

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

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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 treatment of 100 ppm  $GA_3$  at 18 days.

**Keywords:** *Moringa 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*

*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  $\beta$ -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 soaking 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<sub>3</sub> 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<sub>3</sub> at stem apex of beans, leads to stem elongation. While, Metwally *et al.* (1979) showed that application of GA<sub>3</sub> 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<sub>3</sub> 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 gibberellic acid (GA<sub>3</sub>) 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 gibberellic acid (GA<sub>3</sub>) 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 whereas 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<sub>3</sub> (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<sub>2</sub>, 1.8g P<sub>2</sub>O<sub>5</sub> and 0.9 g K<sub>2</sub>O/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<sub>2</sub> 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 <sup>-1</sup>	Chemical analysis of the 1:1 extract (meq/L)								
		Cations				Anions				
		Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>++</sup>	Mg <sup>++</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>==</sup>	CaCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>==</sup>	HCO <sub>3</sub> <sup>-</sup>
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 calibration 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<sub>3</sub> 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 (Farg, 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<sub>3</sub>*

Tables (2 and 3) clearly show that the carbohydrates % in leaves and seeds were significantly 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<sub>3</sub> 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<sub>3</sub> 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<sub>3</sub> 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<sub>3</sub> and CCC favoured the accumulation of carbohydrate in all the tested leguminous species. Gibbrellic acid (GA<sub>3</sub>) and Cycocel (CCC)

increased the content of total ash as well as that of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ ,  $\text{P}^{+++}$  and  $\text{Cl}^-$  in tissues of some leguminous species.

#### *Effect of irrigation intervals*

It is shown from tables (2 and 3) that the concentration 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  $\text{P}^{+++} > \text{Fe}^{+++} > \text{Cu}^{++} > \text{Mg}^{++} > \text{K}^+ > \text{SO}_4^{--} > \text{Ca}^{++}$ , 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  $\text{Cu}^{++} > \text{Fe}^{+++} > \text{Ca}^{++} > \text{P}^{+++} > \text{SO}_4^{--} > \text{K}^+ > \text{Mg}^{++}$  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<sup>3</sup>/Fed) generally increased chlorophyll a,b, proline and ash compared with adding 1335 m<sup>3</sup>/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 gibberellic 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  $\text{GA}_3$  under wider irrigation intervals (18 days) which was significantly higher than other values at other interactions.

The accumulation of  $\text{Fe}^{+++} > \text{P}^{+++}$  and  $\text{Mg}^{++}$  were increased by 34.7%, 32.9% and 21.1% in leaves of *Moringa oleifera* plant at 18 days and 200ppm  $\text{GA}_3$  interaction. While mineral composition in seeds of plants grown under the prolonged irrigation interval (after 18 days) and 100 ppm  $\text{GA}_3$  revealed that  $\text{Cu}^{++} > \text{Mg}^{++} > \text{P}^{+++} > \text{SO}_4^{--}$  and  $\text{K}^+$  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<sub>3</sub> 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<sub>3</sub> 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 refining 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, respectively) which were similar to those of most vegetabolic oils. The results of acidity, saponification values (E<sub>232</sub> and E<sub>270</sub>) 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<sub>232</sub> ranged from 1.17 to 3.15, while E<sub>270</sub> ranged from 0.19 to 1.13.

**TABLE (2). Effect of irrigation intervals (day) and seed soaking in GA<sub>3</sub> 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 <sub>3</sub>	14.4	17.3	18.4	16.70	9.1	10.1	12.2	10.47
200GA <sub>3</sub>	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 <sup>++</sup> (mg/100 g d. wt.)				Mg <sup>++</sup> (mg/100 g d. wt.)			
Control	360	371	385	372	246	262	283	264
100 GA <sub>3</sub>	401	410	421	410	268	284	299	283
200 GA <sub>3</sub>	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 <sup>+++</sup> (mg/100 g d. wt.)				K <sup>+</sup> (mg/100 g d. wt.)			
Control	133	151	175	153	618	654	713	661
100 GA <sub>3</sub>	142	166	186	164	701	750	784	745
200 GA <sub>3</sub>	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 <sup>++</sup> (mg/100 g d. wt.)				Fe <sup>+++</sup> (mg/100 g d. wt.)			
Control	0.49	0.54	0.63	0.55	20.5	23.5	25.5	23.2
100 GA <sub>3</sub>	0.69	0.75	0.84	0.76	23.0	24.5	28.5	25.3
200 GA <sub>3</sub>	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 <sub>4</sub> <sup>++</sup> (mg/100 g d. wt.)							
Control	770	783	808	787				
100 GA <sub>3</sub>	792	822	859	824				
200 GA <sub>3</sub>	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<sub>3</sub> 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 <sub>3</sub>	21.4	22.0	32.1	25.17	15.1	17.6	19.7	17.47
200 GA <sub>3</sub>	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					1.18			
Seed soaking = 1.34					1.90			
Interaction = 2.72					2.14			
	Ca <sup>++</sup> (mg/100 g d. wt.)				Mg <sup>++</sup> (mg/100 g d. wt.)			
Control	120	137	145	134	97	102	62	87
100 GA <sub>3</sub>	131	150	171	151	109	123	131	121
200 GA <sub>3</sub>	135	166	182	161	120	127	134	127
Mean	129	151	166		108	117	109	
LSD at 5% for: Irrig. Intervals = 6.75					8.86			
Seed soaking = 2.36					9.71			
Interaction = 4.09					10.45			
	P <sup>+++</sup> (mg/100 g d. wt.)				K <sup>+</sup> (mg/100 g d. wt.)			
Control	90	95	100	95	311	321	340	324
100 GA <sub>3</sub>	110	120	131	120	351	374	391	372
200 GA <sub>3</sub>	123	130	140	131	369	381	410	387
Mean	108	115	124		344	359	380	
LSD at 5% for: Irrig. Intervals = 4.42					10.01			
Seed soaking = 2.81					4.85			
Interaction = 4.86					8.40			
	Cu <sup>++</sup> (mg/100 g d. wt.)				Fe <sup>+++</sup> (mg/100 g d. wt.)			
Control	2.05	2.55	2.75	2.45	5.1	5.9	7.1	6.1
100 GA <sub>3</sub>	2.30	2.85	3.50	2.88	5.8	6.4	7.4	6.5
200 GA <sub>3</sub>	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					4.42			
Seed soaking = 0.01					1.25			
Interaction = 0.02					2.16			
	SO <sub>4</sub> <sup>++</sup> (mg/100 g d. wt.)							
Control	135	143	151	143				
100 GA <sub>3</sub>	151	164	173	163				
200 GA <sub>3</sub>	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
<b>Oxidative state:</b>	
a) E <sub>232</sub> nm	2.86
b) E <sub>270</sub> 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 18 days) 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 oleifera* revealed that the high number of fatty acids recorded at treatment with 100, 200 ppm GA<sub>3</sub> 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<sub>3</sub> 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 treatment of 100 ppm GA<sub>3</sub> at 18 days. That was more or less similar to olive oil (80 % oleic acid) and peanut oil (59 % oleic 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 oleifera* fatty acids in seeds.**

Fatty acid	Relative %								
	0 ppm GA <sub>3</sub>			100 ppm GA <sub>3</sub>			200 ppm GA <sub>3</sub>		
	6 days	12 days	18 days	6 days	12 days	18 days	6 days	12days	18 days
C <sub>13</sub> Tridecanoic	-	-	-	1.02	0.03	1.00	0.01	1.00	0.01
C <sub>14</sub> Myristic	7.80	4.21	5.61	9.01	8.03	5.19	14.50	9.41	6.41
C <sub>14:1</sub> Myristoleic	16.50	8.22	7.71	4.11	2.49	2.16	-	2.01	2.84
C <sub>15</sub> Pentadecanoic	0.17	0.11	-	0.98	2.41	-	4.65	3.54	0.03
C <sub>16</sub> Palmitic	6.23	3.25	4.11	4.94	7.32	4.37	5.71	3.06	3.22
C <sub>16:1</sub> Palmitoleic	4.48	1.61	5.59	0.42	0.82	1.00	5.62	1.16	5.14
C <sub>17</sub> Heptadecanoic	-	2.25	2.13	-	3.14	2.25	0.69	-	0.72
C <sub>18</sub> Stearic	6.40	8.22	5.71	6.01	3.00	3.41	7.54	3.17	4.42
C <sub>18:1</sub> Oleic	57.20	64.80	68.80	65.40	67.90	75.50	60.30	73.90	74.10
C <sub>18:2</sub> Linoleic	0.62	3.25	-	4.01	0.81	2.35	0.30	0.81	0.91
C <sub>18:3</sub> Linolenic	0.55	2.25	-	2.01	0.93	1.00	0.33	0.92	-
C <sub>20</sub> 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.

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Received: 07/04/2004

Accepted: 25/07/2004



## دراسات بيئة فسيولوجية لمقاومة نبات حب اليسار للجفاف

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قسم البيئة النباتية والمراعى - مركز بحوث الصحراء - المطرية - القاهرة - مصر

تم إجراء تجربته 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 ) بالإضافة إلى تركيز المقارنة (صفر) على التركيب الكيميائى لنبات حب اليسار ، وقد تم استخدام تصميم القطع الكاملة العشوائية في ثلاث مكررات لدراسة التداخل بين كلا من تأثير فترات الرى والنقع بحمض الجبريليك بالإضافة الى التأثيرات المنفردة لكل عامل من عاملى الدراسه ، وقد اظهرت التجربة النتائج الآتية:

١ - ان تباعد فترات الري من ٦ - ١٨ يوم أدى لارتفاع محتوى البروتينيات والكربوهيدرات والأحماض الدهنية أي بنقص الماء المتاح ، كما أدى تركيز ٢٠٠ جزء فى المليون من حمض الجبريليك 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 - ٧٥% من نسبة الاحماض الدهنية الكلية .