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UTILIZATION OF SOME SOIL AMENDMENTS AS A SOURCES OF MICRONUTRIENTS IN SOIL AND THEIR EFFECT ON YIELD OF COWPEA PLANTS *Vigna angiculata* L. IN NEWLY RECLAIMED SOIL

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ABSTRACT

Two field experiment were carried out at the Farm of Institute of Studies and Environmental Research, Minufyia University, Sadat City to evaluate the *individual* or the combined effect of both soil amendments and mineral fertilizers levels on yield and its components of cowpea (Kafr El-Sheikh cv.) plant and Fe, Mn, Zn, Cu uptake. Experimental design was a randomized complete block, factorial. Factor (A) being mineral fertilizers at levels of M0 (0 N, 0 P_2O_5, 0 K_2O), M1 (50N, 15 P_2O_5, 48 K_2O) and M2 (75 N, 22 P_2O_5, 72 K_2O) kg.fad^{-1}, factor (B) was soil amendments of none, chicken manure at the rate of 10 M^3.fad^{-1}, tafla (shale) at a rate of 8 ton. fad^{-1} and iron ore (2 % Fe) at a rate of 200 kg. fad $^{-1}$. Application of soil amendments to the soil significantly increased, vegetative growth (plant height, number of branches/plant and fresh weight of plant foliage) yield and its components, i.e. 100-seed weight, seed yield per plant in both season, except the total dry yield of foliage and seeds per fed. The positive response was as follow: Chicken manure > bentonite > iron ore. The relative average increase of both seeds yield per feddan, were 75.37 > -1.57 > -5.33 % and foliage were 76.59 > -1.63 > -5.52 % respectively.

Application of mineral fertilizers significantly increased all parameters. The average values of the relative increase for NPK levels were, in seeds 3.82, 24.0 % for M1 and M2. Also in foliage they were 3.83, 23.99 % for M1 and M2. The highest values of seeds and foliage yields were obtained by the application of soil amendments with mineral fertilizer at the rate of M2 (75 N, 22 P_2O_5, 72 K_2O). The *relative increase* of seed yield were 7.27, 129.23, 17.38, 9.60 % and of foliage 7.18, 129,86, 17.57, 9.60 % non-amended, chicken manure, bentonite and Iron ore, respectively.

The concentration and uptake of Fe, Mn, Zn and Cu are more affected by application of soil amendments alone or combined with mineral *fertilizers*. The most *effective treatments* were those by applying soil amendments and mineral fertilizers at the rate of M2 according to the following order: Chicken manure > Bentonite > iron ore.

The extractable nutrients Fe, Mn, Zn and Cu were increased in the following order: Chicken manure > Bentonite > iron ore. Except Fe extractable as follow: Chicken manure > iron ore > Bentonite. The best results were obtained by the application of soil amendments and mineral fertilizers at the rate of M2 enhanced the amount of extractable nutrients. The regression analysis suggested that mineral fertilizers levels and soil amendments showed linear relationships between available nutrients (Fe, Mn and Zn) and their contents in plant tissue, except the Cu in soil were not linearly related to the amount of Cu concentration in plants. The results indicate that the use of soil amendments as chicken manure at rate of 10 M^3. $fed.^{-1}$, Bentonite at rate 8 ton. fad^{-1} and iron ore at the rate of 200 kg. fad^{-1} combined with mineral fertilizers at rate M2 (75 N, 22 P_2O_5, 72 K_2O) gave the highest yield of seeds and foliage of cowpea plants. Also improved soil fertility status of some micronutrients.

Key words: Chicken manure, Bentonite, Iron ore, Mineral fertilizers, Cowpea, Yield, Micronutrients.

INTRODUCTION

The use of soil amendments as well as natural Bentonite, Chicken manure and or iron oxide ore were effective for improving soil characteristics and plant growth. Many natural materials such as bentonite (shale) has been used in Egypt to improve the properties of sandy soils and plant growth (El- Shanawany *et al.* 1994). Abdel- Aziz *et al.* (1990) and Hamoud *et al.* (1999) found that the yield of peanut and wheat plants significantly increased with increasing amount of applied shale to the soil, the most effective treatments were 15 ton. fed^{-1} for peanut and 20 ton. fed^{-1} for wheat and that levels exceeding such rates caused reduction in yields but the yield products remained higher than that of the control.

El-Bagoury *et al.* (1998) and Yakout *et al.* (1998) reported that plant height, number of spikes /m^2, spike length, number of spikelets /spike, 1000-grain weight, and grain and straw yield /fad as well as grain protein, phosphorus and potassium contents, were significantly increased with increasing rates of organic manure. Fecenko *et al.* (1995), Shalabey and Bizik (1998) and Shalabey (2004) found that the yield of spring wheat was increased upon addition of sodium humate or potassium humate at the rate equivalent to 5-7 kg ha^{-1}. Tahoun *et al.* (2000) evaluated the feasibility of the town refuse, rabbit manure and tafla (shale) in a newly reclaimed sandy soil under rye grass plants, The data indicated that the improved soil fertility and caused an increase dry matter production by a factor of 3 and nutrient uptake by a factor of 5. Awadalla *et al.* (2002) studied the comparative effect of sludge, town refuse, chicken manure, and Tafla. The rates of addition ranged up to 12.5 ton. fed^{-1}, by treated mathematical tetra computer models. The applied treatments were tested for two successive vegetable and maize seasons. Their results showed the followings: 1. The maximum values of investment ratio came from using low rates of Tafla. 2. Combination of low rates of the organic manures gave the highest values. 3. Mixing Tafla and organic manures using low rates enhanced investment ratio value. Zheljazkov and

Warman (2004) found that addition of both municipal solid waste and manure compost to soil reduced bioavailability and transformation factor for Cu and Zn.

Many investigators reported that iron increased the photosynthesis process through chlorophyll formation, and activated some enzymes as dehydrogenises in plants. (Clarkson and Hanson 1980, Mengel and Krikby 1987), Radwan *et al.* (2001) found that the application of Fe at 4.12, 8 ppm at different forms as Fe-SO_4, Fe- EDTA and Fe – DTPA to different soils, increased the yield of maize plants. Warren *et al.* (2003) found that application of iron oxide at rate of 5 and 10 g/kg to the soil increased yield of vegetables plants (lettuce, spinach, potato and beat root) and also increased Mn, Zn and Cu uptake by plants. Shalabey (2004) found that dry matter yield of maize plants, as well as N, P, K and Fe uptake were increased after addition of ferrous sulphate at rate of 7 and 14 $kg.fed^{-1}$.

The aim of this investigation was to find the suitable rate of mineral fertilizers under using natural and synthetic soil amendments to improve cowpea plants productivity and soil fertility in such newly reclaimed soil

MATERIALS AND METHODS

Two field experiments (in each of two successive seasons) were carried out at the Farm Desert and Environmental Research of Institute, Minufyia University, Sadat City to evaluate the individual or the combined effect of soil amendments and mineral fertilizers on yield and yield components of cowpea (cv. Kafr El-Sheikh) as well as Fe, Mn, Zn, Cu uptake. Experimental design was a factorial, randomized complete blocks involving two factors (A) mineral fertilization, of : M0 (none), M1 (50 N, 15 P_2O_5, 48 K_2O) and M2 (75 N, 22 P_2O_5, 72 K_2O) $kg.fad^{-1}$., (B) soil amendments of: none, Chicken manures (10 $M^3.fad^{-1}$), Tafla (8 ton. fad^{-1}) and iron ore (200 kg. fad^{-1}). The ore was obtained from El-Ahram Company for mining and natural fertilizers.

The properties of the soil and those of the amendments are shown in Tables 1 and 2. Mechanical analysis was carried out by means of the pipette method (Piper 1950), the pH was measured in a, 1 M KCl solution, organic matter according the method of Walkley-Black, cation exchange capacity (CEC) was done using ammonium acetate solution; $CaCO_3$ by means of the calcimeter; all of which methods cited by Black *et al.* (1965). Contents of (N, P, K, Fe, Mn, Zn and Cu) were determined using the methods described by Cottenie *et al.* (1982). The plot area was $9.0m^2$, and included 3 rows of 4.0 m long and 0.75 m width. Seeds of cowpea were sown on the second week of April in the two season of 2002 and 2003 in hills at 25cm a part. Seed were sown in hills on one side of ridge, then it thinned to leave one plant per hill.

All treatments of soil amendments were added before sowing, mineral fertilizers were applied at two splits 2 and 6 weeks after sowing. Fertilizer materials were calcium superphosphate (15% P_2O_5), potassium sulphate (48 % K_2O), and ammonium nitrate (33.5 %N).

At harvest ten plants were randomly taken to determine plant height, number of branches/plant, fresh weight/plant, 100-seed weight, seed yield/plant and total yield. Data were statistically analyzed according to Gomez and Gomez (1984). Plant samples were dried at 70°C until the weight became constant and prepared for chemical analysis.

Table (1): Physical and chemical analysis of soil used in the current experiments.

Location of soils	OM %	$CaCO_3$ %	CEC $cmolc.Kg^{-1}$	Sand %	Silt %	Clay %	Texture Grade
El Sadat City	0.36	5	13.9	72.76	19.35	7.89	Sandy loam

Table (2): Chemical properties and contents of nutrients (available "A" and total "T") in soil and soil amendments.

Materials	pH (water)	EC $dS.m^{-1}$	C % Total	N ppm	P ppm	K ppm	Fe ppm	Mn ppm	Zn ppm	Cu ppm
Soil (A)	7.94	1.82	0.21	11.10	6.85	295	14.98	3.01	1.82	1.01
Bentonite (A)	8.56	7.15	0.48	0.00	14	450	22	11.23	9.6	7.68
Chick.Man.(T)	8.00	6.12	74.12	1632	11480	5017	3575	232	120.8	55.20
Iron ore (T)	12.55	8.47	0.00	0.00	264	400	13879	157.75	32.5	25

*Bentonite is Tafla (shale); Chick. Man. Chicken manure; Iron ore is mainly iron oxide; pH: in 1:2.5 soil/KCl 1 M; or 1 :2.5 amendment :water.

RESULTS AND DISCUSSION

I- Vegetative growth:

a- Effect of soil amendments:

Data in Tables 3 and 4 show that, the vegetative growth of cowpea plants (expressed as plant height, number of branches per plant and fresh weight of plant foliage) were significantly increased with adding soil amendments. It is also evident that the chicken manure gave significantly highest values in this respect during both seasons of growth, followed by bentonit then by iron ore. This is most certainly due, to the enhancing effect of chicken manure on the nutritional statues of soil. In this respect Khalil *et al.* (2002) on onion reported that using, chicken manure as organic matter, increased availability of nutrients, biological nitrogen- fixation and the biological activities of the microorganisms in soil. Adding bentonite to the soil significantly increased vegetative growth of cowpea. These results are in agreement with those reported by El-Shanawany *et al.* (1994) on peanut. With regard to the effect of adding iron ore to the soil data show significant positive effect on vegetative growth during both growing seasons, these results with those reported by Dutta and Dhua (2002) on pea.

b- Effect of mineral fertilizers.

Data presented in Tables 3 and 4 show that, all the studied vegetative growth parameters were significantly increased with adding of NPK fertilizers and progress at up to the highest M2 level in both growing seasons. These results agree with those reported by El-Afifi and Darwesh (1990) on French bean.

Table (3): Influence of soil amendments and mineral fertilizer levels on yield and its vegetative growth characteristics of cowpea plants in two seasons.

Treatments		Plant height (cm)		No. of branch/ plant		Fresh weight/plant (g)		Dry weight of Foliage kg/fed.		Average foliage yield kg/fed.
A	B	2002	2003	2002	2003	2002	2003	2002	2003	
Mo	None	43.3	66.6	2.5	2.8	131.6	255.0	704	771.75	737.87
	Chick. Man.	63.3	90.0	3.6	3.6	298.3	576.6	1543.3	924	1233.65
	Bentonite	53.3	76.6	2.5	3.1	136.6	366.6	606.1	793.8	699.95
	Iron oxide	41.6	70.0	3.0	2.8	135.0	261.6	557.7	814.8	686.25
M1	None	46.3	71.6	2.6	2.8	145.0	256.6	817.3	814.8	816.05
	Chick. Man.	66.6	85.0	3.5	3.8	338.3	441.6	1470.7	951.3	1211
	Bentonite	48.3	78.3	3.7	3.4	145.0	421.6	663.3	814.8	739.05
	Iron oxide	48.6	76.6	2.5	3.6	150.0	431.6	602.8	837.9	720.35
M2	None	50.0	72.6	3.0	3.1	151.6	341.6	726	855.75	790.87
	Chick. Man.	70.0	91.6	4.1	4.2	333.3	593.3	1817.2	1575	1696.1
	Bentonite	50.3	81.6	4.1	4.0	150.0	470.0	889.9	845.25	867.57
	Iron oxide	48.6	80.0	4.2	4.2	153.3	583.3	772.2	845.25	808.72
M0		50.4	75.8	2.9	3.1	175.4	365.0	852.77	826.08	839.43
M1		52.5	77.9	3.1	3.4	194.5	387.9	888.52	854.70	871.61
M2		54.7	81.5	3.8	3.9	197.0	497.1	1051.3	1030.3	1040.82
None		45.6	70.2	2.7	2.9	142.7	284.4	749.1	814.1	781.60
Chick. Man.		66.6	88.9	3.7	2.9	323.7	537.2	1610.4	1150.1	1380.25
Bentonite		50.6	78.8	3.4	3.5	143.9	419.4	719.76	817.95	768.85
Iron oxide		46.2	75.5	3.2	3.5	146.1	425.5	644.23	832.65	738.44
L.S.D. at 0.05	A	3.5	2.5	0.3	0.2	0.01	0.09	20.14	16.12	53.20
	B	4.6	5.1	0.5	0.5	0.04	0.14	2.10	1.98	50.01
	A x B	8.0	8.1	0.7	1.0	0.05	0.24	12.15	10.92	35.13

M0: none; M1 and M2 mineral NPK at rates of (50:15:48) and (75:22:72) Kg of $N:P_2O_5:K_2O$ /fed. respectively.

c- Interaction effects:

Data in Tables 3 and 4 also indicate that, there were interaction effect between soil amendments and NPK fertilization growth characteristics. These results are in agreement with those reported by Abdel-Aty (1997) on pepper. One aspect of the interaction is when mineral fertilizers were of significant positive effect particularly where no amendment was applied. Under condition of chicken manure application, mineral fertilizer "M1" application did not always give positive response in plant growth or yield. Also, another interaction occurred when iron ore caused a decrease in growth in the same cases when mineral fertilizer were given.

2- Yield and its components:

a- Effect of soil amendments:

Date in Tables 3, 4 and 5 reveal that the application of soil amendments to the soil as (chicken manure at the rate of $10m^3.fed^{-1}$, Bentonite at the rate of 5 ton. fed^{-1} and Iron ore at the rate of 200 $kg.fed^{-1}$) significantly increased the total yield and its except foliage dry yield components, i.e. 100-seed weight, seed yield per plant in both seasons, and yield. In this respect, application of chicken manure at 10 m^3/fed, gave the highest increments in total seed yield and its components. However, using Bentonite and iron are, tended to reduce the total yield and its components compared to the control. The superiority of chicken manure application produced the highest growth. The values of all these traits could be arranged at the following order: Iron ore < Bentonite < no-amendment < chicken manure. There fore were decreases of 5.33 and 1.57 caused by iron ore and bentonite respectively; and an increase of for seeds yield; comparative decreases were 5.52 and 1.63 % respectively, and the comparative increase was 76.59 % for foliage yield. This observation can be explained on the basis of the material amount and their chemical composition, which had higher pH, EC there fore caused the deleterious effect on plant growth and plant uptake of nutrients, consequently reduced the yield. El- Shanawany *et al.* (1994) Abdel-Aziz *et al.* (1990) and Hamoud *et al.* (1990) found that the yield of peanut and wheat plants increased with applying shale and that the most effective rate was 15 to 20 ton. fed^{-1}. Any treatment over that levels caused reduction in yields but the yield products still higher than that of the control.

Table (4): Influence of soil amendments and mineral fertilizer levels on yield and its component of cowpea plants in two seasons

Treatments		100 –seeds (g)		Seeds Yield / plant (g)		Total yield kg/fed		Average of seeds yield kg/fed.
A	B	2002	2003	2002	2003	2002	2003	
Mo	None	13.0	17.2	14.1	19.4	640	735	687.5
	Chick. Man.	16.2	19.5	45.1	21.0	1403	880	1141.5
	Bentonite	14.8	18.1	16.5	18.7	551	756	653.5
	Iron oxide	13.5	16.8	13.1	19.3	507	776	641.5
M1	None	14.4	17.5	15.2	20.5	743	776	759.5
	Chick. Man.	15.8	19.1	41.2	25.2	1337	966	1121.5
	Bentonite	15.3	17.5	19.2	20.1	603	776	689.5
	Iron oxide	15.1	17.9	15.8	20.8	548	798	673
M2	None Chick.	17.1	17.4	17.3	21.3	660	815	737.5
	Man.	18.6	20.1	45.5	26.6	1652	1500	1576
	Bentonite	16.6	17.9	20.8	22.3	809	805	807
	Iron oxide	16.0	18.4	18.0	21.6	702	805	753.5
M0		14.4	17.9	22.2	19.6	775	787	781
M1		15.2	18.0	22.9	21.6	808	815	810.87
M2		17.1	18.5	25.4	23.0	955	981	968.5
None		14.8	17.3	15.5	20.4	681	775	728.166
Chick. Man.		16.9	19.6	43.9	24.3	1464	1095	1279.66
Bentonite		15.6	17.8	18.8	20.4	654	779	716.66
Iron oxide		14.9	17.7	15.6	20.6	585	793	689.33
L.S.D. at 0.05	A	0.5	0.4	2.9	1.5	0.08	0.09	21.0
	B	0.7	0.8	3.8	1.2	0.1	0.05	58.0
A x B		1.3	1.4	5.1	2.2	0.2	0.02	10.8

M0: none; M1 and M2 mineral NPK at rates of (50:15:48) and (75:22:72) Kg of $N:P_2O_5:K_2O$ /fed. respectively.

Table (5): Percent increase (or decrease-) due application of each treatment and their averages with regard to foliage and seed yields.

Treatments A	Treatments B	Average of foliage kg/fed.	Rate of relative increase. %	Average Of seeds kg/fed	Rate of relative increase. %
Mo	None	737.87	00.00	687.5	00.00
	Chick. Man.	1233.65	67.19	1141.5	66.03
	Bentonite	699.95	-5.14	653.5	-4.94
	Iron oxide	686.25	-6.69	641.5	-6.69
M1	None	816.05	10.59	759.5	10.47
	Chick. Man.	1211	64.12	1121.5	63.13
	Bentonite	739.05	0.15	689.5	0.29
	Iron oxide	720.35	-2.37	673	-2.10
M2	None	790.87	7.18	737.5	7.27
	Bentonite	16961.1	129.86	1576	129.23
	Chick. Man	867.57	17.57	807	17.38
	Iron oxide	808.72	9.60	753.5	9.6
M0		839.43	00.00	781	00.00
M1		871.61	3.83	810.87	3.82
M2		1040.82	23.99	968.5	24.00
None		781.60	00.00	728.166	00.00
Chick. Man.		1380.25	76.59	1279.167	75.73
Bentonite		768.85	-1.63	716.666	-1.57
Iron oxide		738.44	-5.52	689.333	-5.33

M0: none; M1 and M2 mineral NPK at rates of (50:15:48) and (75:22:72) Kg of $N:P_2O_5:K_2O$ /fed. respectively.

In general, it is clear that application of organic substances promoted plant nutrition as shown in Table 2. which, led to more vegetative growth and consequently greater yield of both foliage and seeds. This agree with Khalil *et al.* (2002) on onion and Shalabey *et al.* (2005) on pepper and Shalabey (2004) on Corn. It is worthy to mention that bentonite treatments came in the second rank in this respect, during both growing seasons of study. These results are similar to those reported by El-Shanawany *et al.* (1994) on peanut. On the other hand, applied iron ore treatments came in the third rank after bentonite but without difference with the non-amended treatment. These results agree with those reported by Dutta and Dhua (2002) on Pea).

b- Effect of mineral fertilizers.

It could be seen from Tables 3, 4 and 5 that the main effect on 100-seed weight, seed yield per plant and total yield per fed. (foliage and seeds) show significant increases with applying the increasing levels of NPK fertilizers. The average increases due to, NPK fertilizers regarding seed yield were, 3.82, 24.0 % for M1, M2 respectively, and for foliage they were 3.83, 23.99 % for M1, M2. Such results are in harmony with the findings of El-Afifi and Darwesh (1990) on French bean and Arafa and El-Maghray (2004) on potato.

c- Effect of the Interaction.

It is shown from Tables 3, 4 and 5 that the effect of soil amendments and mineral fertilizers on yield of cowpea plant and its attributes exhibited interactions. The positive effects were significant especially the mineral fertilizer at rate M2 in presence of amendments. The relative increase in seeds and foliage compared with the none fertilized none amended under condition of M2 were. 7.27, 129.23, 17.38 and 9.60 %, respectively for the non-amended, chicken manure, bentonite and Iron ore for seeds comparable values for foliage were 7.18, 129.86, 17.578 and 9.60 %, respectively. This could be attributed to the mitigation effect of mineral fertilizer which may affect on the chemical properties of soil amendments which would decrease soil pH, and also further mobilization of the native elements from soil amendments decomposition to plants. These results are in agreement with those of Abdel-Aty (1997) on pepper.

3- Micronutrients:

a- Effect of soil amendments:

Data in Table (6) show that the concentration and uptake of Fe, Mn, Zn and Cu are more affected by application of soil amendments. The concentration and uptake of those nutrients were increased upon addition of soil amendments according to the following order: Chicken manure > Bentonite > Iron ore in both seeds and foliage plants. This observation can be explained on the basis of materials nature amounts and their chemical composition. Also the rate of material decomposition and release of nutrients will affect available nutrients to the grown plants. These results could confirm those obtained by Lotfy and El – Hady (1984) who indicated that the addition of bentonite to the soil increased the content and uptake of N, P, K, Fe, Mn, Zn and Cu by plants at different stages of growth. Warren *et al.* (2003) found that the application of iron – oxide at rates of 0.5, and 1% to the soil significantly increased the yield of vegetable plants (Lettuce, Spinach, Potato and Beat root) and also increased Mn Zn and Cu uptake by plants. Shalabey (2004) found that the dry matter yield of maize plants, N, P, K and Fe uptake were increased after addition of ferrous sulphate at rates of 7 and 14 $kg.fed^{-1}$ alone or combined with organic substances.

b- Effect of mineral fertilizer.

Data presented in Table (6) show that the concentration and uptake of Fe, Mn Zn and Cu in seeds and foliage of plants were significantly increased with increasing mineral fertilizers from M0 (0 N, 0 P_2O_5, 0 K_2O), M1(50 N, 15 P_2O_5, 48 K_2O) to M2 (75 N, 22 P_2O_5, 72 K_2O). It is clear that the synergetic effect between macro and four micronutrients (Fe, Mn, Zn and Cu) may have increased the content of these four elements. Also these elements play important roles in biochemical functions in plants. In this respect, Radwan *et al.* (1993) on wheat, Arisha and Bardisi (1999) and Arafa and El-Maghraby (2004) on potato reported that mineral fertilizers (N,P,K) generally increased the plant top content of macro and micronutrients.

c- Effect of the interaction.

With regard to the effect of the interaction between soil amendments and mineral fertilizers on the concentration and uptake of macro and micronutrients in cowpea plants, in Tables (6) the most pronounced effect of soil amendments occurred under condition of the high rate of mineral fertilization. This beneficial effect may be attributed to the both synergistic and acidity effects between mineral fertilizer and soil amendments, which would increase available nutrient content in soils. Radwan *et al.* (1993) Found that the application of compost materials as wheat straw and clover straw with different levels of mineral fertilizer to the soil increased the contents and uptake of N,P,K, Fe, Mn and Cu in wheat plants. El-sisi (1996) concluded that the application of Tafla (shale) in combination with either organic materials or mineral fertilization to sandy soils achieved the highest positive effect on growth, yield and nutritional uptake in plant as well as increasing available nutrients in soil. Warren *et al.* (2003) found that the application of iron - oxide ore at rates of 0.5, and 1% to the soil along with mineral fertilizers, significantly increased the yield of vegetables plants (Lettuce, Spinach, Potato and Beat root) and also increased Mn, Zn and Cu uptake by plants.

Table (6 A): Influence of chicken manures, bentonite, iron ore and mineral fertilizers levels in micronutrient uptake by seeds of cowpea plants grown on a sandy loam soil (average of two season).

Treatments		Yield	Fe		Mn		Zn		Cu	
A	B	$kg.fed^{-1}$	$mg.kg^{-1}$	$g.fed^{-1}$	$mg.kg^{-1}$	$g.fed^{-1}$	$mg.kg^{-1}$	$g.fed^{-1}$	$mg.kg^{-1}$	$g.fed^{-1}$
MM M0	None	687.5	97.96	67.34	33	22.68	37.5	25.78	13.8	9.48
	Chick.Ma.	1141.5	162.9	185.95	46.2	52.73	56.48	64.47	27.6	31.50
	Bentonite	653.5	98.8	64.56	34.25	22.38	38.25	24.99	17.8	11.63
	Iron oxide	641.5	104.06	66.75	33.34	21.38	38.0	24.37	15.8	10.13
M1	None	759.5	99.25	75.38	34.5	26.20	45.2	34.32	14.5	11.01
	Chick.Ma.	1121.5	180.75	202.71	48.65	54.56	52.85	59.27	28.22	31.65
	Bentonite	689.5	103.8	71.57	36.75	25.33	48.85	33.68	18.56	12.79
	Iron oxide	673	116.32	78.28	35.2	23.68	46.8	31.49	16.56	11.14
M2	None	737.5	101.36	74.75	34.5	25.44	45.3	33.40	16.56	12.21
	Chick.Ma.	1576	189.22	298.21	47.5	74.86	51.2	80.69	28.85	45.46
	Bentonite	807	105.3	84.97	35.8	28.89	46.75	37.72	19.32	15.59
	Iron oxide	753.5	117.07	88.21	34.9	26.29	46.0	34.66	17.08	12.86
M0		781	115.93	96.15	36.69	29.97	42.55	34.90	18.75	15.69
M1		810.8	125.03	106.98	38.77	32.44	48.42	39.69	19.46	16.65
M2		968.5	128.23	136.53	38.17	38.87	47.31	46.62	20.45	21.53
None		728.1	99.52	72.49	34	24.77	42.66	31.17	14.95	10.90
Chick. Ma.		1279.6	177.62	228.95	47.45	60.71	53.51	68.14	28.22	36.20
Bentonite		716.6	102.63	73.70	35.6	25.53	44.62	32.13	18.56	13.34
Iron oxide		689.3	112.48	77.75	34.48	23.79	43.60	30.17	16.48	11.38
L.S.D. 5%	A	21.0	3.01	....	1.03	....	1.92	....	1.28	....
	B	58.0	4.6	....	0.33	....	1.05	....	1.85	....
	A.B	10.8	3.3	....	0.23	....	0.65	....	1.40	....

M0: none; M1 and M2 mineral NPK at rates of (50:15:48) and (75:22:72) Kg of $N:P_2O_5:K_2O$ /fed. respectively.

Table (6 B): Influence of chicken manures, bentonite, iron ore and mineral fertilizers levels in micronutrient uptake by foliage of cowpea plants grown on a sandy loam soil (average of two season).

Treatments A	Treatments B	Yield $kg.fed^{-1}$	Fe $mg.kg^{-1}$	Fe $g.fed^{-1}$	Mn $mg.kg^{-1}$	Mn $g.fed^{-1}$	Zn $mg.kg^{-1}$	Zn $g.fed^{-1}$	Cu $mg.kg^{-1}$	Cu $g.fed^{-1}$
MM M0	None	737.875	390.24	287.94	69.6	51.35	39.8	29.36	14.2	10.47
	Chick.Ma.	1233.65	585.36	722.12	116	143.10	59.2	73.03	28.46	35.10
	Bentonite	699.95	410.36	287.23	85	59.49	41.75	29.22	18.75	13.12
	Iron oxide	686.25	940.22	336.41	80	54.9	40.85	28.03	16.2	11.11
M1	None	816.05	422.76	344.99	70.5	57.53	47.75	38.96	15.2	12.40
	Chick.Ma.	1211	593.83	719.12	119	144.10	60.2	72.90	29.5	35.72
	Bentonite	739.05	422.76	312.44	95	70.20	49.5	36.58	19.32	14.27
	Iron oxide	720.35	500.37	360.44	90	64.83	48.2	34.72	17	12.24
M2	None	790.875	480.5	380.01	72.25	57.14	48.5	38.35	18.5	14.63
	Chick.Ma.	1696.1	604.87	1025.9	120	203.53	62.85	106.59	29.5	50.03
	Bentonite	867.575	440.25	381.94	98	85.02	49.2	42.68	20.5	17.78
	Iron oxide	808.725	520.32	420.79	92	74.40	48	38.81	19	15.36
M0		839.431	649.04	408.43	87.65	77.21	45.4	39.91	19.40	17.45
M1		871.612	484.93	434.25	93.62	84.17	51.41	45.79	20.25	18.66
M2		1040.82	511.48	552.17	95.56	105.02	52.13	56.61	21.87	24.45
None		781.6	431.16	337.65	70.78	55.34	45.35	35.56	15.96	12.50
Chick. Ma.		1380.25	594.68	822.39	118.33	163.58	60.75	84.17	29.15	40.28
Bentonite		768.85	424.45	327.20	92.66	71.57	46.81	36.16	19.52	15.06
Iron oxide		738.44	503.63	372.55	87.33	64.71	45.68	33.85	17.4	12.90
L.S.D. 5%	A	53.20	N.S	....	4.6	....	5	....	N.S	....
	B	50.01	6.3	....	15.6	....	13.2	....	4.8	....
	A.B	35.13	18.5	....	5.20	....	2.5	....	1.6	....

M0: none; M1 and M2 mineral NPK at rates of (50:15:48) and (75:22:72) Kg of $N:P_2O_5:K_2O$ /fed. respectively.

4-Residues effect of micronutrients in soil after harvesting of cowpea plants.

a- Influence of soil amendments.

Application of soil amendments significantly increased available nutrients in soil (Table 7). There were increases in the following order (average effect): Chicken manure > Bentonite > iron ore with regard to available Mn, Zn, and Cu. As for available Fe the pattern was: Chicken manure > iron ore > bentonite. The average response according to the main effect was as follows for Fe: 10.62, 2.19 and 1.64 % for chicken manure, iron ore and bentonite respectively. With regard of Mn increases were 18.61, 8.08 and 2.84 % for chicken manure, bentonite and iron ore respectively. For Zn, comparable respective values were, 17.49, 11.04 and 5.89 %, for Cu values were, 24.35. 7.26 and 2.56 % for chicken manure, bentonite and iron ore respectively. The positive effect for chicken manure was higher than bentonite and iron ore. It indicates that the rate of application, degradation and chemical composition for organic material was higher than bentonite and iron ore. Zheljazkov and Warman (2004) found that the addition of both municipal solid waste and manure compost to soil reduced bioavailability and the transfer factor for Cu and Zn. Piccolo (1989) showed that addition of humic substances affectively immobilized the soluble and exchangeable forms of nutrients in soil. Lotfy and El – Hady (1984) found that bentonite increased soil nutrients and attributed this increase to the increase of ion mobility due to the increase of retained water and CEC of the treated soil.

b- Effect of mineral fertilizers.

It is obvious from Table 7, that available nutrients (Fe, Mn, Zn and Cu) were increased by adding fertilizers in the following order M2 > M1. The average increase values of (Fe, Mn, Zn and Cu) for M1 and M2 as were: 1.12, 2.32, 4.50 and 4.08 % Fe, Mn, Zn and Cu respectively due to M1, 3.23, 3.84, 7.21 and 8.09 % same nutrients respectively due to M2. This may be attributed to the acidity effect for fertilizer were added as the form of acid, hence led to decreased soil pH and consequently increased solubility of nutrients in soil.

Table (7): Residual effect of chicken manures, bentonite, iron ore and mineral fertilizers levels on availability of some micronutrient in soil after harvest of two season of cowpea plants.

Treatments		Fe		Mn		Zn		Cu	
A	B	Avail. $mg.kg^{-1}$	Rate of changes %	Avail. $mg.kg^{-1}$	Rate of changes %	Avail. $mg.kg^{-1}$	Rate of changes %	Avail. $mg.kg^{-1}$	Rate of changes %
MM M0	None	21.55	0.0	12.5	0.0	3.5	0.0	3	0.0
	Chick. Ma.	23.50	9.05	14.75	18	4.01	14.57	3.75	25
	Bentonite	21.65	0.46	13.25	6	3.90	11.42	3.14	4.66
	Iron oxide	21.95	1.85	12.75	2	3.70	5.71	3.08	2.66
M1	None	21.75	0.92	12.68	1.44	3.64	4	3.08	2.66
	Chick. Ma.	24.05	11.60	15.0	20	4.30	22.85	3.90	30
	Bentonite	21.90	1.62	13.80	10.40	4	14.28	3.30	10
	Iron oxide	22.13	2.69	13.01	4.08	3.85	10	3.22	7.33
M2	None	21.90	1.62	12.80	2.40	3.72	6.28	3.28	9.33
	Chick. Ma.	24.58	14.06	15.30	22.40	4.45	27.14	3.99	33
	Bentonite	22.31	3.52	13.90	11.20	4.08	16.57	3.45	15
	Iron oxide	22.73	5.47	13.30	6.40	3.95	12.85	3.30	10
M0		22.16	0.0	13.31	0.0	3.77	0.0	3.24	0.0
M1		22.41	1.12	13.62	2.32	3.94	4.50	3.37	4.08
M2		22.8	3.23	13.82	3.84	4.05	7.21	3.50	8.09
None		21.73	0.0	12.66	0.0	3.62	0.0	3.123	0.0
Chick. Ma.		24.04	10.62	15.02	18.61	4.25	17.49	3.88	24.35
Bentonite		22.09	1.64	13.68	8.08	4.02	11.04	3.34	7.26
Iron oxide		22.21	2.19	13.02	2.84	3.83	5.89	3.20	2.56
L.S.D. 5%	A	0.18	...	0.41	...	0.31	...	0.23	..
	B	1.12		1.06	..	0.20	.	0.12	...
	A.B	0.25	.....	0.50	......	0.25	.....	0.30	.....

M0: none; M1 and M2 mineral NPK at rates of (50:15:48) and (75:22:72) Kg of $N:P_2O_5:K_2O$ /fed. respectively.

c- Effect of the interaction.

It could be concluded from Table 7, that application of soil amendments were most effective in presence of mineral fertilizer at rate M2, which reflects that both soil amendments and mineral fertilizers could not act independently. The relative increase were as follow: Fe 1.62,14.06,3.52 and 5.47 %. Mn 2.4, 22.4, 11.2 and 6.4 %; Zn 6.28, 27.14, 16.57 and 12.85 %. Cu 9.33, 33, 15 and 10

% for control, Chicken manure, bentonite and iron ore respectively. Acidity effect on mineral fertilizer due to organic material would enhance nutrient availability by root system. Zheljazkov and Warman (2004) found that the addition of both municipal solid wastes and manure compost to soil reduced bioavailability as well as the transfer factor for Cu and Zn. Piccolo (1989) showed that addition of humic substances effectively immobilized soluble and exchangeable forms of nutrients in soil. Lotfy and El – Hady (1984) found that bentonite increased soil nutrients and attributed this to the increase of ion mobility and to the increase of retained water as well as the CEC of the treated soil.

5. Regression analyses.

Linear regression analysis was used to define the relationship between the concentration of Fe, Mn, Zn in plant tissue and the amounts of available nutrients (Tables 8 & 9. A,B). The regression analysis suggests that mineral fertilizers levels were not linearly related to the available nutrient extraction and plant tissue concentration, but in soil amendment treatments there was a linear relationship between of available nutrients and plant tissue Fe, Mn and Cu except Zn extraction in soil. It means that Zn has relatively high affinity for sorption on the surface of Fe and Mn oxides, and bentonite especially with an increase of pH (Luo and Chrisitie 1998). Over all, addition of chicken manure to the soil reduced relative bioavailability of Zn and relative transfer of Zn from soil to plants.

Table (8): Total yield of cowpea plants and average of elements (Fe, Mn, Zn an Cu) in plants (Seeds and Foliage) and soil after harvest cowpea plants.

Treatments		Total yield $kg.fed^{-1}$	Fe		Mn		Zn		Cu	
A	B		Availa. $mg.kg^{-1}$	Avera. plant $mg.kg^{-1}$	Availa. $mg.kg^{-1}$	Avera. plant $mg.kg^{-1}$	Availa. $mg.kg^{-1}$	Avera. plant $mg.kg^{-1}$	Availa. $mg.kg^{-1}$	Avera. plant $mg.kg^{-1}$
MM M0	None	1425.375	21.55	244.1	12.5	51.3	3.5	38.65	3	14
	Chick.M	2375.15	23.50	374.13	14.75	81.1	4.01	57.84	3.75	28.03
	Bentonite	1353.45	21.65	254.58	13.25	59.625	3.90	40	3.14	18.275
	Iron oxide	1327.75	21.95	297.14	12.75	56.67	3.70	39.425	3.08	16
M1	None	1575.55	21.75	261.00	12.68	52.5	3.64	46.475	3.08	14.85
	Chick.M	2332.50	24.05	387.29	15.0	83.82	4.30	56.525	3.90	28.86
	Bentonite	1428.55	21.90	263.28	13.80	65.87	4.0	49.175	3.30	18.94
	Iron oxide	1393.35	22.13	308.34	13.01	62.60	3.85	47.50	3.22	16.78
M2	None	1528.375	21.90	290.93	12.80	53.375	3.72	46.90	3.28	17.53
	Chick.M	3272.1	24.58	397.04	15.30	83.75	4.45	57.025	3.99	29.175
	Bentonite	1674.575	22.31	272.77	13.90	66.90	4.08	47.975	3.45	19.91
	Iron oxide	1562.225	22.73	318.69	13.30	63.45	3.95	47.00	3.30	18.04
M0		1620.431	22.16	292.48	13.31	62.173	3.77	43.978	3.24	19.076
M1		1682.488	22.41	304.98	13.62	66.20	3.94	49.918	3.37	19.856
M2		2009.319	22.8	319.86	13.82	66.868	4.05	49.725	3.50	21.163
None		1509.767	21.73	265.34	12.66	52.391	3.62	44.008	3.123	15.46
Chick. Ma.		2659.917	24.04	386.15	15.02	82.891	4.25	57.13	3.88	28.688
Bentonite		1485.525	22.09	266.71	13.68	64.475	4.02	45.316	3.34	19.365
Iron oxide		1427.775	22.21	308.06	13.02	60.906	3.83	44.641	3.20	16.94

Total yield $kg.fed^{-1}$=Seeds + Foliage Average plant $mg.kg^{-1}$= concentration of elements in seeds and foliage.

M0: none; M1 and M2 mineral NPK at rates of (50:15:48) and (75:22:72) Kg of $N:P_2O_5:K_2O$ /fed. respectively.

Table (9 A): Linear regression expressions that describe the change the concentration in plants and (Fe, MN, Zn and Cu) as a function of available of these elements in soils.

Treatments	Elements	Linear regression expression	Level of significant	R^2
Mineral fertilizers (A)	Fe	Y=-530.48 + 37.19 X	N.S	0.98
	Mn	Y=-61.79 + 9.34 X	N.S	0.94
	Zn	Y=-41.45 + 22.75 X	N.S	0.85
	Cu	Y=20.56 - 0.015 X	N.S	0.62
Soil amendments (B)	Fe	Y = -885.45 + 52.94 X	*	0.94
	Mn	Y = -100.82 + 12.21 X	*	0.97
	Zn	Y = -29.40 + 19.64 X	N.S	0.71
	Cu	Y = 16.96 + 0.09 X	*	0.93
A x B	Fe	Y = -838.23 + 50.84 X	* * *	0.92
	Mn	Y = -99.09 + 12.08 X	* * *	0.97
	Zn	Y = - 27.45 + 19.19 X	* *	0.62
	Cu	Y = 19.22 + 0.02 X	N.S	0.21

Table (9 B): Linear regression expressions that describe the total yield of cowpea plants and available of (Fe, Mn, Zn and Cu) in soil after harvest plants.

Treatments	Elements	Linear regression expression	Level of significant	R2
Mineral fertilizers (A)	Fe	Y = -10868 + 562.08 X	N.S	0.96
	Mn	Y = -7906.19 + 712.24 X	N.S	0.77
	Zn	Y = - 3409.82 + 1319.89 X	N.S	0.76
	Cu	Y = - 3217.05 + 1478.23 X	N.S	0.86
Soil amendment (B)	Fe	Y = -10738 + 555.45 X	*	0.94
	Mn	Y = - 5292.61 + 519.56 X	N.S	0.83
	Zn	Y = - 5006.01 + 1723.36 X	N.S	0.61
	Cu	Y = -3862.05 + 1663.23 X	*	0.92
A x B	Fe	Y = - 10535 + 547.28 X	* * *	0.89
	Mn	Y = - 5495.45 + 534.81 X	* * *	0.77
	Zn	Y = -4951.48 + 1712.67 X	* *	0.62
	Cu	Y = - 3721 + 1627.59 X	* * *	0.84

*, **, ***. Significant at the 0.05, 0.01, and 0.001 levels of probability respectively
N.S, not significant; P > 0.05.
M0: none; M1 and M2 mineral NPK at rates of (50:15:48) and (75:22:72) Kg of $N:P_2O_5:K_2O$ /fed. respectively.

Concerning the interaction between mineral fertilizer levels and soil amendments were linearly related to the amount of available nutrient (Fe, Mn and Zn) concentration and plant tissue, except for Cu in soil which was not linearly related to the amount of Cu concentration in plants. That phenomenon explains that Cu has relatively high affinity sorption or binding with organic matter. There are a number of plant species which showed response to the Cu and other heavy metals (Rodd *et al.*, 2000).

The regression analysis suggested that mineral fertilizers were not linearly related to available nutrient extraction and total yield of plants Table (8 and 9) but with soil amendments these were linear relation between available nutrients and total yield of plants (seeds and Foliage) except for Mn and Zn in soil. It means that Zn has relatively high affinity for sorption on the surface of Fe and Mn oxides, and bentonite especially with an increase of pH (Luo and Chrisitie 1998). Overall, addition of chicken manure to the soil reduced relative bioavailability of Zn and relative transfer of Zn from soil to plants.

Concerning the interaction between mineral fertilizer levels and soil amendments there were linear relation between available nutrient (Fe, Mn and Zn) and total yield of plants (seeds and Foliage). That phenomenon emphasizes the importance of N,P,K of mineral fertilizers and Fe, Mn, Zn, Cu in soil. The results indicate that the use of soil amendments as chicken manure at rate of 10 $M^3.Fed.^{-1}$, Bentonite at rate of 8 ton. fad^{-1} and iron ore at the rate of 200 kg. fad^{-1} combined with mineral fertilizers at rate M2 (75 N, 22 P_2O_5, 72 K_2O) gave the highest yield of seeds and foliage of cowpea plants; and Also improved soil fertility status.

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الاستفادة من بعض محسنات التربة كمصدر للمغذيات الصغرى في الأرض وأثر ذلك علي نمومحصول اللوبيا النامي في أراضي حديثة الاستصلاح

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أجريت تجربتان حقليتان في أرض رمليه طميه خلال الموسم الصيفي لعامي ٢٠٠٢،٢٠٠٣ بمزرعة معهد الدراسات والبحوث البيئيـة، مدينـه السـادات جامعـه المنوفية لدراسة تأثير محسنات التربة وهي (سماد زرق الدواجن بمعدل ١٠ م٣ /فدان، البنتونيت بمعدل ٨ م٣ /فدان، خام الحديد بمعدل ٢٠٠ كجم/فدان) والتسـميد المعـدني (N,P_2O_5,K_2O) بمعـدلات (0,0,0) M0 و(50,15,48)M1 و(75,22,72)، M2 كمصـدر للعناصر الصغرى وأثر ذلك علي النموالخضري، المحصول ومكوناته وكذلك التركيب الكيماوي علي نبات اللوبيا (صنف كفر الشيخ).

نفذت التجربة في تصميم القطع المنشقة في ثلاث مكررات وكانت مساحه القطعة التجريبيه ٩م٢ ووزعت معاملات التسميد المعدني في القطع الرئيسيه ومعاملات التسميد محسنات التربة في القطع المنشقة وكانت أهم النتائج المتحصل عليها هي:-

١-أدت أضافه التسميد المعدني بمعدلاته المختلفة إلي زيادة معنوية في النموالخضري (طول النبات، عدد الأفرع، الوزن الطازج للنبات) ومحصول البذور ومكوناته (وزن ١٠٠ بذره، متوسط محصول النبات/جم) وكذلك المحصول الكلي للبذور والعرش بالمقارنة بالكنترول. وقدرت هذه الزيادة في محصول البذور الجاف ٣,٨٢، ٢٤,٠٠ % وفي العرش الجاف ٣,٨٣، ٢٣,٩٩ % لكل من المستوي الأول والثاني علي التوالي.

٢-اضافه محسنات التربة المختلفة أدي ألي حدوث زيادة معنوية في النموالخضري ومحصول البذور ومكوناته في كل من الموسمين. وكانت الزيادة معنوية في المحصول الكلى/ للفدان في كلا من البذور الجافة وكذلك محصول العرش الجاف بإضافة سماد زرق الدواجن أما بالنسبة للبنتونيت وخام الحديد كانت هذه الزيادة غير معنوية بالمقارنة بالكنترول وكانت الزيادة النسبية في محصول البذور علي النحوالتالي ٧٥,٣٧، ٧٫٥٧-١،-٥,٣٥ % ومحصول العرش الجاف ٧٦,٥٩، -٣-١,٦، -٥,٥٢ % لكل من سماد زرق الدواجن وخام الحديد .

٣-كان اثر التفاعل بين التسميد المعد ني ومحسنات التربة تأثيرا معنويا علي معظم الصفات السابقة وتم الحصول علي اعلي محصول الكلي من البذور والعرش باستخدام محسنات التربة خاصة سماد الدواجن عندي المستوي الثاني للتسميد المعدني (٧٥ كجم ن + ٢٢ كجم فو٢ ا٥، ٧٢ كجم بو٢ا).

٤-أدت إضافة مستويات التسميد المعدني ومحسنات التربة في صورة منفردة أومشتركة إلي زيادة التركيز والكمية الممتصة بواسطة النباتات من الحديد والمنجنيز والزنك والنحاس وكانت هناك أفضلية للكمية الممتصة في حالة إضافاتهما معا .

٥-أما بالنسبة للتأثير المتبقي لتلك المواد المضافة علي المغذيات تحت الدراسة والتي تم استغلالها من التربة بعد الحصاد فقد وجد أن إضافة التسميد المعدني بمعدلاتة المختلفة منفردا أومتحدا مع محسنات التربة أدى إلي زيادة محتويات التربة من هذة العناصر وكانت الزيادة كالتالي كلا من المنجنيز والزنك والنحاس . سماد زرق الدواجن > البنتونيت >خام الحد يد > للكنترول أما عنصر الحديد فكانت الزيادة كالتالي سماد زرق الدواجن>خام الحديد > البنتونيت > للكنترول .

٦-أوضحت الدر اسه السابقة أن معامل الانحدار قوي بين العناصر المستخلصة من التربة وكل من تركيز العناصر في النبات والمحصول الكلي (البذور والعرش) عند أضافه محسنات التربة والتسميد المعدني معا، عدا عنصر النحاس في النبات

٧-توصي الدراسة باستخدام التسميد المعدني ($N,P_2O_5.K_2O$) بمعدل(75,22,72) كجم/فدان ومحسنات التربة (سماد زرق الدواجن بمعدل ١٠ م٣ /فدان، البنتونيت بمعدل ٨ م٣ /فدان، خام الحديد بمعدل ٢٠٠ كجم/فدان) كمصدر للمغذيات الصغرى لزياد ه خصوبة التربة ومحصول اللوبيا في منطقه السادات.