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SOIL SALINITY PHOSPHORUS AND ZINC FERTILIZATION INFLUENCES ON YIELD, OIL CONTENT AND ZINC UPTAKE BY OILSEED RAPE

EL-Hadidy, E.M.[1]; A.A. Taha[1] and M.M. EL-Zeky[2]

1- Soil Sci., Dep. Fac. Agric., Mansoura University.

2- Soil, Water and Environment Res. Inst. ARC. Giza, Egypt.

ABSTRACT

Two field experiments were conducted in both 1997-98 and 1998-99 growing seasons at EL-Serw Agricultural Research Station, Damietta governorate, Egypt, to study the effect of applying phosphorus fertilizer at two rates, 15 and 30 Kg P_2O_5/Fed., and soil addition of chelating zinc at the rate of 2 Kg element/Fed. under three different levels of natural soil salinity (EC 1.4 - 1.9, 4.6 - 4.8 and 9.1 - 9.8 dS/m) on yield, yield components and oil content as well as the amount of zinc taken up by seeds and straw at maturity stage of rapeseed plant *(Brassica Napus L.)*.

The obtained results showed that the mean values of 1000 seeds weight, seed and straw yields and oil yield per feddan as well as zinc uptake by seeds and straw significantly decreased with increasing soil salinity level.

Results showed that raising phosphorus application rate resulted in increasing 1000 seeds weight, seed, straw and oil yields per feddan. On contrary, the uptake of zinc by seeds and straw were decreased significantly with increasing phosphorus application rate.

The obtained results showed that adding chelating zinc for soil significantly increased all studied characters in both seasons. The highest values of seeds, straw and oil yields were obtained at application rate of 30 Kg P_2O_5/Fed. and addition of 2 Kg Zn/Fed. for oilseed rape plants grown on saline soils.

INTRODUCTION

One of the most important problem in the agricultural sector in Egypt is the shortage of oil production to face the increasing demands of population. Production of oil in Egypt can be increased by expanding the area cultivated with oilseed crops, and maximizing their yields per unit of area. This increase can be achieved by cultivating oilseed crops such as rapeseed which is characterized by high oil content under saline soils, whereas the second target is maximizing the yield per unit of area by using suitable agronomical practices in the field such as phosphorus and zinc fertilization.

Phosphorus is a constituent of many organic compounds in plant and it has an important role in the biological processes of higher plants (Yagodin, 1982). It is essential for plants grown on soils of low phosphorus status (Ward et al., 1985). Rapeseed plant showed a rapid uptake of phosphorus which significantly increased yield and yield components (Sheppard and Bates, 1980; Kandil, 1983 and EL-Baz, 1989).

Zinc plays an important metabolic roles in the plant. One of them is that it enters as a component in numbers of enzymes, such as dehydrogenases, proteinases and peptidases (Price, 1970). Therefore metabolism is strongly affected by zinc deficiency.

Studies on phosphorus-zinc interaction in plant showed that high phosphorus fertilization level reduced zinc utilization by plant (Boawn and Brown, 1968). Nutritional problems of cultivated plants related to phosphorus and zinc fertilization are common and has become known as P-induced Zn deficiency especially in soils having high pH values such as salt affected soils in the northern part of Egypt. Zinc additions to soil may also be needed to satisfy the balanced nutrition status for plants, especially under high phosphatic fertilization (Nychas and Skarlou, 1983 and Ibrahim et al., 1984).

The aim of the present study is to investigate for what extent the application of phosphorus fertilizer and also the soil addition of chelating zinc can contribute in the improving yield and yield components, oil content and zinc uptake by rapeseed plants *(Brassica Napus L.)* grown under saline conditions.

MATERIALS AND METHODS

In two successive seasons, 1997/98 and 1998/99, two field experiments were conducted at EL-Serw Agricultural Research Station, Damietta governorate, Egypt. The investigation was performed to study the influence of different levels of soil salinity, phosphorus fertilization and soil addition of zinc on the uptake of zinc by oilseed rape plant and the reflection of these treatments on the yield and yield components of rapeseed plant *(Brassica Napus L.)*.

Three experimental sites were chosen in every season according to their salinity levels to carry out the field experiment. The levels of soil salinity were 1.4-1.9, 4.6-4.8 and 9.1-9.8 DS/m. The experiment was arranged following split plot design with four replicates. Two phosphorus levels namely: 15 and 30 Kg P_2O_5/Fed. were applied in the main plots, while the sub plots (two treatments) received chelating zinc at the rate of 2 Kg Zn/Fed. and the other treatment was without Zn additions (control). Combined analyses over salinity were performed. The plot area was 10.5 m^2 and the preceding crop was corn in the first season and cotton in the second season. In the two seasons rapeseed seeds were sowing on ridges, 60 cm width and 15 cm between hills. All experimental plots were treated with nitrogen fertilizer (Ammonium nitrate, 33.3% N) in two equal doses to secure the rate of 67 Kg N/Fed. Chelating zinc was added. after thinning operation, while phosphorus fertilizer (concentrated calcium phosphate 37% P_2O_5) was added before planting. All other cultivation practices were followed as recommended. The physical and chemical analyses of the soil before planting are presented in Table (1).

At harvest, in each experimental plot, 1000 seeds weight was recorded, seeds and straw yields were recorded. Dry weight of seeds and straw yields per feddan were calculated. Oil content of seeds was determined by using soxhlet apparatus. Oil yield per feddan was calculated by multiplying seed yield per feddan by oil percentage. Zinc concentration in the acidic digests of both seeds and straw was determined by using Atomic Absorption Spectrophotometer according to Lanyon and Heald (1982). Zn uptake by seeds and straw were calculated by multiplying Zn concentration in seeds and straw dry weights.

Data were exposed to proper statistical analysis of variance according to Snedecor and Cochran (1967).

Table (1): The physical and chemical analysis of the experiment soil before planting.

Soil properties	1st season	2nd season
Practicle size distribution		
Coarse sand %	1.56	1.60
Fine sand %	12.52	12.32
Silt %	21.78	20.06
Clay %	64.14	66.02
Texture class	Clayey	Clayey
Organic matter %	1.08	1.20
$CaCo_3$ %	2.40	2.50
C.E.C., meq/100 g soil	51	52
Available P (ppm)	12	10
Available Zn (ppm)	1.20	1.12
Salinity levels:		
S1	1.4 DS/m	1.9 DS/m
S2	4.6 DS/m	4.8 DS/m
S3	9.1 DS/m	9.8 DS/m
pH 1:2.5 soil suspen.	7.9-8.1	7.8-8.1
E.S.P, meq/100 g soil	8.5	9.1

RESULTS AND DISCUSSIONS

1- The weight of 1000 seeds :

Data presented in Table (2) showed that there was a significant decrease in the weight of 1000 seeds caused by increasing soil salinity level. The mean values were 6.32, 5.70 and 5.29 g/1000 seeds under salinity levels of 1.4-1.9, 4.6-4.8 and 9.1-9.8 ds/m, respectively. These results could be attributed to the assumption that a further increase in soil salinity level extended the period of siliqua formation and seed filling. These results are in harmony with those of Qandil et al., (1995). On the other hand, the same data revealed that the weight of 1000 seeds was increased significantly due to increasing phosphorus application rate. The mean values were 5.70 and 5.84 g/1000 seeds for phosphorus application rates of 15 and 30 Kg P_2O_5/Fed., respectively. These results are in agreement with the Findings of EL-Baz (1989).

The same data indicated that the addition of Zn resulted in a significant increase in the weight of 1000 seeds. The mean values were 5.60 and 5.85 g/1000 seeds for the treatments of control and addition of 2 Kg Zn/Fed., respectively.

Table (2): Weight of 1000 seeds and oil yield of rapeseed plant at maturity as affected by soil salinity, phosphorus and zinc fertilization levels in the two seasons.

Character	1000 seeds weight			Oil yield		
Treat.	1st seas.	2nd seas.	Mean	1st seas.	2nd seas.	Mean
Salinity level	← 1000 seeds, g →			← kg/fed →		
S1	6.27	6.37	6.32	363.9	375.3	369.6
S2	5.67	5.74	5.70	337.7	344.5	341.1
S3	5.20	5.37	5.29	293.8	301.6	297.7
F. Test	**	**		**	**	
L.S.D. at 5%	0.115	0.034		0.430	1.39	
P. Treat.						
15 kg P_2O_5/fed	5.66	5.74	5.70	328.4	338.7	333.6
30 kg P_2O_5/fed	5.77	5.91	5.84	335.2	342.3	338.8
F. Test	**	**		**	**	
L.S.D. at 5%	0.022	0.014		0.351	1.14	
Zn treat.						
Control	5.60	5.60	5.60	314.8	321.5	318.2
2 kg Zn/fed	5.81	5.89	5.85	339.1	345.3	342.2
F. Test	**	**		**	**	
L.S.D. at 5%	0.124	0.210		1.143	1.59	

S1 = 1.4-1.9 dS/m, S2 = 4.6-4.8 dS/m and S3 = 9.1-9.8 dS/m

2- Seed and straw yields:

Data in Table (3) revealed a significant decrease in both seed and straw yields with increasing soil salinity level. This reduction in seed yield was markedly less than straw yield. These reductions in seed yields were 6% and 18% for the soil salinity levels of 4.6 and 9.1 ds/m, respectively compared with the first level of 1.4 dS/m (control) in the first season, while the reductions were 7.8% and 19% less than control in the second season. The reduction in straw yields were 8% and 20% for the two above mentioned soil salinity levels, respectively in the first season, while the reductions in straw yields in the second season were 8.1% and 26% compared with the control. These results may be due to the effect of excessive concentration of soluble salts on stunting plant growth and subsequently the reduction in vegetative growth which reflected on dry matter accumulation and lower numbers of flowers, siliqua formation and seed filling and then affected negatively the final yield.

On the other hand, data showed a significant increase on both seed and straw yields caused by the increase of phosphorus application rate. These results indicated that phosphorus is an essential element required for some physiological processes, energy transfer reactions, phospholipids, phytin and producing more dry matter which reflected on increasing the final yield. Similar results were previously obtained by Sheppard and Bates (1980) and EL-Baz (1989).

Table (3): Seed and straw yields of rapeseed plant at maturity stage as affected by soil salinity, phosphorus and zinc fertilization levels in the two seasons.

Character	Seed yield			Straw yield		
Treat.	1st seas.	2nd seas.	Mean	1st seas.	2nd seas.	Mean
Salinity level	← kg/fed →			← Ton/fed →		
S1	842.9	873.7	828.3	2.75	2.87	2.81
S2	791.3	806.9	799.1	2.53	2.63	2.58
S3	691.7	707.3	699.5	2.21	2.12	2.16
F. Test	**	**		**	**	
L.S.D. at 5%	9.28	9.65		0.01	0.01	
P. treat.						
15 kg P_2O_5/fed	766.7	791.6	779.2	2.47	2.50	2.48
30 kg P_2O_5/fed	783.9	800.3	792.1	2.53	2.58	2.56
F. Test	**	**		**	**	
L.S.D. at 5%	7.58	7.89		0.008	0.008	
Zn treat.						
Control	738.8	751.7	745.7	2.37	2.36	2.36
2 kg Zn/fed	786.3	808.0	797.2	2.55	2.57	2.56
F. Test	**	**		**	**	
L.S.D. at 5%	10.74	2.64		0.015	0.017	

S1 = 1.4-1.9 ds/m, S2 = 4.6-4.8 ds/m and S3 = 9.1-9.8 ds/m

Regarding to the effect of zinc addition on seed and straw yields of rapeseed plants, the same data showed that there were a significant increases in both seed and straw yields due to adding zinc fertilizer. The increment percentages in seed and straw yields were 7% and 8%, respectively above control treatment (without zinc addition). The improvement of rapeseed yield as a result of applying zinc fertilizer may be attributed to the role of zinc in maintenance of auxins in active state, synthesis of indole acetic acid, having indirect effect on water absorption, component of several respiratory enzymes and nitrogen metabolism which lead to an increment in the amount of nuclic acids, chlorophyll, vitamins, auxins and vegetative growth and in turn affects the final yield. These results are in agreement with those obtained by Genaidy et al. (1991).

3- Oil yield:

Data presented in Table (2) showed that increasing soil salinity level resulted in a high significant decrease in oil yield of rapeseed plants. The reductions in oil yield due to increasing soil salinity level were 8% and 20% under soil salinity levels of 4.6-4.8 and 9.1-9.8 dS/m, respectively compared with control level (1.4-1.9 dS/m). These results could be explained on the basis that the successive salts content in saline soil decreases seed yield of rapeseed plant and subsequently decreases the oil yield. The same data indicated that application of 30 Kg P_2O_5/Fed. resulted in a high significant increase in oil yield of rapeseed plant. This increment is namely due to the increase in seed yield with increasing phosphorus application rates as shown before and also to the effect of sulphate ion, included in phosphate fertilizer, on essential oils and glycosides synthesis. Regarding to the effect of applying Zn on oil yield, data revealed that the addition of chelating Zn resulted in increasing oil yield by 8% more than control (without Zn addition).

4- Zinc uptake by seed and straw:

Data in Table (4) revealed a significant negative relationship between soil salinity levels and zinc uptake by seeds and straw of rapeseed plant at maturity stage. The mean values of zinc uptake by seeds are 37.06, 32.85 and 26.39 g/fed. under soil salinity levels of 1.4-1.9, 4.6-4.8 and 9.1 9.8 ds/m, respectively, while the mean values of zinc uptake by straw are 83.63, 73.36 and 56.25 g/Fed. under the above mentioned soil salinity levels, respectively. These results may be attributed to the effect of soil salinity on decreasing both zinc concentration in plant tissue, induced by less water taken up by plant, and the dry matter accumulation of seeds and straw. These results are in agreement with those obtained by Farrag (1978).

Data also showed a significant decrease in zinc uptake by seeds and straw with raising phosphorus application rate. These results may be due to the antagonism between phosphorus and zinc within the plant tissue which affected the uptake, translocation and utilization of zinc. These results are in agreement with those obtained by Sankhyan and Sharma (1997). On the other hand, data showed a high significant increase in zinc uptake by seed and straw as a result of zinc fertilizer addition. It may be due to not only the increasing available zinc in the root zone and then the concentration of zinc, but also to its effect on water absorption which play an important role in growth processes.

Table (4): Zn uptake by seed and straw of rapeseed plant at maturity stage as affected by soil salinity, phosphorus and zinc fertilization level in the two seasons.

Character	**Zn uptake by seed**			**Zn uptake by straw**		
Treat.	1st seas.	2nd seas.	Mean	1st seas.	2nd seas.	Mean
Salinity level	← g/fed →					
S1	35.96	38.15	37.06	81.25	86.00	83.63
S2	31.99	33.71	32.85	71.01	75.71	73.36
S3	25.73	27.06	26.39	56.88	55.63	56.25
F. Test	**	**		**	**	
L.S.D. at 5%	1.00	0.32		2.08	0.86	
P. Treat.						
15 kg P_2O_5/fed	32.36	34.72	33.54	72.26	74.64	73.45
30 kg P_2O_5/fed	30.09	31.22	30.66	67.17	70.25	68.71
F. Test	**	**		**	**	
L.S.D. at 5%	0.82	0.26		1.70	0.70	
Zn treat.						
Control	25.49	25.67	25.58	55.06	56.03	55.54
2 kg Zn/fed	33.92	35.71	34.82	76.35	77.27	76.81
F. Test	**	**		**	**	
L.S.D. at 5%	0.88	0.97		2.43	3.30	

S1 = 1.4-1.9 dS/m, S2 = 4.6-4.8 dS/m and S3 = 9.1-9.8 dS/m

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أثر ملوحة التربة والتسميد بالفوسفور و الزنك على المحصول ومحتوى الزيت وامتصاص الزنك بواسطة نبات الكانولا

السيد محمود الحديدى[1] ـ أحمد عبد القادر طه[1] ـ محمد محسن مسعد الزكى[2]
1- قسم الأراضى بكلية الزراعة – جامعة المنصورة.
2- معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية - الجيزة - مصر.

أجريت تجربتان حقليتان فى موسمى 1997-1998، 1998-1999 فى محطة البحوث الزراعية بالسرو - محافظة دمياط لدراسة تأثير ملوحة التربة والتسميد الفوسفاتى وإضافة الزنك المخلبى للتربة على امتصاص عنصر الزنك وانعكاس ذلك على المحصول ومكوناته لمحصول الشلجم (الكانولا) النامى تحت ظروف متباينة من ملحية التربة. أجريت التجربة فى أرض ذات ثلاث مستويات من ملحية التربة هى: 4.1 - 1.9 ملليموز/سم، 4.6 - 4.8 ملليموز/سم و9.1 - 9.8 ملليموز/سم. كما اشتملت الدراسة على مستويين من التسميد الفوسفاتى 15، 30كجم فو$_2$أ$_5$/فدان (كقطع رئيسية) أما القطع الشقية فكانت عبارة عن معاملتين هى الكنترول وإضافة الزنك المخلبى للتربة بمعدل 2 كجم عنصر/فدان.

هذا ويمكن تلخيص أهم النتائج المتحصل عليها فى الآتى:

أدت زيادة ملحية التربة إلى حدوث نقص معنوى ملحوظ (خصوصاً المستوى الثالث من الملحية) فى وزن الألف بذرة بالجرام ومحصول البذور (كجم/فدان) ومحصول القش (طن/فدان) ومحصول الزيت (كجم/فدان) والكمية الممتصة من الزنك بواسطة كل من البذور والقش فى مرحلة النضج (جرام/فدان).

أظهرت النتائج أيضاً أنه مع زيادة معدل التسميد الفوسفاتى إلى 30 كجم فو$_2$أ$_5$/فدان حدثت زيادة معنوية فى كل الصفات المدروسة مقارنة بالكنترول فيما عدا الكمية الممتصة من الزنك بواسطة كل من البذور والقش فى مرحلة النضج حيث نقصت معنوياً بزيادة مستوى التسميد الفوسفاتى.

أظهرت النتائج أيضاً أن إضافة الزنك المخلبى للتربة بمعدل 2 كجم/فدان أدى إلى زيادة معنوية فى كل الصفات المدروسة بما فيها الكمية الممتصة من الزنك بواسطة كل من البذور والقش فى مرحلة النضج فى كلا الموسمين.