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EFFECT OF SALINITY, PHOSPHOREIN, MICRONUTRIENTS AND GA_3 ON GROWTH, FIBRE YIELD AND CHEMICAL COMPOSITION OF FLAX PLANT.

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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 seeds (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, fibre yield and chemical composition of flax plant. The obtained results indicated that, increasing salinity levels decreasesd most of the studied characters (shoot height, dry weights of roots, stems, leaves as well as whole plant, technical length, stem diameter, number of apical branches, straw and fibre yield/plant) as well as total essential, non-essential and total amino acid, crude protein, N and K. While, total sugars, some amino acids (proline, arginine and histidine), total soluble phenols as well as P, Ca, Mg and Na increased by increasing salinity levels. 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, fibre yield and chemical composition under saline or non-saline soil conditions. Moreover, cotngein seed coated surpassed foliafeed C foliar application on the most of the studied growth, fibre yield characters as well as chemical composition under saline or non-saline soil conditions. Furthermore, GA_3 at the rate of 100 ppm improved, to extent, the negative effect of salinity on flax growth, fibre yield and 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).

Long fibre flax use in textiles and linen industry. In Canada and North America short fibre used for producing special type of paper and automotive industry by composites from natural fibres which blended with polypropylene. Salinity is considered as a significant factor affecting crop production and agricultural sustainability in many regions of the world as it reduces the value and productivity of the affected land.

Some soil microorganisms could improve P-uptake and increase salinity tolerance by different field crops (El-Aggory *et al.*, 2001). 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 among which salinity stress (El-Gazzar and El-Kady, 2000 and El-Sweify *et al.*, 2002). 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 (El-Shourbagy *et al.*, 1995 and Ghoniem, 2004) as well as to support the plants against salinity stress (Aldesuquy and Ibrahim, 2002).

Thus, the aim of this present study was 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 experiment was 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 investigation.

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	1.3
Calcium carbonate%	2.30	SO_4^{--} meq/l	3.5
pH	7.7	Cl^- meq/l	3.4

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 the Ministry of Agriculture(70 Kg N,100 Kg P and 50KgK/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 planting, 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 1:1:0.5 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) fertilizer. 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 from 35 days of planting. The sixth group of pots was 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 and 4% Zn in chelated form on EDTA as well as 4% Mn, 0.5% Cu, 0.5% B, 0.5% Mg, 0.02% Mo on 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- Shoot height (cm). 2- Dry weight (g) of leaves, stems and roots as well as whole plant.

Ethanol extract of shoots and roots were used for the determination of total sugars and total soluble phenols. Total sugars were determined in the ethanolic extract by using the phenol sulphuric acid reagent according to Dubois *et al.* (1956). Total soluble phenols were determined by using the colorimetric method of folin-ciocalteu as described by Swain and Hillis (1959). Determination of different elements (N, P, K, Ca, Mg and Na) were determined in the dried matter of shoots and roots in the two successive samples. The dry matter was digested in a mixture of sulphuric and perchloric acids according to Piper (1947). For the determination of total nitrogen the modified "Micro Kjeldahl" apparatus of Parnas and Wagner as described by Pregl (1945) was used. The crude protein percentage was obtained by multiplying the percentage of total nitrogen by 6.25. Phosphorus was determined colorimetrically using the chlorostannous reduced molybdophosphoric blue colour method as described by Jackson (1973). The determination of K, Ca, Mg and Na was carried out by using Atomic Absorption Spectrophotometer,D.P3300 Perken Elemer.

Individual and total amino acids percentage were determined in shoot of two samples, according to the method described by Widner and Eggum (1966). Oxidation was carried out by using performing acid, to protect methionine and cysteine from destruction during acid hydrolysis, following acid hydrolysis in the oven at 110 °C for 24 hours. High performance amino acid analyzer, Beckman 7300 was used for amino acid determination.

At maturity (150 days from sowing) the flax plants were harvested and the following characters were determined: 1- Shoot height (cm). 2- Technical length (cm). 3- Number of apical branches/plant 4-Main stem diameter (mm). 5- Straw yield/plant (g). 5- Fiber yield/plant (g):was determined after retting process.

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 Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1- Growth and fibre yield characters

It is clear from the result in Tables (2, 3 and 4) that there was significantly and gradually decreases in all the studied growth and fibre yield characters (shoot height, dry weights of roots, stem, leaves and the whole plant in the two successive samples as well as shoot length, technical length, stem diameter, number of apical branches/plant, as well as straw and fiber yield/plant) with increasing salinity level.

Many workers suggested that the harmful effect of salts on plant growth may be attributed to high osmotic pressure of soil solution which restricts the absorption of water by plant roots and/or to the toxic effects of certain ions present in soil solution (Abd El-Karim, 1996 and Rawya, 2001). Moreover, the adverse effect of high salinity concentration on growth could be ascribed to that salinity has been shown to reduce the synthesis of DNA, RNA and protein in many plants which might lead to disturbance in metabolic activities, cell division and elongation. In this connection, many investigators reported that, the effect of salinity on plant height, technical length and other yield components might be attributed to the rise in the osmotic pressure of rooting media which inhibits the meristematic tissue activity, consequently the size and the number of cells per unit length markedly reduced. Similar suggestion was reported by Hanafy Ahmed *et al.* (2002 a) and Rawya (2001).

Furthermore, many workers suggested that the reduction in plant growth due to salinity could be attributed to the decrease in transpiration and photosynthesis. In this respect, Ashraf and O'Leary (1996) pointed out that, CO_2 uptake was decreased by increasing salinity level. They also mentioned that, decrease in CO_2 uptake were paralleled by reductions in transpiration and stomatal conductance and they suggested that the change in stomatal resistance in saline conditions may be responsible for reducing both photosynthesis and water use efficiency.

Results in Tables (2, 3 and 4) reveal that, there is a significant increase on most of the studied growth and fibre yield characters (shoot height, technical length and main stem diameter) 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.

Table (2): Shoot height (cm) and dry weight (g) of various flax plant organs (roots, leaves and stems) 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 character	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	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	24.5	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	
Dry weight of 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	0.151
	GA_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	
Dry weight of 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
	GA_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	0.049	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	0.063	0.053	0.039	
	L. S. D. at 5%	A =0.012	B=N.S		A*B = N.S		A=0.032	B=0.039		A*B =N.S		A=0.011	B=0.013		A*B=N.S		A=0.017	B=0.021		A*B = N.S	
Dry weight of stem	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	0.145
	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
	GA_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	0.683	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	0.157
	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	
Dry weight of 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	0.723	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
	GA_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	0.286	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 (3): Shoot length (cm), technical length (cm) and stem diameter (mm) of flax plant 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)
Shoot length (cm)	Control	55.77	52.48	42.97	40.05	47.8	57.70	49.10	45.30	37.10	47.3
	Phosphorein+ P_2O_5	55.43	53.15	43.33	42.09	48.5	80.10	53.30	44.90	42.90	55.3
	Phosphorein +0.5P_2O_5	54.20	54.10	41.80	40.31	47.6	73.60	49.50	46.10	40.20	52.4
	Cotngein	64.79	53.44	44.31	40.55	50.8	63.90	51.90	47.50	44.60	52.0
	GA_3(0. 1g/l)	55.67	51.72	44.54	41.55	48.4	58.30	53.90	53.20	45.10	52.6
	Foliafeed C (0.7g/l)	56.17	52.17	42.15	41.37	48.0	59.70	52.30	48.10	42.90	50.8
	Mean (A)	57.0	52.8	43.2	41.0		65.6	51.7	47.5	42.1	
	L.S.D at % 5	A= 0.954 B=1.169 A*B= 2.337					A=3.769 B=4.616 A* B = 9.233				
Technical length (cm)	Control	47.07	42.58	33.33	31.05	38.5	50.50	43.80	39.10	32.40	41.5
	Phosphorein+ P_2O_5	47.17	43.31	33.72	32.04	39.1	66.70	45.70	40.20	38.50	47. 8
	Phosphorein +0.5P_2O_5	45.17	43.96	31.86	31.95	38.2	59.30	43.10	42.00	36.10	45.1
	Cotngein	55.57	47.51	34.28	32.61	42.5	55.60	43.60	40.70	38.90	44.7
	GA_3(0.1g /l)	45.35	41.45	34.85	32.16	38. 5	50.50	46.90	46.70	41.20	46.3
	Foliafeed C (0.7g/l)	47.53	42.45	32.24	35.36	39.4	50.60	47.00	41.40	38.50	44.4
	Mean (A)	48.0	43.5	33.4	32.5		55.5	45.0	41.7	37.6	
	L.S.D at % 5	A= 1.076 B=1.318 A*B = 2.635					A= 2.618 B =3.206 A* B = 6.412				
Stem diameter (mm)	Control	1.90	1.47	1.33	1.13	1.46	1.55	1.46	1.38	1.35	1.44
	Phosphorein+P_2O_5	2.00	1.73	1.70	1.20	1.66	1.69	1.36	1.31	1.30	1.42
	Phosphorein+0.5P_2O_5	1.67	1.50	1.47	1.33	1.49	1.63	1.40	1.36	1.29	1.42
	Cotngein	1.93	1.60	1.60	1.33	1.62	1.65	1.43	1.31	1.30	1.42
	GA_3(0.1g/l)	1.90	1.50	1.43.	1.40	1.56	1.62	1.48	1.44	1.41	1.49
	Foliafeed C (0.7 g / l)	2.23	1.73	1.43	1.30	1.67	1.75	1.36	1.42	1.30	1.46
	Mean (A)	1.94	1.59	1.49	1.28		1.65	1.42	1.37	1.33	
	L.S.D at % 5	A= 0.091 B=0.111 A*B = 0.223					A=0.107 B=N. S A*B = N. S				

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.* (2000) and El-Gazzar (2000) on flax plants.

In this respect, it can be suggested that phosphorein combined with full dose of P_2O_5 fertilizer might induce significant favourable effect on most of the studied growth characters. 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). Moreover, the enhancing effect of phosphorein as a biofertilizer on growth and 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 amino acid content (Saber *et al.*, 1998 and Hanafy Ahmed *et al.*, 2002 a), d) increasing the water and mineral uptake from the soil (Sobh *et al.*, 2000 and 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 e) 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.* (2002 c).

Table (4): Number of apical branches, straw yield and fiber yield(g)/ flax plant 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 apical branches / plant	Control	10.99	9.74	6.11	6.00	8.2	4.47	3.87	3.80	3.73	4.0
	Phosphorein+P_2O_5	11.16	10.58	7.28	6.47	8.9	7.87	4.60	4.53	4.73	5.4
	Phosphorein +0.5P_2O_5	11.40	9.82	7.98	6.27	8.9	6.00	5.73	4.67	4.27	5.2
	Cotngein	12.73	10.72	8.14	6.27	9.5	6.07	5.73	5.27	4.33	5.4
	GA_3(0.1g /l)	10.43	9.46	6.46	6.09	8.1	4.73	4.27	4.20	3.89	4.3
	Foliafeed C (0.7 g / l)	12.42	12.06	8.17	6.17	9.7	5.07	5.00	4.20	3.78	4.5
	Mean (A)	11.5	10.4	7.4	6.2		5.7	4.9	4.4	4.1	
	L.S.D at 5 %	A=0.344 B=0.421 A*B = 0.842					A=0.433 B=0.531 A*B =1.061				
Straw yield(g) / plant	Control	2.059	1.991	1.337	1.314	1.68	1.04	0.737	0.704	0.496	0.75
	Phosphorein+P_2O_5	2.844	2.542	1.627	1.646	2.16	2.03	1.460	0.862	0.857	1.30
	Phosphorein+0.5P_2O_5	2.291	2.021	1.520	1.413	1.81	1.52	0.780	0.773	0.770	0.96
	Cotngein	2.693	2.730	1.576	1.577	2.14	1.150	1.200	0.919	0.860	1.03
	GA_3(0.1g /l)	2.370	2.030	1.650	1.427	1.87	1.363	1.000	1.033	0.987	1.10
	Foliafeed C (0.7 g / l)	2.297	2.430	1.479	1.423	1.91	1.050	1.010	0.900	0.794	0.94
	Mean (A)	2.43	2.29	1.53	1.47		1.36	1.03	0.87	0.79	
	L.S.D	A=0.140 B=0.172 A*B=0.343					A=0.156 B=0.191 A*B = 0.382				
Fiber yield (g) / plant	Control	0.217	0.197	0.133	0.130	0.169	0.143	0.137	0.123	0.113	0.129
	Phosphorein +P_2O_5	0.240	0.233	0.163	0.160	0.199	0.160	0.143	0.133	0.127	0.141
	Phosphorein+0.5P_2O_5	0.227	0.180	0.153	0.140	0.175	0.153	0.130	0.127	0.120	0.133
	Cotngein	0.267	0.260	0.163	0.150	0.210	0.163	0.140	0.133	0.123	0.140
	G A_3 (0.1g/l)	0.250	0.237	0.147	0.133	0.192	0.150	0.143	0.133	0.120	0.137
	Foliafeed C (0.7g /l)	0.247	0.197	0.163	0.143	0.188	0.147	0.137	0.133	0.123	0.135
	Mean (A)	0.241	0.217	0.154	0.143		0.153	0.138	0.130	0.121	
	L. S. D. at 5 %	A=0.011 B=0.013 A*B = 0.027					A= 0.110 B=0.120 A*B= 0.240				

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 yield. In this connection, microorganisms have a critical role in the availability of soil immobilized phosphorus through dissolving soil complex inorganic and organic phosphates (El-Dahtory *et al.*, 1989).

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 fiber yield characters, it is clear from results in Tables (2, 3 and 4) that, there was pronounced positive significant difference between means values of studied growth and fiber yield characters in the 1st and 2nd seasons. The present results are in agreement with those reported by El-Shimy *et al.* (2001), El-Aggory *et al.* (2001) and El-Sweify *et al.* (2003). In this respect, Saber and Kabesh (1990) reported that, the application of some biofertilizers such as phosphate dissolving bacteria and microbein under saline soil may 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 and consequently improving plant growth and subsequently increasing yield. There is a strong competition between plants and soils for P in the soil solution. The winner usually is soils, so, it is essential to apply phosphate fertilization or using biofertilizer to mobilize soil phosphorus. This led to increase the plant growth, P-uptake and microbial population in crops rhizosphere and consequently yield (El-Fadaly *et al.*, 2003). It can generally be concluded that, the growing of flax plants in salinity soil with an active bacterial strain as phosphate dissolver namely *Bacillus megatherium* (phosphorein) is of great importance. This led to significant increase in the biofertility of soil as well as the yield of the plant growth. The biofertility of soil expressed in increasing the number of different bacterial groups in rhizosphere area. These groups have active effect in releasing phosphorus in addition to the N_2-fixation process and degradation of the organic materials by the enzymatic systems they have. This can also take part in reducing the pollution of the soil from the chemical showed be added every year. Furthermore, this also increased the yield of flax and the nutritive values as well.

Concerning the effect of micronutrients on growth and fibre yield characters, the data reveal that there is a significant increase on most of the studied growth and fibre yield characters (shoot height, technical length and stem diameter) by using cotngein or foliafeed C micronutrients fertilizers in the two successive seasons. The obtained results are in agreement with those obtained by Grant and Bailey (1997) and Hussien (2002) on flax plant.

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 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.* (1995) on wheat and faba bean. The significant increase in shoot height 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.

Furthermore, it is clear from the results that, cotngein as a micronutrient fertilizer coated seeds surpassed foliafeed C as a foliar micronutrients fertilizer in most of the studied growth and fibre yield characters especially in the 2nd season.

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, straw and fibre yield/plant and its components by using cotngein or foliafeed C micronutrients fertilizers under saline soil condition in the two samples and seasons, except stem diameter in the 2nd season. In this respect, Osman *et al.* (1990) working on faba bean using Fe, Mn and Zn chelates by coating method found that, such method was efficient for correcting the requirements and suitable between such nutrients in alluvial slightly alkaline soil for growth, nutrient uptake and high yield production.

It is important here to mention that, under saline soil conditions the pH value of the soil may be increased and this increase affects on availability of most micronutrients in the soil to plants. Therefore, added these micronutrients either by seed coating as cotngein or foliar application as foliafeed C may compensate micronutrients deficiency under saline soil. In this connection, Potriat and Picard (1983) working on faba bean plants, pointed out that crop yield may evidently be increased by the addition of micronutrient is soil suffer from their deficiencies, the pH of the soil system is an important factor in determining the solubility relationship.

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 fibre yield characters in 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, Lou (1980) and 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.

The increase in plant growth and consequently fibre 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). The effects of gibberellins on whole plants are caused by a stimulation of activity of specific enzymes and/or a changed availability of endogenous auxin. Moreover, Bhattacharjee *et al.* (2000) reported that, growth promotes like gibberellic acid (GA_3) at lower concentration are capable of enhancing vegetative growth through increased meristematic activity due to enhanced cell division and elongation.

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 and fibre yield characters 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 yield of straw and fibre and its component in the two seasons, in addition to shoot height in the 1st sample of the 2nd season. Similar results were obtained by Aldesuquy and Ibrahim (2002), and 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).

Generally, it can be concluded that GA_3 application at the rate of 100 ppm could increased fibre yield and its components of flax plants either the plants were grown under salt stressed or not. The best treatment of fibre yield were followed the order cotngein > phosphorein + full dose of P_2O_5> GA_3 > foliafeed C and then the lowest increase was by phosphorein + half dose of P_2O_5 in the 1st season.

2- Chemical compositions

Data of total sugars and total soluble phenols concentrations in the shoots and roots, of the two successive samples, of flax plant as affected by different level of salinity (0, 2000, 4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 and foliafeed C application are presented in Table (5).

Regarding the effect of salinity, the present results indicate that increasing salinity level increased the concentrations of the total sugars in the shoots and roots gradually by increasing salt soil addition up to 4000 ppm and decreased thereafter. While, there was a significant increase in total soluble phenols in the roots, but an opposite trend was obtained by the shoots in the two successive samples.

In general, the increment in soluble components among which total sugars and total soluble phenols due to salinity stress may in turn play an important role in increasing the osmotic pressure of the cytoplasm. This conclusion is in accordance with the results obtained by Greenway and Munns (1980) who stated that these organic molecules act as osmotica and play an important role in osmotic adjustment in non-halophytes, moreover, sugars as osmolytes enable plants to keep better water relation under salt stress condition. It might be suggested that sugar concentration may be an indicator to the osmoprotectant levels in flax plant and may contribute to salt tolerance in this system. On the other hand, as mentioned before, gradual decreases in total soluble phenols were recorded by the shoot of flax plants with increasing salinity levels. In this respect, Sifola *et al.* (1995) working on eggplant, found that total polyphenols content decreased with increasing salinity. In this connection, Krishnamurthy and Bhagwat (1993) on rice plant,

suggested that this decrease in the total polyphenol concentrations may be attributed to the increase in the activity of enzymes affecting on phenols accumulation in salt-stressed plants. Moreover, Kennedy *et al.* (1999) found that, the levels of four key enzymes involved in oxidatives stress (catalase, polyphenol oxidase, superoxide dismutase and lipoxygenase) were significantly increased in Grevillea species as a result of NaCl treatment.

Data in Table (5) indicate that, application of phosphorein with full or half dose of P_2O_5 mineral fertilizer significantly increased total sugars concentrations and decreased total soluble phenols in shoots and roots in both the 1st and 2nd samples, (except roots in the 2nd sample of sugar concentrations).

In this respect, it can be suggested that using biofertilizer phosphorein might be increase P availability and that might be implicated in enhancing photosynthesis and synthesis of carbohydrates. In this respect, Hopkins (1999) mentioned that, in the plant, phosphorous is found largely as phosphate esters-including the sugar-phosphates, which play such an important role in photosynthesis and intermediary metabolism. Other important phosphate esters are the nucleotides that make up DNA and RNA as well as the phospholipids present in membranes. Phosphorus in the form of ATP, ADP and Pi, phosphorylated sugars and phosphorylated organic acids also plays an integral role in the energy metabolism of cells.

As regard to the interaction between salinity levels and phosphorein on total sugars and phenols, it is clear from the results obtained from Table (5) that, there was significant increase in total sugars concentration and decrease in total soluble phenols in both shoots and roots in the 1st and 2nd samples by using phosphorein with full and/or half dose of P_2O_5, except in roots of the first sample by using phosphorein with half dose of P_2O_5 in total sugars. In this respect, Hanafy Ahmed *et al.* (2002 a) suggested that, simple organic molecules such as sugars, free amino acids and total soluble phenols may act as an osmoticum for the regulation of plant osmosis under saline soil conditions.

Data in Table (5) indicate that, there was a significant increase in total sugar concentrations in both shoots and roots of flax plants by using micronutrients compounds fertilizers cotngein and foliafeed C in the 1st and 2nd samples. While, there was significant decreases in total soluble phenols were recorded by the roots of flax plant treated with micronutrients compound fertilizers (cotngein or foliafeed C) when compared with control micronutrients-untreated plants. Moreover, in the roots foliafeed C foliar application induce more reducing effects on total soluble phenols concentration than cotngein seed coated application.

As regard to the interaction between salinity and micronutrients, it is clear from the results that there was significant positive effect due to using cotngein or foliafeed C treatments under saline soil on total sugars concentration of both shoots and roots in the 1st and 2nd samples as well as total soluble phenols in shoots. However, there is significant decrease in total soluble phenols concentration in roots by the same treatments. In this respect, Eid *et al.* (1993) reported that, $ZnSO_4$ was the best treatment for reducing total soluble phenols concentration at high salinity levels (6000 and

9000 ppm). This may be due to that micronutrients in foliafeed C and cotngein enhanced metabolic activity, consequently enhancing sugars and phenols synthesis and accumulation. These results are in agreement with those reported by El-Khawaga (2003) on pomegranate.

Data in Table (5) indicate that, in the two successive samples, application of GA_3 at the rate of 100 ppm brought about significant increase of total sugars in both shoots and roots of flax plant as well as total soluble phenols concentration in roots and a distinct reduction of total soluble phenols concentrations in shoot. In this connection, gibberellin regulating gene products include amylases and other enzymes responsible for degrading storage carbohydrate and mobilizing the sugars for use by the developing embryo (Hopkins, 1999). In this connection, Law (1987) reported that, gibberellin increased the biosynthesis of IAA by regulating the conversion of L-tryptophan to D-tryptophan which converted to auxin.

In this respect, it might be suggested that the effect of GA_3 on the synthesis of phenols may be induce through it's effect on shikemic acid pathway in which auxins and phenols consists thus, application of GA_3 may caused increase of auxins and phenols or might reduce auxins synthesis and consequently lead to increase of phenols.

As regard to the interaction between GA_3 and salinity levels, it is clear from the data that, in the 1st and 2nd samples, there was significant increase in total sugar concentrations in both shoots and roots and total soluble phenols in roots by using GA_3 foliar application when compared with control plants grown under saline soil but untreated with GA_3. However, a reverse trend was recorded in the shoot on total soluble phenols. These results are in agreement with those reported by Aldesuquy and Ibrahim (2002) on wheat. In this respect, Sultana *et al.* (2000) reported that, the external application of GA_3 improved the seedling growth and alpha-amylase expression in the presence of NaCl. It is suggested that, GA_3 counteracts the stress conditions by enhancing the degradation of starch and alpha-amylase activity in seed which ultimately leads to better seedling growth this increase tolerate plant to salinity leads to increase yield of flax plants.

Data in Tables (6 and 7) indicate that, essential, non essential and total amino acids as well as crude protein percentage exhibited a gradual decrease with increasing salinity level. On the other hand, proline and arginine percentages in the two successive samples as well as histidine in the 1st sample exhibited gradual increases with increasing salinity levels. This result is in accordance with the results obtained by Singh and Singh (1991) on linseed, they found reduction in total nitrogen, protein, RNA and DNA, while accumulation of proline occurred with increased salt stress. From these results it can be inferred that saline media activate the accumulation of more intermediate metabolites such as amino acids by the cells. This may be induced as a result of increasing protein degradation and/or reducing the rate of incorporation of free amino acids into protein. This suggestion was also reported by Hanafy Ahmed *et al.* (2002 a and b) on *Myrtus communis* and wheat plants, respectively.

Table (5): Total sugars and total soluble phenols concentrations (mg/g F.W.) in the shoots and roots of flax plant as affected by different levels of salinity (0,2000,4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 and foliafeed C application in the two samples of the second season, 2001-2002

Chemical composition	Plant organ	Shoots										Roots									
	Plant age (days)	60					90					60					90				
	Salinity levels(ppm) (A) / Treatments (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)
Sugars	Control	2.47	2.48	2.60	1.37	2.23	3.32	5.42	5.12	3.45	4.33	2.23	2.26	2.29	2.06	2.21	3.45	3.53	3.88	3.08	3.49
	Phosphorein+P_2O_5	2.77	3.05	3.45	1.51	2.70	5.04	5.92	8.44	4.48	5.97	2.51	2.44	2.84	2.07	2.47	3.79	5.16	7.59	1.15	4.42
	Phosphorein+0.5P_2O_5	2.64	2.60	2.88	1.44	2.39	4.50	5.61	5.81	3.32	4.81	2.20	2.17	2.45	1.09	1.98	3.68	3.40	3.68	3.19	3.49
	Cotngein	2.48	2.86	2.95	2.86	2.79	3.82	6.38	9.97	2.82	5.75	2.86	2.89	2.92	1.84	2.63	4.86	5.84	8.13	3.04	5.47
	G A_3 (0.1g/l)	2.51	2.79	2.84	1.17	2.33	5.19	5.52	5.66	2.88	4.81	2.85	2.86	2.93	2.07	2.68	5.52	5.67	5.56	3.06	4.95
	Foliafeed C C (0.7g /l)	2.59	3.13	3.40	2.16	2.82	4.37	5.51	7.15	4.81	5.46	2.52	2.95	2.99	2.18	2.66	4.06	4.44	4.48	3.83	4.20
	Mean (A)	2.58	2.82	3.02	1.75		4.37	5.73	7.03	3.63		2.53	2.60	2.74	1.89		4.23	4.67	5.55	2.89	
	L. S. D. at 5 %	A=0.053 B=0.065 A*B =0.129					A=0.085 B =0.104 A*B=0.207					A =0.061 B =0.075 A*B=0.150					A = 0.093 B =0.114 A*B =0.227				
Phenols	Control	2.27	2.16	2.06	1.54	2.01	3.76	3.41	3.33	1.69	3.05	0.34	0.40	0.43	0.47	0.41	0.42	0.43	0.45	0.50	0.45
	Phosphorein +P_2O_5	1.92	1.88	1.81	1.30	1.73	2.96	2.74	2.37	2.04	2.53	0.29	0.30	0.43	0.45	0.37	0.34	0.35	0.45	0.48	0.41
	Phosphorein+0.5P_2O_5	1.87	1.84	1.60	1.30	1.65	2.85	2.53	2.31	2.12	2.45	0.26	0.34	0.35	0.36	0.33	0.34	0.36	0.45	0.48	0.41
	Cotngein	1.89	1.84	1.83	1.81	1.84	2.91	2.83	2.14	1.94	2.46	0.39	0.40	0.42	0.45	0.41	0.44	0.45	0.46	0.47	0.46
	GA_3(0.1g/l)	2.09	2.09	2.00	1.41	1.90	2.99	2.72	2.46	1.76	2.48	0.36	0.43	0.48	0.49	0.44	0.43	0.44	0.46	0.48	0.45
	Foliafeed C C (0.7g /l)	1.82	1.72	1.71	1.14	1.60	2.63	2.41	2.05	1.66	2.19	0.34	0.42	0.45	0.48	0.42	0.43	0.47	0.50	0.51	0.48
	Mean (A)	1.98	1.92	1.84	1.42		3.02	2.77	2.44	1.87		0.33	0.38	0.43	0.45		0.40	0.42	0.46	0.49	
	L. S. D. at 5 %	A=0.038 B=0.047 A*B=0.093					A =0.040 B =0.049 A*B=0.098					A =0.008 B =0.010 A*B=0.020					A =0.014 B =0.018 A*B =0.035				

Table (6): Essential , non essential and total amino acids as well as crude protein (%) in the flaxshoot as affected by different levels of salinity (0, 2000, 4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 and foliafeed C in the first sample of the second season, 2001-2002.

Salinity levels (ppm)	Amino acids / Treatment	Essential									Non - Essential									Total Amino Acid	Crude protein
		Threonine	Cystine	Methionine	Valine	Iso leucine	Tyrosine	Phenyl alanine	Lysine	Essential A.A.	Aspartic	Serine	Glutamic	Proline	Glycine	Alinene	Histidine	Arginine	Total Non-essential A.A.		
Control	Control	1.382	0.570	0.530	1.689	1.225	0.866	1.684	1.524	9.47	2.659	1.386	4.423	2.530	1.589	1.766	0.527	1.816	16.70	26.2	27.6
	Phosphorein+P_2O_5	1.438	0.330	0.620	1.831	1.506	1.257	1.776	1.594	10.35	2.878	1.433	4.558	1.840	1.760	1.894	0.645	1.898	17.21	27.6	28.8
	Phosphorein+0.5 P_2O_5	1.383	0.260	0.600	1.805	1.476	1.175	1.721	1.611	10.03	2.888	1.454	4.502	1.800	1.743	1.928	0.669	1.933	16.62	26.7	28.0
	Cotngein	1.311	0.310	0.570	1.701	1.397	1.129	1.618	1.407	9.44	2.678	1.319	3.678	1.880	1.611	1.762	0.616	2.158	15.90	25.3	28.8
	GA_3 (0.1g/l)	1.206	0.300	0.520	1.569	1.177	0.985	1.599	1.342	8.70	2.684	1.233	4.089	2.000	1.680	1.749	0.668	1.915	16.02	24.7	26.6
	Foliafeed C (0.7g /l)	1.176	0.250	0.500	1.497	1.131	0.990	1.442	1.302	8.20	2.396	1.215	3.779	2.020	1.428	1.565	0.549	1.759	14.71	22.9	24.5
	Mean (A)	1.32	0.34	0.56	1.68	1.32	1.07	1.64	1.46	9.39	2.70	1.34	4.20	2.01	1.64	1.78	0.61	1.91	16.19	25.57	27.4
2000	Control	1.342	0.500	0.550	1.630	1.279	0.985	1.657	1.417	9.36	2.596	1.341	4.334	2.560	1.551	1.716	0.597	1.661	16.36	25.7	27.4
	Phosphorein+P_2O_5	1.351	0.280	0.540	1.629	1.238	0.861	1.601	1.425	8.93	2.547	1.314	4.812	2.280	1.547	1.746	0.608	1.642	16.50	25.4	27.2
	Phosphorein+0.5 P_2O_5	1.282	0.210	0.540	1.647	1.226	0.998	1.585	1.431	8.92	2.594	1.313	4.233	2.420	1.551	1.704	0.607	2.003	16.43	25.4	26.0
	Cotngein	1.097	0.230	0.470	1.432	1.021	0.854	1.315	1.207	7.63	2.253	1.123	4.442	2.370	1.386	1.499	0.678	1.684	15.44	23.1	23.4
	GA_3 (0.1g/l)	1.153	0.280	0.560	1.510	1.251	0.930	1.553	1.412	8.65	2.481	1.190	4.133	2.790	1.516	1.620	0.686	1.600	16.02	24.7	26.0
	Foliafeed C (0.7g /l)	0.900	0.260	0.480	1.298	0.879	0.632	1.155	1.109	6.71	2.107	0.919	3.498	2.830	1.245	1.410	1.013	1.604	14.63	21.3	24.4
	Mean (A)	1.19	0.29	0.52	1.5	1.15	0.88	1.48	1.33	8.35	2.43	1.20	4.24	2.54	1.47	1.61	0.70	1.70	15.89	24.26	25.7
4000	Control	0.854	0.330	0.430	1.528	0.957	0.710	1.337	0.884	7.03	2.154	0.854	4.262	2.560	1.248	1.265	0.875	2.036	15.25	22.3	24.4
	Phosphorein+P_2O_5	0.848	0.230	0.410	1.522	0.954	0.811	1.260	1.136	7.17	2.162	0.871	4.627	2.810	1.159	1.216	0.915	2.101	15.86	23.0	24.3
	Phosphorein+0.5 P_2O_5	0.823	0.230	0.400	1.351	0.848	0.740	1.109	0.838	6.34	1.941	0.852	4.118	2.970	1.197	1.226	0.956	2.108	15.37	21.7	23.4
	Cotngein	0.840	0.250	0.410	1.470	0.986	0.430	1.225	1.063	6.67	2.053	0.881	4.561	2.430	1.170	1.221	0.961	2.194	15.47	22.1	23.0
	GA_3 (0.1g/l)	1.053	0.270	0.460	1.460	0.952	0.630	1.005	1.012	6.84	1.940	0.874	4.088	2.801	1.179	1.225	0.975	2.090	15.17	22.0	24.4
	Foliafeed C (0.7g /l)	0.783	0.270	0.470	1.358	0.877	0.654	1.181	1.017	6.61	1.942	0.811	3.398	2.900	1.133	1.185	1.241	1.990	14.60	21.2	24.8
	Mean (A)	0.87	0.26	0.43	1.45	0.93	0.66	1.19	0.99	6.78	2.03	0.86	4.18	2.75	1.18	1.22	0.99	2.09	15.29	22.06	24.01
6000	Control	0.889	0.230	0.350	1.255	0.839	0.732	1.002	1.084	6.38	1.904	0.815	4.199	2.740	1.070	1.142	0.887	2.311	15.07	21.5	23.4
	Phosphorein+P_2O_5	0.691	0.320	0.350	1.296	0.831	0.700	1.032	1.046	6.27	1.887	0.681	4.368	2.940	1.124	1.094	0.893	2.297	15.28	21.6	23.0
	Phosphorein+0.5 P_2O_5	0.667	0.204	0.400	1.452	0.766	0.444	1.106	1.168	6.21	1.875	0.833	4.306	3.140	1.102	1.055	0.888	2.058	15.26	21.5	22.8
	Cotngein	0.872	0.190	0.330	1.227	0.785	0.549	1.031	0.920	5.90	1.828	0.827	4.075	2.430	1.220	1.024	1.014	2.435	14.85	20.8	22.6
	GA_3 (0.1g/l)	0.816	0.290	0.320	1.232	0.740	0.413	0.992	0.921	5.72	1.716	0.814	3.535	2.910	1.090	1.048	0.921	2.429	14.46	20.2	23.6
	Foliafeed C (0.7g /l)	0.869	0.200	0.410	1.285	0.815	0.522	1.007	0.983	6.09	1.661	0.837	3.099	3.250	1.107	1.109	0.991	2.170	14.22	20.3	24.4
	Mean (A)	0.80	0.24	0.36	1.29	0.80	0.56	1.03	1.02	6.10	1.81	0.80	3.93	2.90	1.12	1.08	0.93	2.28	14.85	20.97	23.3

It is clear from the results in Tables (6 and 7) that, under non-saline soil condition, in the two successive samples, there was increases in essential, non essential and total amino acids as well as crude protein percentage in the leaves of flax plants due to using phosphorein with the full dose of P_2O_5. While, application of phosphorein with the half dose of P_2O_5 caused an increase in essential and total amino acids in the 1st sample as well as crude protein in the 1st and 2nd samples, however, there was a decrease in non-essential amino acids in the 1st sample and essential, non-essential and total amino acid in the 2nd sample by using this treatment when compared with control non-saline plants.

Generally, it can be concluded that the biofertilizer phosphorein increased the concentration of simple organic molecules such as sugars and total soluble phenols as well as, some free amino acids% which played a role in regulation of plants osmosis and consequently better plant growth and yield.

As regard to the interaction between salinity and phosphorein, it is clear from the results in Tables (6 and 7) that, there was slight decreases in essential, non-essential and total amino acids as well as crude protein percentages by using phosphorein with full dose of P_2O_5 combined with the lowest level of salinity (2000 ppm) in the 1st and 2nd sample and under the different levels of salinity by using phosphorein with half dose of P_2O_5. However, slight increases of non-essential and total amino acids in the two successive samples as well as crude protein in the 2nd sample were detected by the plants supplied with phosphorein combined with the full dose of P_2O_5 under 4000 and 6000 ppm salinity levels when compared with corresponding plants supplied by the same level of salinity but untreated with phosphorein.

The data in Tables (6 and 7) indicate that, under non-saline soil conditions, cotngein and foliafeed C treatments, both reduced the mean values of essential, non essential and total amino acids as well as crude protein in both the 1st and 2nd samples, when compared with control plants untreated with micronutrients, except effect of cotngein on total essential amino acid and crude protein in the first sample. While there was increases in aspartic, glycine, histidine and arginine in the 1st sample by using cotngein and threonine, methionine, aspartic, serine, glutamic, proline and histidine in the 2nd sample by using foliafeed C when compared with control-untreated plants. These results are in agreement with those obtained by Nasr El-Din (1983) and Hussien (2002) on flax.

As regard to the interaction between different salinity levels and micronutrients application, in the two successive samples, it is clear from the results in Tables (6 and 7) that there was decreases in the mean values of essential, non-essential and total amino acids as well as crude protein percentages in the shoot of flax plants by using cotngein or foliafeed C when compared with corresponding plants supplied with the same level of salinity alone, with some exceptions. However, there were increases in some amino acids like therionine, methionine, isoleucine and serine percentage under 2000 ppm salinity level by using foliafeed C and cotngein.

It can be suggested that, under physiological drought conditions caused by excess salts in the soil or irrigation water the high molecular

weight compounds such as protein might be converted into low molecular weight compounds such as free amino acids to increase the soluble content materials of the cell. Similar suggestions were reported by Sharma *et al.* (1996) and Hanafy Ahmed *et al.* (2002 a).

Concerning the effect of GA_3 foliar application on essential, non essential and total amino acids as well as crude protein, data in Tables (6 and 7) reveal that, in the two successive samples under non-saline soil conditions, low values of all of these components were detected with some exceptions. Generally, it can be suggested that GA_3 foliar application at the rate of 100 ppm reduced activity of plant to synthesize proteins in different stages, but it can increase some specific amino acids, although it can't increase total amino acids under saline or non-saline soil condition. In this respect, Singh *et al.* (1981) reported that, GA_3 increased the total soluble protein significantly in fruiting bodies of flax and other oil crops, e.g., *Carthamus tincotrium* L. and *Arachis hypoyaca* L.

On the other hand, in the 1st sample, high values of methionine was detected under 2000 ppm soil addition, as well as, in the 2nd sample, therionine, valine, lysine, serine, glycine and alanine under 4000 ppm and methionine and tyrosine were detected under 6000 ppm by the leaves of plants sprayed with 100 ppm of GA_3 foliar application.

3- Nutrients

It is clear from data in Tables (8 and 9) that increasing soil salinity level significantly reduced N and K concentrations but P, Ca, Na and Mg concentrations increased significantly in shoots and roots in the 1st and 2nd samples. These results are in agreement with those reported by Gaballah and Abou Leilah (2000) and Rawya (2001) on flax. In this respect, Edwards and Walker (1983) noted that N is a major constituent of enzymes responsible for photosynthesis carbon reduction and the components of the photosystems including chlorophyll which generate ATP and NADH. Thus, a low N level in stressed flax plants results in suppressed photosynthetic rate and lowering of the carbohydrate supply for growth. Furthermore, Mass and Nieman (1978) attributed the reduction in plant mass under salinity treatment to the retardation of the production of proteins and nucleic acids. In addition, Leidi *et al.* (1991) working on wheat, pointed out that a reduction of transpiration recorded at the higher salinity level could be correlated with an important reduction in K level.

As regard to the increase in P concentration with salinity levels, Gates *et al.* (1970) mentioned that, plants suffering from salt-stress tended to absorb more phosphorus from the root medium. Such plants usually exhibit high rate of respiration (salt or anion respiration) which requires considerable energy expenditure and phosphorus is usually required for the synthesis of metabolic of disequilibrium.

Concerning the increment of Ca and Mg concentrations in the shoots and roots of flax plants grown under saline soil conditions (Tables 8 and 9), the high values of these two elements might be mainly induce due to the accumulation of these elements in the saline soil and subsequently uptaken it by the developing plants at high rates. In this respect, Hanafy Ahmed *et al.*

(2002 a) working on *Myrtus communis*, assumed that the elevated concentration of Ca and Mg in plant material subjected to salinity stress could be due to the increase in roots uptake as well as translocation process from roots to other plant organs in order to accumulate in cell so that the membrane permeability is influenced in a manner for maintaining the integrity of selective ion transport mechanisms.

Concerning the increase of Na concentration in both shoots and roots of flax plant (Table 9), it can be suggested that these increases of Na concentration in shoots and roots of flax plant with increasing salinity levels was quite expected since Na is the dominant element of salts added to salinized soil. Moreover, the increase in Na concentration in plants with salinity may be a result of the ability of plants to use Na to maintain an adequate osmotic potential gradient between the plant tissue and the external solution (Glenn, 1987). In this connection, Hanafy Ahmed *et al.* (2002 b) working on wheat, assumed that severe effects attributed to salinity stress on most of the studied growth characters and yield might be due to increases in Na concentration. In this respect, these deleterious effects of Na on plant growth could be attributed to that Na may affect non-halophyte plants by: 1) decreasing the water potential of the plants. 2) specific- ion toxicity and 3) affecting solute transport (Greenway and Munns, 1980).

Data in Tables (8 and 9) indicate significant increase in N and K concentrations in the shoots and roots as well as P concentration in the shoots and Ca concentration in the roots in the two successive samples by using phosphorein combined with full dose of P_2O_5 when compared with control-untreated plants. However, there was significant decrease in Mg, Na, Ca and P concentrations in both shoots and roots in the 1st and 2nd samples by using phosphorein combined with half dose of P_2O_5, with some exceptions (P concentration in the shoots of the 2nd sample and Ca in the roots of the 1st sample), while N concentration was significant increase in the shoots of the two successive samples as well as in the roots in the 1st sample. These results are in agreement with those reported by Thingstrup *et al.* (2000) on flax.

In this respect, Hanafy Ahmed *et al.* (2002 C) on lettuce and Fatma (2003) on mung bean, revealed that application of some biofertilizers such as phosphate dissolving bacteria and microbein increased the availability of some nutrients such as P and K which could be reflected on plant uptake and its content from these nutrients. Furthermore, all elements concentration by using phosphorein with full dose of P_2O_5 surpassed it by using phosphorein with half dose of P_2O_5, which reach to about 2.9 and 2.4% in shoot, 1.7 and 7.1% in roots of N concentration in the 1st and 2nd samples, respectively.

As regard to the interaction between salinity and phosphorein treatments, it is clear from the data in Tables (8 and 9) that, there was significant increase in roots and decreased in shoot on N and Ca concentrations under 2000 ppm salinity level, in the two successive samples. However, decreases in both Na and Mg concentration were recorded in the shoots and roots in 1st and 2nd samples under 2000 and 4000 ppm, but increase in K concentration was obtained in shoots and roots of the two samples under three different salinity levels except in the 1st sample under

6000 ppm. Finally there was increase in P concentration in the shoots and decrease it in the roots in the 1st and 2nd samples by using phosphorein with full dose of P_2O_5. With respect to phosphorein combined with half dose of P_2O_5, generally it is clear from the results that, there were decreases in Na and Mg concentrations in both shoots and roots in the two successive samples. However, no constant trend could be detected on N, P, K and Ca concentrations. These findings are in harmony with those reported by Abul-Nasr (1999) on flax and El-Sweify *et al.* (2003) on jute. The enhancing effect of biofertilizer on increasing nutrients such as P concentration in plant tissues was recorded by many investigators, they suggested that biofertilizer reducing soil pH by secreting organic acids such as acetic, propionic, fumaric and succinic acids which bring about the dissolution of bonds forms of P and render it available for growing plants (Ibrahim and Abd El-Aziz, 1977).

Data in Tables (8 and 9) indicate significant increase in P and K concentrations in the shoots as well as K and Ca concentrations in the roots of the two successive samples by using cotngein, while foliafeed C induced significant increase in P, K and Mg concentration in the shoots as well as N and K concentration in the roots of the 1st and 2nd samples, also, Ca and Mg concentration in roots of the 1st sample only, when compared with control plants untreated with cotngein or foliafeed C. Similar results were reported by Kukresh and Khodyankova (2001) on flax. The highest values of P, Ca, Na and Mg concentrations were observed in both shoots and roots in case of using cotngein and foliafeed C (micronutrients compound fertilizers) application under 6000 ppm salinity level. These results are in agreement with those reported by Singh and Singh (1994) and Rawya (2001) on flax.

Hence, the present study reveal that micronutrients application as a foliar with foliafeed C or seed coated with cotngein both reduced Na and Mg accumulation in shoots and roots of salt-stressed flax plants, thus avoiding its depressive effect on plant growth and other relevant physiological activities.

Furthermore, it is clear from the data in Tables (8 and 9) that, in the two successive samples, GA_3 foliar application at the rate of 100 ppm significantly decreased N, Ca, Na and Mg concentrations in the shoots, while increased P and K concentrations. However, in the roots there was significant increase in N and K concentrations in the two successive samples as well as Ca and Mg concentrations in the 1st sample when compared with control-GA_3 untreated plants. Similar results were obtained by Bahia *et al.* (1995) on flax. In this respect, El-Khateeb *et al.* (1991) on *Ruta gravelens*, reported that mineral uptake was increased during IAA and GA_3 application in different plant species, but Na was decreased. Moreover, Lou (1980) mentioned that, GA_3 can accelerate the metabolism and transport of photosynthates, enhance root absorption activity and plant growth.

Concerning the interaction between salinity levels and GA_3 foliar application, data presented in Tables (8 and 9) show that, spraying 100 ppm GA_3 had a significant promoted effect on N, K and Ca concentration in the roots and on P concentration in the shoot of flax plants in the 1st and 2nd samples.

Table (7): Essential, non essential and total amino acids as well as crude protein (%) in the flax shoot as affected by different levels of salinity (2000, 4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 and foliafeed C in the second sample of the second season, 2001-2002.

Salinity levels (ppm)	Amino acids / Treatment	Essential									Non - Essential									Total Amino Acid	Crude protein
		Threonine	Cystine	Methionine	Valine	Iso leucine	Tyrosine	Phenyl alanine	Lysine	Total essential A.A	Aspartic	Serine	Glutamic	Proline	Glycine	Alinene	Histidine	Arginine	Total non-essential A.A.		
Control	Control	1.030	0.260	0.450	1.500	1.006	0.840	1.440	1.450	7.98	0.510	1.010	2.996	2.560	1.320	1.530	0.540	1.160	11.63	19.61	23.6
	Phosphorein+P_2O_5	1.248	0.250	0.550	1.552	1.116	0.870	1.400	1.407	8.39	2.412	1.211	3.996	2.510	1.344	1.119	1.033	1.160	14.79	23.2	24.4
	Phosphorein+0.5 P_2O_5	1.100	0.250	6.620	1.360	0.990	0.840	1.260	1.270	7.69	2.050	1.060	3.180	2.240	1.320	1.290	0.670	1.110	12.92	20.6	23.6
	Cotngein	0.980	0.260	0.560	1.310	0.900	0.600	1.140	1.150	6.90	1.840	0.950	2.870	2.500	1.200	1.140	0.640	1.090	12.23	19.1	20.4
	GA_3 (0.1g/l)	0.900	0.260	0.530	1.240	0.840	0.510	1.050	1.160	6.49	1.870	0.960	2.800	2.810	1.140	1.370	0.640	1.160	12.75	19.24	22.8
	Foliafeed C (0.7g /l)	1.050	0.250	0.560	1.400	0.950	0.600	1.200	1.170	7.18	1.930	1.040	3.020	2.820	1.190	1.180	0.650	1.020	12.85	20.0	22.0
	Mean (A)	1.05	0.26	0.55	1.39	0.97	0.71	1.25	1.27	7.45	1.77	1.04	3.14	2.57	1.25	1.27	0.70	1.12	12.9	20.29	22.6
2000	Control	0.840	0.270	0.330	1.420	0.760	0.770	1.350	1.270	7.01	2.110	0.860	2.990	2.90	1.260	1.400	0.540	1.310	13.37	20.38	22.2
	Phosphorein+P_2O_5	0.890	0.240	0.450	1.152	0.780	0.740	1.380	1.140	6.77	1.810	0.870	2.970	3.45	1.244	1.131	0.550	1.140	13.17	19.9	21.6
	Phosphorein+0.5 P_2O_5	0.890	0.220	0.470	1.160	0.780	0.450	1.010	1.110	6.13	1.830	0.910	2.980	3.00	1.120	1.010	0.610	1.030	12.49	18.6	20.6
	Cotngein	0.850	0.220	0.450	1.120	0.770	0.550	1.000	1.080	6.04	1.660	0.870	2.860	2.54	1.050	1.060	0.550	1.040	11.63	17.7	19.8
	GA_3 (0.1g/l)	0.840	0.200	0.320	1.270	0.930	0.640	1.140	1.140	6.48	1.770	0.920	2.740	2.980	1.110	1.260	0.470	1.140	12.39	18.9	20.8
	Foliafeed C (0.7g /l)	0.860	0.170	0.320	1.270	0.960	0.710	1.160	1.120	6.57	1.780	0.920	3.010	2.900	1.080	1.240	0.480	1.010	12.42	19.0	20.4
	Mean (A)	0.86	0.22	0.39	1.23	0.83	0.65	1.17	1.14	6.49	1.83	0.89	2.93	2.96	1.14	1.18	0.53	1.11	12.58	19.1	20.9
4000	Control	0.820	0.170	0.300	1.300	0.970	0.640	1.020	1.110	6.33	1.730	0.850	2.770	3.00	1.070	1.230	0.470	1.770	12.89	19.2	20.6
	Phosphorein+P_2O_5	0.850	0.230	0.280	1.200	0.840	0.640	1.180	1.040	6.26	1.780	0.860	2.870	4.45	1.000	1.130	0.550	1.300	13.94	20.2	21.0
	Phosphorein+0.5 P_2O_5	0.800	0.260	0.260	1.150	0.810	0.540	1.120	1.100	6.04	1.700	0.830	2.880	3.28	0.970	1.000	0.600	1.020	12.28	18.3	20.0
	Cotngein	0.770	0.160	0.270	1.230	0.890	0.580	0.950	1.060	5.91	1.650	0.870	2.840	2.610	1.000	0.990	0.440	1.030	11.43	17.3	19.2
	GA_3 (0.1g/l)	0.860	0.160	0.260	1.320	0.960	0.580	0.950	1.150	6.24	1.720	0.920	2.670	3.00	1.100	1.240	0.460	1.120	12.23	18.5	20.4
	Foliafeed C (0.7g /l)	0.620	0.160	0.290	0.950	0.700	0.420	0.920	0.920	4.98	1.440	0.700	3.000	2.97	0.920	0.910	0.460	1.000	11.40	16.4	20.0
	Mean (A)	0.79	0.19	0.28	1.19	0.86	0.57	1.02	1.06	5.96	1.67	0.84	2.84	3.22	1.01	1.08	0.50	1.21	12.36	18.3	20.2
6000	Control	0.730	0.160	0.260	1.130	0.830	0.500	0.850	1.000	5.46	1.580	0.780	2.660	3.270	0.960	1.050	0.440	1.950	12.69	18.2	20.0
	Phosphorein+P_2O_5	0.720	0.170	0.250	1.110	0.830	0.510	0.830	1.010	5.43	1.580	0.800	2.930	4.70	0.930	1.030	0.450	1.000	13.42	18.9	20.6
	Phosphorein+0.5 P_2O_5	0.680	0.170	0.250	1.070	0.780	0.530	0.900	0.960	5.34	1.530	0.730	2.830	2.930	0.950	1.000	0.490	1.400	11.86	17.2	20.0
	Cotngein	0.680	0.230	0.250	1.000	0.690	0.480	0.800	0.940	5.07	1.520	0.760	2.790	2.700	0.910	0.980	0.370	1.020	11.05	16.1	19.0
	GA_3 (0.1g/l)	0.720	0.170	0.260	1.040	0.780	0.600	0.800	0.930	5.32	1.490	0.760	2.600	3.130	0.890	0.980	0.350	1.000	11.20	16.5	20.0
	Foliafeed C (0.7g /l)	0.750	0.170	0.250	0.960	0.670	0.360	0.840	0.870	4.87	1.589	0.760	2.810	3.310	0.830	0.660	0.410	0.980	11.35	16.2	19.8
	Mean (A)	0.71	0.18	0.26	1.05	0.76	0.50	0.84	0.95	5.25	1.59	0.76	2.77	3.34	0.91	0.95	0.42	1.23	11.93	16.9	19.9

Table (8): Nitrogen, phosphorus and potassium concentrations (mg/g D.W.) in the shoots and roots of flax plant as affected by different levels of salinity (0, 2000, 4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 and foliafeed C application in the two samples of the second season, 2001-2002.

Chemical composition	Plant organ	Shoots										Roots									
	Plant age (days)	60					90					60					90				
	Salinity levels(ppm) A / Treatments B	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)
Calcium	Control	4.87	9.04	17.22	18.84	**12.49**	16.46	16.68	17.29	19.56	**17.50**	1.01	1.85	3.88	6.99	**3.43**	1.73	1.82	1.91	3.44	**2.23**
	Phosphorein +P_2O_5	3.22	7.17	10.45	13.52	**8.59**	10.31	12.18	18.36	21.44	**15.57**	1.52	3.55	6.13	9.68	**5.22**	1.50	1.56	1.95	6.77	**2.95**
	Phosphorein +0.5 P_2O_5	2.74	8.87	9.10	13.20	**8.48**	9.34	13.15	13.74	19.16	**13.85**	1.29	3.90	6.55	7.78	**4.88**	1.20	1.59	1.67	4.50	**2.24**
	Cotngein	4.50	9.71	14.90	18.78	**11.97**	11.66	15.93	16.01	19.11	**15.68**	1.65	2.59	5.18	7.95	**4.34**	0.88	1.98	2.20	6.13	**2.80**
	G A_3 (0.1g/l)	4.10	9.87	15.96	18.81	**12.19**	13.80	15.64	18.12	19.76	**16.83**	1.98	2.01	5.19	8.12	**4.33**	0.94	1.14	2.21	5.41	**2.43**
	Foliafeed C (0.7g /l)	4.65	11.20	18.41	19.20	**13.37**	12.80	19.10	19.32	19.59	**17.70**	1.89	2.06	4.02	6.23	**3.55**	1.19	1.31	2.55	3.92	**2.24**
	Mean (A)	**4.01**	**9.31**	**14.34**	**17.06**		**12.40**	**15.45**	**17.14**	**19.77**		**1.56**	**2.66**	**5.16**	**7.79**		**1.24**	**1.57**	**2.08**	**5.03**	
	L. S. D. at 5 %	A = 0.003 B =0.004 A*B= 0.008					A =0.004 B = 0.005 A*B =0.011					A = 0.048 B = 0.059 A*B =0.118					A = 0.109 B =0.133 A*B= 0.266				
Sodium	Control	2.59	2.92	3.11	3.62	**3.06**	3.25	3.55	3.81	4.04	**3.66**	1.15	1.56	1.82	1.91	**1.61**	1.64	1.78	1.89	2.02	**1.83**
	Phosphorein+P_2O_5	2.23	2.35	2.53	2.58	**2.42**	2.56	2.66	2.70	2.92	**2.71**	1.14	1.52	1.74	1.83	**1.56**	1.59	1.79	1.85	1.93	**1.79**
	Phosphorein +0.5 P_2O_5	2.26	2.39	2.76	2.82	**2.56**	2.58	2.59	2.64	2.84	**2.66**	1.03	1.44	1.56	1.75	**1.45**	1.46	1.65	1.73	1.86	**1.68**
	Cotngein	2.37	2.47	2.68	2.72	**2.56**	2.66	2.63	2.81	2.94	**2.76**	1.07	1.52	1.71	1.79	**1.52**	1.64	1.76	1.87	1.91	**1.80**
	G A_3 (0.1g/l)	2.47	2.59	2.71	2.82	**2.65**	2.87	2.92	2.99	3.00	**2.95**	0.98	1.46	1.67	1.77	**1.47**	1.44	1.65	1.78	1.87	**1.69**
	Foliafeed C (0.7g /l)	2.40	2.50	2.88	2.95	**2.68**	2.67	2.76	2.87	3.00	**2.83**	0.89	1.54	1.68	1.70	**1.45**	1.62	1.76	1.78	1.81	**1.74**
	Mean (A)	**2.39**	**2.54**	**2.78**	**2.92**		**2.77**	**2.85**	**2.97**	**3.12**		**1.04**	**1.51**	**1.70**	**1.79**		**1.57**	**1.73**	**1.82**	**1.90**	
	L. S. D. at 5 %	A = 0.090 B = 0.110 A*B= 0.221					A =0.056 B =0.068 A*B =0.136					A =0.067 B =0.082 A*B =0.162					A =0.051 B = 0.062 A*B= 0.120				
Magnesium	Control	8.83	8.92	12.23	12.39	**10.59**	9.35	10.93	12.72	12.54	**11.39**	4.44	9.25	9.65	10.22	**8.39**	4.32	5.52	7.27	7.65	**6.19**
	Phosphorein+P_2O_5	7.25	8.35	11.23	12.50	**9.83**	9.35	9.85	12.48	12.76	**11.11**	4.80	8.62	9.22	10.67	**8.33**	2.66	3.75	6.85	7.82	**5.27**
	Phosphorein +0.5 P_2O_5	6.39	8.27	11.44	12.25	**9.59**	7.33	8.70	11.75	12.80	**10.15**	3.70	6.00	9.13	10.05	**7.22**	2.46	4.00	4.90	6.07	**4.36**
	Cotngein	7.92	9.22	11.40	11.44	**10.00**	9.13	9.48	12.37	12.38	**10.84**	5.03	5.52	8.12	9.18	**6.96**	3.24	5.37	6.42	6.75	**5.45**
	G A_3 (0.1g/l)	7.31	8.65	12.13	12.20	**10.07**	8.50	10.20	12.59	12.80	**11.02**	4.55	5.62	8.74	9.92	**7.21**	3.82	4.58	6.46	6.71	**5.39**
	Foliafeed C (0.7g /l)	9.20	9.54	11.41	12.22	**10.59**	9.70	11.00	12.32	12.50	**11.38**	5.43	5.96	8.75	9.87	**7.50**	3.24	5.51	6.09	6.79	**5.41**
	Mean (A)	**7.82**	**8.83**	**11.64**	**12.17**		**8.89**	**10.03**	**12.37**	**12.63**		**4.66**	**6.83**	**8.94**	**9.99**		**3.29**	**4.79**	**6.33**	**6.97**	
	L. S. D. at 5 %	A = 0.097 B =0.119 A*B=0.239					A =0.007 B =0.009 A*B =0.017					A =0.118 B =0.144 A*B =0.288					A =0.220 B = 0.269 A*B =0.539				

Table (9): Calcium, sodium and magnesium concentrations (mg/g D.W.) in the shoots and roots of flax plant as affected by different levels of salinity (0, 2000, 4000 and 6000 ppm) as well as phosphorein, cotngein, GA_3 2and foliafeed C application in the two samples of the second season, 2001-2002.

Chemical Composition	Plant organ	Shoots										Roots									
	Plant age (days)	60					90					60					90				
	Salinity levels(ppm) A / Treatments B	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)	Control	2000	4000	6000	Mean (B)
Nitrogen	Control	44.2	43.8	39.0	37.4	**41.1**	37.8	35.5	33.0	32.0	**34.6**	16.9	16.3	15.2	12.1	**15.1**	16.1	15.1	14.6	12.0	**14.5**
	Phosphorein +P_2O_5	46.1	43.5	38.9	36.8	**41.3**	39.0	34.6	33.6	33.0	**35.1**	17.8	17.0	15.8	15.2	**16.5**	16.6	15.7	14.7	12.0	**14.8**
	Phosphorein +0.5 P_2O_5	44.8	41.6	37.4	36.5	**40.1**	38.1	33.0	32.0	32.0	**33.8**	17.5	16.7	16.2	15.0	**16.4**	15.5	15.2	14.5	11.1	**14.1**
	Cotngein	44.1	37.4	36.8	36.2	**38.6**	32.6	31.7	30.7	30.4	**31.4**	17.5	16.1	14.4	11.4	**14.9**	16.2	15.3	13.7	10.6	**14.0**
	GA_3 (0.1g/l)	42.6	41.8	39.0	37.8	**40.3**	36.5	33.3	32.6	32.0	**33.6**	18.3	17.6	16.2	12.6	**16.2**	16.7	16.2	16.0	11.7	**15.2**
	Foliafeed C (0.7g /l)	39.2	39.7	39.1	39.0	**39.2**	35.2	32.6	32.3	31.7	**33.0**	18.8	17.8	16.2	14.2	**16.8**	17.0	16.6	16.0	13.0	**15.7**
	Mean (A)	**43.5**	**41.3**	**38.4**	**37.3**		**36.5**	**33.5**	**32.4**	**31.9**		**17.8**	**16.9**	**15.7**	**13.4**		**16.4**	**15.7**	**14.9**	**11.7**	
	L. S. D at 5 %	A = 0.136 B =0.166 A*B=0.333					A =0.651 B =0.791 A*B =1.581					A =0.516 B =0.632 A*B =1.265					A =0.322 B =0.394 A*B =0.789				
Phosphorus	Control	3.32	3.98	4.00	4.04	**3.84**	3.06	3.16	3.27	3.42	**3.23**	2.44	2.84	2.94	2.98	**2.80**	1.60	1.69	1.89	1.93	**1.78**
	Phosphorein+P_2O_5	4.10	4.32	4.63	4.85	**4.48**	3.74	3.92	4.01	4.46	**4.03**	2.46	2.66	2.82	2.99	**2.73**	1.61	1.65	1.86	1.90	**1.54**
	Phosphorein +0.5 P_2O_5	3.08	3.65	3.81	4.16	**3.68**	3.32	3.88	3.90	4.08	**3.80**	1.75	1.99	2.11	2.69	**2.14**	1.61	1.32	1.77	1.84	**1.76**
	Cotngein	3.45	4.12	4.27	4.78	**4.16**	3.17	3.47	3.64	3.64	**3.48**	1.59	2.03	2.82	2.87	**2.33**	1.50	1.59	1.96	1.99	**1.76**
	GA_3 (0.1g/l)	4.05	4.07	4.28	4.50	**4.23**	3.33	3.54	3.89	3.91	**3.67**	1.96	2.33	2.75	2.85	**2.47**	1.39	1.48	1.56	1.62	**1.51**
	Foliafeed C (0.7g /l)	3.66	3.99	4.51	4.86	**4.26**	3.66	3.74	3.99	4.03	**3.86**	2.40	2.88	2.93	3.00	**2.80**	1.23	1.32	1.57	1.85	**1.49**
	Mean (A)	**3.61**	**4.02**	**4.25**	**4.53**		**3.38**	**3.62**	**3.78**	**3.92**		**2.10**	**2.46**	**2.73**	**2.90**		**1.42**	**1.51**	**1.77**	**1.86**	
	L. S. D at 5 %	A = 0.033 B =0.040 A*B =0.081					A= 0.031 B=0.038 A*B=0.076					A =0.141 B =0.173 A*B =0.346					A = 0.130 B =0.159 A*B =0.318				
Potassium	Control	17.77	14.27	12.31	11.17	**13.88**	11.97	9.49	9.06	7.97	**9.62**	13.14	12.56	11.51	10.39	**11.90**	12.05	11.14	9.80	9.26	**10.56**
	Phosphorein+P_2O_5	19.46	16.44	13.85	10.73	**15.12**	11.98	11.54	10.95	10.73	**11.30**	13.32	13.37	12.00	10.73	**12.36**	12.91	11.99	10.00	9.60	**11.13**
	Phosphorein +0.5 P_2O_5	18.16	16.19	13.26	11.88	**14.87**	11.70	11.20	11.10	10.42	**11.11**	12.96	12.33	11.18	10.49	**11.74**	12.23	11.60	9.22	9.08	**10.53**
	Cotngein	19.28	14.31	13.40	12.16	**14.79**	11.99	11.52	11.34	10.98	**11.46**	13.85	13.09	12.21	10.91	**12.52**	12.70	11.45	10.35	9.60	**11.03**
	GA_3 (0.1g/l)	18.37	14.76	12.43	10.85	**14.10**	12.47	11.58	10.86	8.55	**10.87**	13.71	12.77	11.88	11.11	**12.37**	12.85	11.80	10.03	9.81	**11.12**
	Foliafeed C (0.7g /l)	17.95	14.98	13.27	11.94	**14.45**	12.57	11.80	11.24	11.04	**11.66**	14.18	12.50	12.06	10.78	**12.38**	12.57	11.50	10.16	10.06	**11.07**
	Mean (A)	**18.50**	**15.16**	**13.09**	**11.46**		**12.11**	**11.19**	**10.76**	**9.95**		**13.53**	**12.77**	**11.81**	**10.74**		**12.55**	**11.58**	**9.93**	**9.57**	
	L. S. D at 5 %	A = 0.009 B =0.011 A*B=0.023					A= 0.048 B= 0.059 A*B= 0.119					A =0.285 B =0.349 A*B =0.698					A =0.22 B =0.272 A*B =0.544				

Generally, the reduction in Na concentration by GA_3 foliar application may be due to that growth promoter GA_3 inhibited Na uptake in shoots and roots of salt stressed flax plants. In this respect, Feihu *et al.* (2000) reported that growth regulators (Choline chloride, GA_3, 6-BA and $NaHSO_3$) reduced EC of leaf water extract in ramie. This reveals that the regulators can increase the cell membrane stability, thereby increase the stress resistance of ramie.

Finally, different treatments "phosphorein with full and/or half dose of P_2O_5, cotngein, foliafeed C and GA_3" decreased the influx of Na^+ ions in shoots and roots of salinized flax plants. Thus, the exogenous application of these treatments may be used successfully to ameliorate the stress injuries caused by salinity.

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تأثير الملوحة ،الفوسفورين ، المغذيات الصغرى و الجبريللين على النمو و محصول الألياف و الصفات الكيماوية لنبات الكتان .

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**** المعمل المركزي للأغذية و الاعلاف - مركز البحوث الزراعية - الجيزة - مصر**

أجريت تجربة اصص بالصوبة السلكية للمعمل المركزي للاغذية و الاعلاف بمركز 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 نصف المعدل الموصي به)، الكوتنجين (١٥ جم/ كجم بذرة) ، الفوليافيد ج (٠,٧ جم/ لتر) كمصادر للعناصر الصغري، كذلك استخدام منظم النمو الجبريللين بمعدل ١٠٠ جزء في المليون لتقليل الاثار الضارة الناتجة عن الملوحة علي النمو و محصول الالياف و بعض التقديرات الكيماوية لنبات الكتان. و قد أظهرت النتائج ان زيادة الملوحة أدت الي انخفاض في معظم الصفات المدروسة (ارتفاع النبات، الوزن الجاف للجذور و السيقان و الاوراق و كذلك النبات الكامل، الطول الفعال، قطر الساق، عدد الافرع القمية و محصول القش و الالياف) ، كذلك النسبة المئوية للاحماض الامينية الاساسية و غير الاساسية و البروتين الخام و تركيز النيتروجين و البوتاسيوم بينما سجلت زيادة في السكريات الكلية و بعض الاحماض الامينية (البرولين، أرجنين، الهستيدين) و الفينولات الذائبة و كذلك تركيز الفوسفور و الكالسيوم و الماغنسيوم و الصوديوم بزيادة مستويات الملوحة. علي الجانب الأخر تفوقت المعاملة بالفوسفورين مع التسميد الموصي به علي 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 الفوليافيد ج رشا علي المجموع الخضري كمصدر للعناصر الصغري في معظم صفات النمو و المحصول و الصفات الكيماوية تحت الظروف الملحية و غير الملحية. كما ادي استخدام الجبريللين بمعدل ١٠٠ جزء في المليون الي تقليل بعض التأثير الضار للملوحة علي النمو و المحصول و الصفات الكيماوية.