J. Agric. Sci. Mansoura Univ., 30 (4): 2015 - 2038, 2005

EFFECT OF SALINITY, PHOSPHOREIN, MICRONUTRIENTS AND GA_3 ON GROWTH, SEED YIELD AND OIL COMPOSITION OF FLAX PLANT.

Ahmed, H. H. A. * ; M.K. Khalil*; A.S. Hamza and Sh. A. Sadek****

* **Plant Physiology Section, Agric. Botany Dept., Fac. of Agric., Cairo Univ., Giza, Egypt**

** **Center Laboratory for Food and Feed, Agriculture Research Center (A.R.C.), Giza, Egypt**

ABSTRACT

Pot experiments were conducted in 2000-2001 and 2001-2002 seasons in the wirehouse of the Central Laboratory for Food and Feed, Agriculture Research Center, Giza, Egypt to study the tolerance of flax plant to different levels of salinity (0, 2000, 4000 and 6000 ppm) as 2 NaCl : 2 $CaCl_2$: 1 $MgSO_4$. In addition to study the effect of different treatments: phosphorein 10 g/kg seed (biofertilizer) with full or half dose of P_2O_5, cotngein (15 g/kg seed) and foliafeed C (0.7 g/l), (micronutrients fertilizer compounds), GA_3 (at the rate of 100 ppm), on reducing the hazard effects of salinity on growth, seed yield and chemical composition of flax plant. The obtained results indicated that, increasing salinity levels lead to decreases in most of the studied characters (shoot height, dry weights of roots, stems, leaves as well as whole plant, number of capsules/plant, number of seeds/ capsule, number of seeds/plant and seed yield/plant as well as chlorophyll a, b and total, oil percentage and unsaturated fatty acid). While leaves number and total leaves area/plant increased significantly with salinity levels of soil from zero – 4000 ppm and decreased afterthere. On the other hand, the application of phosphorein with full dose of P_2O_5 surpassed phosphorein with half dose of P_2O_5 on growth, seed yield and chemical composition under saline or non-saline soil condition. Moreover, cotngein seed coated surpassed foliafeed C foliar application on the most of the studied growth and seed yield characters as well as chemical composition under saline or non-saline stress. Furthermore, GA_3 at the rate of 100 ppm may correct, to extent, the negative effect of salinity on growth, yield or chemical composition.

INTRODUCTION

Flax crop (*Linum usitatissimum* L.) is considered as the second fibre crop after cotton in the world. It is grown in Egypt as a dual purpose (seed for oil and stem for fibre). Recently many researches confirmed that nutrition on oil of flax has a lot of benefits for human health like heart diseases, cancer, arthritis, inflammatory diseases and diabetes. This positive effects are due to the omega-3-fatty acids (alpha linolenic acid). Linseed oil is rich in omega-3-fatty acids known to influence blood platelet aggregation, lower blood cholesterol concentration and prevent coronary heart disease (Kolodziejczyk *et al.*, 1995). Linseed oil also contains exceptionally high amounts of lignin precursors, which are antitumorigenic agents. A food supplement, Bioflax, is a product based on defatted flax flour and is an excellent natural additive for improving the texture of bakery products (Kolodziejczyk *et al.*, 1995). Moreover, linseed oil is one of the oldest commercial oils and has been used as a drying oil and still one of the most important oils used in the paint and varnish industry.

Some soil microorganisms could improve P-uptake by different field crops. It was found that, plants infected with phosphorus dissolving bacteria take up more P from low phosphate soil and produce more dry matter than non-infected plants (Sobh *et al.*, 2000). Furthermore, micronutrients are considered one of the important factors for plant nutrition to protect flax plant against adverse environmental conditions (El-Gazzar and El-Kady, 2000). In addition, plant growth promoting substances such as GA_3 has been known to play an important role to increase flax yield and its components (Ghoniem, 2004) as well as to support the plants against salinity stress (Aldesuquy and Ibrahim, 2002).

Thus, the aim of this present study was under taken to investigate the effect of biofertilizer (phosphorein), micronutrients (cotngein and foliafeed C) and gibberellin (GA_3) on the productivity of flax plant grown under saline soil conditions.

MATERIALS AND METHODS

Pot experiments were carried out in the wirehouse of the Central Laboratory for Food and Feed, Agriculture Research Center, Giza, Egypt during the two successive seasons 2000-2001 and 2001-2002.

Plastic pots of 25 cm in diameter were used in this experiment. The pots were filled with 7 kg soil obtained from the Agricultural Research Center Station in Giza. The mechanical and chemical analyses of the soil under investigation are given in Table (1).

Table (1): Some mechanical and chemical properties of the soil under study.

Property	Value	Property	Value
Clay%	37.6	EC (ds/m^2) 1:5	0.54
Silt%	28.0	Ca meq/l	3.2
Sand%	34.4	Mg meq/l	2.0
Texture class	Clay loam	Na meq/l	2.0
Total soluble salts%	0.17	K meq/l	1.0
Organic matter%	0.31	HCO_3 meq/l	1.2
Calcium carbonate%	2.30	SO_4 meq/l	4.5
pH	7.7	Cl meq/l	4.3

Mechanical analysis of the soil samples were performed according to the method of Black (1982). Organic matter, calcium carbonate, pH, total soluble salts, EC, Ca, Mg, Na, K, HCO_3, SO_4 and Cl were determined according to Cottenie *et al.* (1982).

Seeds of flax "*Linum usitatissimum* L." Sakha 1 variety were sown on the 13th November 2000 in the first season and 18th November 2001 in the second one (0.8 gram of seeds for each pot).

Fertilization was carried out according to recommendation of Ministry of Agriculture (70 kg N/fed., 100 kg P_2O_5/fed. And 50 kg K_2O/fed.); each of pot received 2.2 g calcium superphosphate (15.5% P_2O_5) and 0.7 g potassium sulphate (48% K_2O) before planting and 3.0 g ammonium nitrate (33.5% N). Half of the nitrogen fertilizer was added before sowing and the second half after 21 days later.

Soil was subjected to four salinity levels (0, 2000, 4000, 6000 ppm) which were obtained by adding a mixture of calcium chloride, sodium chloride and magnesium sulphate at the ratio of 2:2:1 by weight respectively. For each salinity level the pots were separated into six groups, the first group received the normal level of fertilizers as mentioned before but without any soil addition or foliar application. The second group received the normal level of fertilizers similar to first group but the seeds were coated or treated with the biofertilizer (phosphorein) at the rate of (10 g phosphorein/kg seed). The third group were similar to the second group but with half dose of P_2O_5 (1.1 g) fertilizers. The fourth group received the normal level of fertilizers but the seeds were coated with cotngein (seeds coat contains 2% Fe, 2% Mn and 1% Zn micronutrients) at the rate of 15 g/kg seeds. The fifth group of pots received normal level of fertilizers and the growing plants were sprayed with GA_3 at the rate of (100 ppm), spraying was applied twice with thirty days intervals starting after 35days of planting. The sixth group of pots were also received normal level of fertilizers and the plants sprayed with the micronutrients fertilizer foliafeed C which used at the rate of 0.7 g/l (6% Fe, 4% Zn, 4% Mn and0.5% Cu in the chelated form on EDTA as well as 0.5% B, 0.5% Mg and 0.02% Mo in inorganic forms). Spraying was carried out twice at the same time of GA_3 foliar applications.

Two samples from each treatment were collected after 60 and 90 days from planting and the following growth characters were estimated:

1. Stem height (cm).
2. Number of leaves/plant
3. Leaf area/plant (cm^2).
4. Dry weight (g) of leaves, stems and roots as well as whole plant.

For chlorophylls determination (a, b and total), fresh leaves were extracted with dimethyl formamide solvent as described by Nornai (1982).

At maturity after 150 days from sowing (D.A.S) the flax plants were harvested and the following characters were determined:

1-Number of capsules/plant.
2-Number of seeds/capsule.
3- Number of seeds/plant
4- Seed yield/plant (g).
5- Oil percentage was determined according to the method described by Horwitz *et al.* (1965) using Soxhelt apparatus.
6- Saturated, unsaturated and total fatty acids were determined in the linseed oil by using methyl esters boron trifluoride method (A.O.A.C., 2000). The oil is saponified with sodium hydroxide in methanol. The fatty acids are methylised with boron fluoride in methanol, extracted with heptane and determined on a gas chromatograph with FID detector (PE Auto System XL) with Auto sampler and Ezchrom integration system. Carrier gas (He): ca. 25 psi-Air 450 ml/min – Hydrogen 45 ml/min – split 100 ml/min. Oven temperature 200°C injector and detector 250°C.

The data were statistically analyzed by using factorial experiments and means of different treatments were compared using the least significant difference test (L.S.D.) at 5% level of probability to indicate treatment differences, salinity level was the main factor, different treatments were in the sub-factor. The analysis of variance of the experimental design was done according to the method described by Sendecor and Cochran (1980).

RESULTS AND DISCUSSION

1- Growth and seed yield characters

It is clear from the result that there was significantly and gradually decreases in most of the studied growth characters (plant height, dry weights of roots, stem, leaves and the whole plant) in the two successive samples as well as seed yield components (number of capsules/plant, number of seeds/capsule, number of seeds/plant and seed yield/plant) by increasing salinity level. However, leaf number/plant and total leaf area/plant were increased significantly with increasing salinity levels from (zero-4000 ppm) and decreased afterthere. These results are in agreement with those reported by Beke and Graham (1995) and Rawya (2001) on flax plants.

In this respect, the reduction in plant growth of the plants subjected to salinity stress could be attributed to the disturbance in metabolic activities which affected by the decrease in water absorption and/or disturbance of mineral balance or utilization. These results are consistent with the fact that salinity induces accumulation of certain ions and deficiency of others and in the same time lowers the external water potential below that of the cell (Abd-El-Karim, 1996).

On the other hand, Gaballah and Abou Leilah (2000) working on flax, mentioned that there was a significant increase in dry weights of shoots and roots by increasing salinity up to 3000 ppm, this may be due to the special affinity of oil producing plants to tolerate salinity conditions which could be coordinated with oil biosynthesis. In this respect, Abo-El-Saod *et al.* (1975) found that, flax plants were able to survive and make good growth over a rather wide range of salinity. Kheir *et al.* (1991a) reported that, the increase in plant growth due to low and moderate salinity concentrations could be attributed to the increase in transpiration and photosynthesis in oil producing plants.

Concerning the effect of phosphorein, the data reveal that, there is a significant increase on seed yield and its components and most of the studied growth characters by using phosphorein combined with half or full recommended dose of P_2O_5 fertilizer in both the 1st and 2nd samples of the first and second seasons, as compared with control non-inoculated plants, with some exceptions in the 1st sample of the 1st season of shoot height, and dry weight of roots as well as dry weight of leaves in the 2nd sample of the 1st season and leaf area/plant in the 2nd sample of the 2nd season. Also, the data reveal that, the increase in growth characters due to inoculation with phosphorein + full dose of P_2O_5 mineral fertilizer were more pronounced when compared with those inoculated and supplied with half dose of P_2O_5. The same trend was obtained in the 1st and 2nd samples of the two successive seasons. The obtained results are in harmony with those reported by Thingstrup *et al.* (1998) and El-Gazzar (2000) on flax plants.

These results may be attributed to the fact that biofertilizer phosphorien contained phosphate solubilizing bacteria and this is play a fundamental role in correcting the solubility problem of phosphate in the soil by converting the fixed form to soluble form ready for plant nutrition (Abd El-Lateef *et al.*, 1998 and Fatma, 2003). The enhancing effect of phosphorein as

a biofertilizer on growth and seed yield characters might be attributed to many factors such as: a) its ability to release plant promoting substances, mainly IAA, gibberellic and cytokinin like substances which might be stimulated plant growth and yield (Saber *et al.*, 1998), b) synthesis of some vitamins e.g. B_{12} (Sobh *et al.*, 2000), c) increasing the water and mineral uptake from the soil (El-Agrodi *et al.*, 2003), this could be ascribed to increase in root surface area, root hairs and root elongation as affected by biofertilizer as mentioned by Hanafy Ahmed *et al.* (1997), and d) enhancing the production of biological active fungistatical substances which may change the microflora in the rhizosphere and affect the balance between harmful and beneficial organisms (Apte and Shende, 1981). Similar suggestions were reported by Hanafy Ahmed *et al.* (1997) and Hanafy Ahmed *et al.* (2002).Furthermore, it can be suggested that, this increase might be mainly attributed to the phosphorus effect as an important element for cell division activity leading to the increase of plant height and dry weight of plant and consequently seed yield. This led to increase the plant growth, P-uptake and microbial population in crops rhizosphere and consequently yield.

Concerning the interaction between salinity stress and biofertilizer phosphorein combined with half or full recommended dose of P_2O_5 mineral fertilizer on growth and seed yield characters, it is clear from results in Tables (2,3 and 4) that, there was pronounced significant increases on most of studied growth and seed yield characters in the 1st and 2nd seasons with using phosphorein.The present results are in agreement with those reported by El-Shimy *et al.* (2001), Madlain *et al.* (2002) and El-Sweify *et al.* (2003).In this respect, it can be suggested that ,the enhancing effect of phosphorein on increasing growth, seed yield and its components in plant grown under saline or non saline soil condition may be induced due to the role played by phosphorein biofertilizer to reducing soil pH value which increase as a result of salinity soil addition due to secreting some inorganic acids such as acetic, propionic, fumaric and succinic, which brought about the dissolution of nutrients bound to organic materials or fixed them in soil on unsoluble forms and consequently tender them available for growing plants (El-Fadaly *et al.*, 2003). Moreover, Saber and Kabesh (1990) found that, the application of some biofertilizers such as phosphate dissolving bacteria and microbein resulted in a reduction of soil pH which increased the solubility of some nutrients such as P, Fe, Zn, Mn and Cu which in turn increased nutrient uptake by plants.

Concerning the effect of micronutrients on growth and yield characters, the data reveal that there is a significant increase on most of the studied growth and seed yield characters by using cotngein or foliafeed C micronutrients fertilizers in both samples of the two successive seasons (2000-2001 and 2001-2002).

Cotngein as a micronutrient fertilizer coated seeds compound surpassed foliafeed C as a foliar micronutrients fertilizer in most of the studied growth and seed yield characters especially in the 2nd season. The obtained results are in agreement with those obtained by Grant and Bailey (1997) and Hussien (2002) on flax plant.

Table (2): Shoot height (cm), number of leaves/plant and leaf area (cm^2)/plant of flax plant in the two samples as affected by different levels of salinity (0,2000,4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 and foliafeed C during 2000-2001 and 2001-2002 seasons

Growth characters	Season	1ST season (2000-2001)										2nd season (2001 – 2002)									
	Plant age (days)	60					90					60					90				
	Salinity levels(ppm) / Treatments	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)
Shoot height (cm)	Control	25.4	25.0	21.2	17.9	**22.4**	52.0	44.0	36.3	33.6	**41.5**	26.6	25.2	21.5	14.9	**22.0**	36.3	34.5	30.4	24.4	**31.4**
	Phosphorein +P_2O_5	34.9	29.7	21.1	20.4	**26.5**	59.9	40.6	36.3	36.3	**43.3**	38.3	25.0	21.4	17.5	**25.6**	70.3	36.8	33.2	19.5	**40.0**
	Phosphorein +0.5P_2O_5	33.1	25.0	21.6	18.1	**24.6**	54.8	39.2	35.9	33.6	**40.9**	33.7	25.2	19.1	15.6	**23.4**	61.3	39.7	30.0	26.9	**39.5**
	Cotngein	33.1	25.1	21.2	19.5	**24.7**	56.6	44.3	38.3	35.0	**43.6**	29.4	26.3	25.1	22.4	**25.8**	43.1	36.1	37.1	25.6	**35.5**
	GA_3 (0.1g/l)	28.3	26.2	25.5	20.4	**25.1**	52.7	46.3	36.7	33.7	**42.4**	28.0	26.1	22.8	18.2	**23.8**	39.4	34.7	38.5	26.7	**34.8**
	Foliafeed C (0.7g/l)	30.4	25.5	21.6	20.0	**24.4**	52.0	45.5	37.9	34.1	**42.4**	29.1	25.9	20.0	16.6	**22.9**	41.1	35.5	30.7	26.1	**33.4**
	Mean (A)	**30.9**	**26.1**	**22.0**	**19.4**		**54.7**	**43.3**	**36.8**	**34.4**		**30.9**	**25.6**	**21.7**	**17.5**		**48.6**	**36.2**	**33.3**	**24.9**	
	L. S. D. at 5%	A=2.178 B=N.S A*B=N.S					A = 3.69 B = N.S A*B=N.S					A=2.317 B=N.S A*B=5.676					A=3.505 B = 4.293 A*B = 8.586				
Number of leaves	Control	48.9	73.7	80.8	73.5	**69.2**	77.0	82.7	88.9	87.6	**84.1**	39.2	64.3	70.6	63.6	**59.4**	66.7	69.3	79.3	79.2	**73.6**
	Phosphorein +P_2O_5	49.2	72.4	80.7	78.8	**70.3**	83.2	91.5	92.4	90.7	**89.5**	39.2	58.7	70.5	71.0	**59.9**	73.0	84.3	85.3	85.0	**81.9**
	Phosphorein +0.5P_2O_5	49.1	74.4	77.2	70.0	**67.7**	80.9	89.5	90.4	89.4	**87.6**	39.0	65.7	66.4	60.0	**57.8**	70.3	82.3	86.7	82.3	**80.4**
	Cotngein	55.6	73.5	87.1	79.5	**73.9**	81.4	92.7	97.8	96.8	**92.2**	45.8	61.6	80.3	75.7	**65.9**	71.7	82.7	88.7	87.7	**82.7**
	GA_3 (0.1g/l)	61.2	79.6	81.2	77.6	**74.9**	85.4	87.0	88.7	88.3	**87.4**	52.5	68.7	70.3	67.1	**64.7**	72.5	72.7	85.3	73.9	**76.1**
	Foliafeed C (0.7g/l)	51.1	71.9	81.6	77.4	**70.5**	87.7	90.6	92.4	91.7	**90.6**	40.7	61.7	71.5	67.2	**60.3**	78.0	80.0	82.0	81.6	**80.4**
	Mean (A)	**52.5**	**74.3**	**81.4**	**76.1**		**82.6**	**89.0**	**91.8**	**90.8**		**42.7**	**63.5**	**71.6**	**67.4**		**72.0**	**78.6**	**84.6**	**81.6**	
	L. S. D. at 5%	A =3.35 B =4.11 A*.B = N.S					A = 3..35 B = 4.10 A*B =N.S					A= 4.73 B = 5.79 A*B = N.S					A= 4.83 B= 5..92 A*B = N.S				
Leaf area (cm^2)	Control	10.29	11.36	12.23	10.73	**11.15**	18.49	16.62	15.49	14.72	**16.33**	9.23	10.03	11.23	9.63	**10.03**	18.16	16.45	16.19	15.45	**16.56**
	Phosphorein +P_2O_5	11.98	12.44	14.58	12.97	**12.99**	22.36	21.31	20.78	18.09	**20.64**	10.88	11.53	13.82	12.29	**12.13**	24.75	19.09	18.91	17.61	**20.09**
	Phosphorein +0.5P_2O_5	13.07	12.11	13.66	9.92	**12.19**	24.40	20.55	17.57	16.85	**19.84**	12.00	11.34	13.74	8.45	**11.38**	25.80	21.49	16.52	13.46	**19.32**
	Cotngein	11.48	13.43	15.11	13.79	**13.45**	23.82	21.65	18.93	17.44	**20.46**	10.27	13.12	14.57	13.21	**12.79**	22.32	19.64	18.37	16.24	**19.14**
	GA_3 (0.1g/l)	13.64	14.67	15.77	12.85	**14.23**	27.91	21.64	20.80	18.06	**22.10**	12.79	15.22	16.15	12.25	**14.10**	21.92	20.40	19.29	16.54	**19.54**
	Foliafeed C (0.7g/l)	11.51	13.41	12.85	11.43	**12.30**	27.25	20.78	19.73	17.83	**21.40**	10.91	13.02	11.89	10.51	**11.58**	23.96	18.75	17.81	13.82	**18.59**
	Mean (A)	**12.00**	**12.90**	**14.03**	**11.95**		**24.04**	**20.43**	**18.88**	**17.17**		**11.01**	**12.38**	**13.57**	**11.06**		**22.82**	**19.30**	**17.85**	**15.52**	
	L. S. D. at 5%	A =1.25 B =1.53 A*B = N.S					A = 1.21 B = 1.48 A*B =N.S					A=1.57 B = 1..92 A*B = N.S					A= 1.98 B= N.S A*B = N.S				

Table (3): Dry weight (g) of roots, stems, leaves and whole plant of flax plant in the two samples as affected by different levels of salinity (0,2000,4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 and foliafeed C during 2000-2001 and 2001-2002 seasons

Plant organ	Season	1st season (2000-2001)										2nd season (2001 – 2002)									
	Plant age (days)	60					90					60					90				
	Salinity levels (ppm) / Treatments	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)
Roots	Control	0.089	0.055	0.048	0.045	0.059	0.156	0.088	0.072	0.063	0.095	0.023	0.019	0.015	0.014	0.018	0.052	0.037	0.035	0.034	0.040
	Phosphorein +P_2O_5	0.104	0.056	0.050	0.048	0.065	0.267	0.147	0.140	0.122	0.169	0.087	0.037	0.041	0.025	0.048	0.176	0.081	0.059	0.055	0.093
	Phosphorein +0.5P_2O_5	0.064	0.057	0.048	0.046	0.054	0.191	0.139	0.112	0.093	0.134	0.040	0.032	0.030	0.029	0.033	0.125	0.085	0.080	0.035	0.081
	Cotngein	0.097	0.071	0.051	0.049	0.067	0.330	0.138	0.120	0.092	0.170	0.078	0.042	0.037	0.036	0.048	0.087	0.063	0.061	0.040	0.063
	G A 3 (0.1g/l)	0.094	0.068	0.064	0.063	0.072	0.226	0.118	0.108	0.079	0.133	0.038	0.037	0.025	0.021	0.030	0.074	0.044	0.037	0.040	0.049
	Foliafeed C (0.7g/l)	0.122	0.066	0.059	0.048	0.074	0.285	0.144	0.119	0.114	0.166	0.029	0.025	0.024	0.023	0.025	0.067	0.051	0.048	0.032	0.050
	Mean (A)	0.095	0.062	0.053	0.050		0.243	0.129	0.112	0.094		0.049	0.032	0.029	0.025		0.097	0.060	0.053	0.039	
	L. S. D. at 5%	A =0.012 B =N.S A* B = N.S					A = 0.032 B = 0.038 A*B =N.S					A= 0.011 B = 0.013 A*B = N.S					A=0.017 B= 0.021 A*B = N.S				
Stems	Control	0.268	0.150	0.146	0.105	0.167	1.138	0.584	0.469	0.448	0.660	0.121	0.082	0.059	0.034	0.074	0.192	0.153	0.141	0.097	0.146
	Phosphorein +P_2O_5	0.364	0.255	0.177	0.140	0.234	0.948	0.754	0.461	0.407	0.643	0.175	0.089	0.077	0.073	0.104	0.750	0.285	0.145	0.116	0.324
	Phosphorein +0.5P_2O_5	0.233	0.229	0.120	0.092	0.169	0.608	0.503	0.412	0.380	0.476	0.154	0.086	0.085	0.076	0.100	0.521	0.262	0.178	0.167	0.282
	Cotngein	0.302	0.168	0.139	0.138	0.187	1.003	0.536	0.505	0.471	0.629	0.162	0.141	0.113	0.108	0.131	0.331	0.221	0.207	0.148	0.227
	G A 3 (0.1g/l)	0.278	0.213	0.189	0.159	0.210	0.858	0.531	0.454	0.416	0.565	0.148	0.125	0.116	0.071	0.115	0.341	0.193	0.153	0.141	0.207
	Foliafeed C (0.7g/l)	0.270	0.165	0.163	0.122	0.180	0.883	0.322	0.318	0.277	0.400	0.187	0.117	0.108	0.081	0.123	0.247	0.219	0.191	0.089	0.187
	Mean (A)	0.286	0.197	0.156	0.126		0.873	0.538	0.437	0.400		0.158	0.107	0.093	0.074		0.397	0.222	0.169	0.126	
	L. S. D. at 5%	A =0.042 B =N.S A*B = N.S					A = 0.139 B = 0.171 A*B =N.S					A= 0.025 B = 0.031 A*B = N.S					A= 0.047 B= 0.058 A*B = 0.115				
Leaves	Control	0.137	0.123	0.112	0.075	0.112	0.246	0.205	0.199	0.129	0.195	0.060	0.057	0.055	0.051	0.056	0.113	0.085	0.083	0.080	0.090
	Phosphorein +P_2O_5	0.210	0.195	0.115	0.102	0.156	0.325	0.236	0.199	0.172	0.233	0.141	0.092	0.086	0.085	0.101	0.193	0.143	0.121	0.113	0.143
	Phosphorein +0.5P_2O_5	0.108	0.102	0.072	0.025	0.077	0.270	0.259	0.209	0.186	0.231	0.093	0.085	0.082	0.060	0.080	0.184	0.134	0.125	0.091	0.134
	Cotngein	0.197	0.138	0.135	0.068	0.135	0.351	0.239	0.215	0.208	0.253	0.075	0.073	0.068	0.067	0.071	0.180	0.165	0.153	0.105	0.161
	G A 3 (0.1g/l)	0.139	0.117	0.112	0.097	0.116	0.292	0.238	0.234	0.196	0.240	0.078	0.072	0.071	0.067	0.072	0.159	0.107	0.106	0.105	0.119
	Foliafeed C (0.7g/l)	0.158	0.117	0.095	0.067	0.109	0.446	0.282	0.242	0.228	0.300	0.109	0.088	0.071	0.030	0.075	0.132	0.126	0.118	0.117	0.123
	Mean (A)	0.158	0.132	0.107	0.072		0.322	0.243	0.216	0.187		0.093	0.078	0.072	0.060		0.160	0.127	0.118	0.102	
	L. S. D. at 5%	A= 0.029 B= 0.036 A*B = N.S					A = 0.059 B = N.S A*B =N.S					A= 0.014 B = 0.018 A*B = N.S					A= 0.017 B= 0.021 A*B = N.S				
Whole plant	Control	0.494	0.328	0.306	0.225	0.338	1.540	0.877	0.740	0.640	0.949	0.204	0.158	0.129	0.099	0.148	0.357	0.275	0.259	0.211	0.276
	Phosphorein +P_2O_5	0.678	0.506	0.342	0.290	0.454	1.540	1.137	0.800	0.701	1.045	0.403	0.218	0.204	0.183	0.252	1.119	0.509	0.325	0.284	0.559
	Phosphorein +0.5P_2O_5	0.405	0.388	0.240	0.163	0.299	1.069	0.901	0.733	0.659	0.841	0.287	0.203	0.197	0.165	0.213	0.830	0.481	0.383	0.293	0.497
	Cotngein	0.596	0.377	0.325	0.255	0.388	1.684	0.913	0.840	0.771	1.052	0.315	0.256	0.218	0.211	0.250	0.598	0.449	0.421	0.293	0.440
	G A 3 (0.1g/l)	0.511	0.398	0.365	0.319	0.398	1.376	0.887	0.796	0.691	0.938	0.264	0.234	0.212	0.159	0.217	0.574	0.344	0.296	0.288	0.375
	Foliafeed C (0.7g/l)	0.550	0.348	0.317	0.237	0.363	1.414	0.748	0.679	0.619	0.865	0.325	0.230	0.203	0.134	0.223	0.446	0.396	0.357	0.238	0.359
	Mean (A)	0.539	0.391	0.316	0.248		1.437	0.911	0.765	0.680		0.300	0.217	0.194	0.159		0.654	0.409	0.340	0.268	
	L. S. D. at 5%	A =0.057 B =0.069 A*B = N.S					A = 0.184 B = 0.226 A*B =N.S					A= 0.033 B = 0.040 A*B = N.S					A=0.064 B= 0.078 A*B =0.156				

Table (4): Number of capsules / plant, number of seed / capsule, number of seed / plant and oil percentage of flax as affected by different levels of salinity (0,2000,4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 and Foliafeed C during 2000-2001 and 2001 – 2002 seasons

Yield components	Seasons	2000-2001					2001 - 2002				
	Salinity levels (ppm) / Treatment	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)
Number of capsules / plant	Control	14.27	13.71	7.33	6.08	10.35	10.90	5.70	4.60	2.79	6.00
	Phosphorein+P_2O_5	14.60	10.23	9.94	7.57	10.59	12.60	6.50	5.50	4.50	7.28
	Phosphorein +0.5P_2O_5	13.67	10.11	7.79	6.03	9.40	10.60	5.00	4.30	4.30	6.05
	Cotngein	21.90	10.67	9.69	7.15	12.35	12.70	7.50	7.30	3.30	7.70
	G A_3(0.1g/l)	15.67	13.48	7.21	4.33	10.17	11.60	5.87	6.10	3.80	6.84
	Foliafeed C (0.7g /l)	17.35	17.25	8.35	4.63	11.90	11.10	4.90	4.10	3.40	5.88
	Mean (A)	16.24	12.58	8.39	5.97		11.58	5.91	5.32	3.68	
	L. S. D. at 5 %	A= 0.659	B= 0.807	A*B = 1.615			A= 0.773	B = 0.946	A* B =1.893		
Number of seeds / capsule	Control	6.50	5.30	5.25	4.53	5.40	6.67	6.27	5.17	2.67	5.20
	Phosphorein +P_2O_5	6.62	6.47	4.65	4.33	5.52	7.73	5.69	5.20	4.26	5.72
	Phosphorein+0.5P_2 O_5	6.60	5.12	4.51	4.43	5.17	7.90	7.07	6.47	4.55	6.50
	Cotngein	6.63	5.50	5.33	5.22	5.67	7.37	6.33	5.48	5.23	6.10
	G A_3 (0.1g/l)	6.13	5.13	4.83	4.17	5.07	7.63	6.93	5.32	4.30	6.05
	Foliafeed C (0.7g /l)	6.63	5.45	5.27	4.37	5.43	7.80	5.73	5.39	5.10	6.01
	Mean (A)	6.52	5.50	4.97	4.51		7.52	6.34	5.51	4.35	
	L. S. D. at 5 %	A= 0.215	B= 0.263	A*B =0.526			A= 0.644	B = 0.789	A* B = N.S		
Number of seed / plant	Control	92.8	72.7	38.5	27.5	57.9	72.7	35.7	23.8	7.4	34.9
	Phosphorein+P_2O_5	96.7	66.2	46.2	32.8	60.5	97.4	37.0	28.6	19.2	45.6
	Phosphorein +0.5P_2O_5	90.2	51.8	35.1	26.7	51.0	83.7	35.4	27.8	19.6	41.6
	Cotngein	145.2	58.7	51.6	37.3	73.2	93.6	47.5	40.0	17.3	49.6
	G A_3(0.1g/l)	96.1	69.2	34.8	18.1	54.6	88.5	40.7	32.5	16.3	44.5
	Foliafeed C (0.7g /l)	115.0	94.0	44.0	20.2	68.3	86.6	28.1	22.1	17.3	38.5
	Mean (A)	106.0	68.8	41.7	27.1		87.1	37.4	29.1	16.2	
	L. S. D. at 5 %	A= 3.67	B = 4.49	A*B = 8.99			A= 7.58	B = 9.28	A*B = 18.56		
Seed yield(g) /plant	Control	0.430	0.293	0.217	0.120	0.265	0.233	0.113	0.110	0.030	0.122
	Phosphorein+P_2O_5	0.458	0.350	0.247	0.129	0.296	0.450	0.217	0.217	0.127	0.253
	Phosphorein+0.5P_2 O_5	0.404	0.323	0.226	0.127	0.270	0.393	0.160	0.123	0.103	0.195
	Cotngein	0.473	0.345	0.227	0.137	0.296	0.300	0.227	0.177	0.130	0.209
	GA_3(0.1g /l)	0.438	0.353	0.222	0.131	0.286	0.317	0.253	0.237	0.053	0.215
	Foliafeed C (0.7 g / l)	0.461	0.347	0.234	0.129	0.293	0.453	0.177	0.123	0.030	0.196
	Mean (A)	0.444	0.335	0.229	0.129		0.358	0.191	0.165	0.079	
	L.S.D	A= 0.017	B= 0.021	A*B = N.S			A= 0.044	B =0 053	A*B = 0.107		
Oil percentage	Control	36.3	30.2	28.1	25.3	30.0	35.9	32.3	28.2	20.0	29.1
	Phosphorein+P_2O_5	37.4	34.4	31.3	30.0	33.3	37.8	34.2	30.9	20.6	30.9
	Phosphorein+0.5P_2O_5	37.3	34.1	30.8	29.1	32.8	37.5	34.1	30.0	20.7	30.6
	Cotngein	38.4	34.4	31.3	29.6	33.4	38.3	34.4	28.6	20.2	30.4
	GA_3(0.1g /l)	38.8	35.4	31.4	30.0	33.9	38.4	34.8	31.0	22.4	31.7
	Foliafeed C (0.7 g / l)	37.1	33.8	30.7	29.3	32.7	37.2	33.6	30.5	21.4	30.7
	Mean (A)	37.6	33.7	30.6	28.9		37.5	33.9	29.9	20.9	
	L.S.D	A =0.695	B =0.851	A*B = N.S			A = 0.867	B = 1.060	A*B =N.S		

These results could be attributed to the important role of micronutrients in plant growth as a result of affecting many physiological processes on plant life and/or increasing mineral uptake by flax plants. In this respect, it can be suggested that, micronutrients supply probably increased the net assimilation

rate by increasing the rate of photosynthesis per unit leaf area and/or further by decreasing respiration rate (Moorby and Besford, 1983). Furthermore, it can be suggested that the influence of micronutrient on growth and seed yield of flax plants rather relevant to the enzymatic systems responsible for the biosynthesis of the plant hormones as well as through improvement of nutritive status, which may lead to more branches and seeds,. Similar suggestion and results were reported by Hanafy Ahmed *et al.* (1996) on faba bean. The significant increase in shoot height, number of leaves, leaf area/plant, and dry weights of roots, stems and leaves as well as whole plant obtained by application of micronutrients (Zn, Mn and Cu) might be attributed to the important role of these elements in the biosynthesis and metabolism of carbohydrates by activation of enzymes, catalyzing these processes.

Regarding the interaction between salinity and micronutrients, the results in Tables (2,3 and 4) reveal that, there are positive significant differences in growth characters and seed yield/plant and its components by using cotngein or foliafeed C micronutrients fertilizers under saline soil condition in the two samples and seasons. The higher increases in dry weight of whole plant were 0.25 and 0.44 g due to applying cotngein as compared to the mean value of control cotngein untreated treatments (0.148 and 0.276 g) in the 1st and 2nd sample of the 2nd season with relative increases reached 68.9% and 59.4%, respectively.In this respect, Osman *et al.* (1990) working on faba bean using Fe, Mn and Zn chelated by coating method found that such method was efficient for correcting the requirements and suitable balance between such nutrients in alluvial slightly alkaline soil for growth, nutrients uptake and high yield production.

Regarding the effect of GA_3 application, it is clear from the data that there is a significant increase in most of the studied growth and seed yield characters in the two samples during the two successive seasons by using GA_3 foliar application at the rate of 100 ppm, with some exceptions. Similar results were obtained by Dey and Lama (2000) and Ghoniem (2004) on flax plant.

In this respect, Feihu *et al.* (2000) reported that, GA_3 can accelerate the metabolism and transport of photosynthates, enhance root absorption activity and plant growth as well as yield. Moreover, the increase in plant growth and seed yield of flax in response to GA_3 treatment may be due to highly increased levels of endogenous gibberellins and disappearance of growth inhibitors (Zaky, 1985). Moreover, Bhattachjee *et al.* (2000) reported that the stimulating effect of GA_3 in increased fruit setting and their subsequent growth and development accounted for promotion of seed yield and its components ,the objective was to facilitate translocation of maximum amount of the assimilates to the reproductive zone to enhance flower bud formation ,pod set and consequently the seed yield of Jute.

Concerning the interaction between salinity and GA_3 (100 ppm) application, it is clear from the results that, there is a pronounced increase in most of the studied growth characters and seed yield with GA_3 application when compared to control stressed-untreated plants. These increases were significant in the dry weight of stems and whole plant, as well as shoot height in the 2nd sample of the second season and seed yield and its component

(number of capsules/plant and number of seed/plant) in the two seasons, and shoot height in the 1st sample of the 2nd season. The interaction between salinity stress and GA_3 application brought about a significant increase in dry weight of whole plant with value 0.398 g compared to control (stressed-untreated plants) 0.276 g in the 2nd sample of the 2nd season (2001-2002) with relative increase reached 44.2%. Similar results were obtained by Gherroucha *et al.* (2003) on wheat. In this respect, Sing and Singh (1980) reported that, the growth regulators, GA_3, kinetin, or IAA significantly mitigated the adverse effect of salinity. Moreover, growth regulators reduced the relative EC of ramie in comparison with the control. This reveals that the regulators can increase the cell membrane stability thereby increase the stress resistance of ramie (Feihu *et al.*, 2000).

However, on seed yield/plant, the best treatment under 2000 ppm salinity level were followed the order GA_3 > phosphorein + full dose of P_2O_5> foliafeed c > cotngein and then the lowest increase was by phosphorein + half dose of P_2O_5 with relative increase 20.5, 19.5, 18.4, 17.7 then 10.2%, respectively, when compared with control plants stressed only with 2000 salinity level in the 1st season.

2- Chemical compositions

2-1- Chlorophyll:

The data in Table (5) indicate that, there is a gradual significant depression in chlorophyll a, b and total in the two samples by increasing salinity levels. These findings are in full agreement with those obtained by Singh and Singh (1991) on flax,. In this respect, it can be suggested that, biosynthesis of chlorophylls in generally might be inhibited by the depressive effect of stress conditions on the absorption of some ions which are involved in the chloroplast formation, such as (Mg, Fe). This could be expected as a reason for chlorophyll suppression in leaves and / or increase of growth inhibitors, such as ethylene or abscisic acid production which enhances senescence, which occurred under stress conditions (El-Bagoury *et al.*, 1999) Furthermore, a decrease in the chlorophyll concentration under saline conditions may be attributed to a salt-induced weakening of protein-pigment-lipid complex (Strogonov *et al.*, 1970) or increased chlorophyllase activity (Stivesev *et al.*, 1973).

In this connection, it might be suggested that, growth reduction under salt stressed conditions was probably due to its depressing effect on chlorophyll formation, which subsequently might have decreased net photosynthesis and growth, and subsequently decreased yield of flax plants.

Data presented in Table (5) indicate that, biofertilizer application (phosphorein) combined with full dose of P_2O_5 mineral fertilizer brought a significant increment in chlorophyll a, b and total in the leaves of flax plant grown under either non-saline or saline soil conditions. These results were in agreement with the results obtained by Maiti *et al.* (1988) on mung bean and Rao and Rao (1993) on *Vigna spp.* These may be increase available phosphorus to plant, these findings may prove the role of phosphorus in stimulating chlorophyll synthesis through encourage pyridoxal phosphate enzymes formation which play an important role in α- amino Levulinic acid

synthetase as a primary compound in chlorophyll synthesis (Fatma, 2003). On the other hand, significant decreases in the concentration of chlorophyll a, b and total were recorded with using phosphorein combined with the half dose of P_2O_5 fertilizer under both non-saline or saline soil conditions, with some exceptions.

Table (5): Chlorophylls (a, b and total) concentration [mg / g f.w] in the leaves of flax plant as affected by different levels of salinity (0,2000,4000 and 6000 ppm) as well as phosphorein ,cotngein, GA_3 and follafeed C of the two samples in the second season; 2001-2002.

Plant pigment	Plant age (days)	60					90				
	Salinity levels (ppm) / Treatment	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)
Chlorophyll a	Control	4.21	1.94	1.62	0.80	2.14	3.00	1.00	0.86	0.78	1.41
	Phosphorein+P_2O_5	4.33	3.82	2.32	0.88	2.84	2.61	2.09	1.00	0.82	1.63
	Phosphorein +0.5P_2O_5	3.81	2.33	1 38	0.77	2.10	2.61	1.02	0.93	0.72	1.32
	Cotngein	5.73	5.52	2.87	1.16	3.82	3.56	3.47	1.29	0.58	2.23
	G A_3 (0 1g/l)	5.07	3.85	1.55	0.80	2.82	2.77	1.05	0.96	0.63	1.35
	Foliafeed C (0.7g /l)	3.16	2.88	2.08	0.79	2.23	3.81	1.02	0.93	0.61	1.59
	Mean (A)	4.39	3.39	1.97	0.87		3.06	1.61	1.00	0.69	
	L. S. D. at 5 %	A= 0.056 B = 0.069 A*B = 0 137					A=0.049 B = 0.060 A* B = 0.120				
Chlorophyll b	Control	2.38	2.31	2.01	1.03	1.93	2 30	1.96	1.01	0.41	1.42
	Phosphorein +P_2O_5	2.87	2 63	2 46	0.92	2.22	2.84	1.42	0 85	0.59	1.43
	Phosphorein +0.5P_2O_5	2 54	1 98	1.92	0.68	1.78	1.85	1.11	0.90	0 59	1.11
	Cotngein	2 91	2.54	1 96	0 95	2.09	2.81	1.48	1.25	0.73	1.57
	G A_3 (0.1g/l)	2.83	1.85	1.65	0.64	1.74	2.84	1.25	1.00	0.55	1.41
	Foliafeed C (0.7g /l)	2.67	2.12	1.72	1.02	1.88	2.97	1.26	1.03	0.54	1.45
	Mean (A)	2.70	2.24	1.95	0.87		2.60	1.41	1.01	0.57	
	L. S. D. at 5 %	A= 0.050 B= 0.061 A*B = 0.122					A= 0.014 B = 0.018 A* B = 0.035				
Total chlorophyll	Control	6.59	4.25	3.63	1.83	4.08	5.30	2.96	1.87	1.19	2.83
	Phosphorein+P_2O_5	7.20	6 45	4.78	1.69	5.03	5.45	3.51	1.85	1.41	3.06
	Phosphorein +0.5P_2O_5	6.35	4.31	3.30	1.56	3.88	4.46	2.13	1.83	1.31	2.43
	Cotngein	8.64	8.06	4.83	2.11	5.91	6.37	4.95	2.54	1.31	3.97
	G A_3 (0.1g/l)	7.90	5.70	3.20	1.44	4.56	5.61	2.30	1.96	1.18	2.76
	Foliafeed C (0 7g /l)	5.83	5.00	3 80	1.81	4.11	6.78	2.28	1.96	1.15	3.04
	Mean (A)	7.09	5.63	3.92	1.74		5.66	3.02	2.00	1.26	
	L. S. D at 5 %	A= 0.054 B = 0.087 A* B = 0.133					A= 0.057 B = 0.070 A*B = 0.140				

Data in Table (5) indicate that, there was significant increase in chlorophyll a, b and total in the two successive samples by using cotngein as a seed coating micronutrients compound or foliafeed C as a foliar application micronutrients compound fertilizer under both non-saline or saline soil conditions, with some exceptions. These increments may be due to the important role played by microelements in chlorophylls formation. In this respect, Ibrahim *et al.* (1995)working on broad bean mentioned that, the increase in total chlorophyll caused by Zn treatments was mainly due to the enhancing effect of Zn on chlorophyll b formation, while chlorophyll a concentration remained almost constant under the same treatment because chlorophyll b may be derived directly from the oxidation of chl. a. Mishra and

Singh (1996)revealed that ,the important role of micronutrients in the metabolism may be due to the effect of manganese on enzyme system within foliage as well as through zinc effect on RNA synthesis, moreover ,copper is very important element in protein metabolism and may be associated with chlorophyll formation. Generally, it can be suggested that, micronutrients enhancing growth and seed yield of flax plant through its effect on chlorophyll formation and consequently on photosynthesis efficiency.

Regarding the effect of GA_3 on chlorophylls (a, b and total), it is clear from the results in Table (5) that GA_3 at the rate of 100 ppm combined with the different levels of salinity tended to decrease the mean values of chlorophylls a, b and total concentration in the 2nd sample, while a reverse trend was recorded in chlorophyll a and total chlorophyll concentration in the 1st sample.

On the other hand, significant increases in chlorophyll a, b and total were recorded by the plants treated with GA_3 alone in the two successive samples when compared with GA_3-untreated plants. The enhancement effects of GA_3 application on chlorophylls concentration were in harmony with the results obtained by El-Sweify (1989) on flax. In this respect, El-Khateeb *et al.* (1991) mentioned that, GA_3 increased the content of chlorophyll a and b. This finding may be due to that GA_3 stimulated chlorophylls synthesis.

Concerning the interaction between GA_3 and salinity levels, the results reveal that the highest level of salinity 6000 ppm significantly decreased chlorophylls (a, b and total). However, the lowest levels of salinity (2000ppm) significantly increased chlorophyll a and total chlorophyll concentration by about 98.4% and 34.1%, respectively when compared with control plant in the 1st sample. In this respect, Aldesuquy and Gaber (1993) working on faba bean, reported that GA_3 at the rate of 100 mM alleviated the inhibition of chlorophyll production in sea water irrigated plants, particularly of high level (25%) on photosynthetic $^{14}CO_2$ fixation.

In this respect, it can be suggested that, in the present study, there might be a relationship between GA_3 and chlorophyll biosynthesis; the increase in chlorophyll concentration with GA_3 application might be influence on photosynthesis process efficiency which cause increase in growth and consequently seed yield of flax plant.

2-2- Oil percentage:

As regard to the effect of salinity on oil percentage, it is clear from the results in Table (4) that, there was significant decrease noticed with increasing salinity levels. The highest levels of salinity (6000 ppm) brought about the lowest values of oil percentage of flax seed. These results are in agreement with those reported by Gaballah and Abou-Leilah (2000) and Rawya (2001) on flax, they reached to one conclusion that the low seed oil content is associated with high uptake of Na^+ (or high level of salinity) by flax plant. In this respect, in the 1st season, increasing salinity level (2000, 4000 and 6000 ppm) decreased the mean value of oil percentage by about 11.6.22.8 and 30.1%,respectively ,when compared with the mean value of control non-saline plant.

It is important here to mention that, the reduction in oil percentage due to salinity may be attributed to the inhibitor effect of salinity in the growth through its effect on photosynthesis, transpiration and increase respiration. In this respect, Nemet Alla (1986) reported that activities of the necessary enzymes in glyoxylate cycle, particularly of isocitilase and malic synthetase have been found to increase in response to salinization and salinity appeared to accelerate carbohydrates formation.

It is clear from the data in Table (4) that, there was a significant increase in oil percentage by using phosphorein combined with the full or half dose of P_2O_5 fertilizer in the two successive seasons. In this respect ,under non-saline soil condition, these increases reach to about 3.0 and 5.3% by using phosphorein combined with full dose of P_2O_5 in the 1st and 2nd seasons, respectively, when compared with control plants untreated with phosphorein. Also, it could be noticed that oil percentage recorded by using phosphorein combined with full dose of p_2o_5 surpassed that obtained by using phosphorein with half dose of p_2o_5 by about 0.3 and 0.8% in 1st and 2nd season, respectively. The obtained data agreed with the findings of El-Gazzar and El-Kady (2000) on flax.

Generally, it can be suggested that biofertilizer phosphorein increased the solubility of phosphorous in soil and that may cause increase in growth and yield and consequently lead to increase oil in seeds of flax through the role played by phosphorus on the metabolic activities or biosynthesis of oil. In this respect, Hopkins (1999) reported that, phosphorus in the plant is found largely as phosphate esters-including the sugar phosphates which plays an important role in photosynthesis and intermediary metabolism.

As regard to the interaction between salinity and phosphorein application, the results indicate that, no significant difference could be detected by using phosphorein with full or half dose of p_2o_5 mineral fertilizer on oil percentage in the 1st and 2nd season. High values of oil percentage were recorded under 4000 ppm salinity level by using phosphorein combined with full dose of p_2o_5 with relative increase 9.6% when compared with corresponding control plants untreated with phosphorein at the same salinity level in the 2nd season. Similar finding were obtained by El-Shimy *et al.* (2001) on flax with using phosphorein. The authors mentioned that, the phosphorus beneficial for flax plants to increase growth, by means that it sharing in vital processes for plant and free energy with necessary for different vital function of metabolism in addition to quality and quantity of the yield under saline conditions. In this respect, it can be suggested that, the oil percentage increased by increasing salinity levels up to 4000 ppm but this increase was limited or within specific range, because at the higher level it begin to decrease. Moreover, Gates *et al* (1970) mentioned that, plant suffering from salt stress tended to absorb more phosphorous from the root medium Such plants usually exhibit high rate of respiration (salt or anion respiration) which requires considerable energy expenditure and phosphorous is usually required for the synthesis of metabolic disequilibrium.

Data in Table (4) indicate that, under saline or non-saline soil condition, there was a significant increase in oil percentage by using micronutrients fertilizers in the two successive seasons.

Under non-saline soil condition, oil percentage by using cotngein surpassed it by using foliafeed c with relative increase 5.9 and 6.7% by cotngein and 2.2 and 3.6% by using foliafeed when compared with control untreated plants, in the 1st and 2nd seasons, respectively. These results are in agreement with those obtained by Mostafa *et al.* (1998) and Hussien (2002) on flax. In this respect, Romheld and Marschner (1995) reported that, concentrations of chloroplast membrane constituents, glycolipids and polyunsaturated fatty acids, are reduced by up to 50% in Mn-deficient leaves. Also, the authors mentioned that, In seeds, the oil content may decrease and the composition change with Mn deficiency. It is not clear to what extent these effects of Mn on lipid metabolism are related to the function of Mn in the coupling of C_2 units of long-chain fatty acids. Cakmak and Marschner (1987) mentioned that, Zn-containing isoenzyme of SOD (Cu-Zn-SOD) plays an important role in the detoxification of superoxide radicals (O_2) and thus, in the protection membrane lipids and proteins against oxidation.

As regard to the interaction between salinity stress and micronutrients application the results reveal that there was insignificant increase due to using cotngein or foliafeed on oil seed percentage in the 1st and 2nd seasons. The mean values recorded with cotngein were increased by about 11.3 and 4.5% when compared with the mean values of control plants in the 1st and 2nd seasons, respectively. While, the mean values recorded with foliafeed C were increased by about 9.0 and 5.5% in the two seasons, respectively. It can be suggested that, using micronutrients either by cotngein or foliafeed C fertilizer in flax plant under salt stress increase oil percentage in flax. These may be due to the important role played by micronutrients in many physiological operations occurring in flax plants such as the formation of many enzymes responsible directly or in indirectly to oil synthesis. These results are in agreement with those reported by Moawed (2001).

Data in Table (4) reveal that, under non-saline soil condition GA_3 application brought about a significant increment in oil seed percentage in the 1st and 2nd seasons by about 6.9 and 7.0% respectively as compared with control-untreated plants. The obtained data agreed with the findings of Bahia *et al.* (1995) and El-Azzouni (2003) on flax.. In this respect, it can be suggested that, the enhancing effect of GA_3 foliar application on increasing oil percentage may be due to the effect of gibberellins on mevalonic acid pathway in which Acetyl CoA , fatty acids and gibberellins formed. This means that increasing GA_3 increased oil production in the plant. These results are confirmed by the investigations which were reported by Bewley and Black (1985), apRees (1990) and Hopkins (1999).

Moreover, it is clear from the results that, application of GA_3 seemed to be the best treatment to increase oil percentage under all salinity levels (2000, 4000 and 6000 ppm) with relative increase 17.2, 11.7 and 18.6% in the 1st season, respectively and by about 7.7, 9.9 and 12.0%, respectively in the 2nd season when compared with control corresponding GA3-untreated plants treated with the same level of salinity.

In this respect, it might be suggested that, salt stressed plants subjected to GA_3 application showed an increase in metabolic activities leading to the enhancement of sugars concentration (Hopkins, 1999), in which, sugars are considered as the precursor for the formation of oil. This mechanism includes the induction of metabolic activities that lead to the increase of Acetyl CoA production, which in turn converts into pyruvic acid that gives mevalonic acid as a result of its metabolism. Mevalonic acid is considered essential for the formation of isopropene that forms terpenes which is considered as the essential component of aromatic oils and GA_3. The obtained results are confirmed by finding of various investigators (Aldesuquy and Ibrahim, 2002).

Generally, it can be concluded that, the highest oil percentage was recorded by GA_3 followed by cotngein, phosphorein+ full dose of P_2O_5, phosphorein+half dose of P_2O_5,foliafeed C,while the lowest oil percentage was recorded by control-untreated plants.

2-3- Fatty acids composition:

The results obtained in Table (6) and Fig (1) show that linseed oil contained about 13-15% saturated fatty acids (Myristic, Palmitic, Stearic, Arachidic and Behenic) with palmitic acid being the principal saturated fatty acid followed by stearic acid. The unsaturated fatty acids levels (Palmitoleic, Oleic, Vaccenic, Linoleic, Linolenic and Eicosenoic) was about 84-87% of the total fatty acids, with linolenic acid (omega 3) comprising more than 40% of the total unsaturated fatty acids, followed by oleic and linoleic acids (omega 6). These results are confirmed by the investigations which were reported by Kulkarni *et al.* (1998) who reported that, the major fatty acids in flax seeds were linolenic, linoleic, oleic, palmitic and stearic acids.

It is clear from data that, increasing salinity levels brought about a slight increase in total saturated fatty acids, while reduced slightly total unsaturated fatty acids and total fatty acids. Similar results were reported by Gaballah and Abou-Leilah (2000) and Rawya (2001) on flax.

In this respect, Kheir *et al.* (1991 b) mentioned that high salinity increased the proportion of saturated fatty acids and decreased unsaturated fatty acids in flax seed oil. They suggested that, the increase in saturated fatty acids in oil percentage might be induced due to an increase in the number of oil glands per unit area Higher specialized structures containing secretory and accumulatory elements (oil cells, glandular trichomes, oil or resin ducts, or a glandular epidermis) were probably stimulated as a method of protection against salinity hazards.

El-Gayar (1988) established that, long-chain fatty acids are subjected to oxidative degradation to produce acetyl coenzyme A. This might partially explain the decrease in the unsaturated fatty acids all of them have long chain, in response to increasing salinity. Meanwhile, relatively short chain saturated fatty acids showed a reverse response to increasing salinity. This might be due to the conversion of unsaturated fatty acids to saturated ones under salt stress The increase in acetyl CoA assumed to be due to oxidation of long-chain fatty acids under salinity might be oxidized to CO_2 *via* the B-oxidation and TCA cycle.

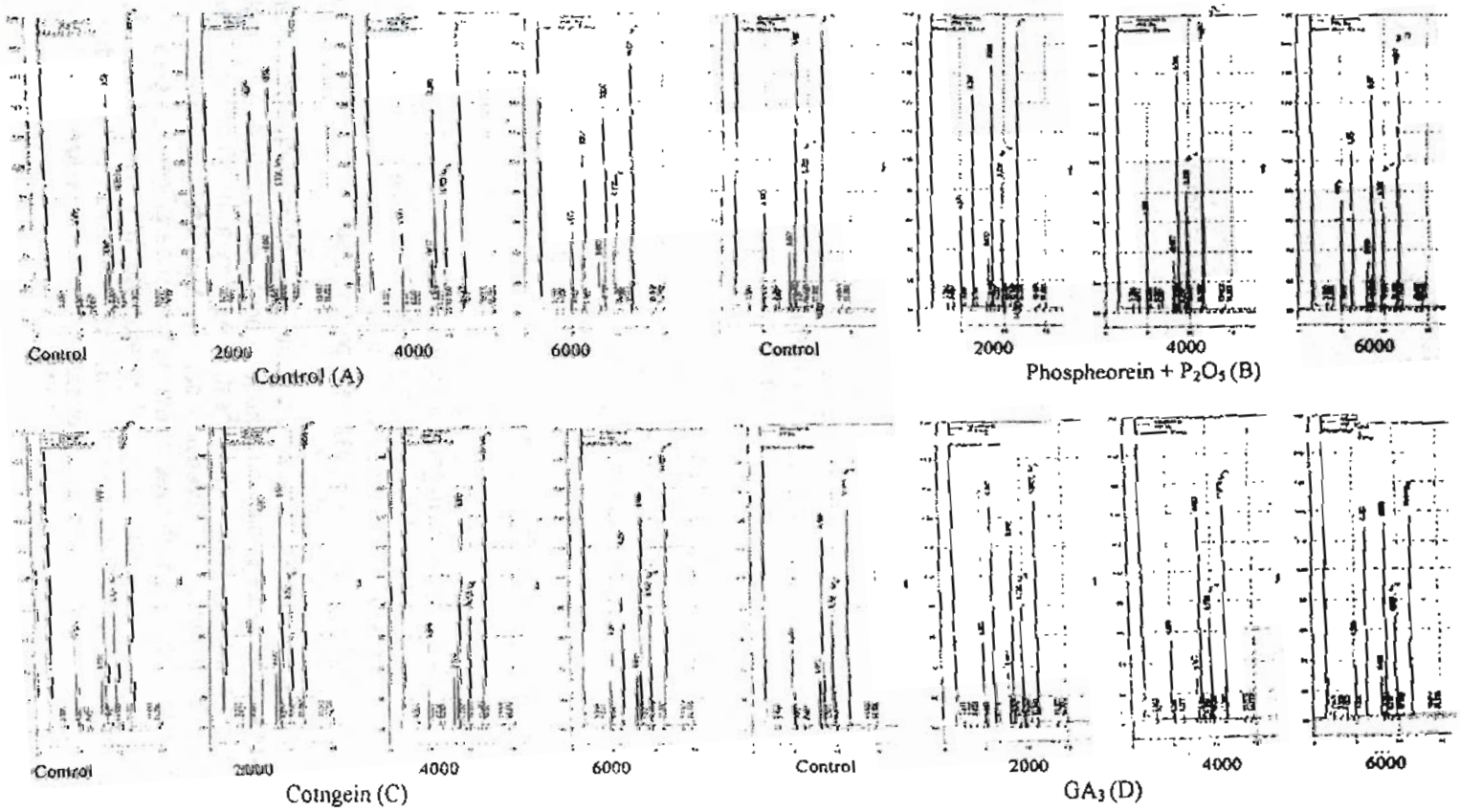

Fig (1): Fatty acid composition in linseed oil as affected by phosphorein , cotngein and GA_3 under different level of salinity (0, 2000, 4000 and 6000 ppm) in the second season

Table (6): Saturated, unsaturated and total fatty acid percentage in the flax seed oil as affected by different levels of salinity as well as phosphorein cotngein, GA_3 and foliafeed C 2001-2002 season.

Salinity levels (ppm)	Fatty acids / Treatment	Saturated Fatty Acids						Unsaturated Fatty Acids							Total Fatty Acids
		Myristic	Palmitic	Stearic	Arachidic	Behenic	Total Saturated Fatty Acids	Palmitoleic	Oleic	Vaccenic	Linoleic (w_6)	Linolenic (w_3)	Eicosenoic	Total Unsaturated Fatty Acids	
Control	Control	-	6.6	6.2	0.3	0.2	13.3	0.1	26.0	0.7	15.9	43.9	0.1	86.7	100.0
	Phosphorein+P_2O_5	0.1	6.5	6.3	0.3	0.2	13.4	0.1	27.1	0.8	15.8	42.1	0.1	86.0	99.4
	Phosphorein +0.5 P_2O_5	0.1	6.7	6.1	0.3	0.3	13.5	0.2	28.3	0.7	15.7	41.0	0.1	86.0	99.5
	Cotngein	0.1	6.6	6.3	0.3	0.2	13.5	0.1	27.3	0.8	16.3	41.4	0.1	86.0	99.5
	GA_3 (0.1g/l)	0.1	6.9	6.0	0.3	0.2	13.5	0.2	28.0	0.8	16.2	41.2	0.1	86.5	100
	Foliafeed C (0.7 g/l)	0.1	6.9	6.0	0.3	0.2	13.5	0.2	28.7	0.8	16.1	40.1	0.1	86.0	99.5
	Mean	0.1	6.7	6.2	0.3	0.2	13.5	0.2	27.6	0.8	16.0	41.6	0.1	86.2	99.7
2000	Control	-	6.7	6.1	0.3	0.2	13.3	0.1	25.2	0.8	17.5	43.0	0.1	86.7	100
	Phosphorein+P_2O_5	0.1	6.8	6.4	0.3	0.2	13.8	0.1	26.9	0.8	17.0	40.4	0.2	85.4	99.2
	Phosphorein +0.5 P_2O	0.1	6.9	6.3	0.3	0.2	13.8	0.1	26.8	0.8	17.5	40.1	0.1	85.4	99.2
	Cotngein	0.1	6.8	6.2	0.3	0.2	13.6	0.1	27.6	0.8	17.6	40.2	0.1	86.4	100.0
	GA_3 (0.1g/l)	0.1	7.0	6.3	0.3	0.2	13.9	0.2	27.0	0.8	17.0	40.6	0.1	85.7	99.6
	Foliafeed C (0.7 g/l)	0.1	7.1	6.2	0.3	0.2	13.9	0.2	27.1	0.8	17.9	40.0	0.1	86.1	100
	Mean	0.1	6.9	6.3	0.3	0.2	13.7	0.1	26.8	0.8	17.4	40.6	0.1	85.8	99.5
4000	Control	0.1	6.7	6.1	0.3	0.2	13.4	0.2	25.0	0.8	17.4	42.0	0.2	85.6	99.0
	Phosphorein+P_2O_5	0.1	7.0	6.5	0.3	0.2	14.1	0.2	26.6	0.8	17.3	40.0	0.2	85.1	99.2
	Phosphorein +0.5P_2O_5	0.1	7.1	6.4	0.3	0.2	14.1	0.2	26.3	0.8	17.4	40.0	0.2	84.9	99.0
	Cotngein	0.1	7.0	6.1	0.3	0.2	13.7	0.2	26.9	0.7	17.4	40.1	0.2	85.5	99.2
	GA_3 (0.1g/l)	0.1	7.1	7.0	0.4	0.2	14.8	0.2	25.9	0.7	17.8	40.4	0.2	85.2	100.0
	Foliafeed C (0.7 g/l)	0.1	7.1	7.0	0.3	0.2	14.7	0.2	26.5	0.7	17.7	40.0	0.2	85.3	100
	Mean	0.1	7.0	6.5	0.3	0.2	14.1	0.2	26.2	0.8	17.5	40.47	0.2	85.4	99.5
6000	Control	0.1	7.1	6.3	0.3	0.2	14.0	0.2	24.9	0.8	17.2	41.8	0.2	85.1	99.1
	Phosphorein+P_2O_5	0.1	7.3	6.6	0.3	0.2	14.5	0.2	26.5	0.8	17.2	39.8	0.2	84.7	99.2
	Phosphorein +0.5P_2O_5	0.1	7.3	6.5	0.3	0.2	14.4	0.2	26.3	0.8	17.3	39.8	0.2	84.6	99.0
	Cotngein	0.1	7.1	6.4	0.3	0.2	14.1	0.2	29.2	0.7	16.3	39.1	0.2	85.7	99.8
	GA_3 (0.1g/l)	0.1	7.2	7.1	0.3	0.2	14.9	0.2	25.6	0.7	17.5	39.9	0.2	84.1	99.0
	Foliafeed C (0.7 g/l)	0.1	7.2	7.1	0.3	0.2	14.9	0.2	26.0	0.7	17.3	39.7	0.2	84.1	99.0
	Mean	0.1	7.2	6.7	0.3	0.2	14.5	0.2	26.4	0.8	17.1	40.0	0.2	84.7	99.2

The latter assumption might be supported by the fact that plants under salt stress usually have high rate of respiration which is known as "anion or salt respiration". Therefore, it is possible that one or both of the above mentioned assumptions are effective to explain the responses of fatty acids to salinity.

Data in Table (6) reveal that, under saline or non-saline soil condition, phosphorein application with full or half dose of P_2O_5 resulted in a relative increase in total saturated fatty acids but slight decreased in total unsaturated and total fatty acids when compared with control phosphorein untreated plants. These results are in agreement with those reported by Asghar *et al.* (2002). Rai *et al.* (1993) revealed that, linolenic acid content had a high positive direct effect on oil content under normal levels of fertility.

Moreover, it is clear from the results that, under 2000 ppm salinity level, linolenic acid "omega 3" unsaturated fatty acid was increased by about 0.75% with using phosphorein combined with the full dose of P_2O_5 when compared with the application of phosphorein combined with half dose of P_2O_5.

Results in Table (6) and Fig. (1,C) indicate that, under saline and non-saline soil condition, slight increase in total saturated fatty acids and decrease in total unsaturated and total fatty acids were detected by using cotngein (as a seed coated) or foliafeed C (as foliar application) micronutrients compound fertilizers when compared with control plants untreated with micronutrients application, with relative increase 1.5% in total saturated fatty acids by application of cotngein or foliafeed C under non saline soil condition. Also, it is noticed from the data that, under non-saline soil condition cotngein was surpassed foliafeed C in linoleic "omega 6" and linolenic "omega 3" percentage by about 1.24% and 3.2%, respectively. In this respect, Wilson *et al.* (1982) found that, manganese has a role on the fatty acid composition of the oil; also, manganese markedly altered the content of linoleic acid. Nagavathna *et al.* (1992) mentioned that, iron is essential constituent of many enzymes, lipoxygenases are enzymes which catalyze the peroxidation of linoleic and linolenic acids, and the increase in lipoxygenase activity is typical for fast growing tissue. Hopkins (1999) reported that, iron appears to catalyze both the initiation and propagation stages of lipid peroxidation Also, the author mentioned that, copper is patent catalyst of lipid oxidation. While, Hussien (2002) pointed out that, unsaturated fatty acids (linolenic acid) of flax seeds were increased with application of microelements.

Generally, it can be suggested that, micronutrients application by using cotngein or foliafeed C increased some fatty acids in flax seed oil, this is may be due to the important role played by some micronutrients on many enzymes which catalyze or altered the content of some fatty acids, specially linoleic acid (ω_3) or linolenic acid (ω_6). Moreover, the results reveal that high values of total fatty acids and total unsaturated fatty acids were recorded under 6000 ppm salinity level by using cotngein as well as total fatty acids under 4000 ppm salinity level by using cotngein or foliafeed C when compared with corresponding plants untreated with micronutrients at the same level of salinity. In this respect, Rawya (2001) reported that. the increase in iron under saline stress may be paralleled to the increase in saturated fatty acids content and higher oil in flax seeds.

Concerning the effect of GA_3 foliar application of the rate of 100 ppm on fatty acids percentage, It is clear from the results in Table (6) and Fig. (1, D) that, under saline and non-saline soil conditions, there was slight increase in total saturated fatty acids. In this respect, under non–saline soil condition, the increase in saturated fatty acids reach to about 1.5% due to using GA_3 foliar application at the rate of 100 ppm when compared with control GA_3- untreated plants. Moreover, the results reveal that GA_3 application caused increase in the percentage of palmitic, oleic and linoleic acids with relative increase 4.5, 7.7 and 1.9%, respectively when compared with control untreated plants with GA_3. In this respect, Bahia *et al.* (1995) pointed out that, application of GA_3 to flax increased linolenic acid content.

However, linoleic, oleic and palmitic acids were decreased. Stearic acid was decreased with GA_3. Thus, it can be suggested that GA_3 foliar application increased some fatty acid in flax seed oil. This may be due to the role played by GA_3 to promote biosynthesis of Acetyl CoA which is the precursor of fatty acid and isoperonids which a precursor unit for biosynthesis of gibberellins.

As regard to the interaction between salinity and GA_3 foliar application, the data reveal that GA_3 caused an increase in total saturated fatty acids percentage and this increase mainly from the increase in palmitic and stearic acids with relative increase 4.5 and 3.3% under 2000 ppm, 7.5 and 14.6% under 4000 ppm and 1.4 and 12.7% under 6000 ppm, respectively when compared with corresponding plants untreated with GA_3 at the same level of salinity. Moreover, the results reveal that, on GA_3 foliar treated plants, oleic and linoleic (omega 6) acids were increased under all salinity levels, except linoleic acid under 2000 ppm. On the other hand, the percentage of linolenic acid (omega 3) generally decreased by GA_3 treated plants under all salinity levels when compared with corresponding plants untreated with GA_3 under the same level of salinity.

The aforementioned results may be attributed to the stimulatory effect of GA_3 for the biosynthesis of the constituents of some fatty acid in flax seed oil, i.e. linoleic acid (ω_6) which has a therapeutic application as mentioned previously.

Generally, it can be suggested that, under different treatments these changes in the fatty acid constituents occurring by several characterizations i.e., by increasing, decreasing or disappearing could be considered as a method for protection plants against salinity stress injuries. The highest percentage of total saturated fatty acid of flax oil under salt stress was recorded by using GA_3 foliar application followed by foliafeed c, phosphorein with full or half dose of P_2O_5, and then cotngein, while the lowest total saturated fatty acid was recorded by control untreated plants.

REFERENCES

A.O.A.C. (2000). Official Methods of Analysis of the Association of Official Analytical Chemists. 17 Ed. 969 3 and 991.39 Fatty Acids in Oils and Fats preparation of Methyl Esters Boron Trifluoride-AOAC-IUPAC Method Codex-Adopted-AOAC Method. Chapter 41, p.19:2.

Abd El-Karim, H (1996). Studies on tolerance of some grape Vine cultivars to stress. Ph. D. Thesis, Fac. Agric. Cairo Univ., Epypt.

Abd El-Lateef, E.M.; M.M. Selim and T.G. Behair (1998). Response of some oil crops to biofertilization with phosphate dissolving bacteria associated with different levels of phosphatic fertilization. Bull. NRC, Egypt, 23(2):193-202.

Abo El-Saod, I.; A. Momtaz and M. Mansour (1975). Effect of foliar application with $ZnSO_4$ and GA_3 on growth and yield of flax crop. Fibra, 20 (2):42-50.

Aldesuquy, H.S. and A.M. Gaber (1993). Effect of growth regulators on *Vicia faba* plants irrigated by sea water, leaf area, pigment content and photosynthetic activity. Biol. Plant., 35 (4) : 519-527.

Aldesuquy, H.S. and A.H. Ibrahim (2002). Water relations, abscisic acid and yield of wheat plants in relation to the interactive effect of sea water and growth bioregulators. Agrochimica, 46 (5): 190-201.

apRees, T. (1990). Carbon metabolism in mitochondria. In: D.T. Dennis, D.H. Turpin (eds.), Plant Physiology, Biochemistry and Molecular Biology. Essex: Longman Scientific and Technical, PP.106-123.

Apte, R. and S.T. Shende (1981). Studies on *Azotobacter chroococum* and their effect on crop yield. Zbl. Bakt. II., 136:637-640.

Asghar, A.; H. Mumtaz; T. Asif; M.A. Nadeem and T. Haq (2002). Effect of different levels of phosphorus on seed and oil yield of two genotypes of linseed (*Linum usitatissimum* L.).Pakistan J. Agric. Sci.,39 (4):281-282.

Bahia, A.A.; M.N. El-Shourbagy and R.A. El-Naggar (1995). Effect of IAA and GA_3 on flax (*Linum usitatissimum* L.). Seed yield and their metabolic constituents. Egypt. J. Bot., 35 (1): 1-9.

Beke, G.J. and D.P. Graham (1995). Growth and chemical composition of flax cultivars on artificially salinized soil. Canadian Journal of Plant Science. 75 (1): 159-162.

Bewley, J.D. and M. Black (1985). Seeds. Physiology of Development and Germination. New York, Plenum Press.

Bhattachajee,A.K.; B.N. Mittra and P.C. Mitra (2000). Seed agronomy of Jute. III. Production and quality of *Corchorus olitroius* L. seed as influenced by growth regulators. Seed Sci. & Technol., 28: 421-436.

Black, C.A. (1982). Methods of Soil Analysis. Part 2. American Society of Agronomy, Inc, Publisher, Madison, Wisconsin, USA.

Cakmak, I. and H. Marschner (1987). Mechanism of phosphorus-induced zinc deficiency in cotton. III. Changes in physiological availability of zinc in plants. Physiol. Plant., 70: 13-20.

Cottenie, A.; M. Verloo; L. Kiekens; G. Velghe and R. Camerlynck (1982). Chemical Analysis of Plants and Soils, Laboratory of Analytical and Agrochemistry, State Univ., Ghent–Belgiun, pp. 14-24.

Dey, A. and P.C. Lama (2000). Effect of penicillin and GA_3 on maintenance of vigour and viability of few crop seeds under storage conditions. J. of Hill Research, 31 (1): 19-23.

El-Agrodi, M.W.; H.A. El-Fadaly; H.A. Shams El-Din and A.M. El-Shehawy (2003). Effect of phosphorus fertilization and grains inoculation with phosphate dissolving bacteria on microbiology of rhizosphere, wheat yield and yield components. J. Agric. Sci. Mansoura Univ., 28 (8): 6353-6369.

El-Azzouni, A.M. (2003). Effect of pulling date and foliar application of microelements and gibberellic acid on yield and its components of flax. J. Agric. Sci. Mansoura Univ., 28 (8): 5903-5913.

El-Bagoury, H.A; Y.A. Hossni; A. El-Tantawy; M. Shehata and R. Asmaael (1999). Effect of saline water irrigation on growth and chemical composition of (*Casuarina equisetifolia* L.) seedlings. Egypt. J. Hort., 26 (1): 47-57.

El-Fadaly, H.A.; M.W. El-Agrodi; H.A. Shams El-Din and A.M. El-Shehawy (2003). Effect of phosphorus fertilization and seeds inoculation with phosphate dissolving bacteria on microbiology of rhizosphere, faba bean yield and yield components. J. Agric. Sci. Mansoura Univ.,28(8): 6371-6388.

El-Gayar,S.H.(1988). Effects of salinity and fertilizer treatments on growth, chemical composition and yield of flax plant. Ph.D. Thesis, Fac. of Agric., Cairo Univ., Egypt.

El-Gazzar, A.M. (2000). Effect of nitrogen rates and some N-Biofertilizer sources on growth, yield and quality of flax. Alex. Sci. Exch., 21(4): 281-292.

El-Gazzar, A.M. and E.A.F. El-Kady (2000). Effect of nitrogen levels and foliar application with Nofatrin, Citrin, Potassin and Ascopin on growth, yield and quality of flax. Alex. J. Agric. Res., 45(3):67-80.

El-Khateeb, M.A.; E.M. Badawy and N.A.E. Boselah (1991). Effect of some growth regulators on growth, chemical composition and essential oil of *Ruta graveolens*. Bull. Fac. of Agric., Cairo Univ., 42 (3): 829-848.

El-Shimy, G.H.; S.H.A. Mostafa and E.A. Moawed (2001). Effect of mineral and Biophosphorus fertilization on productivity and quality of Sakha 1 and Giza 8 flax varieties. Egypt. J. Appl. Sci., 16(8): 138-152.

El-Sweify, A.H.H. (1989). Physiological studies on the effect of some growth regulators on growth and yield of flax. M.Sc. Thesis, Fac. Agric., Menufiya Univ.

El-Sweify, A.H.H.; Sh.M. Abd El-Rasoul; A.M.A. El-Azzouni and M. Haniat, El-Nimr (2003). Comparative studies on mineral and bio-fertilization for some jute cultivar in some different soils. J. Agric. Sci. Mansoura Univ., 28 (2): 1545-1556.

Fatma, A. Abdo (2003). Effect of biofertilizer with phosphate dissolving bacteria under different levels of phosphorus fertilization on mungbean plant. Zagazig. J. Agric. Res., 30 (1):187-211.

Feihu, L.; X.N. Liang; N.G. Zhang; Y.S. Huang and S.W. Zhang (2000). Effect of growth regulators on yield and fiber quality in ramie (*Boemheria nivea* (L.) Guad.) China grass. Field Crops Research, 69: 41-46.

Gaballah, M.S. and B. Abou Leilah (2000): The response of flax plant grown under saline condition to gypsum application in addition to kaolin spray. Egypt. J. Appl. Sci., 15 (1): 316-331.

Gates, C T.; K.P. Haydock and M.F. Robens, (1970). Response to salinity in Glycine: 4. Salt concentration and the content of phosphorus, potassium, sodium and chloride in cultivars of *Glycine wightii* (*G. javanica*). Aust. J. Exp. Agr. Anim. Husb., 10: 99-110.

Gherroucha, H.; Djkoun, A.; Fercha, A. and Baka, M. (2003). Response of growth and yield of wheat plant growth under variant salinity regimes to growth regulators (indole acetic acid, gibberellic acid, kinetin) by seed-soaking. Arab Universities J. of Agric. Sci., 11 (2): 455-468.

Ghoniem, A.E. (2004). Effect of gibberellic acid (GA_3) and 2,4-D on growth and yield of flax. M.Sc. Thesis, Fac. Agric., Cairo Univ., Egypt.

Grant, C.A. and L.D. Bailey (1997). Effects of phosphorus and zinc fertilizer management on cadmium accumulation in flaxseed. J. of the Sci. of Food and Agric., 73 (3): 307-314.

Hanafy Ahmed, A.H.; M.A. Higazy; Y.H. El-Shafey and S.F. Moussa (2002). Effect of salinity, silicon and proline on the growth, yield and chemical composition of wheat plant. Proceedings of the 2nd Congress on Recent Technologies in Agric., Fac. Agric., Cairo Univ., 28-30 October, pp. 965-978.

Hanafy Ahmed, A.H.; N.F. Kheir and N.B. Talaat (1997). Physiological studies on reducing the accumulation of nitrate in jew's mallow (*Corchorus olitrius*) and radish (*Raphanus sativus* L.). Bull. Fac. Agric., Cairo Univ., 48:25-64.

Hanafy Ahmed, A.H.; M.H. Rashad and M.Kh. Khalil (1996). Effect of foliar application of boron and manganese on *Vicia faba* plants. J. Agric. Sci. Mansoura Univ., 21(11):3911-3925.

Hopkins, G. (1999). Introduction to Plant Physiology. John Wily and Sons, Inc., New york, pp. 202-210.

Horwitz, W.; A.H. Robertson; H.J. Fisher; E.A. Epps; F.W. Quackenush and H. Reynolds (1965). Official Methods of Analysis of the Association of Official Agricultural Chemists. Washington A.O.A.C.

Hussien, M.M. (2002). Effect of some fertilization treatments and harvesting dates on yield and yield quality of flax under new reclaimed lands conditions. Ph. D. Thesis., Fac. Agric., Suez Canal Univ., Egypt.

Ibrahim, M.E.; A.E. Moftah and A.A. Gendy (1995). Growth, flowering abscission, endogenous hormones, yield of broad bean (*Vicia faba* L.) as affected by tebepas and zinc. Zagazig J. Agric. Res., 22 (1): 79-104.

Kheir, N.F.; E.Z. Harb; H.A. Moursi and S.H. El-Gayar (1991 a). Effect of salinity and fertilization on flax plants (*Linum usitatissimum* L.) 1- Growth, yield and technical properties of fiber. Bull. Fac. of Agric., Univ. of Cairo, 42 (1):39-56.

Kheir, N.F.; E.Z. Harb; H.A. Moursi and S.H. El-Gayar (1991 b). Effect of salinity and fertilization on flax plants (*Linum usitatissimum* L.). II. Chemical composition. Bull. Fac. of Agric., Univ. of Cairo, 42 (1): 57-70.

Kolodziejczyk, P.; P. Fedec; D. Kozłowska and R. Kozlowski (1995). Linseed in health food and nutrition. Zemedelska Technika, 41 (3): 113-116.

Kulkarni, A.S.; R.R. Khotpal and H.A. Bhakare (1998). Glycolipids composition of some Indian linseed varieties. Journal of Food Science and Tecnology (M.Y Sore), 35 (3): 245-246.

Madlain, M.; R.N. Salib; R.N. Zaki and M.A. Negm (2002). A comparative study on the significance of applied farmyard manure and other affording materials for barley grown on a saline soil. Zagazig J. Agric. Res., 29 (4): 1185-1198.

Maiti, S.; C.C. Das; B.N. Chatterjee and K. Sengupta (1988). Response of greengram and lentil of Rhizobium inoculation. Indian J. Agron.,33(1):92-94.

Mishra, J. and R.S. Singh (1996). Fffect of nitrogen and zinc on the growth and uptake of N and Zn by linseed. J. Indi. Soc. Soil,44(2) :338-340.

Moawed, E.A. (2001). Effect of microelements and row distances on the yield of some flax (*Linum usitatissimum* L.).Egypt.J. Appl.Sci.,16(6):157-172.

Moorby, J. and R.T. Besford (1983). Mineral nutrition and growth. In: Encyclopedia of Plant Physiology, New Series Volume 15 A. Inorganic Plant Nutrition. Springer Verlag, Berlin Heidelberg New York, Tokyo.

Mostafa, S.H.A.; M.E.A. Kineber and S.Z. Zedan (1998). Effect of phosphorus fertilization levels and some microelements on flax yield and quality. Egyptian J. Agric. Res., 76 (1): 163-173.

Nagavathna, K.C.; A. Shetty; S.G. Bhat and H.S. Shetty (1992). The possible involvement of lipoxygenase in downy mildew resistance in pearl millet. J. Exp. Bot., 43: 1283-1287.

Nemet Alla, M.M.A. (1986). Studies on flax metabolism in germinating seeds. M. Sc. Thesis, Mansoura Univ., Egypt.

Nornai, R. (1982). Formula for determination of chlorophyllus pigments extracted with N.N dimethyl formamide. Plant Physiol. , 69:1371-1381.

Osman, A.O ; M.H. Hegazy and S. Ghaly (1990). The effect of seed coating with certain micronutrients on the yield of faba bean. Agric. Res. Review, 70 (3): 693-702.

Rai, M ; S.A. Kerkhi; P.A Naqvi; S. Pandey and A.K. Vashishtha (1993). Path analysis for quality components in linseed (*linum usitatissimum L.*) Indian Journal of Genetics & Plant Breeding, 53(4) 381-386.

Rao, V.U. and A.S. Rao (1993). Dual inoculation of VAM and Rhizobium in blackgram and greengram. Legume Research, 16 (3-4): 119-126.

Rawya A.E., Eid (2001). The influence of some environmental conditions on the productivity and quality of flax fiber and seed. Ph.D. Thesis, Fac. of Agric., Cairo Univ., Egypt.

Romheld, V. and H. Marschner (1995). Functions of micronutrients in Plants. In: Micronutrients in Agriculture 2nd ed. (J.J. Mordvedt, F.R. Cox, L.M. Shuman and R.M. Welch, eds), pp. 297-328. SSSA Book Series, No., 4. Madison, WI, USA.

Saber, M.S.M. and M.O. Kabesh (1990). Utilization of biofertilizers in field crop production, II. A comparison study on the effect of biofertilization or sulphur application on yield and nutrients uptake by Lentil plants. Egypt. J. Soil Sci. , 30(3):415-422.

Saber, M.S.M.; M.K.A. Ahmed and M.O. Kabesh (1998). Utilization of biofertilizers in field crop production II. Yield response and chemical composition of barley. Proc 8th Conf. Agron. , Suez Canal Univ. , Ismailia, Egypt, 28-29 Nov.

Sendecor, G.W. and W.G. Cochran (1980). Statistical Methods. Oxford and J.B.H. publishing com. 7th edition. The Iowa State Univ. Press. Ames, Iowa, U.S.A.

Sing, G and H. Singh (1980). Effect of growth regulators on the growth parameters of chickpea *(Cicer arietinum)* grown under different salinity levels. Indian J. Agric. Sci., 50 (1) . 23-29.

Singh, A.K. and B.B. Singh (1991). Genotypic variability in biomass protein and nucleic acids in four linum species to sodicity stress. Journal of Agronomy and Crop Science, 167 (1): 1-7.

Sobh, M.M.; S. Genaidy and M. Hegazy (2000). Comparative studies on mineral and biofertilization for some main field crops in northern delta soils. Zagazig, J. Agric. Res., 27 (1): 171-179.

Stivesev, M.V.; S.A. Ponnamoreva and E.A. Kuzenstova (1973). Effect of salinization and herbicides on chlorophyllase activity in tomato leaves. Fiziol. Rast., 20: 62-65.

Strogonov, B.P.; V.V. Kabanov;L.P.Lapina and L.S. Prykhodko (1970). Structure and function of plant cells under salinity.Moscow,Nauka, Russia.

Thingstrup, I.; G. Rubaek; E. Sibbesen and I. Jakobsen (1998). Flax (*Linum usitatissimum* L.) depends on arbuscular mycorrhizal fungi for growth and P uptake at intermediate but not high soil P levels in the field. Plant and Soil, 203 (1): 37-46.

Wilson, D.O.; F.C. Boswell; K. Ohki; M.B. Praker; L.M. Shuman and M.D. Jellum (1982). Changes in soybean seed oil and ploYrin as influenced by manganese nutrition. Crop Sci., 22: 952-984.

Zaky, L.M. (1985). Effect of certain chemicals on the physiology of *Linum usitatissimum* L. plant. Ph. D. Thesis, Fac. of Sci. Ain shams Univ., Egypt.

تأثير الملوحة والفوسفورين والعناصر الصغرى والجبريللين على النمو ومحصول البذور والصفات الكيماوية لنبات الكتان

أحمد حسين حنفي أحمد، محمد خليل خليل الدعدع، عقيلة صالح حمزة * ، شيرين عباس صادق
فرع فسيولوجيا النبات- قسم النبات الزراعي- كلية الزراعة- جامعة القاهرة - مصر
*** المعمل المركزي للأغذية و الاعلاف - مركز البحوث الزراعية - الجيزة - مصر**

أجريت تجربة اصص بالصوبة السلكية التابعة للمعمل المركزي للاغذية و الاعلاف التابع لمركز البحوث الزراعية بالجيزة خلال موسمي ٢٠٠٠ - ٢٠٠١، ٢٠٠١-٢٠٠٢ لدراسة مدي تحمل نباتات الكتان لمستويات مختلفة من الملوحة (صفر، ٢٠٠٠، ٤٠٠٠، ٦٠٠٠ جزء في المليون) الناتجة من استخدام كل من كلوريد الصوديوم ، كلوريد الكالسيوم و كبريتات ماغنسيوم بنسبة ٢ : ٢ : ١. كذلك لدراسة تأثير المخصب الحيوي الفوسفورين (١٠ جم/ كجم بذرة مع التسميد الموصي به من سماد السوبر فوسفات و كذلك مع نصفه) الكوتنجين (١٥ جم/ كجم بذرة) ، الفولياقيد ج (٠,٧ جم/ لتر) كعناصر صغري، كذلك استخدام منظم النمو الجبريللين بمعدل ١٠٠ جزء في المليون و كذلك لتقليل الآثار الضارة الناتجة من الملوحة علي النمو و محصول البذور و الصفات الكيماوية لنبات الكتان. و قد أظهرت النتائج ان زيادة الملوحة أدت الي انخفاض في معظم صفات النمو و المحصول المدروسة (ارتفاع النبات، الوزن الجاف للجذور و السيقان و الاوراق و كذلك النبات الكامل، عدد الكبسولات / نبات، عدد البذور / كبسولة، عدد البذور / نبات و محصول البذور) و كذلك تركيز كل من كلورفيل أ، ب ، الكلوروفيلات الكلية و نسبة الزيت و الاحماض الدهنية الغير مشبعة بينما زاد عدد الاوراق و مساحة الاوراق / نبات زيادة معنوية بزيادة مستويات الملوحة الي ٤٠٠٠ جزء في المليون الا أنها انخفضت بعد ذلك. علي الجانب الآخر تفوقت المعاملة بالفوسفورين مع التسميد المرصي به عن المعاملة بالفوسفورين مع نصف التسميد الفوسفاتي علي النمو و المحصول و الصفات الكيماوية تحت الظروف الملحية و غير الملحية. كذلك تفوق مركب الكوتنجين كمغلف للتقاوي عن مركب الفولياقيد - رشا علي المجموع الخضري بالعناصر الصغري في معظم صفات النمو و المحصول و الصفات الكيماوية تحت الظروف الملحية و غير الملحية بالاضافة الي ان استخدام الجبريللين بمعدل ١٠٠ جزء في المليون قلل من التأثير الضار للملوحة علي النمو و المحصول و الصفات الكيماوية.