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EFFECT OF GYPSUM AND NPK-FERTILIZATION ON BARLEY PLANTS GROWN ON SALINE SODIC SOIL AT El-HUSSINIA REGION

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ABSTRACT

A pot experiment was carried out during 2007-2008 season to evaluate the response of barley plants (Hordeum vulgare L.) cv. Giza 126 grown on heavy clay saline sodic soil from El-Hussinia region to different levels of NPK-fertilization with or without gypsum addition. Three N-levels, two for P and two for K were applied. Gypsum and phosphorus treatments were applied before sowing seeds whereas N and K fertilizers were applied as two equal split doses after 4 and 6 weeks respectively. Contents of dry matter of grown plants as well as their total NPK uptake were determined in barley shoots after 10 weeks (vegetative period) and 20 weeks (harvest period).Obtained results indicated that increasing the application of N-fertilizer without gypsum treatment seemed to be significantly favorable for dry matter and total uptake of N and K nutrients; P-content and its total uptake were, however, decreased significantly during the vegetative growth period. However, increasing the application of N-fertilizer with gypsum treatment increased the dry matter and total uptake of N, P and K nutrients during the first growth period. Application of P fertilizer with or without gypsum treatment was not effective on the dry matter and both P-content and its total uptake during the vegetative growth period. On the other hand, application of K-fertilizer without gypsum treatment led to significant increase in the dry matter, K-content and total K-uptake at same growth period. Concerning the harvest period, it is clear that increasing the N-fertilizer level either alone or in combination with gypsum treatment led to increase the dry matter and total uptake of N. However, increasing the P or K-fertilizer levels either alone or in combination

with gypsum treatment led to increase the dry matter and total uptake of nutrients at the harvest growth period.

Key words: barley plants, NPK mineral fertilizers, saline sodic soil, gypsum

INTRODUCTION

Salt affected soils occupy wide regions scattered all over the world [about 954 millions of hectares, Szaboles (1989)]; salt stress is one of the most serious limiting factor for crop growth and production in arid and semi-arid regions. In Egypt, the north regions are mainly saline or saline-sodic soils with heavy texture. El-Hussinia region is one of the new reclaimed saline- sodic soils after drying large area from El-Manzala Lake. This area is not only heavy texture with inherited high saline- sodic characteristics but also the growers use low-quality irrigation water from El-Salam canal; it is a mixture between fresh Nile water with drainage water (1:1) under the optimum conditions.

Barley is widely grown in the arid and semi-arid regions either as for forage purposes or as a grain crop. Al-Karaki (2001) and Othman (2005) stated that most cereals including barley are more salt-tolerant at germination than at seeding stage. Mohamed *et al* (2003) found that the barley plants grown under high saline conditions recorded low dry matter, tiller number and plant height compared to those plants grown on moderate or low saline conditions. In spite of that, Abou Hussien *et al* (2002) reported that the application of P-fertilizer alone or with Zn, Mn, or FYM led to increase the dry matter of barley plants grown on saline soil. Endris and Mohamed (2007) added that application of potassium to barley plants grown on medium saline soil led to increase the yield and its components parameters. Finally, El-Dardiry (2007) studied the effect of application soil amendments, gypsum and organic manure, and saline water ranged between 0.5 to 11.7dS/m on the germination of barley, Giza 58. He found that increasing water salinity significantly reduced percentage and rate of barley germination by application 1.5 and 2.5 ton/ fed of gypsum.

The present study was carried out to investigate the effect of application for different rates of mineral N, P and K fertilizers either alone or in combination with gypsum on dry matter and nutrient

uptake at two growth stages (vegetative, 10 weeks, and harvest, 20 weeks) of barley plants grown on heavy texture saline sodic soil from El-Hussinia region.

MATERIALS AND METHODS

A pot experiment was carried out at the green-house of the Soils Dept, Faculty of Agriculture, Ain-Shams University at Shoubra El-Kheima, to study the effect of application gypsum and mineral fertilizers on barley plants grown on saline sodic soil taken from El-Hussinia region. Two different soil samples [500kg for each] were collected from South El-Hussinia region, one was previously treated by [5 ton gypsum/fed] with the other being untreated. The soils were air dried, crushed and sieved through 2.0mm sieve and their main physical and chemical characteristics are determined according to Jackson (1973) and shown in Table (1).The experiment was carried out as a randomized complete block design. Barley seeds (Hordeum vulgare L.) cv. Giza 126 were sown at 15December, 2007. Three rates of N {2, 3 and 4 gm/pot which are approximately equivalent to 40, 60 and 80 kg N/fed as ammonium sulphate}, two rates of P {1, 2 gm/pot which are approximately equivalent to16.5 and 33 kg P_2O_5/ fed as super phosphate} and two rates of K {0.5and 1 gm/pot which are approximately equivalent to24 and 48 kg K_2O/fed as potassium sulphate} were added in combination with or without gypsum treatment. Application of P-fertilizer was added before seed sowing; N and K fertilizer treatments were added after 4 and 6weeks later on respectively. Irrigation intervals were 4 days to maintain the soil moisture content at 60-70% of water holding capacity during the plant growth. After 10 weeks (70days) from sowing, vegetative plant samples were collected, the dry vegetative growth and seeds were collected after 20 weeks to be all cleaned and dried in aerated oven at 70 c^0.The dry matter of samples as well as their nutrient content and total uptake were determined and calculated according to Cottenine *et al*(1982).

Statistical analysis: obtained data were analyzed using the [MSTAT] Statistical program. Power (1985).

Table (1): The physical and chemical analysis of soil samples.

Soil properties	Soil untreated with gypsum	Soil treated with gypsum	Soil properties	Soil untreated with gypsum	Soil treated with gypsum
Clay %	69. 7	72.8	Soluble cations [meq/100gmsoil		
Silt %	15.5	17.7	Ca^{++}	1.90	2.04
Sand %	14.9	9.49	Mg^{++}	4.14	2.92
Texture class	Clayey	Clayey	Na+	17.9	15.2
SP %	103.9	106.4	K^{+}	0.39	0.24
Ca CO_3 %	1.40	1.42	Soluble anions [meq /100 gm soil]		
Organic matter%	1.51	1.41	Cl^{-}	16.5	12.9
EC [1:2] dS/m soil water extract	7.34	5.48	CO^{-}_3	0.00	0.00
pH [1:2.5] soil water suspension	7.89	7.66	HCO_3	2.32	2.4
CEC meq /100gm	43.9	50.8	SO_4^{-}	5.61	5.16
ESP %	19.1	15.6			

RESULTS AND DISCUSSION

As previously mentioned, response to application for different levels of NPK- mineral fertilizers either alone or in combination with gypsum treatment on the dry matter of grown plants and their NPK content and total uptake at both vegetative and harvest growth periods (10 and 20weeks) of barley plants grown on saline sodic soil from El-Hussinia region were studied.

First growth period (10-weeks).

Data in table (2) indicate that increasing the rate of applied nitrogen fertilizer, with or without gypsum treatment, led to significant increase in the dry matter content, nitrogen content and total uptake in barley shoots; gypsum treatment had, generally, an additive effect treatment. These results are similar to those obtained by Hagag *et al* (1999) who found that increasing N-fertilizer from 60 to 90kg N/fed led to increase the dry matter of grown barley plant and

their total N uptake. Salem *et al* (1999) added that gypsum application led to increase the contents of N, P and K of wheat plants. Concerning the main effect of increasing nitrogen fertilizer application on content and total-uptake of phosphorus, it's clear that the two phosphorus parameters were insignificantly influenced; however, N treatments in combination with gypsum led to significant increase in the total content during the vegetative growth. With respect to the main effect for application of nitrogen mineral fertilizer on the content and total-k uptake, it is clear that it was significantly favorable when being either alone or in combination with gypsum treatment .These results are similar to those obtained by Youssef and El-Saady (1999) who found that splitting of N-fertilizer had a high a significant effect on phosphorus and potassium uptake.

Concerning the main effect for application of phosphorus fertilizer on the dry matter, phosphor content and its total uptake, it's clear that all these parameters were insignificantly affected. These results took the same trend in combination with gypsum treatment. A relatively different trend was obtained for the main effect of application of potassium mineral fertilizer on the dry matter, potassium content and its total uptake; all these parameters were significantly increased under non gypsum treatment, gypsum treatment being to generally not favorable. These results may be attributed to some sort of ions counterbalance between $Ca^{++}$and K^{+} soluble ions by application of gypsum treatment. Gypsum treatment should also reduce the ESP value which should lead to indirect effect on growth and nutrient uptake.

Data in table (3) indicate that the highest dry matter content was obtained by application of N1P2K2 as well as N2P1K2 fertilizer treatments. It means that highest dry matter values of vegetative barley grown on the saline sodic soil were not obtained by application of highest level of N but mainly by application of the highest levels of K and P, respectively.

Concerning the tri interaction effect among N, P and K mineral fertilizer treatments either alone or in combination with gypsum treatments, it is clear that increasing levels of P and K fertilizers led to significant increase in their total uptake; the highest values were obtained by application of N1P2K2 as well as N3P1K2 fertilizer treatments with the lowest values being obtained by application of N1P1K1 treatments during the vegetative growth of barley.

Application of gypsum was more effective in increasing total nutrient uptake at such period of growth.

Table (2): Main effects for application of different levels of NPK-fertilizers either alone or in combination with gypsum on dry matter and nutrient uptake of barley plants grown on saline sodic soil from El-Hussinia region.

Treatments	Dry matter gm/pot	N content %	Total N uptake mg/pot	P content %	Total P uptake mg/pot	K content %	Total K uptake mg/pot
Soil without gypsum treatment							
N1	3.32	1.36	45.8	0.242	8.06	3.16	105.4
N2	3.49	1.48	50.2	0.233	7.93	3.44	117.3
N3	3.58	1.52	54.6	0.224	8.03	3.38	120.9
LSD at 0.05%	0.09	0.12	4.23	N.S	N.S	0.07	5.25
P1	3.54	1.47	52.2	0.237	8.36	3.25	115.8
P2	3.39	1.44	48.2	0.229	7.66	3.40	113.3
LSD at 0.05%	0.08	N.S	3.46	N.S	N.S	0.05	N.S
K1	3.23	1.50	48.4	0.238	7.56	3.27	104.4
K2	3.69	1.41	52.0	0.228	8.46	3.37	124.7
LSD at 0.05%	0.08	N.S	3.46	N.S	N.S	0.05	4.29
Soil with gypsum treatment							
N1	3.04	1.39	42.4	0.255	7.74	3.20	97.5
N2	3.14	1.69	53.4	0.261	8.16	3.41	106.7
N3	3.74	1.86	69.7	0.258	9.66	3.53	131.7
LSD at 0.05%	0.23	0.13	6.23	N.S	0.89	0.06	8.32
P1	3.47	1.75	61.4	0.254	8.81	3.33	116.0
P2	3.14	1.55	49.0	0.262	8.23	3.42	107.9
LSD at 0.05%	0.19	0.10	5.08	N.S	N.S	0.05	6.80
K1	3.30	1.72	56.9	0.255	8.40	3.36	111.1
K2	3.31	1.58	53.5	0.261	8.64	3.39	112.8
LSD at 0.05%	N.S	0.10	N.S	N.S	N.S	N.S	N.S

Table (3): Effect of tri interactions among different N, P and K mineral fertilizer levels either alone or in combination with gypsum on dry matter, content and total uptake of N, P and K nutrients for vegetative growth stages of barley plants grown on saline sodic soil from El-Hussinia region.

Treatments	Dry matter gm/pot	N content %	Total N uptake mg/pot	P content %	Total P uptake mg/pot	K content %	Total K uptake mg/pot
Soil without gypsum treatment							
N1P1K1	2.72	1.30	35.3	0.227	6.17	3.02	82.02
N1P1K2	3.44	1.40	48.3	0.253	8.70	3.11	107.1
N1P2K1	3.01	1.49	48.0	0.230	6.88	3.16	95.4
N1P2K2	4.11	1.26	51.7	0.257	10.5	3.34	137.2
N2P1K1	3.11	1.53	47.6	0.247	7.65	3.14	98.0
N2P1K2	4.20	1.45	60.7	0.230	9.65	3.47	145.5
N2P2K1	3.40	1.60	48.6	0.257	7.90	3.57	109.4
N2P2K2	3.25	1.35	44.0	0.200	6.53	3.58	116.2
N3P1K1	3.94	1.55	61.3	0.243	9.60	3.46	136.5
N3P1K2	3.81	1.58	60.2	0.220	8.39	3.30	125.7
N3P2K1	3.19	1.56	49.4	0.227	7.14	3.28	104.8
N3P2K2	3.37	1.40	47.4	0.207	6.97	3.46	116.7
LS D at 0.05%	0.19	N.S	N.S	N.S	N.S	0.13	10.51
Soil with gypsum treatment							
N1P1K1	3.20	1.45	46.2	0.240	7.70	3.17	101.5
N1P1K2	3.14	1.36	42.7	0.250	7.83	3.16	99.3
N1P2K1	3.18	1.37	43.6	0.257	8.16	3.24	102.8
N1P2K2	2.67	1.40	37.3	0.273	7.28	3.25	86.4
N2P1K1	3.04	1.92	58.4	0.267	8.09	3.40	103.4
N2P1K2	3.63	1.76	63.9	0.253	9.23	3.33	121.1
N2P2K1	3.09	1.69	52.3	0.253	7.79	3.34	103.1
N2P2K2	2.79	1.40	39.0	0.270	7.53	3.55	99.1
N3P1K1	3.75	2.10	78.8	0.267	9.99	3.49	131.1
N3P1K2	4.04	1.92	78.3	0.247	10.0	3.46	139.7
N3P2K1	3.52	1.77	62.2	0.247	8.68	3.54	124.7
N3P2K2	3.63	1.64	59.7	0.273	9.91	3.62	131.3
LSD at 0.05%	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Second growth period (20-weeks).

The following data Table (4) indicate the main effect of N, P and K mineral fertilizers in combination with or without gypsum treatment on dry matter, N, P and K contents and their total uptake at harvest growth period (20weeks).

Increasing nitrogen fertilizer in combination with or without gypsum treatment resulted in significant increases for dry matter and total N-uptake; similar patterns were obtained for both phosphorus and potassium contents and uptake. These results are true with and without gypsum treatment. These results may be due to the indirect effect of application of N-fertilizer on activating the microorganisms and lowering down pH-values in soil under investigation. On the other hand, the main effect of application of P-fertilizer on the dry matter-content and its total uptake after 20 weeks was generally favorable. However, the main effect of application of K-mineral fertilizer on dry matter and K-uptake was insignificant. These results indicate that application of high levels of K-mineral fertilizer for barley plants grown on saline sodic soil led to no economical effects. In other words, increasing N-mineral fertilizer for barley plants grown under salinity stress may be of great concern for barley plants.

Data in table (5) indicate effects of tri interaction among different N, P and K mineral fertilizer levels on barley growth and nutrient uptake either alone or in combination with gypsum treatments. The highest dry matter content was obtained by application of N1P2K1without gypsum as well as N3P2K2 fertilizer with gypsum treatments. Concerning the tri interaction effect among N, P and K mineral fertilizer treatments either alone or in combination with gypsum treatments, it is clear that increasing levels of P fertilizers led to significant increase in their total uptake the highest values were obtained by application of N2P2K2 fertilizer treatments while the lowest values were obtained by application of N1P1K2 fertilizer treatments during the harvest growth of barley. It is clear that K fertilizers were not greatly effective on its uptake; the highest values were obtained by application of N2P2K1 with the lowest values being obtained by application of N1P1K1 as well as N1P2K2 fertilizer treatments.

A comparison between data of table (3) and those of table (5) respecting the dry matter content may indicate the more favorable

effect for gypsum as time goes towards the harvest stage. Of course, this is expected, possibly due to more chances for gypsum to impose its effect as time goes on. This was different regarding the nutrient status particularly the total content; almost apposite trend was observed possibly due to dilution effect for nutrients. Of course, separation of spikes from shoots, at harvest, should also be effective.

From the obtained results, it can be concluded that application of gypsum treatment in combination with different NPK mineral fertilizer resulted in increase the dry matter content and total uptake by the barley plants grown on saline sodic soil from El-Hussinia region.

Table (4): Main effects for application of different levels of NPK-fertilizers either alone or in combination with gypsum on dry matter and nutrient uptake of barley plants grown on saline sodic soil from El-Hussinia region.

Treatment	Dry matter gm/pot	N content %	Total N uptake mg/pot	P content %	Total P uptake mg/pot	K content %	Total K uptake mg/pot
Soil without gypsum treatment							
N1	9.48	0.436	40.4	0.132	13.8	2.53	240.8
N2	9.68	0.824	79.6	0.203	19.6	2.59	251.5
N3	8.50	1.04	88.0	0.195	16.5	2.71	232.3
LSD at 0.05%	0.45	0.06	7.90	0.03	3.96	0.05	13.22
P1	8.96	0.673	59.0	0.127	11.3	2.61	234.1
P2	9.48	0.859	79.7	0.226	21.9	2.61	248.9
LSD at 0.05%	0.37	0.05	6.45	0.02	3.24	N.S	10.8
K1	9.24	0.781	71.3	0.176	17.1	2.61	242.3
K2	9.19	0.751	67.3	0.177	16.1	2.61	240.7
LSD at 0.05%	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Soil with gypsum treatment							
N1	8.85	0.317	28.0	0.062	4.68	2.18	193.3
N2	10.1	0.573	58.1	0.093	9.45	2.53	257.0
N3	9.32	0.711	66.9	0.098	8.19	2.46	230.6
LSD at 0.05%	0.58	0.05	6.75	0.03	1.87	0.06	14.42
P1	9.10	0.483	44.2	0.089	7.54	2.33	213.2
P2	9.76	0.584	57.8	0.079	7.34	2.45	240.8
LSD at 0.05%	0.47	0.04	5.51	N.S	N.S	0.05	11.77
K1	9.35	0.509	47.5	0.079	6.88	2.38	223.6
K2	9.51	0.558	54.6	0.089	8.00	2.40	230.3
LSD at 0.05%	N.S	0.04	5.51	N.S	N.S	N.S	N.S

Table (5): Effect of tri interaction among different N, P and K mineral fertilizer levels either alone or in combination with gypsum on dry matte, content and total uptake of N, P and K nutrients for harvest growth stage of barley plants grown on saline sodic soil from El-Hussinia region.

Treatment	Dry matter gm/pot	N content %	Total N uptake mg/pot	P content %	Total P uptake mg/pot	K content %	Total K uptake mg/pot
Soil without gypsum treatment							
$N_1P_1K_1$	8.57	0.520	43.6	0.117	9.90	2.54	220.4
$N_1P_1K_2$	9.43	0.333	31.3	0.073	7.01	2.55	240.7
$N_1P_2K_1$	10.4	0.430	44.1	0.173	22.3	2.53	261.9
$N_1P_2K_2$	9.53	0.460	42.7	0.163	15.9	2.52	240.3
$N_2P_1K_1$	9.13	0.737	66.7	0.173	16.0	2.60	237.3
$N_2P_1K_2$	9.83	0.533	51.6	0.127	12.7	2.57	253.1
$N_2P_2K_1$	10.1	1.05	106.1	0.240	24.5	2.80	282.7
$N_2P_2K_2$	9.67	0.977	94.1	0.270	25.3	2.40	232.8
$N_3P_1K_1$	8.80	0.913	80.6	0.107	9.41	2.58	226.7
$N_3P_1K_2$	8.00	1.00	80.1	0.167	13.0	2.82	226.5
$N_3P_2K_1$	8.50	1.04	87.0	0.243	20.7	2.64	224.9
$N_3P_2K_2$	8.70	1.20	104.1	0.263	23.0	2.81	250.9
LSD at 0.05%	0.90	N.S	N.S	N.S	N.S	0.09	26.45
Soil with gypsum treatment							
$N_1P_1K_1$	9.23	0.353	31.4	0.073	6.48	2.17	201.3
$N_1P_1K_2$	7.87	0.223	17.5	0.037	2.87	2.20	173.1
$N_1P_2K_1$	9.23	0.350	32.4	0.073	3.60	2.17	200.9
$N_1P_2K_2$	9.07	0.340	30.8	0.063	5.77	2.18	198.0
$N_2P_1K_1$	9.10	0.553	50.7	0.087	7.92	2.42	221.0
$N_2P_1K_2$	10.3	0.420	42.8	0.097	10.1	2.38	245.7
$N_2P_2K_1$	10.6	0.510	53.9	0.063	6.69	2.66	282.0
$N_2P_2K_2$	10.5	0.810	84.9	0.123	13.1	2.66	279.3
$N_3P_1K_1$	9.43	0.603	57.4	0.110	10.6	2.34	222.0
$N_3P_1K_2$	8.70	0.743	65.2	0.130	7.25	2.47	216.1
$N_3P_2K_1$	8.50	0.687	58.9	0.067	5.98	2.50	214.6
$N_3P_2K_2$	10.6	0.810	86.2	0.083	8.94	2.54	270.0
LSD at 0.05%	1.16	0.09	N.S	N.S	N.S	N.S	28.83

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تاثير اضافة الجبس والتسميد باالنيتروجين و الفوسفور و البوتاسيوم على نباتات الشعير النامية فى أراضى ملحية صودية فى منطقة الحسينية

محمودإبراهيم عبدالفتاح نصير ، عبدالصمد سالم إسماعيل حجازى ، هاشم السيد أبوحسين

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آجريت تجربة آصص لدراسة استجابة نباتات الشعير(صنف جيزة 126)لأضافة معدلات مختلفة من التسميد النيتروجينى (3 مستويات فى صورة سلفات نشادر) ومستوين من التسميد الفوسفاتى (فى صورة سوبر فوسفات عادى) ومستوين من التسميد البوتاسى (فى صورة سلفات بوتاسيوم) مع اضافة او عدم اضافة الجبس الزراعى للارض قبل جمعها من منطقة متاثرة بالملوحة والقلوية فى منطقة جنوب سهل الحسينية وتاثير ذلك على محصول المادة الجافة والمحتوى من NPK وا الكمية الكلية التى تم أمتصاصها خلال مرحلتي النمو الخضرية و الحصاد. آظهرت النتائج المتحصل عليها ما يلى:

زيادة معدل التسميد النيتروجينى مع عدم اضافة الجبس الزراعى أدت الى زيادة المادةالجافة وزيادة امتصاص النيتروجين و البوتاسيوم بينما انخفض امتصاص الفوسفور وذلك خلال المرحلة الخضرية كما أدت زيادة معدل إضافة التسميد النيتروجينى مع إضافة الجبس الزراعى الى زيادة المادةالجافة وزيادة امتصاص العناصر الغذائية تحت الدراسة. زيادة التسميد الفوسفاتى مع اضافة او عدم اضافة الجبس الزراعى لم تؤثرعلى المادة ا لجافة او امتصاص الفوسفور خلال المرحلة الخضرية. أدت زيادة معدل إضافة التسميد البوتاسى مع عدم اضافة الجبس الزراعى الى زيادة المادةالجافة وزيادة امتصاص البوتاسيوم خلال المرحلة الخضرية. أدت زيادة معدل التسميد النيتروجينى مع اضافة او عدم اضافة الجبس الزراعى الى زيادة المادةالجافة وزيادة امتصاص النيتروجين بينما أدت زيادة معدل التسميد الفوسفاتى و البوتاسى مع اضافة او عدم اضافة الجبس الزراعى الى زيادة المادةالجافة وزيادة امتصاص المغذيات خلال مرحلة الحصاد.