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EFFECT OF ORGANIC MANURE AND NITROGEN RATES ON YIELD AND CHEMICAL COMPOSITION OF MAIZE (*Zea mays L.*) GROWN UNDER NEWLY RECLAIMED SANDY SOIL

BY

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ABSTRACT

Two field experiments were conducted in Nubaria sandy soil, Behaira Governorate, Egypt. The trials were conducted in the summer seasons of 2004 and 2005aimed to study the effect of nitrogen rates i.e.; 0, 75, 90, and 105 kg N/fad and farmyard manure (FYM) 5, 10, and 20 m^3 /fad with or without 90 kg N/fad on yield and chemical composition of maize yield (C.V. single Hybrid 10) as well as soil properties. The results showed significant effects of N fertilizer and manure application on maize grain yield and protein yield in grains as kg/fed., while straw and biological yields did not reach the significance. Maize yield significantly increased with increasing the rate of manure when combined with inorganic fertilizer. Manure applied at 10 m^3 / fad gave the highest grain yields and surpassed the yield at 20m^3 when combined with 90 kg N/fad. Generally, farmyard manure application at 10 m^3/fed resulted in yield increases of 78.5 % of the untreated control when applied with 90kg N/fad. Chemical analysis of the experimental soil from the selected treatments after maize harvest revealed significant effects for EC, P and K according to the treatment applied. It could be concluded from this study that farmyard manure application to such sandy soil may have beneficial effects on maize yield and quality and some soil properties. In addition rationalization of consumption chemical fertilizers to protect the environment from chemical pollution.
1 Faddan (fad) = 4200m^2

Key Words: Manure, N fertilizer, grain yield, chemical composition, soil properties

INTRODUCTION

The newly reclaimed soils in Egypt are characterized by low fertility and poor moisture retention. The application of cattle manure to soil can increase the soil available macronutrients N,P, and K Sutton *et al.* (1986) and Tran and N'dayegamiye, (1995). Increase plant yields and the concentration of the macronutrients in plant tissue Evans *et al.* (1977); Pratt and Laag, (1981); Bauchamp, (1983); and Sommerfeldt and Mackay, (1987). However, elemental nitrogen contained in manure is generally less available to corn crop than inorganic N fertilizers Jokela, (1992).

Manure application rates to soil depend on many factors, including the crop, amount of manure available, manure composition, amount of land available for spreading, quantity of soil available nutrients, and the fraction of manure nutrients that could become available. Heavy application rates can have adverse effects on soils and plants, Chang *et al.* (1991). Excessive loadings of cattle manure may increase soil salinization and NO_3 contamination of ground waters, Evans *et al.* (1977). To avoid adverse effects of manure on the environment, manure should be managed and adjusted with caution.

The use of farmyard manure and other forms of organic matter can also change the plant- available micronutrients through changing both the physical and biological characteristics of the soil . Moreover, in many circumstances such changes may improve soil physical structure and water holding capacity, resulting in more extensive root development and enhance soil microflora which in turn can affect available micronutrient levels in soil, Stevenson, (1994).

The objective of this study was to investigate the effects of farmyard manure rates in comparison with inorganic N fertilizers on maize yield and quality as well as soil properties.

MATERIALS AND METHODS

Two field trials were conducted in the summer seasons of 2004 and 2005 to study the effect of farmyard manure and nitrogen fertilizer rates on yield and chemical composition of maize (*Zea mays L.*) grains in the newly reclaimed sandy desert soils. The experiments were conducted in a private farm Tawfiq El Hakim Village at Nubaria, Behaira Governorate, Egypt. (84 km Alex-Cairo desert road).

The chemical analyses of the experimental soil site before the first season are listed in Table 1. The soil is sandy in texture (sand 94.2 %, silt 4.6 % and clay 1.2 %). Each experiment included 10 treatments which were sowing the combinations of three farmyard manure rates i.e.; 5,10 and 20 m^3/fad with or without adjusted rate of nitrogen fertilizer (90 kg N/fed) as well as 4 additional nitrogen fertilizer rates 0, 75, 90 and 105 kg N /fad. The experimental design in both trials was randomized complete block design with 4 replicates. The organic manure analyses applied to the trial are presented in Table 2 (means of two seasons of the study).

Table (1): Chemical analysis of the experimental soil site according to Jackson (1967) (Units: EC as dS m-1; OM and CaCO3 as %; other nutrient elements as mg/ kg soil)

pH	EC Ds/m	OM %	$CaCO_3$ %	N	P	K	Fe	Mn	Zn	Cu
8.50	0.84	0.73	5.2	40.3	9.1	62.5	36.2	6.8	4.1	1.7

Table (2): Chemical properties of the farmyard manure applied to the field trial.

Parameter	OM (%)	pH	EC (ds/m)	Total content (% ds)				(mg / kg)		
				N	P	K	Fe	Mn	Zn	Cu
Mean	29.3	7.7	4.6	1.57	0.29	1.34	0.49	112	126	92

The experimental area was ploughed twice, ridged and divided into experimental plots each of $21m^2$= 1/200 fad. Organic manures rates were applied after manually calibration on a volumetric basis to the assigned plots. In order to secure homogenous incorporation with the soil surface layer, a rotary cultivator was used . Maize, c.v. Single Hybrid 10. Grains were sown in June 12 and 15 for 2004 and 2005 season, respectively. Nitrogen fertilizer rates were applied in two equal doses at 21 and 35 days from sowing as well as a common application of phosphatic fertilizer at a rate of 30 kg P_2O_5 /fad, calcium super phosphate 15.5 % P_2O_5, and potassic fertilizer was applied also at rate of 48 kg K_2O/fed (potassium sulphate 48 % K_2O) before sowing. All agricultural treatment was done as followed in the experiments.

At full maturity all plants from each plot were harvested to determine grain, straw and biological yield as ton/fad. Harvest index % was estimated by dividing grain yield / biological yield (ton/fed) 100. Protein yield in grains as kg/fed was calculated by multiplying grain yield as kg/fed concentration of N in grains factor 5.75.

Chemical analysis for soil (0-30 cm depth) for some selected treatments (control, and the heavy applications rates of inorganic and organic fertilizers applied) was carried out after the second season harvest where a composite sample of each treatment was taken from 4 replicates. The chemical analyses of soil and grains were carried out according to the methods described by Chapman and Pratt (1978) and Jackson (1967). Since the data in both seasons took similar trends, Homogeneity test was applied and the combined analysis of the data was done; for means comparison Least Significant Difference (LSD) test was applied at 5% level according to Sendecor and Cochran (1982).

RESULTS AND DISCUSSION

1-Maize yield:

Results presented in Table (3) show that significant effects were detected due to treatments on maize grain yield per faddan. The results in the same Table reveal that the maximum increase in grain yields per fad. reached 78.5% when the plants were fertilized with 10 m^3/fed of organic manure combined with 90 kg N/fed . The same data clearly indicate that the addition of fertilizer significantly increased grain and protein yields per fad although there was not a significant difference between the highest rates of application. Farmyard manure applied at the lowest rate (5 m^3/fad) did not increase yields significantly over the control treatment. However, the yields from the higher rates of manure addition alone or combined with adjusted N rate (90 kg N/fad.) were significantly increased for levels similar to the higher rates of inorganic fertilizer. The combined addition of nitrogen fertilizer with farmyard manure markedly increased yields and harvest index % further, so especially at the higher rates of manure. However, there were no significant effects of the treatments on straw and biological yields.

Table (3): Effect of different N and manure rates on maize yield and its components (combined data of 2004 and 2005 seasons)

Treatment	Grain yield (t /fad)	Straw yield (t /fad)	Biological yield (t /fad)	Harvest index	Protein yield in grains (kg/fad)
Control	1.40	6.63	8.03	17.4	124.2
75 kg N /fad	2.00	8.61	10.61	18.9	200.1
90 kg N /fad + F	2.28	8.19	10.47	21.8	222.8
105 kg N /fad	2.44	9.07	11.51	21.2	237.1
FYM 5 m^3 /fad	1.76	7.58	9.34	18.8	209.5
FYM 5 m^3 /fad + F	2.13	8.72	10.85	21.2	205.8
FYM 10 m^3 fad	2.30	9.59	11.89	19.3	211.6
FYM 10 m^3 /fad + F	2.50	10.36	12.86	19.4	248.7
FYM 20 m^3 fad	2.49	9.10	11.59	21.5	233.4
FYM 20 m^3 /fad + F	2.48	10.07	12.55	19.8	286.6
LSD at 0.05	0.39	Ns	ns	1.6	31.6

F= 90 kg N /fad

Inorganic fertilizer at 90 kg /fad significantly increased grain yield by approximately (62.8 %) when applied alone compared to control treatment. Straw yield was also raised by mineral N compared to plots receiving only the organic manures; this apparent response was statistically insignificant. On average, manure increased yield of straw and grain. Grain yield was raised with increasing rate of manure. However, there was no significant difference in straw yield at the lower or higher rates of manure addition. It is well known that grain yield as well as straw and biological yields could be directly affected by most growth parameters due to the favorable nutritional conditions created from organic manures application. Therefore, the obtained results suggest that the most likely explanations for the high grain maize yield response to the applied organic materials are that: high leaching losses of soluble N supplied in the inorganic fertilizer reduced the yield response to mineral N whereas the slower release of available N from mineralization of FYM organic matter was better synchronized to the crop requirement for N. Moreover, the organic manures supplied additional growth factors, such as essential trace elements and K, which promoted crop productivity in addition to the beneficial effects of plant available N supply. Application of organic matter to soil in the manures improved the soil physical characters, and creating better environment for root growth and also increased soil water availability to the crop. Yadov *et al.* (2006), demonstrated that combination of mineral fertilizers with different types of organic materials reduced rate of NPK application and sustain high crop productivity of rice and wheat.

Similar results were obtained by Wang *et al.* (2005) and Yang *et al.* (2005), they reported that it is important to have balanced application of fertilizers and manure to maximize crop production.

2-Chemical Composition of maize grain:-

The chemical composition of maize grains is summarized in Table (4). The results reveal that no statistically significant differences in nutrient and trace element concentrations were detected by ANOVA. .Paul *et al.* (2003) found that the concentration of N, P, and K in the maize grains inconsistently affected by manure or fertilizer application. They added that potassium concentration in straw at harvest was increased by manure application during 4 years of study, however application of manure and inorganic fertilizer increased N in the straw at harvest in the first, second, and fourth year of their study. On contrast Sutton *et al.* (1986) reported that manure did not consistently increase corn leaf N and P. Evans *et al.* (1977) had more consistent results and reported that manure relative to unfertilized and fertilized plots increased the N, P, and K concentrations in corn ear leaves, grain, and stover. Recently, Wang *et al.* (2005) found that the combined application of NP fertilizer, corn Stover and cattle manure increased either P or K uptake to the grains than the single application of each.

3-Soil characteristics:

Soil samples were taken for chemical analysis from selected treatments after maize harvest and the results are summarized in Table (5). Significant effects were detected by ANOVA for EC, P and K. Unlike some trials where increases in soil salinity from compost or FYM addition have been detected, this trial had a significant decrease in EC due to the treatments compared with the untreated control. P and K concentrations were significantly increased by fertilizer and K by FYM

Evans *et al.* (1977), Sutton *et al.* (1979) and Phillips *et al* (1981), observed increases of soil electrical conductivity at levels that could be considered high but only after heavy applications of liquid manure for 2 to 3 years. Chang *et al.* (1991) observed the same effect after a long period of soil application of cattle feedlot manure. As far as soil organic C and total N was concerned, dry matter content of the liquid cattle manure, is usually low compared with that of the solid cattle manure such as that used in this study, Sutton *et al.* (1986). Increases of soil organic matter resulting from liquid cattle manure have been associated with high application rates over long periods of time., According to Chang *et al.* (1991), soil organic matter and total N were increased after 11 annual applications of cattle feedlot manure at rates equal or higher than recommended.

In conclusion, soil incorporation of cattle manure, at reasonable rates, can enhance growth and increase grain yield at levels similar to those of inorganic N . Manure application can help in environmental protection from chemical pollution and rationalize the consumption of chemical fertilizers in addition improve soil fertility, with respect to K and P, without increasing soil salinity in such sandy soil.

Table (4): Chemical composition of maize grain (Units: nutrients as %; trace elements as mg kg^{-1})

Treatment	N	P	K	Fe	Mn	Zn	Cu
Control	1.48	0.24	0.27	125.0	17.2	16.0	2.88
75 kg N /fad	1.74	0.28	0.32	91.7	9.0	12.3	2.05
90 kg N /fad	1.70	0.32	0.28	150.0	9.7	13.5	2.17
105 kg N /fad	1.69	0.31	0.28	158.3	12.1	15.7	2.97
FYM 5 m^3 /fad	2.07	0.31	0.28	166.7	13.5	14.7	2.77
FYM 5 m^3 /fad + F	1.68	0.31	0.28	183.3	10.2	16.2	2.78
FYM 10 m^3 /fad	1.60	0.33	0.21	250.0	17.3	18.3	3.25
FYM 10 m^3 /fad + F	1.73	0.34	0.28	150.0	11.8	23.0	2.40
FYM 20 m^3 /fad	1.63	0.29	0.27	158.3	13.0	15.5	2.30
FYM 20 m^3 /fad + F	2.01	0.30	0.25	225.0	19.7	22.3	2.45
Mean	1.77	0.29	0.27	159.3	13.1	16.2	2.41
Significance	ns	ns	ns	ns	ns	ns	ns

Table (5): Chemical analysis of soil sampled after maize harvest (Units: EC as dS /m; OM as %; nutrients and other elements as mg /kg)

Treatment	pH	EC	OM	N	P	K	Fe	Mn	Zn	Cu
Control	8.53	1.13	1.24	59	8.8	73.1	52	8.2	8.8	2.21
90 kg N /fad	8.43	0.96	1.25	65	14.0	85.5	81	9.6	9.2	2.26
FYM 10 m^3 /fad + 90 kg N/fad	8.36	0.54	1.29	71	17.8	93.3	91	12.0	15.9	2.87
LSD at 0.05	ns	0.16	ns	ns	2.2	3.5	ns	ns	ns	ns

REFERENCES

Bauchamp, E.G. (1983): Response of corn to nitrogen in preplant and sidedress applications of liquid dairy cattle manure. Can. J. Soil Sci. 63:377-386.

Chang, C; Sommerfeldt, T.G. and Entz, T. .(1991): Soil chemistry after eleven applications of cattle manure. J. Environ. Qual. 20:475-480.

Chapman, H.D. and Pratt, F.E. (1978): Methods of Analysis of Soil, Plant and Water. University of California, USA. applications. Can. J. Soil Sci. 61:35-46.

Evans, S.D; Goodrich, P.R.; Munter, R.C. and Smith, R.E. (1977): Effects of solid and liquid beef manure and liquid hog manure on soil characteristics and on growth, yield, and composition of corn. J. Environ. Qual. 6:361-368.

Jackson, M.L. (1967): Soil Chemical Analysis. Prentic Hall of India, New Delhi, 251-280.

Jokela, W.E. (1992): Nitrogen fertilizer and dairy manure effects on corn yield and soil nitrate. Soil Sci. Soc. Am. Proc. J. 56:148-154.

Paul M. Porter; Huggins, D R.; Perillo, C A.; Quiring, S.R. and Crookston, R.K. (2003): Organic and other management strategies with two- and four-year crop rotations in Minnesota. Agron.J, vol 95 (2)233-244.

Phillips P.A; Hore, F.R. and Patni, N.K. (1981): Soil chemical properties and removal of nutrients by corn resulting from different rates and timing of liquid dairy manure

Pratt, P.F., and Laag, A.E. (1981): Effect of manure and irrigation on sodium bicarbonate-extractable phosphorus. Soil Sci. Soc. Am.Proc. J. 45:887-888

Sendecor G.W. and Cochran, W.G. (1982): Statistical Methods 7th Ed. Iowa state press Iowa U.S.A.

Sommerfeldt, T.G., and Mackay, D.C. (1987): Utilization of cattle manure containing wood shavings: Effect on soil and crop. Can. J. Soil Sci. 67:309-316.

Stevenson, F.J. (1994): Humus Chemistry; Genesis, Composition and Reaction. S. Wiley, New York.pp496

Sutton, A.L; Nelson, D.W.; Kelly, D.T. and Hill, D.L. (1986): Comparison of solid vs. liquid dairy manure applications on corn yield and soil composition. J. Environ. Qual. 15:370-375.

Tran, T.S., and N'dayegamiye, A. (1995): Long-term effects of fertilizers and manure application on the forms and availability of soil phosphorus. Can. J. Soil Sci. 75:281-285.

Wang, X.B.; Cai., D.X.,;.Oenema, O.; Hoogmond, W.B. and Perdok, U.D. (2005): Nutrient Dynamics in a dryland corn cropping system in Northern China: Effects of crop residue, animal manure and NP fertilizer applications. In (C, J, Li et al (Eds) Plant nutrition for foods ecurity human health and environmental protection. pp. 1066 – 1067)

Yadav, R.L.; Dwivedi, B.S.; Prasad, K.; Tomar, O.K., Shurpali, N.J. and Pandey, P.S. (2006): Yield trends and changes in soil organic –C and available NPK in a long-term rice-wheat system under integrated use of manure and fertilizers . Field Crops Res. 68,219-246.

Yang S.M.; Song, J..R; Yue, W.Y.; Wang, J.G; Guo, T.W. and Malhi, S.S . (2005): Effects of fertilizers and manure on yields of wheat and oilseed: Results from a 22-yr trial in rained region of China. In(C, J, Li *et al* (Eds) Plant nutrition for food security, human health and environmental protection. pp1170-1171

تأثير معدلات السماد العضوى والنيتروجيني على المحصول والمكونات الكيماوية لحبوب الذرة الشامية الناميه تحت ظروف التربه الرمليه المستصلحة حديثا

امانى عباس بحر

قسم بحوث المحاصيل الحقلية–شعبة البحوث الزراعية – المركز القومى للبحوث – الدقي – الجيزة– مصر

اجريت تجربتان حقليتان فى ارض رملية بمنطقة النوبارية – محافظة البحيرة – مصر فى موسمى ٢٠٠٤، ٢٠٠٥م لدراسة تأثير إضافة مستويات السماد النيتروجينى بمعدل صفر، ٧٥، ٩٠، ١٠٥ كجم ن/فدان منفردا" والتسميد العضوى بمعدل ٥ ،١٠، ٢٠ م^3/فدان إما منفرد أو مع مستوى مخفض ثابت من التسميد

النيتروجينى (٩٠كجم ن/فدان) على محصول الذرة الشامية (هجين فردى ١٠) والتركيب الكيماوى للحبوب الناتجة وكذلك بعض الخواص للتربة المنزرعه

وتشير نتائج التحليل المشترك الى تأثر محصول الفدان من حبوب الذرة معنويا فى موسمى الدراسة، فى حين لم يصل محصول القش والبيولوجى الى حد محصول المعنويه، كما زاد محصول الفدان معنويا نتيجة زيادة معدل السماد العضوى خاصة عند إضافته مع ٩٠كجم ن/فدان. وقد حققت المعاملة بالمستوى١٠ م^3/فدان أعلى زيادة فى محصول الحبوب ومحصول البروتين فى الحبوب (كجم/فدان). وبصفة عامة فقد حدثت زيادات ملموسة فى المحصول مقارنة بمعاملة الكنترول نتيجة إضافة كل من السماد العضوى منفردا"والتوليفة المطبقة من السمادالعضوى والمستوى المخفض الثابت من السماد النيتروجينى (٩٠كجم ن/فدان). حيث حقق زيادة فى محصول الحبوب بمقدار ٧٨,٥ % عن معاملة المقارنة. حدث نقص معنوى حاد فى درجة التوصيل الكهربى للتربة نتيجة اضافة السماد المعدنى والسماد العضوى كما سجلت زيادة معنوية فى تركيزات عناصر الفوسفور والبوتاسيوم عند إضافة السماد المعدنى نتيجة إضافة السماد العضوى مما يشير الى تحسن بعض خواص التربة.

ويستنتج من هذه الدراسة أن إضافة السماد العضوى الى مثل هذه الاراضى الرملية من الممكن ان يكون له بعض الفوائد الملموسة على محصول الذرة الشامية المزروعة بها كما تؤدى الى تحسين بعض خواص التربه علاوة على ترشيد استهلاك الاسمدة الكيماويه لحماية البيئه من التلوث الكيماوى.