Egypt. J. Agric. Res., 79 (3) , 2001

COMPOSTING OF SUGARBEET RESIDUES.(2) THE EFFECT OF THE APPLICATION DOSE ON THE FERTILITY PROPERTIES OF CALCAREOUS SOIL

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(Manuscript rcceived 29 July 2000)

Abstract

A pot experiment was carried out using pots receiving 6kg calcareous soil; half, same or double recommended dose of either aerobic or anaerobic compost of sugarbeet residues was used. The used compost was one of three composting periods; 3, 6 and 9 months. Wheat was the first crop to be planted up to maturity to study the direct effect of the compost. Sudangrass followed wheat to study the residual effect of the compost. Three successive cuts were taken from the sudangrass.

Results abstained could be summarized in the following:

- Organic matter content in soil decreased with time of application.
- The soil which received aerobic compost contained organic matter higher than that received anaerobic one.
- Period of composting 6 months was the best under aerobic conditions but in case of anaerobic composting 9 months period was the superior.
- Increasing dose of application increased proportionally soil organic matter content.
- Total nitrogen also increased by time of composting; the most superior treatment was addition of 4% compost having 6 months composting period under aerobic condition, while the best treatment of anaerobic compost being of 4% of the 9 months composted one.

These results were the same for soil samples taken either after wheat or following sudangrass. C/N ratio was wider after harvesting sudangrass than that after wheat. This was due to the consumption of nitrogen by sudangrass plants, the ratio narrowed by increasing the dose of compost particularly under aerobic conditions. Available phosphorus and potassium increased by increasing the dose of application. The best period of composting was 6 months for aerobic and 9 months for anaerobic conditions.

INTRODUCTION

Extension of the area cultivated with sugarbeet, year after year, resulted in more and more plant residues after harvesting the crop. On the other hand, calcareous soils in Egypt, the most available resource for agricultural expansion, are in need to continuous manuring with good and safe manures.

Therefore, many trials were conducted in this regard to study the effect of organic residues from sugarbeet plantation on the organic matter, N, P and K in soil. Such trials could be represented by those of Abou-Bakr and El-Maghraby (1994) using town-refuse compost with 2 and 4% w/w. in pots, Abou-Bakr and Omar (1996) using mature organic compost in combination with N P K fertilizers and El-Sersawy *et al.*, (1997) using organic manure mixture, applied N rates and biofertilization. They found that organic matter, organic carbon and total N contents were increased in calcareous soils. Also, Dendooven *et al.*, (1994) and Whitmore *et al.*, (1994) found that incorporation of sugarbeet roots having C/N ratio 40-42 increased N mineralization depending on C mineralization and soil microbial biomass. The soils more rich in organic matter had more available P (El-Shinnawi *et al.*, 1991) and more available K (Benedetti *et al.*, 1982 and Abou-Bakr and Omar, 1996).

The current work aims to investigate the effect of the suggested application of sugarbeet residues composts on soil organic matter, N status and availability of both P and K.

MATERIALS AND METHODS

The soil sample adopted to be used in this investigation was taken from the newly reclaimed area of Noubaria Research Station Farm. Soil sample from the upper 30cm layer, was of normal salinity. Soil sample was air dried, ground and sieved to pass through 2mm sieve. The physical and chemical properties of this soil sample are recorded in Table 1.

Table 1. Physical and chemical properties of the soil used in the study.

Particle Size %				Soil texture	$CaCO_3$ %	O.M %	T.N %	Avail N (ppm)	Avail P (ppm)	Avail K (ppm)
Clay	Silt	F.sand	C.sand							
35.85	27.75	25.3	11.1	Clay loam	26	1.5	0.09	54.6	10.8	275
			Soluble cations and anions meq/100g soil							
CEC Meq/100g soil	pH 1:2.5 susp.	EC. DS/m (*)	Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
16.8	7.9	0.81	1.82	0.79	3.1	0.39	- -	0.9	2.91	2.83

(*) in 1 : 5 soil water extract.

Fifty seven earthenware pots No. 30 were glazed and filled with soil at a rate of 6 kg/ pot. *Sudangrass (sorghum vulgaris)* variety imperial hybrid was sown at a rate of 1g/pot in all the 57 pots to consume any residual manure or chemical fertilizer through three cuts taken every 45 days from 1 July 1994 to 15. November 1994 in order to prepare the soil fór the target of the trial.

After 15 days of the 3^{rd} cut of sudangrass, pots were arranged to include (A) as a control without any compost addition, as well as (B), (C) and (D) manured with sugarbeet residues composted aerobically for 3, 6 and 9 months respectively, along with (E), (F) and (G) manured with sugarbeet residues anaerobically composted for 3, 6 and 9 months, respectively. Amount of 60, 120 or 240 g/pot, corresponding to 1, 2 and 4% per weight of soil were used representing, half, same and double of the recommended dose applied in the field respectively.(Recommended dose = 10 ton/fed.). Each treatment was repeated three times in a complete randomization factorial design. The quantities were consisted on the base that the plowing layer is down to 30 cm of soil surface.

Three heaps were prepared, the 1^{st} was in March 1994, the 2^{nd} in June 1994 and the 3^{rd} in September 1994 to obtain the composting periods of 9, 6and 3 months, respectively. Pots were planted with wheat on the 1^{st} December of 1994 with 10 grains/pot. After 15 days of sowing seedlings were thinned to 5 plants /pot and fertilized after three weeks of sowing with 1.2 g/pot ammonium sulphate (20%N) equivalent to the rate of 40 kg N/fed.

After wheat harvesting on the 4^{th} of May 1995, soil of each pot was mixed once again and planted with 15 grains of sudangrass on the 15^{th} may 1995; plants were thinned to 8 seedlings after 11 days of plantation. After one week from thinning and after each cut, the plants were fertilized with 0.6g ammonium sulphate per pot. As needed, pots were irrigated up to the field capacity with tap water. Three cuts of sudangrass were taken after 45 days from planting, 45 and 60 days from the previous cuts.

Soil samples were collected from each pot before manuring, after wheat harvest and the 3^{rd} cut of sudangrass planted later to determine organic matter, total, and soluble N, available P and K.

The mechanical analysis of the soil was conducted, without $CaCO_3$ removal, according to Kilmer and Alexander (1949), total carbonates were estimated using Scheibler calcimeter and calculated as $CaCO_3$, soil saturation percentage being estimated as described by Black *et al.* (1965). The chemical properties of the soil samples, along with soil organic matter content and level of available phosphorus, extracted with 0.5 $\underline{M}$ $NaHCO_3$ and determined colourimetrically, were evaluated as described by Jackson

(1973). Total nitrogen, nitrate-N and ammoniacal-N were determined; available potassium, extracted in boiling 0.1N HNO_3 solution was flame-photometrically determined according to Page *et al.*, (1982).

RESULTS AND DISCUSSION

Organic matter content in the soil:

Values representing organic matter content of the studied soil, determined after wheat harvesting (155 days of addition) as well as after the 3rd cut of sudangrass (315 days of addition) are tabulated in Table 2.

Aerobic compost provided the soil with organic content higher than anaerobic compost of both 3 and 6 months age of composting. However the period of 9 months composting resulted in a more organic matter content in soil receiving anaerobic compost than that receiving aerobic one. This observation was noticed after wheat and sudangrass cultivations. Responses of the organic matter content under each condition could be explained to be due to the acceleration of decomposition of each compost after the concerned period. This is in agreement with the findings of Greenwood, (1961) and Khalil, (1979).

Table 2. Effect of compost application on organic matter content in the soil after planting

Sample	After wheat harvesting (155 days of addition)						After the 3rd cut of sudangrass (315 days of addition)					
Appl. dose % (w/w)	Composting condition						Composting condition					
	aerobic			anaerobic			aerobic			anaerobic		
	Composting period in months						Composting period in months					
	3	6	9	3	6	9	3	6	9	3	6	9
0	1.45	1.45	1.45	1.45	1.45	1.45	0.90	0.90	0.90	0.90	0.90	0.90
1	2.00	2.13	2.00	1.80	2.08	2.27	1.65	1.92	1.60	1.43	1.74	2.00
2	2.52	2.87	2.35	2.16	2.40	2.79	2.05	2.40	2.00	1.76	2.05	2.34
4	2.90	3.63	3.00	2.42	2.89	3.50	2.54	3.00	2.50	2.19	2.45	2.89

Nitrogen status in the soil:

Values representing nitrogen status, in the soil samples, including those of nitrogen fractions, total nitrogen and C/N ratio are tabulated in Table 3. Ammonification process followed by nitrification seemed to take place through both cultivation seasons, at a higher rate after wheat than that after sudangrass due to the continuous conversion of produced NH_4 to nitrite and finally to nitrate. Plant consumption of NH_4 is also involved. Obtained data agree with those of Hamdi *et al.*, (1969) who found that ammoniacal nitrogen gradually decreased due to the conversion of ammonia to nitrate throughout the nitrification process.

The quantity produced of nitrate was in proportional trend with the rate of compost application; aerobic conditions of 6 months gave the highest values of NH_4-N (132.4 ppm). In this respect, quantities of ammonia could be volatilized and lost as undetermined portion. Nitrate remained after wheat and sudangrass as well as inorganic nitrogen as a summation of (NH_4-N) and (NO_3-N) forms followed the same trend of ammonium-N regarding responses to the rate of application and period of composting under each studied system. This is in agreement with the finding of Hamdi *et al.* (1989).

Generally, 6 months composting period, under aerobic condition and 4% application dose were also the highest in their effect on total nitrogen content of the studied soil either after wheat or sudangrass plantation.

The calculated ratio of C/N was tabulated in the same table. It is narrower after sudangrass, in almost all cases, than that after wheat; this could be explained to be due to the rate of plant consumption of nitrogen; similar results were obtained by Hirose (1973). The C/N ratio was wider in soils amended with anaerobic compost than that with aerobic one; which agrees with results of Khalil (1979). The period of 3 months composting appeared to be relatively wide in C/N ratio than other periods possibly due to relatively immature compost.

These results are in accordance with the results of Dendooven *et al.*, (1994) who mentioned that mineralization of both carbon and N depended on soil microbial biomass.

Available phosphorus

Values representing available phosphorus extracted with 0.5 $\underline{M}$ $NaHCO_3$ are tabulated on Table 4, its utilization was observed through evaluating the difference between values after wheat harvesting (155 days of compost addition) and following sudangrass harvesting (315 days of compost addition) It followed the same trend of organic matter content. pH value and organic matter content seemed to be factors affecting the inorganic P retention (Brady, 1984). As for composting additions, aerobic

Table 3. Effect of compost applications on nitrogen status in the soil.

Composting period		Control	3 months			6 months			9 months		
Nitrogen form	Compost Cond.		1%	2%	4%	1%	2%	4%	1%	2%	4%
		Nitrogen (ppm) after wheat harvesting (135 days of addition)									
NH_4-N	Aerobic	26.4	39.3	46.5	103.2	63.3	91.2	132.4	46.2	54.1	102.3
	Anaerobic	26.4	20.2	37.5	58.1	49.2	81.0	113.1	59.5	90.4	116.2
NO_3-N	Aerobic	18.6	20.6	40.2	22.7	21.0	24.6	22.5	17.3	30.8	14.4
	Anaerobic	18.6	23.0	23.3	34.4	21.2	17.3	18.3	18.3	22.5	27.1
Inorganic-N	Aerobic	45.0	59.5	86.7	125.9	84.3	115.8	154.9	63.5	84.9	116.7
	Anaerobic	45.0	47.2	60.8	92.5	70.4	98.3	131.4	77.7	112.9	143.3
Organic-N	Aerobic	705.0	940.5	1143.3	1264.1	1245.7	1464.0	1795.1	1236.5	1365.1	1703.3
	Anaerobic	705.0	842.8	949.2	997.5	1039.6	1101.7	1278.6	1282.3	1507.1	1846.7
Total N	Aerobic	750.0	1000.0	1230.0	1390.0	1330.0	1580.0	1950.0	1300.0	1450.0	1820.0
	Anaerobic	750.0	890.0	1010.0	1090.0	1110.0	1200.0	1410.0	1360.0	1620.0	1990.0
C/N ratio	Aerobic	11.2	11.6	11.9	12.1	10.1	10.5	10.8	8.9	9.4	9.6
	Anaerobic	11.2	11.7	12.4	12.9	10.9	11.6	11.9	9.7	10.0	10.2
		Nitrogen (ppm) after the 3rd cut of sudangrass (315 days of addition)									
NH_4-N	Aerobic	18.5	21.3	33.2	45.5	35.1	55.3	88.0	19.3	39.0	49.1
	Anaerobic	18.5	18.3	29.2	44.1	30.7	39.5	58.2	31.6	59.5	75.3
NO_3-N	Aerobic	9.2	10.0	21.6	24.3	20.0	32.2	18.6	18.5	19.2	27.3
	Anaerobic	9.2	11.1	15.5	17.3	15.2	26.3	34.1	22.1	19.4	22.2
Inorganic-N	Aerobic	27.7	31.3	54.8	69.8	55.1	87.5	106.6	37.8	58.2	76.4
	Anaerobic	27.7	29.4	44.7	61.4	45.9	65.8	92.3	53.7	78.9	97.5
Organic-N	Aerobic	602.3	1018.7	1195.2	1430.2	1334.9	1592.5	1953.4	1332.2	1581.8	1853.6
	Anaerobic	602.3	840.6	975.3	1168.6	1114.1	1324.2	1427.7	1396.3	1571.1	1842.5
Total N	Aerobic	630.0	1050.0	1250.0	1500.0	1390.0	1680.0	2060.0	1370.0	1640.0	1930.0
	Anaerobic	630.0	870.0	1020.0	1230.0	1160.0	1390.0	1520.0	1450.0	1650.0	1940.0
C/N ratio	Aerobic	8.3	9.1	9.5	9.8	8.0	8.3	8.4	6.8	7.1	7.5
	Anaerobic	8.3	9.5	10.0	10.3	8.7	8.6	9.3	8.0	8.2	8.6

compost gave highest available P values with 6 months composting period, 3 months of composting being the least. Under anaerobic conditions, the long period of composting increased available P proportionally, possibly due to reduction process leading to more available phosphorus.

Increasing application rate of compost caused a parallel increase in soil available P continued after the second season. Within a certain range, aerobic compost was preferred than anaerobic one for the 3 or 6 months of composting, while after 9 months anaerobic compost was superior. El-Shinawi *et al.* (1991) emphasized that aerobic incubation resulted in greater dephosphorylation. On the other hand, Campell and Racz (1975) and Lin (1975) observed that a greater P mineralization was brought about in soil under anaerobic submerged conditions.

Table 4. Effect of compost applications on available P in the soil.

Sample	After wheat harvesting (155 days of addition)						After the 3rd cut of sudangrass (315 days of addition)					
Appl. dose % (w/w)	Composting condition						Composting condition					
	aerobic			anaerobic			aerobic			anaerobic		
	Composting period in months						Composting period in months					
	3	6	9	3	6	9	3	6	9	3	6	9
0	10.3	10.3	10.3	10.3	10.3	10.3	8.0	8.0	8.0	8.0	8.0	8.0
1	12.4	14.2	13.1	11.5	12.5	14.3	10.0	10.5	9.8	8.5	9.8	11.2
2	20.2	26.0	22.2	17.2	20.1	25.0	13.5	17.6	15.6	11.6	14.1	18.2
4	31.4	44.3	34.8	25.3	29.6	42.6	21.5	27.8	23.9	16.4	21.3	27.3

Available potassium:

Table 5 shows that the values of available K after the second cultivation (sudangass) were less than those after the first one (wheat). This is in agreement with the finding of Montasser (1987) who found that values of available K generally increased at early time intervals and decreased at the end of incubation. The highest value of available K was found under aerobic composting of 6 months compared to composting 9 months, which was however superior with anaerobic compost even when compared with similar aerobic composting period. The rate of application was of a positive relationship with increasing available K. Similar responses for differences between aerobic and anaerobic composts at a certain rate, were obtained at various composting periods. El-leboudi *et al.* (1976) and Benedetti *et al.* (1982) showed that organic manuring was favorable for the availability of K in soil and responses being dependent on the source and rate of applied manure.

Table 5. Effect of compost applications on available K in the soil.

Sample	After wheat harvesting (155days of addition)						After the 3rd cut of sudangrass (315 days of addtion)					
Appl. dose % (w/w)	Composting condition						Composting condition					
	aerobic			anaerobic			aerobic			anaerobic		
	Composting period in months						Composting period in months					
	3	6	9	3	6	9	3	6	9	3	6	9
0	263	263	263	263	263	263	220	220	220	220	220	220
1	284	310	280	268	289	295	258	274	246	235	257	266
2	301	337	305	281	309	326	268	293	274	260	275	287
4	327	369	330	311	344	353	293	318	300	279	305	319

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كمر مخلفات بنجر السكر : (٢) اثر معدل الإضافة على خصوبة الأرض الجيرية

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صممت تجربة أصص تسع ٦ كجم ارض باستخدام ارض جيرية أعطيت نصف أو مثل أو ضعف المعدل الموصى به من مخلفات مكمورة كمر هوائى أو غير هوائى ، والمكامير المستعملة كانت أما مكمورة لمدة ٣ أو ٦ أو ٩ اشهر ، وزرعت الأصص قمحا حتى النضج واتبع بحشيشة سودان أخذ منها ٣ حشات وذلك لدراسة الأثر المباشر والمتبقى لإضافات المكامير المذكورة ، ويمكن تلخيص النتائج المتحصل عليها فيما يلى :

قلت المادة العضوية فى الأرض بمرور الوقت منذ الإضافة ، والأرض التى أعطيت مكمورا هوائيا زادت بها نسبة المادة العضوية عن تلك التى أعطيت مكموراً غير هوائى كما ان الكمر الهوائى لمدة ٦ اشهر كان افضل مدة إلا انه فى حالة إضافة المكمور غير الهوائى كان الكمر لمدة ٩اشهر هو الأفضل ، كما أن معدل الإضافة زاد طرديا من محتوى المادة العضوية بالأرض كذلك زاد النيتروجين الكلى بمدة الكمر وكانت افضل معاملة هى إضافة ٤٪ (من وزن الأرض) من مكمور المخلفات لمدة ٦ اشهر كمراً هوائياً ، أما افضل معاملة المكامير الغير الهوائية فكانت افضل معدل إضافة هو ٤٪ لمدة كمر ٩اشهر ، وكان هذا الاتجاه عاما سواء فى عينات الأرض بعد القمح أو بعد حشيشة السودان. هذا وقد اتسعت النسبة ك/ن بعد حشات حشيشة السودان عنها بعد حصاد القمح لامتصاص النباتات للنيتروجين الموجود بالأرض ، عموماً لوحظ ضيق هذه النسبة مع زيادة المعدل المضاف من المكمور فى حالة الكمر الهوائى ، كذلك زاد الفوسفور والبوتاسيوم الميسران بزيادة معدل الإضافة وكانت افضل فترة للكمر الهوائى هى ٦ اشهر ولغير الهوائى ٩ اشهر .