EFFECTS OF SOIL AMENDMENTS APPLICATION ON SOME SOIL PROPERTIES AND CROP PRODUCTION IN A SALINE SODIC SOIL

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ABSTRACT:

A complete randomized block design field experiment with three replicates was conducted at Mounshaet Bakhaty Village, Shebin El-Kome, Minufiya Governorate during the two successive seasons summer 2004 using maize and winter 2004-2005 using wheat) to study the effect of some soil amendments (gypsum, sulphur, farmyard, and sand) application individually or in combinations with each other on some soil physical properties (soil aggregates and soil moisture constants) of a saline-sodic soil irrigated with drainge water (Nasr El-Din drain), plant growth and grain yield of maize and subsequent wheat were also studied.

The obtained results showed that:

- Soil aggregates of diameter (> 1.0 mm) were decreased whereas aggregates of diameters (1-0.5 mm) and (< 0.5 mm) were increased after both maize and wheat crops. The most effective treatment on soil aggregates was (gypsum + sulphur + farm yard and sand).
- Mean values of field capacity, wilting point and available water were increased by applying soil amendments.

Available (N, P and K content rations) were significantly in creased after maize and slightly enhanced after wheat and the most effective treatment was farmyard application. Both grain and straw yields of both maize and wheat as well as plant height in addition to the 100 grain weight were increased by applying all soil amendments.

Key words: Soil aggregates, moisture content, crops production and macro nutrients.

INTRODUCTION:

Saline-sodic soils (ECe > 4 dS/cm, ESP > 15 and pH < 8.5) contain excess soluble salts that maiz interfere with growth of most crops, thereby soil particles disperse and the hydro-physical properties become unfavaourable leading to minimizing soil fertility. Available nitrogen was decreased with increasing Sodicity or alkalinity of saline-sodic soil **(Patra and Singh, 1992; Maliwala and Tinboding, 1993). Mirza *et al.* (2005)** pointed out that macronutrients were increased by applying farmyard especially nitrogen uptake, however, the solubility and availability of native and applied P either increase or decrease or show no response under saline-sodic conditions depending on the nature of reacting salts, ionic strength and ionic activity **(El-Toukhy, 1987).** The application of either farmyard or gypsum on the availability of P in saline-sodic soil was investigated by many workers **(Abou-Hadid *et al.* 2001; Picchioni *et al.*, 2004 and Baig *et al.*, 2004)**, who indicated that P uptake was increased by such application. Regarding the effect of sodicity on potassium content. **El-Gibaly *et al.* (1972)** showed that soluble and exchangeable K, Ca and Mg were decreased. **Bijay *et al.* (1992), Ali *et al.* (1992 b) and Anand-Swarup (1992)** reported that reclamation of

salts – affected soil by gypsum or sulphur increased availability of N, P and K. Also, **Sharma *et al.* (1995)** observed that the farmyard combined with gypsum was the most effective treatment for saline-sodic soil reclamation.

Water stable aggregates (expressed as mean weight diameter) were significantly increased by the addition of both gypsum and organic manure in a saline-sodic soils **(El-Toukhy, 1982, Omar and Aziz, 1982, Chorom and Rengasmy, 1997).**

Soil water retention of saline-sodic soil was affected by organic manure application. In this respect, **Selem (1978), Tester (1990) and Laila and Abdel Aziz (1992)** indicated that the range between field capacity and wilting point has been increased by organic manure application.

Abdul-Wahid *et al.* (1998) showed that the water holding capácity and thus water availability were increased with organic materials application. Therefore the aim of the current study is to investigate the effect of some soil amendments on soil moisture content, soil aggregates, plant growth and grain yield of maize and subsequent wheat in a saline-sodic soil irrigated with drainage water.

MATERIALS AND METHODS

A complete randomized block design field experiment with three replicates was conducted at Mounshaet Bakhaty Village, Shebin El-Kome, Minufiya Governorate during the two successive seasons summer 2004 using corn plant and winter 2004/2005 using wheat plants to study the effect of some soil amendments (gypsum, sulphur element, farmyard and sand) individually or in a combination with each other on soil aggregation and soil moisture contents of saline-sodic soil irrigated with drainage water (Nasr El-Din drain). Plant growth and grain yield of maize and subsequent wheat were also studied.

The plot area was 42 m^2. The used soil amendments; gypsum, sulphur element, farmyard and sand were applied to the plots individually or combined at rates of (20 ton/fed. farmyard, 5 ton/fed. gypsum, 10 ton/fed. sulphur and 20 m^3/fed. sand).

Soil amendments and superphosphate (150 kg/fed.), were added and mixed well with the soil surface (0-30 cm) before the second plowghing. Maize grains (Hybrid-10) were sown at the mid of June, 2004 under furrow irrigation while wheat grains (Sakha-69) were sown at the end of November, 2004. All agricultural practices were conducted according to the recommendations of the Ministry of Agriculture. At harvesting of the maize and wheat, plant samples were collected from each plot and subjected to analysis. Also soil samples from each plot (0-30 cm) were taken and subjected to some physical and chemical analysis as fallows.

1- Soil physical properties:

The bulk density and moisture characteristics according to **Klute (1986)** were determind. Pore size distribution and aggregations were determind according to **De Leenheer and De Boodt (1965).**

Chemical analysis:

Total carbonates were determind according to **Page (1982).**
Total souluble salts were determind according to **Jackson (1973).**
Soil pH were determind according to **Richards (1954).**
Carbonates and bicarbonate were determind according to **Jackson (1973).**
Chloride were determind according to **Jackson (1973).**
Sulphates were determind by difference.

Ca^{++} and Mg^{++} were determind according to **Richards (1954).**
Na^{+} and K^{+} were determind according to **Jackson (1973).**
N were determind according to **Chapman and Pratt (1961).**
P was determind according to **Murphy and Riley (1962).**

Some physical and chemical properties of the studied soil are presented in Table (1). Some chemical analyses of the irrigation water are presented in Table (2). Some characteristics of applied amendments are presented in Tables (3 and 4).

Table (1). Some initial properties of the studied soil.

Properties	**Value**
Physical properties	
Particle size distribution (%)	
Sand	15.3
Silt	35.2
Clay	49.5
Textural class	Clayey
Soil moisture (%)	
Field capacity	39.20
Permentant wilting point	18.20
Available water	21.00
Soil aggregates (mm %)	
> 1.0	45.50
1-0.5	14.70
0.5-0.06	39.80
Hydraulic conductivity (cm/h)	0.25
Bulk density (g/cm^3)	1.45
Total porosity (%)	41.88
Chemical properties:	
pH [soil suspension. (1:25)]	7.90
EC (dS/m. soil paste)	8.30
Soluble cations (mmolc L^{-1})	
Ca^{++}	22.30
Mg^{++}	14.50
Na^{+}	60.00
K^{+}	0.75
Soluble anions (mmolc L^{-1})	
CO^{-}_{3}	-
HCO^{-}_{3}	3.70
Cl^{-}	57.50
$SO^{=}_{4}$	36.35
ESP	17.20
SAR	14.00
Organic matter, (%)	0.70
$CaCO_3$, (%)	3.80
Cation exchange capacity (CEC) cmole kg^{-1}	40.68
Gypsum (me/100 g soil)	0.25
Available macronutrients (mg/kg)	
N	18.50
P	10.40
K	320.00

Table (2). Some Chemical characteristics of Naser El-Din water.

EC (dS/m)	Soluble cations ($mmol_c L^{-1}$)				Soluble anions ($mmol_c L^{-1}$)				SAR
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	Cl^{-}	$SO^{=}_4$	
1.9	4.84	5.01	9	0.15	-	4.58	5.9	8.52	4.05

Table (3): Some properties of the used farmyard manure.

Properties	Value
Organic wetness (%)	24.0
Organic ash (%)	48.0
Organic matter (%)	52.0
Organic carbon (%)	30.2
Total nitrogen (%)	1.76
NO^{-}_3 (mg/kg)	30.0
NH_4^{+} (mg/kg)	655
C/N ratio	17.2
Bulk density (kg/m^3)	740
EC (dS/m) (1:10) water extract	6.05
pH (1:10) material : water extract	8.55
Available P (%)	1.30
Available K (%)	1.28

Table (4): Some properties of applied Gypsum and sand.

Properties	Sand	Gypsum
pH (1:2.5, soil suspension)	7.70	7.30
EC, dS/m	1.15	4.37
Soluble cations ($mmol_cL^{-1}$)		
Ca^{++}	5.63	32.92
Mg^{++}	2.95	7.10
Na^{+}	2.47	4.90
K^{+}	0.45	0.08
Soluble anions ($mmol_c L^{-1}$)		
$CO^{=}_3$	0.00	0.00
HCO^{-}_3	1.36	0.00
Cl^{-}	1.89	1.92
$SO^{=}_4$	8.25	43.08

RESULTS AND DISCUSSIONS

i- Soil Aggregate Size Distribution:

Data in Table (5) showed the effect of soil amendents application on aggregates size (mm %). It is clear from the table that aggregates sizes > 1.0 mm were decreased, aggregates sizes from 1-0.5 mm and < 0.5 mm were increased after both maize and subsequent wheat. Applying of sand and gypsum had the highest effect. In agreement with such observations, **Selem (1978),** pointed out the breaking of the large aggregates into small aggregates was the result of addition and gypsum to the soil.

Table (5). Soil Aggregate size distribution in soil after treatment with soil amendments during summer and winter seasons (2004-2005).

Treatments	Aggregate Size Distribution					
	Summer season (after maize)			Winter season (after wheat)		
	> 1.0	1-0.5	< 0.5	> 1.0	1-0.5	< 0.5
Control	47.2	16.6	36.2	46.4	18.4	38.8
G	44.7	18.9	42.4	35.0	13.0	52.0
S	36.6	22.1	41.8	36.0	12.9	51.1
FYM	36.5	21.2	42.3	32.5	17.7	49.8
D	36.4	23.4	40.2	31.0	23.9	45.1
G + S	35.3	24.4	40.3	28.9	25.0	46.1
G + FYM	35.0	18.6	46.4	28.5	19.2	52.3
G + d	34.4	14.0	38.2	27.5	25.4	47.1
S + FYM	33.6	17.2	49.2	26.8	21.3	51.9
S + d	31.6	15.6	52.8	25.0	19.8	55.3
FYM + d	30.2	18.7	51.1	24.1	21.1	54.8
G + S + FYM	29.9	23.1	47.0	23.9	26.2	49.9
G + S + d	28.6	23.7	47.7	22.8	30.5	46.7
G + FYM + d	28.5	24.0	47.5	21.8	31.9	46.3
S + FYM + d	28.5	23.1	48.4	23.1	27.2	49.7
G+S+FYM+d	26.8	24.2	49.0	20.1	22.3	57.6

G = Gypsum S = Sulphur FYM = farmyard manure d= Sand

ii- Soil moisture constants:

Data in Table (6) revealed that the mean values of field capacity, wilting point and available water percent were increased after both maize and wheat by applying the soil amendments individually or in a combination. However, gypsum + sulphur + Farmyard + sand was the most effective treatment. These results agreed well with those outlined by the **Tester (1990), Laila and Abd El Aziz (1992) and Eid (1994).**

Table (6). Soil Moisture characteristics of after treatment with soil amendments during summer and winter seasons.

Treatments	Soil moisture (P.F.C) (%)					
	Summer season (after maize)			Winter season (after wheat)		
	A.W.	F.C.	W.P.	A.W.	F.C.	W.P.
Control	21.2	39.6	18.4	21.5	40.5	19.0
G	21.9	40.6	18.7	24.3	43.3	19.0
S	21.9	40.2	18.3	22.3	41.3	19.0
FYM	22.3	41.4	19.1	26.5	46.0	19.5
D	22.1	40.8	18.7	25.5	45.0	19.5
G + S	22.1	41.5	19.4	26.5	46.0	19.5
G + FYM	22.3	42.3	20.0	26.8	47.3	20.5
G + d	22.6	42.9	20.3	28.0	48.5	20.5
S + FYM	22.5	42.1	19.6	27.0	47.0	20.0
S + d	22.4	41.8	19.4	27.0	47.0	20.0
FYM + d	22.3	42.4	20.1	27.5	47.5	20.0
G + S + FYM	22.8	43.3	20.5	29.0	49.0	20.5
G + S + d	22.6	43.5	20.9	29.0	50.0	21.0
G + FYM + d	23.0	44.5	21.5	29.5	51.4	21.9
S + FYM + d	22.5	42.9	20.4	28.3	49.3	21.0
G+S+FYM+d	24.5	46.4	21.9	30.5	53.0	22.5

G = Gypsum S = Sulphur FYM = farmyard manure d= Sand

A.W = available water F.C= Field capacity W.P= wilting point

iii- Macronutrients availability:

Data in Table (7) showed that available N, P, and K were increased after both maize and subsequent wheat. The most effective treatments were farmyard and gypsum. Such increases may be due to the high content of both N and K applied farmyard. These results are in line with those of (**Anand–Swarup 1992 and Barros *et al.*, 2004**). Also, it may be referred to the fact that soil amendments played an important role in improving soil physical properties of such saline-sodic soils in addition to the liberation of CO_2 from organic materials decomposition and its role in organic acid formation, and thereby lowering the soil pH. Both the enhanced availability of macronutrients and improving the soil physical properties was reflected on plant productivity of maize and subsequent wheat.

Table (7). Macronutrients availability in soil after treatment with soil amendments during summer and winter seasons (2004-2005).

Treatments	Summer season (after maize)			Winter season (after wheat)		
	N (mg/kg)	P (mg/kg)	K (mg/kg)	N (mg/kg)	P (mg/kg)	K (mg/kg)
Control	34.0	10.9	330	20.2	6.0	255
G	82.0	15.5	385	36.8	12.7	370
S	79.0	14.7	380	36.6	12.6	356
FYM	87.0	16.0	399	38.0	15.9	389
D	65.5	14.5	378	37.9	13.0	348
G + S	45.0	12.6	363	29.4	9.7	307
G+FYM	72.5	13.0	367	35.7	11.8	322
G+d	41.0	12.2	360	23.1	9.3	284
S+FYM	85.0	13.6	370	25.2	9.6	341
S+d	78.0	13.4	368	23.9	9.3	341
FYM+d	72.0	13.0	365	25.0	9.7	318
G+S+FYM	76.0	12.6	352	26.8	8.9	277
G+S+d	40.0	11.4	349	31.9	7.6	258
G+FYM+d	27.0	12.0	352	23.0	8.4	277
S+FYM+d	51.0	12.0	350	23.0	12.1	274
G+S+FYM+d	37.0	11.2	340	25.0	6.7	257

G = Gypsum S = Sulphur FYM = farmyard manure d= Sand

IV- Yield and yield components of maize and subsequent wheat:

Data presented in Tables (8 and 9) showed the effect of the tested soil amendments as applied individually or combined on plant height, straw and grain yields and the 100 grain weight of both maize and subsequent wheat. The values of all plant parameters were positively affected by the application of these amendments. The most effective treatment was (gypsum + sulphur + farmyard + sand). Farmyard showed the greatest role in increasing these parameters and this may be due to its role in increasing nutrients availability in addition to improving physico-chemical characteristics of such soils.

Table (8). Yield and yield components of maize grown on the studied saline sodic soil treated with amendments.

Treatments	Plant height (cm)	Straw (ton/fed.)	Grains (ton/fed.)	Weight of 100 seeds (g)
Control	225	1.40	2.28	19.85
G	280	2.85	2.80	28.10
S	270	2.40	2.75	27.70
FYM	280	2.90	2.80	28.20
D	280	2.20	2.70	27.00
G + S	280	3.00	3.00	28.30
G+FYM	325	3.80	3.15	30.20
G+d	295	3.30	3.04	29.10
S+FYM	315	3.20	3.07	29.20
S+d	295	4.60	3.04	29.00
FYM+d	325	3.40	3.20	30.20
G+S+FYM	340	3.80	3.26	31.10
G+S+d	340	3.80	3.27	31.30
G+FYM+d	340	3.80	3.43	31.90
S+FYM+d	343	3.80	3.57	32.00
G+S+FYM+d	343	4.10	3.65	35.50

G = Gypsum S = Sulphur FYM = farmyard manure d= Sand

Table (9). Yield and yield components of wheat grown on the investigated soil treated with amendments.

Treatments	Plant height (cm)	Straw weight (ton/fed.)	Grains weight (ton/fed.)	Weight of 100 seeds (g)
Control	67.5	1.67	6.40	37.8
G	84.0	2.94	13.00	40.7
S	81.0	2.89	12.50	38.6
FYM	84.0	3.20	13.50	41.3
d	84.0	2.91	7.80	35.7
G + S	87.0	3.42	13.50	41.5
G+FYM	97.0	3.56	15.00	44.3
G+d	88.5	3.50	14.30	43.4
S+FYM	94.5	3.50	14.80	43.8
S+d	88.5	3.43	15.20	44.4
FYM+d	97.5	3.63	14.00	42.8
G+S+FYM	102.0	4.10	15.25	44.4
G+S+d	102.0	4.20	15.40	45.0
G+FYM+d	102.0	4.30	15.80	45.9
S+FYM+d	103.0	4.80	16.60	48.3
G+S+FYM+d	103.0	5.15	19.20	49.7

G = Gypsum S = Sulphur FYM = farmyard manure d= Sand

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اثر استخدام بعض محسنات التربة على بعض خواص التربة وإنتاجية المحاصيل فى التربة الملحية

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أقيمت تجربة حقلية كاملة العشوائية ذات مكررات ثلاثة فى منشاة نجاتى – شبين الكوم – محافظة المنوفية فى موسمين متتاليين [الصيفى ٢٠٠٤ ذرة شامية (هجين ١٠) والشتوى ٢٠٠٤/٢٠٠٥ قمح (سخا ٦٩)] وذلك لدراسة تأثير إضافة بعض محسنات التربة (الجبس الزراعى والكبريت، والسماد البلدى ، الرمل). منفردة او مخلوطة مع بعضها البعض على بعض خواص التربة الطبيعية (تجمعات حبيبات التربة، والمحتوى الرطوبى) وكذلك العناصر الغذائية الكبرى بالإضافة إلى إنتاجية محصول الذرة الشامية والقمح تحت ظروف الاراضى الملحية والتى تروى بمياه صرف.

أوضحت النتائج الاتى:

- تجمعات التربة اكبر من ١ مم% انخفضت بينما تجمعات التربة من ١-٠,٥مم% وتجمعات التربة اقل من ٠,٥ مم زادت.
- متوسط قيم السعة الحقلية، ونقطة الذبول الدائمة، والماء الميسر زادت باستخدام المحسنات.
- العناصر الغذائية الكبرى زادت باستخدام محسنات التربة.
- إنتاجية كلا من الذرة والقمح وطول النبات ووزن ١٠٠ حبه زادت باستخدام محسنات التربة المستخدمة.