EFFECT OF DIFFERENT SOURCES AND RATES OF COMOPST ON GROWTH, YIELD AND QUALITY OF POTATO CROP

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(Manuscript received 28 November 2006)

Abstract

This study was conduced during the two summer seasons of 2004 and 2005 on potato cv. Diamant at Abou Awad village, Aga, Dakahlia Governorate, to investigate the utilization of different sources and rates of compost manures (rice straw , maize stalks, banana wastes and sugarcane bagasse composts) on growth, yield and its components as well as tuber quality.

The obtained results indicated that plant stand (%) at 45 days after planting was the highest with the application of rice straw compost at the rate of 21 (ton/fed.) in the first season and banana wastes compost at the rate of 15 (ton/fed.) in the second one. Vegetative growth characteristics which included plant height, number of main stems/ plant, foliage fresh , dry weights and NPK in the leaves at 85 days after planting (DAP), as well as total tuber yield (ton/ fed.), number of tubers/ plant, tuber weight/ plant NPK in tubers at harvesting were significantly increased by the adding mineral fertilizer (Check) in both seasons. On the same trend, treatments of banana waste compost at the rate of 15 (ton/fed.) and compost of rice straw at the rate of 21 (ton/fed.) increased dry matter and starch contents of tubers in both seasons.

The lowest content level of nitrate (ppm) in the tubers was obtained when plants were supplied with sugarcane bagasse at the rate of 11 (ton/fed.) and rice straw compost at the rate of 7 (ton/fed.) in both seasons.

In general, it is essential to adopt a system of organic farming in potato production for exportation and maintenance of soil fertility as well as reducing the pollution of environment.

Keywords: rice straw compost, maize stalks compost, banana waste compost, sugarcane bagasse compost, NPK fertilizer and potatoes.

INTRODUCTION

Organic agriculture should be a synonym of sustainability although, in the broadest sense of the word, organic system are not always more sustainable than conventional ones (Aguirre, 2005).

Marketing of organic crops in Egypt is mainly produced for exports. Local consumption of organic vegetables and fruits followed in latter stages but of a lower significance and requires large efforts to be organized (Abou- Hadid, 2001).

Composting is a technology for recycling organic materials in order to achieve and enhancement agricultural production by playing an important role in supplying nutrients to potatoes in sustainable production system (Stark and Porter, 2005).

Organic matter affects both the chemical and physical properties of the soil . These properties influenced by organic matter include soil structure, moisture holding capacity diversity and activity of soil organisms and aggregate stability. It also, influences the effects of chemical amendments, fertilizers such as pesticides and herbicides (Rechcigl 1995).

Banerjee and Das (1988) found that potatoes given 20 ton/ha of ordinary compost or compost enriched by inoculation with *Trichurus spiralis* or *Azotobacter chroococcum* beside a mixture of both gave the lowest tuber yield compared with 100% NPK of the recommend rate. Vogtmann *et al.* (1993) stated that nitrate content in potato tubers was significantly increased with mineral fertilizers than organic manure showed the lowest values. Goriachkin (1995) found that the highest yield of potato (22.1- 22.5 ton/ ha) was obtained from plants received cattle manure compost as compared with other sources of organic or inorganic fertilizers. Iud (1995) reported that organic yield was consistently about 33% lower than the conventional yield. Smith (1996) indicated that mature compost increased potato yield by 30 %. Ribeiro *et al.* (1997) found that application of NPK fertilizer resulted in a significant increase in production and contents of N, P and K in the leaves of potato. Rizk (2001) detected application of organic nitrogen fertilizer (Nile compost) at the level of 180 kg/ fed. resulted in the best growth characters. Applying the mixture of enciabein + Nile compost (1:1) at the level of 150 N kg/ fed. gave the highest tuber yield and its components while, using this mixture at the highest level of 180 kg N/ fed. exerted the maximum values of starch, total carbohydrates and total NPK content in the tubers.

Abou- Hussein *et al.* (2002) reported that applying compost with chicken manure and biofertilizer to the soil or inoculated with the seed tubers increased the vegetative growth characteristics, nutrients in the leaves, dry matter, total carbohydrates in the tubers and total yield/ plant. Awad (2002) showed that starch content in potato tubers was significantly increased with the compost application (rice straw + wheat straw) over the mineral fertilizers. El-Shahat (2005) indicated that compost application significantly increased potato vegetative growth parameters and fresh tuber yield.

The aim of this investigation was to study the utilization of different sources and rates of compost on growth, yield and quality of potato crop.

MATERIALS AND METHODS

This investigation was conducted during the growing summer seasons of 2004 and 2005 at Abou Awad village, Aga, Dakahlia Governorate, Egypt. Tuber seed of potato cv. Diamant were used in both seasons and planted in rows 0.75 m apart at 0.25 m spacing between plants. Individual plot consisted of five ridges 5 m in length and 0.75

m width and each plot was 18.75 m^2 in area. Planting dates were *carried* out on January 15th and 19th in the two seasons of 2004 and 2005 while harvesting time was done on May 16th and 20th, respectively.

The physical and chemical properties of the experimental soil at the depth of 0-30 cm are shown in Table (1).

Table 1. The physical and chemical properties of the experimental soil.

Sand	Silt	Clay	Texture	O.M.	CaCO3	pH	Available nutrients (ppm)					
%	%	%		%	%		N	P	K	Fe	Zn	Mn
26.5	31.8	40.0	clayey	1.7	3.0	7.9	51.9	25.0	175	6.42	2.9	2.0

Preparation of the different sources of compost :

The plant materials rice straw, maize stalks, banana wastes, sugarcane bagasse were air dried. Each plant material was composted by addition of chemical fertilizer accelerator for decomposition confined 20 kg ammonium sulfate, 10 kg super phosphate and 10 kg potassium sulfate per one ton of dry matter material. Each type of materials was prepared by mixing 30 % with 70 % of fresh cattle manure which mixed together. Under aerobic conditions. The optimal decomposition took place at 55 - 66 °C, C:N ratio 1:19, moisture 50% that supplied continuously by spraying water. The wastes were inverted every week and the compost was mature at four months. Compost was packed in plastic bags and every bag contain 50 kg. Before the addition to soil a samples were taken of each type of compost was subjected to chemical analysis on the bases of dry weight (Table 2).

Table 2. The chemical analysis of the different sources of composts.

Compost sources	Macro-elementS(%)			O. M.	C/ N	Micro- elementS(ppm)			
	N	P	K			Fe	Zn	Mn	pH
1- Rice straw	1.30	0.56	1.53	45	18:1	840	248	400	7.30
2- Maize stalks	1.20	0.89	1.04	40	19:1	648	190	310	7.22
3- Banana wastes	1.88	1.20	3.10	55	17:1	966	340	885	8.10
4- Sugarcane bagasse	0.82	0.40	0.75	45	21:1	350	146	160	7.12

The experimental design was randomized complete blocks (RCB) with three replicates. The experiment included 13 treatments, mineral fertilizer (NPK), different sources and rates of compost application as follows:

1- Mineral fertilizers confined 180 kg N + 75 kg P_2O_5+ 48 kg K_2O/ fed. (check). The used fertilizers were ammonium nitrate (33.5 % N) was added at three equal rates after 3,5 and 7 weeks from planting date, super phosphate (15.5 % P_2O_5) was added

during soil preparation, potassium sulfate (48% kg K_2O) was added after 7 weeks from planting date.

2- Rice straw compost at rates of 7, 14 and 21 ton/ fed.

3- Maize stalks compost at rates of 7.5, 15 and 22.5 ton/ fed.

4- Banana waste compost at rates of 5, 10 and 15 ton/ fed.

5- Sugarcane bagasse compost at rates of 11, 22 and 33 ton/ fed.

Crop N requirement needed for the desired yield and the amount of N needed from Compost manure was determined according N input (chemical analysis for total N) from each source of compost. composts were spread and thoroughly mixed with the surface of soil layer (0-30 cm) before planting during the soil preparation. The other agricultural practices were applied according to the organic farming recommendations.

Data recorded:

1. Vegetative growth parameters:

The percent of plant stand after 45 days from planting date was calculated. Random samples of five potato plants were taken after 85 days from planting (DAP) from each plot for measuring plant height (cm), number of main stems/ plant, foliage fresh and dry weight (g)/ plant.

2. Yield and its components:

Total tubers yield (ton/ fed.), number of tubers/ plant, weight of tubers/ plant (g) were determined at harvesting time , after120 days from planting (DAP).

3. Tuber quality:

At harvest time, random samples of tubers were dried at 70 °C untill constant weight was reached for the determination of dry matter, starch (%) and Nitrate concentration in the tubers was determined as ppm dry weight basis.

4. Chemical contents:

The mineral content of N, P and K were determined in the fourth leaf from the plant top after 85 days from planting and the tubers at harvest time.

Statistical analysis:

The data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the randomized complete block design according to Gomez and Gomez (1984). The treatments means were compared using the new least significant difference (N-LSD) at 5 % level of probability. All statistical analyses were performed using the facility of computer and SAS software package.

RESULTS AND DISCUSSION

1. Vegetative growth characteristics:

The data in Table (3) show that plant stand percentage at 45 days after planting (DAP) was significantly affected by various treatments in both seasons. It is also clear that rice straw compost at rate of 21t/fed . followed by banana wastes compost at the rate of 15 t/fed. gave the 'best plant stand values. The data in the same table indicated significant increases in plant height, number of main stems/ plant, foliage fresh and dry weight at 85 days after planting (DAP) in the two growing seasons by using treatment the inorganic fertilizer (check) as compared with the other treatments. The highest values of all the vegetative characters were obtained from using the mineral fertilizers (NPK) as compared with the other treatments in both seasons. These results may be due to the rapid uptake of essential nutrients from mineral fertilizers (NPK), which in turn are the simulative effect of NPK in initiating the meristematic activity and enhancing the amount of metabolites necessary for building plant organs (Marschner,1995). However, these results are in agreement with those obtained by Stark and Porter (2005) and Westermann (2005) on potato crop.

2. Yield and its components:

Data presented in Table (4) show the effect of different fertilizers treatments on total tuber yield (ton/ fed.), number of tubers/ plant and tuber weight/ plant. The results cleared that the total tuber yield (t/fed.) differed significantly with the various fertilizer managemen*ts*. The maximum total tuber yield (15.083 and 16.133) and its components were produced when fertilizing potato plants with the mineral fertilizers alone (NPK) that was seasons, followed by those received compost of banana waste at the rate of 15 t/fed. in both seasons . On the other hand, the minimum total tuber yield and its components were obtained from using the compost of sugarcane bagasse at the rate of 11(t/fed.) in two seasons. The increase in yield owing to the application of NPK may be attributed to the fact that these nutrients have direct impact on the vegetative growth characters (Table 3). The obtained results are in harmony with those reported by Simth (1996), Tabatabel and Malakovti (1999), Mahendran and Chandramani (1998) and EL-Shahat (2005).

Table 3. Effect of different sources and rates of compost on potato plant stand at 45 days and vegetative parameters at 85 days after planting (DAP) in 2004 and 2005 summer seasons.

Parameters / Treatments	Plant stand %		Plant height (cm)		No. of main stems/plant		Foliage fresh weight (g/plant)		Foliage dry weight (g/plant)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Mineral fertilizers (NPK)	94.00	94.33	48.6	50.9	3.77	4.02	336.1	340.7	28.83	30.00
Rice straw compost 7.0 t/fed	92.44	92.77	32.2	33.5	1.95	2.06	179.6	187.0	18.83	19.13
Maize stalks compost 7.5 t/fed	93.33	93.33	29.6	31.1	1.94	2.20	183.7	185.4	19.40	19.70
Banana wastes compost 5 t /fed	93.55	94.00	32.0	34.0	2.13	2.28	198.7	200.4	19.67	19.97
Sugarcane bagasse compost 11t/fed	90.77	91.99	27.7	29.7	1.84	1.93	176.9	177.2	17.27	17.63
Rice straw compost 14 t/fed	93.00	93.66	36.1	37.6	2.23	2.34	222.2	226.3	21.40	21.57
Maize stalks compost 15.0 t/fed	91.78	93.00	35.4	36.8	2.22	2.32	220.3	225.2	20.17	20.43
Banana wastes compost 10 t/fed	92.78	94.55	38.2	38.5	2.32	2.48	243.7	245.7	22.37	22.57
Sugarcane bagasse compost 22 t/fed	91.89	92.66	33.6	35.1	2.05	2.15	212.2	212.9	19.47	20.07
Rice straw compost 21 t/fed	95.33	97.22	39.5	41.5	2.72	2.76	255.4	259.7	23.73	23.87
Maize stalks compost 22.5 t/fed	93.66	95.33	39.3	40.0	2.74	2.86	245.2	253.4	23.03	23.40
Banana wastes compost 15 t/fed	94.33	96.00	42.0	41.9	2.82	2.89	269.1	273.4	24.30	24.57
Sugarcane bagasse compost 33 t /fed	92.55	94.11	36.9	38.1	2.43	2.34	236.3	239.8	21.40	21.33
N-LSD at 5%	1.20	1.48	1.4	1.2	0.15	0.19	7.6	9.4	1.15	0.91

Table 4. Effect of different sources and rates of compost on potato total tuber yield and its components in 2004 and 2005 summer seasons.

Parameters / Treatments	Total tuber yield (ton/fed)		No. of tubers/plant		Tuber weight/plant (g)	
	2004	2005	2004	2005	2004	2005
Mineral fertilizers (NPK)	15.083	16.133	9.00	9.17	758.8	825.4
Rice straw compost 7 t/fed	8.353	8.427	3.80	3.81	417.2	430.7
Maize stalks compost 7.5 t/fed	8.137	8.330	3.75	3.78	404.4	414.8
Banana wastes compost 5 t/fed	8.323	8.533	4.05	4.07	432.3	449.9
Sugarcane bagasse compost 11 t/fed	8.033	8.113	3.58	3.65	399.2	409.6
Rice straw compost 14 t/fed	9.477	9.797	4.20	4.29	458.9	479.9
Maize stalks compost 15 t/fed	9.260	9.468	4.13	4.18	444.5	460.1
Banana wastes compost 10 t/fed	9.723	9.940	4.58	4.67	482.4	500.2
Sugarcane bagasse compost 22 t/fed	9.000	9.167	4.12	4.16	423.7	443.2
Rice straw compost 21 t/fed	11.240	11.423	6.30	6.12	570.6	586.8
Maize stalks compost 22.5 t/fed	10.743	10.967	6.20	6.28	549.1	557.1
Banana wastes compost 15 t/fed	11.543	11.930	6.95	7.04	588.5	598.6
Sugarcane bagasse compost 33 t/fed	10.022	10.383	5.22	5.13	504.3	543.4
N-LSD at 5%	0.183	0.197	0.32	0.23	20.4	18.4

3.Tuber quality:

The results in Table (5) show that tuber dry matter and starch contents were significantly affected by the different nutrient sources in both season . The highest values of tuber dry matter was observed with the application of compost banana waste at 15 t/fed. in the first season and compost of rice straw (21t/fed.)in the second season. Tuber starch content was the highest when plant fertilized by using compost rice straw at 21 t/fed. in the first season and compost banana waste at 15 t/fed. in the second one over the mineral fertilizers. These results could be attributed to the effect of organic manure on the increase in the absorption of nutrients and photosynthesis process that led to more accumulation of metabolites in reproductive organs which in turn improve the tuber quality. The obtained results are in accordance with Abou-Hussein *et al.* (2002) and Awad (2002 and 2005).

Data in the same Table clearly indicate that nitrate content in tubers was affected by the different treatments. The lowest level of nitrate by using compost of sugarcane bagasse at 11 t/fed. followed by compost of rice straw at 7 t/fed. in the two seasons. On the other hand, the highest level of nitrate was detected in potato tubers produced by those plants treated with the mineral fertilizers (check) in both seasons. The steady release of nitrogen from organic manures in the form of ammonium at relatively slow release which probably caused low nitrate contents in the tubers (Abou- Hussein *et al.* 2002 and Awad 2005).

Table 5. Effect of different sources and rates of compost on the contents of potato tubers dry matter, starch and nitrate in 2004 and 2005 summer seasons.

Parameters / Treatments	Tuber dry matter (%)		Tuber starch content (%)		Tuber nitrate content(ppm)	
	2004	2005	2004	2005	2004	2005
Mineral fertilizers (NPK)	19.63	19.81	14.73	14.83	141.7	133.7
Rice straw compost 7 t/fed	18.55	18.68	14.10	14.16	42.3	42.0
Maize stalks compost 7.5 t/fed	18.48	18.64	14.08	14.09	46.0	45.7
Banana wastes compost 5 t/fed	18.97	19.08	14.02	14.28	55.3	51.0
Sugarcane bagasse compost 11 t/fed	18.40	18.61	13.93	14.08	39.0	45.7
Rice straw compost 14 t/fed	20.13	20.42	14.82	14.87	46.7	50.7
Maize stalks compost 15 t/fed	20.02	20.15	14.54	14.44	49.7	54.7
Banana wastes compost 10 t/fed	20.53	20.77	14.61	14.95	56.7	61.3
Sugarcane bagasse compost 22 t/fed	19.95	20.09	14.24	14.29	44.3	51.0
Rice straw compost 21 t/fed	20.80	22.40	15.81	15.54	53.7	60.0
Maize stalks compost 22.5 t/fed	20.69	20.70	15.34	15.31	60.0	59.0
Banana wastes compost 15 t/fed	20.89	21.00	15.57	15.82	66.3	70.0
Sugarcane bagasse compost 33 t/fed	20.13	20.23	15.19	15.03	47.0	48.0
N-LSD at 5%	0.27	0.31	0.13	0.14	5.0	4.4

4. Chemical contents:

Data presented in Table (6) reveal that the addition of inorganic fertilizer and the different sources of compost had significant effect on NPK in both leaves and tubers in the two growing seasons. The percentage of these nutrients depends on the type and rate of organic materials and the growth stage of potato plant. The maximum values of nitrogen, phosphorus and potassium in the leaves and tubers were found in plants fertilized with mineral fertilizer in the two seasons. Contrariety, the minimum values was produced by applying compost of sugarcane bagasse at the rate of 11 t/fed. followed by compost of maize stalks at 7.5 (t/fed.) in both seasons. This result may be due to the more available nutrients and quick absorption of mineral elements in the mineral fertilizers that led to increase their concentration in plant tissues. These results are in harmony with those obtained by Riberio *et al.* (1997) Mahendran and Chandramani (1998) and Awad (2005).

Table 6. Effect of different sources and rates of compost on contents NPK in the leaves at 85 days after planting and the tubers at harvesting in 2004 and 2005 summer seasons.

Parameters / Treatments	Leaves content (%)						Tubers content (%)					
	N		P		K		N		P		K	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Mineral fertilizers (NPK)	3.29	3.42	0.40	0.42	2.95	3.08	2.23	2.31	0.29	0.32	2.40	2.50
Compost rice straw 7 t/fed	1.77	1.83	0.25	0.26	1.63	1.66	1.36	1.39	0.20	0.21	1.24	1.27
Compost maize stalks 7.5 t/fed	1.75	1.80	0.25	0.25	1.54	1.65	1.30	1.31	0.21	0.22	1.15	1.19
Compost banana wastes 5 t/fed	1.88	1.92	0.26	0.27	1.72	1.82	1.42	1.46	0.23	0.23	1.30	1.34
Compost sugarcane bagasse11t/fed	1.76	1.75	0.24	0.24	1.55	1.61	1.26	1.26	0.19	0.21	1.12	1.14
Compost rice straw 14 t/fed	2.03	2.05	0.26	0.27	1.78	1.82	1.41	1.44	0.22	0.23	1.26	1.30
Compost maize stalks 15 t/fed	1.90	1.95	0.24	0.27	1.63	1.77	1.47	1.43	0.23	0.22	1.21	1.23
Compost banana wastes 10 t/fed	2.05	2.16	0.27	0.29	1.74	1.90	1.48	1.50	0.22	0.22	1.39	1.43
Compost sugarcane bagasse 22t/fed t/fed	1.93	1.92	0.24	0.25	1.62	1.72	1.35	1.38	0.21	0.25	1.18	1.21
Compost rice straw 21 t/fed	2.10	2.14	0.30	0.31	1.82	1.86	1.55	1.58	0.24	0.24	1.35	1.40
Compost maize stalks 22.5 t/fed	2.05	2.09	0.31	0.30	1.76	1.80	1.49	1.53	0.24	0.24	1.29	1.33
Compost banana wastes 15 t/fed	2.17	2.20	0.31	0.32	1.89	1.94	1.61	1.64	0.23	0.25	1.44	1.47
Compost sugarcane bagasse t/fed33 33 t/fed	1.89	1.95	0.26	0.27	1.72	1.76	1.39	1.42	0.20	0.22	1.18	1.26
N-LSD at 5%	0.07	0.11	0.03	0.02	0.04	0.06	0.07	0.06	0.02	0.02	0.05	0.05

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تأثير مصادر ومعدلات مختلفة من الكمبوست على النمو والمحصول والجودة في البطاطس

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أجريت هذه الدراسة لموسمين صيفيين متتاليين ٢٠٠٤ و٢٠٠٥ على محصول البطاطس صنف دايمونت بقرية أبو عوض، مركز أجا، بمحافظة الدقهلية، لدراسة تأثير استخدام مصادر ومعدلات مختلفة من سماد الكمبوست (قش الأرز، حطب الذرة، مخلفات الموز، مصاصة قصب السكر) على النمو والمحصول ومكوناته بالإضافة إلى جودة الدرنات.

وأوضحت النتائج المتحصل عليها إلى أن أعلى نسبة ظهور للنبات في الحقل عند ٤٥ يوم بعد الزراعة كانت مع كمبوست قش الأرز عند إضافة بمعدل ٢١ طن / فدان (في الموسم الأول) وكمبوست مخلفات الموز عند معدل ١٥ طن/ فدان (في الموسم الثاني).

وقد أشارت النتائج إلى أن صفات النمو الخضرية والتي تضمنت طول النبات، وعدد السيقان الرئيسية للنبات، والوزن الطازج والجاف للمجموع الخضري ومحتوى النيتروجين- الفوسفور- البوتاسيوم في الأوراق عند ٨٥ يوم بعد الزراعة و المحصول الكلي (طن/ فدان)، وعدد ووزن الدرنات/ نبات ومحتوى النيتروجين- الفوسفور- البوتاسيوم في الدرنات عند الحصاد إلى زيادات معنوية باستخدام السماد المعدني (كنترول) في موسمي الزراعة.

وفي نفس الاتجاه فقد وجد أيضا أن إضافة سماد الكمبوست من مخلفات الموز بمعدل ١٥ طن/ فدان، وكمبوست قش الأرز بمعدل ٢١ طن/ فدان قد زادا من محتوى المادة الجافة والنشا في الدرنات وكان أقل مستوى للنترات في الدرنات قد تم الحصول عليه من النباتات التي تم تسميدها بكمبوست مصاصة القصب عند معدل ١١ طن/ فدان، وكمبوست قش الأرز ٧ طن/ فدان في كلا الموسمين.

وبصفة عامة من الضروري لتبني نظام الزراعة العضوية في إنتاج درنات البطاطس الصالحة للتصدير مع المحافظة على خصوبة التربة بالاضافة إلى تقليل التلوث البيئي.