Bull. Fac. Agric., Cairo Univ., 60: 433-442 (2009)

EFFECT OF WATER AND SALT STRESS ON THE GROWTH AND CHEMICAL COMPOSITION OF *Peganum harmala* L. UNDER RAS SUDR CONDITIONS

(Received:16.8.2009)

By
W.M. Abd El-Azim , S. Th. Ahmed * and N. H. Mohamed

*Medicinal and Aromatic Plants Department and * Plant Ecology and Range Department, Desert Research Center, El-Matareya, Cairo, Egypt.*

ABSTRACT

A field experiment was carried out in Ras Sudr Research Station, Desert Research Center, at South Sinai Governorate, Egypt, during two successive growing seasons, *vis.* 2007 and 2008 to study the effect of three irrigation intervals (10, 20 and 30 days), two levels of saline water (3000 and 7000 ppm) and their interaction on the growth and chemical composition of *Peganum harmala* L. plants. Growth measurements were taken at 2 (first cut), 4 (second cut) and 6 (third cut) months after transplanting, while the chemical composition was determined after 6 months. The results could be summarized as follows:

1- Prolonging the irrigation interval from 10 to 30 days depressed significantly plant height, fresh and dry weight / plant in the first, second and third cuts. Percentage of crude protein, total ash, potassium, total flavonoids and water-insoluble ash % in plant tissues decreased by increasing irrigation intervals from 10 to 30 days. In contrast, total carbohydrates, crude fiber, total lipids, total tannins, total alkaloids, sodium content and acid-insoluble ash % increased by increasing irrigation intervals up to 30 days.

2- Irrigation with saline water had a dwarfing effect on *Peganum harmala* plants. There was a significant reduction in plant height, fresh and dry weight / plant at the 2, 4 and 6 months from transplanting. On the other hand, there was a decrease in the crude protein, total ash, total flavonoids, potassium content and water-insoluble ash % with increasing salinity levels of irrigation water, while total carbohydrates, crude fiber, total lipids, total alkaloids, sodium content and acid-insoluble ash % increased by increasing salinity level from 3000 to 7000 ppm.

3- The tallest plants and the heaviest fresh and dry weights / plant, as well as the highest crude protein and potassium content were obtained when plants were irrigated with 3000 ppm saline water every 10 days.

***Key words**: chemical composition, growth , irrigation intervals, Peganum harmala, salinity.*

1. INTRODUCTION

Peganum harmala L. is a much branched deciduous herb or sub shrub. Leaves much divided, lobes or segments, linear, short pointed. Stipules bristle like. Flower solitary, sessile or stalked in the axils of branches. Sepals five, linear, pointed, persistent, usually longer than the petals. Petals five, white oblong, soon falling off. Seeds many, angled. The whole plant has a disagreeable and powerful odor (Täckholm, 1974).

Peganum harmala L. has antioxidant properties (Moura *et al.*, 2007); ground seeds have been used occasionally to treat skin cancer and subcutaneous cancers traditionally in Morocco. Seed extracts also show effectiveness against various tumor cell_lines both *in vitro* and *in vivo* (Lamchouri *et al.*, 1999). The seeds are antispasmodic, hypnotic, antiperiodic, emetic, alterative, anthelmintic, and a narcotic. Seeds powder is recommended as anthelmintic and decoction of seeds is given in laryngitis. Leaf decoction is given in rheumatism. Root decoction is applied to kill lice. It forms a useful medicine in hysterical affections in coughs, croupy, infections,colic and flatulence, being a mild stomachic.

Water stress, which is caused by insufficient soil moisture, is among the chief causes of poor growth or poor health in plants. It is responsible for slow growth and, in severe cases, dieback of stems. It also makes the plants more susceptible to disease and less tolerant of insect feeding. Thus, on other plants, the same pervious view was detected showing that water stress during the two weeks before harvest was associated with reduced plant height of *Artemisia annua* (Denys *et al.*, 1993). On fenugreek plants, it was reported that water stress caused a reduction in growth parameters such as height, weight and total leaf area (Alhadi *et al.*, 1999). More investigations, on

Atropa belladonna plants, proved that the maximal yield of tropane alkaloids (hyoscyamine: 54 mg/plant; scopolamine: 7 mg/plant) was achieved in plants grown under an optimal irrigation regime (35% depletion of available soil water) accompanied with total nitrogen supply of 0.37 g/pot (Dea *et al.*, 1999). On *Grindelia camporum*, it was reported that prolonging the irrigation interval from 1 to 8 days decreased the plant growth, the flower yield and the resin content of the plants (Mahmoud, 2001). Thereafter, on *Satureja hortensis*, it was shown that great soil water stress decreased plant height and total fresh and dry weights. (Baher *et al.*, 2002). On *Ochradenus baccatus* and *Colutea isteria*, it was found that prolonging the irrigation interval from 10 to 30 days depressed significantly the growth characteristics, crude protein and total carbohydrate (Ahmed *et al.*, 2002). On *Taverniera aegyptiaca*, it was mentioned that the high moisture contents have destructive effects on growth (Amin and Moussa, 2006).

Soil salinity is a wide spread problem in crop production. However, this problem is usually confined to arid and semi-arid regions. Saline conditions cause physical and chemical changes in soil. This decreases significantly the soil productivity. The kind as well as the concentration of salt affect soil structure and interfere with the nutrition of the plant. The anion of salt whether chloride or sulphate is also important. Increasing salinity up to 7000 ppm decreased growth and some chemical components of *Peganum harmala*. Some investigators found that increasing irrigation intervals decreased growth and yield of many species, (Ahmed *et al.* 2002) on *Ochradenus baccatus* and *Colutea isteria*, Zhang *et al.* (2004) on *Populus euphratica*, Shalan *et al.* (2005) on *Majorana hortensis*, Koyro (2006) on *Plantago coronopus*, Cheruth *et al.* (2008) on *Catharanthus roseus* and Falleh *et al.* (2008) on *Cynara cardunculus*.

The aim of this investigation was to determine the growth and the chemical composition of *Peganum harmala* L. plant under different irrigation intervals and salinity levels under Ras Sudr conditions.

2. MATERIALS AND METHODS

Seeds of *Peganum harmala* were obtained from the plants grown under natural conditions of Wadi Sudr in South Sinai. Seeds of the experimental plants were sown in polyethylene bags filled with sand and clay soil (1:1) in January, 2007 and 2008 under the green-house conditions at Ras Sudr Station. After complete emergence of seedlings, irrigation of beds was continued with saline water (2500 ppm) until transplantation, which was done in March, 2007 and 2008.

A field experiment was carried out on *Peganum harmala* plant. Three months old transplants were used. This experiment was conducted in Ras Sudr Research Station, Desert Research Center, at South Sinai Governorate, Egypt during 2007 and 2008 seasons. Mechanical and chemical analyses of the experimental soil are shown in Tables (1 and 2).

Table (1): Mechanical properties of the experimental soil.

Depth (cm)	Sand	Silt	Clay	Soil texture
0-40	51.16%	14.49%	34.35 %	Sandy clay loam

The plants were irrigated immediately after transplanting by water pumped from a well (3000 ppm) for two weeks. The analysis of the irrigation water is given in Table (3).

The aim of this experiment was to study the growth and chemical composition of *Peganum harmala* plant in response to the following treatments:

1- Irrigation intervals; three irrigation levels, *viz.* 10, 20 and 30 days.
2-Irrigation water salinity (3000 and 7000 ppm)

The design of the experiment was strip plot with three replicates, every replicate included 6 treatments which were the combination of three irrigation intervals and two salinity treatments. The experimental plots of 4 m^2 area (2 x 2 m) were established after ploughing twice, consisting of 4 ridges, each of 50 cm width and 2 m length. Before planting, 15 m^3 sheep manure and 100 kg calcium super phosphate (15.5% P_2O_5) were added per feddan. In addition, 150 kg ammonium sulphate (20.5% N) and 100 kg potassium sulphate (48% K_2O) were applied after one and two months from transplanting.

Three plants were cut from each sub-plot after 2, 4 and 6 months from transplanting to determine plant height and fresh weight. Plants were air dried for one day, then oven dried at 70°C to determine the dry weight. Also, the chemical composition was determined after 6 months from transplanting for each season.

2.1. Determination of primary metabolites

2.1.1. Estimation of total ash, acid-insoluble ash and water-insoluble ash were determined according to Askar and Treptow (1993).

2.1.2. Crude fiber was determined according to the British Pharmacopoeia (1980).

2.1.3. Total lipid content

Ten gm of the powdered plant samples were extracted with petroleum ether (40-60° C): (1:1 v/v) for 24 hours using Soxhlet apparatus. The lipids were obtained by distilling off the solvent. The last traces of the solvent were removed by heating the liquid samples in a vacuum oven at 50° C to constant weight (British Pharmacopoeia, 1980).

2.1.4. Estimation of total nitrogen:

The total nitrogen content was determined by micro-Kjeldahl method (British Pharmacopoeia 1980). The results were expressed as gm nitrogen/100 gm dry weight of plant material. Crude protein was calculated by multiplying total nitrogen by 6.25.

2.1.5. Estimation of the total carbohydrates:

Total carbohydrates content was determined using the gravimetric method, and glucose was used for the calibration curve (Chaplin and Kennedy, 1994).

2.2. Determination of secondary metabolites:

2.2.1. Quantitative estimation of total flavonoids:

The method adapted was based on measuring the intensity of the colour developed when flavonoids formed complexes with aluminum chloride (Karawya and Aboutable, 1982). The flavonoid content of all samples was calculated as kaempferol which was deduced from the calibration curve.

2.2.2. Quantitative estimation of total tannins:

The percentage of total tannins of all plant samples was determined gravimetrically using cupper acetate method according to Makkar and Goodchild (1996).

2.2.3. Quantitative estimation of total alkaloids:

The total alkaloids of the plant samples were determined by two methods acid-base titration and gravimetric methods. (Egyptian Pharmacopoeia, 1953, Woo *et al.*, 1977 and Balbaa, 1986).

2.3. Determination of Minerals:

Potassium and sodium contents were determined by the flame photometer method as described by Dewis and Freitas (1970).

The differences between means were tested according to L.S.D. (at 5%) method (Steel, 1960).

3. RESULTS AND DISCUSSION

3.1. Effect of irrigation intervals:

3.1.1. Growth characteristics:

Results in Table (4) indicate that plant height, fresh and dry weights / plant significantly decreased with increasing irrigation intervals from 10 to 30 days. Prolonging irrigation intervals up to 30 days caused a reduction in plant height by 20.94, 20.52 and 19.56% at 2, 4 and 6 months after transplanting, respectively during 2007 season and by16.66, 18.53 and 17.09% during 2008 season as compared with irrigation every 10 days. The reduction in plant height due to extending irrigation intervals may be attributed to the decrease in the number and size of cells as well as the internode length as a result of drought which led to decreasing plant height. Fresh and dry weights / plant significantly decreased by increasing the irrigation period. This is expected since water plays an important role in plants and moisture deficits can have a deleterious effect on most vital processes in the plant. The highest values of fresh and dry weights / plant of *Peganum harmala* were obtained with 10 day irrigation interval, while the lowest values were recorded with irrigation at 30 day intervals after 2, 4 and 6 months from transplanting during two seasons. These results are in accordance with those reported by Alhadi *et al.* (1999), Ahmed *et al.*, (2002) and Amin and Moussa (2006).

3.1.2.Chemical composition:

Plants produce different kinds of primary and secondary metabolites during their metabolism, where these compounds vary according to the environmental conditions. Some of these compound have an essential role in growth and development as flavonoids, but the majority of them are involved in defense systems (Michael 1997).

Data given in Table (5) show that prolonging the irrigation intervals from 10 to 30 days decreased the percentage of crude protein, total ash, water insoluble ash, total flavonoids and potassium of *Peganum harmala* after 6 months from transplanting in the first and second seasons. The decrease in protein content may be due to disturbance in energy metabolism in plants grown under the longest irrigation interval. Such effect caused an increase in amino acids because of the failure incorporation of these substances into protein. The decrease in the contents of total ash and potassium with prolonging irrigation is due to the decrease in total ion accumulation because of decreasing of soil moisture stress (Larcher, 1995). The decrease of flavonoids with irrigation may be due to an increase in the metabolism of the plant which yield primary metabolites (Inderjit and Foy, 1999), while a significant increase was observed in the total carbohydrate, crude fiber, acid insoluble ash, total lipids, total tannins, total alkaloids and sodium content in tissues of *Peganum harmala* with increasing irrigation intervals from 10 to 30 days. The increase of total carbohydrates with irrigation may be related to more favorable conditions necessary for carrying out metabolic processes,beside the greater mass of

Table (2): Chemical properties of the experimental soil.

Depth (cm)	pH	EC (ms)	Saturation soluble extract							
			Soluble anions (meq / L)				Soluble cations (meq / L)			
			CO_3^-	HCO_3^-	SO_4^-	Cl^-	Ca^{++}	Mg^{++}	Na^+	K^+
0-40	8.32	2.48	0.00	1.2	5.5	18.0	4.00	3.25	15.79	1.66

Table (3): Chemical analysis of the irrigation water.

Well (ppm)	pH	EC Ds/m^2	Soluble anions (meg/l)				Soluble cations (meg/l)			
			CO_3^-	HCO_3^-	SO_4^-	Cl^-	Ca^{++}	Mg^{++}	Na^+	K^+
3000	7.8	4.85	-	2.50	16.42	81.08	25.29	19.43	54.83	0.45
7000	8.6	11.25	-	2.89	7.67	89.44	23.54	16.62	59.34	0.50

Table (4): Effect of irrigation intervals on growth characters of *Peganum harmala* at 2, 4 and 6 months from transplanting during 2007 /2008 seasons.

Irrigation intervals (days)	2 months (First cut)		4 months (Second cut)		6 months (Third cut)	
	2007	2008	2007	2008	2007	2008
	Plant height (cm)					
10	59.75	68.18	49.52	55.85	33.10	38.45
20	53.12	62.05	44.11	51.08	30.08	35.30
30	47.24	56.82	39.36	45.50	26.63	31.88
L.S.D. at 5%	0.52	0.71	0.31	0.29	0.42	0.57
	Fresh weight (g) / plant					
10	402.42	511.73	657.04	820.33	1020.90	1284.23
20	318.28	434.11	546.25	674.43	880.38	1119.15
30	247.55	361.14	416.64	527.52	713.89	906.41
L.S.D. at 5%	17.45	23.39	22.39	34.31	51.85	60.02
	Dry weight (g) / plant					
10	87.581	115.8	145.71	188.64	230.16	298.23
20	68.617	96.08	120.47	153.83	196.08	257.84
30	52.762	78.79	92.974	120.11	157.39	207.72
L.S.D. at 5%	3.84	5.33	6.08	7.28	15.41	12.89

Table (5): Effect of irrigation intervals on chemical composition of *Peganum harmala* at 6 months (third cut) from transplanting during 2007 /2008 seasons.

Irrigation intervals (days)	Crude protein %		Total carbohydrates %		Crude fiber %		Total ash %	
	2007	2008	2007	2008	2007	2008	2007	2008
10	11.67	12.20	35.5	36.23	27.64	25.52	16.33	17.12
20	11.38	11.87	36.2	36.89	28.1	25.96	16.00	16.67
30	11.09	11.55	36.45	37.25	28.56	26.30	15.69	16.38
L.S.D. at 5%	0.03	0.05	0.08	0.12	0.10	0.08	0.10	0.08
	Total lipids %		Potassium %		Sodium %		Flavonoids %	
10	5.21	4.87	2.97	3.55	2.37	2.08	1.04	1.29
20	5.64	5.25	2.62	3.06	2.715	2.36	0.89	1.13
30	5.94	5.54	2.26	2.77	3.05	2.69	0.74	1.03
L.S.D. at 5%	0.03	0.13	0.07	0.12	0.06	0.04	0.05	0.07
	Total tannins %		Total alkaloids %		Acid-insoluble ash %		Water-insoluble ash %	
10	6.14	5.44	1.13	1.53	11.87	13.01	11.57	10.35
20	6.70	5.87	1.51	2.79	13.95	15.08	10.13	9.92
30	7.07	6.23	2.90	4.42	15.85	16.42	9.70	8.91
L.S.D. at 5%	0.18	0.06	0.33	0.41	0.69	0.40	0.87	0.44

Table (6): Effect of salinity on the growth characters of *Peganum harmala* at 2, 4 and 6 months from transplanting during 2007 /2008 seasons.

Salinity (ppm)	2 months (First cut)		4 months (Second cut)		6 months (Third cut)	
	2007	2008	2007	2008	2007	2008
	Plant height (cm)					
3000	57.14	66.74	46.84	54.71	34.75	38.93
7000	49.59	57.96	41.82	46.91	25.12	31.49
L.S.D. at 5%	0.34	0.42	0.35	0.81	0.15	0.33
	Fresh weight (g) / plant					
3000	362.08	488.13	597.99	775.73	974.65	1252.23
7000	283.42	383.22	481.96	572.14	768.83	954.57
L.S.D. at 5%	23.41	29.17	30.25	32.23	32.98	36.13
	Dry weight (g) / plant					
3000	78.39	109.34	132.58	178.22	218.36	291.40
7000	60.92	84.43	106.85	130.13	170.72	217.74
L.S.D. at 5%	2.85	6.78	4.25	7.19	4.98	8.30

Table (7): Effect of salinity on the chemical composition of *Peganum harmala* plant at 6 months (third cut) from transplanting during 2007 /2008 seasons.

Salinity (ppm)	Crude protein %		Total carbohydrates %		Crude fiber %		Total ash %	
	2007	2008	2007	2008	2007	2008	2007	2008
3000	11.67	12.22	35.47	36.39	27.94	25.66	16.29	17.36
7000	11.09	11.52	36.63	37.19	28.26	26.2	15.69	16.09
L.S.D. at 5%	0.04	0.08	0.13	0.11	0.12	0.09	0.03	0.07
	Total lipids %		Potassium %		Sodium %		Flavonoids %	
3000	5.39	4.94	2.74	3.37	2.57	2.09	1.13	1.36
7000	5.8	5.49	2.49	2.88	2.85	2.65	0.64	0.94
L.S.D. at 5%	0.05	0.07	0.04	0.08	0.06	0.04	0.04	0.03
	Total tannins %		Total alkaloids %		Acid-insoluble ash %		Water-insoluble ash %	
3000	5.87	5.31	1.51	2.57	13.45	14.43	11.08	10.06
7000	7.39	6.38	2.18	3.23	14.33	15.23	9.85	9.39
L.S.D. at 5%	0.17	0.05	0.18	0.11	0.39	0.27	0.32	0.14

green photosyntheting tissue (Bannister, 1981). Carbohydrates are the most important metabolic products acummulating in the plant tissue. El-Monayeri *et al.* (1986) concluded that, seasonally, there was a general tendency to increase of carbohydrate content with increase in soil moisture contents. The increase in alkaloids percentage may be due to a rise in the level of amino acids which are the precursor of alkaloids, this accumulation also attributed to decline in crude protein (Hsiao,1973). These results are in agreement with those obtained by Ahmed *et al.* (2002) and Amin and Moussa (2006).

3.2.Effect of saline water irrigation

3.2.1. Growth characteristics

Results in Table (6) indicate clearly that irrigation water salinity had a dwarfing effect on *Peganum harmala* plants. There was a significant reduction in plant height, as well as fresh and dry weights / plant with increasing water salinity levels from 3000 to 7000 ppm. Growing plants at a high level of salinity (7000 ppm) reduced the height as compared to the low level (3000) by 27.71, 10.72 and 13.21 % and by 18.63, 14.26 and 13.16 % at the 2, 4 and 6 months from transplanting during 2007 and 2008 seasons, respectively. This result was expected since salinity reduced the cell size or the number of cells. Similar results were obtained by Ahmed *et al.* (2002), Zhang *et al.*(2004), Koyro (2006) and Falleh *et al.* (2008). However, increasing irrigation water salinity up to 7000 ppm resulted in a significant decrease in fresh and dry weights / plant of *Peganum harmala*. The depression effect of irrigation water salinity might be attributed to the increase in the energy amount required for absorption of water and minerals. These results are in accordance with those reported by Ahmed *et al.* (2002) on *Ochradenus baccatus* and *Colutea isteria*, Shalan *et al.* (2005) on *Majorana hortensis* and Cheruth *et al.* (2008) on *Catharanthus roseus*.

3.2. 2.Chemical composition: Data illustrated in Table (7) show that raising irrigation water

Table (8): Effect of interaction between irrigation intervals and salinity on the growth characters of *Peganum harmala* plants at 2, 4 and 6 months from transplanting during 2007 / 2008 seasons.

Season	2007 Season					
Irrigation intervals (days)	2 months (First cut)		4 months (Second cut)		6 months (Third cut)	
	Salinity (ppm)					
	3000	7000	3000	7000	3000	7000
	Plant height (cm)					
10	63.89	55.61	51.78	47.25	37.85	28.34
20	56.44	49.79	46.58	41.64	34.52	25.64
30	51.09	43.38	42.15	36.57	31.87	21.39
L.S.D. at 5%	0.68		1.25		018	
	Fresh weight (g) / plant					
10	439.58	365.25	745.51	568.57	1136.3	905.64
20	357.24	279.32	612.83	479.66	975.36	785.39
30	289.42	205.68	435.62	397.65	812.33	615.45
L.S.D. at 5%	N.S		43.57		51.36	
	Dry weight (g) / plant					
10	96.05	79.11	165.88	125.54	257.36	202.95
20	77.24	60.00	135.99	104.95	217.80	174.36
30	61.88	43.65	95.88	90.07	179.93	134.85
L.S.D. at 5%	N.S		11.56		14.29	
	2008 Season					
	Plant height (cm)					
10	73.47	62.90	59.47	52.23	42.33	34.57
20	65.87	58.23	55.00	47.17	38.70	31.90
30	60.90	52.73	49.67	41.33	35.77	28.00
L.S.D. at 5%	0.99		N.S		0.22	
	Fresh weight (g) / plant					
10	561.93	461.64	940.72	699.93	1476.24	1092.31
20	486.21	382.34	775.25	572.94	1252.12	986.74
30	416.42	305.93	611.32	443.60	1028.08	784.71
L.S.D. at 5%	N.S		N.S		85.92	
	Dry weight (g) / plant					
10	127.73	103.80	216.92	160.32	346.13	250.22
20	108.64	83.58	177.91	129.80	290.74	224.91
30	91.63	65.95	139.84	100.30	237.40	178.21
L.S.D. at 5%	N.S		N.S		19.74	

salinity from 3000 to 7000 ppm decreased crude protein percentages which were obtained at 2, 4 and 6 months from transplanting during the two seasons. Such reduction in crude protein % may be due to the failure of the plants to fully utilize nitrogen compounds,as the accumulation of nitrogen compounds is more rapid than their utilization in building more cells and organs. Also, increasing salinity level of irrigation water up to 7000 ppm decreased the total ash, water insoluble ash, total flavonoids and potassium % in all growing periods. On the other hand, increasing salinity levels of irrigation water caused a significant increase in the total carbohydrates, crude fiber, total lipids, total tannins, total alkaloids and sodium percentage in *Peganum harmala* plants under study. Such increases were noticed at the different periods of plant age during 2007 and 2008 seasons. Such a result was in agreement with those recorded by Ahmed *et al* (2002), Ahmed *et al.*(2004) Zhang *et al.*(2004), Safavi and Khajehpour (2007) and Kambiz *et al.*(2008). This quantitative variation of chemical composition must be derived from the induction by environmental factors to which the plant is subjected (Inderjit and Foy, 1999)

Table (9): Effect of the interaction between irrigation intervals and salinity on the chemical composition of *Peganum harmala* plant at 6 months (third cut) from transplanting during 2007 / 2008 season.

Season	2007 Season							
Irrigation intervals (days)	Salinity (ppm)							
	3000	7000	3000	7000	3000	7000	3000	7000
	Crude protein %		Total carbohydrates %		Crude fiber %		Total ash %	
10	11.98	11.35	34.85	36.15	27.48	27.79	16.55	16.10
20	11.68	11.08	35.66	36.74	27.95	28.25	16.24	15.67
30	11.34	10.84	35.91	36.99	28.38	28.73	16.08	15.29
L.S.D. at %	0.12		0.16		N.S		N.S	
	Hexane extract %		Potassium %		Sodium %		Flavonoids %	
10	4.89	5.52	3.12	2.81	2.23	2.5	1.32	0.75
20	5.44	5.83	2.75	2.49	2.64	2.79	1.10	0.68
30	5.83	6.05	2.34	2.18	2.85	3.25	0.97	0.50
L.S.D. at %	N.S		0.14		0.13		N.S	
	Total tannins %		Total alkaloids %		Acid-insoluble ash %		Water-insoluble ash %	
10	5.40	6.87	0.72	1.55	11.55	12.19	12.54	10.59
20	5.97	7.42	1.16	1.85	13.34	14.56	10.52	9.74
30	6.25	7.88	2.65	3.14	15.54	16.24	10.18	9.22
L.S.D. at %	N.S		N.S		N.S		0.55	
	2008 Season							
10	12.66	11.73	35.61	36.84	25.24	25.80	17.77	16.47
20	12.19	11.54	36.52	37.27	25.64	26.29	17.30	16.04
30	11.81	11.30	37.04	37.46	26.10	26.49	17.00	15.75
L.S.D. at %	0.19		0.26		N.S		N.S	
	total lipids %		Potassium %		Sodium %		Flavonoids %	
10	4.53	5.20	3.86	3.24	1.82	2.34	1.53	1.05
20	5.01	5.48	3.30	2.81	2.11	2.60	1.32	0.94
30	5.28	5.80	2.94	2.59	2.35	3.02	1.23	0.83
L.S.D. at %	N.S		0.18		0.10		0.01	
	Total tannins %		Total alkaloids %		Acid-insoluble ash %		Water-insoluble ash %	
10	4.86	6.02	1.25	1.81	12.45	13.57	10.59	10.11
20	5.36	6.38	2.65	2.87	14.56	15.59	10.32	9.51
30	5.70	6.75	3.82	5.02	16.29	16.54	9.28	8.54
L.S.D. at %	0.06		0.19		0.47		N.S	

3.3. Effect of the interaction between irrigation interval and water irrigation salinity:

3.3.1.Growth characteristics:

The data presented in Table (8) show that the interaction between salinity and irrigation intervals had a significant effect on the plant height of *Peganum harmala* at all three cuttings during 2007 season, and the first and third cuts during 2008 season. High water salinity (7000 ppm) decreased the fresh and dry weights / plant of *Peganum harmala* under prolonged irrigation interval (30 days). The interaction between salinity and irrigation interval had a significant effect on fresh and dry weights / plant at 4 and 6 months from transplanting in the 2007, and at 6 months in 2008. These results are in harmony with those obtained by Ahmed *et al.* (2002), Amin and Moussa (2006) and Alireza *et al.* (2008).

3.3.2.Chemical composition:

Data in Table (9) show that crude protein, total carbohydrates, potassium and sodium percentages in *Peganum harmala* plants were significantly affected by the interaction between irrigation interval and salinity, whereas crude fiber, total ash and total lipids at 6 months from transplanting during the two growing seasons

were not significantly affected. The highest value of crude protein, total ash and potassium % was recorded with 3000 ppm and 10 days, while the highest value of total carbohydrates, crude fiber, total lipids and sodium percentage in *Peganum harmala* plants was obtained at 7000 ppm and 30 days irrigation interval. The data also show that the highest concentration of total flavonoids was recorded with 3000 ppm salinity and irrigation every 10 days irrigation interval during 2008, whereas the highest concentrations of total tannins and total alkaloids were recorded with 7000 ppm and 30 days irrigation interval. The quantitative variation of chemical constituents of the plant was derived from the induction factors to which the plant was subjected. (Inderjit and Foy, 1999).

4. REFERENCES

Ahmed O., Unlukara A., Ipeki A. and Gurbuzi B. (2004). Growth and essential oil content of lemon balm (*Melissa officinalis*, L.). Pak. J. Bot, 36 (4): 787-792.

Ahmed S.Th., Abd El-Gawad A.A., Ahmed A.M., Edres A.S.A. and Khalifa A.A. (2002). Yield and chemical composition of some natural range plants as affected by salinity and irrigation intervals under Ras Sudr conditions. Res. Bult., Ain Shams Univ., 1: 1-17.

Alhadi F.A., Yasseen B.T. and Jabr M. (1999). Water stress and gibberellic acid effects on growth of fenugreek plants. Irrigation Science, 18 (4): 185-190.

Alireza K., Mahallati M.N. and Azizi G. (2008). Effect of drought, salinity, and defoliation on growth characteristics of some medicinal plants of Iran. Journal of Herbs, Spices & Medicinal Plants, 14 (1&2): 37-53.

Amin S.A. and Moussa E.E.A. (2006). Effect of salinity and water stress on growth and allocation of metabolites in *Taverniera aegytiaca* Boiss. Egypt J. Bot., 46: 1-14.

Askar A. and Treptow H. (1993). Quality Assurance in Tropical Fruits Processing. Springer-Verlag, Berlin, Heidelberg, Germany. 238 pp.

Baher Z.F., Mirza M., Ghorbanli M. and Rezaii M.B. (2002). The influence of water stress on plant height, herbal and essential oil yield and composition in *Satureja hortensis*, L. Flavour and Fragrance Journal, 7 (4): 275-277.

Balbaa S.I. (1986). Chemistry of Crude Drugs. Laboratory Manual, Fac. of Pharm., Cairo Univ., 195 pp.

Bannister P. (1981). Carbohydrate concentration of heath plants of different geographical origins. J. Ecol., 69: 769-780

British Pharmacopoeia (1980). Her Majesty's Stationary Office, London, 189.

Chaplin M.F. and Kennedy J.F. (1994). Carbohydrate Analysis-A Practical Approach. Oxford Univ. Press, Oxford, New York., Tokyo. 2nd Ed. 324 p

Cheruth A.J., Gopi R., Kishorekumar A., Manivannan P., Sankar B. and Panneerselvam R. (2008). Interactive effects of triadimefon and salt stress on antioxidative status and ajmalicine accumulation in *Catharanthus roseus*. Acta Physiologiae Plantarum, 30 (3): 287-292.

Dea B., Umek A., Kreft S., Maticic B. and Zupancic A. (1999). Effect of water stress and nitrogen fertilization on the content of hyoscyamine and scopolamine in the roots of deadly nightshade (*Atropa belladonna*). Environmental and Experimental Botany, 42 (1): 17-24.

Denys J.C., Simon J.E., Shock C.C., Feibert E.B.G. and Smith R.M. (1993). Effect of water stress and post-harvest handling on artemisinin content in the leaves of *Artemisia annua*, L. J. Janick and J.E. Simon (eds.), New crops. Wiley, New York. p. 628-631.

Dewis J. and Freitas F. (1970). Physical and chemical methods of soil and water analysis. Food and Agric. Organ, United Nations. Soils Bulletin, No. 10.

Egyptian Pharmacopoeia (1953). 1st English Ed., Cairo Univ. Press, Cairo, U.A.R.

EL-Monayeri M.O., Khafaga O.A., Ahmed A.M. and EL-Tantawy H.E. (1986). Contribution to the chemical composition of plants belonging to various ecological groups in the Red Sea area. Desert Inst. Bull., A.R.E., 36 (2): 405-430.

Falleh H., Ksouri R., Megdiche W., Trabelsi N., Boulaaba M. and Abdelly C. (2008). Effect of salinity on growth, leaf-phenolic content and antioxidant scavenging activity in *Cynara cardunculus*, L. Biosaline Agriculture and High Salinity Tolerance, 111: 335-343.

Hsiao T.C. (1973). Plant responses to water stress. Annu. Rev. Plant Physiol., 24 (5): 19-70.

Inderjit D.K. and Foy C.L. (1999). Principles and Practices in Plant Ecology. Allelochemical Interactions. Library of Congress Cataloging in Publication Data, CRC Press, Boca Raton, London, New York, Washington, D.C., 589 pp.

Kambiz B.A., Haghiry M.R. and Mohammadi A. (2008). Effect of saline irrigation water on agronomical and phytochemical characters of chamomile (*Matricaria recutita*, L.). Scientia Horticulturae, 116 (4): 437-441.

Karawya M.S. and Aboutable E.A. (1982). Phytoconstituents of *Tabernaemontana cornaria* Jac Q. Willd and *Dichotoma roxb.* Growing in Egypt. Part IV: The flavonoids. Bulletin of Fac. Pharm, Cairo Univ., XXI (1): 41-49.

Koyro H.W. (2006). Effect of salinity on growth, photosynthesis, water relations and solute composition of the potential cash crop halophyte *Plantago coronopus* (L.). Environmental and Experimental Botany, 56 (2): 136-146.

Lamchouri F., Settaf A., Cherrah Y., Zemzami M., Lyoussi B., Zaid A., Atif N. and Hassar M. (1999). Antitumour principles from *Peganum harmala* seeds. Thérapie, 54 (6): 753–8.

Larcher W. (1995). Physiological Plant Ecology. Springer Verlage, Berlin Heidelberg, Germany. 506 pp.

Mahmoud S.M. (2001). Effect of water stress and NPK fertilisation on growth and resin content of *Grindelia camporum* Green. Acta Horticulturae, 3: 125-137

Makkar H.P.S. and Goodchild A.V.L.(1996). Quantification of Tannins: A Laboratory Manual. International Center for Agricultural Research in The Dry Areas,Aleppo,Syria.p:2.

Michael J.C. (1997). Plant Ecology Department of Biology Imperial College of Science. Technology and Medicine, Silwood Park, Ascot. Berks.

Moura D.J., Richter M.F., Boeira J.M., Pêgas Henriques J.A. and Saffi J. (2007). Antioxidant properties of beta-carboline alkaloids are related to their antimutagenic and antigenotoxic activities Mutagenesis 22 (4): 293–302.

Safavi S. and Khajehpour M.R. (2007). Effects of salinity on Na, K and Ca contents of borage (*Borago officinalis*, L.) and echium (*Echium amoenum* Fish. & Mey.). Pharmaceutical Sciences, 2 (1): 201-215.

Shalan M.N., Abd El-Latif T.A.T. and El-Ghadban E.A.E. (2005). Effect of water salinity and some nutritional compounds on the growth and production of sweet marjoram plants (*Majorana hortensis* L.). Egypt J. Agric. Res., 84 (3): 159-176.

Steel G.D.R. (1960). Principles and Procedures of Statistics. New York McGraw-Hill Book Co., 481 pp.

Täckholm V. (1974). Student's Flora of Egypt. 2 nd Ed. Published by Cairo Univ., Printed by Co-operative Printing Company Beirut.

Woo W.S., Chi H.J. and Yun H.S. (1977). Alkaloid screening of some Saudi rabian Plants. Kor. J. Pharmacog., 8 (3): 10 113.

Zhang F., Yang Y.L., He W.L., Zha X. and Zhang L.X. (2004). Effects of sa ity on growth and compatible solutes of callus induced from *Populus euphratica*. *In Vitro* Cellular and Developmental Biology – Plant, 40 (5):491-494.

تأثير الإجهاد المائى والملحى على النمو والتركيب الكيميائى لنبات الحرمل تحت ظروف رأس سدر

وليد محمد عبد العظيم – سعيد ثابت أحمد* – نوال هداية محمد

قسم النباتات الطبية والعطرية و * قسم البيئة النباتية والمراعى
شعبة البيئة وزراعات المناطق الجافة – مركز بحوث الصحراء – المطرية – القاهرة – مصر.

ملخص

أقيمت تجربة حقلية على نبات الحرمل *Peganum harmala* ، بمحطة بحوث رأس سدر التابعة لمركز بحوث الصحراء بمحافظة جنوب سيناء خلال موسمى ٢٠٠٧ و ٢٠٠٨ و ذلك لدراسة تأثير فترات الرى ١٠ و ٢٠ و ٣٠ يوما ومستويات الملوحة ٣٠٠٠ و ٧٠٠٠ جزء فى المليون والتداخل بينهما على بعض صفات النمو والتركيب الكيميائى وقد جمعت بذوره من وادى سدر. وتضمنت التجربة ٦ معاملات وزعت فى تصميم قطاعات شبكية وتم أخذ قياسات النمو بعد ٢ و ٤ و ٦ شهور من الشتل، بينما أخذت القياسات الكيميائية بعد ٦ شهور خلال موسمى الدراسة. ومن أهم النتائج المتحصل عليها التالى :

أ- تأثير فترات الرى:-

– أدى إطالة فترات الرى من ١٠ إلى ٣٠ يوما إلى نقص معنوى فى طول النبات و كذلك الوزن الغض والجاف / نبات خلال فترات النمو المختلفة.

– أدت إطالة فترات الرى من ١٠ إلى ٣٠ يوما إلى نقص معنوى فى نسبة البروتين الخام والرماد والفلافونات والبوتاسيوم والى زيادة معنوية فى الكربوهيدرات الكلية و نسبة الألياف الخام والمستخلص الهكسانى والقلويدات والصوديوم فى أنسجة نبات الحرمل عند عمر ٦ شهور.

ب- تأثير الملوحة:-

– أدت زيادة تركيز الأملاح من ٣٠٠٠ إلى ٧٠٠٠ جزء فى المليون إلى نقص معنوي في طول النبات و الوزن الغض والجاف لنبات الحرمل عند أعمار ٢، ٤، ٦شهور من الشتل. وأمكن الحصول على أقصى قيمة للوزن الغض والجاف للنبات عند تركيز ملوحة ٣٠٠٠ جزء فى المليون.

– أدت زيادة الملوحة من ٣٠٠٠ إلى ٧٠٠٠ جزء في المليون إلى نقص النسبة المئوية للبروتين الخام والرماد والفلافونات والبوتاسيوم والرماد غير الذائب فى الماء فى أنسجة نبات الحرمل وزادت النسبة المئوية للكربوهيدرات الكلية والألياف الخام والمستخلص الهكسانى والقلويدات والصوديوم والرماد غير الذائب فى الأحماض فى أنسجة نبات الحرمل بزيادة تركيز الملوحة من ٣٠٠٠ إلى ٧٠٠٠ جزء فى المليون.

ج- تأثير التفاعل بين فترات الرى و الملوحة:-

– أمكن الحصول على أعلى القيم من طول النبات والوزن الغض والجاف لنبات الحرمل وكذلك نسبة البروتين الخام والرماد والفلافونات والبوتاسيوم عند اقل تركيز للملوحة (٣٠٠٠ جزء في المليون) واقصر فترة للرى (١٠ أيام).

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (٦٠) العدد الرابع (أكتوبر٢٠٠٩):٤٣٣-٤٤٢.