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EFFECT OF GAMMA RAYS, ABSCISIC ACID AND PUTRESCINE ON PRODUCTION OF WHEAT PLANTS MORE TOLERANT TO SALINITY:

A- GROWTH, CHEMICAL COMPOSITION, HORMONAL STATUS, AND PRODUCTIVITY OF WHEAT PLANTS GROWN IN POTS UNDER SALINE CONDITIONS

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ABSTRACT

Pot experiment were carried out during two successive seasons; 1999-2000 and 2000-2001, to investigate the effectiveness of the exogenous applications of gamma rays, abscisic acid and putrescine in improving the salinity tolerance of the salt-sensitive Giza 167 wheat cultivar aiming to approach nearly similar tolerance and productivity of the untreated salt-tolerant Sakha 8 cultivar, when both of them were irrigated with 15%, 30% and 45% sea water, i.e. 4950, 9900 and 14850 ppm respectively, in addition to the fresh (tap) water, i.e. 147 ppm in the control treatment. The obtained data strongly confirmed the absolute superiority of the weekly spraying either with 10µM putrescine or 2 ppm ABA as well as the grains irradiation with 15 KR gamma rays treatments, especially the first one, in inducing the highest degree of the physiological tolerance to salinity in the treated sensitive Giza 167 cultivar plants which enables them to be adapted to the all applied levels of salinity, and even could confirmed their superiority at least, up to 30% sea water level in comparison with the salt-tolerant Sakha 8 cultivar plant under the same conditions. This physiological tolerance to salinity brought about by creating more negative osmotic potentials (Osmotic Adjustment) through the accumulation of much more quantities of inorganic osmotica, i.e. N, P, K^+, Mg^{+2} Ca^{+2} and the highest K^+/Na^+ ratio as well as the lowest quantities of Na^+ and lowest Na^+/Ca^{+2} ratio in addition to considerable accumulation of organic protective osmolytes, i.e. sugars, proline, free amino acids and protein in their growing tissues as well as the produced grains which greatly exceeded the all other treatments especially both sensitive and tolerant untreated controls up to 30% sea water level. This was accompanied with an endogenous hormonal status, induced by these three treatments, in favor of increasing tolerance to salinity, i.e. the accumulation of cytokinin in the stressed roots alongside the sugars, associated with another accumulation of IAA, GA3 and ABA in the stressed shoots, in addition to the lowest invertase activity in the stressed leaves in favor of accumulation more non-reducing sugars. Moreover, the most interesting feature of the obtained data is that, the superiority of these treatments as regards growth, dry matter accumulation, chemical composition, endogenous hormonal status, invertase activity, was reflected in much more pronounced degree on the productivity of the treated plants, so much so that, it could highly significantly surpassed the corresponding productivity of the all other treatments even that the salt-tolerant untreated control up to 30% sea water level. Therefore, the obtained

results in the first part of this study strongly suggested that the salinity tolerance of the salt-sensitive Giza 167 cultivar can be improved to a considerable extent, hence, it can be successfully cultivated in the new Egyptian lands and could tolerate the irrigation with the diluted sea water up to 30% level and nevertheless, approach their optimal productivity which highly significantly exceeded the comparable productivity of the salt-tolerant Sakha 8 cultivar under the same 30% sea water salinity level, if these sensitive plants were weekly sprayed either with 10 µM putrescine or 2 ppm ABA as well as when their grains were irradiated with 15 KR gamma rays before sowing.

INTRODUCTION

Wheat [*Triticum aestivum* L.] is a highly demanded winter cereal crop in Egypt as the main source of food for the Egyptian people. Unfortunately, the total production from this crop in Egypt is still insufficient to cover the local consumption. Thus, there is a great need to overcome this gap between the local national production and the consumption demand, through the increasing of wheat productivity per unit area which can be achieved through the applying of some specific physiological treatments, in addition to the expansion of wheat cultivation in the newly reclaimed areas which represents the great hope in increasing our cultivated land and consequently the economic agricultural production. On the other hand, and due to the restricted resources of the fresh water from the River Nile, the use of saline water or even diluted sea water becomes the only source of irrigation water in such newly cultivated areas, but the sensitivity of some wheat cultivars to salinity will restricts or even prevents their cultivation in such reclaimed areas. Thus, it is mandatory to improve the salinity tolerance of such sensitive wheat cultivars and consequently enhancing their ability to tolerate salinity, which in turn, increasing the possibility of their successful cultivation in such newly reclaimed areas. Therefore, there is increasing attention to accommodate wheat cultivars to grow in salinities outside the natural range of tolerance and nevertheless obtain appropriate economic productivity.

On the other hand, it is well documented that, two types of plant responses to salinity are distinguished, firstly, the " preexisting resistance mechanisms" that enable the plant to cope with salinity within its natural range of tolerance, and secondly, the adaptation. Both the strategies employed by intact salt-resistant plant can be found in salt adapted cell lines. The adaptation is achieved during a specific physiological treatments (such as irradiation treatments with gamma and laser rays as well as fast neutrons, biofertilizers treatments, soil and foliar fertilization, applying of the specific growth regulators) and involves changes in the plant behavior and expression of properties that were not evident before the treatment. A plant is considered "adapted to salinity" when the increase in the mean relative growth rate of the salt-treated plant occurs so that the growth is restored to a value more or less similar to that of the control plant, or when the plant has acquired the capacity to complete its life cycle in saline environment in which the nonadapted plant is not able to do so (Amzallag *et al.*, 1990a).

The irradiation with fast neutrons and gamma rays may provide insight into the mechanism of action of the radiation in producing physiological and genetic variability, thus have been used directly to produce useful variation in quantitively inherited characters (Brock, 1970), therefore, the results previously obtained by many authors suggested the possibility of successful application of the gamma rays (El-Shafey *et al.*, 1998 and Ghallab and Nesiem, 1999) and fast neutrons (El-Shafey *et al.*, 1994) to improve salinity tolerance of the sensitive wheat cultivars, since the mutagen agents including gamma rays and fast neutrons are the effective tools for inducing genetical changes in the treated plant material.

On the other hand, ABA is the primary hormone that mediates plant responses to cold, drought and salt stress (Wu *et al.*, 1997). Also, Gong *et al.* (1990) found that during NaCl stress, ABA content in wheat and barley leaves increased with duration and intensity of stress. Moreover, Maslenkova *et al.* (1993) found that endogenous level of ABA increased with salinity stress and that this level correlates with plant resistance to the stress. Also, the recent current researches disclosed that the grain soaking in 1 µm ABA stimulate the growth of wheat seedling root system, especially root hairs which could increase the water absorption and consequently improves seedling growth under salt stress. Moreover, the treatment of sorghum with ABA during the first week of salinization (150 mol $NaCl/m^3$) enhanced growth and accelerated the adaptation to high salinity (300 mol $NaCl/m^3$), i.e. ability to survive, growth and set grains upon exposure to NaCl concentration which lethal for nonadapted plants (Amzallag *et al.*, 1990b), meanwhile the weekly foliar spraying with 10 µM ABA increased salinity tolerance and consequently increased root length and dry weight as well as grain yield/plant and 1000 grains–weight of wheat plants (Nesiem and Ghallab, 1999). Similarly, Krishnamurthy (1991) reported that the foliar application of putrescine inhibited Na^+ and Cl^- uptake and accelerated the accumulation of K^+, Ca^{+2}, Mg^{+2}, proline and endogenous putrescine in the leaves of salt-stressed rice plants. Also, it prevented chlorophyll degradation. On the other hand, Galston (1983), Evans and Malmberg (1989) and Bagni and Torrigiani (1992) described diamine putrescine and polyamines as a new class of plant growth regulators are present in the all examined plants. Thus, improved plant growth under saline conditions (Altman *et al.*, 1983), and considered as one of the important factors involved in growth and its regulation (Smith, 1985).

Therefore, the main objective of the present study was to investigate the effectiveness of the exogenous application of gamma rays, abscisic acid and putrescine in improving tolerance to salinity of the salt sensitive Giza 167 wheat cultivar aiming to approach nearly similar tolerance and productivity of the salt-tolerant Sakha 8 cultivar, when both cultivars were grown in pots and irrigated either with tap water (in control treatments) or with the different concentrations of the diluted sea water, i.e. 15.0%, 30.0% and 45.0%.

MATERIALS AND METHODS

The present work was carried out during two successive seasons; 1999/2000 and 2000/2001 in the wire green house of the Plant Physiology Division, Faculty of Agriculture, Cairo University, Giza, Egypt, and included two pot experiments. Wheat (*Triticum aestivum* L.) grains cultivars; the salt tolerant Sakha 8 and the sensitive Giza 167 one were obtained from the Department of Wheat Research, Ministry of Agriculture, Giza, Egypt and were used in both seasons Before sowing, samples from the used soil, tap water and sea water were taken for the chemical analysis according to the standard procedures. (Piper, 1950; Jackson, 1958 and 1973 and Lindsay and Norvell (1978). The chemical analyses of the used soil were as follows: pH = 7.66, EC = 0.72 ds/m, HCo_3 + Co_3 = 2.1 Me/l , Cl^- = 11 Me/l , So_4 = 4.0 Me/l ,Ca = 8.0 Me /l ,Mg = 4.0 Me /l , Na = 9.7 Me /l and K = 2.1 Me /l. and for tap water as follows:

pH = 7.1 , EC = 0.23 ds/m* , HCo_3 = 1.51 Me/l , Cl^- = 0.54 Me/l , So_4 = 0.36 Me/l, Ca = 0.85 Me /l , Mg = 0.61 Me /l , Na = 0.91 Me /l , K = 0.12 Me /l and Sodium Adsorption Ratio[SAR] = 1.1. Meanwhile the chemical analyses of the used sea water (obtained from the Mediterranean Sea, Gleem Region, Alexandria) were as follows: EC = 51.56 ds/m = 32998.4 ppm** about 33000 ppm, pH = 7.8 , HCo_3 = 6.2 Me/l, Cl^- = 721 Me/l , So_4 = 46.9 Me/l, Ca = 51.5 Me /l , Mg = 154.5 Me /l , Na = 556.0 Me /l, K = 11.8 Me /l and Sodium Adsorption Ratio[SAR] = 54.8.

On the other hand, it seems logic to investigate the effect of some specific physiological treatments only on the salt-sensitive Giza 167 cultivar aiming to approach nearly similar tolerance and productivity of the comparable tolerant Sakha 8 one. Thus, in the first season, a group of 10 treatments were designed to be applied on the salt-sensitive Giza 167 cultivar plants, in addition to both the untreated controls of the tolerant as well as the sensitive cultivar as follows:

1- Control I [the tolerant untreated cultivar]. **2-** Control II [the sensitive untreated cultivar]. **3, 4, 5, and 6** the grains irradiation either with 5, 10, 15 or 20 KR gamma rays before sowing. **7, 8, and 9** the grains soaking either in 2, 4, or 6 ppm ABA before sowing. **10, 11 and 12**, the weekly spraying either with 2, 4, and 6 ppm ABA.

Also, four levels of salinity at the rate of 0.0, 15% , 30% and 45% sea water (51.56 ds/m) were used for the irrigation of the plants of each treatment, for each cultivar. Thus, the electrical conductivity (EC) of the four different salinity levels of the irrigation water were 0.23 (control tap water irrigation), 7.73, 15.47 and 23.20 ds/m, respectively. Accordingly, this experiment included 48 treatments with 4 replicates for each, arranged in a completely randomized design. Meanwhile, the most promising four treatments in the first season were selected to be applied in the second one which were grains irradiation either with 15 or 20 KR gamma rays, soaking in 2.0 ppm ABA and the weekly spraying with 2.0 ppm ABA in addition to the both two new treatments; soaking+spraying with 2 ppm ABA and the weekly spraying with 10 µM putrescine as well as the both untreated controls for both tolerant and sensitive cultivars. The same salinity levels as the first season were used for the irrigation of the plants of each treatment, for each cultivar, accordingly this experiments included 32 treatments, with four replicates for each, arranged also, as did in the first season, in a completely randomized design.

*1 ds/m = 1 mmoh/cm = approximately 640 ppm.

**The concentration as ppm = Me/L X atomic weight of each element.

960 pots of 50 cm in diameter were prepared for each growth season; (20 pots for each treatment in the first season and 30 in the second one). In each pot an equal amount of gravel was placed in its bottom, then the pots were filled with an equal quantities from a mixture of 2:1 clay and fine sand (Ghallab and Nesiem, 1999) and were prefertilized according to the same authors with 2.2 g superphosphate (15.5% P2O5); 1.1 g potassium sulphate (48% K2O) and 2.0 g urea (46% N).

In both experiments, mature wheat grains of the salt-sensitive Giza 167 cultivar were soaked for 12 hours in distilled water, then exposed to the different doses of gamma rays [5, 10, 15 and 20 KR] in the first experiment and [15 and 20 KR] in the second one from " Gamma cell 220, model G.C.220 type 13, Atomic Energy of Canada Cobalt 60 at dose rate 19.8 rad/second provided by the Radiation Technology Center, Nasr City, Cairo, Egypt. For ABA soaking treatments, mature grains of the salt-sensitive Giza 167 cultivar were soaked for 24 hours in the dark at 20 ± 1 0C in distilled water (control) or in one of ABA concentrations before sowing. In the spraying treatments with ABA (started 3 weeks after sowing) the plants were weekly sprayed with one of ABA concentrations supplemented with 0.025% Tween20 solution and maintained till the milky ripe stage [95 days after sowing] according to Nesiem and Ghallab (1999). At the same time the salt-sensitive control plants were sprayed only with 0.025% Tween20 solution.

Grains of both wheat cultivars were hand planted on 15^{th} of Nov.1999 in the first season and on 14^{th} of Nov. 2000 in the second one at the rate of 10 grains / pot. The pots were irrigated with tap water until the complete germination (7 days), then the plants were later thinned to leave only four plants / pot. Afterwards, the plants were equally irrigated either with tap water (in the control treatments) or with one of the different concentrations of sea water when needed. During the experimental growth period of both seasons two samples were taken at 75 and 105 days after sowing from each treatment. At each sampling date in the first season 20 plants were then carefully cleaned with moist muslin to remove any adherent dirt, and were arranged to form 4 replicates, then, the plants were separated into shoots and roots and the following growth characters were recorded: **1-** Plant height. **2-** Length of the main root. **3-** Average number of tillers /plant. **4-** Average number of leaves /plant. Thereafter, the plant parts were dried in an electric oven at 70 ^{0}C for 48 hours, and the crude dry weight of both shoots and roots were determined. Meanwhile, in the second season, 30 plants were taken at each sample date and were divided into two groups. The first group, (18 plants) were arranged to from 3 replicates for growth measurements and dry weight determination. The crude dry materials were kept for nutrients, carbohydrates and total free amino acids estimations. The second group (12 plants) was separated into roots and shoots and kept as fresh materials for proline, phytohormones and invertase activity estimation. At harvest (145 day from sowing) the following yield components were recorded: 1- Average number of spikes / plant. 2- Average number of grains / plant. 3- Weight of spikes (g) / plant. 4-Grain yield (g)/plant. 5-Weight of 1000 grains (g). 6-

Weight of straw (g) / plant. The crude dry materials of the produced grains were kept for chemical analyses.

Chemical analyses:

The root and shoot as well as produced grains in the second season; 2000-2001, were chemically analyzed in order to determine their chemical composition.

Hot ethanolic extract of dry plant material was used fore determination of reducing, non-reducing, and total sugars in the different plant parts were by phosphomolybdic acid method according to (A.O.A.C., 1975). Total free amino acids were determined using ninhydrin reagent, (Moore and Stein, 1954). Free proline in the fresh materials was determined calorimetrically using sulphosalicylic acid ninhydrin method as described by Bates *et al.* (1973). The total nitrogen content of the dried material was determined by using the modified- micro-Kjeldahel method as described by Peach and Tracy (1956). Crude protein was calculated as follows:- crude protein (C.P.) = Total nitrogen % X 6.25. Determination of K, P, Na, Ca and Mg were carried out on the ground dry material. The samples were digested in a mixture of sulphoric acid, salicylic acid and hydrogen peroxide according to Linder (1944). Phosphorus was determined sepectrophotometrically by using stannous chloride method according to (A.O.A.C., 1975). Potassium, Sodium, calcium and magnesium were determined by the Atomic Absorption Spectrophotometer (GBC, 932 AA). Endogenous phytohormones determination; indol-3-acetic acid (IAA), cytokinins (equivalent zeatin), gibberellic acid (GA) and abscisic acid (ABA) were determined in freeze-dried plant parts using Gas Liquid Chromatography according to Ibrahim (1997). Extraction of invertase enzyme from the fresh tissues of wheat leaves collected in the first sample was carried out according to (Rathert, 1982 b). Invertase activity was expressed in terms of µmol glucose liberated during 1 min. per (g) fresh weight of the pellet (105 ^{o}C) obtained from centrifugation of the crude extract, according to Rathert (1982 a).

Statistical analysis:

Data of growth characters and yield components were statistically analyzed by using three factorial completely randomized design and the mean values were compared using the least significant difference test [New L.S.D.] at 5 % and 1% levels [Gomez and Gomez, 1984].

RESULTS AND DISCUSSION

It is worthy drawing attention to that the most effective treatments that were applied in both seasons exhibited the same trend of effect in both cases. Therefore, the tabulated and discussed data of the various determinations represent the results obtained in the second season; 2000-2001.

A- Growth characters:

Comparing the effect of saline irrigation (% sea water) on the plant height, root length, number of tillers and leaves /plant, dry matter accumulation in the roots, shoots and the whole wheat stressed cultivar plants (Tables 1 and 2) it can clearly noticed that, the all studied parameters showed a gradual highly significant reduction in response to increasing samples, if compared with the fresh water irrigation (in the control treatments of both tolerant and sensitive cultivars). These results are in full agreement with those previously reported by Sharma and Gary (1985); Ghallab and Nesiem (1999) with wheat and Salem *et al.* (2002) with faba bean. In this connection, also, Mansour (1994) reported that salt stress (100 mM NaCl) for 7 days decreased water permeability and osmotic potential of 10 days-old wheat seedling of Urban (salt-sensitive) and Sakha 8 (salt-tolerant) cultivars, especially Urban. Botella *et al.* (1997) also confirmed the significant reduction of root and shoot growth of wheat plants due to salinity. Moreover, Khan *et al.* (1997) demonstrated that, plant height, shoot and root growth were seriously decreased by salinity (0.0 up to 200 mM NaCl). In addition, Sherief *et al.* (1998) concluded that Giza 162 wheat cultivar was the most sensitive one at the higher concentration of salinity (10.0 – 15.0 ds/m) while Sakha 8 and Sahel 1 showed the highest tolerance to salinity. Nevertheless, dry weight of the all wheat cultivars were decreased with increasing salinity level. On the other hand, the situation was completely different when compared the mean values of the all previously mentioned studied growth parameters as well as dry matter accumulation in the same stressed plants of the sensitive Giza 167 cultivars when treated with the different applied treatments. The obtained data in Tables 1 and 2 clearly confirmed the absolute superiority of the weekly spraying either with 10 µM putrescine or 2 ppm ABA as well as the grains irradiation with 15 KR gamma rays, especially putrescine treatment which recorded the highest highly significant increases, expressed as Mean T, in the all growth parameter and dry weights over the respective Mean T values of the salt-tolerant Sakha 8 control plants in both collected samples. Meanwhile, the second group of treatments, i.e. 20 KR gamma rays, grain soaking in 2 ppm ABA and soaking + spraying with 2 ppm ABA, recorded their highly significant increments only over the salt-sensitive Giza 167 control plants under the same conditions. Moreover, the superiority of the first group of treatments was clearly emphasized when the effect of the interaction between the treatments and salinity level was considered, since, they recorded their highly significant excellence over the salt-tolerant Sakha 8 control plants up to 30% sea water level, meanwhile the second group of treatments could recorded this excellence only up to 15% sea water level, in the all growth parameters and dry weight except that the root length and dry weight when no significant differences were detected due to the interaction between treatments and salinity levels, nevertheless, both group of treatments caused a considerable increases over the salt tolerant control in the root length and dry weight either up to 30% sea water for the first group or up to 15% for the second one. The favorable effects of gamma rays, ABA and putrescine in stimulation the growth and dry matter accumulation of the salt-stressed plants and consequently improving their tolerance to salinity to a

considerable extent was previously evidenced by several workers; El-Halim *et al.* (1989) and Ghallab and Nessiem (1999) who concluded that the possibility of successful application of gamma rays to improve salinity tolerance of the sensitive wheat cultivars. The vital role of ABA in improving adaptation of the salt-stressed plants especially the salt-sensitive cultivars, was also emphasized by Amzallag *et al.* (1990a) and Nesiem and Ghallab (1999). With putrescine, Prakash and Prathapsenen, (1988) suggested that the exogenous application of putrescine can be used successfully to alleviate

Table (1): Effect of gamma rays, abscisic acid and putrescine treatments on the plant height, root length (cm) and number of tillers and leaves/plant of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ %Sea water	75					105				
	0	15	30	45	MeanT	0	15	30	45	MeanT
	Plant height									
Sakha 8 control	63.49	54.80	46.76	39.27	51.00	74.30	63.40	51.40	41.11	57.55
Giza 167 control	59.50	48.13	40.38	30.30	44.58	66.40	48.70	41.30	33.00	47.35
Gamma rays 15 KR	75.94	68.14	55.49	21.77	55.34	85.86	76.55	65.66	22.80	62.71
Gamma rays 20 KR	78.88	69.13	28.23	19.33	48.89	88.30	75.80	30.00	21.30	53.85
Soaking in 2 ppm ABA	79.99	66.90	26.40	19.43	48.18	89.20	74.50	29.50	20.90	53.53
Soaking + spraying with 2 ppm ABA	75.87	67.57	28.03	22.33	48.45	84.30	78.20	30.40	24.50	54.35
Weekly spraying with 2 ppm ABA	80.47	64.52	54.50	19.67	54.79	86.90	78.20	66.60	20.80	63.12
Weekly spraying with 10 µM putrescine	83.53	71.20	68.63	20.27	60.91	89.50	76.20	70.90	21.30	64.48
Mean (S)	74.71	63.80	43.55	24.05		83.03	71.44	48.22	25.65	
New LSD value at		0.05	0.01				0.05	0.01		
Salinity (S)		1.70	2.25				2.66	3.53		
Treatment (T)		2.40	3.19				3.76	4.99		
(S) X (T)		4.80	6.38				7.51	9.99		
	Number of tillers									
Sakha 8 control	3.73	3.13	2.93	2.63	3.11	3.93	3.40	3:06	2.83	3.31
Giza 167 control	3.33	2.21	2.02	1.64	2.30	3.43	2.56	2.11	2.03	2.53
Gamma rays 15 KR	5.99	4.30	3.96	0.66	3.73	6.06	4.44	3.99	0.87	3.84
Gamma rays 20 KR	5.87	4.23	1.11	0.63	2.96	5.97	4.50	1.20	0.73	3.10
Soaking in 2 ppm ABA	5.15	4.09	1.10	0.72	2.77	5.24	5.02	1.17	0.84	3.07
Soaking + spraying with 2 ppm ABA	5.09	4.22	1.11	0.69	2.78	5.33	4.67	1.18	0.96	3.04
Weekly spraying with 2 ppm ABA	5.42	4.31	4.17	0.62	3.63	5.94	4.63	4.01	0.67	3.81
Weekly spraying with 10 µM putrescine	6.17	4.90	4.51	0.73	4.00	6.29	5.01	4.66	0.87	4.21
Mean (S)	5.09	3.92	2.61	1.04		5.27	4.28	2.67	1.23	
New LSD value at		0.05	0.01				0.05	0.01		
Salinity (S)		0.24	0.32				0.25	0.33		
Treatment (T)		0.34	0.45				0.36	0.47		
(S) X (T)		0.67	0.89				0.70	0.90		

Treatments \ %Sea water	75					105				
	0	15	30	45	MeanT	0	15	30	45	MeanT
	Root length									
Sakha 8 control	28.20	24.31	20.62	18.33	22.87	31.22	27.31	23.21	19.90	25.41
Giza 167 control	26.52	19.51	16.33	14.41	19.19	29.11	22.13	18.34	16.33	21.48
Gamma rays 15 KR	35.43	30.22	28.31	13.44	26.85	39.91	35.10	31.11	15.32	30.36
Gamma rays 20 KR	33.50	28.43	15.81	12.82	22.64	36.31	32.22	16.33	14.32	24.80
Soaking in 2 ppm ABA	31.88	30.31	14.00	11.23	21.86	35.30	33.86	16.91	13.11	24.80
Soaking + spraying with 2 ppm ABA	32.82	29.11	13.92	12.30	22.04	36.81	32.21	16.31	14.61	24.99
Weekly spraying with 2 ppm ABA	36.60	33.21	28.33	11.62	27.44	38.51	35.44	30.99	14.33	29.82
Weekly spraying with 10 µM putrescine	38.50	34.40	29.30	12.21	28.60	40.60	36.52	31.21	15.31	30.91
Mean (S)	32.93	28.69	20.83	13.30		35.97	31.85	23.05	15.40	
New LSD value at		0.05	0.01				0.05	0.01		
Salinity (S)		1.71	2.27				2.02	2.69		
Treatment (T)		2.42	2.65				2.86	3.30		
(S) X (T)		N.S.	N.S.				N.S.	N.S.		
	Number of leaves									
Sakha 8 control	8.11	7.81	7.11	6.66	7.42	8.91	8.21	7.77	7.03	7.98
Giza 167 control	7.21	6.88	6.22	5.76	6.52	7.93	7.22	6.71	6.01	6.97
Gamma rays 15 KR	9.04	8.88	8.61	4.90	7.86	11.91	9.52	8.84	5.02	8.82
Gamma rays 20 KR	8.93	8.65	5.38	4.86	6.96	9.99	9.31	5.71	4.99	7.50
Soaking in 2 ppm ABA	8.95	8.78	5.33	4.76	6.96	10.11	9.19	5.71	5.01	7.51
Soaking + spraying with 2 ppm ABA	9.84	8.73	5.36	4.64	7.14	10.96	9.46	5.66	4.87	7.74
Weekly spraying with 2 ppm ABA	9.96	8.99	7.99	4.71	7.91	11.09	9.33	8.94	5.01	8.59
Weekly spraying with 10 µM putrescine	10.02	8.88	8.71	4.88	8.12	11.33	10.18	9.51	5.02	9.01
Mean (S)	9.01	8.45	6.84	5.15		10.28	9.05	7.36	5.37	
New LSD value at		0.05	0.01				0.05	0.01		
Salinity (S)		0.22	0.29				0.26	0.35		
Treatment (T)		0.31	0.41				0.37	0.49		
(S) X (T)		0.62	0.82				0.73	0.98		

Table (2): Effect of gamma rays, abscisic acid and putrescine treatments on the dry weight of roots, shoots and the whole plants of the salt-sensitive Giza 167 wheat cultivar in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ % sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Roots									
Sakha 8 control	0.68	0.53	0.41	0.36	0.50	0.97	0.73	0.51	0.42	0.66
Giza 167 control	0.52	0.31	0.27	0.11	0.30	0.82	0.40	0.36	0.13	0.43
Gamma rays 15 KR	1.07	0.77	0.68	0.07	0.65	1.45	1.09	0.88	0.08	0.88
Gamma rays 20 KR	0.96	0.80	0.18	0.07	0.50	1.40	1.08	0.25	0.07	0.70
Soaking in 2 ppm ABA	1.01	0.78	0.16	0.05	0.50	1.33	1.11	0.22	0.06	0.68
Soaking + spraying with 2 ppm ABA	0.95	0.78	0.13	0.06	0.48	1.32	1.00	0.18	0.06	0.66
Weekly spraying with 2 ppm ABA	1.11	0.77	0.65	0.04	0.64	1.45	1.25	0.86	0.06	0.91
Weekly spraying with 10 µM putrescine	1.19	0.87	0.70	0.06	0.71	1.56	1.33	0.93	0.08	0.98
Mean (S)	0.94	0.70	0.40	0.10		1.29	1.01	0.52	0.12	
New LSD value at		0.05	0.01				0.05	0.01		
Salinity (S)		0.06	0.08				0.09	0.12		
Treatment (T)		0.09	0.11				8.13	0.18		
(S) X (T)		N.S.	N.S.				N.S.	N.S.		

Treatments \ % sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	5.19	4.18	3.76	3.27	4.01	6.89	6.12	5.12	4.51	5.66
Giza 167 control	4.04	3.05	2.65	2.17	2.98	5.10	4.21	3.91	3.20	4.11
Gamma rays 15 KR	6.88	5.81	4.88	0.97	4.64	10.88	9.79	7.67	1.10	7.36
Gamma rays 20 KR	6.57	5.47	1.60	0.93	3.64	10.69	9.10	1.93	1.07	5.77
Soaking in 2 ppm ABA	6.34	5.81	1.38	0.86	3.60	10.96	8.86	1.57	1.04	5.63
Soaking + spraying with 2 ppm ABA	6.35	5.60	1.59	1.00	3.67	10.89	8.20	1.82	1.19	5.53
Weekly spraying with 2 ppm ABA	6.61	5.49	5.23	1.15	4.62	10.85	9.83	8.36	1.01	7.61
Weekly spraying with 10 µM putrescine	6.96	5.95	5.87	1.16	4.99	10.99	10.88	9.67	1.20	8.11
Mean (S)	6.12	5.18	3.37	1.45		9.66	8.37	5.03	1.79	
New LSD value at		0.05	0.01				0.05	0.01		
Salinity (S)		0.27	0.35				0.85	0.93		
Treatment (T)		0.38	0.50				1.21	1.40		
(S) X (T)		0.76	1.00				1.61	1.91		

Treatments \ % sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Whole plant									
Sakha 8 control	5.87	4.71	4.17	3.63	4.60	7.86	6.85	5.63	4.93	6.32
Giza 167 control	4.56	3.36	2.92	2.28	3.28	5.92	4.61	4.27	3.33	4.53
Gamma rays 15 KR	7.95	6.58	5.56	1.04	5.28	12.33	10.88	8.55	1.18	8.24
Gamma rays 20 KR	7.53	6.27	1.78	1.00	4.15	12.09	10.18	2.18	1.13	6.40
Soaking in 2 ppm ABA	7.35	6.59	1.54	0.91	4.10	12.29	9.97	1.79	1.10	6.29
Soaking + spraying with 2 ppm ABA	7.30	6.46	1.72	1.14	4.16	12.21	9.28	2.00	1.25	6.19
Weekly spraying with 2 ppm ABA	7.72	6.26	5.88	1.19	5.26	12.30	11.08	9.42	1.07	8.47
Weekly spraying with 10 µM putrescine	8.15	6.82	6.57	1.22	5.69	12.55	12.21	10.60	1.28	9.16
Mean (S)	7.05	5.88	3.77	1.55		10.94	9.38	5.36	1.91	
New LSD value at		0.05	0.01				0.05	0.01		
Salinity (S)		0.00	0.11				0.24	0.25		
Treatment (T)		0.12	0.14				0.31	0.36		
(S) X (T)		1.18	1.36				2.13	2.90		

the NaCl stress injuries in rice plants and consequently improved their growth to a considerable extent. Bagni and Torrigiani (1992) reported that diamine putrescine and polyamines are recognized as new class of plant growth regulators present in the all plants examined so far. Moreover Parakash and Thrope (1991) emphasized that di- and polyamine (mainly putrescine) are required for growth and differentiation in many plant species, thus might serve as reserve of carbon and nitrogen during *de novo* organogensis. Krishnamurthy (1991) reported that the foliar application with 10 μM putrescine on the salt stressed rice plants grown in pots, considerably increased their shoot fresh and dry weights and grain yield.

B: Chemical composition of the growing plants

1-Sugars, free proline and total free amino acids:

As shown in Tables 3, 4 and 5, and in sharp contrast with that obtained data with the growth parameters and dry weight (Table 1 and 2), increasing salinity level in the irrigation water caused a gradual increase in the concentrations of sugars, i.e. reducing, non-reducing and total sugars, proline and total free amino acids in the roots and shoots of the stressed wheat plants in both collected samples, when compared with those irrigated with the fresh water in control treatment. Moreover, it could be realize in Table 3 that, both stressed plant organs accumulated much more quantities of non-reducing sugars, which greatly surpassed the respective quantities of reducing ones under the all salinity levels in both samples. Supportive evidence for these results was found in the reported data by Strogonov (1970) who concluded that, under saline conditions, the accumulation of non-toxic substances such as sucrose, proline, organic acid and protein considered to be a protective adaptation.

Moreover, Santarius (1973) found that, the sugars as osmolytes enable plants to keep better water relations under stress conditions. Also, Simpson (1981) stated that, glycophytes adapt themselves to somewhat saline conditions by lowering osmotic potential through converting starch to sugars. Itoth and Kumuro (1987) reported that, both K^+ and sugars contribute to the osmotic adjustment in many species, and in (1990) Gananasiri insured this concept, suggesting that, osmoregulation is stressed plants was higher with K^+ and sugars, both of them were found to correlate negatively with osmotic potential. Also, Kirst (1990) described sucrose as one of the compatible solutes, that increase during salt stress. Ashraf *et al.* (1991) stated that salinity decreased dry matter accumulation and increased solutes accumulation,proline betaine and total soluble sugar, such accumulation, thus considered as a suitable screening for salinity tolerance. More recently, Pessarakli (2002) concluded that plant use soluble sugars as an osmoticum under saline conditions. Hence, the plants that fail to increase soluble sugars biosynthesis could not tolerate salt stress. Also, Salem *et al.* (2002) reported that both the salt-tolerant faba bean two cultivars; Giza 429 and Giza 843 showed much higher degree of osmotic adjustment through the accumulation of considerable quantities of organic protective osmolytes, i.e. sugars (especially non-reducing ones), proline and free amino acids in their shoots and roots, which greatly exceeded that in the salt susceptible two cultivars, i.e. Giza 674 and Giza 3.

Table (3): Effect of gamma rays, abscisic acid and putrescine treatments on the reducing, non-reducing and total sugars concentrations (mg glucose/g dry weight) in the shoot and root of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ % Sea water	75					105					75					105					75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T
	Reducing sugars										Non-reducing sugars										Total sugars									
	Shoots																													
Sakha 8 control	32.94	38.11	49.95	55.94	44.24	40.42	46.34	60.94	67.44	53.79	36.98	44.17	63.72	75.60	55.12	49.96	65.54	88.98	96.80	75.32	69.92	82.28	113.67	131.54	99.36	90.38	111.88	149.92	164.24	129.11
Giza 167 control	28.64	31.63	38.95	41.32	35.14	33.16	39.98	47.97	54.51	43.91	26.40	30.16	41.46	56.68	38.68	31.21	42.91	64.65	77.93	54.18	55.04	61.79	80.41	98.00	73.82	64.37	82.89	112.62	132.44	98.09
Gamma rays 15 KR	49.74	53.66	59.81	61.34	56.14	55.99	63.70	71.26	74.36	66.33	52.53	61.07	72.10	79.33	66.26	63.23	79.60	89.77	99.62	83.06	102.27	114.73	131.91	140.67	122.40	119.22	143.30	161.03	173.98	149.39
Gamma rays 20 KR	35.37	40.22	42.13	45.06	40.70	46.34	49.96	52.76	57.11	51.54	45.92	51.71	55.41	60.86	53.48	62.56	69.41	72.27	79.52	70.94	81.29	91.93	97.54	105.92	94.18	108.90	119.37	125.03	136.63	122.48
Soaking in 2 ppm ABA	36.29	40.71	42.66	44.89	41.14	45.09	50.06	52.89	56.31	51.09	44.55	52.62	56.64	61.65	53.87	65.70	69.01	71.82	79.11	71.41	80.84	93.33	99.30	106.54	95.01	110.79	119.07	124.71	135.42	122.50
Soaking + spraying with 2 ppm ABA	35.91	41.05	43.01	45.11	41.27	44.70	51.56	53.25	55.92	51.36	45.82	52.51	54.23	60.78	53.34	66.75	68.91	72.01	79.36	71.76	81.73	93.56	97.24	105.89	94.61	111.45	120.47	125.26	135.28	123.12
Weekly spraying with 2 ppm ABA	49.98	53.81	59.68	61.11	56.15	56.26	64.20	72.22	74.56	66.81	53.75	62.31	73.98	79.42	67.37	68.50	88.89	99.25	102.11	89.69	103.73	116.12	133.66	140.53	123.52	124.76	153.09	171.47	176.67	156.50
Weekly spraying with 10 µM putrescine	51.19	54.16	59.91	61.45	56.68	56.61	65.06	73.73	75.02	67.61	54.16	63.87	74.59	80.11	68.18	69.11	95.20	100.80	103.20	92.08	105.35	118.03	134.50	141.56	124.86	125.72	160.26	174.53	178.22	199.69
Mean (S)	40.01	44.17	49.51	52.03		47.32	53.86	60.63	64.40		45.01	52.30	61.52	69.30		59.63	72.43	82.44	89.71		85.02	96.47	111.03	121.33		106.95	126.29	143.07	154.11	
	Roots																													
Sakha 8 control	8.79	10.57	15.38	18.43	13.29	10.05	13.55	17.58	22.44	15.91	11.91	19.38	25.50	34.01	22.70	13.10	27.04	33.79	46.01	29.99	20.70	29.95	40.88	52.44	35.99	23.15	40.59	51.37	68.45	45.90
Giza 167 control	6.91	8.57	10.83	12.56	9.72	8.41	10.41	12.67	15.12	11.65	11.01	13.21	16.45	19.77	15.11	11.98	16.40	22.60	29.11	20.02	17.92	21.78	27.28	32.33	24.83	20.39	26.81	35.27	44.23	31.67
Gamma rays 15 KR	12.51	14.94	19.77	20.34	16.89	18.66	20.93	24.89	25.21	22.42	23.19	28.99	34.35	36.11	30.66	30.98	35.41	42.61	47.51	39.13	35.70	43.93	54.12	56.45	47.55	49.64	56.34	67.50	72.72	61.55
Gamma rays 20 KR	9.16	11.42	12.61	13.92	11.78	11.50	13.89	14.11	16.07	13.89	13.61	20.21	22.13	25.61	20.39	20.77	28.59	30.01	32.41	27.95	22.77	31.63	34.74	39.53	32.17	32.27	42.48	44.12	48.48	41.84
Soaking in 2 ppm ABA	9.58	11.61	12.51	13.81	11.88	11.43	13.72	14.24	16.10	13.87	13.98	20.50	22.18	26.11	20.69	21.01	28.10	30.25	32.79	28.04	23.56	32.11	34.69	39.92	32.57	32.44	41.82	44.49	48.89	41.91
Soaking + spraying with 2 ppm ABA	9.04	11.31	13.06	14.02	11.86	11.40	13.69	14.52	16.13	13.94	14.01	20.66	23.11	26.41	21.05	20.71	27.96	30.11	32.19	27.74	23.05	31.97	36.17	40.43	32.91	32.11	41.65	44.63	48.32	41.68
Weekly spraying with 2 ppm ABA	13.04	15.10	19.02	20.28	16.86	18.98	20.16	24.95	25.11	22.30	23.28	28.87	35.36	36.91	31.11	30.21	36.62	43.37	47.72	39.48	36.32	43.97	54.38	57.19	47.97	49.19	56.78	68.32	72.83	61.78
Weekly spraying with 10 µM putrescine	14.59	16.59	19.84	20.69	17.93	19.63	21.85	25.15	26.31	23.24	24.59	30.27	36.78	38.01	32.41	31.72	37.97	44.80	47.85	40.59	39.18	46.86	56.62	58.70	50.34	51.35	59.82	69.95	74.16	63.83
Mean (S)	10.45	12.51	15.38	16.76		13.76	16.03	18.51	20.31		16.95	22.76	26.98	30.37		22.56	29.76	34.69	39.45		27.40	35.27	42.36	47.13		36.32	45.79	53.20	59.76	

Table (4): Effect of gamma rays, abscisic acid and putrescine treatments on free proline concentration (mg/g fresh weight) in the shoot and root of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (% sea water) during 2000-2001 season.

Treatments \ % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	2.17	2.62	3.94	4.63	3.34	2.95	3.43	4.92	5.28	4.15
Giza 167 control	1.89	2.13	2.55	3.05	2.41	2.21	2.75	3.18	3.37	2.88
Gamma rays 15 KR	3.27	3.76	4.56	4.89	4.12	3.66	4.15	5.22	5.71	4.69
Gamma rays 20 KR	2.22	2.87	2.97	2.41	2.62	3.17	3.59	3.78	3.89	3.61
Soaking in 2 ppm ABA	2.13	2.85	2.91	3.33	2.81	3.43	3.68	3.75	3.87	3.68
Soaking + spraying with 2 ppm ABA	2.21	2.89	2.99	3.40	2.87	3.10	3.75	3.81	3.92	3.65
Weekly spraying with 2 ppm ABA	3.37	3.86	4.58	4.95	4.19	3.89	4.27	5.39	5.81	4.84
Weekly spraying with 10 μM putrescine	3.49	3.91	4.61	5.02	4.26	3.93	4.32	5.48	5.91	4.91
Mean (S)	2.59	3.11	3.64	3.96		3.29	3.74	4.44	4.72	
	Roots									
Sakha 8 control	1.14	1.38	2.14	2.89	1.89	1.33	1.71	3.12	4.24	2.60
Giza 167 control	0.96	1.11	1.33	1.71	1.28	1.15	1.36	1.64	1.93	1.52
Gamma rays 15 KR	1.74	2.47	2.89	2.91	2.50	1.97	2.53	3.86	4.7[illegible]	3.27
Gamma rays 20 KR	1.37	1.96	2.13	2.36	1.96	1.88	2.12	2.67	2.94	2.40
Soaking in 2 ppm ABA	1.46	1.88	2.21	2.30	1.96	1.96	2.09	2.44	2.83	2.33
Soaking + spraying with 2 ppm ABA	1.58	1.99	2.29	2.41	2.07	1.98	2.15	2.62	2.92	2.42
Weekly spraying with 2 ppm ABA	1.88	2.42	2.81	2.95	2.52	2.07	2.60	3.92	4.80	3.35
Weekly spraying with 10 μM putrescine	1.98	2.49	2.88	2.99	2.59	2.19	2.79	3.99	4.91	3.47
Mean (S)	1.51	1.96	2.34	2.57		1.82	2.17	3.03	3.66	

Table (5): Effect of gamma rays, abscisic acid and putrescine treatments on total free amino acids concentration (mg/g dry weight) in the shoot and root of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (% sea water) during 2000-2001 season.

Treatments \ % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	5.13	6.23	8.85	9.93	7.54	5.85	6.95	9.81	10.16	8.19
Giza 167 control	3.86	4.18	5.13	6.98	5.04	4.11	5.35	6.53	7.79	5.95
Gamma rays 15 KR	7.13	8.91	10.13	11.53	9.43	7.84	9.38	11.64	12.66	10.38
Gamma rays 20 KR	5.87	6.96	7.19	7.44	6.87	6.16	7.13	8.34	9.51	7.79
Soaking in 2 ppm ABA	5.77	6.76	7.08	7.63	6.81	6.35	7.73	8.41	9.41	7.98
Soaking + spraying with 2 ppm ABA	5.88	6.84	7.11	7.79	6.91	6.48	7.29	8.45	9.53	7.94
Weekly spraying with 2 ppm ABA	7.29	8.93	10.26	11.61	9.52	8.43	9.46	11.73	12.75	10.59
Weekly spraying with 10 μM putrescine	7.44	8.98	10.37	11.66	9.61	8.64	9.61	11.84	12.88	10.74
Mean (S)	6.05	7.22	8.27	9.32		6.73	7.86	9.59	10.59	
	Roots									
Sakha 8 control	2.18	2.88	4.19	4.81	3.52	2.84	3.24	5.44	5.81	4.33
Giza 167 control	1.27	1.95	2.16	2.36	1.94	2.16	2.38	2.71	2.98	2.56
Gamma rays 15 KR	3.01	4.17	5.16	5.54	4.47	3.49	5.01	6.60	6.88	5.50
Gamma rays 20 KR	2.93	3.19	3.38	3.52	3.26	3.16	4.12	4.41	4.71	4.10
Soaking in 2 ppm ABA	2.69	3.24	3.41	3.53	3.22	3.19	4.22	4.51	4.73	4.16
Soaking + spraying with 2 ppm ABA	2.55	3.01	3.45	3.59	3.25	3.15	4.31	4.55	4.76	4.19
Weekly spraying with 2 ppm ABA	3.45	4.76	5.25	5.83	4.82	3.94	5.18	6.66	6.91	5.67
Weekly spraying with 10 μM putrescine	3.35	4.98	5.36	5.96	4.91	4.19	5.21	6.69	6.93	5.76
Mean (S)	2.73	3.52	4.05	4.39		3.27	4.21	5.20	5.46	

The considerable accumulation of proline as a striking sequence and main feature of increasing water or salt stress has been previously confirmed by several workers, due to its major physiological functions under such stress conditions.These functions include osmoregulation; as a compatible cytoplasmic solute it apparently counteracts the osmotic potential of the vacuole salts (Dov-Posternak, 1987). Moreover, proline and other compatible solutes are believed to cause the minimal inhibition of metabolism.

Also, proline is organic osmolytes solute with an amphiphilic molecule protects the hydrophobic parts of proteins which suffer first when water potential is lowered. By forming association with the hydrophobic proteins of macromoleculles, proline converts them into hydrophilic parts, (Kirst, 1990). In general, proline concentrations are directly proportional to the salinity level or to the intensity of water stress. Restoring plants to optimal growth conditions results in a rapid decline in proline content. In addition Giovanna *et al.* (1989) found that, free amino acids concentration increased in tomato leaf tissues treated with salt 3.5 times compared with control. Also, Good and Zaplackinski (1994) reported that, the concentration of free amino acids (particularly proline) often increases markedly in the leaves or other plant tissues with exposure to many biotic or abiotic stress. Moreover, Sharma *et al.* (1996) reported that the greater effects of chloride salinity on wheat plants were mediated through decline in soluble carbohydrates, protein synthesis, N and K^+ content and K^+/Na^+ ratio concomitant with greater accumulation of proline and amino acids. The considerable accumulation of sugars, proline, free amino acids in the stressed plant organs was more obvious when such stressed plants were treated with the different physiological treatments. In this concern the recorded data in Table 3, 4 and 5 clearly confirmed the superiority of the weekly spraying either with 10 μM putrescine or 2 ppm ABA and grains irradiation with 15 KR gamma rays, respectively, in inducing the highest increments in the Mean T of sugars, proline and amino acids over the Mean T of salt-tolerant control values, in both samples. The same conclusion can be also drawn when consider the effect of the interaction between treatments and the all applied salinity levels on the sugars, proline and free amino acids concentrations, since the superiority of these three treatments was emphasized under the all salinity levels up to the highest one, i.e. 45 % sea water. Meanwhile, the treatments with 20 KR gamma rays, soaking in 2 ppm ABA and soaking + spraying with 2 ppm ABA induced these increments only over the respective Mean T values of the salt-sensitive control, and could exceeded the respective values of the salt-tolerant control only up to 15% sea water level.

The favorable effects of the exogenous application of gamma rays, ABA and putrescine were previously evidenced by many authors. Ghallab and Nesiem (1999) reported that salt tolerance which was more pronounced as a result of 5.0 KR gamma rays treatment, was associated with high accumulation of ABA, sucrose, proline and amino acids in the roots and shoots of both partially salt tolerant Sakha 92 and the sensitive Giza 163 cultivars. Moreover, the grains produced from the treated plants with 5.0 KR gamma rays were characterized by increased accumulation of protein, sucrose and mineral nutrients by increasing salinity levels up to 20.0% sea water. Therefore, they suggested the possibility of successful application of gamma rays to improve salinity tolerance of the sensitive wheat cultivars. With the same both wheat cultivars Nesiem and Ghallab (1999) reported that, the foliar applications with ABA increased tolerance of both cultivars to salinity through the increasing root length and dry weight as well as grain yield (g)/plant. The same authors added that, ABA treatment may partially increase the ability to counteract salinity by accumulating relatively higher amounts of sugars, free proline, amino acids and endogenous ABA as well as lowering the Na^+ level and increase K^+ and Ca^+ in the shoots. On the other hand, Prakash and Prathapasenan (1988) mentioned that the exogenous application of putrescine increased K^+ level and chlorophyll content in the all tissues of salt-stressed rice plants. Moreover, Krishnamurthy (1991) reported that foliar application of 10 µM putrescine prevented chlorophyll in the leaves of rice plants exposed to saline conditions.

2-Total crude protein:

As would be expected according to well-documented previously published data by several authors, which indicated that plant metabolism and more specifically protein synthesis are adversely affected under salt stress. Supportive evidence for this view is found in the recorded data in Table 6, which clearly reveal that total crude protein concentrations in the stressed shoots and roots showed gradual decrease associated with the increase in salinity level to reach its maximum at the highest level of salinity in the irrigation water, i.e. 45% sea water as compared to the fresh water irrigation in the control treatment.

Decreasing protein level due to salinity was previously reported by Youssef (1989); Farahat (1990); Shehata (1992); Younis *et al.* (1993); Ramanjulu *et al.* (1993); Sharma *et al.* (1996) and Salem *et al.* (2002). The negative effects of salinity on protein level in the stressed plants as a result of the decreased protein synthesis as well as increased activities of hydrolyzing enzymes was previously reported by Sallam (1999) who mentioned that in faba bean plants, proline, free amino acids and protease (proteinase) increased with increasing salinity level. On the other hand, in certain cases, however, an increased protein level was recorded under salt stress, which would be explained as due to the increased synthesis of new salt induced proteins or the decreased activities of proteolytic enzymes.

The favorable positive effects of the applied physiological treatments which were previously evidenced as regards sugars, proline and free amino acids accumulation in the stressed wheat plants, were also reflected on the total crude protein concentration in the treated roots and shoots (Table 6) when considered the mean values of each treatment regardless salinity level (Mean T). Consequently, the response of protein concentrations in the stressed roots and shoots to the various applied treatments corresponded to similar trend that described with sugars, proline and free amino acids concentrations. However, when considered the interaction effect between the applied treatments and the salinity levels, it could be noticed that the weekly spraying either with 10 µM putrescine or 2 ppm ABA as well as irradiation with 15 KR gamma rays exerted their positive increments on the protein concentrations over the respective values of the salt-tolerant control up to 30 % sea water level, meanwhile, 20 KR gamma rays, soaking in 2 ppm ABA and soaking + spraying with 2 ppm ABA treatments, were able to do so, only up to 15 % sea water at both sampling dates. The super positive effect of putrescine treatment on the protein contents in the roots, shoots and the whole treated plants under saline conditions would be explained as due to important regulatory role played by putrescine in promotion of plant growth and development (Smith, 1982 and Parakash and Prathapsenan, 1988) influencing protein and nucleic acid synthesis (Slocum *et al.* 1984) and associated with photosynthetic activity (Chatterjee *et al.* 1988) or because putrescine and polyamines have been frequently described as endogenous plant growth regulators or intercellular second messengers mediating the effect of phytohormones (Galston 1983) or because that putrescine and polyamines are involved in important biological processes, e.g. ionic balance, and DNA, RNA and protein stabilization (Lucarini and Sangwan, 1987) or due to that putrescine and possible the polyamines may serve as reserves of carbon and nitrogen in the plants (Parakash and Thrope, 1991), putrescine brought about a considerable alleviation of stress injury induced by salinity (Reddell *et al.* 1986) or due to that foliar application with putrescine accelerated the accumulation of K^+, Ca^{+2} , Mg^{+2}, proline and prevented degradation of chlorophyll as well as inhibition of the reductions of soluble and total protein as well as RNA and DNA contents in the plant tissues exposed to salinity (Krishnamurthy, 1991).In this concern ,Willadino *et al.*(1996) also reported that the stimulation of shoot growth under saline conditions induced by putrescine application may be due to its effects on the synthesis of macromolecules for polyamines which are known to increase nucleic acids synthesis and stimulate various processes associated with the synthesis of protein as well as promote cell division. On the other hand, increasing protein content induced by gamma rays irradiation under saline conditions was previously reported by Kumar and Yadav (1983); with wheat, El-Shafey *et al.* (1998); with rice and wheat and Ghallab and Nesseim (1999) with wheat. As for ABA, its effectiveness in increasing protein content of the salt-stressed plant was previously stated by Mundy and Chau (1988) with rice and Nesseim and Ghallab (1999) with wheat.

Table (6): Effect of gamma rays, abscisic acid and putrescine treatments on total crude protein concentration (mg/g dry weight) in the shoot and root of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (% sea water) during 2000-2001 season.

Treatments / % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	163.81	135.50	121.00	95.13	128.86	182.75	152.50	128.25	106.38	142.47
Giza 167 control	152.75	107.50	90.56	71.63	105.61	166.88	120.25	101.25	82.56	117.73
Gamma rays 15 KR	199.69	107.06	162.56	45.00	148.58	201.69	197.50	174.44	56.31	157.48
Gamma rays 20 KR	191.25	127.75	63.19	43.13	106.33	196.25	177.50	56.94	53.75	121.11
Soaking in 2 ppm ABA	182.50	167.50	67.81	42.81	115.16	193.06	170.63	68.81	51.25	120.94
Soaking + spraying with 2 ppm ABA	187.75	168.88	68.81	44.38	117.45	195.06	176.25	68.31	49.38	122.25
Weekly spraying with 2 ppm ABA	203.75	188.19	165.00	47.44	151.09	207.50	195.00	177.50	55.69	158.92
Weekly spraying with 10 µM putrescine	207.50	199.06	180.06	50.63	159.31	213.75	200.63	188.81	57.00	165.05
Mean (S)	186.13	160.18	114.88	55.02		194.62	173.78	120.54	64.04	
	Roots									
Sakha 8 control	106.63	91.50	78.94	59.63	84.17	112.25	94.88	82.06	68.13	89.33
Giza 167 control	90.00	78.75	58.31	49.25	69.08	94.88	83.25	66.31	54.88	74.83
Gamma rays 15 KR	136.25	116.44	106.94	28.38	97.00	147.81	134.00	123.06	36.63	110.38
Gamma rays 20 KR	117.50	103.75	47.56	27.50	74.08	125.63	111.88	50.50	31.88	79.97
Soaking in 2 ppm ABA	118.25	104.31	45.00	26.88	73.61	126.31	108.75	47.00	31.94	78.50
Soaking + spraying with 2 ppm ABA	118.81	105.63	46.56	27.56	74.64	127.50	109.38	47.88	32.94	79.42
Weekly spraying with 2 ppm ABA	138.31	128.13	118.69	31.31	104.11	143.81	131.94	130.00	33.50	109.81
Weekly spraying with 10 µM putrescine	146.13	135.06	125.06	35.56	110.45	156.00	138.75	131.88	37.06	115.92
Mean (S)	121.48	107.95	78.38	35.76		129.27	114.10	84.84	40.87	

3-Nutrient elements:

a-Nitrogen, phosphorus and potassium:

The obtained results in Tables 7, 8 and 9 showed that the concentrations of N, P and K were adversely affected by increasing salinity level in the irrigation water. Hence, such concentrations tended to decreased gradually by increasing salinity level to reach their lowest Mean S values in the stressed plants irrigated with 45% sea water level. The detrimental effects of salinity on nutrients uptake and accumulation in the stressed plants have been previously reported by several workers. It is well documented that nutrient concentrations and contents were adversely affected under saline conditions. Moreover, salinity appears to affect the distribution pattern of nutrient elements with various plant organs. In this regard, Said *et al.* (1966) and Balasubramanin and Sinha (1976), found that in most cases, salinity decreased soluble protein and total nitrogen content in the different organs of cowpea plants.

Table (7): Effect of gamma rays, abscisic acid and putrescine treatments on nitrogen concentration (mg/g dry weight) in the shoot and root of the sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments / % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	26.21	21.68	19.36	15.22	20.62	29.24	24.40	20.52	17.02	22.80
Giza 167 control	24.44	17.20	14.49	11.46	16.90	26.70	19.24	16.20	13.21	18.84
Gamma rays 15 KR	31.95	29.93	26.01	7.20	23.77	32.27	31.60	27.91	9.01	25.20
Gamma rays 20 KR	30.60	20.44	10.11	6.90	18.51	31.40	28.40	9.11	8.60	19.38
Soaking in 2 ppm ABA	29.20	26.80	10.85	6.85	18.43	30.89	27.30	11.01	8.20	19.35
Soaking + spraying with 2 ppm ABA	30.04	27.02	11.01	7.10	18.79	31.21	28.20	10.93	7.90	19.56
Weekly spraying with 2 ppm ABA	32.60	30.11	26.40	7.59	24.18	33.20	31.20	28.40	8.91	25.43
Weekly spraying with 10 µM putrescine	33.20	31.85	28.81	8.10	25.49	34.20	32.10	30.21	9.12	26.41
Mean (S)	29.78	26.38	18.38	8.80		31.14	27.81	19.29	10.25	
	Roots									
Sakha 8 control	17.06	14.64	12.63	9.54	13.47	17.96	15.18	13.13	10.90	14.29
Giza 167 control	14.40	12.60	9.33	7.88	11.05	15.18	13.32	10.61	8.78	11.97
Gamma rays 15 KR	21.80	18.63	17.11	4.54	15.52	23.65	21.44	19.69	5.86	17.66
Gamma rays 20 KR	18.80	16.60	7.61	4.40	11.85	20.10	17.90	8.08	5.10	12.80
Soaking in 2 ppm ABA	18.92	16.69	7.20	4.30	11.78	20.21	17.40	7.52	5.11	12.56
Soaking + spraying with 2 ppm ABA	19.01	16.90	7.45	4.41	11.94	20.40	17.50	7.66	5.27	12.71
Weekly spraying with 2 ppm ABA	22.13	20.50	18.99	5.01	16.66	23.01	21.11	20.80	5.36	17.57
Weekly spraying with 10 µM putrescine	23.38	21.61	20.01	5.69	17.67	24.96	22.20	21.10	5.93	18.55
Mean (S)	19.44	17.27	12.54	5.72		20.68	18.26	13.57	6.54	

Table (8): Effect of gamma rays, abscisic acid and putrescine treatments on phosphorus concentration (mg/g dry weight) in the shoot and root of the sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments / % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	3.19	2.85	2.54	2.12	2.68	3.29	3.18	2.91	2.36	2.94
Giza 167 control	2.51	2.04	1.96	1.67	2.05	2.64	2.36	2.15	1.97	2.28
Gamma rays 15 KR	4.62	3.93	3.33	1.11	3.25	5.95	4.65	3.85	1.16	3.90
Gamma rays 20 KR	3.87	3.33	1.25	1.06	2.38	4.19	3.61	1.34	1.11	2.56
Soaking in 2 ppm ABA	3.72	3.25	1.20	1.10	2.32	4.13	3.93	1.30	1.20	2.64
Soaking + spraying with 2 ppm ABA	3.79	3.28	1.22	1.13	2.36	4.22	3.99	1.35	1.22	2.70
Weekly spraying with 2 ppm ABA	4.72	3.93	3.71	1.19	3.39	6.11	5.17	4.34	1.34	4.24
Weekly spraying with 10 µM putrescine	4.87	4.19	4.05	1.22	3.58	6.23	5.23	4.92	1.44	4.46
Mean (S)	3.91	3.35	2.41	1.33		4.60	4.02	2.77	1.48	
	Roots									
Sakha 8 control	2.24	2.02	1.98	1.33	1.89	2.41	2.24	2.17	1.53	2.09
Giza 167 control	1.92	1.81	1.57	1.18	1.62	1.84	1.68	1.56	0.92	1.50
Gamma rays 15 KR	3.11	2.77	2.55	0.57	2.25	3.20	2.88	2.67	0.68	2.36
Gamma rays 20 KR	2.89	2.55	1.20	0.54	1.80	2.92	2.61	1.25	0.60	1.85
Soaking in 2 ppm ABA	2.81	2.51	1.22	0.59	1.78	2.91	2.62	1.33	0.68	1.89
Soaking + spraying with 2 ppm ABA	2.82	2.55	1.15	0.55	1.77	2.93	2.66	1.27	0.66	1.88
Weekly spraying with 2 ppm ABA	3.15	2.80	2.56	0.60	2.28	3.29	2.91	2.69	0.70	2.40
Weekly spraying with 10 µM putrescine	3.22	2.91	2.59	0.65	2.34	3.35	3.01	2.82	0.73	2.48
Mean (S)	2.77	2.49	1.85	0.75		2.86	2.58	1.97	0.81	

Also, Hammad (1979) pointed out that, increasing NaCl salinity tended to decrease the total N percentage in barley plant. Moreover, Waheb and Zahran (1981) found that in *Vicia faba* plants, salt stress retarded the growth and N content. Also with *Vicia faba* El-Shakweer and Barakat (1984) showed that, N, P and K contents were depressed by increasing salinity. Similar results were reported by Aly (1987); El-Gayar (1988); Hamdy (1988); Nour *et al* (1989) Khalil (1991); Kumar and Singh (1996) and Salem *et al*., (2002).

In contrast, the substantial favorable effects, which in turn induced the consistent considerable increases in nutrients concentrations due to the effect of the applied treatments was recorded in the treated plants of Giza 167 sensitive cultivar. The recorded data in Table 7, 8 and 9 showed that such stressed plants when weekly sprayed either with 10 µM putrescine or 2 ppm ABA or their grains were irradiated with 15 KR gamma rays showed much higher Mean T values of these nutrient concentrations than the respective values of the salt-tolerant control plants, meanwhile the second group of treatments could only exceeded the salt-sensitive control in this respect in both collected samples.

Table (9): Effect of gamma rays, abscisic acid and putrescine treatments on potassium concentration (mg/g dry weight) in the shoot and root of the sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	34.91	31.60	25.39	19.10	27.75	38.86	33.21	28.13	21.76	30.49
Giza 167 control	28.23	25.49	20.00	16.10	22.46	33.88	27.58	22.40	17.90	25.44
Gamma rays 15 KR	40.96	37.87	33.51	9.42	30.44	45.01	43.71	38.89	10.30	34.48
Gamma rays 20 KR	38.11	33.14	15.22	9.36	23.96	41.29	37.57	17.07	10.10	26.51
Soaking in 2 ppm ABA	38.16	32.77	15.19	9.65	23.94	42.02	37.75	17.30	10.40	26.87
Soaking + spraying with 2 ppm ABA	38.81	32.79	15.49	9.75	24.21	42.85	38.27	17.87	10.42	27.35
Weekly spraying with 2 ppm ABA	40.28	37.25	35.25	9.90	30.67	46.78	44.99	38.69	10.49	35.24
Weekly spraying with 10 µM putrescine	41.92	39.42	37.43	10.17	32.24	47.35	45.35	41.66	10.56	36.23
Mean (S)	37.67	33.79	24.69	11.68		42.26	38.55	27.75	12.74	
	Roots									
Sakha 8 control	21.88	18.12	16.18	15.06	17.81	25.86	20.72	18.57	17.25	20.60
Giza 167 control	16.87	15.54	13.28	11.16	14.21	18.69	16.30	14.84	12.27	15.53
Gamma rays 15 KR	32.52	25.68	22.55	7.80	22.14	34.67	28.99	25.26	8.30	24.31
Gamma rays 20 KR	23.37	21.57	9.60	7.77	15.58	25.81	22.17	10.99	8.61	16.90
Soaking in 2 ppm ABA	23.63	21.11	9.61	7.64	15.50	25.38	21.82	10.95	8.14	16.57
Soaking + spraying with 2 ppm ABA	23.95	21.87	9.94	7.58	15.84	25.63	22.57	10.02	8.46	16.67
Weekly spraying with 2 ppm ABA	32.90	26.42	23.19	8.48	22.75	34.98	31.85	26.72	9.40	25.74
Weekly spraying with 10 µM putrescine	33.55	27.64	24.80	8.04	23.51	35.37	33.20	27.90	9.96	26.61
Mean (S)	26.08	22.24	16.14	9.19		28.30	24.70	18.16	10.30	

Moreover, when consider the effect of the interaction between salinity level and treatments, it could noticed that, the first group of three treatments recorded their considerable increases in nutrients concentrations over the salt-tolerant control up to 30% sea water level, while the second group (20 KR gamma rays, soaking in 2 ppm ABA and soaking + spraying with 2 ppm ABA) could do that only up to 15% sea water. In this concern, special referring to the superiority of putrescine treatments followed by spraying with 2 ppm ABA then 15 KR gamma rays must be recorded. Increasing nutrient accumulation induced by gamma rays + sodium azide under saline conditions was previously recorded by El-Shafey *et al.* (1998) with rice and wheat, Ghallab and Nesiem (1999) with 5.0 KR gamma rays with wheat. As for putrescine, Parakash and Thrope (1991) concluded that putrescine may serves as reserve of carbon and nitrogen during *de novo* organogensis. On the other hand, Chudinova *et al.* (1985) reported that increasing intracellular concentrations of putrescine in *P. filifolia* under saline conditions had an adaptive significance increased its salt tolerance. Also, Krishnamurthy (1991) mentioned that foliar application with 10 µM putrescine accelerated the accumulation of K^+, Ca^{+2}, Mg^{+2}, in the salt-stressed rice plants. Moreover, Manoj-Sharma *et al.* (1997) stated that foliar application of putrescine increased K^+ content in chickpea plants under chloride salinity. Vantoai (1993) suggested that ABA applications could improve plant resistance to drought and salt stress. Similar results were reported by Nesiem and Ghallab (1999).

b-Calcium, magnesium and sodium:

Unlike N,P and K^+ which were negatively affected by salinity, the complete reverse was true with Ca^{+2} Mg^{+2} and Na^+ concentrations, especially the latter one (Mean S) in the stressed shoots and roots of wheat plants (Tables 10, 11 and 12). Thereby, a gradual marked increases were recorded over the non-stressed control (fresh water irrigation) in such nutrient concentrations, which positively correlated with the increase in salinity level in the irrigation water to reach their maximum values in the shoots and roots irrigated with 45% sea water in the all collected samples.

In this concern, Saber (1988) found that, the Mg^{+2} and Ca^{+2} content in the shoots and roots of *Casuarina* plants were increasing as salinity increased. Kandeel and Abu-Grab (1992) reported that, salinity application tended to increase the contents of Ca^{+2}, Mg^{+2} and Na^+, but decreased K^+ content of faba bean plants. Also, Hamada *et al.* (1992) found that, Na^+, Ca^{+2}, and Mg^{+2} contents increased, while K^+ and N content decreased in barely plants with increasing salinity. Moreover, Hamada and El-Enany (1994) mentioned that, Ca^{+2} concentration in shoots as well as K^+ and Ca^{+2} contents in faba bean roots increased with increasing NaCl salinity. More recently, Mansour and Hussein (2002) noted that Na^+, Ca^{+2}, Cl^- and proline contents increased by increasing salinity in turfgrasses.

Table (10): Effect of gamma rays, abscisic acid and putrescine treatments on calcium concentration (mg/g dry weight) in the shoot and root of the sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	5.46	6.64	7.22	8.42	6.54	6.71	7.94	9.86	10.94	8.86
Giza 167 control	3.91	4.61	5.79	6.02	5.08	4.83	5.82	7.25	8.68	6.65
Gamma rays 15 KR	6.12	7.72	8.99	9.85	8.17	7.91	8.95	10.01	10.11	9.25
Gamma rays 20 KR	4.11	5.23	5.61	5.81	5.19	5.01	6.91	7.05	8.29	6.82
Soaking in 2 ppm ABA	4.15	5.32	5.66	5.83	5.24	5.06	6.92	7.09	8.22	6.82
Soaking + spraying with 2 ppm ABA	4.21	5.41	5.70	5.91	5.31	5.10	6.95	7.10	8.17	6.83
Weekly spraying with 2 ppm ABA	6.18	7.85	9.01	9.74	8.20	7.94	8.97	10.19	10.25	9.34
Weekly spraying with 10 µM putrescine	6.21	7.90	9.05	9.83	8.25	7.98	8.99	10.25	10.36	9.40
Mean (S)	5.04	6.34	7.13	7.68		6.32	7.68	8.60	9.38	
	Roots									
Sakha 8 control	3.22	4.43	5.11	6.28	4.76	4.52	5.79	7.52	8.23	6.52
Giza 167 control	1.92	2.52	3.68	4.91	3.26	2.78	3.49	5.72	6.72	4.68
Gamma rays 15 KR	4.82	5.63	6.49	6.62	5.89	5.61	6.69	8.45	8.89	7.41
Gamma rays 20 KR	2.56	3.95	4.23	4.69	3.86	3.67	4.40	5.11	6.36	4.89
Soaking in 2 ppm ABA	2.43	3.92	4.35	4.62	3.83	3.72	4.32	5.15	6.32	4.88
Soaking + spraying with 2 ppm ABA	2.49	3.94	4.42	4.61	3.87	3.74	4.36	5.21	6.35	4.92
Weekly spraying with 2 ppm ABA	4.81	5.72	7.15	7.69	6.34	5.82	6.80	8.29	8.43	7.34
Weekly spraying with 10 µM putrescine	4.89	5.81	7.21	7.71	6.41	5.92	6.94	8.42	8.51	7.45
Mean (S)	3.39	4.49	5.33	5.89		4.47	5.35	6.73	7.48	

Table (11): Effect of gamma rays, abscisic acid and putrescine treatments on magnesium concentration (mg/g dry weight) in the shoot and root of the sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	3.54	4.29	4.88	4.99	4.43	4.14	4.64	5.38	5.79	4.99
Giza 167 control	2.46	2.69	3.18	3.88	3.05	2.97	3.17	3.71	4.13	3.50
Gamma rays 15 KR	5.13	5.65	5.95	6.11	5.71	5.94	6.22	6.78	6.21	6.29
Gamma rays 20 KR	2.96	3.87	3.96	4.01	3.70	3.13	4.10	4.62	4.89	4.19
Soaking in 2 ppm ABA	2.93	3.75	3.91	4.05	3.66	3.26	4.17	4.58	4.71	4.18
Soaking + spraying with 2 ppm ABA	2.96	3.69	3.89	4.12	3.67	3.17	4.24	4.65	4.96	4.26
Weekly spraying with 2 ppm ABA	5.26	5.72	5.91	6.24	5.78	5.89	6.44	6.81	6.93	6.52
Weekly spraying with 10 µM putrescine	5.39	5.81	5.99	6.31	5.88	5.99	6.58	6.86	6.99	6.61
Mean (S)	3.83	4.43	4.71	4.96		4.31	4.95	5.42	5.58	
	Roots									
Sakha 8 control	2.18	2.30	2.79	2.95	2.56	2.44	2.88	3.11	3.36	2.95
Giza 167 control	1.63	1.71	1.83	1.94	1.78	1.79	1.96	2.05	2.15	1.99
Gamma rays 15 KR	3.34	3.69	3.85	3.98	3.72	3.65	3.89	3.98	4.15	3.92
Gamma rays 20 KR	1.78	1.92	2.07	2.29	2.02	1.88	2.11	2.26	2.34	2.15
Soaking in 2 ppm ABA	1.69	1.84	2.11	2.22	1.97	1.91	2.14	2.29	2.38	2.18
Soaking + spraying with 2 ppm ABA	1.75	1.89	2.14	2.25	2.01	1.95	2.21	2.34	2.41	2.23
Weekly spraying with 2 ppm ABA	3.48	3.62	3.81	3.91	3.71	3.77	3.91	4.07	4.19	3.99
Weekly spraying with 10 µM putrescine	3.51	3.79	3.88	3.99	3.79	3.84	3.95	4.10	4.23	4.03
Mean (S)	2.42	2.60	2.81	2.94		2.65	2.88	3.03	3.15	

Moreover, Salem *et al.* (2002) reported that although N, P and K^{+} levels in the shoots, roots and the whole faba bean plants cultivars were negatively affected by sea water irrigation, the concentrations of Ca^{+2} , Mg^{+2} and Na^{+} showed positive gradual increases over the non-stressed control, with increasing salinity level in the irrigation water.

Comparing the response of Ca^{+2} concentration in the plant organs to the various applied treatments irrespective the salinity level (Mean T), the obtained data in Table 10 clearly reveal that only the shoots and roots which were weekly sprayed either with putrescine, or with 2 ppm ABA or 15 KR gamma rays showed a considerable increases in their Ca^{+2} concentrations over the respective ones of the salt-tolerant control, meanwhile Ca^{+2} concentrations in the plant organs treated with one of the other three treatments were slightly exceeded only the salt sensitive control in the both collected samples.

Taking into consideration the effect of the interaction between different treatments and salinity levels, it could be noticed that, the increases in Ca^{+2} concentration over the salt tolerant control were recorded in the roots at the all applied salinity levels in both samples, and in the first sample in the shoots as well as up to 30% in the last sample, only as affected by the most effective treatments, i.e. putrescine, spraying with 2 ppm ABA and 15 KR gamma rays, meanwhile, the other three treatments, exerted their increases in Ca^{+2} concentration only over the respective values of the salt-sensitive control up to only 15% sea water in both taken samples, except in the roots of the first sample whice recorded these increases up to 45% sea water level. Comparing the effect of various physiological treatments on Mg^{+2} concentration irrespective the salinity level (Mean T), the obtained data in Table 11 which strongly confirmed the superiority of the weekly spraying either with putrescine or 2 ppm ABA and 15 KR gamma rays treatments in increasing Mg^{+2} concentration in the treated shoots and roots over the respective values of the salt-tolerant control in both collected samples. Supportive evidence for the superiority of the above mentioned three treatments is found in the recorded values of Mg^{+2} concentration due to the effect of the interaction between these treatments and salinity levels which clearly reveal that the Mg^{+2} concentration in the treated shoots and roots with these treatments showed much higher values than the corresponding values of the salt-tolerant control at the all applied salinity level up to the highest one; 45% sea water, meanwhile the treatments of 20 KR gamma rays, soaking in 2 ppm ABA and soaking + spraying with 2 ppm ABA, exhibited higher Mg^{+2} concentration values only over the sensitive control ones if the Mean T was considered or when the interaction between these treatments and salinity level up to the highest one, were detected. The effectiveness of gamma rays increasing nutrients accumulation in wheat and rice plants under saline conditions was previously reported by El-Shafey *et al* (1998) and Ghallab and Nesiem (1999), and of ABA, by Nesiem and Ghallab (1999) with wheat also. As regards putrescine Krishnamurthy (1991) found that, foliar application of 10 µM putrescine inhibited Na^+ and Cl^- uptake and accelerated the accumulation of K^+, Ca^{+2}, Mg^{+2} and proline in the leaves of salt-stressed rice plants.

Table (12): Effect of gamma rays, abscisic acid and putrescine treatments on sodium concentration (mg/g dry weight) in the shoot and root of the sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments / % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	2.57	3.99	4.23	4.98	3.94	3.19	4.66	5.18	5.96	4.75
Giza 167 control	3.68	5.02	6.13	7.81	5.66	4.37	5.83	7.40	8.88	6.62
Gamma rays 15 KR	1.88	2.11	2.93	8.41	3.83	2.13	3.01	3.43	10.13	4.68
Gamma rays 20 KR	2.31	2.58	6.95	8.97	5.20	2.86	3.19	9.90	10.17	6.53
Soaking in 2 ppm ABA	2.34	2.72	6.87	8.93	5.22	2.97	3.12	9.54	10.59	6.56
Soaking + spraying with 2 ppm ABA	2.43	2.63	6.74	8.22	5.01	2.95	3.25	9.46	10.56	6.56
Weekly spraying with 2 ppm ABA	1.77	2.17	2.99	8.50	3.86	2.16	2.99	3.22	10.06	4.61
Weekly spraying with 10 µM putrescine	1.99	2.12	2.73	8.56	3.85	2.14	2.77	3.11	10.01	4.51
Mean (S)	2.37	2.92	4.95	8.05		2.85	3.60	6.41	9.55	
	Roots									
Sakha 8 control	2.28	3.31	3.88	4.11	3.40	2.83	3.19	4.06	4.94	3.76
Giza 167 control	3.19	4.84	5.14	6.74	4.98	3.27	4.14	6.14	7.15	5.18
Gamma rays 15 KR	1.36	1.56	1.86	7.27	3.01	1.93	2.15	2.44	8.01	3.63
Gamma rays 20 KR	1.38	1.79	6.95	7.12	4.09	1.84	2.32	7.10	8.90	5.04
Soaking in 2 ppm ABA	1.56	1.86	6.08	7.49	4.25	1.72	2.34	7.21	8.51	4.95
Soaking + spraying with 2 ppm ABA	1.88	1.99	6.02	7.43	4.33	1.97	2.23	7.13	8.17	4.88
Weekly spraying with 2 ppm ABA	1.42	1.51	1.98	7.23	3.04	1.89	2.01	2.36	8.06	3.58
Weekly spraying with 10 µM putrescine	1.59	1.63	1.82	7.19	3.06	1.97	1.99	2.16	8.02	3.54
Mean (S)	1.83	2.31	4.10	6.82		2.18	2.55	4.83	7.72	

Probably the most interesting and important finding in the obtained results concerning sodium concentration is found in the comparison between the salt-tolerant Sakha 8 control and the salt-sensitive Giza 167 one in their Na^+ concentrations. The obtained results in Table 12 evidently indicate, unlike the all determined chemical constituents in the present study, Na^+ concentrations in the shoots and roots of the salt-tolerant control showed much lower values than that the respective ones in the salt-sensitive control at the all applied salinity levels in the all collected samples which emphasized the superiority of the active osmoregulation process in the tolerant plant tissues of Sakha 8 control, since salt tolerance is related to the ability of plants to either exclude Na^+ or avoid Na^+ excess as recently evidenced by

Salem *et al.* (2002) who disclosed that the physiological tolerance which characterized both the salt-tolerant Giza 429 and Giza 843 faba bean cultivars brought about by creating more negative osmotic potential (Osmoregulation or Osmotic Adjustment) through the accumulation of much more quantities of N, P, K^+, Ca^{+2}, Mg^{+2} and lowest quantities of Na^+ as well as higher K^+/Na^+ ratio and lower Na^+/Ca^+ one in addition to the considerable accumulation of sugars (especially non-reducing ones), proline, free amino acids and protein in their shoots and roots. Similar results also previously reported with wheat by Maftoun and Sepashah (1989); Gorham and Jones (1990); Zsoldos *et al.* (1990) in addition to Schactman and Munns (1992) who reported that, two mechanisms of salt tolerance were suggested, the first is lowering Na^+ accumulation and the second is ions compartmentation within the leaves. Here, it is of great interesting and importance to find the same trend of the negative effects on Na^+ concentration due to the different applied physiological treatments, especially spraying with putrescine, 2 ppm ABA and irradiation with15 KR gamma rays ones, which were manifested by their high positive effects on the all previously mentioned components in the present study, i.e. sugars, proline, free amino acids, protein, N, P, K^+, Ca^{+2} and Mg^{+2}. This can be evidenced by comparing the effect of various treatments regardless level (Mean T) on Na^+ concentrations (Table 12) in the shoots and roots of the salt-sensitive Giza 167 cultivar treated plants. The obtained data in this respect clearly reveal that Na^+ concentrations in the roots and shoots of the weekly sprayed plants either with putrescine, or 2 ppm ABA or their grains were irradiated with 15 KR gamma rays showed much lower mean values than those in both sensitive and tolerant controls in both collected samples. These data represent a strong supportive evidence on the highly degree of the physiological tolerance in the treated plants of the sensitive Giza 167 wheat cultivar which enable them to be adapted to salinity (through the active Osmoregulation process) and consequently lowering Na^+ accumulation in their tissues below its levels in both sensitive and tolerant controls up to 30% sea water level if the interaction between these three treatments and salinity level was considered. It is of great importance to mentioned also that the other three treatments, i.e. 20 KR gamma rays, soaking in 2 ppm ABA and soaking + spraying with 2 ppm ABA, resulted in increasing the tolerance to salinity in the treated plant, though to lesser extent. Since, the mean values of Na^+ concentration (Mean T) in the treated plant organs, exceeded the respective mean values of the salt-tolerant, meanwhile the same treated plant organs showed lower mean values than that in the salt-sensitive and tolerant controls in both collected samples only at 0.0% and 15% levels, and surpassed them at 30% and 45 % sea water levels. In this regards, it is well documented that the salt tolerance between wheat cultivars was due to higher shoot K^+ and lower Na^+ accumulation (Maftoun and Sepashah, 1989) and a high wheat leaf K^+/Na^+ ratio has been associated with salt tolerance. According to Sharma (1995) salt tolerance in wheat is related to the ability of plants to exclude Na^+ or avoid Na^+ excess.

Accordingly, K^+/Na^+ ratio (Table 13) showed gradual decreases, contrary to Na^+/Ca^{+2} (Table 14), in the stressed shoots and roots in response to increasing salinity levels as compared to the respective ratios of the non-stressed control organs. Comparing the effect of different treatments (Mean T) on the mean values of K^+/Na^+ ratio in the stressed shoots, the obtained data confirmed the absolute superiority of spraying with putrescine, 2 ppm ABA and irradiation with 15 KR gamma rays treatments in increasing K^+ concentration in these plant organs as well as their negative effects on Na^+ concentration in the same stressed shoots, thus the treated shoots with each one of the above mentioned treatments showed the highest values of this ratio than the respective ones of the salt-tolerant control which emphasized the superiority of active osmoregulation process in the treated shoots of the salt sensitive Giza 167 cultivar. On the other hand, K^+/Na^+ ratio in the shoots treated with either 20 KR gamma rays, soaking in 2 ppm ABA or soaking + spraying with 2 ppm ABA, exceeded only the respective ratios of the salt-sensitive control in both samples. In the stressed roots the results in Table 13 reveal that, although K^+/Na^+ ratio induced by the all applied treatments exceeded those of the salt-tolerant control, the highest considerable increments in K^+/Na^+ ratio over the respective ones of the tolerant control were recorded by the roots sprayed with putrescine or 2 ppm ABA as well as 15 KR gamma rays respectively, which strongly confirm the high activity of the osmoregulation process in these treated roots and consequently increased their tolerance to salinity especially the roots of the plants treated with putrescine.

Moreover, the superiority of the most effective treatment was more pronounced when consider the effect of the interaction between these treatments and salinity levels on K^+/Na^+ ratio in the roots and shoots which clearly reveal that such treatments, i.e. spraying with putrescine, 2 ppm ABA and 15 KR gamma rays considerably increased K^+/Na^+ ratio in both organs over the respective ratio of the salt-tolerant control up to 30% sea water, and only up to 15% sea water level for the other three treatments.

Table (13): Effect of gamma rays, abscisic acid and putrescine treatments on K^+/Na^+ ratio in the shoot and root of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	13.58	7.92	6.00	3.84	7.84	[illegible]	7.13	5.43	3.65	7.10
Giza 167 control	7.67	5.08	3.26	2.06	4.52	7.75	4.73	3.03	2.02	4.38
Gamma rays 15 KR	21.79	17.95	11.44	1.12	13.08	21.13	14.52	11.34	1.02	12.00
Gamma rays 20 KR	16.50	12.84	2.19	1.04	8.14	13.90	12.04	1.79	0.95	7.17
Soaking in 2 ppm ABA	16.31	12.05	2.21	1.08	7.91	14.15	12.10	1.81	0.98	7.26
Soaking + spraying with 2 ppm ABA	15.97	12.47	2.30	1.19	7.98	14.53	11.78	1.89	0.99	7.30
Weekly spraying with 2 ppm ABA	22.76	17.17	11.79	1.16	13.22	21.66	15.05	12.02	1.04	12.44
Weekly spraying with 10 µM putrescine	21.07	18.59	13.71	1.19	13.64	22.13	16.37	13.39	1.10	13.25
Mean (S)	16.96	13.01	6.61	1.59		15.93	11.72	6.34	1.47	
	Roots									
Sakha 8 control	9.60	5.47	4.17	3.66	5.73	9.14	6.50	4.57	3.49	5.93
Giza 167 control	5.29	3.21	2.58	1.66	3.19	5.72	3.94	2.42	1.72	3.45
Gamma rays 15 KR	23.91	16.46	12.12	1.07	13.39	17.96	13.48	10.35	1.04	10.71
Gamma rays 20 KR	16.93	12.05	1.59	1.10	7.92	14.03	9.56	1.55	0.97	6.53
Soaking in 2 ppm ABA	15.15	11.35	1.58	1.02	7.28	14.76	9.32	1.52	0.96	6.64
Soaking + spraying with 2 ppm ABA	12.74	10.99	1.65	1.02	6.60	13.01	10.12	1.41	1.04	6.40
Weekly spraying with 2 ppm ABA	23.17	17.50	11.71	1.17	13.39	18.51	15.85	11.32	1.17	11.71
Weekly spraying with 10 µM putrescine	21.10	16.96	13.63	1.12	13.20	17.95	16.68	12.92	1.24	12.20
Mean (S)	15.99	11.75	6.13	1.48		13.89	10.68	5.76	1.45	

More supportive evidences for the absolute superiority of spraying with putrescine, or 2 ppm ABA and irradiation with 15 KR gamma rays treatments in stimulation the osmotic adjustment process which in turn increasing the salinity tolerance in the treated plants, can be deduced from the recorded Mean T values of Na^{+}/Ca^{+2} in the same organs (Table 14) which evidently indicate that, because their sever inhibitory effects on Na^{+} uptake and accumulation and/or Na^{+} exclusion as well as their positive effects on Ca^{+}, the treated shoots and roots showed much lower values of Na^{+}/Ca^{+} ratio than the respective ones of both sensitive and tolerant controls in both collected samples. However the organs treated with the other three treatments showed higher Na^{+}/Ca^{+2} ratio than that in the salt tolerant control.

Another interesting finding in the obtained data in Table 14 which represents another strong evidence for the superiority of spraying with putrescine, 2 ppm ABA and grains irradiation with 15 KR gamma rays is that, the treated shoots and roots with any of these treatments showed much lower Na^{+}/Ca^{+} ratio than that in both tolerant and sensitive controls at the all applied salinity levels except only at the highest one, i.e. 45% sea water, meanwhile, Na^{+} / Ca^{+} in the shoots and roots treated with the other three treatments showed much higher values, thus, exceeded the respective values of Na^{+}/Ca^{+} ratios of the salt sensitive as well as the salt-tolerant controls at 30% and 45% sea water levels in both samples. The lowering of Na^{+} accumulation as well as the higher K^{+}/Na^{+} ratio and lower Na^{+}/Ca^{+2} as an adaptive mechanism in favor of more tolerance to salinity was recently evidenced by Salem *et al.* (2002). The suggestion of the possibility of successful application of gamma rays to improvement salinity tolerance of the sensitive wheat cultivars was reported by Ghallab and Nesiem (1999). Also, Gong *et al.* (1990) found that seedlings of barley and wheat previously treated with ABA had significantly lower Na^{+} and Cl^{-} contents and Na^{+}/K^{+} ratio. In addition, Nesiem and Ghallab (1999) reported that ABA treatment may partially increase the ability to counteract salinity by accumulating relatively higher amounts of sugars, free proline, free amino acids as well as lowering the Na^{+} level and increase K^{+} and Ca^{+2} in the shoots may induce better performance for the sensitive wheat cultivar plants.

Table (14): Effect of gamma rays, abscisic acid and putrescine treatments on Na^{+}/Ca^{+2} ratio in the shoot and root of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt - tolerant Sakha 8 cultivar plants under saline conditions%) sea water) during 2000-2001 season.

Treatments / % Sea water	75					105				
	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots									
Sakha 8 control	0.47	0.60	0.59	0.59	0.56	0.48	0.59	0.53	0.54	0.54
Giza 167 control	0.94	1.09	1.06	1.30	1.10	0.90	1.00	1.02	1.02	0.99
Gamma rays 15 KR	0.31	0.27	0.33	0.85	0.44	0.27	0.34	0.34	1.00	0.49
Gamma rays 20 KR	0.56	0.49	1.24	1.54	0.96	0.57	0.46	1.40	1.23	0.92
Soaking in 2 ppm ABA	0.56	0.51	1.21	1.53	0.95	0.59	0.45	1.35	1.29	0.92
Soaking + spraying with 2 ppm ABA	0.58	0.49	1.18	1.39	0.91	0.58	0.47	1.33	1.29	0.92
Weekly spraying with 2 ppm ABA	0.29	0.28	0.33	0.87	0.44	0.27	0.33	0.32	0.98	0.48
Weekly spraying with 10 µM putrescine	0.32	0.27	0.30	0.87	0.44	0.27	0.31	0.30	0.97	0.46
Mean (S)	0.50	0.50	0.78	1.12		0.49	0.49	0.82	1.04	
	Roots									
Sakha 8 control	0.71	0.75	0.76	0.65	0.72	0.63	0.55	0.54	0.60	0.58
Giza 167 control	1.66	1.92	1.40	1.37	1.59	1.18	1.19	1.07	1.06	1.13
Gamma rays 15 KR	0.28	0.28	0.29	1.10	0.49	0.34	0.32	0.29	0.90	0.46
Gamma rays 20 KR	0.54	0.45	1.43	1.52	0.99	0.50	0.53	1.39	1.40	0.96
Soaking in 2 ppm ABA	0.64	0.47	1.40	1.62	1.03	0.46	0.54	1.40	1.35	0.94
Soaking + spraying with 2 ppm ABA	0.76	0.51	1.36	1.61	1.06	0.53	0.51	1.37	1.29	0.93
Weekly spraying with 2 ppm ABA	0.30	0.26	0.28	0.94	0.45	0.32	0.30	0.28	0.96	0.47
Weekly spraying with 10 µM putrescine	0.33	0.28	0.25	0.93	0.45	0.33	0.29	0.26	0.94	0.46
Mean (S)	0.65	0.62	0.90	1.22		0.54	0.53	0.83	1.06	

Also, in accord with the obtained results in the present study Krishnamurthy (1991) reported that, foliar application with 10 µM putrescine inhibited Na^+ and Cl^- uptake and accelerated the accumulation of K^+, Ca^{+2}, Mg^{+2}, proline and endogenous putrescine in the leaves of salt-stressed rice plants.

4-Invertase activity:

As shown in Table 15 salinity exerted its detrimental negative effects also on invertase activity, thus, showed gradual decrease in the stressed leaves of 75 days-old plants by increasing salinity level to reach its lowest activity at 45% sea water level, as compared with the non-stressed control leaves. The data also reveal that invertase activity in leaves of the salt-tolerant Sakha 8 cultivar control showed much lower values than the respective ones in the salt-sensitive one, as did with Na^+. Moreover, treatments of the weekly spraying either with putrescine, or 2 ppm ABA and 15 KR gamma rays showed the same trend of reduction that described with the salt-tolerant cultivar control, and even with much lower activity, in favor of inducing more tolerance to salinity in the sensitive treated plants of Giza 167 cultivar through the increased accumulation of non-reducing sugars especially those treated with putrescine which recorded the lowest in the Mean T of invertase activity, i.e. 33.68% µmol glucose/min/g fresh weight compared with 41.72 in the tolerant control and 52.37 in the sensitive one In the meantime, invertase activity expressed as Mean T of treatment of 20 KR gamma rays, soaking in 2 ppm ABA as well as soaking + spraying with 2 ppm ABA showed higher values than that in the salt-tolerant control. In addition, the leaves of the treated plant with the weekly spraying either with putrescine or 2 ppm ABA as well as 15 KR gamma rays exhibited the lowest activities in comparison with the all other treatments including both sensitive and tolerant control at the all salinity levels except the highest one, while the other three treatments showed much higher activities than that in the salt tolerant control at the all salinity levels. Supportive evidence for this finding is found in the results obtained by Dubey and Singh (1999) who reported that invertase activity decreased in rice shoots of the salt tolerant cultivars, whereas increased in the salt sensitive ones. In this concern, also Chraibi *et al* (1995) reported that although the energy charge in Chicory suspension cells was not modified during the growth cycle, regardless the growth conditions, yet, ABA modified the intercellular carbohydrate metabolism and inhibited acid invertase activity. On the other hand, Parakash and Prathapasenan (1989) found that spraying putrescine before NaCl application in the irrigation water on the salt-stressed rice which had been pretreated with putrescine resulted in intermediate values of invertase activity, between the controls and the untreated salt-stressed plants. Another fact that may be of interest is that, invertase activity in the leaves of the all applied treatments, tended to decreased gradually by increasing salinity level to reach the lowest values at the highest level of salinity in favor of more tolerance to the increased level of salinity through the accumulation of more quantities of non-reducing sugars. Such behavior seems to induce more ability of the treated plants to tolerate the increased salt concentrations in the plant medium, especially those plants treated with putrescine, spraying with 2 ppm ABA and 15 KR gamma rays.

Table (15):Effect of gamma rays, abscisic acid and putrescine treatments on Invertase activity as µ mol /glucose / min per g fresh weight in the leave of 75 days-old plants of the salt-sensitive Giza 167 wheat cultivar in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (% sea water) during 2000-2001 season.

Treatments / % Sea water	0	15	30	45	Mean T
Sakha 8 control	70.68	44.24	31.29	20.67	41.72
Giza 167 control	72.21	58.04	46.82	32.42	52.37
Gamma rays 15 KR	55.53	39.65	27.59	22.89	36.42
Gamma rays 20 KR	61.64	52.73	41.32	30.72	46.60
Soaking in 2 ppm ABA	63.11	51.54	40.93	30.89	46.62
Soaking + spraying with 2 ppm ABA	62.73	50.89	39.23	30.18	45.76
Weekly spraying with 2 ppm ABA	53.79	37.69	26.36	21.75	34.90
Weekly spraying with 10 µM putrescine	51.58	35.92	25.84	21.39	33.68
Mean (S)	61.41	46.34	34.92	26.36	

5-Phytohormones:

Depending on the previously obtained data in the present study as regards growth, dry matter accumulation and chemical composition, the treated plants with the most effective three treatments, i.e. the weekly sprying either with 10 µM putrescine or 2 ppm ABA as well as grain irradiation with 15 KR gamma rays were selected for hormonal analyses at the first sampling date, i.e. 75 days after sowing. The obtained data in Table 16 regarding hormonal analyses clearly reveal that the concentrations of IAA, GA_3 and cytokinin (µg/g fresh weight) were adversely affected by increasing salinity level, thus, showed a gradual decreases with increasing salinity levels to reach their lowest values in the stressed shoots and roots of 75 days-old at the highest level of salinity, in the meantime, a complete opposite trend was obtained with ABA concentration under the same conditions. In this concern, Meiri and Shalhevet (1973) reported that saline conditions restrict the synthesis of cytokinins in the roots and their translocation to upper plant parts can also be inhibited. Moreover, Kuiper *et al.* (1990) mentioned that cytokinin concentrations in root and shoot tissues of wheat and barley decreased rapidly after an exposure to 65 mol $NaCl/m^3$. Zeinab and Sallam (1996) reported that cytokinin activity decreased with increase in salt stress in barley plants. The same authors added that with increasing Na^+ concentration, the tryptophan synthase α-monomers were gradually dissociated from the oligomers producing less active isoenzyme.

Table (16):Effect of gamma rays, abscisic acid and putrescine treatments on IAA, ABA, GA3 and CK concentrations (µg/g F.W.) in the shoots and roots of 75 days old plant of the salt - sensitive Giza 167 wheat cultivar in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments / % Sea water	IAA					ABA					GA3					CK				
	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T
	Shoots																			
Sakha 8 control	22.16	18.34	15.19	11.76	16.86	2.41	3.01	3.25	3.95	3.16	23.45	21.19	19.27	11.66	18.89	25.42	23.93	21.19	17.16	21.93
Giza 167 control	18.51	15.99	13.14	10.68	14.58	2.52	2.72	2.99	3.11	2.84	18.93	16.35	13.96	8.86	14.53	22.67	18.16	16.35	12.93	17.53
Gamma rays 15 KR	31.45	26.90	22.92	8.05	22.33	2.35	3.55	3.71	3.82	3.36	29.74	25.85	22.84	7.52	21.49	35.19	31.76	26.11	10.15	25.80
Weekly spraying with 2 ppm ABA	33.88	30.81	24.25	8.29	24.31	2.33	3.58	3.74	3.84	3.37	30.00	27.62	24.43	7.62	22.42	35.87	32.25	27.01	10.32	26.36
Weekly spraying with 10 µM putrescine	35.09	31.57	26.68	8.71	25.51	2.31	3.65	3.79	3.88	3.41	33.81	28.81	25.71	7.70	24.01	36.01	32.94	27.85	10.69	26.87
Mean (S)	28.22	24.72	20.44	9.50		2.38	3.30	3.50	3.72		27.19	23.96	21.24	8.67		31.03	27.81	23.70	12.25	
	Roots																			
Sakha 8 control	10.70	8.48	5.73	4.41	7.33	1.14	1.61	1.99	2.89	1.91	13.43	10.23	8.24	7.15	9.76	28.61	26.84	23.62	19.94	24.75
Giza 167 control	6.91	5.11	4.55	3.11	4.92	1.25	1.38	1.68	1.99	1.58	11.77	8.35	6.61	4.36	7.77	26.31	21.35	19.72	16.23	20.90
Gamma rays 15 KR	17.21	14.33	11.62	2.81	11.49	1.16	2.01	2.31	2.49	1.99	18.91	15.52	11.93	5.04	12.85	38.54	35.79	30.52	13.66	29.63
Weekly spraying with 2 ppm ABA	19.91	15.46	12.64	2.84	12.71	1.15	2.03	2.34	2.55	2.02	20.18	18.25	14.51	5.25	14.55	38.85	36.82	31.33	13.73	30.18
Weekly spraying with 10 µM putrescine	22.22	17.65	13.85	2.86	14.15	1.17	2.89	2.36	2.59	2.05	22.28	20.66	16.36	5.89	16.30	40.71	37.91	31.65	13.81	31.02
Mean (S)	15.39	12.21	9.68	3.21		1.17	1.82	2.14	2.50		17.31	14.60	11.53	5.54		34.60	31.74	27.37	15.47	

This reduced the biosynthesis of L- tryptophan and consequently that of IAA, so that wheat growth was retarded or even stopped. The same authors added that at higher salinity there was an accumulation of gibberellin inhibitors and no gibberellin activity was found in barley plants. El-Desouky and Atawia (1998) stated that in sour orange the biological activities of cytokinins, gibberellins and auxins were significantly reduced by excess salinity (5000 ppm) in the irrigation water. Meanwhile, Prakash and prathapasenan (1990) reported that when rice plants were subjected to salt stress (12 ds/m), the extension growth and dry weight of the shoot system as well as GA-like substances were markedly reduced.

On the contrary, and in full accordance with the obtained results in the present work, Jones *et al.*, (1987) demonstrated that physiological studies have shown that endogenous ABA levels increased in plant tissue subjected to NaCl salinity. Gong *et al.* (1990) found that ABA content in wheat and barley leaves increased with duration and intensity of NaCl stress. Moreover, Maslenkova *et al.* (1993) reported that ABA level increased with salinity stress, and that this level correlated with plant resistance to the salt stress. On the other hand, Wu *et al.* (1997) considered ABA is the primary hormone that mediates plant responses to stresses such as cold, drought and salinity; thus its endogenous level increases with salinity stress. On the other hand, the obtained results also indicated that both organs of the salt-tolerant control contained much higher hormonal concentration than that the salt-sensitive one under the all applied salinity levels, also, the roots of the same tolerant control contained much higher concentrations of cytokinin than that of its shoots at the all applied levels of salinity, as mentioned earlier with sugars in the same roots, which associated with another accumulation of IAA, GA_3 and ABA in the shoots of the same tolerant control suggesting that the hormonal status in the salt-tolerant control plants most directly involved in inducing some sort of resistance against salinity. Probably the most interesting feature of the hormonal status analysis data is that, the same recorded observations with the salt-tolerant control, were more obvious in the sensitive Giza 167 cultivar plants when treated either with the weekly spraying with 10 µM putrescine or 2 ppm ABA or when their grains irradiated with 15 KR gamma rays. This can be evidenced from the comparative results of the such treated organs of 75 days-old plants and that of salt-tolerant control in the first sample which clearly reveal that the concentrations of the all estimated hormones in the above mentioned treated plants greatly exceeded the comparable concentrations in the salt-tolerant control in favor of increasing the salt tolerance in the treated plants over even that tolerance degree of the untreated tolerant Sakha 8 control, to reach their particular highest increases over the salt-tolerant control in the treated plants with these treatments. This conclusion can be drawn, if the mean value of each treatments (Mean T), or the effect of the interaction between salinity levels and treatments were considered up to 30% sea water level. This represents another supportive evidence for the absolute superiority of these treatments especialy putrescine one. This can also be evidenced by calculating the percentage of increases in the mean value of concentrations (Mean T) of each hormones in both shoots and roots, over the comparable values of the salt-tolerant control as affected by these treatments which were in the treated shoots 51.3%, 44.2%, 32.4% for IAA, 7.9%, 6.6%, 6.3% for ABA, 27.1%, 18.7%, 13.8% for GA3 and

22.5%, 20.2%, 17.6% for cytokinin. Meanwhile, the respective values in the treated roots were 93.0%, 73.4%, 56.8% for IAA, 7.3%, 5.8%, 4.2% for ABA, 67.0%, 49.1%, 31.7% for GA3, and 25.3%, 21.9%, 19.7% for cytokinin, for spraying with putrescine, 2ppm ABA and irradiation with 15 KR gamma rays, respectively. For another interesting comparison, the ratios of the mean values of IAA in the treated shoots / that in the treated roots for the various treatments were calculated. These ratios were 1.8:1, 1.9:1 and 1.9:1 contrary to that of cytokinins which were 0.86: 1 , 0.87:1 and 0.87:1. This comparison clearly confirmed that in the treated plants with the most effective three treatments the shoots accumulated much more quantities of IAA which considerably exceeded the comparable quantities in its roots, contrary to cytokinin which appeared in much higher concentrations in the roots as compared with the treated shoots of the same plants. Thus, it could be concluded that the applied three treatments especially the supper one, i.e. putrescine induced a especial hormonal status in the treated plants, which in favor of more tolerance to salinity, this in particular, was accompanied by accumulation of considerable amounts of sugars in their roots since the plants that fail to increase soluble sugar biosynthesis could not tolerate salt as evidenced by Pessarakli (2002). The most interesting finding also is that the accumulation of either of IAA in the shoots or sugars and cytokinins in the roots was considerably exceeded the comparable accumulation even in the salt-tolerant cultivar control, which might indicate noticeable increases in the tolerance of the treated plants to salinity over that of the salt tolerant Sakha 8 control as previously evidenced by El-Ghamrawy *et al.* (1999).

As regards the beneficial effects of the exogenous application of ABA, gamma rays and putrescine. Raggiani *et al.* (1993) suggested that ABA-induced accumulation of 4-aminobutyrate is a mechanism involved in the tolerance of plant tissues to stress conditions. Also, It is assumed that ABA is involved in the normal induction of the synthesis of the 26-KD protein (Osmotin) and the presence of NaCl is necessary for the protein to accumulate (Brassan *et al.* 1985). Similary, Singh *et al.,* (1987) reported that exposure of tobacco cultured cells to ABA, led the cells to synthesize a 26-kD protein. Moreover, Pekic *et al.* (1993) suggested that in wheat, rice and maize ABA improved crop tolerance under salinity stress conditions. Moreover, Gong *et al.* (1990) found that in barley and wheat seedlings treated with ABA their salt resistance and survival rate improved significantly compared with the untreated once. In addition, Nesiem and Ghallab (1999) found that foliar application with ABA would increase the capacity for osmoregulation in Giza 163 than the partially salt-tolerant Sakha 92. As for gamma rays, Ghallab and Nesiem (1999) suggested that possibility of successful application of gamma rays to improvement salinity tolerance of the sensitive wheat cultivars. As for the positive effects of the exogenous application of putrescine on the plants under saline conditions, Galston (1983) stated that putrescine and polyamines have been frequently described as endogenous plant growth regulators or intracellular second messengers mediating the effects of phytohormones. Similar conclusion was also drawn by Line (1984); Smith, (1985); Evans and Malmberg (1989); as well as Bagni and Torrigiani (1992). Moreover, Chaudinova *et al.* (1985) reported that the increased intracellular putrescine and polyamines in *Puccinellia filifolia* (halophyte) under saline conditions had an adaptive significance and together with other changes in metabolism, increased its salt tolerance. On the othe hand, Reddell *et al.* (1986) found that application of putrescine on *Casuarina obesa* brought about an alleviation of stress injury induced by NaCl, thus significantly increased growth. Also, Slocum *et al.* (1984) demonstrated its influence in protein and nucleic acid synthesis. Meanwhile, Chatterjee *et al.*, (1988) confirmed its association with photosynthetic activity in rice plants.

C- Chemical analyses of the produced grains:

The chemical analyses of the produced grains either from both controls or the treated Giza 167 plants (Tables 17-20) clearly show that the sugar concentrations in the grains showed a similar positive trend to that obtained with the organs of the growing plants. Thus, sugar concentrations, especially the non-reducing ones, showed gradual increases by increasing salinity levels to reach the highest levels at the highest level of salinity. Also, the same observation could be drawn when compared the mean values of sugars due to each treatments (Mean T) or the effect of the interaction between treatments and the salinity levels, with special referring to the absolute superiority of putrescine treatment which recorded the highest increments over the salt-tolerant control in the all sugar fractions at the all salinity levels, followed by the weekly spraying with 2 ppm ABA then the grains irradiation with 15 KR gamma rays. Moreover, free amino acids in the grains were similarly positively affected by increasing salinity levels as did in the stressed shoots and roots. Also, the response of amino acids in the produced grain as affected by the various treatments were similar to that in the plant organs. As for protein concentrations in the grains, although it adversely affected by increasing salinity levels, unlike sugars and free amino acids, the mean values of protein concentration (Mean T) in produced grains by the treated plants either with the weekly spraying of putrescine or 2ppm ABA or 15 KR gamma rays irradiation showed much higher concentrations over the respective value of the salt-tolerant control which continued up to 30% sea water level, meanwhile, the other three treatments exceeded the tolerant control up to 15% level. As for the nutrient concentrations in the produced grains, the obtained data show that, as did with their concentrations in the growing plant organs, although N, P and K^+ were negatively affected by increasing salinity level, the complete reverse was true with Ca^{+2}, Mg^+ and Na^+, especially the latter one. It is to be observed that the all estimated nutrient showed much lower values especially Na^+ in the grains than their concentrations in the stressed roots and shoots.

On the other hand, nutrient concentrations in the grains showed general behavior in response to the various treatments similar to that obtained and recorded in the plant organs. Moreover, the most important observation as regards the superiority of spraying with putrescine, 2 ppm ABA and irradiation with 15 KR gamma rays in increasing N, P, K^+, Ca^{+2} and Mg^{+2} content as well as reducing Na^+ quantities to the lowest level in the plant organs which even much lower than that of the salt-tolerant control, this observation was more pronounced in the produced grains due to the same most effective previous three treatments, i.e. the Mean T of Na^+ due to the three treatments were 0.89, 0.96 and 0.93, respectively compared with 1.45 and 1.15 mg/g dry weight in the sensitive and tolerant control, respectively.

Also, the same three treatments recorded the lowest Na^+ concentration values in the produced grains as compared with the all other treatments including both controls at the all applied salinity levels up to 45%

Table(17): Effect of gamma rays, abscisic acid and putrescine treatments on reducing, non-reducing and total sugars concentration (mg glucose/g dry weight) in the grains of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the grains produced by the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (% sea water) during 2000-2001 season.

Treatments \ % Sea water	Reducing sugars					Non-reducing sugars					Total sugars				
	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T
Sakha 8 control	4.73	6.44	10.60	15.02	9.20	18.67	25.50	29.47	33.26	26.73	23.40	31.94	40.07	48.28	35.92
Giza 167 control	3.43	4.54	6.45	9.79	6.05	14.88	18.17	20.59	25.23	19.72	18.31	22.71	27.04	35.02	25.77
Gamma rays 15 KR	6.42	9.55	13.59	18.83	12.10	24.24	28.18	35.51	40.21	32.04	30.66	37.73	49.10	59.04	44.13
Gamma rays 20 KR	5.04	7.99	9.01	11.12	8.29	20.17	26.01	28.10	29.02	25.83	25.21	34.00	37.11	40.14	34.12
Soaking in 2 ppm ABA	5.11	8.01	9.10	11.13	8.34	20.18	26.07	28.25	29.14	25.91	25.29	34.08	37.35	40.27	34.25
Soaking + spraying with 2 ppm ABA	5.19	8.11	9.20	11.17	8.42	20.21	26.15	28.19	29.15	25.93	25.40	34.26	37.39	40.32	34.34
Weekly spraying with 2 ppm ABA	6.41	9.66	13.63	18.94	12.16	29.79	35.16	38.17	47.02	37.54	36.20	44.82	51.80	65.96	49.70
Weekly spraying with 10 µM putrescine	6.94	9.92	14.08	19.20	12.54	30.53	36.36	40.84	48.58	39.08	37.47	46.28	54.92	67.78	51.61
Mean (S)	5.41	8.03	10.71	14.40		22.33	27.70	31.14	35.20		27.74	35.73	41.85	49.60	

Table (18): Effect of gamma rays, abscisic acid and putrescine treatments on free amino acids and crude protein concentrations (mg/g dry weight) in the grains of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the grain produced by the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (% sea water) during 2000-2001 season.

Treatments \ % Sea water	Free amino acids					Crude protein				
	0	15	30	45	Mean T	0	15	30	45	Mean T
Sakha 8 control	0.99	1.81	2.72	3.29	2.20	111.38	88.94	79.00	65.50	86.20
Giza 167 control	0.87	0.91	1.54	2.53	1.46	97.63	72.81	61.50	41.44	68.34
Gamma rays 15 KR	1.61	2.15	2.95	3.01	2.43	135.13	119.75	101.13	31.19	96.80
Gamma rays 20 KR	1.05	2.05	2.25	2.61	1.99	115.38	103.44	54.25	27.75	75.20
Soaking in 2 ppm ABA	1.03	2.02	2.19	2.55	1.95	112.56	103.94	55.06	25.38	74.23
Soaking + spraying with 2 ppm ABA	1.04	1.99	2.15	2.59	1.94	116.31	112.63	55.81	30.50	78.81
Weekly spraying with 2 ppm ABA	1.72	2.27	2.99	3.09	2.52	138.88	126.31	108.81	31.38	101.34
Weekly spraying with 10 µM putrescine	1.80	2.39	3.05	3.18	2.61	147.50	135.00	115.00	32.25	107.44
Mean (S)	1.26	1.95	2.48	2.86		61.41	46.34	78.82	35.67	

Table (19): Effect of gamma rays, abscisic acid and putrescine treatments on N,P,K^+,Na^+,Ca^{+2},Mg^{+2} concentrations (mg/g dry weight) in the grains of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the grains produced by the grains produced by the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (% sea water) during 2000-2001 season.

Treatments \ % Sea water	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T
	N					P					K				
Sakha 8 control	17.82	14.23	12.64	10.48	13.79	1.98	1.83	1.61	1.40	1.71	3.49	2.85	2.46	2.11	2.73
Giza 167 control	15.62	11.65	9.84	6.63	10.94	1.75	1.57	1.34	1.16	1.46	2.66	2.40	2.23	1.71	2.25
Gamma rays 15 KR	21.62	19.16	16.18	4.99	15.49	2.53	2.18	2.01	0.99	1.93	5.19	4.33	3.46	1.62	3.65
Gamma rays 20 KR	18.46	16.55	8.68	4.44	12.03	2.13	2.03	1.11	0.72	1.50	4.13	3.15	1.16	1.01	2.36
Soaking in 2 ppm ABA	18.01	16.63	8.81	4.06	11.88	2.18	2.04	1.09	0.75	1.52	4.16	3.11	1.14	1.05	2.37
Soaking + spraying with 2 ppm ABA	18.61	18.02	8.93	4.88	12.61	2.15	2.08	1.10	0.81	1.54	4.23	3.18	1.21	1.09	2.43
Weekly spraying with 2 ppm ABA	22.22	20.21	17.41	5.02	16.22	2.87	2.19	2.04	0.98	2.02	5.28	4.39	3.52	1.63	3.71
Weekly spraying with 10 µM putrescine	23.60	21.60	18.40	5.16	17.19	2.95	2.22	2.07	1.01	2.06	5.32	4.41	3.59	1.66	3.75
Mean (S)	19.50	17.26	12.61	5.71		2.32	2.02	1.55	0.98		4.31	3.48	2.35	1.49	
	Na					Ca					Mg				
Sakha 8 control	0.80	1.11	1.26	1.41	1.15	1.96	2.46	2.93	3.91	2.82	2.82	2.99	3.45	4.26	3.38
Giza 167 control	0.91	1.31	1.63	1.96	1.45	1.27	1.59	1.91	2.11	1.72	2.41	2.55	2.88	3.02	2.72
Gamma rays 15 KR	0.52	0.84	1.04	1.32	0.93	2.35	2.98	3.32	3.52	3.04	3.15	3.26	3.69	3.88	3.49
Gamma rays 20 KR	0.74	1.01	1.74	1.99	1.37	2.15	2.64	2.81	2.99	2.65	2.89	3.08	3.25	3.48	3.18
Soaking in 2 ppm ABA	0.63	1.03	1.76	2.01	1.36	2.11	2.59	2.78	2.93	2.60	2.92	3.09	3.22	3.50	3.18
Soaking + spraying with 2 ppm ABA	0.71	1.01	1.79	2.02	1.38	2.16	2.62	2.80	2.96	2.64	2.98	3.10	3.26	3.67	3.22
Weekly spraying with 2 ppm ABA	0.52	0.91	1.05	1.34	0.96	2.47	3.01	3.40	3.71	3.15	3.13	3.34	3.79	3.91	3.54
Weekly spraying with 10 µM putrescine	0.49	0.75	1.01	1.30	0.89	2.51	3.10	3.51	3.79	3.23	3.25	3.41	3.82	4.01	3.62
Mean (S)	0.67	1.00	1.41	1.67		2.12	2.62	2.93	3.24		2.94	3.10	3.42	3.72	

Also, the same three treatments recorded the lowest Na^+ concentration values in the produced grains as compared with the all other treatments including both controls at the all applied salinity levels up to 45% sea water level. The other three treatments exhibited some favorable effects, though to lesser extent, in this regard compared with the first three treatments. In addition, and as would be expected although K^+/Na^+ ratio in the produced grains was negatively affected by salinity levels, contrary to Na^+/Ca^{+2} ratio in the same grains. The produced grains from the plants which weekly sprayed either with putrescine or 2 ppm ABA or 15 KR gamma rays showed the completely opposite trend to that of salinity. Thus, they recorded the highest mean values (Mean T) of K^+/Na^+ ratio, i.e. 5.39, 4.89 and 4.92, respectively compared with 2.59 and 1.75 for both tolerant and sensitive controls, respectively as well as 2.47, 2.70 and 2.58 for the other three treatments. On the contrary, the same super treatments recorded the lowest mean values (Mean T) of Na^+/Ca^{+2} ratio in the produced grains, i.e. 0.27, 0.30 and 0.30, respectively, and 0.51, 0.50 and 0.50 for the other three treatments.

Table (20): Effect of gamma rays, abscisic acid and putrescine treatments on K^+/Na^+ and Na^+/Ca^{+2} ratios of the grains of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the grains produced by the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (% sea water) during 2000-2001 season.

Treatments / % Sea water	K/Na					Na/Ca				
	0	15	30	45	Mean T	0	15	30	45	Mean T
Sakha 8 control	4.36	2.57	1.95	1.50	2.59	0.41	0.45	0.43	0.36	0.41
Giza 167 control	2.92	1.83	1.37	0.87	1.75	0.72	0.82	0.85	0.93	0.83
Gamma rays 15 KR	9.98	5.15	3.33	1.23	4.92	0.22	0.28	0.31	0.38	0.30
Gamma rays 20 KR	5.58	3.12	0.67	0.51	2.47	0.34	0.38	0.62	0.67	0.50
Soaking in 2 ppm ABA	6.60	3.02	0.65	0.52	2.70	0.30	0.40	0.63	0.69	0.50
Soaking + spraying with 2 ppm ABA	5.96	3.15	0.68	0.54	2.58	0.33	0.39	0.64	0.68	0.51
Weekly spraying with 2 ppm ABA	10.15	4.82	3.35	1.22	4.89	0.21	0.30	0.31	0.36	0.30
Weekly spraying with 10 µM putrescine	10.86	5.88	3.55	1.28	5.39	0.20	0.24	0.29	0.34	0.27
Mean (S)	7.05	3.69	1.94	0.96		0.34	0.41	0.51	0.55	

D-Yield components:

The obtained data in Tables 21 and 22 and clearly reveal that the all studied yield components (Mean S) were highly significantly decreased in the salt-stressed wheat plants as compared with the respective values of yield components of the non-stressed control plants.

The detrimental and injurious effects of salinity on the growth and productivity of the stressed plants which were confirmed in the present work are in accordance with those previously reported by several authors. Kumar *et al.* (1987) mentioned that increasing salinity level in the irrigation water decreased growth and yield components of wheat plants. Such reduction amounted to 30-100% in the grain yield of wheat as evidenced by (Hanks *et al.*, 1989). Similar results with barely were reported by Al-Khaffaf *et al.* (1990), and by Padole (1991) with wheat. Moreover, Holloway and Alston (1992) reported that salt stress (0, 13, 39 or 75 mmol/kg) decreased tillering, dry matter production and grain yield of the stressed wheat plants. Moreover, Zeng *et al.* (2000) reported that in rice plants the reduction of tillers number/plant and spikelet number /pancile were the major causes of yield loss under salinity. Recently, Salem *et al.* (2002) indicated that salinity or salinity + *Orobanche* infection resulted in highly significant reduction in the seed yield (g) /plant of the most resistant faba bean cultivars, i.e. Giza 429 and Giza 843 in spite of their superiority in growth, dry matter accumulation and chemical compositions. Accordingly, they recommended that a special specific physiological treatments must be applied on both cultivars, in order to increasing their salt tolerance and consequently approach their optimal productivity under such saline conditions. However, The most interesting and important feature of the obtained data in the first part of the present investigation in spite of the sever negative effects of salinity on yield component of stressed plants is that, the highly significant positive responses of the all studied yield components of the sensitive Giza 167 cultivar plants were recorded as a result of the weekly spraying either with 10 µM putrescine or 2 ppm ABA as well as the grain irradiation with 15 KR gamma rays, so much so that, their yield components were highly significantly exceeded the comparable ones of the salt-tolerant untreated Sakha 8 control at the all applied salinity levels, except only the highest one, i.e. 45% sea water. The superiority of these treatments can be evidenced by calculating the percentages of the highly significant increases in the grain yield/ g plant due to each treatments over the salt-tolerant control at 30% sea water level which were 53.0%, 44.4% and 38.4% for spraying with putrescine, 2 ppm ABA and 15 KR gamma rays treatments, respectively. In the meantime, the recorded percentages by the same three treatments over the salt-sensitive control were, 126.5%, 113.7% and 104.9%, respectively at the same 30% sea water level. On the other hand, the highly significant increases in the grain yield due to the other three treatments, i.e. 20 KR gamma rays, soaking in 2 ppm ABA and soaking + spraying with 2 ppm ABA were recorded either over the Mean T of the sensitive control or over the tolerant one were recorded only up to 15% sea water level, meanwhile, at 30% and 45% sea water levels, a highly significant reduction in the yield components due to the same three treatments were recorded in comparison with the respective yield of both controls.

Increasing the yield and its components due to gamma rays, ABA and putrescine treatments under saline conditions has been reported by several investigations. In this concern, El-Halim *et al.* (1989) reported that although wheat germination rate, plant growth and yield components decreased with increasing salinity, the same parameters increased when the wheat grains were irradiated with 2-8 KR gamma rays. Also Ghallab and Nesiem (1999) suggested that possibility of successful application of gamma rays to improvement salinity tolerance of the sensitive wheat cultivars. On the other hand, Aldesuquy *et al.* (1998) studied the effects of presoaking wheat grains in two different antitranspirant solutions (sodium salicylate at 5 mM or abscisic acid at 1 mM) and found that both antitranspirant increased growth and pigment contents as well as yield components of stressed wheat plants. Gong *et al.* (1990) found that barely seedlings and wheat previously treated with ABA had significantly lower Na^+ and Cl^- contents and Na^+/K^+ ratio, in addition, their salt resistance and yield were significantly improved compared with the untreated ones.

Moreover, Nessiem and Ghallab (1999) reported that foliar applications of ABA increased tolerance of Giza 163 (sensitive) and Sakha 92 (partially salt tolerant) to salinity expressed in increasing root length and dry weight as well as grain yield/plant and 1000 grains-weight. They attributed the increase in the grain yield/plant due to the effect of ABA on enhancement of assimilates translocation to the grains under salinity. In addition, the superiority of putrescine treatment in improving salinity tolerance of the stressed plants, which in turn, led to enhancement of their productivity under saline conditions was previously evidenced by several workers as due to that putrescine associated with cell division and active growth and metabolism (Biondl *et al.*, 1993), plays an important regulatory role in plant growth promotion (Smith, 1982); influenced protein and nucleic acid synthesis (Slocum *et al.*, 1984), associated with photosynthetic activity in rice

(Chetterjee *et al.*, 1988), mediators of hormone action in many plants (Bernel-Lugo, 1983), also putrescine and polyamines described as endogenous plant growth regulators or interacellular second messengers mediating the effect of phytohormones (Galaston, 1983). The increased interacellular concentrations of putrescine and polyamines under saline conditions had an adaptive significance increased the salt tolerance (Chaudinova *et al.*, 1985). Moreover, Prakash and Prathapasenan (1988) concluded that foliar application of putrescine (10^{-5} M) significantly increased the growth and yield of salt-stressed rice plants.

Table (21):Effect of gamma rays, abscisic acid and putrescine treatments on number of spikes, weight of spikes and weight of straw / plant of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ % sea water	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T
	Number of spikes/plant					Weight of spikes/plant					Weight of straw/plant				
Sakha 8 control	2.41	2.20	2.02	1.30	1.98	3.29	2.65	2.10	1.65	2.42	7.33	6.03	4.55	3.54	5.36
Giza 167 control	2.03	1.61	1.40	0.72	1.44	3.02	1.92	1.32	0.92	1.80	6.48	4.36	2.92	1.87	3.91
Gamma rays 15 KR	4.14	3.16	2.66	0.11	2.52	5.28	3.69	2.95	0.13	3.01	10.26	8.09	6.99	0.19	6.38
Gamma rays 20 KR	3.89	2.87	0.63	0.10	1.87	4.67	3.43	0.54	0.11	2.19	9.96	7.77	1.21	0.15	4.77
Soaking in 2 ppm ABA	3.84	2.85	0.69	0.08	1.87	4.71	3.41	0.44	0.12	2.17	9.99	7.75	1.17	0.13	4.76
Soaking + spraying with 2 ppm ABA	3.76	2.91	0.71	0.09	1.87	4.74	3.40	0.41	0.11	2.17	9.97	7.71	1.11	0.11	4.73
Weekly spraying with 2 ppm ABA	4.18	3.27	2.69	0.10	2.56	5.44	4.06	3.13	0.12	3.19	10.38	8.17	6.96	0.21	6.43
Weekly spraying with 10 µM putrescine	4.43	3.47	2.77	0.11	2.70	5.63	4.15	3.25	0.16	3.30	10.41	8.31	7.01	0.23	6.49
Mean (S)	3.59	2.79	1.70	0.33		4.60	3.34	1.77	0.42		9.35	7.27	3.99	0.80	
New LSD value at		0.05	0.01				0.05	0.01				0.05	0.01		
Salinity (S)		0.16	0.21				0.19	0.25				0.43	0.57		
Treatment (T)		0.22	0.30				0.27	0.36				0.61	0.81		
(S) X (T)		0.45	0.59				0.54	0.72				1.21	1.61		

Table (22):Effect of gamma rays, abscisic acid and putrescine treatments on number of grains, grain yield (g) / plant and weight of 1000 grains of the salt-sensitive Giza 167 wheat cultivar plants in comparison with the untreated salt-tolerant Sakha 8 cultivar plants under saline conditions (%sea water) during 2000-2001 season.

Treatments \ % sea water	0	15	30	45	Mean T	0	15	30	45	Mean T	0	15	30	45	Mean T
	Number of grains/plant					Grain yield(g)/plant					Weight of 1000 grains				
Sakha 8 control	98.65	80.36	60.02	49.22	72.06	2.52	1.76	1.51	1.38	1.79	42.48	31.83	25.62	18.24	29.54
Giza 167 control	75.40	59.11	40.28	30.01	51.20	1.88	1.22	1.02	0.84	1.24	35.50	24.53	19.34	13.11	23.12
Gamma rays 15 KR	185.50	128.88	88.16	10.71	103.31	3.66	2.56	2.09	0.31	2.16	58.33	41.66	32.88	7.55	35.11
Gamma rays 20 KR	129.90	101.79	19.05	10.15	64.97	3.08	2.40	0.43	0.24	1.54	48.10	38.68	12.02	7.03	26.46
Soaking in 2 ppm ABA	120.50	103.71	18.02	10.01	63.06	3.11	2.42	0.41	0.34	1.57	48.47	39.09	12.26	7.11	26.73
Soaking + spraying with 2 ppm ABA	118.10	100.46	16.54	10.12	61.31	3.04	2.32	0.39	0.25	1.50	47.90	37.82	13.11	7.07	26.48
Weekly spraying with 2 ppm ABA	196.40	137.77	98.75	10.36	110.82	3.95	2.53	2.18	0.34	2.25	59.63	44.41	33.73	7.85	36.41
Weekly spraying with 10 µM putrescine	209.80	158.80	101.68	10.47	120.19	4.25	2.91	2.31	0.36	2.46	61.45	46.49	35.33	7.96	37.81
Mean (S)	141.66	108.86	55.31	17.63		3.19	2.27	1.29	0.51		50.23	38.06	23.04	9.49	
New LSD value at		0.05	0.01				0.05	0.01				0.05	0.01		
Salinity (S)		5.32	6.40				0.09	0.12				1.15	1.53		
Treatment (T)		7.94	9.89				0.18	0.21				1.63	2.16		
(S) X (T)		14.88	19.01				0.31	0.45				3.25	4.32		

A wide survey of the obtained data of this first part in the present investigation strongly confirmed the superiority of the weekly spraying either with 10 µM putrescine or 2 ppm ABA as well as grain irradiation with 15 KR gamma rays in inducing the highest degree of the physiological tolerance to salinity which enables the stressed plants of the sensitive Giza 167 cultivar to be adapted and keep better performance against the all applied levels of salinity and even confirmed their superiority up to 30% sea water level in comparison with the salt-tolerant Sakha 8 cultivar.

Such highest degree of adaptation induced-by these above mentioned three treatments, strongly indicating the induction of high degree of the physiological tolerance in the treated plants brought about by creating more negative osmotic potential "Osmotic Adjustment" in their tissues, as previously evidenced by several authors, through the accumulation of much more quantities of inorganic osmotica, i.e. N, P, K^+, Ca^{+2}, Mg^{+2} as well as highest K^+/Na^+ ratio and the lowest Na^+/Ca^{+2} ratio in addition to the lowest quantities of Na^+ in their shoots and roots. This in addition to the considerable accumulation of organic protective osmolytes, i.e. non-reducing sugars, proline, free amino acids and protein which greatly exceeded that in the all other treated or untreated control plants, as an adaptive mechanism enable the treated plants to adjust the ratio between the protective and toxic intermediates of metabolism in favor of more tolerance to salt stress. Moreover, this was accompanied by an endogenous hormonal status in such treated plants was also, in favor of more physiological tolerance to salinity through maintaining of the most favorable water relation, i.e. the high accumulation of IAA, GA_3 and ABA in the treated shoots as well as cytokinins (and sugars) in their roots. This in addition to the considerable reduction in invertase activity in the treated tissues in favor of more accumulation of non-reducing sugars, especially in the stressed roots. Such behavior in the treated plants evidently increased their ability to counteract salinity stress, thus were able to keep better performance against salinity till harvest, which was reflected in a highly significant increments in their yield components over the respective yield of the all other treatments including even the salt-tolerant control up to 30% sea water level. This strongly indicates that, these results are not only of academic interest but also of great applied importance. If we consider these results from the economical applied point of view, the obtained results strongly suggested that the tolerance to salinity of the salt-sensitive Giza 167 cultivar can be improved to a considerable extent, hence, it can be successfully cultivated in the new Egyptian land areas and could tolerate the irrigation with the diluted sea water up to 30% sea water level, and nevertheless, approach their optimal productivity which highly significantly exceeded the comparable productivity of the salt-tolerant Sakha 8 cultivar plants under the same saline conditions, if these sensitive plants were weekly sprayed either with 10 µM putrescine, (which was superior amongst the all applied treatments), or 2 ppm ABA as well as when their grains were irradiated with 15 KR gamma rays before sowing. Further genetical and physiological studies must be done to disclosed whether the roles of the weekly spraying either with 10 µM putrescine or 2 ppm ABA as well as grain irradiation with 15 KR gamma rays in improving salinity tolerance of the sensitive wheat cultivar were attributed to some alternation in the properties of the cell membranes, enhancement in the physiological metabolic processes rates, somatic mutation (especially with gamma rays) or to any other genetic changes at the cell level.

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تأثير أشعة جاما وحمض الابسيسيك والبتروسين على انتاج نباتات قمح اكثر تحملا للملوحة:

ا- النمو والتركيب الكيميائي والحالة الهرمونية وانتاجية نباتات القمح المعاملة النامية في اصص تحت ظروف الملوحة

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أجريت تجارب أصص خلال موسمين متتاليين ، ١٩٩٩ – ٢٠٠٠ ، ٢٠٠٠ – ٢٠٠١ بغرض دراسة تأثير أشعة جاما و حمض الابسيسيك و البتروسين علي تحسين المقاومة للملوحة في نباتات صنف القمح الحساس جيزة ١٦٧ بهدف الوصول بها وكذلك بانتاجيتها إلى المستوي الذي يتميز به صنف القمح المقاوم للملوحة سخا ٨ ، وذلك في حالة ريهما بتركيزات متدرجة من ماء البحر (١٥ ٪ ، ٣٠ ٪ ، ٤٥ ٪) بالإضافة لمعاملة المقارنة (الري بماء الصنبور). وقد أكدت النتائج التفوق المطلق لمعاملات الرش الأسبوعي اما بتركيز ١٠ ميكرومول بتروسين او ٢ جزء في المليون حمض الابسيسيك و كذلك تشعيع الحبوب قبل الزراعة بجرعة ١٥ كيلوراد أشعة جاما (خاصة معاملة البتروسين) ، في إحداث أعلى درجات التحمل الفسيولوجي للملوحة في النباتات الحساسة لصنف جيزة ١٦٧ والمعاملة بها والتي مكنت تلك النباتات من التأقلم مع جميع مستويات الملوحة المستخدمة ، وتاكيد تفوقها الواضح علي معاملة المقارنة للصنف المقاوم سخا ٨ حتى مستوي ٣٠٪ ماء بحر على الاقل. هذا التحمل الفسيولوجي للملوحة قد تحقق لهذه النباتات -كما اوضحت النتائج- من خلال خلق جهد أسموزي اكثر سالبيه داخل أنسجتها (عملية التنظيم الإسموزي) وذلك بتراكم كميات كبيرة ومتزايدة من عناصر النيتروجين والفوسفور والبوتاسيوم والكالسيوم والمغنيسيوم مع الاحتفاظ بنسبة البوتاسيوم : الصوديوم عند أعلى حد ممكن لها مع تقليل تركيز الصوديوم وكذلك نسبة الصوديوم : الكالسيوم عند اقل مستوى لها ، وذلك بالإضافة إلى تراكم كميات كبيرة من السكريات (خاصة غير المختزلة منها) والبرولين والأحماض الأمينية الحرة والبروتين- سواء في الانسجة النامية او الحبوب الناتجة- والتي فاقت كثيرا مثيلتها في نباتات وحبوب جميع المعاملات الاخرى بما فيها معاملتي المقارنة للصنفين الحساس والمقاوم حتى مستوى ٣٠٪ ماء بحر على الاقل. وقد صاحب هذا حالة خاصة للتوزيع الداخلي للهرمونات النباتية في صالح المزيد من تحمل الملوحة في هذه النباتات ، تمثل هذا في تراكم السيتوكاينينات (الى جانب السكريات) في الجذور، بالاضافة الى تراكم آخر للجبريللينات والاوكسينات وحمض الابسيسيك في المجموع الخضري لتلك النباتات . هذا مع تقليل نشاط انزيم الانفرتيز الى اقل مستوى له مما ادى لتراكم المزيد من السكريات غير المختزلة خاصة في الجذور. ولعل ابرز واهم ملامح النتائج المتحصل عليها خلال هذا البحث هي أن التفوق المطلق للمعاملات الثلاث السابق ذكرها والذي أكدته نتائج قياسات النمو وتراكم المادة الجافة والتركيب الكيميائي والهرمونات الداخلية وانزيم الانفرتيز قد انعكس -وبصورة اكثر تفوقا ووضوحا- على إنتاجية هذه النباتات المعاملة والتي أظهرت تفوقا عالي المعنوية على إنتاجية معاملة المقارنة للصنف المقاوم سخا ٨ حتى مستوى ٣٠٪ ماء بحر. ولهذا فان النتائج المتحصل عليها من خلال هذا البحث تؤكد إمكانية تحسين صفة التحمل للملوحة في نباتات صنف القمح الحساس جيزة ١٦٧ الى درجة كبيرة وبالتالي إمكانية زراعتها بنجاح تحت ظروف الأراضي الجديدة وتحملها للري بماء البحر حتى تركيز ٣٠٪ ورغم هذا يمكنها الوصول الى إنتاجيتها المثلى تحت هذه الظروف والتي تتفوق تفوقا عالي المعنوية على إنتاجية الصنف المقاوم سخا ٨ وذلك عند رش النباتات الحساسة اسبوعيا اما بتركيز ١٠ ميكرومول بتروسين او ٢ جزء في المليون حمض الأبسيسيك او تشعيع الحبوب قبل الزراعة بـ ١٥ كيلو راد أشعة جاما .