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Research Article

Utilization of Water Hyacinth and Banana Wastes Compost in Reclamation of Sandy Soils for increasing Growth, Yield of Cowpea

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Abstract: Pot experiments were carried out in the greenhouse of the Faculty of Agriculture, Fayoum University, to study the effect of water hyacinth and banana wastes compost (0, 10, 15 and 20 ton/fed) combined with inorganic nitrogenous fertilizers namely ammonium sulphate, ammonium nitrate and urea (in the rate of 60 kg N/Fed and this rate was 50% of the recommended dose), on the growth, yield and nutrient content of cowpea plants. All pots received P and K as recommended. The addition of various rates of water hyacinth and banana wastes composts (H.B.C.) under study significantly increased all plant growth parameters under the study, i.e., plant height, plant fresh weight and dry weight of both shoots and roots, the number of root nodules as well as the nutrient content of the different plant organs compared with the control and the chemical fertilizer application of the recommended dose (100%). There was a marked increase in pod characters, yield and its components, i.e., number of pods per plant, length, diameter and weight of pods per plant. The highest values of growth characters of yield and its components and the contents of nutrient elements were noticed when applying compost at the higher rates (20 ton/fed.) followed by 15 and 10 ton/fed., in a descending order as compared with the control. The best combination of nitrogen forms and the compost is considered to be one of the primary factors for high yield production and quality as well as yield components of cowpea. The highest significant increase in growth characters, yield and yield components, as well as the total carbohydrates and crude protein content of the seeds, were obtained *via* the application of compost in combination with ammonium sulphate at the rate of 20 ton/fed.

Keywords: Water hyacinth, Banana wastes, Compost, *Trichoderma harzianum, Trichoderma viride*, cowpea plants, Sandy soil reclamation.

1. Introduction

Cowpea (*Vigna sinensis* L.) is considered as one of the most important leguminous vegetable crops in Egypt. It serves as a good source of carbohydrates, proteins as well as the macro- and micronutrients. The pods are harvested either at the green shell stage for fresh market consumption or at the mature stage for dry seed production.

The Egyptian economy suffers from the rapidly increased human population. Therefore, several efforts have been carried out to increase the agricultural production through the horizontal and vertical expansion of the agricultural projects especially that of the newly reclaimed soils, which may be either sandy soils or sandy calcareous soils. So, many efforts have been made to serve in increasing seed production of many leguminous crops to face the ever-increasing demands of the increased population.

Sandy soils are very poor in organic matter and nutrient content with low water-holding capacity, for that they require extra irrigation, supplemental fertilization, and surface mulches to improve growing conditions. Applying compost to sandy soil is a good way to recycle the agricultural wastes and increase its organic matter content, which may help in solving the sandy soil hydro-physical problems. In addition, FAO (1975) reported that, with the exception of small-scattered areas in the Delta and Nile Valley, most of the sandy soil is in the desert, which represents more than 95% of the total area of Egypt. It also posses poor physical, chemical and biological properties. For this

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reason, the use of organic wastes that are present in great amounts and need to be recycled as organic manure fertilizers may provide materials that can be used for soil fertility improvement and the physical, chemical and biological properties of sandy soils. (Tester, 1990; El-Hady *et al.*, 1995; Abd El-Moez and Saleh, 1999 and Siam, 2008).

Improving the physical, chemical and biological properties of the sandy soils under reclamation could be accomplished by the addition of organic material. The organic materials can supply the plants with their nutritional requirements without having an undesirable effect on the surrounding environment (Sterrett and Savange, 1989). There is a growing interest in the use of organic amendments for the reclamation of sandy soils. So, the use of manure application enhances soil productivity, increases the soil organic carbon content, soil microorganisms, improves soil crumb structure, the nutrient status of the soil and enhances crop yield (EL-Sharawy *et al.*, 2003); In this respect, Celik *et al.*, 2004; Francis *et al.*, 2006, reported that the addition of organic materials of various origins to soil has been considered as one of the most common rehabilitation practices to improve soil physical properties. The addition of compost is of great agricultural interest because it increases the soil organic matter content, (Tejada and Gonzalez, 2003). Newly cultivated sandy soil was supplemented with composted (rice straw, maize stalks, water hyacinth) or farmyard manure (FYM) in the presence, absence of multi-biofertilizer to evaluate its effect on growth, chemical composition and peanut yield as well as its quality; Radwan and Awad (2002). Also, Wanas and Omran (2006) indicated that the application of types of compost (two types prepared from cotton and banana wastes) showed significant effects to improve hydro-physical properties of sandy soil, on water stable aggregates, pore size distribution and soil available water in addition to converting agricultural wastes to useful materials in agricultural fields especially sandy soil. Organic matter is a key component of soils affecting their physical, chemical and biological properties and is important as a source of energy and nutrient elements for soil ecosystems. Maintenance of sufficient levels of organic matter in soils is a prerequisite for sustainable and high production of crops (Arafat, 1994). The amendment of soil with composted rice straw recorded higher counts of testing microorganisms in the peanut rhizosphere as compared to composted water hyacinth or maize stalks under biofertilizers application. The addition of biofertilizers with different organic wastes led to an improvement in the quantity and quality yield of peanut plants as compared to various organic wastes alone or with chemical fertilizer application.

The application of organic materials including compost in crop production influences plant growth and provides the plants with some growth regulators as well as its effect on plant physiological behavior (Rabie *et al.*, 1995 and Siam, 2008).

Organic manure as compost is considered as an important source of macro and micronutrients and humus that enhance plant growth, dry matter accumulation of vegetable crops beside it increased their uptake of N, P and K by plant roots (Ribeiro *et al.*, 2000; Salama, 2002 and Siam, 2008), it also increases the activity of the useful microorganisms in soil. So, it helps in increasing the yield and its constituents of several vegetable crop plants (El-Gizy, 1994; Ouda, 2000; Salama, 2002 and Siam, 2008).

The best means of maintaining soil fertility and productivity level could be achieved through the periodic addition of organic materials in combination with the inorganic fertilizer; this may be explained that the organic materials may increase the efficiency of inorganic fertilizers, especially in the long-term productivity (Ibrahim *et al.*, 1986 and Sakr *et al.*, 1992).

Efforts at remediating soil fertility over the years have basically been achieved using traditional resources of farmyard manure and crop residues in composted forms as well as the use of inorganic fertilizer (Lata and Veenapani, 2011). Water hyacinth *Eichhornia crassipes* is a floating aquatic weed and the world most harmful weed because of its negative effects on waterways and people's livelihoods (Ghabbour *et al.*, 2004; Wilson *et al.*, 2005 and Gupta *et al.*, 2007). However, findings from many investigators have shown that the water hyacinth weeds have a useful role for other purposes. They are considered as a valuable source of macronutrients such as phosphorus, nitrogen and potassium that are essential for plant nutrition (Woomer *et al.*, 2000; Sannigrahi *et al.*, 2002 and Gunnarsson and Petersen, 2007). To evaluate the impact of water hyacinth manure (WHM) on the growth and yield of *Celosia argentea* (Lagos spinach), the results revealed that the application of water hyacinth manure significantly influenced the growth and yield of *C. argentea* and among the treatments water hyacinth manure (WHM) applied at the rate of 2.64kg/plot (60g/plant) performed better in all parameters evaluated. From the study, it can be concluded that water hyacinth is locally available, plentiful and cost free, its effective use as an organic soil amendment would be an interesting method for soil restoration and would minimize partially and/ or totally the negative impacts of this weed on the aquatic ecosystem and socioeconomic activities (Adesina *et al.*, 2011; Sanni and Adesina, 2012).

According to Requena *et al.*, (1996) and Badran (2003) the inoculation of compost with lignocellulolytic microorganisms is a potential strategy for improving the product for agronomic purpose. Many studies demonstrated that some of the isolates of *Trichoderma* spp. showed biocontrol potentiality against several microorganisms involved in cotton damping-off, root rot and wilt disease (Omar *et al.*, 1998; El-Samawaty *et* *al*., 2007). *Trichoderma* species are useful, a virulent plant symbionts that act as biocontrol agents against phytopathogenic fungi via mechanisms of competition, rhizosphere competence, mycoparasitism, production of antimicrobial compounds (antibiotic) and enzyme production, induced resistance, promoting plant growth and accelerate waste degradation during the composting process (Handelsman and Stabb, 1996 and Nzanza *et al*., 2011).

The aim of this investigation was to study the effect of organic compost as another alternative method of water hyacinth management (water hyacinth and banana waste compost) by using it as an organic fertilizer mixed with some forms of nitrogen fertilizers on growth, yield component and yield quality of cowpea plants grown on a sandy soil conditions.

2. Materials and Methods

2.1 Materials

Raw materials: Water hyacinth and banana wastes were used as raw material for compost production; water hyacinth was harvested from irrigation canals, banana wastes collected from surrounding farms at Fayoum Governorate, Egypt. Fungal strains of effective microorganisms *Trichoderma harzianum* and *Trichoderma viride* were obtained from Microbiology Department, Faculty of Agriculture, Fayoum University, Egypt.

2.2 Methods

2.2.1 Preparation of inoculum

For the production of *Trichoderma* spp. inoculum used; pure cultures of *Trichoderma harzianum* and *Trichoderma viride* were grown on Potato Dextrose Agar (PDA) at 28-30ºC for 5 days before inoculation.

Spawn fresh preparation of the substrate, strains growth was prepared in 500-ml glass bottles, each contained 150g of surface sterilized sorghum grains with Clorox 1% and washed several times, and 1% Calcium carbonate was added, bottles were autoclaved at 121ºC for 30 minutes for 3 days, then inoculated after cooling with the above-mentioned strains were taken from one-week-old PDA cultures and aseptically introduced 3 disks into each bottle and allowed to colonize on sorghum grains for three weeks incubation at 30ºC.

Spore suspensions of *Trichoderma* spp. were prepared by washing the agar surface with 10ml sodium acetate buffer (50mM; pH 4.5) and 0.1% tween 80. The obtained spores were resuspended in the same volume of water and diluted with Arabic gum 5% solution to the ratio of 1:10 (v:v) sprayed for cowpea seed coating before planting in the greenhouse.

2.2.2 Compost heaps construction and enrichment materials

Compost heaps were constructed by building heaps from mixture of chopped water hyacinth and banana residues in several layers one over the other in an area of 1.25 x 1.25m^2. For the preparation of Water hyacinth and Banana residues Compost, (H.B.C.) was prepared by aerobic composting. The roots of collecting water hyacinth were removed, and then the raw materials were chopped into small pieces (3-5cm) before compost preparation to give a large surface for liquid adhesion and direct contact with microorganisms.

In order to start with composting the appropriate mixture of water hyacinth and banana residues as composting material, the C/N ratio of the mixture has to be optimized at a C/N ratio of were adjusted to ~ 25-30 using cow dung manure to maximize microbial decomposing activities within the heaps. Approximately parts of the air-dried cow dung manure were distributed on the surface of each layer and moistened with water, moisture was maintained at 60% and the temperature of the compost was monitored every week.

Enrichment materials: Ammonium sulfate 20.5% N (3.5Kg/ton) and superphosphate 15.5% P_2O_5 (7.0Kg/ton) also, 35kg calcium carbonate per ton, dry matter were mixed with all heaps as amendment. After heaping, each heap was covered with a plastic sheet to keep up the moisture and to help in the decomposition work by increasing temperature. The heaps were left without turning over with enough moisture for the first three weeks. Aeration and moistening were done regularly every week for air exchange within the heap for aerobic compositions as well as no percolation of compost exertion. Inoculation of compost heaps with the *Trichoderma* spp. inoculums was done after the stage of active decomposition when the temperature had stabilized around 30-35ºC (4 weeks of composting period). That's 18 weeks composting are enough to produce stable and mature compost suitable for use as organic fertilizer. Compost was added and mixed with soil before sowing.

2.2.3 Experimental procedures

This investigation was carried out under the greenhouse condition. Pot experiments were designed in a complete block randomized design in three replicates in plastic pots. The pots were filled with 10kg of air-dried soil to study the response of cowpea plants to organic water hyacinth and banana wastes compost in combination with different forms of nitrogen fertilizers. The growth characters, yield components and yield quality were measured. The investigated soil was characterized by pH 8.1, the texture was sandy contain 75.3% sand, 20.4% silt and 4.3 clay, EC 1.02dsm^{-1}, $CaCO_3$ 3.2% O.M. 0.60% and available of Fe, Mn and Zn 4.14, 3.11 and 1.50ppm respectively. The chemical characteristics of the experimental soil are presented in Table (1) while the chemical analysis of organic composts; water hyacinth and banana waste compost (H.B.C.) in Table (2).

Table 1. Some chemical properties of experimental soil.

Soluble cations (mq^{-1})				Soluble anions (mq^{-1})		
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3	HCO_3	SO_4
1.40	1.9	2.40	0.43	-	2.02	3.12

The three rates of organic composts (10, 15 and 20 ton/fed) received 50% of the chemical recommended dose of N and mixed with 0-30cm of the surface soil layer two weeks before planting. Both phosphorus and potassium was added to the different treatments in the form of calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) at rates of 100kg superphosphate and 60kg potassium sulphate / fed, respectively. Three nitrogen forms were used namely ammonium sulphate (20.5% N), ammonium nitrate (33.5% N) and urea (46% N) at the rate of 60kg N/fed. (50% of recommended dose). Seeds of cowpea (*Vigna sinensis* L.) were sown in each pot at the depth of 1cm then thinned out to 4 seedlings per pot after 15 days and allowed for a period of 90 days. At harvest time data were recorded on the following characters; growth parameters and pod character i.e. length, diameter, number of nodules, number of pods/plant and weight of the pod. NPK contents in all parts were determined according to methods described by Cottenie *et al*., (1982) and Black (1982). The crude protein content was calculated by multiplying N% x 6.25. Total carbohydrate was determined according to the method described by Michel *et al*., (1956).

Statistical analysis was carried out according to Snedecor and Cochran (1980). Means were compared using the least significant differences (LSD) at the 5% level.

3. Results and Discussion

3.1 Effect of organic composts on vegetative growth characters

Cowpea plants responded significantly to any rate of the applied organic manure (water hyacinth and banana wastes compost) which caused a promotion effect in plant growth characteristics compared with the control. The results in Table (3) indicated that all vegetative growth parameters namely plant height, number of nodules/ plant, both fresh and dry weights either roots or shoots of cowpea plants as influenced by both factors rates of organic compost (H.B.C.), sources of nitrogen applied and interaction between them increased significantly as compared with control. It could be concluded that, in spite of that cowpea plant is one of the Leguminosae which can fix the atmospheric nitrogen through its bacterial nodules, it needs to supply the soil with an external source of nitrogen such as organic one (water hyacinth and banana wastes compost) hence this source cause a promotion for building the bacterial nodules on cowpea plant roots. This point was studied previously by many investigators such as Sangakkara *et al.,* (1999); You and Duanwel (1999); Ouda (2000); Ribeiro *et al.*, (2000); Salama (2002) and Siam (2008). They reported that it's necessary to supply leguminous plant by nitrogen to increase the activity of bacterial nodules.

Data in Table (3) showed also a significant increase in vegetative growth parameters when using high level of water hyacinth and banana wastes compost compared with the low rate of organic fertilization and control. The mean of roots and shoots, fresh and dry weight significantly increased by 126 and 192% for roots and 121 and 115% for shoots compared with control respectively.

It is worth mentioning that, good effect of organic fertilizer increasing leguminous plant growth parameters may be mainly due to improving the rhizosphere conditions i.e. soil structure and moisture content (Awad *et al.,* 1993). Or maybe due to increasing the soil organic matter content, cations exchange capacity and mineral nutrients, which in turn encourage the plant growth to go forward, Ewais-Magda *et al.*, (2004). Other investigators had a good accordance of the obtained data (You and Duanwel, 1999; Kandasawy *et al.*, 2000; Karmegam and Daniel, 2000; Ouda, 2000; Ribeiro *et al.*, 2000; Salama 2002; Siam, 2008 and Anjanabha and Pawan, 2010).

3.2. Effect of nitrogen forms on vegetative growth characters

The results in Table (3) indicated that all vegetative growth parameters were increased as a result of the application of various forms of nitrogen if mixed with organic compost if compared with control. Among N forms used, ammonium sulphate gave the highest values of the all parameters growths than urea or ammonium nitrate. This may be due to higher efficiency of ammonium sulphate than other forms either nitrate or urea loss N through leaching and volatilization (Mahapatra *et al.*, 1997). The increase could be explained, as ammonium sulphate form is an easy nitrified form rather the amide forms of urea (Hassan and Gaballah, 2000).

Table 2. Chemical analysis of the used compost (H.B.C.).

pH (1 : 10)	E.C (m mhos)	O.M. (%)	O.C (%)	Total N (%)	C/N ratio	Available nutrients				
						P (%)	K (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)
7.48	3.85	51.42	29.82	1.96	15.2	0.81	3.10	160.10	200.20	38.00

Table 3. Vegetative growth characters of cowpea plants as affected by various forms of nitrogen application and H.B.C.

Treatments		Plant height (cm)	No. of nodules	Roots wt. g/pot		Shoots wt. g/pot	
Compost*	Nitrogen forms			Fresh	Dry	Fresh	Dry
Control	Amm. nitrate	25.30	2	3.00	1.14	25.00	10.00
	Urea	29.10	5	3.80	1.32	29.00	11.00
	Amm. sulfate	32.20	6	4.30	1.50	32.50	11.65
	Mean	28.87	4	3.70	1.32	28.83	10.88
H.B.C. (10 ton/fed)	Amm. nitrate	34.15	7	4.80	1.60	39.25	13.75
	Urea	38.35	10	5.40	2.00	43.10	15.25
	Amm. sulfate	42.25	13	5.80	2.10	47.00	16.45
	Mean	38.25	10	5.33	1.90	43.12	15.15
H.B.C. (15 ton/fed)	Amm. nitrate	44.10	14	6.00	2.90	49.40	17.20
	Urea	49.30	18	6.80	3.20	53.00	19.00
	Amm. sulfate	53.20	21	7.30	3.50	57.00	20.00
	Mean	48.87	18	6.70	3.20	53.13	18.73
H.B.C. (20 ton/fed)	Amm. nitrate	54.20	22	7.10	3.30	59.00	21.75
	Urea	57.20	25	8.85	4.00	63.50	23.50
	Amm. sulfate	60.15	28	9.18	4.26	69.00	24.85
	Mean	57.18	25	8.38	3.85	63.83	23.37
Average of forms of nitrogen	Amm. nitrate	39.44	11	5.23	2.24	43,16	15.68
	Urea	43.49	15	6.21	2.68	47.15	17.19
	Amm. sulfate	46.95	17	6.65	2.63	51.38	18.24
L.S.D, at 5% level	Source N	2.04	2.26	0.14	0.02	2.62	0.15
	Compost	2.36	2.61	0.16	0.03	3.00	0.18
	Interaction	2.8	2.93	0.30	0.05	3.10	0.22

*H.B.C.: water hyacinth and banana wastes compost

It was also noticed that the addition of nitrogen form as ammonium sulphate fertilizers with the compost at 20 ton/fed increased significantly the mean of roots and shoots on the fresh and dray weight plants as 113 and 184% and shoots 112 and 113% respectively, then which received ammonium sulphate only. Similar results were obtained by many investigators; i.e., Badran (2003); Singh *et al*., (1992) and Abdul Galil *et al*., (1997); Lutcher and Mahler (1988); Hassanien *et al.*, (1997); Hassan and Gaballah (2000); Francis *et al*., (2006) and Siam (2008) who recorded the highest grain yield from application of nitrogen as ammonium sulphate than urea or ammonium nitrate on productivity of wheat in the newly reclaimed lands.

3.3 Effect of the interaction treatments on vegetative growth characters

The interaction between organic manure (H.B.C.) at different rates; i.e. 0, 10, 15 and 20 tons/fed, and the application of inorganic fertilizers as nitrogen forms as a growth promotion significantly affected the plant growth characters of the cowpea plant compared with the control. However, the best growth resulted from that plant received organic compost at the highest rate (20 tons/fed.) plus the addition of ammonium sulphate, whereas, plants recorded the highest values of plant height, average number of nodules, fresh and dry weight. In the same Table, addition of nitrogen as urea with different rates of compost increased all growth parameters than ammonium nitrate, Christensen and Meints (1982), observed that wheat straw yield/ha was higher when N was added as urea than ammonium nitrate.

The noticeable increase in different vegetative growth parameters of cowpea plants is due to the application of organic compost (H.B.C.) at different rates (0, 10, 15 and 20 ton/fed) and the addition of various forms of nitrogen. With the best results being obtained due to the application of ammonium sulphate in combination with organic compost at 20 ton/fed., for fresh and dry roots and shoots amounted to 9.18 and 4.26g and shoots 69 and 24.85g/pot, respectively. On the other hand, the minimum values obtained by applying ammonium nitrate with organic compost at 10 ton/fed, amounted to 4.80 and 1.60g and shoots 39.25 and 13.75g/pot for fresh and dry weight of roots and shoots, respectively.

Table (4) shows the effects of various forms of nitrogen application and compost on N, P and K % in roots and shoots of cowpea plants. It was noticed that the addition of N form as ammonium sulphate fertilizer with compost at 20 ton/fed, increased significantly roots and shoots content of N, P and K % by 98, 100 and 97% for roots and 55, 114 and 36% for shoots, respectively, compared with ammonium sulphate alone. The highest values were obtained at ammonium sulphate +20 ton/fed, compost (H.B.C.), while the lowest values were obtained at ammonium nitrate alone and urea fertilizer came in between.

Table 4. N, P and K content in roots and shoots of cowpea plants as affected by various forms of nitrogen application and water hyacinth and banana wastes compost.

Treatments		Roots %			Shoots %		
Compost*	Nitrogen forms	N	P	K	N	P	K
Control	Amm. nitrate	0.40	0.11	0.31	1.00	0.18	1.65
	Urea	0.44	0.12	0.32	1.12	0.20	2.00
	Amm. sulfate	0.48	0.13	0.35	1.20	0.21	2.10
	Mean	0.44	0.12	0.33	1.11	0.20	1.92
H.B.C. (10 ton/fed	Amm. nitrate	0.59	0.16	0.47	1.38	027	2.35
	Urea	0.65	0.17	0.50	1.43	0.29	2.41
	Amm. sulfate	0.70	0.18	0.51	1.47	0,30	2.48
	Mean	0.65	0.17	0.49	1.43	0.29	2.41
H.B.C. (15 ton/fed)	Amm. nitrate	0.71	0.20	0.56	1.48	0.35	2.52
	Urea	0.77	0.21	0.58	1.55	0.36	256
	Amm. sulfate	0.82	0.21	0.60	.60	0.38	2.61
	Mean	0.77	0.21	0.58	.54	0.36	2.56
H.B.C. (20 ion/fed)	Amm. nitrate	0.85	0.23	0.64	.65	0.39	2.70
	Urea	0.91	025	066	.75	0.42	2.80
	Amm. sulfate	0.95	0.26	0.69	,86	0.45	2.85
	Mean	0.90	0.25	0.66	1.75	0.42	2.78
Average of forms of nitrogen	Amm. nitrate	0.64	0.18	0.50	1.38	0.30	2.31
	Urea	0.69	019	0.52	1.46	0.32	2.44
	Amm. sulfate	0.74	0.20	0.54	1.53	0,34	2.51
LS.D. at 5% level	Source N	0.03	0.01	0.01	0.03	0.01	0.02
	Compost	0.04	0.01	0.02	0.04	0.01	0.03
	Interaction	0.06	0.01	0.03	0.06	0.02	0.04

*H.B.C.: water hyacinth and banana wastes compost

3.4 Effect of compost (H.B.C.) on vegetative growth characters

Data in Table (5) indicate that further improvements of pods characters were obtained after the addition of compost. The values of yield parameters significantly increased and reached the highest values with the addition of 20 ton/fed as organic compost compared to the other rates.

The highest weight of pods of cowpea plants was (49.41g/pot) as well as the highest value at 20 ton compost (H.B.C.), while the minimum value was recorded (20.93g/pot) with the addition of inorganic fertilizers alone. It could be concluded that the highest weight of pods yield (55.44g/pot) was harvested from the cowpea plants supplied by ammonium sulphate if mixed with organic compost at 20 ton while the minimum values when addition of ammonium nitrate (18.4g). Similar results have been reported by Shiva Kumar *et al*., (2000); Francis *et al*., (2006) and Siam (2008).

3.5 Effect of compost (H.B.C.) on nutrient content, crude protein and total carbohydrates

Generally, (Table 6) shows the highest values of N, P and K content (%) and micronutrients [Fe, Mn and Zn] by cowpea seeds when adding 20ton/fed, compost (H.B.C.). The values were 3.64, 0.54, 1.91, 2.740, 0.377 and 0.345ppm, respectively. The macro and micronutrients followed the same trend for their effect on total carbohydrate and crude protein. Applying the organic manure at a high rate, i.e. 20 ton/fed, of compost gave the highest content of nutritional elements. This effect could result from the increase of elements in the soil at rooting zone.

Consequently, the uptake of these elements increased in plant tissues. Table (6) also shows that total carbohydrate and crude protein significantly increased when 20 ton compost (H.B.C.) were used with the application of ammonium sulphate amounted by 32.80 and 23.63%, respectively, than that received ammonium sulphate alone.

3.6 Effect of nitrogen forms on nutrients content

In the same Table, plants received ammonium sulphate or urea showed an increase in their contents of NPK and Fe, Mn and Zn compared with ammonium nitrate. Also, the addition of ammonium sulphate with 20 ton compost (H.B.C.) significantly increased macro and micronutrients except P content in cowpea seeds followed by urea with 20 ton compost (H.B.C.) and ammonium nitrate with 20 ton composts. The highest values as means of N forms were 2.95 and 1.69 for N, K and 2.11, 0.305 and 0.281 for Fe, Mn and Zn, respectively for ammonium sulphate and the least values were 2.61, 1.58, 1.80, 0.263 and 0.234 for N, K, Fe, Mn and Zn, respectively for ammonium nitrate and where urea came in between.

Table 5. Pods characters of cowpea plants as affected by various forms of nitrogen application and water hyacinth and banana wastes compost.

Treatment		Pod diameter (cm)	Pods. No./plant	Pod length (cm)	Pods weight/plant (g)
Compost*	**Nitrogen forms**				
Control	Amm. nitrate	0.57	6.00	7.00	18.40
	Urea	0.59	7.00	7.70	21.20
	Amm. Sulfate	0.60	8.00	8.20	23.20
	Mean	0.59	7.00	7.63	20.93
H.B.C. (10 ton/fed)	Amm. nitrate	0.66	10.00	8.85	28.00
	Urea	0.68	12.00	9.65	32.40
	Amm. Sulfate	0.70	13.00	10.50	35.00
	Mean	0.68	11.67	9.67	31.80
H.B.C. (15 ton/fed)	Amm. nitrate	0.73	14.00	10.75	38.00
	Urea	0.74	15.00	11.60	45.20
	Amm. Sulfate	0.76	16.00	12.30	48.00
	Mean	0.74	15.00	11.55	43.73
H.B.C. (20 ton/fed)	Amm. nitrate	0.77	17.00	12.50	40.80
	Urea	0.78	18.00	13.20	52.00
	Amm. Sulfate	0.79	19.00	14.00	55.44
	Mean	0.78	18.00	13.23	49.41
Average of forms of nitrogen	Amm. nitrate	0.68	11.75	9.78	31.30
	Urea	0.70	13.00	10.54	37.70
	Amm. Sulfate	0.71	14.00	11.25	40.41
L.S.D, at 5% level	Source N	0.01	0.73	0.47	0.77
	Compost	0.01	0.85	0.40	0.89
	Interaction	ns	ns	0.55	1.60

*H.B.C.: water hyacinth and banana wastes compost

Table 6. Nutrients contents in seeds and crude protein as affected by various forms of nitrogen application and water hyacinth and banana waste compost.

Treatment		Nutrient content						Crude protein (%)	Total Carbohydrate
		%			ppm				
Compost	Nitrogen forms	N	P	K	Fe	Mn	Zn		
Control	Amm. nitrate	1.50	0.25	1.10	1.00	0.150	0.120	9.38	25.45
	Urea	1085	0.27	1.22	1.25	0.185	0.163	11.56	26.10
	Amm. Sulfate	20.00	0.29	1.25	1.35	0.210	0.185	12.50	26.34
	Mean	1.78	0.27	1.19	1.20	0.812	0.155	11.15	25.96
H.B.C. (10 ton/fed)	Amm. nitrate	2.45	0.35	1.62	1.50	0.240	0.210	15.31	27.10
	Urea	2.57	0.38	1.69	1.70	0.260	0.240	16.06	28.00
	Amm. Sulfate	2.70	0.41	1.71	1.85	0.275	0.265	16.88	28.50
	Mean	2.57	0.38	1.67	1.68	0.258	0.238	16.08	27.87
H.B.C. (15 ton/fed)	Amm. nitrate	3.00	0.44	1.75	2.10	0.300	0.280	18.75	29.10
	Urea	3.15	0.46	1.81	2.23	0.325	0.300	19.69	29.85
	Amm. Sulfate	3.30	0.49	1.83	2.35	0.340	0.310	20.63	30.25
	Mean	3.15	0.46	1.80	2.23	0.322	0.297	19.69	29.73
H.B.C. (20 ton/fed)	Amm. nitrate	3.50	0.52	1.85	2.60	0.360	0.325	21.88	31.75
	Urea	3.65	0.50	1.92	2.75	0.375	0.345	22.81	32.30
	Amm. Sulfate	3.78	0.59	1.95	2.88	0.395	0.365	23.63	32.80
	Mean	3.64	0.54	1.91	2.74	0.377	0.345	22.77	32.28
Average of forms of nitrogen	Amm. nitrate	2.61	0.39	1.58	1.80	0.263	0.234	16.33	28.35
	Urea	2.81	0.40	1.66	1.98	0.286	0.262	17.53	29.06
	Amm. Sulfate	2.95	0.45	1.69	2.11	0.305	0.281	18.41	29.47
L.S.D, at 5% level	N source	0.12	0.01	0.01	0.01	0.004	0.004	0.05	0.13
	Compost	0.14	0.01	0.02	0.01	0.005	0.004	0.05	0.15
	Interaction	0.14	NS	0.02	0.03	0.009	0.009	0.09	0.30

*H.B.C.: water hyacinth and banana wastes compost

These different responses might be associated with difference in plant monotype, plants performed better with NO_3, and this may be related to the fact that assimilation of NH_4 ions is less energy demanding than that of nitrate ions Gloser *et al.*, (1996). The efficient uptake of NH_4 by roots (Marschner, 1995; Forde and Clarkson, 1999 and Francis *et al.*, 2006) may also contribute to its advantage over nitrate. So, cowpeas prefer ammonium sulphate than nitrate. Also, the use of ammonium sulphate tented to make the soil acidic, so the obtained results may be due to the fact that lower pH values induced by ammonium sulphate evidently is responsible for higher level of Fe and Mn in leave tissue (Jones *et al.,* 1991; Francis *et al*., 2006 and Siam, 2008).

Generally, it could be concluded that the use of water hyacinth and banana wastes compost and NPK fertilizers are very important to improve yield and quality of cowpea. The use of compost (H.B.C.) decreases the needed amounts of chemical fertilizers and decreases both cost and environmental pollution.

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