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SOIL SALINITY AND FERTILIZATION INFLUENCES ON Fe AND Mn UPTAKED BY OIL SEED RAPE

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ABSTRACT

Two field experiments were performed at EL-Serw Agricultural Research Station, Damietta Governorate, Egypt, during 1997-98 and 1998-99 growing seasons, to study the influence of phosphorus fertilizer applied in two rates, 15 and 30 kg P_2O_5/fed. and soil additions of chelating iron and manganese at the rate of 2 kg elements/fed. On the yield, yield components as well as both Fe and Mn uptakes of seeds and straw at maturing stage of oil seed rape plant *(Brassica Napus L.)* grown on soils differ in their natural salinity levels (EC of soil extracts were 1.4-1.9, 4.6-4.8 and 9.1-9.8 ds/m).

The obtained results showed that increasing soil salinity levels induced a significant decrease in 1000 seeds weight, seed and straw yields per feddan, oil yield as well as both Fe and Mn uptakes of seeds and straw at maturity stage.

Results showed that increasing phosphorus application rate up to 30 kg P_2O_5/fed. caused significant increases in 1000 seeds weight, seed, straw and oil yield. Also, Mn uptakes of seeds and straw were increased, while Fe uptake of seeds and straw was significantly decreased with increasing phosphorus application rate in the two seasons. The obtained results showed that the highest values of Fe uptakes of seeds and straw were obtained at the addition of chelating Fe, while the lowest values were obtained at the addition of Mn fertilizer alone. Also, the highest values of Mn uptake were obtained at the addition of chelating Mn, while the lowest values were obtained from applying chelating Fe alone.

INTRODUCTION

The studies carried out in Egypt over the last decade concluded that it is impossible to rely on cotton and maize for providing population with their future requirements of oil. Since it is difficult to increase their cultivated area throughout the Nile Valley, cultivating a new and non-traditional oil crops such as oil seedrape which contains low level of erucic acid in the newly reclaimed soils seems to be one of the most promising solution to close up the increasing gap between the production and consumption of seed oil. The seeds of rape crop contain high oil content ranging between 40-50% (Susulski, 1983).

Oilseed rape cultivars yield potential and its quality was found to be highly affected by several environmental factors (Jonsson, 1975). Among these factors, soil salinity (Rupa *et al*., 1987). They revealed that seed yield per plant and 1000-seeds weight also decreased with increasing soil salinity in all Brassica species. Qandil *et al*., (1995) found that increasing soil salinity level resulted in decreasing yield and its components (e.g. seed yield/plant, 1000 seeds weight as well as oil content). This depressive effect was increasingly prominent with increasing soil salinity level. Also, phosphorus is one of the most important factors that affects the final yield of rapeseed plant (Sheppard and Bates, 1980; Kandil, 1983 and EL-Baz, 1989). Another factor affected the yield and its quality is applying micronutrients (Awadh, 1991 and Mousa, 1998).

Phosphorus-iron-manganese interactions have been reported (Randall, 1981). The concentration of Mn in the growth medium apparently interferes with iron absorption, translocation and utilization (Epestein and stout, 1951; Biddulph and Woodbridge, 1952). Therefore, this investigation was carried out to study the possibility of increasing or maximizing yield and yield components of rapeseed plant *(Brassica Napus L.)* grown on salt affected soils by applying phosphorus fertilizer and chelating Fe and Mn and to study for extent, these treatments which can contribute in the improvement of the uptake of both Fe and Mn by oilseed rape plant *(Brassica Napus L.)*.

MATERIALS AND METHODS

In two successive seasons, 1997-98 and 1998-99, two field experiments were carried out at EL-Serw Agricultural Research Station, Damietta Governorate, Egypt. The investigation was directed to study the effect of different levels of soil salinity, phosphorus fertilization and addition of Fe and Mn on the uptake of those micronutrients by oilseed rape plant and the reflection of these treatments on the yield and yield components of oilseed rape plant *(Brassica Napus L.)*, variety Pactol.

Three experimental sites were chosen for every season according to their salinity levels to carry out these field experiments. These levels of soil salinity were 1.4-1.9, 4.6-4.8 and 9.1-9.8 ds/m. The experiments were conducted following split plot design with four replicates. Two phosphorus levels namely; 15 and 30 kg P_2O_5/fed., were arranged in the main plots, while the sub-plots received three treatments, control treatment (without micronutrients addition), addition of chelating Fe at the rate of 2 kg Fe, and the addition of chelating Mn at the rate of 2 kg Mn/Fed. Combined analysis over salinity was performed. The plot area was 10.5 m^2, where the preceding crop was corn in the first season, while it was cotton in the second season. In the two seasons, rape plant, seeds were sowing on ridges, 60 cm width and 15 cm between hills. All experimental plots were treated with nitrogen fertilizer in two equal doses to secure the rate of 67 kg N/fed. Chelating Fe and Mn added at the rate of 2 kg elements/fed. after thinning operation, while phosphorus fertilizer as concentrated calcium phosphate (37% P_2O_5) was added to each plot before planting. All other cultivation practices were followed as recommended. The physical and chemical analysis of the soils before planting are presented in Table (1).

At harvest, in each experimental plot, 1000 seeds weight, seeds and straw yields were recorded. Dry weight of seeds and straw yield per feddan were calculated. Oil content of seeds was determined by using soxhlet apparatus and oil yield per feddan was calculated by multiplying seed yield per feddan by oil percentage. Both Fe and Mn concentration in nitric acid digests of seeds and straw were determined by using Atomic Absorption Spectro-photometer according to Lanyon and Heald (1982). Fe and Mn uptakes of seeds and straw were calculated by multiplying concentration of each element by seed and straw dry weight. Data were exposed to proper statistical analysis of variance according to Snedecor and Cochran (1967).

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

	1st seasons	**2nd season**
Practical 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 Fe (ppm)	6.1	6.00
Available Mn (ppm)	4.1	3.90
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 rape seeds:

Data presented in Table (2) showed that there was a significant decrease in the weight of 1000 rape seeds as a results of increasing soil salinity level. The reductions percentages are 10 and 16% below that of the control level of salinity, under soil salinity levels of 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 for siliqua formation and seed filing. These results are in agreement with those obtained by Qandil *et al.* (1995).

On the other hand, data indicated that increasing phosphorus application rate resulted in a significant increase in the weight of 1000 seeds of oilseed plant. The average values are 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 harmony with findings of EL-Baz (1989).

The same data indicated that the addition of micronutrients (e.g. Fe and Mn) resulted in a significant increase in the weight of 1000 seeds. The average values are 5.60, 5.70 and 5.78 g/1000 seeds for treatments of control (without micronutrients addition), Fe and Mn additions, respectively. Such response may be due to the physiological, chemical effects and role of Fe and Mn on enzymes synthetase and functions on plant growth as well as yield and yield components. Similar results were obtained by Mousa (1998).

Table (2): 1000 seeds weight and oil yield of rapeseed plant at maturity stage as affected by soil salinity and P fertilization levels in the two seasons.

Studied variables	1000 seeds weight			Oil yield		
	1st seas.	2nd seas.	Mean	1st seas.	2nd seas.	Mean
Salinity level	←— g/1000 seeds —→			←— 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%	0.023	0.077		0.351	1.14	
Micro treat.						
Control	5.60	5.60	5.60	314.8	321.5	318.2
Fe 2 kg/fed	5.67	5.72	5.70	321.8	332.0	326.9
Mn 2 kg/fed	5.74	5.82	5.78	330.0	341.0	335.5
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) showed that raising soil salinity level induced a significant decrease in both seed and straw yields. It was noticeable that the reduction was markedly less for seed yield than straw yield. The average values of reductions in seed yield were 7% and 18.5% for salinity levels of 4.6-4.8 and 9.1-9.8 ds/m, respectively below the control (1.4-1.9 ds/m), while the average values of reductions in straw yields were 8% and 23% for the above mentioned soil salinity levels, respectively below the control level. These results may be attributed to the effect of excessive concentration of soluble salts on stunting plant growth and the reduction of vegetative growth which reflected in lowering number of flowers, silique formation and seed filling and subsequently affects negatively the final yield.

On the other hand, data revealed a significant increase in both seed and straw yields caused by increasing the rate of phosphorus application. These results indicated that phosphorus is an essential nutrient required for some physiological processes and fruit ripening which reflected in increasing the yield. Similar results were previously obtained by Sheppard and Bates (1980) and EL-Baz (1989). The same data showed that a significant increase in both seed and straw yield was obtained by applying Fe and Mn. Data revealed that there was a variant response in seed and straw yields as a result of applying Fe and Mn. The increment percentages of seed yield were 3% and 5% for adding Fe and Mn, respectively, while these increments were 4% and 7% with respect to straw yield. Similar results were obtained by Awadh (1991) and Mousa (1998).

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

Studied Variables	Seed yield			Straw yield		
	1st seas.	2nd seas.	Mean	1st seas.	2nd seas.	Mean
Salinity level	← kg/fed →			← ton/fed →		
S1	842.9	873.7	858.3	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	796.6	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	
Micro treat.						
Control	739.8	751.7	745.7	2.37	2.36	2.37
Fe 2 kg/fed	754.3	776.8	765.5	2.44	2.45	2.45
Mn 2 kg/fed	773.5	799.2	786.3	2.49	2.55	2.52
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

3- Oil yield:

Data presented in Table (2) showed that increasing soil salinity level significantly decreased the oil yield of oilseed rape plant per feddan. Data revealed that when oil yield was exposed to soil salinity level, it was reduced by 8% and 20% under soil salinity levels of 4.6-4.8 and 9.1-9.8 ds/m, respectively below the control level of 1.4-1.9 ds/m. These results could be explained on the basis that the excessive salts content affects soil moisture stress, decreases water and nutrients uptakes and disturbance of nutrients balance, which in turn reduced the final yield and subsequently decreased the oil yield.

The same data indicated that the application of 30 kg P_2O_3/fed resulted in a high significant increase in oil yield of rapeseed plant. This increment is mainly due to the increase of seed yield with increasing phosphorus application rate as shown before. Also, there were significant increases in oil yield due to addition of chelating Fe and Mn. The increment percentages are 4% and 5.4% over control, for applying Fe and Mn, respectively.

4- Fe uptake of seed and straw yield:

Data in Table (4) showed a significant decrease in Fe uptake by both seed and straw at maturity stage. The mean values of Fe uptake by seeds are 47.9, 42.1 and 33.7 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 Fe uptake by straw are 307, 265 and 201 g/fed under the above mentioned soil salinity levels, respectively. These results may be attributed to the depressive effect of high salt concentration on dry matter accumulation of seeds. The same data indicated that were significant decrease in Fe uptake by seed and straw due to increasing phosphorus application rate in the two seasons. It may be attributed to decreasing Fe mobility within the plant and subsequently reducing its activity.

On the other hand, data showed that addition of chelating Fe resulted in a high significant increase in Fe uptakes of seed and straw yield. It could be noticed that adding Mn alone caused a significant decrease in Fe uptakes of seed and straw. These results may be due to the competition between Fe and Mn in their metabolic functions and the interference of Mn with the intake and movement of Fe within the plant (Epstein and Stout, 1951).

Table (4): Fe uptake by seed and straw yields of rapeseed plant at maturity stage as affected by soil salinity and phosphorus fertilization levels in the two seasons.

Studied Variables	Fe uptake by seed			Fe uptake by straw		
	1st seas.	2nd seas.	Mean	1st seas.	2nd seas.	Mean
Salinity level	← g/fed →					
S1	47.04	48.68	47.86	304	310	307
S2	41.78	42.46	42.12	262	267	265
S3	33.26	34.17	33.72	207	195	201
F. Test	**	**		**	**	
L.S.D. at 5%	0.60	0.51		3.07	2.99	
P. treat.						
15 kg P_2O_5/fed	42.67	44.36	43.52	278	275	277
30 kg P_2O_5/fed	38.78	39.18	38.98	236	239	237
F. Test	**	**		**	**	
L.S.D. at 5%	0.49	0.42		2.51	2.44	
Micro treat.						
Control	34.91	35.07	34.99	227	217	222
Fe 2 kg/fed	43.31	44.60	43.96	265	267	266
Mn 2 kg/fed	35.76	36.01	35.88	227	227	227
F. Test	**	**		**	**	
L.S.D. at 5%	1.13	0.90		3.58	4.37	

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

5- Mn uptake of seed and straw:

Data in Table (5) revealed a significant negative relationship between soil salinity level and Mn uptake by seed and straw yields. Concerning the effect of applying phosphorus fertilizer, the obtained data revealed that there was a significant increase in Mn uptake by seed in the two seasons and also in Mn uptake by straw only in the first season. These results may be attributed to influence of phosphorus on increasing dry matter production.

The same data revealed that the addition of chelating Mn caused a high significant increase in Mn uptake by both seed and straw at maturity stage, while adding Fe alone caused a significant decrease in Mn uptake by both seed and straw of rapeseed plants at maturity. These results may be attributed to the competition between Fe and Mn which affects the movement and translocation and then amount of Mn taken up by plant roots (Epstein and Stout, 1951).

Table (5): Mn uptake by seed and straw of rapeseed plant at maturity stage as affected by soil salinity and phosphorus fertilization levels in the two seasons.

Studied variables	Mn uptake by seed			Mn uptake by straw		
	1st seas.	2nd seas.	Mean	1st seas.	2nd seas.	Mean
Salinity level	← g/fed →					
S1	30.04	29.68	29.86	123.2	126.4	124.8
S2	29.67	28.87	29.27	117.7	122.1	119.9
S3	26.55	25.87	26.21	107.2	100.6	103.9
F. Test	**	**		**	**	
L.S.D. at 5%	0.73	0.58		1.25	1.88	
P. treat.						
15 kg P_2O_5/fed	28.44	28.32	28.38	116.7	116.2	116.5
30 kg P_2O_5/fed	29.07	29.96	29.52	117.3	116.2	116.8
F. Test	*	*		*	N.S.	
L.S.D. at 5%	0.59	0.42		1.02	--	
Micro treat.						
Control	25.07	23.89	24.50	104.3	98.9	101.6
Fe 2 kg/fed	22.48	21.30	21.90	94.5	92,9	93,7
Mn 2 kg/fed	31.43	32.01	31.70	128.9	128.6	128.8
F. Test	**	**		**	**	
L.S.D. at 5%	0.92	0.98		3.69	2.99	

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 على امتصاص الحديد والمنجنيز بواسطة الكانولا

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أجريت تجربتين حقليتين فى موسمى 1997-1998، 1998-1999 فى محطة البحوث الزراعية بالسرو ــ محافظة دمياط تحت ظروف الحقل لدراسة تأثير ملوحة التربة والتسميد الفوسفاتى وإضافة كل من الحديد والمنجنيز على امتصاص عنصرى الحديد والمنجنيز وانعكاس ذلك على محصول ومكونات محصول الكانولا النامى تحت ظروف مختلفة من ملحية التربة.

اشتملت التجربة على ثلاث مستويات من ملوحة التربة وهم المستوى الأول 1.4-1.9 ملليموز/سم والمستوى الثانى 4.6-4.8 ملليموز/سم والمستوى الثالث 9.1-9.8 ملليموز/سم.

اشتملت الدراسة على مستويين من التسميد الفوسفاتى 15، 30 كجم فو2أ5/فدان (كقطع رئيسية)، أما القطع الشقية فكانت 3 معاملات هى الكنترول ــ إضافة الحديد بمعدل 2 كجم عنصر/فدان وإضافة المنجنيز بمعدل 2 كجم عنصر/فدان. وتتلخص النتائج المتحصل عليها فيما يلى:

- أدت زيادة ملوحة التربة إلى نقص معنوى فى وزن الألف بذرة بالجرام ــ محصول البذرة (كجم/فدان) ــ محصول القش (طن/فدان) وكذلك محصول الزيت (كجم/فدان) ــ الكمية الممتصة من كل من الحديد والمنجنيز (بالجرام/فدان).
- أظهرت النتائج أنه مع زيادة التسميد الفوسفاتى إلى 30 كجم فو2أ5/فدان حدثت زيادة معنوية فى كل الصفات المدروسة مقارنة بالكنترول ماعدا الكمية الممتصة من الحديد حيث نقصت معنوياً بزيادة مستوى التسميد الفوسفاتى.
- أظهرت النتائج أيضاً أن إضافة الحديد المخلبى أدت إلى زيادة معنوية فى كل الصفات المدروسة ماعدا الكمية الممتصة من المنجنيز بواسطة كل من البذور والقش. كما أدت إضافة المنجنيز المخلبى إلى زيادة معنوية فى كل الصفات المدروسة ماعدا الكمية الممتصة من الحديد بواسطة كل من البذور والقش فى كلا موسمى الدراسة.
- تم الحصول على أعلى قيمة للكمية الممتصة من الحديد من إضافة الفوسفور بمعدل 15 كجم فو2أ5/فدان مع إضافة الحديد المخلبى للمستوى الأول من ملحية التربة (1.4-1.9 ملليموز/سم). أما أعلى قيمة للكمية

الممتصة من المنجنيز فكانت مع إضافة الفوسفور بمعدل 30 كجم فو$_2$أ$_5$/فدان مع إضافة المنجنيز المخلبى للمستوى الأول من ملحية التربة (1.4-1.9 ملليموز/سم).