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Growth and Yield of Cowpea Plants in Response to Organic Fertilization

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Abstract: Two field experiments were carried out during the summer seasons of 2007 and 2008 to study the effect of organic manures fertilizer such as pigeon, chicken, cattle, rabbit, farmyard manures and their combinations as well as mineral fertilizers on growth and yield of cowpea (*Vigna unguiculata*) plants. The obtained results indicated that, application of chicken manure combined with cattle manure or pigeon manure combined with chicken manure, cattle manure or rabbit manure was superior and significantly increased plant height, number of leaves, number of branches, leaf area, number of pods, seed index, seeds total yield and contents of P and K in seeds and P in leaves. However, the difference between combined organic manures and mineral fertilizers in most of the previously mentioned characters was insignificant. These results indicated that organic manures could be used as safe, cheep and environmentally-friendly substitutes to mineral fertilizers.

Key words: Organic manure fertilizers, cowpea (*Vigna unguiculata*), vegetative growth, yield, yield quality.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L) walp) is one of the important vegetable crops grown in Egypt as well as many other countries. Production of cowpea for local consumption and exportation is of great importance. It is considered as an inexpensive source of protein. It is mainly used for human consumption, livestock feed and soil cover as green manure (Abd El-Mageed *et al*., 2001).

Due to the new generation of the world to the clean environment, one of the directions is alternative agriculture, in which no chemicals are used in agriculture (El-Kouny, 1999). Recently, a great attention has been given to the use of organic fertilizer in cowpea production in order to reduce plant and soil contaminations with different elements and also to reduce the application of mineral fertilizers (Radwan, 2003). Organic manures contain higher levels of relatively available nutritional elements which are essentially required for plant growth. Moreover, using manure fertilizers such as cattle manure, chicken manure, pigeon manure, rabbit manure and farmyard manure play an important role for improving soil physical properties. It has been stated that, organic manures are slow release nitrogen fertilizers where natural organic materials are broken down slowly by the soil microorganisms (Kolbe *et al*., 1995; Marschner, 1995; El-Badawy, 1997; Rizk, 2001 and El-Gamal and Selim, 2005). Moreover, organic fertilizer is considered as an important source of humus, macro and micro elements carrier, and at the same time it increases the activity of the useful microorganisms (El-Gizy, 1994). Using organic manure fertilizers was found to improve plant growth, yield and yield quality on snap bean (Soliman *et al*., 1991 and Gabr, 2000), broad beans (El-Fakhrani, 1997), pea (Osman, 1998 and El-Mansi *et al*., 2004) and sweet pepper (El-Zawily, 2002).

To investigate the possibility of producing organic cowpea to minimize the side effects of chemicals which harm our health and give more opportunities for exportation, the purpose of this work was to study the effect of different sources of organic manures such as cattle manure, chicken manure, pigeon manure, rabbit manure and farmyard manure and their combinations on growth, yield and yield quality of cowpea plants.

MATERIALS AND METHODS

Field Experiments:

Two field experiments were carried out in a clay soil (some chemical properties of the soil during the two seasons are presented in Table 1) during the summer seasons of 2007 and 2008 at the experimental farm of the Faculty of Agriculture, Tanta University, Egypt. To study the effect of organic manure sources on growth, yield and yield quality of cowpea plants, five different sources of organic manure were selected (the doses of

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organic manures were 3-fold doses of the organic fertilizers that have been recommended from the Egyptian Ministry of Agriculture for cowpea crop).

Each experiment consisted of 16 treatments as follows:

1- Chicken manure (Ch.M.) (45 m^3/feddan).
2- Cattle manure (Ca.M.) (21 m^3/feddan).
3- Pigeon manure (P.M.) (15 m^3/feddan).
4- Rabbit manure (R.M.) (30 m^3/feddan).
5- Farmyard manure (FY.M.) (45 m^3/feddan).
6- 50 % (Ch.M.) + 50 % (Ca.M.).
7- 50 % (Ch.M.) + 50 % (P.M.).
8- 50 % (Ch.M.) + 50 % (R.M.).
9- 50 % (Ch.M.) + 50 % (FY.M.).
10- 50 % (Ca.M.) + 50 % (P.M.).
11- 50 % (Ca.M.) + 50 % (R.M.).
12- 50 % (Ca.M.) + 50 % (FYM.).
13- 50 % (P.M.) + 50 % (R.M.).
14- 50 % (P.M.) + 50 % (FY.M.).
15- 50 % (R.M.) + 50 % (FY.M.).
16- Recommended doses of mineral fertilizers (control): 300 kg ammonium sulphate (20.5% N), 300 kg calcium super phosphate (15.5% P_2O_5) and 100 kg potassium sulphate (48% K_2O) per feddan.

Table 1: Chemical analysis of soil before sowing according to Ryan *et al*. (1996).

		2007 season	2008season
Soluble cations in saturation extract 1:5 (meq /L)			
Ca^{++}		6.60	5.94
Mg^{++}		5.00	5.7
Na^{+}		12.0	12.4
K^{+}		0.37	0.43
Soluble anions in saturation extract 1:5 (meq /L)			
CO_3^{--}		0.0	0.0
HCO_3^{-}		5.49	4.84
Cl^{-}		8.78	7.89
SO_4^{--}		10.09	9.79
pH		7.78	7.85
EC /2 5°C (m mohos / cm)		3.22	3.09
Organic matter %		0.75	0.90
Nitrogen :	Total (mg / 100g soil)	229.4	240.7
	Available (mg / 100g soil)	38.0	38.8
Phosphorus :	Total (mg / 100g soil)	29.0	32.4
	Available (mg / 100g soil)	5.9	6.9
Potassium :	Total (mg / 100g soil)	840.0	795.0
	Available (mg / 100g soil)	185.2	182.0

Chemical analysis of all manures in both seasons is shown in Table (2).

Treatments were arranged in a randomized complete block design with three replications. Each experimental plot was 12 m^2 and includes 3 rows, each raw was 5 m length and 80 cm width and one plant per hill with 25 cm apart were planted. Guard row was left between each two adjacent experimental plots. Seeds of cowpea cv. "Kaha 1" were sown on 3nd and 6th of May in 2007 and 2008 cropping season, respectively.

The manure fertilizers were added during soil preparation with calcium super phosphate, while ammonium sulphate and potassium sulphate were added at three equal portions after 2, 4 and 6 weeks of sowing. The cultural practices were done according to the general program of cowpea cultivation in the region.

Data Recorded:

1- Vegetative Traits:

Five plants were uprooted from each plot at the full blooming stage (Morsy, 1986 and Metwally *et al*., 1998) to measure plant height, number of leaves/plant, number of branches/plant and leaf area/plant. Leaf area was determined using the fresh weight method according to the following formula:

$$\text{Leaf area in } cm^2 = \frac{\text{Fresh wt. of leaves}}{\text{Fresh wt. of disks}} \times \text{leaf area of disks in } cm^2.$$

Table 2: Chemical analysis of organic manures sources.

Characters	Sources of organic manures	2007	2008
Organic.Material. (%)	Cattle manure (Ca.M.)	16.1	15.0
	Chicken manure (Ch.M.)	25.2	22.9
	Pigeon manure (P.M.)	33.4	31.5
	Rabbit manure (R.M.)	20.9	19.5
	Farmyard manure (FY.M.)	20.2	22.4
pH	Cattle manure (Ca.M.)	7.32	7.15
	Chicken manure (Ch.M.)	7.25	7.19
	Pigeon manure (P.M.)	6.91	6.78
	Rabbit manure (R.M.)	7.27	7.20
	Farmyard manure (FY.M.)	7.35	7.26
EC ms/cm	Cattle manure (Ca.M.)	9.6	9.1
	Chicken manure (Ch.M.)	10.2	9.9
	Pigeon manure (P.M.)	14.2	12.9
	Rabbit manure (R.M.)	10.9	10.5
	Farmyard manure (FY.M.)	9.7	9.3
N (%)	Cattle manure (Ca.M.)	1.22	1.16
	Chicken manure (Ch.M.)	2.98	3.05
	Pigeon manure (P.M.)	4.67	4.31
	Rabbit manure (R.M.)	2.43	2.48
	Farmyard manure (FY.M.)	0.91	0.83
P (%)	Cattle manure (Ca.M.)	0.60	0.65
	Chicken manure (Ch.M.)	1.07	0.99
	Pigeon manure (P.M.)	0.98	0.96
	Rabbit manure (R.M.)	0.96	1.04
	Farmyard manure (FY.M.)	0.82	0.75
K (%)	Cattle manure (Ca.M.)	1.00	0.92
	Chicken manure (Ch.M.)	1.21	1.13
	Pigeon manure (P.M.)	2.0	2.3
	Rabbit manure (R.M.)	1.09	1.17
	Farmyard manure (FY.M.)	1.16	1.05

2. Yield and Seeds Quality:

Number of pods/plant, number of seeds/pod, seed index (100-seed weight) and seed yield (ton/feddan) were recorded.

3- Chemical Composition:

Contents of nitrogen (%), phosphorus (mg/100g) and potassium (mg/100g) in seeds and leaves were determined following to Association of Official Analytical Chemists International (A.O.A.C) (1995). The total protein percentage of seeds was calculated by the multiplication of nitrogen values by 6.25.

Statistical Analysis:

Data were analyzed by MSTATC computer software program (Bricker, 1991) using ANOVA with the least significant difference (LSD) at the 0.05 probability level.

RESULTS AND DISCUSSION

Vegetative Growth:

The results in Table 3 indicated that the pigeon manure either alone or combined with (Ch.M.), (Ca.M.) or (R.M.) significantly increased plant height, number of leaves/plant, number of branches/plant and leaf area/plant in both seasons. The results also showed that there were no significant differences between mineral fertilization treatment and pigeon manure either alone or combined with Ch.M ., Ca.M . or R.M . or chicken manure combined with Ca.M . or R.M. in both seasons (Table 3). This effect may be due to the high contents of the nutrient elements in (P.M.) with (Ch.M.), (Ca.M.) or (R.M.). These results are in agreement with those previously obtained by Soliman *et al*., (1991) and Gabr, (2000) on snap bean; El-Fakhrani, (1997) on broad beans; Osman, (1998) and El-Mansi *et al*., (2004) on pea; El-Zawily, (2002) and Arisha, (2003) on pepper; Radwan, (2003) on potato.

Yield and Quality:

Among other sources, using pigeon manure as an organic fertilizer gave the highest number of pods per plant, seed index and seeds total yield in both seasons (Table 4). In the same manner, applying Ch.M. combined with Ca.M. or applying P.M. combined with Ch.M., Ca.M. or R.M. exhibited the highest values of

Table 3: Effect of organic manure sources on vegetative growth of cowpea plants during 2007 and 2008 seasons.

Treatments	First season 2007				Second season 2008			
Organic manures	plant height (cm)	No. of leaves/ plant	No. of branches/ plant	leaf area / plant (cm^2)	plant height (cm)	No. of leaves/ plant	No. of branches/ plant	leaf area / plant (cm^2)
Ch.M.	42.4	16.24	4.25	134	43.4	16.95	4.64	147
Ca.M.	41.9	15.92	4.28	136	46.0	16.91	4.66	145
P.M.	45.3	16.59	4.43	139	47.3	17.21	4.74	150
R.M.	39.7	16.00	4.30	133	45.1	16.87	4.68	144
FYM.	38.1	15.61	4.21	130	40.3	16.54	4.59	138
Ch.M. + Ca.M.	48.8	16.81	4.52	140	48.2	17.19	4.82	153
Ch.M. + P.M.	49.9	17.21	4.59	142	53.7	17.45	4.91	156
Ch.M. + R.M.	45.4	16.82	4.48	140	48.0	17.22	4.86	151
Ch.M. + FYM.	44.9	16.54	4.41	137	47.3	16.89	4.75	148
Ca.M. + P.M.	48.7	17.16	4.55	144	51.9	17.51	4.90	154
Ca.M. + R.M.	45.9	17.09	4.45	138	50.4	17.03	4.79	150
Ca.M.+ FY.M.	44.2	16.43	4.42	137	46.9	16.99	4.74	148
P.M. + R.M.	50.4	17.20	4.56	142	53.4	17.53	4.93	157
P.M. + FY.M.	47.6	16.80	4.45	140	47.3	17.32	4.85	151
R.M. + FY.M.	46.5	16.33	4.44	137	46.9	16.98	4.71	147
Mineral fert.	50.1	17.19	4.58	145	52.6	17.50	4.94	159
L.S.D. at 5%	2.71	0.147	0.156	3.76	3.11	0.26	0.127	5.32

number of pods, seed index and seeds yield in both seasons (Table 4). The results also showed that there were no significant differences between mineral fertilization treatment and pigeon manure either alone or combined with Ch.M ., Ca.M . or R.M . or chicken manure combined with Ca.M . or R.M. in both seasons (Table 4). This increase in yield characteristics may be attributed to the high levels of organic nutrients in the manures that could encourage the vegetative growth of cowpea plants to go forward and accelerate the photosynthetic rate. In this respect, similar findings were also found by Soliman *et al*., (1991) and Gabr, (2000) on snap bean; El-Fakhrani, (1997) on broad beans; Osman, (1998) and El-Mansi *et al*., (2004) on pea; El-Zawily, (2002), Arisha, (2003) and Osman, (2004) on pepper; Radwan, (2003) on potato.

Table 4: Effect of organic manure sources on yield and quality of seeds during 2007 and 2008 seasons.

Treatments	First season 2007				Second season 2008			
Organic manures	No. of seeds / pods	No. of pods / plant	Seed index	Seeds yield (ton / fed.)	No. of seeds / pods	No. of pods / plant	Seed index	Seeds yield (ton / fed.)
Ch.M.	10.91	27.5	13.91	1.152	11.99	24.9	13.72	1.185
Ca.M.	10.88	26.4	13.89	1.159	11.96	25.4	13.95	1.174
P.M.	11.05	28.1	14.00	1.170	12.01	26.1	13.94	1.191
R.M.	10.95	26.9	13.74	1.167	11.91	25.3	13.89	1.182
FYM.	10.84	25.0	13.60	1.143	11.82	23.4	13.52	1.160
Ch.M.+ Ca.M.	11.00	30.6	14.39	1.207	12.04	29.2	14.49	1.248
Ch.M. +P.M.	11.16	31.8	14.59	1.239	12.26	30.5	14.68	1.263
Ch.M. + R.M.	11.04	29.4	14.30	1.188	12.07	29.6	14.26	1.251
Ch.M.+ FY.M.	11.01	28.7	14.12	1.170	12.00	28.0	14.21	1.200
Ca.M. + P.M.	11.18	30.8	14.46	1.230	12.23	30.9	14.61	1.255
Ca.M. + R.M.	11.08	29.1	14.02	1.186	12.15	30.0	14.35	1.246
Ca.M.+ FY.M.	11.02	28.2	14.06	1.172	12.05	28.4	14.50	1.207
P.M. + R.M.	11.19	31.4	14.50	1.219	12.28	30.7	14.62	1.260
P.M. + FY.M.	10.99	28.3	14.00	1.179	12.10	27.9	14.40	1.220
R.M. + FY.M.	10.95	29.1	14.11	1.175	12.06	27.3	14.31	1.211
Mineral fert.	11.17	31.7	14.57	1.228	12.25	30.1	14.65	1.262
L.S.D. at 5%	N.S*	1.69	0.31	0.032	N.S*	1.37	0.26	0.021

N.S*: Not significant.

Chemical Composition:

The effect of all treatments on N and protein content in cowpea seeds or on N and K content in the leaves was insignificant in both seasons (Tables 5 and 6). However, contents of P and K in seeds or P content in leaves were significantly affected by using organic manure as fertilizers in both seasons. The highest values of all characters were obtained when pigeon manure was applied either alone or combined with Ch.M., Ca.M. or R.M. as well as when chicken manure was used in combination with Ca.M. or R.M. The results also showed that there were no significant differences between mineral fertilization treatment and pigeon manure either alone or combined with Ch.M., Ca.M. or R.M. or chicken manure combined with Ca.M. or R.M. in both seasons (Table 5).

Table 5: Effect of organic manure sources on seed chemical composition during 2007 and 2008 seasons.

Treatments	First season 2007				Second season 2008			
Organic manures	N (%)	P (mg / 100g)	K (mg /100g)	Seed protein (%)	N (%)	P (mg / 100g)	K (mg /100g)	Seed protein (%)
Ch.M.	3.15	438	1033	19.69	3.19	425	1031	19.94
Ca.M.	3.16	440	1037	19.75	3.20	431	1029	20.00
P.M.	3.19	446	1047	19.94	3.20	436	1036	20.00
R.M.	3.17	442	1035	19.81	3.16	426	1026	19.75
FY.M.	3.14	435	1029	19.62	3.16	422	1019	19.75
Ch.M.+ Ca.M.	3.19	446	1047	19.94	3.22	434	1036	20.12
Ch.M. +P.M.	3.20	452	1050	20.00	3.24	439	1042	20.25
Ch.M. + R.M.	3.18	447	1047	19.87	3.20	436	1035	20.00
Ch.M.+ FY.M.	3.16	441	1036	19.75	3.18	429	1030	19.87
Ca.M. + P.M.	3.19	452	1049	19.94	3.23	438	1044	20.19
Ca.M. + R.M.	3.17	440	1042	19.81	3.21	435	1030	20.06
Ca.M.+ FY.M.	3.16	441	1038	19.75	3.19	432	1030	19.94
P.M. + R.M.	3.20	450	1052	20.00	3.24	441	1046	20.25
P.M. + FY.M.	3.18	443	1040	19.87	3.20	431	1036	20.00
R.M. + FY.M.	3.16	441	1035	19.75	3.19	431	1031	19.94
Mineral fert.	3.19	451	1051	19.94	3.25	440	1043	20.31
L.S.D. at 5%	N.S	5.03	6.35	N.S	N.S	7.56	10.24	N.S

N.S*: Not significant.

Table 6: Effect of organic manure sources on leaves chemical composition of cowpea leaves during 2007 and 2008 seasons.

Treatments	First season 2007			Second season 2008		
Organic manures	N (%)	P (mg / 100g)	K (mg /100g)	N(%)	P (mg / 100g)	K (mg /100g)
Ch.M.	3.28	400	991	2.99	371	949
Ca.M.	3.30	405	982	3.02	379	954
P.M.	3.26	418	979	3.03	391	958
R.M.	3.26	410	986	3.00	377	959
FY.M.	3.31	395	975	2.95	365	945
Ch.M.+ Ca.M.	3.33	415	995	3.01	389	965
Ch.M. +P.M.	3.31	422	999	3.04	395	975
Ch.M. + R.M.	3.28	416	994	3.02	387	971
Ch.M.+ FY.M.	3.27	407	971	2.96	375	961
Ca.M. + P.M.	3.35	417	992	3.03	391	977
Ca.M. + R.M.	3.34	421	985	3.00	384	969
Ca.M.+ FY.M.	3.30	411	969	2.95	393	954
P.M. + R.M.	3.36	427	994	3.04	399	980
P.M. + FY.M.	3.34	404	972	2.98	384	967
R.M. + FY.M.	3.30	401	965	2.96	376	969
Mineral fert.	3.32	420	994	3.04	394	980
L.S.D. at 5%	N.S	6.25	N.S	N.S	9.45	N.S

N.S*: Not significant.

Conclusions:

This study provides evidence about the possibility of using organic fertilizers, especially the pigeon manure combined with chicken manure, cattle manure or rabbit manure for growing cowpea plants to produce safety products. Furthermore, these results indicated that organic manures could be used as safe, cheep and environmentally-friendly substitutes to mineral fertilizers.

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