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Some Active Ingredients, Total Protein and Amino Acids in Plants Produced from Irradiated *Ambrosia maritima* Seeds Growing under Different Soil Salinity Levels

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ABSTRACT

This study was carried out at the National Center for Radiation Research and Technology during two successive seasons, of 2007/2008 and 2008/2009, respectively in pots 30 cm in diameter. The aim of this experiment was to study the response of damsisa (*Ambrosia maritima* L.) seeds that exposed to different doses of radiation (0, 20, 40, 80 Gy) after planting in soils contain mixtures of salts. The dose rate was 0.89 and 0.87 rad sec^{-1}. The salts used were NaCl, $CaCl_2$ and $MgSO_4$ in ratio 2:2:1 with concentrations 2000, 4000 and 6000 ppm. Irradiated and un- irradiated seeds were sown in, sand-loamy, soil with mixture of salts. Also, a group of irradiated and un-irradiated seeds were sown in normal soils without salt and serve as a control, all pots irrigated with tap water until field capacity. It was observed that saline condition decreased ambrosin, protein and amino acids trend, in damsisa shoots. While, the results obtained refer to increasing proline concentration separated as a result of uses γ-rays and salinity treatments. The extreme sensitivity of the metabolic processes of proline synthesis and degradation themselves may be of benefit by regulating metabolic processes which adversely affected by stress. So, it was concluded that γ-rays improve plant growth and increase its chemical components under saline stress condition.

Key words: *Ambrosia maritima,* amino acids, protein, minerals, ambrosin, damsin

INTRODUCTION

Damsisa (*Ambrosia maritima* L.) is one of the wild plants present in Egypt and different African countries of Nile valley. It belongs to subfamily Tubuliflorae, that represent a branch of family Compositae from flowering plants (Evans, 1996). Shoeb and El-Emam (1976) stated that ambrosin and damsin considered as the most active ingredients in damsisa plants. Ambrosin was synthesized and described by Grieco *et al.* (1982), they attribute it to a group of natural products known as psuedo-guaianolides. Drinking decoctions of damsisa were the most commonly used remedy for schistosomiasis in upper Egypt (Kloos *et al.*, 1982). Aqueous methanol extract of damsisa plant had hepatoprotective and antioxidant actions in drug that induce hepatotoxicity in rats (Ahmed and Khater, 2001). Gamma irradiation considered as a valuable tools in many purposes, from which, developing varieties that economically and agriculturally important and have high productivity potential. Moreover, gamma irradiation increases plant resistance to unfavorite

conditions such as salinity, water stresses, cold and in some condition insects or diseases (Jain *et al*., 1998). The many mutant varieties which are resistant to diseases, cold, salt and with high quality, have been developed (Jain *et al*., 1998). The increase in some of amino acids in irradiated *Arachis hypogaea* and *Phaseolus vulgaris* seeds was attributed to the breakdown of proteins (Hussein, 1998). Release of free amino acids following radiation treatment was reported in wheat grains (Srinivas *et al*., 1972); this might be due to autolysis or proteolysis. Similar results were obtained in gamma irradiated red gram (*Cajanus cajan*) proteins (Nene *et al*., 1975). It was cleared that amino acids were continually synthesized during water stress (Prat and Fathi-Ettai, 1990; Guerrier and Bourgeais-Chaillou, 1994; Sundaresan and Sudhakaran, 1995). The present investigation introduces a study of the response of gamma irradiated *A. maritima* seeds that grown in different levels of soil salinity and the changes that takes place in their chemical components. The main objective of this study was estimation of active ingredients (ambrosin and damsin) in flowering stage of damsisa shoots as affected by radiation treatments, salinity levels and both of them, to report the changes that take place according to aforementioned treatments and whether affects their amounts.

MATERIALS AND METHODS

Damsisa seeds (*A. maritima* L.) were obtained from the Agriculture Research Center, Ministry of Agriculture, Dokki, Egypt. Seeds were irradiated with different doses of gamma rays (0, 20, 40 or 80 Gy). The irradiation process was carried out in the National Center for Radiation Research and Technology (NCRRT) using Cesium 137 as a source of gamma rays. The dose rate was 0.89 and 0.87 rad sec^{-1}, during the two successive seasons, respectively. Seeds were sown in the first of October of 2007/2008 and 2008/2009 seasons. The soil chemical analysis was determined according to Jackson (1973). The organic matter content was determined according to Walkley and Black method (Black, 1982). Data of soil analysis were shown in Table 1.

During the two successive seasons, four levels of salinity (0, 2000, 4000, 6000 ppm) were obtained by adding the mixture of sodium chloride, calcium chloride and magnesium sulphate at ratio of 2:2:1 by weight and were mixed with soil in each pot. Plants were fertilized according to the recommendations of the Egyptian Ministry of Agriculture and Land reclamation (150 kg calcium super phosphate/fed, 100 kg potassium sulphate/fed and 100 kg ammonium sulphate/fed).

The pots (30 cm in diameter) were filled with 5 kg sand-loamy soil obtained from the farm of (NCRRT). In the two successive seasons, pots were divided into 4 groups. The first group consists of non irradiated control seeds and other three doses of irradiated seeds by 20, 40 and 80 Gy and sown in normal soil (control). The first group was also serving as control for salinity groups. Three

Table 1: Average of some physico-chemical and mechanical analysis of experimental soil during two successive seasons of 2007/2008 and 2008/ 2009

Properties	Values	Properties	Values
pH	7.40	Ca^{+2} (meq L^{-1})	8.40
Ec (dS m^{-1})	2.10	Mg^{+2} (meq L^{-1})	2.70
HCO_3^-	1.65	O.M (%)	1.10
Cl^-(meq L^{-1})	12.00	Clay (%)	12.80
SO^-_4 (meq L^{-1})	8.45	Sand (%)	60.00
Na^+(meq L^{-1})	10.35	Silt (%)	27.20
K^+(meq L^{-1})	0.36	Texture class	Sandy loam

sets as mentioned above in the first group were reply for salt treatments which were 2000, 4000, and 6000 ppm. The irradiated seeds were divided into four groups according to soil salinity used in planting (0, 2000, 4000, 6000 ppm).

Ten seeds were germinated in pots with 0, 2000, 4000 and 6000 ppm and left to grow then plants were thinned to three plants per pot, all plastic pots were irrigated with tap water until field capacity.

The produced plants were air dried and then milled for extraction of ambrosin and damsin in shoots of flowering stage and HPLC analysis were carried out according to Slacanin *et al.* (1988) and Amin (1990).

- Total protein percent was obtained by multiplying the values of nitrogen concentration by 6.25, Nitrogen was estimated using micro Kjeldahl method of AOAC (1990)
- Amino acids analysis were done in amino acids laboratory at NCRRT according to method of Winders and Eggum (1966), after preparing the sample by weighing 100 mg powdered sample in glass tube containing 10 mL of 6 N HCl, the tube was sealed and kept in an oven at 110°C for 24 h for complete digestion as method of AOAC (1990). The system used for analysis was High performance amino acid analyzer (HPLC), Biochroma 20 (auto sampler version) pharmacia Biotech at NCRRT. Data analysis of chromatogram was done by Chromatography Data System Tutorial and user's Guide-version 6.7
- Determinations of K, Ca, Mg and Na were carried out in the dry material of damsisa plant shoots (Vegetative, Flowering and Fruiting stages). The wet digestion of 0.5 g plant material with sulphuric and perchloric acids was carried out on shoots as reported by Piper (1947). Flame photometer apparatus (CORNING M 410) was used to determine K and Na, atomic absorption spectrophotometer (GBC, 932 AA) was used to determine Ca and Mg

RESULTS AND DISCUSSION

Ambrosin and damsin: Some active ingredients of *A. maritima* shoots during flowering stage were shown in Table 2. It was observed that gamma radiation increase ambrosin percentage in damsisa shoots produced from seeds treated by 20, 40 or 80 Gy doses. The highest level of salinity 6000 ppm was noticed to increase ambrosin percentage in shoots produced from different doses of radiation as compared by normal, control. Meanwhile, all treatments used at different levels of salinity either irradiated or un-irradiated control for salinity mostly produced shoots having high

Table 2: Average percentage of active ingredients as affected by γ-rays and soil salinity in *A. maritima* L. shoots at flowering stage during 2008/2009 season

	Dose (Gy)									
	Ambrosin					Damsin				
Salinity (ppm)	0	20	40	80	Mean A	0	20	40	80	Mean A
0	0.41	0.39	0.41	0.67	0.47	2.17	1.43	1.07	0.97	1.41
2000	0.45	0.56	0.41	0.43	0.46	1.43	0.81	1.50	0.97	1.18
4000	0.41	0.65	0.52	0.53	0.53	0.89	0.89	1.67	0.90	1.09
6000	0.57	0.49	0.43	0.59	0.52	0.81	0.90	0.97	0.90	0.90
Mean b	0.46	0.52	0.44	0.55	1.32	1.01	1.30	0.94		
LSD 5%	A = NS	B = NS	A*B = NS			A = 033	B = 0. 26	A*B = 0.52		

A: Salinity, B: Irradiation, A*B: Interaction and LSD: Least significant difference

ambrosin percentage than the control set, same findings were obtained by Khater *et al.* (2002), on damsisa plants irrigated with saline water levels. The opposite is true in percentage to damsin content, except for 40 Gy dose. The results declare that shoots produced from seeds treatment by 40 Gy contain more damsin percentage than its corresponding control in different salinity sets.

It was found that damsin percentage increase by 4.9, 87.6 and 19.7% above its corresponding control at 2000, 4000 and 6000 ppm soil concentration. Sangwan *et al.* (2001) stated that the production of essential oil not only depends upon the metabolic state of the source tissues but also may be integrated with the stress factors. Razmjoo and Sabzalian (2008) indicated that increased salinity significantly reduced essential oil content of chamomile. Ashraf and Harris (2004) also showed that oil content in the seed of medicinal plant, bishops weed (*Ammolei majus*), was decreased consistently with increase in external salt levels. Meanwhile, Agastian *et al.* (2000) noticed that all major processes such as photosynthesis, protein synthesis and energy and lipid metabolism are affected, during the onset and development of salt stress within a plant, Baher *et al.* (2002), on basil, Hendawy and Khalid (2005) on *Salivia officinalis* and Khalid (2006) on *Ocimum americanum*.

Protein: There are fluctuations on protein% in damsisa shoots at the three different stages of growth during two seasons as shown in Table 3. But it was clear that shoots of plants that grown in soil under 4000 or 6000 ppm salt concentration mostly had the highest percentage of protein as

Table 3: Total protein percentage as affected by different doses of γ-rays and soil salinity in shoots of *A. maritima* L. shoots during 2007/2008 and 2008/2009

	Dose (Gy)									
	2007/2008					2008/2009				
Salinity (ppm)	0	20	40	80	Mean A	0	20	40	80	Mean A
Vegetative stage										
0	10.81	14.94	16.44	17.38	14.89	14.06	20.31	19.75	16.94	17.77
2000	10.50	18.88	18.19	16.00	15.89	20.69	12.56	12.13	21.94	16.83
4000	10.25	24.88	22.88	22.38	20.10	31.31	16.75	18.63	26.81	23.38
6000	8.81	18.25	17.50	36.13	20.17	20.00	17.06	39.00	26.44	25.63
Mean b	10.09	19.23	18.75	22.97		21.52	16.69	22.38	23.03	
LSD 5%	A = 0.39	B = 0.48	A*B = 0.9			A = 071	B = 0.95	A*B = 1.9		
Flowering stage										
0	12.44	29.75	20.75	16.38	19.83	20.50	14.81	23.56	19.44	19.58
2000	8.69	30.56	18.56	18.13	18.98	15.81	23.31	26.38	18.81	21.08
4000	6.25	25.38	25.81	16.63	18.52	16.44	21.38	25.88	22.50	21.55
6000	16.13	26.25	35.19	31.63	27.30	23.31	11.44	16.38	24.44	18.89
Mean b	10.88	27.99	25.08	20.69	19.02	17.74	23.05	21.30		
LSD 5%	A = 0.73	B = 0.53	A*B = 1.1			A = 0.80	B = 0.61	A*B = 1.22		
Fruiting stage										
0	12.13	8.63	33.63	27.19	20.40	23.19	23.00	20.81	16.44	20.86
2000	9.50	30.94	26.75	21.19	22.10	17.50	22.25	26.56	20.13	21.61
4000	22.25	18.75	19.50	22.50	20.75	22.56	25.88	14.00	16.19	19.66
6000	31.75	19.69	16.00	14.44	20.47	24.63	17.06	20.31	18.69	20.17
Mean b	18.91	19.50	23.97	21.33	21.97	22.05	20.42	17.86		
LSD 5%	A = 0.65	B = 0.57	A*B = 1.13			A = N.S	B = 0.73	A*B = 1.46		

A: Salinity, B: Irradiation, A*B: Interaction, LSD: Least significant difference

compared by control normal soil. At vegetative stage, the mean of protein percentage was 20.10% and 23.38% for plants grown at 4000 ppm soil concentration comparing to unstressed control (14.89%, 17.77%) in control set for the first and second season, respectively. In contrast to the above results, a progressive and consistent decrease in the percent of total protein were found. El-Mogy (1999) showed that the moderate and higher treatments of soil salinity (0.2, 0.4%) tended to decrease the nitrogen percentage and protein content of *A. maritima* leaves compared to control. Whereas, the maximum content of protein was obtained when using soil salinity of 0.1%, same finding on *A. maritima* was obtained by El-Sanafawy (2000). Salinity affecting both water absorption and biochemical processes such as N_2 and CO_2 assimilation and protein synthesis (Delfine *et al*., 1999).

Also, in gamma radiation treatments the 20 or 40 Gy dose of radiation produced the highest protein concentration as compared by un-irradiated control. Also, significant changes were observed as a result of sowing irradiated seeds in 4000 or 6000 ppm and producing plants having highest protein percentage mainly at first and second stages of growth at 2007/2008 season and at second stage of growth at 2008/2009 season. Prasad *et al*. (1997) found that both NH_4 and NO_3-N increased with increasing salinity up to 5 dS m^{-1}. The effect of NaCl salinity in presence or absence of the irradiated lupin (*Lupinus termis* L.) seeds with gamma rays, on nitrogen assimilation and ion uptake was investigated by Khodary (2004). Significant decreased in the contents of protein and amino acids, were observed upon exposure (0, 500, 1000, 2000, 3000 ppm). On the other hand, in seeds irradiated with gamma rays (10, 25, 100 Gy) these nitrogenous fractions were increased after NaCl treatments, the effect was more pronounced particularly with 25 Gy. Also, Hussein (2010) observed that treating seeds before sowing by gamma rays (50-250 Gy) increased total protein contents in the produced seedlings of mungbean seeds. Radiation caused oxidative injury by accelerating free radical generation in living systems. The primary damage induced by ionizing radiation is modified in enzymatic repair processes (Alikamanoglu *et al*., 2007). It was previously shown that gamma irradiation significantly influences the cell metabolism and protein synthesis in plant meristem cells (Casarett, 1968). According to the results obtained in the present study, it was observed that increased gamma dosage caused a reduction of total protein concentration. However, plants irradiated at relatively low dosage (10, 20 Gy) displayed a higher total protein concentration compared to their non-irradiated counterparts. This result demonstrated that there was a direct correlation between gamma dosage and protein content. Gamma irradiation caused inhibition of tissue culture growth along with failure of RNA and subsequently of protein synthesis (Bajaj, 1970). This accounts for the lower protein concentration in plants irradiated at high dosage (70 Gy).

Amino acids: Data in Table 2 and 3 demonstrated the effect of salinity treatment and γ-rays on essential amino acids (threonine, cystine, methionine, valine, isoleucine, tryrosine and phenylalanine) and non essential amino acids (aspartic, serine, glutamic, proline, glvcine, alanine, histidine and arginine) in *A. maritima* plants in the two successive seasons. The concentration of amino acids in *A. maritima* plants at flowering stage were shown in Table 4 and 5 during 2007/2008 and 2008/2009 season respectively as affected by different levels of salinity and doses of gamma rays. It was observed that the amino acid pool increased by salinity in shoot produced from seeds planted in soil with salt concentration 2000, 4000 or 6000 ppm during two seasons 2007, 2008 except 4000 ppm level of salinity at 2007 season where it's value less than control. The results obtained were similar with several reports of increase level of free amino acid pool during salt treatment in different plant species (Muthukumarasamy *et al*., 2000; Wang and Nii, 2000). Concerning amino acids concentration as affected by γ-rays, it was observed

Table 4: Amino acids concentration (mg g^{-1} DW) as affected by different doses of γ-rays and soil salinity *A. maritima* L. shoots at flowering stage of during 2007/2008 season

	Salinity levels															
	Control (ppm)				2000 (ppm)				4000 (ppm)				6000 (ppm)			
	Dose (Gy)															
Amino acids	0	20	40	80	0	20	40	80	0	20	40	80	0	20	40	80
Aspartic	1.42	1.96	2.36	1.26	1.72	1.06	2.02	1.78	1.18	1.64	1.92	1.94	1.54	1.50	1.82	1.58
Threonine	0.70	1.18	1.30	0.60	0.74	0.48	0.94	0.82	0.50	0.88	0.96	1.04	0.90	0.82	0.94	0.74
Serine	0.86	1.14	1.38	0.70	0.88	0.62	1.14	1.02	0.64	0.98	1.10	1.18	1.06	0.94	1.10	0.90
Glutamic	1.90	2.92	3.36	1.56	1.98	1.24	2.60	2.32	1.44	2.36	2.58	2.68	2.36	2.24	2.50	2.06
Proline	6.60	16.22	20.70	3.12	4.98	1.98	16.00	11.68	1.38	6.92	9.50	11.80	14.90	8.24	9.80	6.50
Glycine	0.98	1.32	1.30	0.80	1.04	0.64	1.06	0.98	0.84	1.04	1.14	1.16	1.14	0.94	1.06	0.86
Alanine	1.16	1.40	1.86	1.10	1.40	0.94	1.52	1.40	0.88	1.36	1.54	1.66	1.62	1.30	1.52	1.20
Cystine	0.06	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Valine	0.62	0.90	1.16	0.60	0.80	0.48	0.84	0.74	0.52	0.76	0.84	0.96	0.90	0.76	0.84	0.62
Methionine	0.02	0.04	0.22	0.00	0.06	0.00	0.02	0.02	0.00	0.02	0.08	0.18	0.04	0.08	0.02	0.04
Isoleucine	0.38	0.66	0.84	0.34	0.48	0.28	0.54	0.44	0.28	0.46	0.48	0.62	0.58	0.50	0.54	0.38
Leucine	1.12	1.44	1.86	0.90	1.22	0.78	1.34	1.18	0.74	1.26	1.38	1.54	1.50	1.18	1.38	0.98
Tryrosine	0.46	0.68	0.96	0.32	0.52	0.26	0.66	0.50	0.24	0.56	0.68	0.74	0.72	0.48	0.66	0.38
Phenylalanine	0.64	0.92	1.20	0.44	0.66	0.36	0.82	0.66	0.38	0.68	0.82	0.86	0.90	0.62	0.82	0.52
Histidine	0.28	0.72	0.86	0.20	0.30	0.16	0.52	0.32	0.12	0.28	0.42	0.40	0.54	0.30	0.40	0.34
Lysin	0.96	1.50	1.58	0.84	1.10	0.70	1.20	1.04	0.72	1.14	1.22	1.30	1.24	1.02	1.20	0.88
Arginine	0.76	3.14	2.90	0.72	1.34	0.60	1.46	1.18	0.52	1.08	1.40	1.28	1.66	1.08	1.30	1.56
Total mg g^{-1}	18.90	36.30	43.80	13.50	19.20	10.60	32.70	26.10	10.40	21.50	26.10	29.30	31.60	22.00	25.90	19.50

Table 5: Amino acids concentration (mg g^{-1} DW) as affected by different doses of γ-rays n and soil salinity in *A. maritima* L. shoots at flowering stage during 2008/2009 season

	Salinity levels															
	Control (ppm)				2000 (ppm)				4000 (ppm)				6000 (ppm)			
	Dose (Gy)															
Amino acids	0	20	40	80	0	20	40	80	0	20	40	80	0	20	40	80
Aspartic	2.3	2.0	2.0	1.86	1.92	2.06	2.1	1.9	2.1	2.38	2.18	1.92	2.02	1.90	1.78	1.66
Threonine	1.4	1.1	1.3	1.08	1.06	1.20	1.1	1.1	1.3	1.42	1.28	1.08	1.12	1.04	0.98	0.90
Serine	1.3	1.1	1.2	1.06	1.04	1.20	1.1	1.1	1.2	1.32	1.24	1.08	1.14	1.08	1.02	0.98
Glutamic	3.2	2.7	2.9	2.60	2.62	2.94	2.7	2.7	3.0	3.30	3.00	2.58	2.76	2.64	2.52	2.26
Proline	2.2	13.0	17.0	14.10	13.10	19.60	18.0	12.0	17.0	7.90	12.80	12.40	16.50	15.40	11.90	10.60
Glycine	1.4	1.1	1.3	1.06	1.04	1.24	1.1	1.1	1.3	1.30	1.16	1.02	1.02	0.98	0.92	0.88
Alanine	1.6	1.2	1.2	1.44	1.32	1.74	1.5	1.5	1.3	1.98	1.74	1.42	1.48	1.40	1.28	1.28
Cystine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Valine	1.2	1.0	1.0	1.02	0.98	1.34	1.0	1.0	1.1	1.56	1.20	0.94	1.06	0.96	0.9	0.84
Methionine	0.1	0.2	0.1	0.14	0.04	0.46	0.1	0.2	0.2	0.38	0.22	0.04	0.24	0.12	0.02	0.14
Isoleucine	0.9	0.9	0.8	0.74	0.74	0.98	0.7	0.7	0.9	1.46	0.96	0.68	0.92	0.76	0.72	0.60
Leucine	1.8	1.6	1.6	1.5	1.44	2.02	1.5	1.6	1.7	2.30	1.74	1.54	1.78	1.44	1.30	1.28
Tryrosine	1.2	1.4	1.0	0.88	0.6	2.06	0.8	0.8	1.1	2.14	1.18	1.22	1.64	0.78	0.42	0.66
Phenylalanine	1.4	1.2	1.1	1.02	1.02	1.48	1.0	1.0	1.2	1.84	1.32	1.12	1.30	0.98	0.92	0.80

Table 5: Continued

	Salinity levels															
	Control (ppm)				2000 (ppm)				4000 (ppm)				6000 (ppm)			
	Dose (Gy)															
Amino acids	0	20	40	80	0	20	40	80	0	20	40	80	0	20	40	80
Histidine	0.8	0.5	0.6	0.54	0.48	0.60	0.5	0.5	0.6	0.86	0.68	0.44	0.56	0.48	0.44	0.36
Lysin	1.6	1.2	1.4	1.22	1.12	1.36	1.2	1.2	1.4	1.48	1.32	1.16	1.22	1.12	1.04	1.00
Arginine	2.7	2.0	2.4	2.06	1.52	2.24	2.1	1.4	1.9	2.60	2.02	1.48	1.96	1.86	1.40	1.26
Total mg g^{-1}	25.0	32.0	37.0	32.40	30.00	42.50	37.0	30.0	37.0	34.20	34.00	30.10	36.70	32.90	27.50	25.50

that 20, 40 and 80 Gy dose increased levels of amino acids pool, markedly above normal control (un-irradiated and unstressed control) during two season of experiment. Also, treating seeds b γ-rays then sowing at different salinity levels mostly accumulate total amino acids pool as compared to its corresponding controls. The results revealed that glutamic acid (3.22 mg g^{-1}) was the prominent amino acid followed by arginine (2.68 mg g^{-1}) and aspartic acid (2.26 mg g^{-1}) in herb of *A. maritima* plants. Similar results were reported by Al-Jassir (1992) on black cumin, Hussein (2010) on mungbean; Swailam (2009) on sesame and Hussein and Atia (2009) on mushroom, they observed that amino acids increased above the control values.

In the first season 2007, it was observed that, in control, 2000 and 4000 ppm, total amino acid increased in plants produced from irradiated seeds by 20, 40 or 80 Gy above its corresponding control and above the normal control (unstressed and un irradiated). Meanwhile, at the second season (2008), the control and 2000 ppm only significant supremacy were observed above its corresponding control and above normal control. In other word, 6000 ppm in the first season and 4000, 6000 ppm salinity levels decrease total amino acids concentration. It was mentioned that these levels of salinity mainly at 6000 ppm inclusive marked decline in proline concentration, as compared by its corresponding control. It is well known that proline content in the leaves of many plants get enhanced by several stresses including salt stress (Lee and Liu, 1999; Hernandez *et al.*, 2000) and gamma radiation. Ali (1991) in coincidence with our results obtained, the author stated that free amino acids other than proline increased significantly with the rise of salinization level. Proline in particular was frequently recorded to be considerably accumulated more than any other free amino acids in stress plants. There are some exceptions during two seasons, in 4000 and 6000 ppm salinity set during 2008 season.

Proline serves as a storage sinke for carbon and nitrogen and a free-radical scavenger. Khodary (2004) investigated the effect of NaCl in presence or absence of gamma irradiation on seeds of *Lupinus termis*. The author determined protein, amino acids, nucleic acids and nitrate, potassium and phosphorus uptake. Significant decreases in the contents of protein, amino acids and nucleic acids were observed upon NaCl exposure (0, 500, 1000, 2000, 3000 ppm). On the other hand, in seeds irradiated with gamma rays (10, 25, 50, 100 Gy), these nitrogenous fractions were increased after NaCl treatments, particularly with 25 Gy. Proline may contribute to osmotic adjustment at the cellular level. Many investigators recorded an accumulation of amino acids especially proline in plant exposed to salt stress (Perez-Alfocea *et al.*, 1993; Rhodes and Hanson, 1993; Zidan and Al-Zahrani, 1994; Aziz and Larher, 1995; Hartzendorf and Rolletschek, 2001; Xiong and Zhu, 2002; Moghaieb *et al.*, 2004; Eraslan *et al.*, 2007; Costa *et al.*, 2008).

It is clearly shown that salinity stress increased proline content in shoots. These results indicated that the increasing in proline levels at high salinity concentration might be one of the earliest metabolic responses triggered in the translocation pathway that links the perception of many environmental stresses to the elicitation of physiological responses at the cellular level (Hare *et al*., 1996).

Many studies suggested that proline is a protective agent of enzyme and membrane (Solomon *et al*., 1994) and as an intracellular structure (Mudgal *et al*., 2010) or a storage compound of carbon and nitrogen for rapid recovery from stress (Jager and Meyer, 1977). Moreover, Maiti *et al*. (2000) demonstrated that proline increased in all barley genotypes with the increase in salt stress. Also, proline is regarded as a source of energy and nitrogen for recovering tissue. So, it increased under stress levels and considered an osmotic adjuster (Costa *et al*., 2008).

It also stabilizes sub cellular structures (membranes and proteins) and buffers cellular redox potential under stress (Bohnert and Jensen, 1996; Chen and Murata, 2002). The extreme sensitivity of the metabolic processes of proline synthesis and degradation themselves may benefit by regulating metabolic processes which are adversely affected by stress (Hare and Cress, 1997).

Hanafy Ahmed *et al*. (2002) suggested that, the high values of total free amino acids concentration under saline soil conditions may be induced as a result of reducing the rate of incorporation of free amino acid into protein. In addition, the authors mentioned that the osmotic adjustment within the cytoplasm might be maintained by synthesis of compatible solutes such as amino acids which have deleterious effects on metabolism and growth at high concentrations.

Minerals: Plant growth and the accumulation of Na^+, K^+, Ca^{2+} and Mg^{2+} were considered to be the most important factors related to the specific effects of ions under salt stress, Mineral investigated in *Ambrosia maritima* shoots were shown in Table 6. Salinity stress disturbs the uptake and accumulation of essential nutrients. Generally Na^+ and K^+ percentage increased with increasing salinity levels in soil. In the first stage of growth, Na percentage increased to 0.32% in plant having 2000 ppm, 0.26% for 4000 ppm and 0.37% at 6000 ppm soil percentage. In contrast, in control Na percentage was 0.24% at vegetative stage. But in case of K the untreated plants gave 0.34% while its values in plants grown in salty soil increase to be 1.02, 0.80 and 1.07%, for the stressed control in 2000, 4000 and 6000 ppm, respectively. Similar results have been found in number of studies as on wheat Begum *et al*. (1992), Ashraf and Rauf (2001) on maize and Hussain *et al*. (2009) on black seeds.

Also, treating seeds before sowing by gamma radiation generally increase Na percentage in damsisa plant during vegetative stage of growth as compared by its corresponding control or un-irradiated and unstressed control. Meanwhile, at flowering and fruiting stages, decreases in Na percentage were observed with some exception mainly on 40 Gy and rarely at 80 Gy where Na percentage was show similar increase as in the first stage of growth.

K^+ percentage was higher in plants produced from seeds treated by 40 Gy and sown in soil having different salinity levels or normal soil as compared by its corresponding control. These results are in agreement with Izzo *et al*. (1996). It was observed that Na^+ and K^+ decreased at high salt concentration (6000 ppm) at fruiting stage, as compared by its corresponding control or normal control.

It was evident from data in the first and second stages of growth, that Ca percentage enclose more or less about 1% as affected by salinity stress in control set and in 2000 or 4000 ppm sets, while at 6000 ppm, the stressed control had 1.64% in vegetative stage. Concerning the Ca^{2+} percentage at the fruiting stage the control was 1.59%, decreased to 1.22, 1.28 and 1.07% under

Table 6: Mineral percentage as affected by different doses of γ-rays and soil salinity in *A. maritima* L. shoots during 2008/2009 season

	Stage														
	Vegetative stage					Flowering stage					Fruiting stage				
	Dose (GY)														
Salinity levels	0	20	40	80	M	0	20	40	80	M	0	20	40	80	M
Calcium															
0	1.04	1.03	1.01	0.83	0.98	0.86	0.87	0.93	0.84	0.88	1.59	1.43	1.01	1.04	1.27
2000	1.00	1.42	1.19	1.22	1.21	1.07	1.07	0.88	0.95	0.99	1.22	1.34	1.23	1.47	1.32
4000	0.92	0.95	1.22	1.14	1.06	1.33	0.91	1.24	1.35	1.21	1.28	1.26	1.46	0.87	1.22
6000	1.64	1.15	0.85	0.87	1.13	1.16	1.13	0.87	0.81	0.99	1.07	1.09	0.97	1.42	1.14
M	1.15	1.14	1.07	1.02		1.11	1.00	0.98	0.99		1.29	1.28	1.17	1.20	
Potassium															
0	0.34	0.95	1.02	0.80	0.78	1.63	0.46	1.62	0.14	0.96	1.19	1.21	0.58	1.04	1.01
2000	1.02	0.56	1.19	1.07	0.96	1.31	1.34	1.38	0.36	1.10	0.95	1.41	1.24	1.62	1.31
4000	0.80	1.09	1.45	1.14	1.12	1.35	0.95	1.65	1.16	1.28	1.43	1.28	1.46	1.60	1.44
6000	1.07	1.19	1.12	1.14	1.13	1.50	1.33	1.19	1.50	1.38	1.11	1.04	0. 77	0.73	0.91
M	0.81	0.95	1.20	1.04		1.45	1.02	1.46	0.79		1.17	1.24	1.11	1.14	
Sodium															
0	0.24	0.26	0.29	0.26	0.26	0.29	0.15	0.31	0.15	0.23	0.34	0.31	0.15	0.22	0.26
2000	0.32	0.32	0.19	0.36	0.30	0.39	0.34	0.48	0.14	0.34	0.41	0.19	0.54	0.34	0.37
4000	0.26	0.31	0.41	0.29	0.32	0.31	0.22	0.39	0.32	0.31	0.24	0.17	0.24	0.29	0.24
6000	0.37	0.49	0.37	0.39	0.41	0.34	0.36	0.32	0.29	0.33	0.22	0.20	0.17	0.10	0.17
M	0.30	0.35	0.32	0.33		0.33	0.27	0.38	0.23		0.30	0.22	0.28	0.23	
Magnesium															
0	0.66	0.62	0.41	0.36	0.52	0.45	0.42	0.46	0.56	0.47	0.65	0.39	0.32	0.31	0.42
2000	0.36	0.43	0.58	0.48	0.46	0.45	0.45	0.55	0.46	0.48	0.54	0.36	0.35	0.37	0.41
4000	0.56	0.4	0.43	0.39	0.45	0.46	0.51	0.50	0.51	0.50	0.46	0.35	0.43	0.38	0.41
6000	0.51	0.45	0.34	0.31	0.40	0.36	0.31	0.30	0.26	0.31	0.45	0.32	0.32	0.39	0.37
M	0.52	0.48	0.44	0.39		0.43	0.42	0.45	0.45		0.53	0.36	0.36	0.36	

M: Median

the effect of 2000, 4000 and 6000 ppm soil salinity, respectively. The reduction in Ca was observed and similar to that, respectively El-Tarawy (1976) on *Matthiola incana*, El-Makawy (1999) on *Dimorphotheca ecklonis* and *Callistephus chinensis*, Khan (1992), Al-Harbi (1995) and Ashraf and Khanum (1997) on wheat and El-Sanafawy (2000) on *Ocimum basilicum* and *Ambrosia maritima* who reported that Ca% in plants increased with increasing soil salinity levels. Regarding the effect of gamma rays on Ca percentage in shoots of damsisa plants, it was observed that, in 2000 ppm salinity level increased Ca percentage at the first and second stage of growth. Also, the dose 40 and 80 Gy in 4000 ppm increased Ca percentage. While at fruiting stage, it was noticed a reduction in Ca percentage. These results are in agreement with those obtained by El-Tarawy (1976) on *M. incana*, El-Makawy (1999) on *Dimorphotheca ecklonis* and *Callistephus chinensis* and El-Sanafawy (2000) on *Ocimum basilicum* and *A. maritima* who reported that Ca% in plants increased with increasing soil salinity levels. The contrast was take place at flowering stage except 80 Gy. It was noticed that set treated by different doses of radiation and sown in soil, having 4000 ppm salt concentration, produced plants having high Ca^{2+} percentage as compared by its corresponding control, Table 6.

Concerning Mg^{2+} percentage in the shoots of *A. maritima* plants, the data indicated that decreases were detected with increasing salinity concentration in soils during the three stages of growth as compared by unstressed and un-irradiated control as shown in Table 4. Concerning the effect of γ-rays, it was observed the at the first stage of growth that all radiation dose decreased Mg% comparing with normal control (unstressed and un-irradiated). But, the opposite takes place at 2000 ppm set; all plants produced from 20, 40 or 80 Gy doses had higher Mg% than its corresponding control at vegetative and flowering stage. The highest percentage of Mg^{2+} as compared by those in control set were in 40 and 80 Gy dose at control set. Meanwhile, at 4000 and 6000 ppm, Mg% decreased in plant produced from radiation dose (20, 40, 80 Gy) as compared by its corresponding control at vegetative stage. The results are in according with those of El-Tarawy (1976) on *M. incana*, El-Makawy (1999) on *D. ecklonis* and *C. chinensis* and El-Sanafawy (2000) on *Ocimum basilicum* and *Ambrosia maritima,* who stated that Mg% in the leaves decreased with increasing soil salinity levels. Also, similar results were obtained by Youssif *et al.* (2010) on *Tetragonia tetragonioides* in shoots. Ntage in shoots with different doses of radiation comparing with stressed control.

CONCLUSION

It was concluded that gamma rays can alleviate harmful effect of soil salinity and this appear in an increase of most amino acids, proteins and some chemical components of damsisa plants that grow under salinity stress condition.

REFERENCES

Agastian, P., S.J. Kingsley and M. Vivekanandan, 2000. Effect of salinity on photosynthesis and biochemical characteristics in mulberry genotypes. Photosynthetica, 38: 287-290.

Ahmed, M.B. and M.R. Khater, 2001. Evaluation of the protective potential of *Ambrosia maritima* extract on acetaminophen-induced liver damage. J. Ethnopharmacol., 75: 169-174.

Al-Harbi, A., 1995. Growth and nutrient composition of tomato and cucumber as affected by sodium chloride salinity and supplemental calcium. J. Plant Nutr., 18: 1403-1416.

Ali, R.M., 1991. Changes in chemical composition of fruits of salinized *Datura stramonium*. J. Islamic Acad. Sci., 4: 289-292.

Alikamanoglu, S., O. Yaycili, C. Atak and A. Rzakoulieva, 2007. Effect of magnetic field and gamma radiation on *Paulownia tomentosa* tissue culture. Biotechnol. Biotechnological Equip., 21: 49-53.

Al-Jassir, M.S., 1992. Chemical composition and microflora of black cumin (*Nigella sativa* L.) seeds growing in Saudi Arabia. Food Chem., 45: 239-242.

Amin, W.M.A., 1990. A pharmacognostical study of certain Egyptian Molluscicidal plants. Ph.D. Thesis, Faculty of Pharmacy, Cairo Universty, Egypt.

AOAC, 1990. Official Methods of Analysis of the Association of Official Analytical Chemists. 15th Edn., Association of Official Analytical Chemists, Arlington, VA.

Ashraf, M. and A. Khanum, 1997. Relationship between ion accumulation and growth in two spring wheat lines differing in salt tolerance at different growth stages. J. Agron. Crop Sci., 178: 39-51.

Ashraf, M. and H. Rauf, 2001. Inducing salt tolerance in maize (*Zea mays* L.) through seed priming with chloride salts: Growth and ion transport at early growth stages. Acta Physiol. Plant, 23: 407-414.

Ashraf, M. and P.J.C. Harris, 2004. Potential biochemical indicators of salinity tolerance in plants. Plant Sci., 166: 3-16.

Aziz, A. and F. Larher, 1995. Change in polyamine titers associated with the proline response and osmotic adjustment of rape leaf disc submitted to osmotic stresses. Plant Sci., 112: 175-186.

Baher, Z.F., M. Mirza, M. Ghorbani and M.B. Rezaii, 2002. The influence of water stress on plant height, herbal and essential oil yield and composition in *Satureja hortensis* L. Flav. Frag. J., 17: 275-277.

Bajaj, Y.P.S., 1970. Effect of gamma-irradiation on growth, RNA, protein and nitrogen contents of bean callus cultures. J. Bot., 23: 231-236.

Begum, F., J.L. Karmoker, Q.A. Fattah and A.F.M. Muniruzzaman, 1992. The effect of salinity on germination and its correlation with K^+, Na^+, Cl^-accumulation in germinating seeds of *Triticum aestivum* L. cv. Akbar. Plant Cell Physiol., 33: 1009-1014.

Black, E.D., 1982. Methods of Soil Analysis. Part 1. Physical and Mineralogical Properties. 2nd Edn., Madison, Wisconsin, USA.

Bohnert, H.J. and R.G. Jensen, 1996. Strategies for engineering water-stress tolerance in plants. Trends Biotechnol., 14: 89-97.

Casarett, A.P., 1968. Radiation Biology. 1st Edn., Prentice-Hall Inc., New Jersey pp: 191-195.

Chen, T.H.H. and N. Murata, 2002. Enhancement of tolerance of abiotic stress by metabolic engineering of betaines and other compatible solutes. Curr. Opin. Plant Biol., 5: 250-257.

Costa, R.C.L., A.K.S. Lobato, C.F.O. Neto, P.S.P. Maia, G.A.R. Alves and H.D. Laughinghouse, 2008. Biochemical and physiological responses in two *Vigna unguiculata* (L.) Walp cultivars under water stress. J. Agron., 7: 98-101.

Delfine, S., A. Alvino, M.C. Villani and F. Loreto, 1999. Restrictions to carbon dioxide conductance and photosynthesis in spinach leaves recovering from salt stress. Plant Physiol., 119: 1101-1106.

El-Makawy, M.A.M., 1999. Effect of certain cultural treatments on growth and chemical composition of some medicinal plants grown under North Sinai conditions. Ph.D. Thesis, Faculty of Agriculture, El-Arish Sues Canal University, Egypt.

El-Mogy, A.M.E., 1999. Physiological studies on growth and active ingredients of *Ambrosia maritima* L. plants. Ph.D. Thesis, Faculty of Agriculture, Zagazig University, Egypt.

El-Sanafawy, S.S., 2000. Physiological studies on *Ocimum basilicum*, L. and *Ambrosia maritima*, L. plants. Ph.B. Thesis, Faculty of Agriculture, Kafer-El-Shakh, Tanta University, Egypt.

El-Tarawy, M.A., 1976. Effect of soil salinity on *Kokia tricophylla*, *Zinnia elegans*, *Matthiola incana* and *Calendula officinalis*. M.Sc. Thesis, Faculty of Agriculture, Kafr-El-Seikh, Tanta University, Egypt.

Eraslan, F. A. Inal, O. Savasturk and A. Gunes, 2007. Changes in antioxidative system and membrane damage of lettuce in response to salinity and boron toxicity. Sci. Hortic., 114: 5-10.

Evans, W.C., 1996. Trease and Evans Pharmacognosy. 4th Edn., W.B. Saunders Company Ltd., London, Pages: 50.

Grieco, P.A., G.F. Majetich and Y. Ohfune, 1982. Pseudoguaianolides. 1. *Stereospecific* total synthesis of the ambrosanolides dl-ambrosin and dl-damsin. J. Am. Chem. Soc., 104: 4226-4233.

Guerrier, G. and P. Bourgeais-Chaillou, 1994. Solute contents in roots and root calli of NaCl-tolerant and NaCl-sensitive tissues of *Lycopersicon*. BioI. PlantArum, 36: 321-328.

Hanafy Ahmed, A.H., M.A. Higazy, Y.H. El-Shafey and S.F. Moussa, 2002. Effect of salinity, silicon and proline on the growth, yield and chemical composition of wheat plant. Proceeding 2nd Congress Recent Technology Agriculture, October 28-30, 2002, Cairo University, pp: 965-978.

Hare, P.D. and W.A. Cress, 1997. Metabolic implications of stress-induced proline accumulation in plants. Plant Growth Regul., 21: 79-102.

Hare, P.D., S.D. Plessis, W.A. Cress and J. van Staden, 1996. Stress-induced changes in plant gene expression: Prospects for enhancing agricultural productivity in South Africa. S. Afr. J. Sci., 92: 431-439.

Hartzendorf, T. and H. Rolletschek, 2001. Effects of NaCl-salinity on amino acid and carbohydrate contents of *Phragmites australis*. Aquat. Bot., 69: 195-208.

Hendawy, S.F. and K.A. Khalid, 2005. Response of sage (*Salvia officinalis* L.) plants to zinc application under different salinity levels. J. Appl. Sci. Res., 1: 147-155.

Hernandez, J.A., A. Jimenez, P. Mullineaux and F. Sevilla, 2000. Tolerance of (*Pisum sativum*) to long term salt stress is associated with induction of antioxidant defenses. Plant Cell Environ., 23: 853-862.

Hussain, K., A. Majeed, K. Nawaz, K.H. Bhatti and F.K. Nisar, 2009. Effect of different levels of salinity on growth and iIon contents of black seeds (*Nigella sativa* L.). Curr. Res. J. Biol. Sci., 1: 135-138.

Hussein, O.S., 1998. Effect of certain treatments on some metabolites particualrly the toxic substances. in *Arashis hypojaea* and *Phaseolys vylgaris* seeds. Ph.D. Thesis, Botany Dep., Fac. of Sci., Ain Shams Univ., Cairo, Egypt.

Hussein, O.S. and I.A. Atia, 2009. Using of gamma rays in stimulation and improvement of mushroom spawns *Plerotus ostreatus* Egypt. J. Rad. Sci. Applied, 22: 275-285.

Hussein, O.S., 2010. Effect of ascorbic acid and or sodium chloride on irradiated mungbean seeds. Arab J. Nucl. Sci. Applied, 43: 281-288.

Izzo, R., A. Belligno, G. Muratore and F.N. Izzo, 1996. Seedling growth and Ca2+,K+ and Na+ accumulation in maize roots as affected by NaCl. Agrochimica, 40: 25-32.

Jackson, M.L., 1973. Soil Chemical Analysis. 1st Edn., Prentice Hall of India Pvt. Ltd., New Delhi, India.

Jager, H.J. and H.R. Meyer, 1977. Effect of water stress on growth and proline metabolism of *Phaseolus vulgaris* L. Oecologia, 30: 83-96.

Jain, S.M., B.S. Ahloowalia and R.E. Veilleux, 1998. Somaclonal Variation and Induced Mutation in Crop Improvement. Vol. 12, Kluwer Academic Publishers, The Netherland, pp: 203-218.

Khalid, K.A., 2006. Influence of water stress on growth, essential oil and chemical composition of herbs (*Ocimum* sp.). Inter. Agrophys., 20: 289-296.

Khan, A.A., 1992. Preplant physiological seed conditioning. Hortic. Rev., 13: 131-181.

Khater, M.R., S.H. Hussein, E.M. Mohamed and T.A.A. El-Latife, 2002. Effect of saline irrigation water and plant spacing on damsisa plant (*Ambrosia maritima* L.). J. Agric. Sci. Mansoura Univ., 27: 3451-3461.

Khodary, S.E.A., 2004. Effect of NaCl salinity on improvement of nitrogen metabolism and some ions uptake in lupine plants subjected to gamma irradiation. Int. J. Agric. Biol., 6: 1-4.

Kloos, H., W. Sidrak, A.A. Michael, E.W. Mohareb and G.I. Higashi, 1982. Disease concepts and treatment practices relating to *Schistosomisis haematobium* in Upper Egypt. J. Trop. Med. Hyg., 85: 99-107.

Lee, T.M. and C.H. Liu, 1999. Correlation of decreased calcium contents with proline accumulation in the marine green macroalga *Ulva fasciata* exposed to elevated NaCl contents in seawater. J. Exp. Bot., 50: 1855-1862.

Maiti, R.K., S. Moreno-Limon and P. Wesche- Ebeling, 2000. Response of some crops to various abiotic stress factors and its physiological and biochemical basis of resistances. Agric. Rev., 21: 155-167.

Moghaieb, R.E.A., H. Saneoka and K. Fujita, 2004. Effect of salinity on osmotic adjustment, glycinebetaine accumulation and the betaine aldehyde dehydrogenase gene expression in two halophytic plants, *Salicornia europaea* and *Suaeda maritima*. Plant Sci., 166: 1345-1349.

Mudgal, V., N. Madaan and A. Mudgal, 2010. Biochemical mechanism of salt tolerance in plants: A review. Int. J. Bot., 6: 136-143.

Muthukumarasamy, M., S.D. Gupta and R. Panneerselvam, 2000. Influence of triadimefon on the metabolism of NaCl stressed radish. Biol. Plant., 43: 67-72.

Nene, S.P., U.K. Vakil and A. Sreenivasan, 1975. Effect of gamma radiation on red gram (*Cajanus cajan*) proteins. J. Food Sci., 40: 815-819.

Perez-Alfocea, F., M.T. Estan, M. Caro and M.C. Bolarin, 1993. Response of tomato cultivars to salinity. Plant Soil, 150: 203-211.

Piper, G.S., 1947. Soil and Plant Analysis. Interscience Publishers Inc., New York, pp: 368.

Prasad, A., D.D. Patra, M. Anwer and D.V. Singh, 1997. Interactive effects of salinity and nitrogen on mineral N status in soil and growth and yield of German chamomile (*Matricaria chamomilla*) (*Chamomilla recutital*). J. Indian Soc. Soil Sci., 45: 537-541.

Prat, D. and R.A. Fathi-Ettai, 1990. Variation in organic and mineral components in young Eucalyptus seedlings under saline stress. Physiol. Plant, 79: 479-486.

Razmjoo, K.P.H. and M.R. Sabzalian, 2008. Effect of salinity and drought stresses on growth parameters and essential oil content of *Matriaria chamomile*. Int. J. Agric. Biol., 10: 451-454.

Rhodes, D. and A.D. Hanson, 1993. Quaternary ammonium and tertiary sulfonium compounds in higher plants. Ann. Rev. Plant Physiol. Plant Mol. Biol., 44: 357-384.

Sangwan, N.S., A.H.A. Farooqi, F. Shabih and R.S. Sangwan, 2001. Regulation of essential oil production in plants. Plant Growth Regul., 34: 3-21.

Shoeb, H.A. and M.A. El-Emam, 1976. The molluscicidal properties of natural products from *Ambrosia maritima*. Egypt J. Bilharz., 3: 157-167.

Slacanin, I., D. Vargas, A. Marston and K. Hostettmann, 1988. Determination of molluscicidal sesquiterpene lactones from *Ambrosia maritima* (Compositae). J. Chromato., 457: 325-331.

Solomon, A., S. Beer, Y. Waisel, G.P. Jones and L.G. Paleg, 1994. Effect of NaCl on the carboxylation activity of rubisco from tamarix ordanis in the presence and absence of proline related compatible solutes. Physiol. Plant., 90: 198-208.

Srinivas, H., H.N. Ananthaswamy, U.K. Vakil and A. Sreenivasan, 1972. Effect of gamma radiation on wheat proteins. J. Food Sci., 37: 715-718.

Sundaresan, S. and P.R. Sudhakaran, 1995. Water stress-induced alterations in the proline metabolism of drought-susceptible and btolerant cassava (*Manihot esculenta*) cultivars. Physiol. Plant, 94: 635-642.

Swailam, M.H., 2009. Quality characteristics of irradiated sasame seeds during sorage. J. Rad. Sci. Applic., 22: 323-342.

Wang, Y. and N. Nii, 2000. Changes in chlorophyll, ribulose bisphosphate carboxylase-oxygenase, glycine betaine content, photosynthesis and transpiration in *Amaranthus tricolor* leaves during salt stress. J. Hortic. Sci. Biotechnol., 75: 623-627.

Winders, K. and B.O. Eggum, 1966. Proteinhydrolysis: A description of the method used at the department of animal physiology in copenhagen. Acta Agric. Scandinavia, 16: 115-119.

Xiong, L. and J.K. Zhu, 2002. Molecular and genetic aspects of plant responses to osmotic stress. Plant Cell Environ., 25: 131-139.

Youssif, B.S., N.T. Nguyen, Y. Fukuda, H. Hakata, Y. Okamoto, Y. Masaoka and H. Saneoka, 2010. Effect of salinity on growth, mineral composition, photosynthesis and water relations of two vegetable crops: New Zealand spinach (*Tetragonia tetragonioides*) and water spinach (*Ipomoea aquatic*). Int. J. Agric. Biol., 12: 211-216.

Zidan, M.A. and H.S. Al-Zahrani, 1994. Effect of NaCl on the germination seedling and some metabolic changes in sweet basil (*Ocimum blasilicum*). Pak. J. Ind. Res., 37: 541-543.