistance to water flow. In this concern, Younis *et al.* (2003) stated that kinetin increased IAA, GA_3 and zeatin in the stressed plants to reach control but reduced ABA. These findings indicated that relief of the damage and restoration of normal conditions were maintained. In addition, Kaufman and Ross (1970) stated that kinetin affected water uptake under stress conditions either by increasing membrane permeability or by increasing the internal concentration of osmotically active solute.

Finally, Shi Gong *et al.* (1999) found that BA inhibited the absorption and translocation of Na^+ in shoots, and increased the K^+ content in wheat seedling as well as the rate of its translocation to shoots and decreased the Na^+ to K^+ selectivity ratio of translocation to shoots. Also, they found that BA improved absorption of Cl^- in roots, and decreased the translocation and content in shoots. This suggested that BA promoted salt stress avoidance by reducing the accumulation of harmful Na^+ and Cl^- ions in plant tissues.

2) Photosynthetic pigments:

Data presented in table (4) show that all salinity levels significantly decreased chlorophyll a, b and carotenoides in canola leaves as compared to the non-salinized (control) plants. While, BA application to canola plants increased the photosynthetic pigments as compared to the untreated (control) plants.

Table (4): Effect of salinity and BA as well as their interactions on chlorophyll a, chlorophyll b and carotenoids (mg/g fresh weight).

Salinity (ppm)	Chllorophyll a. BA (ppm)			Salinity average	Chllorophyll b BA (ppm)			Salinity average	Carotenoides BA (ppm)			Salinity average
	0	50	100		0	50	100		0	50	100	
0	1.561	2.052	2.046	1.886	1.186	1.611	1.588	1.462	0.597	0.733	0.654	0.661
2000	1.1569	1.984	2.046	1.642	0.886	1.406	1.224	1.169	0.379	0.672	0.622	0.558
4000	0.992	1.714	1.701	1.469	0.710	1.211	1.164	1.028	0.376	0.615	0.598	0.530
6000	0.935	1.554	1.516	1.337	0.679	1.152	1.116	0.982	0.323	0.543	0.517	0.461
BA average	1.139	1.826	1.786		0.863	1.345	1.237		0.419	0.641	0.598	
L.S.D 5%	S	B	S x B		S	B	S x B		S	B	S x B	
	0.186	0.161	0.323		0.098	0.085	0.168		0.064	0.055	0.106	

The results in the same table proved that BA application as a foliar spray overcome the depressing effect of salinity stress on chlorophyll a, b and carotenoides concentrations. In addition, BA at 50 ppm proved to be more effective in this concern.

The decrease in chlorophylls under salinity stress may be attributed to an inhibitory effect of the accumulated ions of the various salts on the biosynthesis of different pigment fractions (Strogonov, 1964) On the other hand, Yu and Rengel (1999) concluded that salt stress exposed chloroplasts to excessive excitation energy, thus leading to oxidative stress. Furthermore, they indicated that Cl^- toxicity disrupts normal electron flow to PS II. Such disruption might result in excessive electron leaking, which, in turn, could increase the generation of reactive oxygen species which attacking lipid, protein and nucleic acids.

Previous studies showed that salt and osmotic stress induced changes in the photosynthetic apparatus (Mitsuya *et al.*, 2003) in the membrane permeability properties of chloroplasts (Lutts *et al.*, 1996b). Salama *et al.* (1994) and El-Banna & Attia (1999) stated that the high salinity level disturbed chloroplast structure, number and size. They added that salinity caused swelling of membrane in chloroplasts of sensitive plants, which affect their chlorophyll content.

The increase in photosynthetic pigments by BA application may be due to an enhancement of chlorophyll synthesis (Beevers, 1968) and an inhibition of its degradation (Lutts *et al.*, 1996 b and Mumtaz *et al.*, 1997), and

/ or delay senescence of leaves by decreasing chlorophyllase enzyme activity or increasing protochlorophyllide content and activity of chlorophyll synthesis (Chen, 1990) and/or increase the number of chloroplasts in the leaf by increasing both intensity of cell growth phytohormones and the activity of cytoplasm ribosomes and consequently stimulate chlorophyll synthesis (Brozenkova and Mokronzov, 1976).

The inhibitory effects of salt stress on photosynthetic pigments were partially nullified when salinized plants were sprayed with cytokinins (Shadi *et al.*, 2001; Mumtaz *et al.*, 1997 and Younis *et al.*, 2003). In addition, Mitsuya *et al.* (2003) stated that the presence of BA alleviated the salt stress–induced decrease in chlorophyll content and chloroplasts damages through retardation of leaf aging.

3) Ion concentrations:

Data presented in tables (5 and 6) reveal that all salinity levels (2000, 4000 and 6000 ppm) increased Na^+ and Cl^+ concentration, while K^+ concentration was decreased in canola shoot as compared to the control. On the contrary, BA spraying showed a decrease in Na^+ and Cl^- concentration and an increase in K^+ concentration.

Table (5): Effect of salinity and BA as well as their interactions on Na^+ and K^+ concentrations (mg/g dry weight).

Sallnity (ppm)	Na^+ BA (ppm)			Salinity average	K^+ BA (ppm)			Sallnity average
	0	50	100		0	50	100	
0	5.118	4.938	4.118	4.725	28.959	30.911	29.935	29.935
2000	8.484	6.890	7.482	7.619	19.848	27.983	27.657	25.163
4000	9.825	7.086	7.678	7.874	17.896	27.332	26.356	23.861
6000	11.056	7.284	8.070	8.137	15.857	22.125	21.150	16.377
BA average	8.879	6.550	6.837		20.39	27.088	26.300	
L.S.D 5%	S	B	S x B		S	B	S x B	
	0.714	0.618	1.234		1.007	0.872	1.741	

Data in the same tables, show that the presence of BA improved the concentrations of Na^+ and Cl^- and overcame the depressing effect of salinity on K^+ concentration.

Salinity stress is generally as injurious to plants by disturbing the ion imbalance, resulting an excess of Na^+ and Cl^- and deficiency of others as K+ (He and Cramer, 1992 on six *Brassica* spp., Grieve *et al.*, 2001 on some plants; and Tanveer-ul-Hag *et al.*, 2002 on some *Brassica* spp.).

In saline stressed plants take up excessive amount of Na^+ and Cl- and increasingly displace mineral nutrients such as K^+ and Ca^{2+}, resulted in high Na^+/Ca^{2+} and Na^+/K^+ ratios which may impair the selectivity of the root membrane and result in the passive accumulation of Na^+ in the root and shoot system (Khan *et al.*, 1997).

The increase of Na^+ in the vacuole provides an osmotic adjustment of salt affected canola plants (Binzyl *et al.*, 1985). This accumulation might be due to an important role of sodium in reducing osmotic pressure, which facilitate absorption of water needed for plants to tolerate the harmful effect on growth caused by salinity. Th great accumulation of Na^+ has direct toxic effect, as it interferes with enzyme structure and function. It may also interfere with the function of K^+ as co-factor in various reactions (Kurth *et al.*, 1986). Many of the deleterious effects of Na^+, however, seem to be resulted to the structural changes observed in various membranes of salt stressed plants, and the plasmalemma has been shown to loose its selective permeability (Leopold and Willing, 1984).

Table (6): Effect of salinity and BA as well as their interactions on Cl^- and proline concentrations .

Salinity (ppm)	Cl^- (mg/g dry weight). BA (ppm)			Salinity average	Proline (μ mol/g D.W.) BA (ppm)			Salinity average
	0	50	100		0	50	100	
0	22.2	21.6	20.4	21.4	4.12	3.98	4.01	4.04
2000	27.4	24.2	26.3	26.0	7.82	5.90	5.49	6.40
4000	37.8	31.2	30.8	33.3	13.24	11.91	11.30	12.15
6000	50.3	45.8	41.2	45.8	16.72	14.70	15.11	15.51
BA average	34.4	30.7	29.7		10.48	9.12	8.98	
L.S.D 5%	S	B	S x B		S	B	S x B	
	1.566	1.356	2.707		0.851	0.737	1.472	

Chloride is a more sensitive indicator of salt damage than Na^+, since it is stored by the plant. Accumulation of Cl^- may cause leaf injury, thereby decreasing photosynthesis and productivity (Allam, 1994). The reduction of internal K^+ concentration under salinity stress may be related to an interference with its uptake or its transport (Lynch and Lauchli, 1985), or increased K^+ efflux into the growth media due to a disrupt in membrane integrity caused by Na^+ (Cramer *et al.*, 1985) and the antagonism between Na^+ and K^+ cations leading to high Na^+/K^+ ratio (Mozafar & Oertli, 1992).

BA like the other phytohormones, inhibited Na^+ and Cl^- uptake and stimulated the uptake of K^+. BA also increased Ca^{2+} transplant leading to improvement in membrane structure and function (Erdei and Matsumoto, 1991) as well as an increase in transport of other ions and nutrients (Erdei *et al.*, 1989).

The ion imbalance caused by salinity stress can be alleviated by BA application to the salinized plants. In this concern, Shi Gong *et al.* (1999) reported that BA inhibited the absorption and translocation of Na^+ in shoots, increased the K^+ content in wheat seedlings and the rate of its translocation to shoots, -and decreased the Na^+ to K^+ selectively ratio of translocation to shoots. They stated also that BA improved absorption of Cl^- in root and decreased the translocation and content in the shoots.

4) Proline concentration:

Data in table (6) reveal that increasing salinity levels progressively increased proline concentration in canola shoots as compared to the unsalinized plants. Furthermore, BA application had no effect in this respect.

Regarding the interaction treatments, the results show that spraying the salinized plants by BA increased proline concentration in canola shoots as compared to the salinized plants (Table 6).

Accumulation of the amino acid proline is widespread plant response to salinity stress (Qasim *et al.*, 2003a). Proline has a clear role as an osmoticum and acts as a compatible solute, which can accumulate to high concentration in the cell cytoplasm without interferring with cellular structure or metabolism (Yancey *et al.*, 1982).

It was demonstrated that under osmotic stress proline accumulates through its synthesis together with depression of its catabolism. In addition, salt stress stimulated proline biosynthesis and inhibited proline degradation (Delauney and Verma, 1993). Moreover, proline accumulation may be due to protein hydrolysis or accelerated protein breakdown (Stewart, 1972).

5) Seed yield and its components:

Data presented in Tables (7 and 8) show that salinity significantly decreased canola seed yield and its components, *i.e.*, number of siliquae / plant, number of seeds / siliqua and 100 seed weight (g) as compared to the control plants. On the other hand, exogenous application of BA significantly enhanced these parameters as compared to the untreated plants.

Table (7): Effect of salinity and BA as well as their interactions on seed yield/plant (g). and Number of siliquae / plant.

Salinity (ppm)	Seed yield / plant (g)			Salinity average	Number of sillquae / plant			Salinity average
	BA (ppm)				BA (ppm)			
	0	50	100		0	50	100	
0	8.86	12.11	11.00	10.66	129.0	146.4	138.5	136.87
2000	7.75	8.55	8.35	8.22	120.5	122.3	119.8	120.87
4000	5.70	6.55	6.35	6.20	90.3	103.6	101.8	98.57
6000	4.20	5.60	5.50	5.10	53.2	65.0	62.5	60.23
BA average	6.63	8.20	7.80		98.25	109.33	104.83	
L.S.D 5%	S	B	S x B		S	B	S x B	
	0.805	0.679	1.391		4.852	4.202	8.388	

Table (8): Effect of salinity and BA as well as their interactions on Seed number / silique and 100 seed weight (g).

Salinity (ppm)	Seed number / silique			Salinity average	100 seed weight (g)			Salinity average
	BA (ppm)				BA (ppm)			
	0	50	100		0	50	100	
0	25.1	30.4	29.2	28.23	0.411	0.680	0.601	0.564
2000	21.3	26.8	25.4	24.50	0.289	0.402	0.395	0.362
4000	17.6	20.8	19.5	19.30	0.194	0.309	0.285	0.263
6000	8.5	11.2	10.7	10.13	0.115	0.216	0.221	0.184
BA average	18.13	22.3	21.2		0.252	0.402	0.376	
L.S.D 5%	S	B	S x B		S	B	S x B	
	1.332	1.153	2.302		0.029	0.025	0.053	

Regarding the interaction between salinity and BA, the data in the same tables reveal that plants spraying with BA improved seed yield and its components as compared to the salinized plants. BA at 50 or 100 ppm alleviated the depressing effects of salinity on canola seed yield and its components.

The depressing effect of salinity on canola seed yield may be due to the decrease in number of siliquae/plant, number of seeds/siliqua and seed weight (Aktar *et al.*, 2002 and Gul *et al.*, 2002) or may be due to a decrease in the leaf area/plant resulting in reduction in the supply of carbon assimilation, due to decreasing the net photosynthesis rate and finally dry matter production and plant yield (Sultana *et al.*, 1999; Gul *et al.*, 2002 and Qasim *et al.*, 2003b). In addition, the yield may be reduced due to accumulation of certain toxic ions as Na^+ and Cl^- in high concentration and decreased useful ions as K^+ (Table 5) resulting in fewer and smaller fruits . Moreover, the reduction in siliquae number may be due to substantial abscission of flowers or young fruits due to ethylene induction by salinity (Osborn, 1982).

The increase in seed yield due to BA application may be a result of increasing number of siliquae/plant, number of seeds /siliqua and seed weight (Tables 7 and 8) and enhancing photosynthetic pigments as well as increasing K^+ concentration (Table 5) leading to enhanced dry matter accumulation, which, in turn, resulted in increasing seed yield. Moreover, BA decreased fruit abscission and consequently increased seed yield.

Generally, foliar application of BA at 50 and 100 ppm counteracted the reduction in canola seed yield grown under NaCl salinity stress.

6) Oil yield/plant:

Data presented in table (9) show that increasing salinity levels decreased oil concentration in canola seeds and oil yield/plant. Salinity at 6000 ppm showed a pronounced decrease in this respect. On the other hand, application of BA increased seed oil concentration and oil yield as compared to the untreated and salinized plants, BA at 50 ppm proved to be more effective in this respect.

Table (9): Effect of salinity and BA as well as their interactions on oil concentration and its yield/plant.

Salinity (ppm)	Oil (mg/g seed) BA (ppm)			Salinity average	Oil yield/plant BA (ppm)			Salinity average
	0	50	100		0	50	100	
0	34.42	40.50	36.11	37.01	3.05	4.91	3.97	3.98
2000	31.21	38.89	35.40	35.17	2.42	3.33	2.96	2.90
4000	25.11	30.70	28.90	28.24	1.45	2.02	1.83	1.76
6000	21.40	24.13	23.55	23.03	0.890	1.35	1.30	1.18
BA average	28.04	33.56	30.99		1.95	0.92	2.52	
L.S.D 5%	S	B	S x B		S	B	S x B	
	2.206	1.911	3.814		0.221	0.191	0.384	

Data in the same table reveal that BA application to the salinized plants could overcome the harmful effect of salinity on oil concentration and its yield / plant in canola seeds. BA at 50 ppm was more effective in this respect.

BA at 50 ppm with the low salinity level (2000 ppm) was more effective in increasing oil concentration and its yield per plant. Akhter *et al.*

(2002) and Sureena *et al.* (2002) reported that oil content in some *Brassica* species was decreased steadily with the increase in level of salinity.

The reduction in oil concentration and its yield with NaCl salinity in canola seeds may be due to oil conversion to carbohydrates which are the essential metabolites in respiration (Yang et al., 1999 a) and /or its effects on triacylglyceriol biosynthesis enzymes. Moreover, the reduction in oil yield/plant with salinity was due to a reduction in oil percentage (Table 9).

Generally exogenous application of BA enhanced the plant to tolerate the harmful effect of salinity stress on seed oil concentration and its yield / plant.

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دور البنزيل أدينين على نباتات الكانولا النامية تحت مستويات مختلفة من ملوحة كلوريد الصوديوم

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لقد تم دراسة تأثير المعاملة برش البنزيل أدنين (عند تركيزات ٥٠ ، ١٠٠ جزء في المليون) وملوحة كلوريد الصوديوم(عند تركيزات صفر ، ٢٠٠٠ ، ٤٠٠٠ ، ٦٠٠٠ جزء في المليون) على النمو والمحتوى الكيماوى ، وكذلك المحصول ومكوناته لنباتات الكانولا .

وقد أدت الملوحة بمستوياتها المختلفة إلى نقص في نمو نباتات الكانولا والمتمثلة في طول النبات ، وعدد الفروع ، وكذلك الوزن الغض والجاف للمجموع الخضرى ، وكان تأثيرهما على صبغات البناء الضوئى مشابها لتأثيرهما على النمو ، وعلى العكس من ذلك فإن زيادة مستويات الملوحة ادت إلى زيادة تراكم أيونات كل من الصوديوم والكلوريد وكذلك البرولين ونقص تركيز البوتاسيوم بالإضافة إلى ذلك فإن محصول البذور ومكوناته اعطت نفس الإستجابة للملوحة ، حيث أدت الملوحة إلى نقصها متمثلة في عدد القرون للنبات وعدد البذور للقرن الواحد ووزن ١٠٠ بذرة وكذلك محصول النبات من الزيت .

أدت معاملة نباتات الكانولا بالبنزيل أدنين تحت الظروف العادية إلى زيادة نمو النبات وصبغات البناء الضوئى وتركيز البوتاسيوم بالإضافة إلى المحصول ومكوناته ومحتوى البذور من الزيت بينما أدت هذه المعاملة إلى نقص تراكم أيونات كل من الصوديوم والكلوريد وكذلك البرولين .

وقد أدت معاملة نباتات الكانولا النامية تحت الظروف الملحية إلى تقليل التأثير الضار للملوحة على كل من النمو وصبغات البناء الضوئى والمحصول ومكوناته وكذلك محتوى البذور من الزيت .