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EFFECT OF PHOSPHOGYPSUM, FYM AND SUBSOILING ON SOME SALT AFFECTED SOIL PROPERTIES AND ITS PRODUCTIVITY AT NORTH DELTA

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ABSTRACT

Field experiment was carried out during the two successive seasons 2000 and 2000/2001 to study the effect of some amelioration processes on some physical and chemical properties and yield productivity of salt affected soil at North Delta. A split-split plot design with four replicates was used. Phosphogypsum (PG) treatment with three levels: zero, 50% and 100% of gypsum requirements was assigned to the main plots. The sub plots were occupied by subsoiling treatment with two levels: without and with subsoiling. Farmyard manure (FYM) treatment with two levels: without and with FYM application. Amelioration treatments (organic manure and/or Phosphogypsum) have a significant effect on decreasing bulk density and increasing the aggregation parameters (WSA, opt. size, MWD, AI and SC) in the sequent layers of soil profile especially in the surface layers.

Also, amelioration processes have a highly significant effect on O.M., EC. pH and ESP.

Moreover, amelioration processes had a highly significant effect on sorghum and barley yield. PG has a highly significant effect on the yield of both crops. These results may be attributed to that Phosphogypsum affected the soil properties such as porosity, ESP, pH and nutrients availability, which enhance plant growth. Regarding subsoiling and FYM, it could be noticed that subsoiling and FYM as well have a highly significant effect on both crop yields.

Keywords: Amelioration processes, Phosphogypsum, FYM, Subsoiling, Soil physical and chemical properties, Sorghum and barley yield.

INTRODUCTION

Salt affected soils are scattered allover the world, especially in arid and semi-arid regions. In Egypt, it is located, mostly, at the North Delta regions. Soil salinity and alkalinity affect soil properties and hence soil productivity. Reclamation processes of such soils are commonly using chemical (as gypsum or phosphogypsum) and/or organic amendments (as Farmyard manure) in addition to deep ploughing using sub-soiler.

Gypsum ($CaSO_4$, xH_2O) is used in agriculture either as sources of Ca and S for crops or as soil conditioners to improve certain physical properties of deteriorated soils. They are available as mined gypsum or as industrial by-products; such as: phosphogupsum (PG). They, likewise, can be used as source of Ca and S for crops, soil ameliorants for sodic and nonsodic dispersed soils, soil conditioners for hard setting clay soils and hardpans, bulk carriers for micronutrients (Alcordo and Rechcigl, 1993) and/or in modifying Ca ratios in soil (Alva and Gascho, 1991) and in reducing NH_3-H losses from urea fertilizers and farm manure (Da Gloria *et al.* 1991). PG is

produced during phosphoric acid production from rock phosphate according to the following reaction:

$$Ca_{10}(PO_4)_6F_2 + 10\ H_2SO_4 + 20\ H_2O \longrightarrow 6\ H_3PO_4 + 10\ CaSO_4.2H_2O + 2HF$$

Many countries produce PG, e. g. USA, Russia, Canada, etc. (Novikov *et al.*1990 and Collings, 1980). PG is highly acidic with pH in water ranging from 2.0 to 5.0 while mined gypsum ranged from 6.7 to 7.4. PG solubility is 2.6 gl^{-1} in water while that of mined gypsum is 2.41 gl^{-1} in water (Weast, 1981).

Moreover, it is stated that gypsum addition lead to an increase in the yield of many crops such as rice and wheat (*Abrol and Bhumbla*, 1975; and *Gazia et. al.*, 1996), wheat and berseem (*Hussain et al.*, 1988), bean and barley (*Ghowail et. al.* 1978) and wheat and broad bean (*Dora*, 1996).

Abou Youssef (2001) stated that PG application decreased EC, ESP, and bulk density, while it increased hydraulic conductivity and water stable aggregates. Also PG application increased fruit pepper yield.

The current study was carried out to study the effect of some amelioration processes on some salt affected soil properties and its productivity at North Delta.

MATERIALS AND METHODS

A field experiment was conducted at Sakha Agricultural Research Station farm, Kafr El-Sheikh, Egypt for two successive seasons. In the summer of 2000 sorghum was cultivated and in winter of 2001 barley was cultivated. This investigation aims to study the effect of some amelioration processes on some soil properties, and productivity of salt affected soil at North Delta. Area of 2100 m^2 of deteriorated uncultivated land was chosen to implement these processes. A split-split plot design with four replicates was used. Plot area was 24 m^2. The main plots were occupied by phosphogypsum (PG) treatment with three levels namely: zero (PGo), 50% (PG1) and 100% (PG2) of gypsum requirements. The sub plots were occupied by subsoiling treatment with two levels namely: without subsoiling (So) and with subsoiling (S1). Sub-sub plots were assigned to farmyard manure (FYM) treatment with two levels namely: FYMo and FYM1 to represent without and with FYM application respectively. Chemical and physical properties of the experimental soil and its content of macro and micronutrients are given in Tables' 1, 2 and 3. Chemical composition of FYM is given in Table 4. Chemical analyses were done according to Jackson, 1973. Micronutrients were determined according to Cotteine *et al.* (1982a). Statistical analyses were done according to Cochran and Cox, (1960).

Table 1: Some chemical properties of the experimental soil.

Soil depth cm	pH 1:2.5 S.W. sus.	EC dSm^{-1}	Soluble ions (meq/l)							O.M.%	CaC3 %	CEC meq/100 g soil	SAR	ESP
			Cations				Anions							
			Ca	Mg	Na	K	Cl	HC O3	SO4					
0 – 15	8.87	17.31	22.8	21.6	152	3.7	153.8	2.1	44.2	1.4	3.6	33.8	32.4	31.7
15-30	8.85	15.2	20.2	14.9	116	1.3	116.3	2	34.1	1.2	3.2	41.6	27.7	28.4

Table 2: Macro and micronutrients soil content (ppm)

Soil depth cm	N		P		K		Fe		Mn		Zn		Cu	
	Total	Available	Total	Available	Total	Available	Total	Available	Total	Available	Total	Available	Total	Available
0 – 15	160.4	8.9	25.3	1.3	8240	864	3214	10.5	621	2.5	52	.8	51	.95
15-30	153	8.1	19.5	.9	7560	845	3977	7.0	447	1.8	84	.4	45	.8

Table 3: some physical properties of the experimental soil.

Soil depth cm	Particle size distribution %				Soil tex.	BD g/cm3	T. porosity	HC m/day	WSA %
	Coarse sand	Fine sand	Silt	Clay					
0 –15	1.81	24.67	27.43	46.09	clay	1.29	51.32	0.051	15.22
15-30	0.98	21.5	27.31	50.21	clay	1.37	48.30		14.6

Table 4 chemical composition of FYM.

Properties	Values	
ph (1:2.5)	6.30	
O.M. %	33.02	
O. C. %	19.12	
C:N ratio	13.2	
Macronutrients		
Total N %	1.45	
Total P %	1.60	
Total K %	2.00	
Micronutrients	**Total**	**Available**
Fe ppm	6608	158.1
Mn ppm	3561.3	519.9
Zn ppm	33.37	5.55
Cu ppm	11.60	1.00

RESULTS AND DISCUSSION

1 - Effect of amelioration processes on some soil physical properties:

Data in Table 5 indicated that gypsum application led to highly significant decrease in bulk density. This result was more pronounced in the surface layer. These results may be attributed to that addition of gypsum to saline alkali soils increased the soluble and exchangeable calcium cation, which plays an important role in the formation of large stable aggregates. These results are in agreement with El-Gala *et al.* (1998) and Awad (1998). Also, subsoiling led to a highly significant decrease in bulk density. This result was more pronounced in the surface layer. These results could be interpreted to that subsoiling improved soil aeration and reduced soil compaction that increased the bulk density. These results were confirmed with El-Gohary *et al.* (1998) and El-Shanawany *et al.* (2000). Moreover, data show that FYM

application decreased bulk density. This result was more pronounced in the surface layer. These results may be attributed to that FYM increased soil aggregation and its density is lower than those of soil mineral particles. These results are in agreement with those obtained by Rechcigl (1995) and Awad (1998).

Regarding the aggregation parameters data in Table (5) show that gypsum application significantly increased water stable aggregates (WSA %), optimum size (Opt. S)., mean weight diameter (M.W.D), aggregation index (AI), and structure coefficient (S.C.) This finding may be explained through the fact that the presence of Calcium cation helps in aggregate formation and enhance in removing Na cation. Also, data show that aggregation parameters increased with FYM application. This may be attributed to that FYM is linked to polyvalent metal cations on soil surface (e. g. Ca^{2+}, Mg^{2+}, Fe^{3+} and Al^{3+}.. etc) and forms micro aggregates. These results are in agreement with Ghazy (1994) and Talha (1997). Also data show that most of the studied aggregation parameters are improved as a result of subsoiling due increase the aeration and decrease bulk density. This result is in agreement with Hamoud (1992).

Table 5: Effect of some amelioration processes on some physical properties.

Treatment	Bulk Density (BD)	WSA	Opt. Size	MWD	AI	S.C.
	0.0 - 15	0.0 - 15	0.0 - 15	0.0 - 15	0.0 - 15	0.0 - 15
Phosphogypsum(PG):						
PGo	1.336	25.551	11.158	0.1815	.0909	.3609
PG1	1.324	31.318	15.286	0.2316	.1161	.4781
PG2	1.301	33.181	17.216	0.2504	.1254	.5146
F-test	**	**	**	**	**	**
LSD.05	.012	2.412	1.555	.0306	.0154	.0636
0.01	.016	3.450	2.195	.0463	.0234	.0913
Subsoiling (S):						
So	1.351	28.231	13.240	.2064	.1034	.4151
S1	1.290	31.801	15.866	.2360	.1182	.4873
F-test	**	**	**	**	**	**
Farmyard manure (FYM):						
FYMo	1.335	25.966	11.210	.1845	.0924	.3633
FYM1	1.306	34.067	17.896	.2579	.1292	.5392
F-test	**	**	**	**	**	**
Interactions:						
PGxS	Ns	*	Ns	Ns	Ns	Ns
PGxFYM	*	Ns	Ns	Ns	Ns	Ns
SxFYM	Ns	Ns	Ns	Ns	Ns	Ns
PGxSxFYM	Ns	**	*	ns	ns	*

2 - Effect of amelioration processes on some soil chemical properties:

Data in Table 6 show that addition of PG caused a highly significant decrease in EC values. This may be due to that PG allows continuous supply of calcium replacing the exchangeable sodium from soil matrix and forming new stable aggregates. These processes increase hydraulic conductivity and

encourage the water to flow down leaching the salts out side the soil profile. (Ilyas *et al.* (1993). These results are in agreement with those of Ghazy, 1994, and Wahdan *et al.* 1999. Also, EC values were decreased as a result of subsoiling operation. The reduction of EC were more pronounced in the surface layer. These results may be attributed to the increase penetration of water with subsoiling which led to leaching the salts through the soil profile. These results are in agreement with those of Rezk *et al.* (1982). Moreover, FYM greatly affected soil physical properties and consequently salt movement in soil.

Regarding pH, PG caused a significant decrease in soil pH values due to producing some organic acids like as humic and fulfic acids.

Table 6: Effect of some amelioration processes on some soil chemical properties

treatment	O.M.		EC		pH		ESP	
	0 -15	15 – 30	0 -15	15 – 30	0 –15	15 – 30	0.0 - 15	15 – 30
Phosphogypsum (PG):								
PGo	1.400	1.200	9.901	9.599	8.72	8.35	22.283	20.432
PG1	2.646	1.739	7.203	7.679	8.59	8.25	20.648	17.845
PG2	2.623	1.789	6.626	6.941	8.49	8.18	18.796	17.320
F-test	**	**	**	**	**	**	*	Ns
LSD 0.05	0.113	0.114	0.042	0.106	.021	.004	2.489	-
0.01	0.166	0.145	0.061	0.155	.030	.007	-	--
Subsoiling (S):								
So	1.400	1.200	8.803	8.679	8.64	8.27	22.914	19.287
S1	2.795	1.834	7.017	7.467	8.56	8.25	18.238	17.778
F-test	**	*	**	**	**	**	Ns	Ns
Farmyard manure (FYM):								
FYMo	1.400	1.200	8.617	8.721	8.66	8.32	20.840	17.625
FYM1	2.333	1.900	7.203	7.425	8.54	8.20	20.312	19.438
F-test	**	*	**	**	**	**	Ns	Ns
Interactions:								
PGxS	Ns	ns	**	**	Ns	**	Ns	Ns
PGxFYM	*	*	**	**	**	**	Ns	Ns
SxFYM	*	*	**	**	*	Ns	Ns	Ns
PGxSxFYM	*	*	**	**	**	**	ns	Ns

3 - Effect of amelioration processes on sorghum and barley yield:

Data in Table 7 show that the three amelioration processes have a highly significant effect on sorghum and barley yield. phosphogypsum (PG) have a highly significant effect on both crops. These results may be attributed to that phosphogypsum affected the soil properties such as porosity, ESP, pH and nutrients availability, which enhance plant growth.

Regarding subsoiling and FYM, it was noticed that subsoiling and FYM as well have a highly significant effect on the yield of both crops. Moreover, all possible combinations of interaction between the three treatments are highly significant with respect to sorghum yield. But for barley, only the paired interaction between PG and the other two treatments (Subsoiling or FYM) are significant.

Table 7: Effect of amelioration processes on sorghum and barley yield

treatment	Sorghum ton/fed.)	Barley (ton/fed.)
Phosphogypsum(PG):		
PGo	0.613	2.082
PG1	1.185	3.309
PG2	1.277	3.647
F-test	**	**
LSD 0.05	0.044	0.079
0.01	0.066	0.110
Subsoiling (S):		
So	0.867	2.545
S1	1.183	3.481
F-test	**	**
Farmyard manure (FYM):		
FYMo	0.920	2.598
FYM1	1.130	3.428
F-test	**	**
Interactions:		
PGxS	**	**
PGxFYM	**	*
SxFYM	**	Ns
PGxSxFYM	**	ns

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تأثير الجبس المفسفر والسماد البلدي والحرث تحت التربة على الخواص الطبيعية والكيميائية وإنتاجية الأراضي المتأثرة بالأملاح شمال الدلتا

محمد إسماعيل الشهاوى

معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية

نفذت هذه التجربة الحقلية على مدى موسمين زراعيين (٢٠٠٠ و ٢٠٠٠/٢٠٠١) في أراضي متدهورة ومتأثرة بالأملاح لدراسة تأثير عمليات الإصلاح (إضافة الجبس المفسفر بثلاث مستويات: صفر و٥٠% و ١٠٠% من الاحتياجات الجبسية – الحرث العميق تحت التربة وبدون – و/أو السماد البلدي وبدون) على بعض الخواص الطبيعية (مثل الكثافة الظاهرية ومقاييس التجمع WSA and SC ,MWD ,Size .Opt) والكيماوية (مثل : المادة العضوية والتوصيل الكهربائي E C وتفاعل التربة pH و ESP لهذه الأراضي ، الى جانب تأثير عمليات الإصلاح على إنتاجية هذه الأراضي ومحصولي السورجم والشعير. وقد استخدم تصميم القطع المنشقة ثنائيا.

وقد اتضح من نتائج هذه الدراسة أن لعمليات الإصلاح المختبرة تأثير معنوي على الخواص الطبيعية حيث تؤدى هذه العمليات الى خفض الكثافة الظاهرية وزيادة جميع مقاييس التجمع(التجمعات الثابتة فى الماء ومتوسط القطر الفعال ومعامل البناء والحجم الأمثل ومعامل التحبب) .كما أن لهذه العمليات تأثير عالي المعنوية على الخواص والكيماوية حيث أدت الى زيادة المادة العضوية زيادة معنوية وخفض قيم (E C , pH , ESP) .

كما اتضح أيضا أنه قد تحققت زيادة معنوية فى محصولي السورجم والشعير نتيجة لتنفيذ هذه المعاملات .