Library

THE EFFECTIVENESS OF ANIMAL MANURE TEAS ON THE GROWTH OF MAIZE (ZEA MAYS)

BY

MAAMBO MUDENDA

A PROJECT REPORT

SUBMITTED IN PATIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE

DEPARTMENT OF SOIL SCIENCE

SCHOOL OF AGRICULTURAL SCIENCES

UNIVERSITY OF ZAMBIA, LUSAKA

ZAMBIA.

2002

DEDICATIONS

To my parents, brothers and cousins too numerous to mention, for their tireless support and encouragement they rendered me through out my studies. May God shower you with blessings.

ACKNOWLEDGEMENTS

First of all, I wish to thank my supervisor Dr. Olusegun A. Yerokun for his support and contribution to this work. I also thank Mr Siwo and the rest of the technicians at the soil science lab. I thank Lusaka Water and Sewerage Company for their assistance they offered towards this project.

ABSTRACT.

A greenhouse experiment was conducted to evaluate the effectiveness of the newly introduced manure teas, on the growth of maize (Zea mays). Manure teas prepared from leaf or animal manure have the potential use as organic fertilizer and insecticide. But most Zambian farmers who use these teas, apply them without proper knowledge on the optimum application rate and the effects on the soil chemical and physical properties.

Ten treatment combinations, (control, 15kg chicken manure (CM)/210L, 15kg cowdung (CD)/210L, 30kg CM/210L, 30kg CD/210L, 3tonnes CM/ha, 3tonnes CD/ha, 6 tonnes CM/ha, 6 tonnes CD/ha and 250kg D compound/ha) were applied to maize grown in plastic pots. The experiment was arranged as a Randomized Complete Block Design with three replications. Two crops were grown, each for a six-week period. The second crop did not receive fresh treatment application. The data collected included plant height, dry matter weight of roots and shoots, EC and pH.

For the first crop, the highest dry matter production and tallest plants were with D compound fertilizer, with 23.1g average weight per pot and 50.3cm average plant height. These were significantly higher than for the manures and the control. 15kg CM tea was best among the manures, with 13.4g average weight per pot. Solid manure treatments were only slightly but not significantly better than the control. The residual effects of 15kg and 30kg CM were highest with 14.23g and 13.63g average weight per pot of dry

matter production. Generally, soil EC values were increased by all treatments during the first cropping with 15kg and 30kg CM tea manure ranking highest (3.15 and 6.24mS/cm) compared to the control (0.91mS/cm). All EC values were reduced during the second cropping, to an average of 1.0 mS/cm. The tea manures also raised the soil pH.

15 kg CM was found to be as effective as 30 kg CM, since there was no significant difference observed on the effects of most measured parameters. 15kgCM or CD was proved to be economical compared to 30kg CM or CD (usual rate applied by Zambian farmers), as less manure quantities are used.

TABLE OF CONTENTS

1. INTRODUCTION

Many small scale as well as large scale commercial farmers in Zambia are adopting methods of making agriculture sustainable. The objective of sustainable agriculture is to synergise the farming system practiced with nature. This phenomenon has been brought about, due to the enormous negative effects that are being experienced as a result of continuous use of large amounts of chemical fertilizers over the past decades (Munyinda, 1983). The negative effects include soil acidity, reduced soil fertility, soil erosion and general land degradation, which has lead to the reduction of crop yield and productivity in most places of Zambia. Chibbamulilo and Phiri (2000), indicated that there was a decline in maize yield in seven provinces of Zambia between the 1981-85 and 1991-95 year periods due to soil degradation as illustrated in Table 1.

Table1: Average maize yields (Tonnes/ha) by province: 1981 - 1995 Five year periods

Period	Eastern	Lusaka	Southern	Central	Northern	Copperbelt	Western
1981-85	1.8	1.7	2.6	2.4	2.2	1.6	0.9
1986-90	1.6	1.7	2.0	2.7	2.0	2.7	1.2
1991-95	1.4	1.4	1.3	2.2	2.3	2.3	0.8

Source: Computed by authors based on data from MAFF (1997)

In order to increase crop productivity while maintaining the soil fertility at the same time, natural organic resources are increasingly being used by farmers as agricultural inputs. Apart from being environmentally friendly, these inputs are cheap and readily available. Some of the inputs used are rock phosphate, animal manure and agroforest trees like leuceana, sesbania and sunhemp. Rock phosphate is used as a source of phosphorous, while most agroforest trees are used to replenish nitrogen in the soil as they have a high C: N ratio. Animal manure is also used to supply N and other nutrients like P, K, Ca and Mg (Tisdale et. al., 1985).

More recently, leaf and animal manure teas are being used as liquid fertilizer. Leaf teas are made from agroforest tree leaves with a high C: N ratio or legumes, while animal manure tea is made from cow dung and chicken manure. In certain cases, compost is also used to make tea. These teas appear to be more suitable to farmers involved in vegetable and maize production. However, Agriflora and Kasisi Agriculture Training Center (KATC) have demonstrated that tea manure can be used on large scale with maize. Liquid fertilizer have been found to have several advantages over solid fertilizer in that nutrients are easily or immediately available to plants (Tisdale et.al. 1985). In the case of leaf and animal manure teas, which are cheap and easy to prepare, they also have another additional advantage over compost, which is widely used in organic farming .The advantage is that, teas do not need much laborious work of turning heaps, as it is the case in composting.

The objective of this experiment was to determine the effects of animal tea manures on maize growth and dry matter in the greenhouse.

2. LITERATURE REVIEW

One of the factors contributing to the decline of maize or crop production is the low fertility status of the soil. This is caused by soil degradation such as soil compaction and hard pan formation, alkalinity and acidity. Singh (1985) reported that about 38% of the total arable land in Zambia belongs to Oxisols and Ultisols, which are characterized by low pH, high Al and Mn, high P fixing capacity, low organic matter and low nutrient retention capacity. The decline of soil fertility has been promoted by continuous application of acid forming chemical fertilizers like ammonium nitrate, which initially increases maize yield for that particular year and at the same time it increases the soil acidity, which is an adverse effect on future maize production (Munyinda, 1983). The application of chemical fertilizers at high rates with a view of increasing maize yield is accompanied by high costs, hence the need to change attention to utilizing cheaper sources of plant nutrients such as animal manure. Donovan et al (2002) indicated the price of D compound fertilizer to be K1240/kg at Golden valley and K1360 /kg at Msekera, while chicken manure was K150/kg of total dry matter weight, around Lusaka.

Research experiments on the effects of animal manure on different crops as a source of nutrients have been conducted. As for animal manures, its' quality depends on the feed consumed, age of livestock and manure, use of bedding in the manure, presence of liquid excreta, extent of decomposition that the manure has under gone and extent of leaching that has taken place (Cooke, 1982). Javaheri et. al. (1996: 13), while explaining how animal manure can improve soil fertility, provided indications on the contents of dry matter and nutrients that can be obtained through use of animal manure from pigs, cattle and poultry. Poultry manure was reported to be the best because it had the highest nutrient content while cattle manure trailed (Table 2).

Table 2: Nutrient Composition of livestock Manure in Comparison to chemical fertilizer

Material	% N per Tonne of Dry Matter	% P_2O_2 per Tonne of Dry Matter
Chicken manure	0.3-0.6	0.2-0.3
Sheep/Goat	0.35	–
Pig	0.35	–
Cattle	0.1-0.2	–
D compound	10	20
Urea	46	0

Source: Farming Systems Research Team (FSRT), 2002

Animal manure with bedding is assumed to have an average composition of 0.5%N, 0.125%P and0.4%K. While manure without bedding normally have 10% less of the total amount of nutrient content that is found in manure with bedding (Thompson, 1978 and Tisdale et.al., 1985). The age of manure also influence the quality of manure. One year old manure may contain more nutrients than that which is three years old (Chibbamulilo and Phiri, 2000).

Organic matter, especially the animal source has a positive effect on the yield of crops (Tisdale et. al., 1985). The use of poultry manure as a nutrient source for production of maize and vegetables has long been recognized (George, 1983 and Thomas, 1987). Harper et. al. (1980) also studied row planted spacing and broiler litter effects on maize yields .It was found that nitrogen from broiler litter was effective in producing high maize yields. Daka (1985) reported that poultry manure performed just as good as commercial fertilizer.

Daka (1985) established that increasing rates of manure significantly increased maize yield and 30 tonnes / ha of poultry manure was found to be as effective as the recommended rate of commercial fertilizer application (300kg D – compound or 200kg ammonium nitrate). The grain yield of the two treatments were not significantly different ($P<0.05$), with 2685kg/ha of grain produced from 30 tonnes/ha poultry manure and chemical fertilizer produced 3469kg/ha. But the recommendation of manure application per hectare has a wide range, as it ranges from 6 to 60 tonnes /ha, hence the effort of trying to find the optimal application rate that can match with manure supply. According to an experimental research in SADC region, Sola (2001) reports that eight tonnes of manure are required for each hectare to maintain high maize yields on granitic soils. On the other hand it takes approximately six cows to produce enough manure for one hectare of cultivated land, while six cows require 36 ha of grazing land. The land that is available for grazing in the SADC region, can not adequately support enough cattle to produce large amounts of manure (Sola, 2001). Further the average subsistence cattle head size in the region has dropped due to disease like corridor disease (GART, 2000).

Pichot (1971), concluded that manure application increases organic carbon, organic nitrogen and exchangeable calcium, which increases soil pH. Lungu et. al. (1993) reported that animal manure can be used as a liming material as it reduced soil acidity. In the case of liquid manure they have an added advantage of not contributing to weeding problems apart from increasing soil pH.
Tisdale et. al. (1985), reported that animal manures have a high nutrient content when handled in liquid form than when in solid form. Available N concentration in liquid poultry and beef cattle manure was 64 lb/tonne and 24 lb/tonne of manure, respectively. While solid poultry manure had 49 lb/tonne and beef cattle manure had 16 lb/tonne of manure. P and K concentrations were also high in the liquid manure than in solid manure as it was the case with N.

3. MATERIALS AND METHODS

3.1. Location:

A greenhouse pot study was conducted in the School of Agricultural Sciences greenhouse, University of Zambia, between July and October 2002.

3.2. Soil:

The soil used for the experiment is a fine loamy mixed isohyperthermic oxic paleustalf according to USDA classification (Msoni, 1985). Bulk soil sample was obtained from the Ap horizon (0-20cm) of a plot previously under vegetables, in the School of Agricultural Sciences Field Station. The soil was transported to the greenhouse, dried and sieved to pass through a 2mm sieve. This soil had a pH of 7.48, electrical conductivity (EC) of 0.56 mS/cm, 0.92%C, 0.4%N and 0.6mg B/kg. Soil texture was 55.8% sand, 19.2% clay and 25% silt making the soil a sandy loam.

3.3. Manure

The cowdung manure used in the preparation of the teas was got from the School of Veterinary Medicine, University of Zambia. The chicken manure was got from one of the smallscale farmers in Lusaka West. The manures were tested for total nitrogen using the kjeldah method.

1g of manure was weighed and put in a digestion tube together with 10ml of concentrated H_2SO_4 and 4g of mixed catalyst. It was left to cool down after being digested for 1hour in the digestion block. The digest was then transferred quantitatively into a 100ml bottle, which was made to volume with distilled water.10ml of the digest, was taken from the bottle and steam distilled with 15ml 10M NaOH for 5 minutes. The distillate was collected in 25ml boric acid indicator, which was then titrated with 0.01M HCl. Chicken manure had 1.7% N and cowdung had 0.6% N.

3.4. Greenhouse Study:

Three kilograms each of soil was weighed into plastic pots. One of ten treatments listed below was thereafter applied to each pot:

a) Control

b) 3.57kg Chicken manure (CM) in 50L or 15kg CM in 210L water

c) 7.14 kg Chicken manure (CM) in 50L or30kg CM in 210L water

d) 3.57kg Cowdung (CD) in 50L or15kg CD in 210L water

e) 7.14kg Cowdung (CD) in 50L or30kg CD in 210L water

f) 3.2g CM/pot or 3 tonnes CM/ha

g) 6.4g/pot CM or 6 tonnes CM/ha

h) 3.2g CD/pot or 3 tonnes CD/ha

i) 3.2g CD/pot or 6 tonnes CD/ha

j) 0.3g D compound/pot or 250kg/ha D compound

*Note: Treatments b, c, d and e are hereafter designated as weight / 210L because that is the normal farm practice in Zambia.

Tea manures were prepared by soaking chicken manure or cowdung manure in 50L of water two weeks prior to use. The teas were applied at volumes to take the soil to 80% field moisture capacity. The soils treated with dry manures and inorganic fertilizers were also watered to 80% field moisture capacity. Three seeds of maize were planted in each pot and these were arranged in a Randomized Complete Block Design with three replications. Application of tea manure or water, to bring the soil to 80% field moisture capacity was done twice each week until harvest. Six weeks after planting, plant height was measured before maize top and root were harvested from the pots. These were dried separately at 65 C for 24 hours, then weighed. Soil samples were collected for determination of pH and EC.

Immediately after harvesting the first crop, a second crop was grown for another six weeks. In this case, treatment application were not repeated. All pots were watered to 80% field moisture capacity twice a week using distilled water. All cultural practices and data collected were similar.

3.5. Sample Analysis

pH - Ten grams of soil was placed in 25 ml of 0.01M $CaCl_2$, placed on a shaker for 30minutes and the pH measured using a glass electrode.

EC -Ten grams of soil was weighed and placed in 50ml of water, then shaken for one hour and the EC measured on a conductivity bridge.

3.6. Statistical Analysis

The data was processed for analysis of variance and means were separated using Duncan's multiple range test (Little and Hills, 1978). Linear correlations were performed where needed.

4. RESULTS AND DISCUSSION

4.1. Crop 1

4.1.1. Soil pH:

The pH of the soil under different treatments was generally increased except where D compound was used (Table 3). There were significant differences ($P < 0.05$) in the pH values induced among the different treatments. Highest pH values were obtained where manure teas were used, giving pH 8.5 and 8.6 with 15kg and 30kg CM, respectively. While pH8.2 and 8.8 were produced by 15kg and30kg CD, respectively. All the solid manures gave soil pH similar to the control (7.9), while D compound depressed soil pH to 7.3.

Table 3: Effect of treatments on soil pH, EC, plant height, plant dry matter weight of roots and shoots and total dry matter weight

Treatment	pH	EC(mS/cm)	Plant height (cm)	Root weight (g)	Shoot weight (g)	Total dry matter (g)
Control	7.90b	0.91a	29.7a	4.5	3.7a	8.3a
15kg CM	8.53d	3.15bc	36abc	4.2	9.0c	13.4a
30kg CM	8.64d	6.24d	40.7c	3.6	8.4bc	12a
15kg CD	8.21c	1.5ab	37abc	3.9	7.2abc	11a
30kg CD	8.76d	3.10b	37abc	4.3	5.9abc	10.2a
3 ton CD	7.89b	1.21a	38.7bc	4.5	6.6abc	11a
6 ton CD	7.84b	0.84a	34.3abc	2.5	4.13ab	6.6a
3 ton CM	7.87b	1.08a	30.3ab	2.9	4.5ab	7.4a
6 ton CM	7.84b	0.40a	32ab	4.2	5.0abc	9.3a
D comp	7.32a	4.11c	50.3d	5.6	17.5d	23.1b

The pH increase, which was recorded in the manure tea treatments can be attributed to the readily available basic salts like Ca and Mg. Sanchez (1976), attributed the cause of slight pH increase observed in poultry manure to high salt content, mainly Calcium. The decrease in soil pH with D compound treatment on the other hand was due to the acidifying effect of the chemical fertilizer. This fact supports the results obtained by Munyinda (1979) at Mochipapa were soil pH decreased with successive use of chemical fertilizers.

4.1.2. EC:

There were significant differences in the EC values caused by the different treatments (P<0.05). The highest EC value was 6.24mS/cm, obtained from using 30kg CM. D compound trailed second with 4.11mS/cm. The rest of the tea manures had similar EC values which were not significantly different but higher than that of the solid manure treatments. The solid manure treatments and the control were not significantly different from each other.

The high EC values obtained from chicken manure can be due to the high salt nutrients present in chicken manure especially when handled in liquid form. The nutrients are made available to the plant immediately when applied in liquid form. This also applies to cowdung (Tisdale et. al, 1985).
D compound also provided available salt nutrients in the soil solution immediately, which made the EC values higher than the solid manures and the control. Solid manures release nutrients at a slow rate, hence the low EC values recorded by the soils with solid manures treatments.

4.1.3. Plant Height:

D compound produced the highest plant height value of 50.3cm, followed by 30kg CM with 40.7cm.The two treatments produced height values, which were significantly different. The other remaining treatments were different but there was no systematic sequence that was followed. The two outstanding treatments that produced high plant height values, were as a result of high K content which was made available to the plant by D compound and 30kg CM. High application rate of 30kg CM did not produce taller plants than those of 15kg CM (36 cm). Although there was no significant difference in height values obtained despite the fact chicken manure generally has high K content. Tisdale (1985), demonstrated the effects of manure handling on nutrient content. It was found that poultry manure handled as liquid fertilizer, had high available total N, P and K than in goat and cowdung liquid manures and solid manures. This can explain the slight superiority of chicken manure tea over the other tea manure treatments and the solid manure treatments.

4.1.4. Dry Matter Weight of Roots

There was no significant difference in plant root weights produced by the plants due to the different treatments. This can be attributed to the fact that the distribution of the nutrients which encourage root proliferation like P might have relatively been equal in all the treatments.

4.1.5. Dry Matter Weight of Shoots

Dry matter weight of plant shoots had significantly different ($P<0.05$) responses to the treatments. D compound produced the highest weight value of 17.5g followed by 15kg CM with 9.0g and then 30kg CM with 8.4kg. The two tea manures were the same but different from D compound. On the other hand 30kg was not significantly different from rest of CD tea manures and the solid manures except with the control, which was the least with 3.7g.

4.1.6. Total Dry Matter Weight

The total dry matter weight produced by the plants was not significantly different within the animal manure treatments and the control. D compound was the only treatment, which produced different results and was the highest with 23.1g.15kg CM was the second and then 30kgCM followed with weight values of 13.4g and 12g respectively. This can be due to the fact that D compound had high readily available N content to the plants as opposed to the manures. While in animal manure N content is highest when manure is handled in liquid form.

4.2. Crop 2

4.2.1. Soil pH:

The soil pH of the tea manure treatments still remained high in the second cropping as well.30kg CD was the highest with pH 8.42and 15kg CM producing pH of 8.20.The two were not significantly different. Apparently, 15 kg CD and 30kg CM trailed the sequence with 8.18 and 8.11 respectively, while the solid treatments and the control were the same as there was no significant difference among these treatments.

4. 2. 2. EC:

The data collected on EC, was not significantly different among all the treatments in the second trial. The drop in EC values especially with the tea manure treatments could be due to leaching of the salts and plant uptake.

4. 2. 3. Plant Height:

The results collected on plant height were significantly different ($P < 0.05$). Chicken manure tea treatments produced the highest values with 15kg CM having 32.7cm and 32cm for 30kg CM. D compound also produced 32cm plant height. Solid manures and cowdung tea manure treatment were similar without a systematic sequence. The high performance of chicken manure teas and D compound were due to the high residual effects of these treatments with respect to the content of K.

Table 4: Residual effect of treatments on soil pH, EC, plant height, plant dry matter weight of roots and shoots and total dry matter weight.

Treatment	pH	EC(mS/cm)	Plant height (cm)	Root weight (g)	Shoot weight (g)	Total dry matter (g)
Control	7.85a	0.53	25.7ab	2.5	1.9a	4.6a
15kg CM	8.20bc	1.26	32.7c	4.4	9.8c	14.23d
30kg CM	8.11b	1.01	32.0c	4.0	9.6c	13.63d
15kg CD	8.18b	1.06	25.7ab	2.6	2.6a	5.17b
30kg CD	8.42c	1.19	29.7bc	3.8	5.1b	8.83c
3 ton CD	7.86a	0.89	24.7a	1.8	2.0a	3.38a
6 ton CD	7.84b	0.73	25.3a	1.5	1.6a	3.13a
3 ton CM	7.86a	1.12	25a	2.0	2.0a	4.0a
6 ton CM	7.83a	0.62	27ab	2.4	1.7a	4.1a
D comp	7.69a	1.95	32c	2.9	4.6b	7.6bc

4. 2. 4. Dry Matter Weight of Roots

There was no significant difference with the root dry matter weight .The nutrients, which are necessary for root development were equally distributed in the root zone where treatments were applied.

4. 2. 5. Dry Matter Weight of Shoots

The weight of plant shoots produced significantly different results ($P<0.05$). Chicken manure teas produced high weight values and were similar.15kg CM and 30kg CM had 9.8g and 9.6g as dry matter weight of the shoots. 30kg CD and then D compound followed with 5.1g and 4.6g, repectively. The other treatments were statistically the same with the control being the least (1.9g)

4. 2. 6.Total Plant Dry Matter

Total plant dry matter weight showed significantly different results ($P<0.05$), which was due to the different treatments. 14.2g was the highest then 13.6g which were produced by 15kg CM and 30kg CM respectively. There was no significant difference between these two treatments. 30 kg CD (8.8g), D compound with 6.6g and15kg CD (5.17g) were also the same but they were different from the rest of the treatments (Table 4).

The high performance of chicken manure can again be attributed to the high residual effects of N content. Chicken manure was superior to cowdung as chicken manures' average N content is 1.7%, P 0.9% and 1.1 % K while the average nutrient content of cowdung is 0.6% N, 0.1% P and 0.5% K (Cooke, 1982). The N concentration of the manures used in this particular experiment were 1.6 % N for chicken manure and 0.6 % N for cowdung manure.

4. 3. Summary

The treatments in this study showed significant differences in soil pH. Tea manures exhibited high pH values than the solid manures in both the first and second trial. This can be attributed to the high basic salt concentration of the liquid manures while the solid manures release the salts at a slow rate. The EC values of the teas was also high indicating that the salt concentration was high. Chicken manure teas had both high EC (3.2mS/cm for 15kg and 6.24mS/cm for30kg) and pH (8.53 and 8.6, respectively) as shown in Table 3.There was a slight drop in pH in the second cropping although the tea manures maintained to be the highest. EC also dropped making it the same with the other treatments. Leaching could have contributed to the decrease in EC.

The residue effects of Chicken manure were very effective as their performance was outstanding. This was apparently shown in the following parameters; total plant dry matter weight, shoot weight and plant height. This is explained by the fact that chicken manure has a relatively high amount of nutrients (Cooke, 1982). Correlation coefficients (Tables 5 and 6) were also higher in the residual effects than in the first trial except for the one between EC and plant height. It was significant ($P<0.01$) with a coefficient of 0.669.This justifies the fact that high salt content with K will increase the plant height. The coefficient correlation (0.683) between pH and root dry matter was significant ($P<0.05$) in the residual trial but not in the first trial. There was no concrete reason, which could explain this observation.

Correlation between plant total dry matter and plant height was positive and significant ($P<0.01$) in both cases, 0.904 for the first trial and 0.948 for the second trial. This could be due to the fact that, tall plants produced large quantity dry matter, as there is more surface area for photosynthesis to take place (Bgli and Legget, 1972).

Table 5: linear correlation of the treatment effects on pH, EC, Root and Shoot weight and Total dry matter

	PH	EC	Plant height	Root weight	Shoot weight	Total dry matter
PH						
EC	0.425					
Plant height	-0.176	0.669*				
Root weight	-0.228	0.252	0.580			
Shoot weight	-0.286	0.611	0.925**	0.664*		
Total dry matter	-0.287	0.577	0.904**	0.765**	0.989**	

Note: *Correlation is at the 0.05 level

**Correlation is at the 0.01 level

Table 6: linear Correlation of the treatments residual effects on pH, EC, Root and Shoot weight and Total dry matter

	pH	EC	Plant height	Root weight	Shoot weight	Total dry matter
PH						
EC	0.038					
Plant height	0.338	0.630				
Root weight	0.683*	0.384	0.876**			
Shoot weight	0.527	0.407	0.889**	0.913**		
Total dry matter	0.563	0.407	0.901**	0.995**	0.995**	

Note: *Correlation is at the0.05 level

**Correlation is at the 0.01 level

Correlation coefficient between plant dry matter of shoot weight and plant height was positive and significant (P<0.01) in the first and second trial, with values of 0.925and 0.889 respectively. This can be attributed to the fact that tall plants normally produce high plant dry matter weight of shoots, as the tallness may creates a large surface area for photosynthesis to take place, hence having more dry matter production (Tisdale et.al. 1985). The correlation coefficient of 0.904 (P<0.01) by plant height and total plant dry matter, in the first trial and 0.901(P<0.01) in the second trial can attributed to the same facts as those given to the relationship between plant shoot weight and plant height.

The plant height and root dry matter weight correlation coefficient was positive but insignificant in the first trial, while it was significant in the second trial with a correlation coefficient of 0.876 (P<0.01).
A plant with high root weight usually indicates that the plant roots are highly proliferated. This promotes high nutrient interception, hence having a high nutrient uptake, including K that promotes plant height (Tisdale et. al., 1985)
Correlation between root dry mater weight and shoot dry matter weight was significant and positive with

a correlation coefficient of 0.663 ($P<0.05$) in the first trial and 0.913 in the second trial ($P<0.01$). Since a plant with high root dry matter weight, promotes production of high shoot dry matter weight, it becomes definite that total plant dry matter weight produced will be high as well. This is so as there is a high nutrient interception by the roots, thus promoting high dry matter production by the plant. Root dry matter weight and total plant dry matter weight correlation coefficient was also positive and significant ($P<0.01$) in both the first and second trials. The correlation coefficients were 0.765 in the first trial and 0.995 in the second trial. Shoot dry matter weight and total dry matter weight had a correlation coefficient of 0.989 ($P<0.01$) in the first trial and 0.995 ($P<0.01$) in the second trial, respectively. This is due to the definite relationship that exist between plant shoot and total dry matter. Usually, the shoot dry matter of the plant contributes significantly to the total plant dry matter as it contributes more than the root system in weight terms.

5. CONCLUSION

The study has shown that tea manures are effective in maize growth. This was evident from the significant differences ($P<0.05$) that were observed in plant height, plant shoot weight and total plant dry matter weight in the first and second trials. There was an increase in pH and the trend in a decreasing order had the tea manures first then solid manures, the control and lastly D compound. The drop in pH in D compound was due to the known acidifying effects of chemical fertilizers.

Generally, chicken manure tea was better than cowdung in influencing maize growth in all the parameters measured, except with root weight, which was the same. Ngoma (1998), had similar results of poultry manure performance on Sesbania sesban plant height were D compound had 133cm followed by chicken manure with 121cm and the least with cowdung (118cm). This was also demonstrated in the residual effects of the treatments in which it produced total dry matter weight of 14.2g for 15kg CM and 13.6g for 30kg CM compared to D compound that had 7.6g.This shows that the effects of chicken manure tea are more lasting than D compound. However, 15 kg CM was observed to be as effective as 30 kg CM as it was found that there were no statistical differences between the two in all the parameters measured. So, 15kg CM can be used instead of 30kg CM in order to serve cost as less quantities of manure are used. This can also apply to cowgung.

It is evident that tea manures increase soil pH as it was raised from 7.4 to as high as 8.8 which was more than that by the solid manures. The solid manure treatments only managed to raise pH upto 7.9.

REFFERENCE

1) Bgli, O. B and Legget, J. E. 1976. Rate of dry matter accumulation in soyabeans seeds with varying source-link relations. Agron. Journal 68; 371-374.

2) Chibbamulilo, P.M, Phiri, C, 2000. Farming Practices and soil degradation in Northern and Southern Provinces of Zambia. Environmental Support Program, Ministry of Environment and Natural Resources, Lusaka.

3) Cooke, W.G, 1982. Fertilizing for maximum yield. Granada Publishing ltd, Frogmore, USA. Pages 94 –110.

4) Daka, P.B.J. 1985. Evaluation of animal manure as a fertilizer in maize production. AGG 500 Project Report, School of Agricultural Sciences, University of Zambia

5) Donovan, C., Damaseke, M., Govereh, J. and Simumba, D. 2002. Framework and initial analysis of fertilizer profitability in maize and cotton in Zambia. FSRP working paper

6) FSRT, 2002. Developments in fertilizer marketing in Zambia: Food Security Research Project. Work shop paper No.4 May 2002.Ministry of Agriculture and cooperative. Agricultural Consultative Forum. Food Security Research Project, Lusaka.

7) GART, 2000. GART year Book 2000: Volume 2: Small Scale Conservation Farming Demonstration Hand hoe. Pages 37-39.

8) George, J. M. 1983. Poultry productions technology. The AVI publishing company, Inc. Westport, Connecticut. Pages 277-281.

9) Harper, L.A, Wilkinson, S.R and Box, S. E. Jr. 1980. Row plant spacing and broiler litter effects on intercropping corn in tall fescue. Agron.J. 72: 5- 10.

10) Javaheri, F. 1996. Integrated Crop Management: a guide for sustainable smallholder Farming. Integrated crop management / food legume Project, FAO, Lusaka.

11) Little, T.M and Hills, F.J. (1978). Agricultural experimentation, design and analysis. John Wiley and Sons Ltd, NY. Pages 101-113.

12) Lungu, O. I., Temba, B., Chirwa, B. and Lungu, C.1993. Effects of Lime and Farmyard manure on soil acidity and maize growth on acid alfisol from Zambia. Trop. Agric. (Trinidad), Vol. 70, No 4. Pages 309- 314.

13) MAFF. 1997. 1995/ 96 Agricultural Statistics Bulletin, Policy and Planning Division, Lusaka.

14) Msoni, R.1985.Climatologically Based Irrigation Scheduling for Wheat and physical characterization of soil at the School of Agricultural Sciences Field Station, University of Zambia. B. Sc. Thesis. Pages 4-18.

15) Munyinda, K.1979. Review 0f Acidity and Lime trials. Natl. Lime trial. Department of Agriculture Research Branch, Zambia.

16) Munyanda, K. 1983. Use of Lime in Management of acid soils. In proceedings of the seminar on soil productivity in the high rainfall areas of Zambia. Lusaka, Zambia.

17) Ngoma, A.1998.Emergence and early growth of sesbania sesban treated with manures at the nursery stage. AGG 500 Project Report, School of Agricultural Sciences, University of Zambia

18) Pichot, J. 1971.Etude de L' evolution de sol enpresence de fumure organiques au mine'rales. Cinq annes's d'experimentation a' la station de Bouakoko (Republique Centrale d' Afrique). Agron.Tropicale (France): 26:736-754.

19) Sanchez, P.A.1976. Properties and Management of soils in the Tropics. John Wiley and sons ltd, NY. Pages 162- 181.

20) Singh B. R.1985. The effects of Liming on soil properties of Oxisols and Ultisols. Published in the proceedings of the 11 th International Forum on Soil Taxonomy and Agrotechnology Transfer, Zambia, July 15 th 1985.

21) Sola, l. 2001. Organic Farming in Southern Africa. Ground Up: Volume1. No. 6 page 6

22) Thomas, S.J, 1987. Agricultural evaluation of poultry manure as a source of nitrogen for convectional and non -tillage corn. Agron.J.70: Pages 213-216

23) Thompson, L.M. and Troeh, F.R.1978. Soils and Soil Fertility. McGraw Hill publication in the Agricultural sciences, USA. Pages 228-231.

24) Tisdale, S. L, Nelson, W.L. and Beaten, J.D. 1985. Soil fertility and fertilizers. Macmillan Publishing Company, NY