Egypt. J. Soil Sci ., **Vol. 42,** No. 3, pp.435-447 (2002)

Effect of Farmyard Manure and Potassium Sulphate Applications on Maize in a Calcareous Soil

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A FIELD experiment was carried out at the Agricultural Research Station Farm of Noubaria on a calcareous soil to study the efficiency of FYM to provide maize with its needs of nutrients when added, either alone or in combination with potassium.

The experiment included six fertility treatments. Each treatment was replicated three times. The fertility treatments were: control, $15m^3$ FYM, $30m^3$ FYM, $15m^3$ FYM + 25 kg K_2O, $30m^3$ FYM+25 kg K_2O and 25 kg K_2O per feddan.

Results obtained indicated the following:

1-FYM alone at the low and high rates as well as K alone gave the most significant increase in grain yield.

2-Addition of K to the FYM did not significantly increase grain yield over that obtained from either low or high rate of the F.Y.M.

3-Harvest index was not significantly affected by various manurial treatments.

4-100 kernels weight was only significantly affected when maize was fertilized with $30m^3$ FYM+ 25 kg.K_2O.

5-Both rates of FYM were significantly effective in increasing most of absorbed macro and microelements by different parts of plant, However the lowest increase was obtained from the treatment which was fertilized with K alone.

Keywords: Calcareous soil, Farmyard manure, Potassium, Maize.

The possibility of farmyard manure (FYM) to provide plants with their essential nutrient elements was discussed a long time ago and still needs a particular attention.

Within the last ten years a gradual replacement of organic manuring was undertaken to replace some of mineral fertilizers, particularly in calcareous soils.

A lot of work has been undertaken in this regard particularly on maize which is considered a heavy nutrient feeder field crop.

In this connection, Patel *et al* . (1993), Sekhon and Aggarwall (1994) pointed out the positive correlations between leaf area, leaf longevity and grain yield which were increased by FYM addition. The efficiency of FYM was compared with chemical fertilizers which reached to about 40% compared with nitrogenous fertilizers (Grignani *et al.* 1994). The best treatment was a combination of 20 ton FYM/ha and 1 ton pyryte for the uptake of N,P,K, S and Fe (Balsaraf and Mohite 1994). The efficiencies of FYM and superphosphate were similar in increasing P content in plants (Sarkadi 1995). Mishra and Sharma (1997) contributed the significant enhancing grain yield by addition of 10 ton FYM/ha for 10 years to the effectiveness of FYM on aggregation of water transmission and hardness of the soil in addition to its ability to provide with half nutrient requests of plants. At the same time, Saber (1997) stated that the major objective of soil conservation is prevention of nitrogen, phosphorus and potassim losses which usually take place during the decomposition of FYM. He added that because the nutrient elements in the fresh farmyard manure are so readily available, attention needs to be paid to the weather and time of application. In a pot experiment. (Barsoom, 1998) reported that 5% FYM application increased dry weight, N, P, Fe, Mn, Zn, Cu uptake by 45 days age maize plants over that untreated soil. Recently, Delibacak *et al.* (2000) considered that addition of different levels of 2, 8, 14 ton FYM /da. (Turkish donem =250 m^2) increased porosity, total soluble salts, organic matter, structure stability index and aggrigation percentage. The increasing levels of manure obtained the lowest bulk densities.

In this work, the target was to compare the efficiency of FYM to provide maize plants with their need of nutrients with application of potassium as an essential element.

Material and Methods

A field experiment was carried out in the Agricultural Research Station Farm at Noubaria where the physical and chemical properties of its soil were determined after Kilmer and Alexander (1949) and Page (1982) as tabulated in Table 1. The treatments of the experiment were arranged in a complete randomized block design with three replicates. These treatments were (A) control, (B) $15m^3$ farmyard manure (FYM), (C) $30m^3$ FYM, (D) $15m^3$ FYM+25kg K_2O, (E) $30m^3$ FYM+25kg K_2O and (F) 25kg K_2O each per feddan. FYM was collected of good quality containig on dry weight basis: 30.54%, 0.45%, 0.25%, 0.65% organic matter, nitrogen, phosphorus, potassium, respectively and 300ppm, 125ppm, 80ppm and 60ppm iron, zinc, manganese and copper, respectively. It was added 15 days before planting mixed with soil while K_2O was added as potassium sulphate (K_2SO_4) (50% K_2O) one dose after 21 days of planting. Maize grains of variety Giza 10 were sown. The recommended practices, concerning irrigation and phosphorus fertilization with 15kg P_2O_5/fed. as calcium superphosphate (15% P_2O_5) were performed.

A soil sample was taken from each plot as well as a plant sample of 5 plants from each plot at maturity. Plant samples were divided into kernels, cobs, leaves and stalks. The air-dried grain yield for all plots were recorded at harvesting. The soil samples were analyzed to determine the changes in salinity according to Jackson (1973) and dry matter, N,P,K, Fe, Zn, Mn and Cu contents in plant organs after Chapman and Pratt (1961). The data were statistically analyzed according to Snedecor and Cochran (1971).

Results and Discussion

Maize yield and yield components

Data recorded in Table 2 indicate that:

1- FYM alone at the low and high rates as well as K alone gave the most significant increase in grain yield.

2- Addition of potassium to FYM did not significantly increase yield of grain above that obtained from either low or high rate of F.Y.M. Bizhaev (1988) and Mishra and Sharma (1979) were confirmed with thet data of FYM application and Fernandez-del (1996) for K results.

3- Harvest index was not significantly affected by various manurial treatments.
4- 100 kernels weight was only siginificantly affected when maize was fertilized with $30m^3$ of FYM + 25 kg of K_2O.

The positive relationship between increasing kernel yield and shoot by FYM application was in agreement with that obtained by Sekhon and Aggarwal (1994).

TABLE 1. Some physical and chemical properties of experiment soil.

Property	Depth (cm)		property		Depth (cm)	
	0-25	25-50			0-25	25-50
Course sand %	14.26	13.89	Soluble $CO_3^{=}$		--	--
Fine sand %	31.15	30.08		HCO_3^-	0.50	0.62
Silt %	36.70	35.14		Cl^-	1.50	2.00
Clay %	18.89	20.89		$SO_4^{=}$	2.33	2.73
Texture grade	Sandy loam		Meq/100g soil	Ca^{++}	0.85	1.10
CaCO3 %	31.75	32.13		Mg^{++}	1.05	1.00
Saturation %	52.12	54.36		Na^+	2.18	2.60
Filed capacity %	26.06	27.18		K^+	0.08	0.05
pH (1-2.5 susp.	8.15	8.20	Exchange K+		0.72	0.63
O.M %	0.22	0.20	Available K+		0.80	0.68
T.S.S. %	0.17	0.24	C.E.C.		16.72	16.13

TABLE 2. Effect of FYM and K_2SO_4 applications on yield and yield components of maize.

Items and Units	Treatments						L.S.D. at 0.05 level
	A	B	C	D	E	F	
Kernels yield (ardab/fed)	8.40	15.68	20.01	16.28	17.37	15.02	7.89
Harvest index(*)	22.54	22.61	25.39	25.05	27.27	23.30	4.92
100 Kernels (g)	22.09	25.33	20.16	23.57	27.22	25.52	4.34

(*) Kernels / whole a plant ration.

Dry matter production

Data recorded in Table 3 indicate that:

1-Yield of kernels/plant was significantly increased by various fertility treatments. The highest yield was obtained from the application of $30m^3$ of FYM + 25 kg of K_2O/feddan. On the other hand, the lowest increase in yield was obtained from the treatment which received 25 kg of K_2O/fed.

2-As regards to the cobs and leaves, the highest yield was obtained from the treatment which received $30m^3$ of FYM/fed.

3-It was found that the increase in yield of stalks due to various fertility treatments did not reach the level of significancy.

TABLE 3. Effect of FYM and K_2SO_4 applications on dry matter of maize (g/plant).

Plant organ	Treatments						L.S.D. at 0.05 level
	A	B	C	D	E	F	
Kernels	38.46	53.29	66.58	61.37	85.90	50.89	10.49
Cobs	10.38	12.97	17.72	14.30	17.35	14.10	6.10
Leaves	81.92	125.27	124.60	124.75	159.17	110.74	44.57
Stalks	40.01	44.76	56.26	44.77	58.55	44.27	34.80
Whole plant	170.77	236.29	265.08	245.19	320.96	220.01	71.45

As for cobs, application of $30m^3$ FYM alone or with K gave significant increases over the control or $15m^3$ FYM alone.

In this respect, Grignani *et al.* (1994), Fernandez-del (1996) and Barsoom (1998) obtained similar results.

Macronutrient contents and uptake

1- Contents

As indicated in Table 4, contents of different parts of the plant were not markedly affected by different fertility treatments.

TABLE 4. Effect of FYM and K_2SO_4 applications on macronutrients concentrations by maize organs (%).

Nutrient	Plant organ	Treatments					
		A	B	C	D	E	F
N	Kernels	1.89	1.82	1.53	1.58	1.90	1.55
	Cobs	0.55	0.70	0.42	0.64	0.99	0.57
	Leaves	1.56	1.23	1.64	1.65	1.64	0.88
	Stalks	0.57	0.55	0.64	0.53	0.62	0.39
P	Kernels	0.32	0.33	0.34	0.35	0.34	0.35
	Cobs	0.03	0.05	0.04	0.04	0.05	0.05
	Leaves	0.13	0.29	0.29	0.20	0.17	0.12
	Stalks	0.05	0.06	0.05	0.04	0.03	0.06
K	Kernels	0.51	0.59	0.59	0.66	0.70	0.61
	Cobs	1.34	1.72	1.78	1.63	1.72	1.52
	Leaves	1.37	1.68	1.50	1.63	1.50	1.56
	Stalks	1.99	2.83	2.47	3.03	2.88	3.28

2-Uptake

As regards to the amounts of macronutrients absorbed by different parts of maize plant, the data obtained as recorded in Table 5 indicate the following:

TABLE 5. Effect of FYM and K_2SO_4 applications on macronutrients uptake by maize (mg/plant).

Nutrient	Plant organ	Treatments						L.S.D. at 0.05 level
		A	B	C	D	E	F	
N	Kernels	726.89	969.88	1017.45	969.699	1632.16	788.85	179.68
	Cobs	57.07	90.79	74.42	91.54	171.40	80.35	44.23
	leaves	1277.94	1540.78	2043.41	2058.32	2610.33	974.54	654.78
	Stalks	228.07	246.20	360.07	237.27	362.99	172.66	86.26
	Whole plant	2289.98	2847.65	3495.35	3356.83	4776.89	2016.40	901.73
P	Kernels	123.07	175.86	226.10	214.81	291.68	178.13	67.09
	Cobs	3.11	6.49	7.09	5.72	8.66	7.04	2.76
	leaves	106.49	363.27	361.33	249.49	270.58	132.89	90.19
	Stalks	20.01	26.86	28.13	17.91	17.56	26.56	19.93
	Whole plant	252.68	572.47	622.65	487.92	588.48	344.62	122.13
K	Kernels	196.15	314.41	392.35	405.06	601.32	310.45	62.89
	Cobs	133.05	223.09	315.42	233.14	297.79	214.27	98.72
	leaves	1122.29	2104.47	1868.97	2033.37	2387.50	1727.60	681.45
	Stalks	796.26	1266.83	1389.65	1356.48	1686.13	1089.08	283.57
	Whole plant	224.775	3908.80	3966.37	4028.03	4972.75	3341.39	1053.28

a. The highest amounts of N absorbed by rains and the whole plant were obtained from the treatment which received the high rate of FYM whether alone or with K_2O application. On the other hand, the lowest increase in yield was obtained from the treatment which received potash alone. Studies of Balsaraf and Mohite (1994), Grignani *et al.* (1994), and Barsoom (1998) confirmed these results.

b.The highest amounts of phosphorus absorbed by grain as well as the whole plant were also obtained from the treatment which received the high rate of FYM whether added alone or in combination with potash. On the other hand, application of potash alone did not significantly affect the amount of P utilized by plant. Also each of Balsaraf and Mahite (1994), Sarkadi (1995) and Barsoom (1998) obtained similar results.

c. As regards to potassium, the highest amounts absorbed by grains and different parts of plant were also obtained from treatments fertilized with FYM whether added alone or in combination with K salt. On the other hand, the lowest increase was obtained from the treatment which received potash alone. Balsaraf and Mohite (1994) and Fernandez-del (1996) gave similar results where the latter attributed that effect to the ready available K in the soil.

Micronutrient contents and uptake

Uptake of micronutrients by different parts of the plant as shown in Table 6 may indicate that :

1-Iron uptake by the plant was increased by various manurial treatments. However, the increase over control did not reach the level of significancy as far as potassium alone was concerned.

2-Zinc uptake by grains and leaves was positively affected by FYM application. The highest value was obtained when maize received $30m^3$ of FYM +25 kg of K_2O. On the other hand cobs, and stalks were not significantly affected by various manurial treatments. As regards to the zinc uptake by the whole plant, the treatment which received the high rate of the FYM +25 kg of K_2O was the best.

3-For Mn uptake, with the exception of corn stalks, other parts of the plant were significantly affected with some manurial treatments. For the whole plant, the highest rate of FYM whether added alone or in combination with potash gave the highest values of Mn uptake by the whole plant. Balsaraf and Mohite (1994) and Barsoom (1998) abtained similar results.

TABLE 6. Effect of FYM and K_2SO_4 applications on macronutrients uptake by maize (mg/plant).

Nutrient	Plant organ	Treatments						L.S.D. at 0.05 level
		A	B	C	D	E	F	
Fe	Kernels	21.54	32.51	40.57	36.21	59.27	32.57	6.31
	Cobs	3.25	5.71	6.02	6.15	6.75	6.06	3.32
	Leaves	54.89	85.18	87.22	81.09	106.64	75.31	30.43
	Stalks	22.41	28.65	32.63	33.13	35.13	32.76	20.92 N.S
	Whole plant	102.25	152.04	166.44	156.57	207.78	146.70	45.51
Zn	Kernels	5.77	3.73	5.99	6.75	10.31	4.58	1.05
	Cobs	0.93	1.04	1.06	0.72	1.21	0.99	0.40 N.S
	Leaves	5.73	11.27	12.46	9.98	17.51	12.18	4.71
	Stalks	3.20	2.69	3.94	2.69	2.93	2.66	2.16 N.S
	Whole plant	15.64	18.73	23.45	20.13	31.96	20.41	6.49
Mn	Kernels	1.15	1.60	2.66	1.23	1.72	1.53	0.28
	Cobs	0.31	0.26	0.53	0.43	0.35	0.70	0.19
	Leaves	2.46	3.76	7.48	3.74	7.96	3.32	2.10
	Stalks	1.60	1.34	1.69	1.34	2.43	1.77	1.29 N.S
	Whole plant	5.52	6.96	12.36	6.74	12.37	7.33	2.94
Cu	Kernels	1.15	1.60	3.33	1.84	2.58	1.53	0.31
	Cobs	0.31	0.52	0.53	0.43	0.52	0.42	0.19
	Leaves	2.46	3.76	4.98	3.74	4.78	4.43	1.55
	Stalks	1.60	1.34	1.69	1.34	1.76	1.77	1.23 N.S
	Whole plant	5.72	7.22	10.53	7.36	9.63	8.15	2.35

Total soluble salts of soil

To measure soil salinity after addition of any amendment not only for recording the salts which may added but also to detect the reaction of that material in the soil. Table 7 reveal that a very slight increase was noticed in the total soluble salts and the soluble cation and anions of soil after harvest of the crop. It could be attributed to salinity of the soil used for preparing the FYM, the mineral composition of the manure and the conditions of irrigation during summar season. Delibacak *et al* . (2000) noticed also some slight increase in soil salinity after FYM addition to the soil.

TABLE 7. Changes in soil salinity after 5 months of additions (*) .

Treat.	T.S.S	Anions (meq/100 soil)				Cations (meq/100 soil)			
	%	$Co_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
A	0.131	---	0.78	1.18	0.08	0.60	0.42	0.90	0.12
B	0.154	---	0.95	1.18	0.32	0.85	0.51	0.97	0.12
C	0.195	---	1.36	1.24	0.47	1.00	0.58	1.32	0.17
D	0.220	---	1.25	1.64	0.57	1.45	0.77	1.05	0.19
E	0.276	---	1.56	1.98	0.86	1.75	0.85	1.56	0.24
F	0.189	---	0.85	1.59	0.56	0.80	0.70	1.30	0.20

(*) In 1-5 soil water extract.

References

Balsaraf, M.D. and Mohite, A.V. (1994) Effects of FYM, PMC and pyrite on nutrint uptake and yield of crops in black calcareous soil. *J. Maharashtra Agric. Univ* . **19** (1) , 125.

Barsoom, S.W. (1998) Comparative effects of inoculation with VA mycorrhizal fungi and organic matter addition on phosphorus and micronutrients uptake by maize. *Egypt. J. Soil Sci.*, **38** (1-4), 21.

Bizhaev, M.V. (1988) Effect of long-term application of fertilizers on soil fertility, nutrient balance and yield of a crop rotation in the steppe zone of Kabardino-Balkar ASSR. Agrokhimiya, **5**, 37 [c.f Soils and Fert. **52**].

Chapman, H.D. and Pratt, P.F. (1961) *Methods of Analysis for Soils, Plant and Water* . Div . Agric., Univ of Calif., U.S.A.

Delibacak, S., Okur, B., Esiyok, D. and Duman, L. (2000) Effect of manure doses and growth media on some physical and chemical properties of soil and productivity of Rocket leaves. *Sixth International Colloquium For the Optimization of Plant Nutrition, 8-13 April, Cairo, Egypt.*

Fernandez-del, P.M. (1996) Long-term effects of fertilizers on maize and persistence of P and K in a calcareous Mollisol. *Agriculture-Tecnica-Santiago,* **56** (2), 107 [*c.f. Field Crop Abs* . **51** (3), 1527].

Gatti, M., Silvay, S. and Fontana, P. (1987) The effect of organic materials on the uptake of phosphorus fertilizers. *Annali-della-Facolta-di-Agraria-Universita-Cattolica* -del-Sacro-Cuore-Milano, 27 (1); 55 . [*c.f. Soils and* Fert. 51]

Grignani, C., Acutis, M., Borin, M. and Sattin, M. (ED) (1994) orgarnic fertilizaion efficiency and nitrogen leaching in maize based forage systems. *Proceedings of the* 3^{rd} *Cong. of the European Soc. For Agron. Padova Univ., Abano-Padova, Italy* 18-22 Sep., 1994, pp. 804-805.

Jackson, M.L. (1973) *"Soil Chemical Analysis "* Prentice Hall Inc. N.J., California (Indian Private Press, Limited, New Delhi).

Kilmer, V.J. and Alexander, L.T. (1949) Methods of making mechanical analysis of soils. *Soil Sci* **68**, 15 .

Mishra, V.K. and Sharma, R.B. (1997) Effect of fertilizers alone and in combination with manure on physical properties and productivity of Entisol under rice-based cropping. *J. Ind. Soc. Soil Sci.*, **45** (1), 84.

Page, A.L., Miller, R.H. and Keeny, D.R. (1982) " *Methods of Soil Analysis, II. Chemical and Microbiological Properties.* " Amer. Madison Wisconsin, U.S. A.

Patel, M.S., Gundalia, J.D., Polara, K.B. and Patel, A.G. (1993) Effect of depth and frequency of saline well water irrigation and FYM on yield of wheat, maize, groundnut/paddy cropping sequence on two calcareous sodic soils of coastal belt. *Gujarat Agric. Univ. Res. J.* **18** (2), 40.

Saber, M.S.M (1997) Organic manuring. In: *Proceeding of the Training Course* on Bio-Organic Farming Systems for Sustainable Agriculture 26 Nov- 6 Dec. 1995, Cairo, Egypt, pp. 61 -63.

Sarkadi, J. (1995) Utilization of the nutrient contents of organic manure and mineral fertilizers in long-term experiments. IIP. balance. *Agrokemia-es-Talajtan,* **44**(1-2), 5.

Sekhon, N.K. and Aggarwal, G.C. (1994) Changes induced in maize leaf growth and development by organic amendments and N fertilizers in calcareous Ustochrept soil , Northwestern India. *Arid Soil Research and Rehabilitation.* **8** (3), 261.

Snedecor, G.W. and Cochran, W.G (1971) *Statistical Methods,* 6th ed. Iowa State Univ. Press, Ames.

(Received 9 / 2000)

تأثير إضافات من السماد البلدى وكبريتات البوتاسيوم على الذرة فى أرض جيرية

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معهد بحوث الأراضى والمياه والبيئة - مركز البحوث الزراعية- الجيزة- مصر .

نفذت تجربة حقلية بمزرعة محطة البحوث الزراعية بالنوبارية على أرض جيرية لدراسة كفاءة السماد البلدى لامداد الذرة باحتياجاته من العناصر الغذائية عندما يضاف بمفرده أو مع البوتاسيوم .

وقد اشتملت التجربة على ست معاملات تسميدية كل منها ثلاث مرات هى :المقارنة، ١٥، ٣٠ م٣ سماد بلدى ، ١٥ م٣ سماد بلدى + ٢٥ كجم بو٢أ ، ٣٠ م ٣ سماد بلدى + ٢٥ كجم بو٢ أ ، ٢٥ كجم بو ٢أ / فدان .

ويمكن تلخيص النتائج المتحصل عليها فيما يلى :

١- أعطى السماد البلدى بمفرده بمعدليه الأدنى والأعلى وكذلك البوتاسيوم منفردا معظم الزيادات المعنوية فى محصول الحبوب.
٢- إضافة البوتاسيوم للسماد البلدى لم يؤدى لزيادة معنوية فى محصول الحبوب على ذلك المتحصل عليه من أى من المستويين المنخفض والمرتفع من السماد البلدى .
٣- الدليل المحصولى لم يتأثر معنويا بأى من المعاملات المختلفة .
٤- وزن ١٠٠ حبة كان معنويا فقط عندما سمدت الذرة بمعدل ٣٠م٣ سمادا بلديا + ٢٥ كجم بو٢أ / فدان .
٥- أثر كل من معدلى السماد البلدى معنويا فى زيادة معظم المتص من العناصر الغذائية الكبرى والصغرى الممتصة بواسطة أجزاء النبات المختلفة وعلى أية حال فان أقل زيادة من هذه العناصر الممتصة تحصل عليها من المعاملة التى سمدت بالبوتاسيوم بمفرده .