

Yield Response and Nutrient Uptake of Cowpea Following Application of Different Organic Compost Mixture

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A FIELD experiment was conducted at the farm of the National Research Center, Qualubia Governorate, Egypt to study the application effects of different mixture of organic composts on the yield and uptake of some macronutrients by cowpea plants. Wastes of potatoes, banana and hyacinth plants and chicken were composted and added at the rate of 10 tons/feddan in different combination ratios (1:3, 1:1 and 3:1) in addition to 50 % of recommend chemical fertilizer dose.

Yield of cowpea was significantly increased as a result of different treatments application as compared with the control, viz. 100% chemical fertilizer recommended dose.

Application of different compost treatments significantly increased the uptake of N, P, K, Ca and Mg as compared to control treatment. The maximum increase of cowpea grain yields over control was recorded under the treatment of potatoes + chicken (102%) and the lowest was by potatoes + banana (74%). Generally, the positive effect of these treatments on yield and uptake of the macronutrients decreased in the following order: potatoes + chicken > potatoes + hyacinth > potatoes + banana.

It is well known that soils of arid and semi-arid regions are poor in organic matter, so maintenance of soil organic matter is a partial problem of soil fertility in Egypt. Organic materials such as crop residues (potato, banana and hyacinth) are available in abundance and reach tremendous amounts every year. The recycling of these materials to produce organic fertilizers (as compost) is very important for increasing the agricultural production, reducing the application rates of chemical fertilizers and therefore the prevention of environmental pollution.

The use of organic compost in crop production is receiving renewed attention worldwide. The application of organic manures occasionally influences the plant growth physiologically (Kawata *et al.*, 1976), provides the plants with growth-regulating substances (Flaig, 1974) and modifies soil physical behavior (Khaled, 1993). The economic grain yield of wheat was found with an application rate of 8.25 ton of chicken manure/ha and the maximum yield was found with an application rate of 16.5 t/ha or higher (Hago *et al.*, 1993). However, N and P uptake by wheat increased progressively with increasing the rate of chicken manure application. Rabie *et al.* (1995) showed that application of water hyacinth compost at 5 t/fed to sandy soil enhanced dry matter yield of groundnut, maize and barley and increased their uptake of N, P and K.

The aim of this work was to examine the application effects of different organic compost mixtures on the yield and nutrients uptake by cowpea plants. Moreover, to minimize environmental pollution which resulted from the intensive application of chemical fertilization by substituting a part of it with organic compost.

Material and Methods

A field experiment was conducted on the farm of the National Research Center, Kalubia Governorate, in 2000 season. Seeds of cowpea (*Vigna sinensis*) cv. Cream 7 were sown in 20th of Feb. The experiment was performed in randomized complete block design with four replicates (the plot area was 3x2m) to evaluate the application effect of different composts combinations at the rate of 10 tons/feddan on the production of cowpea plants as compared to chemical fertilizer application.

The different treatments added to the soil before sowing the grain are shown as follows:

1. Control = the recommended chemical fertilizer dose (120 kg/fed as ammonium nitrate + 100 kg/fed as super phosphate + 60kg/fed as potassium sulphate)
2. Potato : Banana compost (1: 3).
3. Potato : Banana compost (1: 1).
4. Potato : Banana compost (3: 1).
5. Potato : Hyacinth compost (1: 3).

6. Potato : Hyacinth compost (1:1).
7. Potato : Hyacinth compost (3:1).
8. Potato : Chicken compost (1:3).
9. Potato : Chicken compost (1:1).
10. Potato : Chicken compost (3:1).

Some properties of soil used in this study are shown in Table 1.

TABLE 1. Some physical and chemical properties of the studied soil.

pH (1:2.5)	EC(ds/m) (1:2.5)	O.M (%)	CaCO ₃ (%)	C.E.C (Meq/100g)	Particle size distribution (%)			Textural
					Sand	Silt	Clay	Grade
8.23	0.58	1.80	3.41	31.9	21	34	45	Clay
Total N (ppm)		Available macronutrients (ppm)						
		P	K	Ca	Mg			
866		18.9	232	389	149			

All different organic treatments received also 50 % of the chemical recommended dose of N, P and K viz. 60 kg/fed. as ammonium nitrate + 50 kg/fed as super phosphate + 30 kg/fed as potassium sulphate. Some properties of applied organic compost were presented in Table 2.

TABLE 2. Some chemical properties of the applied organic manure.

Material	pH 1:1	C:N ratio	C %	N %	P %	K %	Ca %	Mg %
Chicken manure	6.45	10.61	34.00	3.22	2.10	2.3	2.6	1.2
Hyacinth compost	7.10	18.1	23.35	1.29	0.70	1.9	1.5	0.5
Potato compost	6.80	19.0	49.40	2.6	0.50	4.0	1.4	0.4
Banana compost	7.00	18.3	34.77	1.90	0.69	3.3	2.3	0.8

At harvest time, 105 days from sowing, grain yield were monitored and recorded. Representative samples of grains, were grounded, also soil samples were collected at the depth of 20cm and prepared for chemical analysis, according to Cottenie *et al.* (1982), rectify.

Result and Discussion

Cowpea yield

The response of grain yield of cowpea plants to the different organic compost combinations is presented in Fig. 1.

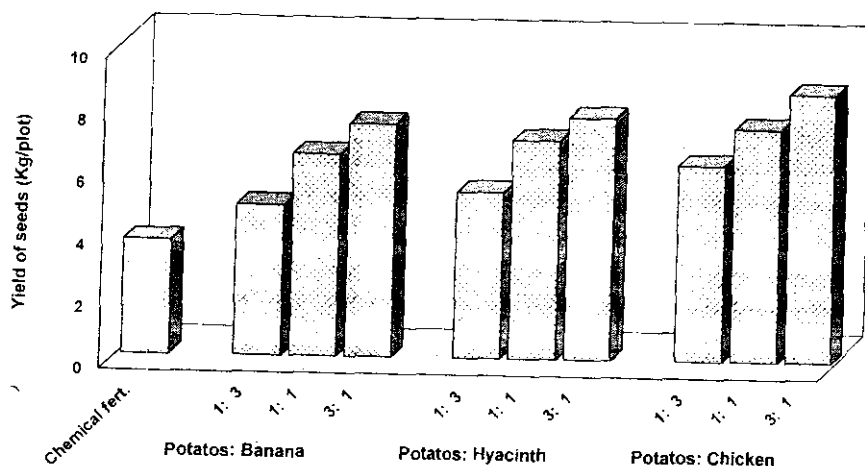


Fig. 1. Effect of application of organic and chemical fertilizers on the yield of Cowpea.

The results indicate a significant increase in the grain yield as a result of compost addition compared with that of control. This may be due to the decomposition of organic material and release of its nutrients in available form rather than the beneficial effect of organic matter on soil chemical, physical and biological properties (Omran *et al.*, 1979). Such results are also in close agreement with Ibrahim (1989); Gaffar *et al.* (1992) and Saleh & Abd El-Fattah (1997), who indicated that the application of organic manures fertilizers increased the yield of plants and their nutrients uptake. The increase of grain yield depends on the type and the rates of organic compost.

The percentage of increase over the control of grain yield was 30.8, 75.3 and 102.3 under the different combinations of potato: banana treatments at ratios of 1:3, 1:1 and 3:1, respectively.

In respect of the percentage of increase of grain yield was 44.5, 99 and 109.9 in the combination treatments between potato and banana composts at ratios of 1:3, 1:1 and 3:1, respectively.

Regarding the effect of potato with chicken composts application on seed yield, data show that the maximum increase of grain yield was occurred with Egypt. *J. Soil Sci.* 43, No. 4 (2003)

potato/chicken composts. The percentage of increases of grain yield was 69.7, 102.2 and 134 at the ratios of 1:3, 1:1 and 3:1 over control treatments, respectively.

Generally, the use of chicken manure combined with potato compost gave the best results. The highest increase of grain yield was obtained under the mixture treatments from potato: chicken composts followed by potato hyacinth and then potato: banana treatments as compared with inorganic treatments.

Availability of macronutrients

The data presented in Table 3 show that the application of organic compost materials increased the total N and the availability of P, K, Ca and Mg in soil samples as compared to that for control.

TABLE 3. Effect of application of different organic compost (10 tons/fed) on the total N and availability of P, K, Ca and Mg in the soil (mgkg⁻¹).

Treatments	Total N	P	K	Ca	Mg
Control (chemical)	502	12.5	155	267	105
Potato : Banana (1 : 3)	750	20.5	252	260	149
(1 : 1)	768	22.8	308	317	138
(3 : 1)	850	24.1	344	365	155
Mean	789	22.5	301	314	147
Potato : Hyacinth (1 : 3)	701	18.6	125	189	77
(1 : 1)	712	17.4	149	238	95
(3 : 1)	830	16.9	175	255	112
Mean	748	17.6	150	227	95
Potato : Chicken (1 : 3)	1128	20.5	175	367	167
(1 : 1)	986	18.3	201	422	182
(3 : 1)	894	16.5	236	450	196
Mean	1003	18.4	204	413	182
L.S.D.0.05	167.5	13.8	42.2	68.9	55.7

The highest availability of macronutrients in compost-amended soil over fertilizer treatment alone (control) could be attributed to difference between the rate of loss and the rate of supplement the nutrient under different treatments. The net nutrients application was slightly lower for the compost application treatment than that for the mineral fertilizer treatment (control 100% NPK) but the nutrients were more available and efficient. The percentage of this increase related to the content of organic compost from these elements, the decomposition degree of the organic materials and the release of its nutrients in available form. The availability of elements to the plants depend on many factors such as the chemical and physical properties of the soil. In this respect, Abd El-Moez (1985); Abd El-Moez & Saleh (1999) and Taalab (1999) pointed out that the use of organic fertilizers increased the availability of many nutrients, and enhanced the total uptake by plants.

Uptake of macronutrients

The data in Table 4 represents the average of each element for three ratios of both compost mixture. The increase of nitrogen uptake reaches 3, 1.4 and 3.7 times than that of the control for (Po : Ba), (Po : Hy) and (Po : Ch) treatments, respectively. (Po : Ch) is superior for nitrogen uptake due to their enrichment in nitrogen (Table 2). In addition, potato combined with chicken manure at ratio (3:1) is superior for nitrogen uptake. This may be due to the formed nitrogen in chicken manure which was easily to lose by leaching and volatilization. On the other side the bounded nitrogen in potato compost.

In the case of phosphorus, uptake of P was 1.63, 1.62 and 1.9 times than that of the control treatment at ratios 3:1 for (Po:Ba), (Po:Hy) and (Po:Ch) treatments, respectively. It is worth mention that the mixtures of potato and chicken compost were much more effective on increasing the phosphorus uptake by cowpea.

The composts (potato + banana, potato + hycinth and potato + chicken manure) application increased the uptake of K, Ca and Mg by cowpea compared to the control treatment (Table 4). The increase for K uptake were 2, 2.1 and 2.25 and for Ca were 2.03, 2.2 and 2.4 and for Mg were 2.06, 2.19 and 2.36 times than that of the control, respectively.

It is clearly evident from the data presented in Table 4 that the increase of N, P, K, Ca and Mg uptake were paralled to the increase in grain yield of cowpea.

TABLE 4. Effect of application of different organic compost (10 tons/fed) and chemical fertilizers on macronutrients uptake of cowpea.

Treatments	mg / plant				
	N	P	K	Ca	Mg
Control (chemical)	235	69	192	34	16
Potato : Banana (1 : 3)	415	84	287	54	25
(1 : 1)	815	125	420	75	36
(3 : 1)	852	128	444	78	38
Mean	694	112	384	69	33
Potato : hyacinth (1 : 3)	285	102	328	64	29
(1 : 1)	317	113	415	76	35
(3 : 1)	385	120	460	82	41
Mean	329	112	401	74	35
Potato : chicken (1 : 3)	780	114	313	70	30
(1 : 1)	894	131	474	84	38
(3 : 1)	925	148	507	93	45
Mean	866	131	431	82	38
L.S.D.0.05	54.4	12.8	40.4	10	4.9

The uptake of macronutrients of cowpea grain increased with an application of organic compost as compared to control (chemical fertilizer).

This finding is in close agreement with those of Pritam *et al.* (1994) who found that the addition of organic fertilizers enhanced the uptake of N, P, K, Ca and Mg by wheat plants. They concluded that, this effect could be attributed to one or more of the following reasons: a) improvement of root CEC. b) synthesis of certain stimulating substances. c) improvement of microbial population and physical properties of soil.

Conclusion

The results presented in this work for the field trial conducted to assess the potential benefits to cowpea from fertilizing with different ratios of (Po : Ba), (Po : Hy), (Po : Ch) and chemical fertilizer revealed best yield and nutrient uptake were most apparent with potato : hyacinth at ratio of (3 : 1).

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استجابة امتصاص العناصر والمحصول لنبات اللوبيا نتيجة لإضافة خلطات مختلفة من الكمورات العضوية

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أقيمت تجربة حقلية فى مزرعة المركز القومى للبحوث بالقناطر الخيرية - محافظة القليوبية لدراسة تأثير إضافة خلطات مختلفة من بعض الكمورات العضوية وينسب مختلفة على محصول نبات اللوبيا وامتصاصها للعناصر الغذائية. حيث تم استخدام كمورات كل من مخلفات ورد النيل والموز والدواجن وخلط كل واحدة منها مع كمورة مخلفات نبات البطاطس بنسب مختلفة هى (١:٢)، (١:١)، (٢:١) وقد تم إضافة كل واحدة من تلك الخلطات بمعدل ١٠ طن/فدان - كما أضيفت الأسمدة الكيماوية لكل معاملة بمقدار ٥٠٪ فقط من معدلات السماد الكيماوى المقررة ويمكن تلخيص أهم النتائج فى الآتى:

١- زيادة محصول اللوبيا زيادة معنوية نتيجة لجميع المعاملات مقارنة بالتسميد الكيماوى فقط.

٢- أدت إضافة الكمورات بالنسب المختلفة الى زيادة معنوية فى امتصاص كل من النيتروجين - الفوسفور - البوتاسيوم - الكالسيوم - المغنسيوم مقارنة بالكنترول.

٣- أدت إضافة المعاملة المكونة من مخلفات نبات البطاطس ومخلفات الدواجن الى زيادة المحصول بأعلى معدل زيادة وكانت أقل زيادة فى المحصول نتيجة إضافة المعاملة المكونة من مخلفات البطاطس والموز.

٤- يمكن ترتيب المعاملات المختلفة من حيث تأثيرها على كل من المحصول وامتصاص العناصر ترتيباً تنازلياً كالآتى:

مخلفات نبات بطاطس + دواجن > مخلفات نبات بطاطس + ورد النيل > مخلفات نبات بطاطس + موز.