8 Egyptian J. Desert Res., **54**, No.1, 141-155 (2004)

ECOPHYSIOLOGICAL STUDIES ON THE DROUGHT RESISTANCE OF *Moringa oleifera* (Lam).

Nour El-Din, Nahed M.
Plant Ecology and Range Management Dept., Desert Research Center,El-Matareya, Cairo, Egypt.

A pot trial was conducted at the green house of Desert Research Center during 2001-2002 growing season to study the effect of irrigation intervals (6, 12 and 18 days) and presoaking of seeds with different gibbrellic acid (GA_3) concentrations (0, 100 and 200 ppm) on chemical components of *Moringa oleifera*.The results indicated that carbohydrates % and protein (mg/100g d.wt.) in leaves and seeds of *Moringa oleifera* tended to increase with GA_3 seed soaking as well as by prolonging of the irrigation intervals. Seed soaking in 200 ppm GA_3 as well as prolonging irrigation intervals from 6 to 18 days (increasing water deficit) increased all minerals composition. The 18 days interval treatment recorded the highest mineral values in both leaves and seeds. The results also revealed that the highest value of either total carbohydrates or total protein in both leaves and seeds was obtained by treatment of 200 ppm GA_3 under wider irrigation intervals (18 days).

The highest yield of seed oil was 36.1% (obtained from treatment of 100 ppm GA_3 at 18 days). However the number of fatty acids in seeds of *Moringa oleifera* after plants exposure to irrigation intervals (6, 12, 18 days) varied between 7 to 11. The essential unsaturated oleic fatty acid was detected in all treatments with high percentage ranged from 57.2% in the control to 75.5% in treatmeat of 100 ppm GA_3 at 18 days.

Keywords: *Morigna oleifera*, Gibbrellic acid (GA_3), irrigation intervals, total carbohydrates, total protein, minerals composition, fatty acids.

Moringa oleifera is one of the most useful tree for semi-arid and drought-prone areas. Its leaves are harvested daily for soups, sauces or salads (Palada and Chang, 2003). These palatable leaves are high in protein, vitamin A and vitamin C. Where diets lack in these essential nutrients like on Pacific atolls the Drumstick tree makes a major contribution to human health (Verma *et* *al.*,1976). Most of these seed plants are adapted to various marginal growing conditions in the tropics and can help to mitigate the prevailing deficit in protein and energy sources (Engineering Solution To Malnutrition, 2000).

M. oleifera used as a vegetable crop, the leaves are widely used, analysis of the leaf composition have revealed them to have significant quantities of vitamins A, B and C, calcium, iron and protein (Ram, 1994). The leaves are considered to offer great potential for those who are nutritionally at risk and may be regarded as a protein and calcium supplement. The flowers, which must be cooked, are consumed either mixed with other foods or fried in butter and have been shown to be rich in potassium and calcium. The seeds are utilised in some regions of India either as a green pea, in their immature state, or fried, in their mature state, possessing a peanut like flavour (Ramachandran *et al.*, 1980). According to Hartwell (1971), the flowers, leaves and roots are used in folk remedies for tumors whereas they are include the anti-tumor compound β-sitosterol and pectinesterase, the seed for abdominal tumors. The root decoction is used in Nicaragua for dropsy. Root juice is applied externally as rubefacient or counter-irritant. Leaves applied as poultice to sores, rubbed on the temples for headache, and said to have purgative properties. Bark, leaves and roots are acid and pungent, and are taken to promote digestion. Roots are bitter, act as a tonic to the body and lungs, and are emmenagogue, expectorant. mild diuretic and stimulant in paralytic affections, epilepsy and hysteria (Von Maydell, 1986).

Growing plants under arid climate, rare rain and variable degree of temperature are suffering from difficult germination of seeds, stunting of growth and decreasing quality and quantity of seed yield. Therefore, plants grown under these environmental conditions require a certain management to overcome these factors and to achieve suitable yield (Booth and Wickens, 1988).

Some investigators take there problems into consideration by using different growth regulators to overcome the drastic changes imposed by drought. Hegazi *et al.* (1995a) found application of growth regulators (IAA and kinetin mixture) in general, increased the protein content in grains of wheat. This was more pronounced when the growth regulators were applied by grain sooking and at tillering stage.

The important effects of moisture stress on changes in growth yield, chemical composition and accumulation of organic and inorganic solutes in different barley and wheat varieties were studied by El-Monayeri *et al.* (1983).

In this respect, Khafagi and El-Lawendy (1997) revealed that the concentration of total carbohydrate in roots of sugar beet increased generally with low and moderate soil moisture stress, while decreased with the higher levels during the different stages of growth. The reduction of different growth criteria however at the same time the carbohydrate % was increased as the soil water stress increases, this may be accounted by osmotic adjustment.

Number of reports indicate that auxins such as IAA and GA_3 induce rapid increases in mRNA and promoting growth characteristics with increase of chemical constituents (Theologis, 1986; Guilfoyle *et al.*, 1987 and Key, 1989)

Kezeli *et al.* (1972) reported that application of 50 ppm GA_3 at stem apex of beans, leads to stem elongation. While, Metwally *et al.* (1979) showed that application of GA_3 on tomato plant at 50, 75 and 100 ppm caused significant increase in plant height but subsequently these increases diminished gradually.

Khafagi *et al.* (1986a) reported that application of GA_3 at 50 and 100 ppm on some leguminous plants, increased carbohydrate, protein and minerals concentration.

The aim of the present investigation is to study the effect of gibbrellic acid (GA_3) on the performance of *Moringa oleifera* plants to grow under drought conditions(irrigation intervals).

MATERIALS AND METHODS

Experimental design and layout

A pot experiment was carried out during 2001/2002 growing season in the green house of the Desert Research Center, Cairo to investigate the effect of irrigation intervals (6, 12, 18 days) and seed soaking with different gibbrellic acid (GA_3) concentration (0,100, 200 ppm) on some metabolic products of *Moringa oleifera* (Lam). Planting was done on March 2001, in porcelain pots (50 cm in diameter and 60 cm in depth). Each pot was filled with 25 kg of fine sand soil wherease the analysis of the experimental soil was represented in Table (1).

Moringa seeds were soaked for 12 hours with each of the concentrations of the growth regulator GA_3 (0, 100 and 200 ppm), then the seeds were air-dried directly before planting as described by Hegazi and Kausch (1978). Plants were irrigated every 6, 12 and 18 days using tap water. Seeds were planted at 1 cm in depth and germinated within ten days. All pots received a constant level of NPK at the rate of 3.6 g N_2, 1.8g P_2O_5 and 0.9 g K_2O/pot in the form of ammonium nitrate, superphosphate and potassium sulphate, respectively. Superphosphate was added before planting, whereas half of nitrogen and all potassium were applied three weeks after planting as a side dressing. The another half of N_2 was applied after three weeks.

TABLE (1). Analysis of the experimental soil.

Mechanical analysis %				Texture Class	Saturation Point %	Field Capacity %
C. sand	F. Sand	Silt	Clay			
30.06	60.1	3.6	6.24	Fine sand	31.2	5.9

pH	EC $mScm^{-1}$	Chemical analysis of the 1:1 extract (meq/L)								
		Cations				Anions				
		Na^{+}	K^{+}	Ca^{++}	Mg^{++}	Cl^{-}	SO_4^{--}	$CaCO_3^{-}$	CO_3^{--}	HCO_3^{-}
6.5	1.6	4.1	1.2	2.3	12.1	5.2	0.91	0.41	-	0.50

1. Chemical composition

The chemical analysis was carried out on leaves and seeds at harvest on october 2002.

Total available carbohydrates were determined according to Said and Naguib (1964) and values were expressed as g/100 g dry matter. Total nitrogen content was determined using microkjeldahl method according to British pharmacopoeia (1980) and the protein content was calculated by multiplying the total nitrogen by 6.25, the results were expressed as mg/100 g dry weight.

Calcium, Magnesium, Iron and Copper were determined by flame atomic absorption using Unicam SP 1900 Atomic Absorption and expressed as mg/100 g dry weight.

Total Sulphurs (sulphate, sulphur) in plant determined by turbidimeter according to Cottenie *et al.* (1982).

Phosphorus content in the digested samples was determined colorimetrically by molybdic acid method as described by Humphries (1956). The optical density of the colour developed was measured at 710 nm using Spekol Spectrocolourimeter. A calibraiton curve was constructed using standard solution. Results were expressed as mg/100 g dry weight of the plant material.

Potassium was determined photometrically using flame photometer Corning 400. Results were expressed as mg/100 g dry weight of the plant material.

2. Extraction of oil from *M. oleifera* seeds

About 100g of *Moringa* seeds were subjected to extraction using n-hexane with using Soxhlet apparatus. The volatile oil content was determined by using the method described by British Pharmacopoeia (1980)

3. Oil quantity and quality

3.1. Physical properties of oil

The oil fraction odour, color, physical nature and solubility in petroleum ether, diethyl ether, benzene, chloroform, acetone, carbon tetrachloride and warm alcohol were studied.

3.2. Fundamental chemical properties

The chemical properties of oils were carried out on *Moringa* seeds of the treatment 100 ppm GA_3 at 18 days irrigation interval. Acidity value, saponification value, ester value, iodine value, oxidative state (E_{232nm} and E_{270nm}) were estimated by using the method described in British Pharmacopoeia (1980).

3.3. Separation and investigation of Saponifiable fraction using Gas-liquid chromatography (GLC)

The extracted fatty acids and the standard ones were converted to the corresponding methyl esters using ethereal solution of diazomethane (Farag, 1995). The methyl esters of the fatty acids were analyzed with a GCV Pye-Unicam gas chromatographic apparatus. The fraction of fatty acid methyl esters was conducted using GLC column.

Pots were arranged in complet randomized block design with three replicats. Data were statistically analyzed by using the analysis of variance as mentioned by Snedecor and Cochran (1980). The significance between means were tested against the LSD at 5% probability level.

RESULTS AND DISCUSSION

1. Chemical composition

Effect of seed soaking in GA_3

Tables (2 and 3) clearly show that the carbohydrates % in leaves and seeds were signifcantly increased by seeds soaking in gibbrellic acid. Carbohydrates were increased by 19.3% and 35.7% in leaves and by 20.8% and 31.9% in seeds by GA_3 application at 100 and 200 ppm, respectively. Protein concentration in the seeds was more than that of the leaves, it increased by 21.3% and 46.7% in seeds and by 19.4% and 31.1% in leaves. This result agreed with that of Hegazi *et al.* (1995b) who reported that protein contents were significantly increased in wheat plant by IAA and kinetin mixture application. This was true by using the growth regulators as grain soaking or as foliar spraying at tillering or at heading stages .

Tables(2 and 3) indicated that seed soaking in 200 ppm GA_3 significantly increased mineral composition in leaves by descending order of $Cu^{++} > Mg^{++} > K^{+} > Fe^{+++} > P^{+++} > Ca^{++}$ and SO_4^{--} and their percentages were 54.5%, 25.0%, 24.2%, 23.7%, 19.6%, 13.7% and 7.6%, respectively as compared with untreated seeds. Application of GA_3 at 200 ppm significantly increased mineral concentrations in the seeds. They were arranged in descending order of $Mg^{++} > P^{+++} > Cu^{++} > SO_4^{--} > Ca^{++} > K^{+}$ and Fe^{+++}, their percentages were 46.0%, 37.9%, 32.7%, 23.8%, 20.1%, 19.4% and 18.0%, respectively. In this regard, Khafagi *et al.* (1986b) found that the most used levels of GA_3 and CCC favoured the accumulation of carbohydrate in all the tested leguminous species. Gibbrellic acid (GA_3) and Cycocel (CCC) increased the content of total ash as well as that of Na^+, K^+, Ca^{++}, Mg^{++}, P^{+++} and Cl^- in tissues of some leguminous species.

Effect of irrigation intervals

It is shown from tables (2 and 3) that the concentraiton of carbohydrates and protein in leaves and seeds of *Moringa oleifera* tended to increase with prolonging of the irrigation intervals. The concentration of carbohydrates and protein in leaves of plants irrigated after 18 days increased by 35.9% and 28.9%, respectively over the control, while the high concentration of carbohydrates and protein (67.7% and 29.9%, respectively) were accumulated in seeds with increasing of irrigation period. In this context, Nour El-Din and Khidr (2002) revealed that the highest significant values of protein and carbohydrate in roots of fodder beet were occurred as water deficit increased.

Data in tables (2 and 3) show that prolonging irrigation intervals from 6 to 18 days tended to increase water deficit and increased all mineral composition. However, the 18 days treatment recorded the highest mineral values in both leaves and seeds of *Moringa oleifera* as compared with the control. The accumulation of minerals in leaves takes the order of P^{+++} > Fe^{+++} > Cu^{++} > Mg^{++} > K^+ >SO_4^{--} > Ca^{++}, their percentages were 32.2%, 27.8%, 21.5%, 16.5%, 11.8%, 7.0% and 6.1%, respectively. While in seeds it takes the order of Cu^{++} >Fe^{+++} > Ca^{++} > P^{+++} > SO_4^{--} > K^+ > Mg^{++} and their percentages were 45.5%, 31.6%, 28.7%, 14.8%, 13.2%, 0.5% and 0.93%, respectively. Mamoun (1994) indicated that *Vicia monatha* grown under soil moisture stress (428m^3/Fed) generally increased chlorophyll a,b, proline and ash compared with adding 1335 m^3/fed. Moreover,Youssef (1988) and Hussein (1988) reported that the total ash content varied remarkably in different plant species during different seasons under different soil moisture conditions reaching its highest values in the dry period.

Effect of the interaction

The obtained results showed that the interactions between the main factors; irrigation intervals and gibbrellic acid concentrations showed significant effect in both leaves and seeds (Tables 2 and 3). It was observed that the highest value of either total carbohydrates or total protein in both leaves and seeds was obtained at level of 200 ppm GA_3 under wider irrigation intervals (18 days) which was significantly higher than other values at other interactions.

The accumulation of Fe^{+++} > P^{+++} and Mg^{++} were increased by 34.7%, 32.9% and 21.1% in leaves of *Moringa oleifera* plant at 18 days and 200ppm GA_3 interaction. While mineral composition in seeds of plants grown under the prolonged irrigation interval (after 18 days) and 100 ppm GA_3 revealed that Cu^{++} > Mg^{++} > P^{+++} > SO_4^{--} and K^+ percentages were increased by 52.2%, 20.2%, 19.1%, 14.6% and 11.4% as compared with the control. Some authors reported that different kinds of growth promoters counteracted, at least partially, the adverse effect imposed by stress condition on protein and carbohydrate metabolism and restored the balance of mineral ions composition in tissues of the studied plant species (Khafagi *et al.*, 1986b and Ebad *et al.*, 1992).

3. Oil quantity and quality

The highest yield of seed oil was 36.1% as obtained from treatment 100 ppm GA_3 at 18 days. These results agreed with those obtained by Von Maydell (1986) who reported that *Moringa oleifera* seed contains about 35% oil.

3-1 Physical properties of oil

The obtained oil was pale yellow in colour, liquid, having a characteristic odour. It was soluble in petroleum-ether (b.p. 40-60°C), ether, chloroform, acetone, benzene, warm methyl and ethyl alcohol.

3-2 Fundamental chemical properties

The fundamental chemical properties of the extracted oils (from treatment 100 ppm GA_3 at 18 days) of *Moringa oleifera* seeds are presented in table (4). It is clear that *Moringa oleifera* oil had a low acidity value (0.72%) and didn't require a refinning process before human consumption. Furthermore, regarding to saponification and ester values of *Moringa* oil (167.1 mg of KOH/g and 155.7 mg of KOH/g, resepctively) which were similar to those of most vegetabolic oils. The results of acidity, saponification values (E_{232} and E_{270}) were agreed with those of Tsaknis *et al.* (1999) who found that the acidity of *Moringa oleifera* oil extracted by different methods was ranged from 0.85% to 1.01%, while those of saponification value ranged from 176.2 to 179.8. Moreover, they found that E_{232} ranged from 1.17 to 3.15, while E_{270} ranged from 0.19 to 1.13.

TABLE (2). Effect of irrigation intervals (day) and seed soaking in GA_3 concentration (ppm) on some chemical composition of *Moringa oleifera* leaves.

Treatments (ppm)	Irrigation intervals day				Irrigation intervals day			
	6	12	18	Mean	6	12	18	Mean
	Total carbohydrate (g/100g d.wt.)				Crude protein (mg/100g d.wt)			
Control	11.2	14.6	16.2	14.00	8.1	9.0	9.2	8.77
100 GA_3	14.4	17.3	18.4	16.70	9.1	10.1	12.2	10.47
200GA_3	16.2	18.6	22.2	19.00	9.8	11.2	13.5	11.50
Mean	13.9	16.9	18.9		9.0	10.1	11.6	
LSD at 5% for:	Irrig. Intervals = 1.22				0.84			
	Seed soaking = 0.92				0.97			
	Interaction = 1.58				1.13			
	Ca^{++} (mg /100 g d. wt.)				Mg^{++} (mg /100 g d. wt.)			
Control	360	371	385	372	246	262	283	264
100 GA_3	401	410	421	410	268	284	299	283
200 GA_3	413	419	439	423	304	320	368	330
Mean	391	400	415		272	288	317	
LSD at 5% for:	Irrig. Intervals = 4.22				2.68			
	Seed soaking = 3.12				6.10			
	Interaction = 5.41				10.56			
	P^{+++} (mg /100 g d. wt.)				K^{+} (mg /100 g d. wt.)			
Control	133	151	175	153	618	654	713	661
100 GA_3	142	166	186	164	701	750	784	745
200 GA_3	155	188	206	183	791	810	862	821
Mean	143	168	189		703	738	786	
LSD at 5% for:	Irrig. Intervals = 4.65				5.07			
	Seed soaking = 2.31				2.98			
	Interaction = 4.00				5.16			
	Cu^{++} (mg /100 g d. wt.)				Fe^{+++} (mg /100 g d. wt.)			
Control	0.49	0.54	0.63	0.55	20.5	23.5	25.5	23.2
100 GA_3	0.69	0.75	0.84	0.76	23.0	24.5	28.5	25.3
200 GA_3	0.77	0.86	0.90	0.85	24.5	28.5	33.0	28.7
Mean	0.65	0.72	0.79		22.7	25.5	29.0	
LSD at 5% for:	Irrig. Intervals = 0.24				0.41			
	Seed soaking = 0.13				0.19			
	Interaction = 0.23				0.33			
	SO_4^{--} (mg /100 g d. wt.)							
Control	770	783	808	787				
100 GA_3	792	822	859	824				
200 GA_3	813	855	873	847				
Mean	791	820	846					
LSD at 5% for:	Irrig. Intervals = 1.55							
	Seed soaking = 2.83							
	Interaction = 4.89							

TABLE (3). Effect of irrigation intervals (day) and seed soaking in GA_3 concentration (ppm) on some chemical composition in *Moringa oleifera* seeds.

Treatments (ppm)	Irrigation intervals day				Irrigation intervals day			
	6	12	18	Mean	6	12	18	Mean
	Total carbohydrate (g/100g)				Crude protein (mg/100 g d.wt.)			
Control	13.1	19.2	30.2	20.83	12.8	14.2	16.2	14.40
100 GA_3	21.4	22.0	32.1	25.17	15.1	17.6	19.7	17.47
200GA_3	23.1	25.1	34.2	27.47	18.2	21.1	24.1	21.13
Mean	19.2	22.1	32.2		15.4	17.7	20.0	
LSD at 5% for: Irrig. Intervals = 2.51 Seed soaking = 1.34 Interaction = 2.72					1.18 1.90 2.14			
	Ca^{++} (mg /100 g d. wt.)				Mg^{++} (mg /100 g d. wt.)			
Control	120	137	145	134	97	102	62	87
100 GA_3	131	150	171	151	109	123	131	121
200 GA_3	135	166	182	161	120	127	134	127
Mean	129	151	166		108	117	109	
LSD at 5% for: Irrig. Intervals = 6.75 Seed soaking = 2.36 Interaction = 4.09					8.86 9.71 10.45			
	P^{+++} (mg /100 g d. wt.)				K^+ (mg /100 g d. wt.)			
Control	90	95	100	95	311	321	340	324
100 GA_3	110	120	131	120	351	374	391	372
200 GA_3	123	130	140	131	369	381	410	387
Mean	108	115	124		344	359	380	
LSD at 5% for: Irrig. Intervals = 4.42 Seed soaking = 2.81 Interaction = 4.86					10.01 4.85 8.40			
	Cu^{++} (mg /100 g d. wt.)				Fe^{+++} (mg /100 g d. wt.)			
Control	2.05	2.55	2.75	2.45	5.1	5.9	7.1	6.1
100 GA_3	2.30	2.85	3.50	2.88	5.8	6.4	7.4	6.5
200 GA_3	2.70	3.05	4.00	3.25	6.1	7.5	8.1	7.2
Mean	2.35	2.82	3.42		5.7	6.6	7.5	
LSD at 5% for: Irrig. Intervals = 0.11 Seed soaking = 0.01 Interaction = 0.02					4.42 1.25 2.16			
	SO_4^{--} (mg /100 g d. wt.)							
Control	135	143	151	143				
100 GA_3	151	164	173	163				
200 GA_3	166	178	188	177				
Mean	151	162	171					
LSD at 5% for: Irrig. Intervals = 9.01 Seed soaking = 2.49 Interaction = 4.32								

TABLE (4). Chemical characteristics of *Moringa oleifera* oil.

Determination	Values
Acidity value (% as oleic acid)	0.72
Saponification value (mg of KOH/g of oil)	167.1
Ester value	155.7
Iodine value (g of I/100 of oil)	74.0
Oxidative state:	
a) E_{232} nm	2.86
b) E_{270} nm	1.46

3-3 Fatty acids composition

The oil extracted from *M. oleifera*, known commercially as "Ben" or "Behen" oil, has existed for well over a century. The oil was said to have unique properties being able to resist becoming rancid. The oil has also been reported to have been used extensively in the "enfleurage" process whereby delicate fragrances are extracted from flower petals and seeds (Dahot and Memon, 1985).

The results obtained in table (5) indicate variation between the investigated plants in fatty acids composition. The number of fatty acids in seeds of *Moringa oleifera* after plants exposure to water intervals (6, 12 and 18days) varied between 7 to 11 with oleic and myristoleic acids as the major acids. But interaction between irrigation intervals and growth regulators on composition and relative percentage concentration of fatty acids in seeds of *Moringa olifera* revealed that the high number of fatty acids recorded at treatment with 100, 200 ppm GA_3 at 12 days. While the high concentration of unsaturated fatty acid (oleic acid) recorded in both treatments of growth regulator of 100, 200 ppm GA_3 were 75.5 % and 74.1% at 18 days, respectively.

From the previous results, it was cleared that the essential unsaturated oleic fatty acid was detected in all treatments with high percentage ranged from 57.2% in the control to 75.5% in treatmeat of 100 ppm GA_3 at 18 days. That was more or less similar to olive oile (80 % oleic acid) and peanut o il (59 % oliec acid) according to Holloway (1982). On the other hand , Abd El-Fattah (1990) stated that there was variation in the number and the concentration of the fatty acids of plants grown under different levels of soil moisture stress.

TABLE(5). Interaction between growth regulators and irrigation intervals on composition and relative percentage concentration of *Morigna oliefera* fatty acids in seeds.

Fatty acid	Relative %								
	0 ppm GA_3			100 ppm GA_3			200 ppm GA_3		
	6 days	12 days	18 days	6 days	12 days	18 days	6 days	12days	18 days
C_{13} Tridecanoic	-	-	-	1.02	0.03	1.00	0.01	1.00	0.01
C_{14} Myristic	7.80	4.21	5.61	9.01	8.03	5.19	14.50	9.41	6.41
$C_{14:1}$ Myristoleic	16.50	8.22	7.71	4.11	2.49	2.16	-	2.01	2.84
C_{15} Pentadecanoic	0.17	0.11	-	0.98	2.41	-	4.65	3.54	0.03
C_{16} Palmitic	6.23	3.25	4.11	4.94	7.32	4.37	5.71	3.06	3.22
$C_{16:1}$ Palmitioleic	4.48	1.61	5.59	0.42	0.82	1.00	5.62	1.16	5.14
C_{17} Heptadecanoic	-	2.25	2.13	-	3.14	2.25	0.69	-	0.72
C_{18} Stearic	6.40	8.22	5.71	6.01	3.00	3.41	7.54	3.17	4.42
$C_{18:1}$ Oleic	57.20	64.80	68.80	65.40	67.90	75.50	60.30	73.90	74.10
$C_{18:2}$ Linoleic	0.62	3.25	-	4.01	0.81	2.35	0.30	0.81	0.91
$C_{18:3}$ Linolenic	0.55	2.25	-	2.01	0.93	1.00	0.33	0.92	-
C_{20} Arachidic	-	1.77	-	2.11	3.12	2.01	0.31	1.03	2.11
Number of fatty acids	**9**	**11**	**7**	**11**	**12**	**11**	**11**	**11**	**11**

From the obtained results it can be concluded that there were obvious variations in the fatty acid composition of plants belonging to different treatments. This is in agreement with that stated by different authors (Von Maydell 1986; Morton 1991; and Valian *et al.*, 1993) who that *Moringa* seed contains about 35% oil, sweet and non-sticking. This oil is often extracted for cooking and in rare cases even lubrication purposes. Moreover, it does not turn rancid, is excellent in salads, can be used for soap making and burns without smoke.

CONCLUSION

1. *Moringa* is a fast growing tree and can be used as tolerant drought plant.
2. Minerals composition which were presented in both leaves and seeds of *Moringa oleifera* can be considered a valuable source for nutrition.
3. It seems doubtful that the seed oil could be viewed as fountains of energy. It burns with a clear light and without smoke.
4. It is obvious from the results that, the seed oil of *Moringa* contain the highest value of oleic acid similar to olive oil. So it can be used like it.

REFERENCES

Abd El-Fattah, R.I. (1990). Ecological studies on the adjustment of the plants to their environments. *Ph.D. thesis*, Fac. Sci., Zagazig Univ., Benha, Egypt.

Booth, F. E. M. and G. E. Wickens (1988). Timber uses of selected arid zone trees and shrubs in Africa. FAO, Rome, p.92-101.

British Pharmacopocia (1980). Published on the recommendation of the medicines commission. Printed in England for her Majesty's Stationary Office at the University Press., Cambridge, UK., 2: 561 pp.

Cottenie, A.; V. Verloo; L. Kiekens, G. Velghe and R. Camerlynck (1982). In "*Chemical analysis of plants and soils*". Laboratory of analytical and agrochemistry, State Univ., Ghent, Belgium.

Dahot, M.U. and A. R. Memon (1985). Nutritive signifiance of oil extracted from *Moringa oleifera* seeds. *Pharmacy*, University of Karachi , 3 (2): 75-79.

Ebad, F. A.; H. M. Salm; S. A. Abdel Rahman and Z. S. Khidr (1992). Growth and chemical composition of wheat plants as conditioned by salinity and growth regulators. *Desert Inst. Bull., Egypt*, 42: 1-25.

El-Monayeri, M. O.; A. M. Hegazi.; N. H. Ezat.; M. M. Salem and S.M. Tahoun (1983). Growth and yield of some wheat and barley varieties grown under different moisture stress levels. *Moshtohor, Annals of Agric. Sci., 19 (1): 201-216.*

Engineering Solution To Malnutrition (2000). Published in SEEDLING,http://www.grain.org/publication/mar002-en-p.htm

Farag, R.S. (1995). In "*Chemical and Physical Analysis of Oils and Lipids*", Published by Academic Library, Egypt 210 pp.

Guilfoyle, T.; G. Hagen; B. Meclure; R. Wright and M. Gee (1987). Auxin regulated gene expression in soybean. *Plant Biochem. Physiol., 6: 1-7.*

Hartwell, J. L. (1971). Plants used against cancer. A survey. *Lloydia,* 30-34.

Hegazi, A. M.; Fayka M. El-Gaaly, and,Nahed M. Nour-El-Din (1995). Effect of some growth regulators on yield and yield components of wheat growth under saline conditions. *Annals of Agric. Sc., Moshtohor, 33 (2): 709-717.*

Hegazi, A.M.; Fawzia A. Ebad; Fayka M. El-Gaaly, and Nour El-Din, Nahed M. (1995) Interaction effects of salinity and growth regulators on some chemical composition of wheat plants. *Annals of Agric. Sci., Moshtohor, 33 (2): 659-668.*

Hegazi, A.M. and W. Kausch (1978). The interaction between salinity and (2-Chloroethyl) - Trimethyl-ammonium chloride (CCC) on salt tolerance in maize. *Zeitschrift für pf/ anzenphysiologie.*, Band 88, Heft 1,Seite:39-45.

Holloway, P.J. (1982). In *"The plant cuticle":* The chemical constitution of plant cutins. (Cutler, D.F.; L.K. Alvin and C.E. Price, eds), Academic Press, London, p. 1-32.

Humphries, E.C. (1956). In" *Mineral composition and ash analysis: Modern Methods of Plant Analysis".* (Peatch, K. and Tracey, M.V., eds.). Springer, Verlag, Berlin. I, p 148

Hussein, E.M. (1988). Ecological studies on Wadi Sudr, South Sinai, Egypt. *Ph.D. thesis*, Bot. Dept., Fac. Sci., Al-Azhar Univ., Cairo, Egypt (Girls Branch).

Key, J.L. (1989). Modulation of gene expression by auxin. *Bio Essays*, 1: 52-58.

Kezeli, T. A.; K. M. Guanichavo,Tarasashvidi and N. S. Piranishvili, (1972). The effect of the interaction of gibberellic acid and sulphate of ammonium on the growth of three bean varieties. *Turrialba*, 22:299-304 (C.F. Hort. abst., 7718).

Khafagi, O. A.; S.M. Khalaf; F.A. Ebad and W.I. El-Lawendy (1986a). Effect of GA_3 and CCC on protein, carbohydrate and mienrals content of some leguminous crops grown under NaCl salinization, *Annals Agric. Sci., Moshtohor,* 24(4): 49-63.

Khafagi, O. A.; S.M. Khalaf and W.I. El-Lawendy (1986b). Effect of GA_3 and CCC on germination and growth of soybean, common bean, cowpea and pigeon pea plants grown under different levels of NaCl salinity. *Annals. Agric. Sci., Moshtohor,* 24(4): 111-124.

Khafagi, O. A. and W.I. El-Lawendy (1997). Accumulation of some organic and inorganic compounds in sugar beet plants in response to soil moisture deficit. *Ann. Agric. Sci., Moshtohor,* 35(1): 321-334.

Mamoun, H. A. (1994). Physiological Response of Certain Forage Crops to Drought. *M.Sc. Thesis,* Fac. Agric., Ain Shams Univ., Cairo, Egypt. p. 40.

Metwally, A. M.; M. Abd-El-Kader and H. Mahmoud (1979). Effect of some growth substances on the growth and yield of tomatoes. *Agric. Research Review*, 57, No.3

Morton, J. F. (1991) The horse-radish tree, *Moringa Pterygosperma (Moringaceae)-* A boon to arid Lands?. *Economic Botany.* 45 (3): 318-333.

Nour El-Din, Nahed M. and Zainb A. Khidr (2002). Ecophysiological studies of fodder beet tolerance to drought and slainity at South Sinai. *Internatioal Symposium on Optimum Resources Utilizatioin in Salt-Affected Ecosystems in Arid and Semi-Arid Regions*, Cairo, 8-11 Apr, p 367-377.

Palada, M. C.; L. C. Chang (2003). In "*Suggested Cultural Practices for Moringa*" .(Kalb,T.,ed.).Asian Vegetable Research and Development Center,Taiwan, p 1-5.

Ram, J. (1994).Iu" Moringa a highly nutritious vegetable tree". Tropical Rural and Island/Atoll Development Experimental Station (TRIADES), Technical Bulletin No. 2.

Ramachandran, C.; K.V. Peter and P. K. Gopalakrishnan (1980). Drumstick (*Moringa oleifera*) a multipurpose Indian vegetable. *Economic Botany*, 34(3) :276-283.

Said, A. and M. I. Naguib (1964). Sucrose determintion as a mean of estimation of the draw back tax on exported Halawa Tehinia .*Bull.Fac.Sci.,Cairo Univ*.,39:207.

Snedecor, G.W. and W.G. Cochran (1980). In "*Statistical Methods*". 7th Ed. Iowa Stat Univ. Press, Ames, Iowa, USA., 507pp.

Theologis, A. (1986). Rapid gene regulation by auxin. *Annu. Rev. Plant Physiol*., 37: 407-438.

Tsaknis, J. Lalas; S. Gergis; V. Dourtoglou and V. Spiliotis (1999). Characterization of *Moringa oleifera* Variety Mbololo Seed Oil of Kenya. J. Agric. Food Chem.,47: 9445-4499.

Valian, R. Z.; V.K. Patil; Z.N. Patel and P.K.Kapadia (1993). Physiological responses of Drumstick (*Moringa oleifera* Lam.) to varying levels of ESP. *Indian J. Plant Physiol*.,36(4): 261-262.

Verma, S. C.; R. Banerji; G. Misra; S.K. Nigam (1976). Nutritional value of *Moringa current* Sci., 45 (21): 769-770.

Von Maydell, H. J. (1986). In" *Trees and Shrubs of the Sahel*: Their *Characteristics and Uses*". *Deutsche Gesellschaft für Technische Zusammenarheit (GTZ)*. Federal Republic of Germany, 334-337.

Youssef, A. M. (1988) Ecological studies on the plant communities of the desert area south Ismailia. *M.Sc. thesis*, Fac. Sci., Ain Shams Univ., Cairo, Egypt.

Received: 07/04/2004
Accepted: 25/07/2004

دراسات بيئة فسيولوجية لمقاومة نبات حب اليسار للجفاف

ناهد محمد نور الدين
قسم البيئة النباتية والمراعى ــ مركز بحوث الصحراء ــ المطرية ــ القاهرة ــ مصر

تم إجراء تجربه أصص بصوبة مركز بحوث الصحراء لدراسة تأثير ثلاث فترات للرى (٦ ، ١٢ ، ١٨ يوم)، مع نقع البذور في تركيزين من حمض الجبريليك(١٠٠، ٢٠٠ جزء في المليون) بالاضافه إلى تركيز المقارنة(صفر) على التركيب الكيميائى لنبات حب اليسار ، وقد تم استخدام تصميم القطع الكاملة العشوائية في ثلاث مكررات لدراسة التداخل بين كلاً من تأثير فترات الرى والنقع بحمض الجبريليك بالاضافه الى التاثيرات المنفرده لكل عامل من عاملى الدراسه ، وقد اظهرت التجربة النتائج الآتية:

١ - ان تباعد فترات الري من ٦ ــ ١٨ يوم أدى لارتفاع محتوى البروتينيات والكربوهيدرات والأحماض الدهنية أي بنقص الماء المتاح ، كما أدى تركيز ٢٠٠ جزء فى المليون من حمض الجبريللك الى نتائج متشابهة مع زيادة نسبة المحتوى المعدنى لنبات حب اليسار عند نفس التركيز.

٢ - أظهر النبات درجة تحمل عالية للجفاف باستخدام منظم النمو الجبريليك بنقع البذور قبل الزراعة بتركيز ٢٠٠ جزء فى المليون بتحسين صفات الزيت ووجود عدد من الاحماض الدهنية الغير مشبعة وكان الحمض الدهنى السائد هو حمض ألا وليك حيث تراوحت نسبته بين ٥٥ ــ ٧٥% من نسبة الاحماض الدهنية الكلية .