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Effect of Organic Manure and Phosphorus Fertilization on Wheat Crop in Salt-Affected Soils.

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ABSTRACT

Two factorial field experiments on wheat *(Var. Msr$_2$)* have been carried out during two successive seasons of (2015 / 2016 and 2016/2017), at Sakha Agric. Res. Station. The factors comprised organic fertilizer rates (0, 10 and 20 m^3 fed^{-1}) and phosphorus fertilizer rates (0, 30 and 45 kg $P_2O_5fed^{-1}$) in four replicates. The soils of the experimental locations is a clay loam in texture and have mean values of EC_e = 6.1dS.m^{-1}, ESP = 8.4 % and pH = 8.15; which indicated moderate effects with salinity and sodicity.The important results could be summarized as follows:(1) organic manuring (as compost) with rates of 10(OM_{10}) or 20(OM_{20}) m^3 fed^{-1} led to higher values of wheat grain and straw yields ,as well as grains- protein content relative to the none-manured treatment.(2) Phosphorusfertilizationwithrates of 30 and / or 45 kg P_2O_5 fed^{-1} have been resulted in better grain and straw yields beside higher values of wheat grains- protein content as compared to the controltreatment (P_0).(3) The interaction treatment of (20 m^3 compost x 45 kg P_2O_5 fed^{-1}) was the best onewhich recorded the maximum values for the previous studied parameterswith increments of[(79.8 %) $_{S1}$, (78.6 %) $_{S2}]_N$; [(69.2 %) $_{S1}$,(100 %) $_{S2}]_P$ and [(79.9 %) $_{S1}$, (78.6 %) $_{S2}]_{prot}$ over control treatments ($OM_{0.0}$ × $P_{0.0}$) and for the two seasons, respectively.(4) The co-fertilization of organic manure along with P-fertilization enhanced many biochemical reactions which have beenincreased the availability of phosphate ions and subsequent increment in P-relative efficiencies of P-fertilizer, which have been led to higher wheat yields.

Keywords: Organic manure, Salt –affected Soils, P- fertilizer, Wheat (*Var. Msr$_2$*).

INTRODCTION

Wheat is the most important food crop in Egyptian Agriculture. Its better productivity from Egyptian soils is a major aim and is a function of some important variables; i.e. soil fertility, irrigation water, plant cultivar and organic and inorganic fertilization.

Many researches about organic fertilization from different sources cleared some important facts about the beneficial role of organic matter as a source of many nutrients i.e. N, P, K, Ca, Fe, Mn, Zn, etc.; and improving soil physicochemical and biological properties beside its role of increasing the solubility of some nutrients i.e. Ca, Mg, Fe, Zn, P, S. etc. and subsequent itsavailability to plant absorption (Genaidy and Hegazy,2001; Genaidy, 2011; Abedi *et al.,* 2010; Ahmed *et al.,*2011). Phosphorus fertilization for various cultivated crops became necessary for obtaining better yield. Many researches approved higher crops yields by apply P-fertilization. That is related to P-deficiency in such salt -affected soils. On the other hand, P-fertilization from (calcium super phosphate source) reacts as source of Ca^{++} for replacing Na^+ in such soils (Genaidy, 2011). Also, El-Sirafy *et al.,* (2012) showed that wheat yield components have been increased by applying organic manure, bio-treated compost along with N, P, K and Zn mineral fertilization. So the objective of this presented research is to indicate the main effects of organic fertilization rates (as compost) and phosphorus fertilization (as calcium super phosphate) as well as interaction effects on wheat yield, wheat grains – N, P concentrations and protein content in slightly salt- affected soils.

MATERIALS AND METHODS

Twofactorial fieldexperiments on wheat crop (*Triticum aestivum, L.*) var.Msr (2) have been carried out at Sakha Agric. Res. Station during 2015/2016 and 2016/2017 growth seasons at two different experimental locations for realizing the purpose of the presented work. The factors comprised organic manure (as compost) fertilization of rates (0, 10 and 20 m^3 fed^{-1}) × phosphorus fertilization rates (0, 30 and 45 kg $P_2O_5fed^{-1}$) × 4 replicates.The soils of the two experimental locations have the fertility characteristics as seen in (Table 1) that have been determined according to the standard methods mentioned by Richards, 1954; Black, 1965 and Jackson, 1973.The statistical completely randomized block design has been applied with plot area of 6 m^2.

Table 1. Some physical and chemical properties of the two experimental locations before wheat planting.

Soil fert. characteristics	Location$_1$ (1st season)	Location$_2$ (2nd season)
Mechanical analysis (%)	sand 15.50, silt 35, clay 48 %	sand 16.50, silt 33.80, clay 48.5 %
Soil texture class	Clay loam	Clay loam
EC_e (Soil paste at 25^{oC})	3.95 dSm^{-1}	8.20 dSm^{-1}
a- Soluble cations (m equiv.,L^{-1})	Ca^{2+} = 7.20; Mg^{2+} = 9.98 Na^+ = 22.30; K^+= 0.35	Ca^{2+} = 18.6; Mg^{2+} = 20.80 Na^+ = 44.05; K^+ = 0.85
b- Soluble anions (m equiv., L^{-1})	CO_3^{2-}= 0.00; HCO_3^- = 4.09 Cl^-=21.49; SO_4^{2-} = 14.25	CO_3^{2-} = 0.00; HCO_3^- = 1.43 Cl^- = 44.91; SO_4^{2-} = 37.96
Soil – pH (1: 2.5susp.)	8.25	8.05
$CaCO_3$ % (calcimeter method)	2.51	2.63
O.M % (Wakely&Black method)	1.43	1.17
Soil-CEC(cmol kg^{-1}) (Amm. acetate ext.)	33.00	30.00
Soil-ESP (%) (Amm. acetate ext.)	7.67	9.13
Available –N ($mgkg^{-1}$) (K2SO4 ext.)	21.15	17.18
Available –P ($mgkg^{-1}$) (Olsen ext.)	4.08	3.50
Available –K ($mgkg^{-1}$) (Amm. acetate ext.)	307.11	325.00

Notes:1- The two experiments were carried out in two different experimental locations for the two growth seasons.
2- Soil analyses were done by analyzing representative composite samples.

Organic fertilization of compost and phosphorus fertilizer of superphosphate treatments have been added during soil tillage processes.The physical and chemicalproperties of the tested compost have been presented in (Table 2).Wheat crop (*Triticum aestivum, L.*) var. Msr (2) as high yielding variety was sown on 20/11/2015 and 23/11/2016.Planting irrigation was applied directly after wheat sowing for the two seasons, respectively.Nitrogen fertilization (as ammonium sulfate 20.5%N) was added in two equal doses; the first addition was at mohayah irrigation (30 days after sowing); and the second one was at 30 days after the first addition; for the two seasons, respectively.

Table 2. Some physical and chemical characteristics of the tested organic manure.

organic manure characteristics	Location$_1$ (1st season)	Location$_2$ (2nd season)
Moisture content (%)	27.73	28.12
Bulk density (g cm^{-3})	0.415	0.401
Organic matter (OM) %	35.86	41.63
Organic carbon (C) %	20.80	24.15
Total nitrogen (N) %	1.18	1.16
C/N ratio	17.62	20.81
pH (1 : 10 extract)	7.73	7.84
EC_e (1 : 10 extract)	1.67	1.55
Total –P (%)	0.47	0.55
Total –K (%)	1.93	2.61

Irrigation water requirements and irrigation intervals as well as all the agronomic practices, have been done according to the recommended methods of wheat applied researches. Wheat harvesting has been conducted at 15/5/2016 and at 18/5/2017; for the two seasons, respectively. Wheat yield and yield components have been recorded; and wheat-grains have been analyzed for N, P concentrations and protein content according to the standard methods mentioned by Chapman and Pratt, (1961).The statistical field design and analysis of variance have been done according to Snedecor and Cochran (1971).

RESULTS AND DISCUSSION

I- Effects of the main variables:

1-Organicmanuring effects:

As shown in Table (3); wheat grain and straw yields as well as grain / straw ratio have been significant increased by adding organic manure ratesof 10 and 20 m^3 fed^{-1}.The obtained increments were [(12.9, 32.9 %)$_{S1}$, (14.1, 36.7 %)$_{S2}$]$_{gr.\ y.}$; [(7.3, 20.8 %) $_{S1}$,(10.4, 21.5 %) $_{S2}$]$_{st.\ y.}$ and [(4.8, 9.5 %) $_{S1}$,(2.4, 9.5 %) $_{S2}$]$_{gy/st.}$over control treatment ($OM_{0.0}$) for the two seasons, respectively. With respect to wheat grains-N,P concentrations and protein content; organic fertilization led to increases of [(39.5, 53 %) $_{S1}$, (36.3, 10.8 %) $_{S2}$]$_N$; [(8.8, 17.7 %) $_{S1}$,(13.36, 23.3 %) $_{S2}$]$_P$ and [(39.1, 52.7%) $_{S1}$, (35.7, 49.9 %) $_{S2}$]$_{prot}$ over ($OM_{0.0}$) treatment for the two seasons, respectively. The values of the above mentioned parameters that obtained with application of 20 m^3 fed.$^{1-}$ compost were better than that received 10 m^3 fed.$^{1-}$.These findings are in agreement with those obtained by Singh and Agrawal, (2005) who reported that application of 10 and 20 tones ha^{-1} FYM increased the grains yield and the total N P and K uptake in wheat crop. Also, Hammad *et al.* (2011) found a positive effect of organic fertilizers on soil nutrients availability and wheat productivity.

Table 3. Main effects of organic manuring and phosphorus fertilization rates on wheat yield, wheat Grains N and P concentrations as well as grains-protein content for the two growth seasons.

Wheat characteristics			Grain yield kg plot^{-1}		Straw yield kg plot^{-1}		Grain / Strawratio		N %		P %		*Protein %	
Treatment			Growth season											
			1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Main Variables	1-organic fert.m^{3}fed^{-1}	0	3.19	2.91	7.60	6.92	0.42	0.42	1.47	1.35	0.34	0.30	8.59	7.89
		10	3.60	3.32	8.16	7.64	0.44	0.43	2.05	1.84	0.37	0.34	11.95	10.71
		20	4.24	3.89	9.18	8.41	0.46	0.46	2.25	2.03	0.4	0.37	13.12	11.83
	LSD(0.05)		0.13	0.10	0.27	0.24	0.01	0.01	0.05	0.03	0.02	0.03	0.43	0.43
	2-phosphorus fert. Kg P_2O_5 fed^{-1}	0	3.23	2.93	7.45	6.8	0.43	0.43	1.81	1.64	0.31	0.27	10.53	9.54
		30	3.66	3.33	8.26	7.56	0.44	0.44	1.92	1.73	0.39	0.35	11.18	10.10
		45	4.14	3.86	9.22	8.62	0.45	0.45	2.05	1.85	0.41	0.39	11.95	10.78
	LSD(0.05)		0.15	0.1	0.31	0.23	0.01	0.01	0.07	0.05	0.03	0.03	0.31	0.31

***Protein % = N % x 5.83 according to Ronald *et al.* (2005).**

2-Phosphorusfertilization effects:

Data presented in Table (3) indicates the significant effect of phosphorus fertilization rate of 30 and 45 kg P_2O_5fed^{-1} on wheat grains and straw yields as well as grains / straw ratio; where the obtainable increments were [(13.3, 28.2 %) $_{S1}$, (13.7, 31.2 %) $_{S2}$]$_{gr.\ y.}$;[(10.9, 23.8 %) $_{S1}$,(11.2, 26.7 %) $_{S2}$]$_{st.\ y.}$ and [(2.2, 4.7 %) $_{S1}$,(2.3, 4.7 %) $_{S2}$]$_{gy/st.}$over control treatments ($P_{0.0}$) and for the two seasons, respectively. With regard to wheat grains-N Pconcentrations and protein percentage,phosphorus fertilization have realized significant increments foe that characters of [(6.1, 13.2 %) $_{S1}$, (5.5, 12.8 %) $_{S2}$]$_N$;[(25.8, 32.3 %) $_{S1}$,(29.6, 44.4 %) $_{S2}$]$_P$ and [(6.2,13.5%)$_{S1}$,(5.9,13%)$_{S2}$]$_{prot}$ over ($P_{0.0}$) treatments and for the two seasons,respectively.These results were similar to those obtained by Sharaf, (2008) and Kaleem *et al.* (2009) who recorded maximum yield by the application of (NP) ratio 1:1 which was indicating importance of phosphorus at its highest dose in achieving maximum wheat productivity. In addition, the data obtained by Ali *et al.*,(2011) as well as supported the current findings.

II - Interaction effects:

Results shown in Table (4) indicates the significant interactions (organic fert. × P-fert.) effects on that wheat characters. With respect towheat grain and straw yields, the higher values have been realized by applying the treatments of (OM_{10} × P_{45}) and /or (OM_{20}× P_{45}) with gained increments of [(54, 64.6%) $_{S1}$,(58.6, 71.7%) $_{S2}$] $_{gr.y}$ and [(37.3, 45.3%) $_{S1}$,(44.2, 49.8%)$_{S2}$] $_{st.y.}$ over the control treatments ($OM_{0.0}$ × $P_{0.0}$) and for the two seasons, respectively.

Table 4. Organic manuring × phosphorus fertilization interaction effects on wheat yield, wheat grains-N P concentrations and grains-protein content for the two growth seasons.

Wheat characteristics		Grain yield kg plot^{-1}		Straw yield kg plot^{-1}		N %		P %		Protein %	
Treatment		Growth season									
Organic fert. m^3 fed^{-1}	P - fert. Kg P_2O_5 fed^{-1}	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0	0	2.78	2.51	6.78	6.15	1.29	1.17	0.26	0.21	7.52	6.82
0	30	3.23	2.93	7.51	6.83	1.43	1.33	0.37	0.32	8.34	7.75
0	45	3.57	3.28	8.5	7.78	1.7	1.56	0.4	0.36	9.91	9.09
10	0	3.15	2.87	7.43	6.83	1.95	1.77	0.32	0.3	11.37	10.32
10	30	3.37	3.1	7.73	7.23	2.07	1.84	0.38	0.35	12.07	10.73
10	45	4.28	3.98	9.31	8.87	2.13	1.9	0.4	0.38	12.42	11.08
20	0	3.75	3.41	8.15	7.41	2.18	1.97	0.35	0.31	12.71	11.49
20	30	4.39	3.96	9.54	8.61	2.25	2.03	0.41	0.39	13.12	11.83
20	45	4.58	4.31	9.85	9.21	2.32	2.09	0.44	0.42	13.53	12.18
LSD(0.05)		0.17	0.13	0.29	0.31	0.1	0.08	0.04	0.02	0.51	0.21

Regarding wheat grains-N P concentrations and protein content;the higher values have been resulted by applying the treatment (OM_{10} × P_{45}) and /or (OM_{20}× P_{45}) with obtainable increases of [(65.1, 79.8 %) $_{S1}$, (62.4, 78.6 %) $_{S2}]_N$; [(53.8, 69.2 %) $_{S1}$,(81, 100 %) $_{S2}]_P$ and [(65.2, 79.9 %) $_{S1}$, (62.5, 78.6 %) $_{S2}]_{prot}$ over control treatments ($OM_{0.0}$ × $P_{0.0}$) and for the two seasons, respectively. The interaction treatment of (20 m^3 compost x45kgP_2O_5 fed^{-1}) was the best one which recorded the maximum values forthe previous studied parameters. These findings were in accordance with those obtained by Hati *et al*. (2006) who said that addition of FYM with inorganic fertilizers to soil has been reported to increase the efficiency ofapplied fertilizers.Moreover; addition of FYM with inorganic fertilizers improves organic matter content of soil and consequently water holding capacity of soil.

CONCLUSION

According to the results that achieved from the current study; it may be recommended that:

- To improve the productivity of salt affected soils, organic manures must be applied i.e., compost of rates (10 and / or 20 m^3.fed^{-1}) before wheat planting combined with adding P-fertilizer rates of (30and /or 45 kg P_2O_5 fed^{-1}).
- In the meanwhile, the interaction effects of these treatments enhanced soil physical; bio-chemical and subsequently soil fertility and nutritional properties for wheat plants grown in this soilespecially under high level of compost.

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تأثير التسميد العضوي و الفوسفاتي علي محصول القمح في الأراضي المتأثرة بالأملاح.

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لتحقيق هذا الهدف تم إجراء تجربتين حقليتين عامليتين في موسمين متتاليين ٢٠١٥/٢٠١٦، ٢٠١٦/٢٠١٧ وبموقعين مختلفين علي محصول القمح [صنف مصر (٢)]بمحطة البحوث الزراعية بسخا بمنطقة شمال الدلتا ، حيث اشتملتاعلي دراسة العوامل التالية: التسميد العضوي بمعدلات (صفر - ١٠- ٢٠ م^{3} فدان$^{-1}$) في صورة سماد عضوي صناعي (compost) و التسميد الفوسفاتي بمعدلات (صفر –٣٠–٤٥ كجم فو$_{2}$أ$_{5}$ / فدان في صورة سوبر فوسفات الكالسيوم). وكان متوسط قيمة بعض خصائص خصوبة الأرض في الموقعين : قوام طيني طميي؛ تركيز الأملاح (EC) = ٦.٤ ديسيسيمنز / م؛ دليل الصودية ٨.٤ % ؛ الرقم الهيدروجيني = ٨.١٥ ؛ الصور الصالحة لعناصر(ن – فو- بو) هي (١٩.١٧–٣.٧٩– ٣١٦.٠٦ مللجم كجم$^{-1}$ علي الترتيب).و تتلخص أهم النتائج المتحصل عليها في الأتي :١- أدي استخدام السماد العضوي (كمبوست) بمعدل ١٠ و / أو ٢٠ م^{3} فدان$^{-1}$إلي زيادة محصولي الحبوب و القش وكذا محتوي البروتين في حبوب القمح بالمقارنة بالمعاملة بدون إضافة السماد العضوي.٢- التسميد الفوسفاتي بمعدلي ٣٠ و / أو ٤٥ كجم فو$_{2}$أ$_{5}$ / فدان نتج عنه محصول أفضل من الحبوب والقش وكذلك محتوى حبوب القمح من البروتين بالمقارنة بالمعاملات الغير مسمدة.٣- معاملة التفاعل ٢٠ م٣ كمبوست مع ٤٥ كجم فو$_{2}$أ$_{5}$ / فدان كانت أفضل المعاملات حيث سجلت أقصى قيم للخصائص السابقة حيث أعطت زيادات تقدر بـ ٧٩.٨ ، ٧٨.٦ % للنيتروجين ٦٩.٢ ، ١٠٠ % للفوسفور و ٧٩.٩، ٧٨.٦% للبروتين فوق معاملة الكنترول للموسمين على التوالي. ٤- أدي التأثير المشترك للتسميد العضوي مع التسميد الفوسفاتي إلي تحسين عديد من التفاعلات البيوكيميائية والتي بدورها أدت إلي زيادة تيسر أيونات الفوسفات بالإضافة إلي زيادة الكفاءة النسبية للسماد الفوسفاتي مما انعكس على زيادة محصول القمح.