THE EFFECT OF PALM KERNEL CAKE, CHICKEN MANURE, GLIRICIDIASEPIUMAS COMPARED TO INORGANIC MANURES (NPK15:15:15 &UREA) FERTILIZATION ON GROWTH, YIELD COMPONENT AND YIELD OF IRRIGATEDMAIZE (ZEA MAYS L.)

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ABSTRACT

Most Sierra Leone soils are poor infertility and cannot effectively support maize production without improving their fertility status. However, the rising cost of inorganic fertilizers and their unavailability at certain times are major factors contributing to the low yields of maize in Sierra Leone. A field experiment was conducted at the faculty of Agriculture,, Ernest Bai Koroma University of Science and Technology in an Inland Valley Swamp to investigate the effect of Palm Kernel Cake, Chicken manure, and Gliricidiasepium fertilization at equal rates of 10t/ha on the growth and yield of maize. The variety of maize used in the experiment was the most widely adopted improved DMR-ESR yellow maize. The maize was planted with treatments as thus: No fertilization (control), recommended rate of NPK-15:15:15 & Urea, 10t/ha PKC, Chicken manure, and Gliricidiasepium. The trial was laid out in a randomized complete block design with three replications. The plot size was 12m2 and the planting distance was 75cm by 50cm. Traits evaluated were subjected to analysis of variance using Genstat. The results of the study indicate that the fertilization of maize with PKC and Chicken manure significantly increased the yield of maize in the lowland soils of Njala. NO significant difference was observed between these organic minerals and the recommended rates of NPK. The application of organic minerals(PKC, Chicken manure, and Gliricidiasepium) at 10t/ha significantly out yielded the control without fertilization. The high yields obtained by the application of PKC, Chicken manure, and NPK fertilizer could be attributed to increased Nitrogen availability which promoted vegetative growth and development hence higher grain yield.

1.0 INTRODUCTION

1.1 Background

Maize (Zea mays L.) is a member of the grass family, Poaceae. It grows up to 1-3m in height producing a single upright stem with about ten to fourteen leaves inserted alternatively. It is believed that the crop was originated in Mexico and introduced to West Africa in the early 1500s by the Portuguese traders (Dowswellet al., 1996). It was brought to Ethiopia in the 1600s to 1700s (Haffanaghel, 1961). Currently, maize is widely grown in most parts of the world over a wide range of environmental conditions ranging between 50° latitude North and South of the equator. It also grows from sea level to over 3000 m.a.s.l elevations (Singh, 1987; Dowswellet al., 1996). One of the members of the cereal family that has added great value to man and animals is maize. It ranks third following wheat and rice in world production (FAO, 2002), while in Sierra Leone it ranks second to rice. Africa produces about 60% of the total world production of the crop, most of which is used for human consumption (FAO, 2003). Widely grown in the humid tropics and sub-Saharan Africa, the crop serves for food and livelihood for millions of people today(Enujeke, 2013). It is consumed roasted, baked, fried, boiled, or fermented in Nigeria (Agbato, 2003). In developed countries, maize is a source of such industrial products as corn oil, syrup, cornflour, sugar, brewers' grit, and alcohol (Dutt, 2005). As an energy supplement in livestock feed, maize is cherished by various species of animals, including poultry, cattle, pigs, goats, sheep, and rabbits (DIPA, 2006).In Sierra Leone, the statistical survey indicates that the area under cultivation is approximately 16,060ha with an average yield of 0.8t/ha (FAO, 2003). Most of its cultivation in Sierra Leone is by traditional methods in mixed cropping systems in the upland with cassava, rice, groundnut, and several vegetables. However, due to the increase in demand for maize in Sierra Leone, most farmers have resorted to the commercial production of maize as a sole crop. Three crops of maize can be grown in Sierra Leone. The first (late May or early June and second planting (early September) are done on the upland soils. Third planting is done in the Inland Valley Swamp (IVS) during the dry season to ensure an uninterrupted supply of maize. Maize is rich in starch or carbohydrate (71%) and low in protein. It contains 11.6% water, 9.4% protein, and 4.2% fat (FAO, 2003). It is a good source of energy for both humans and animals and it is high yielding and easy to process. Many varieties have been discovered worldwide. Some improved recommended varieties grown for consumption in both upland and Inland Valley Swamp ecologies in Sierra Leone include DMR-ESR Yellow, TZSR-Yellow, and Western Yellow. These have high yielding potential. It is one of the most adaptable crops grown in a wide range of environments between Latitude 60 N and 42 S (Corazzina et al., 1991). In developing countries, maize is a major source of income for many farmers (Tagneet al., 2008). Maize is relatively a short duration crop and capable of utilizing inputs more efficiently and is potentially capable of producing a large number of food grains per unit area. The low productivity of maize, in general, is attributed to many factors like the frequent occurrence of drought in arid regions, declining of soil fertility, poor agronomic practice, limited use of input, insufficient technology generation, lack of credit facilities, poor seed quality, disease, insect, pests and weeds particularly, Striga (CIMMYT, 2004).

1.2 Statement of the research problem and justification

In sub-Saharan Africa, maize is one of the most widely grown staple food crops occupying more than 33 million hectares yearly (Adepetu et al,1997). In Sierra Leone, maize is widely cultivated in the Moyamba District in the South and Tonkolili District in the north. The average annual grain production of maize in Sierra Leone was about 70 metric tons at a growth rate of 19.3% (Agbato, 2003). Maize production in Sierra Leone is very significant amongst resource-poor farmers as it is a source of income, vitamins A, C, and E, essential minerals, contain 9% protein, rich in dietary fiber and calories, which are a good source of energy (Amujoyugbe, et al, 2003 and Brady et al 1999). Sierra Leone is constrained by pests and diseases as problems for crop production in general, but the declining soil fertility, in particular, is a constant source of concern for limiting self-sufficiency in food production. Smallholder farmers are the main actors in food production and hardly adopt high input farming technologies, thus the majority of farm households are managing plots that do not exceed two cropped hectares(Bremmer, et al 1982) due to these problems. In spite of substantial fertilizer use in Sierra Leone, the crop yields are not increasing correspondingly, which reflects low fertilizer use efficiency (FUE). Some of the work done on inorganic fertilization including the use of appropriate fertilizer types, optimum rates, time, and methods of application has been transferred to farmers but the high cost and limited availability in the market have restricted their use by farmers. And in fact, most of the chemical nitrogenous fertilizers leach down to the root zone or pollute the groundwater causing certain diseases in plants and humans (Cheemaet al., 2010). This has discouraged farmers from growing maize. Most Sierra Leone soils cannot effectively support maize production without improving their fertility status. Appropriate and affordable soil amendment strategies are, therefore, required to possibly increase maize production. In order to improve the soil, a nutrient management system should be practiced in which, organic resources are used in combination with inorganic materials. Organic materials such as chicken manure, palm kernel cake (PKC), Nitrogen Fixing Tree (Gliricidiasepium) can serve as the best substitute of chemical fertilizers as they have high nitrogen content which is one of the major nutrients required for maize production. Application of these organic manures has various advantages such as improving soil properties, water holding capacity, organic carbon content; apart from providing soil nutrients (Sharif et al., 2004). The addition of organic sources could increase maize yield through improving soil fertility and higher fertilizer use efficiency (Gangwaret al., 2006). Higher and sustained yield could be obtained with judicious and balanced fertilization combined with organic manures for ecological balance, low-cost cultivation, cleanenvironment, and nutritious food without affecting human health (Bhatti et al.,2008). A study on the effects and performance of these organic manures on maize could be of great importance to maize growers as it will contribute to the database on their efficiencies and rate of application on maize.

2.0 OBJECTIVES OF THE STUDY

2.1 General Objective

The general objective of this study is to evaluate the effects of Palm Kernel Cake, Gliricidiasepium, Chicken manure, and NPK 15:15 15 & Urea fertilizers when applied on maize and to promote their uses as an alternative source of fertilizer for maize production in Sierra Leone.

Specific objectives

1. To determine which of the organic manures have higher nutrient content for maize production?

2. To compare the growth and yield performance of maize to the application at an equal rate of these organic manures with the conventional recommended rate of inorganic fertilizers.
3. To determine how effective maize can perform when applied with equal rates of organic manures of Palm Kernel Cake(PKC), Gliricidiasepium, Chicken manure, as compared with the inorganic (NPK-15:15:15 and Urea).

3.0 MATERIALS AND METHODS

3.1 Location and climate of the study area

The experiment was conducted in the dry season in 2017 in the inland Valley swamp (IVS) at the Faculty of agriculture and natural resources management of the Ernest Bai Koroma University of Science and Technology of agriculture Makeni, Northern Sierra Leone. Makeni is located at an elevation of 50m above sea level on 80 06N latitudes and 120 06W longitudes. Makeni experiences a distinct dry and wet season. The rainy season which is monomodal lasts from April to November while the dry season extends from December to March. Mean monthly maximum temperature ranges from 210 C to 230 C for the greater part of the day and night especially during the rainy season.

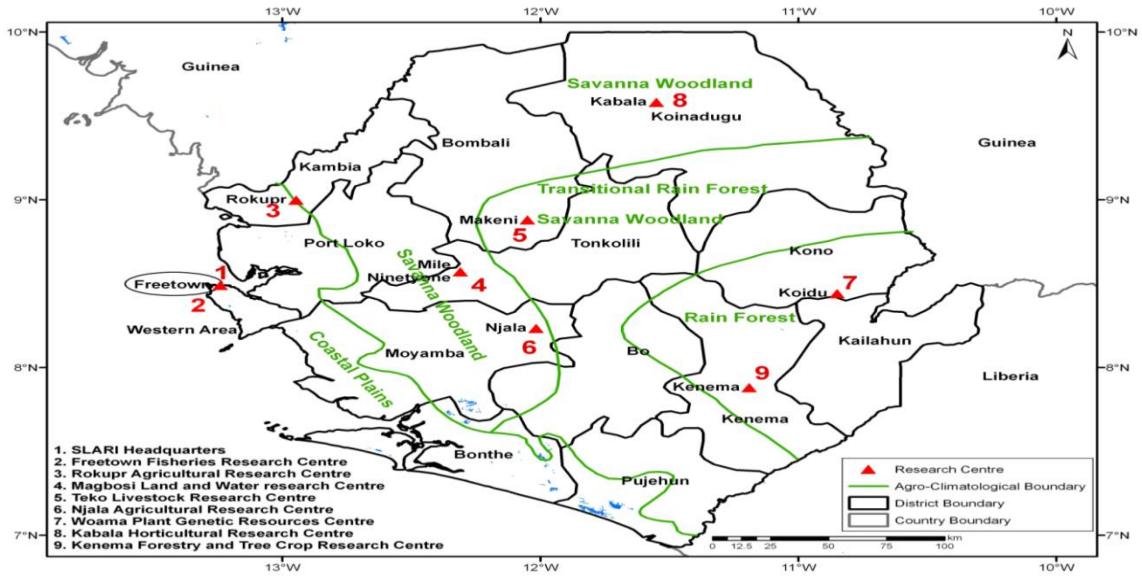


Fig. 1: Map of Sierra Leone showing major agro-ecologies

3.2 Description of Experimental Site

The predominant vegetation of Makeni is a secondary swamp. The soil at the experimental site belongs to the Makeni series (OrthoxicPalehumult). Textures are usually gravely clay in the subsoil. The soils are low in soil moisture, have a very low nutrient status, and are slightly acidic with a pH ranging from 5.5-6.0. The experiment was conducted in an Inland Valley Swamp (IVS) close to the faculty of Agriculture and natural resources Management, Ernest Bai Koroma University of Science and Technology.

3.3 Land Preparation

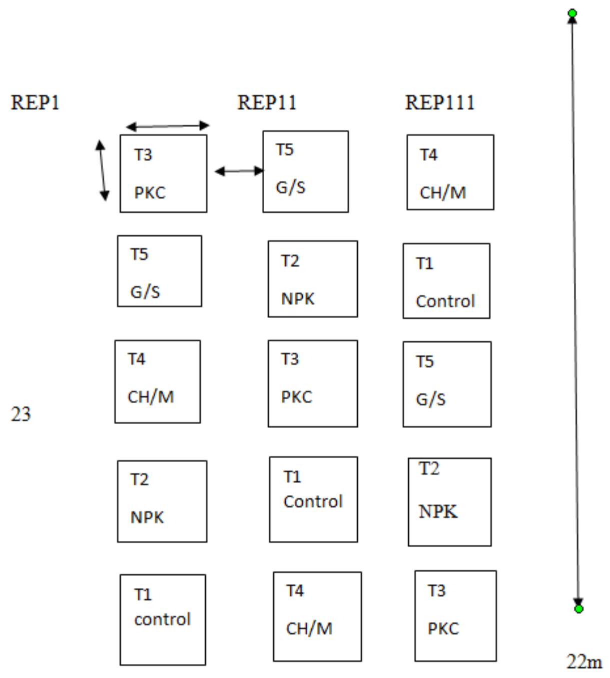
The experimental site was manually cleared with cutlasses and left to lie for a week before the site was ploughed. Garden hoes were used to plough and harrow the site. The experimental layout was done and sectioned into blocks and plots. Pocket holes were dug on flat land in each of the plots as determined by the plant population per plot. The holes were filled with various manure as prescribed by the experiment. Watering was done on alternate days to enhance the fast decomposition of manure for two (2) weeks before planting.

3.4 Description of Crop Variety

An improved variety known as DMR-ESR-Yellow was planted. This variety was introduced in Sierra Leone from IITA, Nigeria. It is particularly resistant to downy mildew and early streak disease. It takes about 50-70 days to silk. It has a sweet taste and matures in about 80-85 days. Tassel type is primary and yield potential is in the range of 1.5-2.1 tons per hectare.

3.5 Experimental design, layout, and randomization

The experiments were laid out in a randomized complete block design (RCBD) and lasted for three months with each treatment replicated thrice. Each replicate consisted of five (5) treatments. The total land area measured 242 m2 (22 m by 11m) with 15 plots in all and each plot size measured 4m by 3m (12 m2) with 0.5 m alleyways between plots and 1m between replicates



3.6 Treatments

All treatments were applied as basal during the cropping period. The Palm kernel cake and Chicken manure were applied to the soil in powdery form and Gliricidiasepiumas green manure by incorporating it into the soil. The applied treatments were well watered and thoroughly mixed seven days before planting maize. The treatment comprised the followings:

I. control (no treatment)
II. NPK 15:15:15 and Urea
III. 10 tons (10,000 kg/ha) of Palm Kernel Cake
IV. 10 tons (10,000 kg/ha) of Chicken manure
V. 10 tons (10,000 kg/ha) of GliricidiaSepium

Table 2: NPK, Urea and Organic Manure Application rates 0n Maize in the lowland.

TREATMENT NUMBER	TREATMENTS	RATE KG/HA	AMOUNT/PLOT 12M^2 (KG)	AMOUNT/STAND (G)
T 3	Palm Kernel Cake	10 tons (10,000)	12	375
T 2	NPK 15:15:15 & Urea	200(15:15:15)&130 Urea	0.24 & 0.16 Respectively	7.6&5.0 Respectively
T 4	Chicken manure	10 tons (10,000)	12	375
T 5	Gliricidiasepium	10 tons (10,000)	12	375
T 1	Control	-	-	-

3.7 Planting and cultural practices

The seeds of maize (Zea mays L.) were sown in an already prepared experimental field manually at 3 cm depth. Maize was sown at a spacing of 75 x 50 cm between and within rows respectively resulting in 32 stands per plot with a planting population of 53,333 plants/ha. Weed control was done manually by hand pulling and hoeing. Weeding was done three times throughout the cropping period. The first, second, and third weeding was carried out at the 2nd, 6th, and 9th weeks after planting. Weeds were not allowed to thrive before weeding was carried out in the experimental plots. Weeds uprooted were packed out of the experimental plots, so as not to interfere with the results of the experiment. The plants were watered once every day and mostly in the evening hours. Watering continued until the ears attained physiological maturity. Harvesting was done when the ears were physiologically matured at …….days

3.8 Data collection

In each plot, five plants were tagged for the collection of data on the above-ground parts. The following characteristics were measured:

1. Percentage germination-Number of seeds that germinated after sowing per plot divided by the total number of seeds planted multiplied by 100.

2. Number of leaves- The leaves produced by each tagged plant was counted and the number got was recorded.
3. Plant height (cm2) - Plant height was measured from the base of the plant to the tip. The values were recorded in centimeters (cm).
4. Leaf area (cm2) –Length and breadth of one middle leaf of each tagged plant were measured to determine the leaf area.
5. Ear height – Average ear height was recorded from the base of the plant to the uppermost height of the ear-bearing node.
6. Number of ears per 5 tagged plants was counted per plot.
7. Total number of ears per plot was also counted and the values were recorded.
8. Fresh weight of cobs per 5 tagged plants per plot
9. Total fresh weight of cobs per plot.
10. Dry weight of cobs/5 tagged plants/plot
11. Dry weight of cobs produced per plot
12. Grain weight/5 tagged plant/plot
13. 1000 grain weight/plot
14. Total grain weight harvested/plot.
15. Total fresh weight of biomass produced/plot.

3.9 Data analysis

The data collected were subjected to analysis of variance using GenStat revised version 10.3. Standard Error of Difference (SED) was used as to separate means.

4.0 RESULTS

4.1 Agronomic Parameters

Table: 3- Effects of Various Treatments on Growth and Yield Component of Maize

TREATMENT	GERMINATION (%)	PLANT HEIGHT (Cm)	LEAF NUMBER
C. manure	90.0	124.5	10.67
Control	91.7	66.8	8.67
G. *sepium*	91.7	68.1	9.00
NPK- 15:15:15& urea	86.7	97.3	10.33
PKC	80.0	100.8	11.00
Mean	88.0	91.8	9.93
SED	4.08	11.17	0.516

C. V %	5.7	14.9	6.4

4.2Germination Percentage

Differences in germination observed among treatments were not significant except for plants in plots treated with PKC (80%) which obtained the lowest germination % significantly different from other treatments. Control and Gliricidiasepium scored the same germination % (91.7%) and is the highest. The lowest germination % in PKC as observed can be attributed to the heat that could have been generated during the decomposition process (Table3).

4.3 Plant Height

Plant height increased from two weeks after planting (WAP) to two months WAP. However, the application of 10 t/ha chicken manure at an equal rate of both PKC and GliricidiaSepium, had the tallest plants (124.5 cm) followed by PKC (100. cm). The recommended NPK fertilizer application had (97.3 cm) which also showed a significant effect. The control crop had significantly the shortest plant with 66.8 cm (Table 3).

4.5 Leaf Number

Leaf number increased from germination to two months after planting (MAP). Control with no treatment produced the least number of leaves (8.67), highly significantly lower than all other treatments. However, in comparison of treatments means, application of GliricidiaSepium at 10 t/ha of the same rate of that of PKC and chicken manure, produced more leaves than the control plots but significantly lower leaves in plots of NPK-15:15:15, PKC, and chicken manure (Table 3).

4.6 Leaf Area

Leaf area varied with treatments at various stages of growth of plants. The largest leaf area (664cm2) was observed in the 10 t/ha application of chicken manure which showed the most significant difference from the 10 t/ha treatments of both PKC and NPK 15:15:15 fertilizer. The control (381 cm2)had the least leaf area which was significantly smaller than the other treatments. However, a significant difference was observed among 10 t/ha application of GliricidiaSepium and those of PKC, chicken manure, and NPK 15:15:15 of the same application rate of 10 t/ha (Fig. 2).

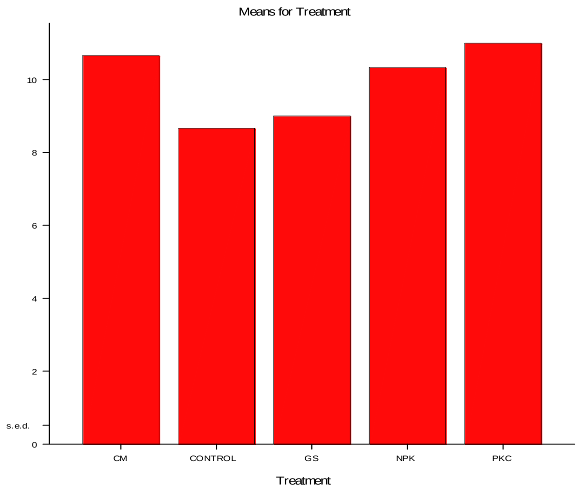


Figure 2: Shows the Leaf Area (Cm2)

4.7 Stem Girth

Palm kernel cake (7.70 cm3) produced the largest stem girth, followed by chicken manure (7.17 cm3) and NPK 15:15:15 (7.03 cm3) respectively with no significant difference. The control (5.37 cm3) produce the smallest size stem girth which was highly significantly different from PKC, chicken manure, and NKP treatments. No significant difference was observed between the stem girth of the plant in the control plot and that of the plot treated with GliricidiaSepium (Figure 3).

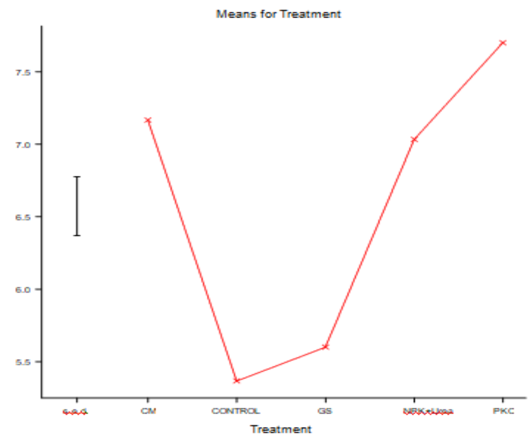


Figure 3: Shows the Stem Girth

4.8 Fresh Biomass Weight

No significant difference was observed in terms of the total weight of biomass (kg) among PKC and chicken manure treatments, except for the control (4.30 kg) which had significantly the lowest weight followed by the Gliricidiasepium plot (4.90 kg). The highest weight (12.83 kg) total biomass was attained by the 10 t/ha application of PKC.

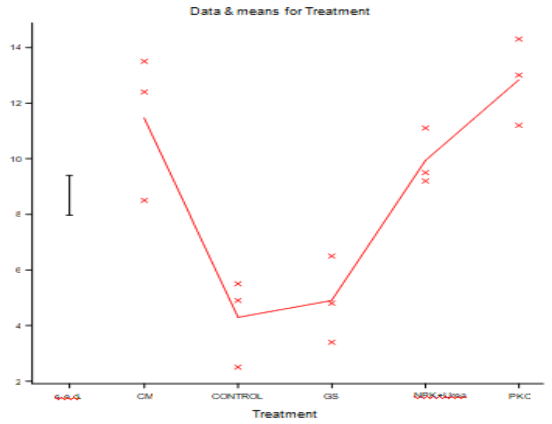


Figure 4. Shows the Fresh Biomass Weight

Effect of Various Treatments on the Yield of on Irrigated Maize

TREATMENT	EAR HEIGHT (cm)	NO OF EAR	F. EAR WT (kg)	TOTAL NO. OF EAR	TOTAL F.EAR WEIGHT kg)	F. COB WT. (kg)	TOTAL WT.OF FRESH COB (kg)
C. manure	87.5	10.0	2.067	29.7	6.32	1.467	4.07
Control	58.2	7.00	1.233	20.0	3.07	0.900	1.80
G. *sepium*	72.9	8.67	1.600	25.0	4.37	1.100	2.73
NPK-15:15:15& urea	81.9	9.67	2.267	30.0	6.77	1.533	4.03
PKC	88.1	11.67	2.633	30.0	9.23	1.667	4.07
Mean	77.9	9.40	1.960	26.9	5.58	1.333	3.34
SED	7.56	1.211	0.2319	3.35	0.733	0.2338	0.938
C V %	11.9	15.8	14.5	15	16.2	21.5	34.4

4.9 Ear Height

No significant difference was observed among PKC, Chicken Manure, and NPK 15:15:15 treatments. The lowest ear height was observed in the control plot which had (58.2cm) after (72.9cm) application of Gliricidiasepium. Palm kernel cake (88.8cm) treatment attained the highest height (Table 4).

4.10 Ear Number

The palm kernel cake (PKC) plot produced the highest number of Ear (11.67) which was not significantly different from plots treated with chicken manure and NPK-15:15:15. The control plot had the least number of Ears (7.00), significantly lower than other treatments followed by Gliricidiasepium (8.67) (Table 4)

4.11 Fresh Ear Weight

A significant difference was not observed in terms of fresh weight of Ear per 5 plants among treatments except for the control plot (1.233kg). The largest weight was attained by plot with PKC treatment (2.633kg) (Table 4)

4.12 Total Number of Ear

Maximum Ear of equal number was recorded from plots treated with PKC and recommended rate of NPK -15:15:15. The control plot recorded the least number of Ear significantly lower than other treatments. No significant difference was observed among applications of PKC, Chicken manure, and Gliricidiasepium (Table 4)

4.13 Total Fresh Ear Weight

Total fresh Ear weight per plot did not show significant difference among plots with treatments of PKC (7.23kg), NPK-15:15:15 (6.77kg) and chicken manure (6.23kg). Significant difference in fresh Ear weight was observed in the control plot which produced the least weight (3.07kg) followed by plot with Gliricidiasepium (4.37kg) (Table 4).

4.14 Fresh Cob Weight

The highest weight was attained by plot treated with PKC (1.667kg) followed by a recommended rate of NPK-15:15:15 (1.533kg) and Chicken manure (1.467kg) with no significant difference. The control (0.900kg) plot had significantly the lowest height than other treatments followed by Gliricidiasepium (1.100kg) (Table 4)

4.15 Total Weight of Fresh Cob

No significant differences were observed among treatments with the exception of the control plot which had significantly lower fresh cob weight(1.80kg) compared to the Gliricidiasepium which had (2.73kg) per plot. Total fresh cob weight per plot was highest for a plot with PKC and Chicken manure treatments (4. 07kg) with no significant difference from NPK-15:15:15 application (Table 4)

4.16 Dry Cob Weight

No significant difference was observed in cob weight per 5 plants among Chicken manure (1.267kg), NPK-15:15:15 (1.00kg), and PKC (0.900kg). The control plot had significantly the lowest (0.500kg) dry cob weight per 5 plants compared to the plot of Gliricidiasepium(0.633kg). However, the highest dry cob weight was exhibited by Chicken manure (1.23kg) followed by NPK (0.9kg) and PKC (0.83kg) (Fig 5).

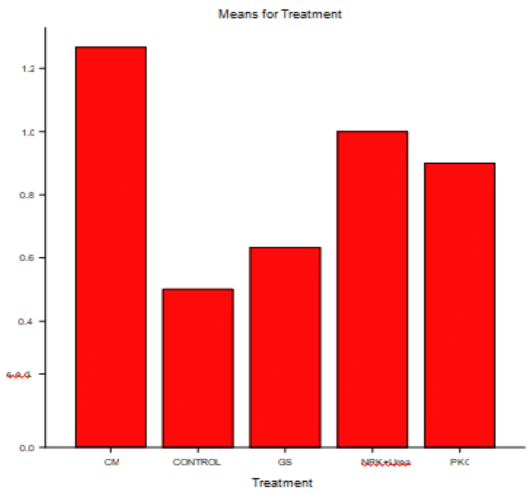


Figure 5: Shows the Dry cob weight

4.17 Total Weight of Dry Cob

The total weight of dry cob did not produce any significant difference among treatments. Though no significant difference occurred among treatments, the control plot had the least weight of dry cob per plot. Chicken manure (2.73kg) attained the highest dry cob weight per plot followed by NPK-15:15:15 (2.60kg), PKC (2.38kg), and Gliricidiasepium (1.73kg) respectively. (Fig.6).

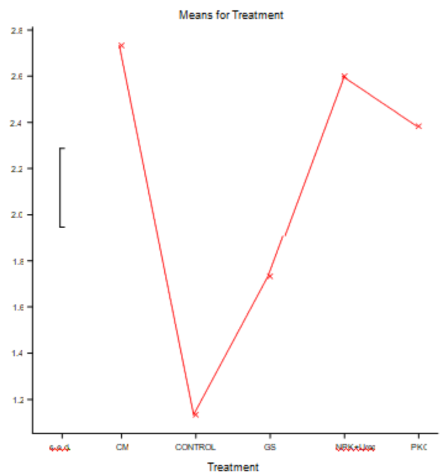


Figure 6: Shows the Total weight of dry cob (Kg)

4.18 Grain weight

NPK-15:15:15 exhibited the largest weight (0.600kg) with no significant difference among Chicken manure (0.567kg) and PKC (0.500kg) treatments. Control (0.167kg) had the lowest grain weight per 5 plants significantly different from other treatments followed by Gliricidiasepium (1.333kg) (Fig 7).

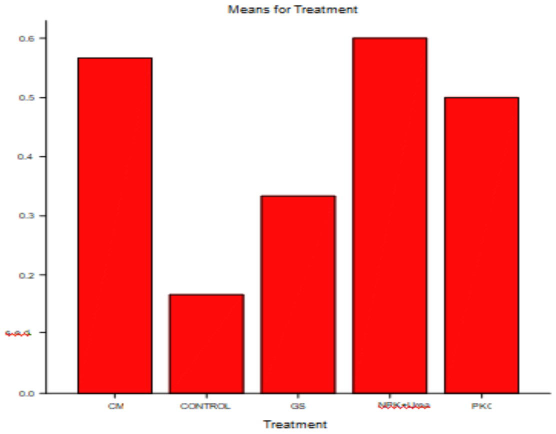


Figure 7: Shows the grain weight (Kg)

4.19 1000 Grain Weight

Treatments of Chicken manure (178.9gm), NPK-15:15:15 (178.6gm), and PKC (160.7gm) exhibited no significant difference except for the control (134.3gm) which had the lowest grain weight significantly lower than other treatments followed by Gliricidiasepium (156.6gm). Chicken manure produced the largest weight in terms of 1000 grain weight per plot (Fig. 8).

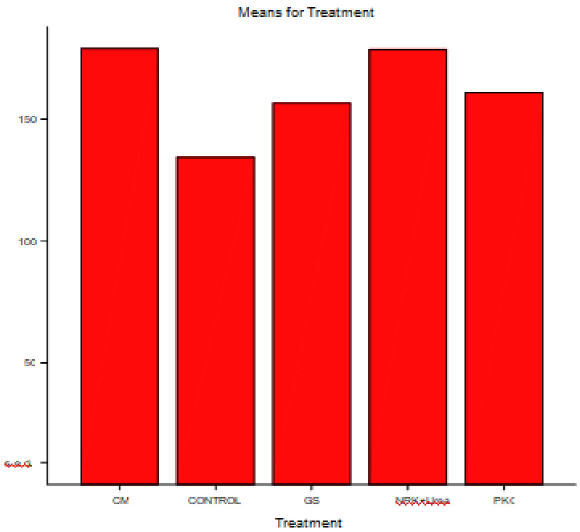


Figure 8: Shows the 1000 grain weight of maize

4.20 Total Grain Weight

NPK-15:15:15 and Chicken manure had the same grain weight (1.87kg) per plot with no significant difference from PKC (1.57kg) treatment. Control (0.50kg) had the least grain weight per plot significantly lower than Gliricidiasepium (1.10kg) (Fig. 9).

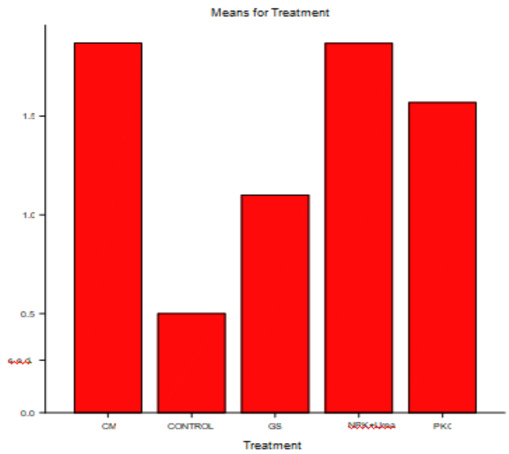


Figure 9: Shows the Total grain Weight

5.0 DISCUSSION

Fertilizer use, being one of the factors influencingproduction, holds the key to increased maize production in Sierra Leone, especially in areas where soils of lownutrient status are found. The need for improved soil fertility is imperative for these farmers. It is, however, true that Sierra Leonean farmers like most farmers in Africa have always recognized the need for improving the fertility status of their soils. As a measure to improving on the low nutrient status soils, organicsepium which are within the reach of the resource poor farmers, were used in this experiment to determine their effects on the growth, yield and yield components of maize as compared to the recommended inorganic fertilization.

It can be noted from the results that germination percentage (%) of the crop in general was not affected by chemical fertilizer (NPK -15:15:15& Urea) and organic manures. More than90% of the germination was noted in control plots. However, seed germinationpercentage in plot treated with PKC was the lowest. This could be as a result of high heat generation during decomposition. The results suggested that the factors like soil moisture and environment required for seed germination were similar throughout the field and thus, the crop response was similar in all the treatments. These results were quite in line with Loeckeet *et al.* (2004) and Theodora *et al.* (2003) who concluded that plant emergence was not affected by manure treatments.

This study revealed that Chicken manure, Palm Kernel Cake (PKC) and Gliricidiasepium has significant effect on the growth, development and yield of maize. The application of10t/ha of Chicken manure and Palm Kernel Cake significantly produced better growth parameters, yield and yield components of maize than the control during growth period and at harvest. Plant height was found to be significantly influenced by organic manure. Chicken manure produced significantly the tallest plants at 10 t/ha followed by PKC and Gliricidiasepium respectively than the control at all the sampling dates. An increase in plant height might be due to the adequate availability of nutrients required for plant growth and development. This supports the integrated use of chemical and organic nutrient sources for an improvement in excellent vegetative growth of plant. These results are in agreement with those of Shah *et al.* (2009) and Achienget *al.* (2010) who reported that application of mineral N alone or with organic N significantly increased the height of maize plants.The increase in plant height was mainly due to the reason of more availability of nutrients by the organic materials throughout the growing season. These results are in accordance with the findings of Mitchell and Tu (2005) and Warren *et al*. (2006).

Maximum number of green leaves was recorded in plots where PKC was applied, while minimum number of green leaves was recorded from control treatment. An increase in number of green leaves might be due to the chlorophyll content of leaves, which improved significantly with the availability of essential nutrients at all growth stages of maize. The results are in agreement with thefindings of Namakha*et al.* (2008) and Mahmood*et al.* (2001) who also found that it might be due to optimum and regular supply of nitrogen to plants from soilduring growth period with more assimilation rate and its integral part of protein and the building blocks of plant.

Total leaf area per plant of vegetable maize was significantly influenced by organic manure. The application of 10t /ha PKC and chicken manure produced significantly larger leaf area than the control at all the sampling dates. Application of 10t/ha Chicken manure produced the largest total leaf area during growth period. In a similar vein, Silva et al. (2003) reported that poultry litter leads to increase in leaf number and size, which results in more longer photosynthetic apparatus by increasing total leaf area of maize plant. Ibeawuchi et al. (2007) reported the leaf area of a maize plant gradually increased with increase in poultry manure and the application of 10t/ha poultry manure gave the widest leaf area than the plots treated with various amounts of NPK.

The maximum stem girth was recorded from plants grown with PKC followed by Chicken manure treatment, while minimum stem girth was recorded in plot with no treatment. Increase in stem girth is a reflection of retention of appreciable amount of assimilates in the stem for leaf production. This might be due to the better nutrient uptake anddevelopment of the plants due to the combined application of mineral fertilizer and organic manures. It was also due to the increase in nitrogen content of soil, which was responsible for overall enhancement of growth, increase in metabolicactivities, assimilation rate and cell division within the plant (Cyrus *et al.*, 2010; Lawogbomo and Lawogbomo, 2009).

Maximum number (30.0) of cobs per plant was noted in both plots of PKC and NPK-15:15:15 treatments. Organic manures and inorganic fertilizerresulted in more number of cobs per plant, possibly due to least N losses and availability of nutrients throughout the growing season of the crop. Control plots resulted in less number of cobs (20.0). The increase in number of cobs might be attributed to the availability of more nitrogen and other nutrients from both inorganic and organic source required for plant development at least up to cob formation. These results suggested that adequate supply of nutrients from both organic and inorganic fertilizers throughout vegetative growth was necessary for proper cob development in maize. These results are in line with Chapagain (2010) and Zhang *et al.* (1998) who reported that application of organic manure and mineral fertilizer to maize crop could be as effective as commercial Nfertilizer for yield response.

Dry kernel yield of maize was significantly influenced by chicken manure and Palm Kernel Cake. Application of 10t/ha chicken manure produced the highest maize kernel yield. In a similar report, Smaling*et al.* (2002) recorded a significant increase in the number of kernel per ear of maize with the application of poultry manure. They attributed this significant increase in yield to the favorable beneficial effect of poultry manure on leaves and its number, leaf size, dry matter production, length and number of ears per plant, kernel weight which all have direct bearing on yields of cereals. PKC and Chicken manure had significant influence on the weight of fresh husked cob in this study. Application of 10t/ha PKC produced significantly higher fresh cob yield than Chicken manure, and NPK-(15:15:15).

Grain yield is a function of interaction among various yield components that were affected differentially by the growing conditions and crop management practices. The maximum 1000-grain weight (178.9 g) was recorded in plots with Chicken manure followed by NPK-15:15:15 plot (128.6) while minimum 1000-grain weight (134.3g) was recorded in control plotwhereno treatment was applied. The grain yield usually depends upon various factors such as status of soil fertility, water availability, crop management, agronomic practices, environmental factors and plant genetic characteristics. The results of this study show that treatments received N from organic and mineral sources producedmaximum 1000-grain weight. Yield improvement under these treatments might be due to enhanced use of N, water and other associated soil improving benefits of organic sources, which made plants more efficient in photosynthetic activity. Decrease in required 1000-grain weight in control treatment might be due to low availability of nitrogen and other nutrients (Khan *et al.*, 2009). These results are in agreement with the findings of Achieng*et al.* (2010) and Shah *et al.* (2009) who were of the view that increase in 1000-grain weight was mainly due to the balanced supply of nitrogen with P and K and maximum N use efficiency from both inorganic and organic sources during the grain filling, development and growth stages.

6.0 CONCLUSION

The results of this study showed the advantages of using PKC, Chicken manure and Gliricidiasepium for the production of maize in terms of growth, yield and nutrient composition. The trend of events in plant growth and yield observed in this research implies that organic manure use could compete favorably with inorganic fertilizer. Plant growth and yield monitored in this research work showed that Palm Kernel Cake(PKC), Chicken manure and*Gliricidiasepium*,applied at 10 t/ha enhanced the nutrient composition and yield of maize. This suggest that the above materials are good source of sustainable and efficient organic amendment which could be recommended to small holder maize farmers for improving soil properties, optimum growth and yield of maize in the study area. The nutrient composition of maize as influenced by organic minerals used in this research is also capable of meeting the nutritional requirement of the people. Therefore, the use of Palm Kernel Cake, Chicken manure and Gliricidiasepium as source of nutrient for Maize growth has further lend credence to the possibility of organic materials increasing the yield and nutritional content of maize.

The results have shown that there is potential for increase in the average yields of maize in Sierra Leone from 0.8t/ha to over 2t/ha through the use of PKC and Chicken manure.

From the result of the study, the following conclusion can be made:

1. The application of Chicken manure and Palm Kernel Cake tended to increase the nitrogen content of the leaves and hence the chlorophyll content resulting in increased grain yield
2. That the application of Chicken manure or Palm Kernel Cake at 10t/ha can be used in place of the recommended NPK: 15:15:15 without any significant reduction in grain yield.
3. Nitrogen fertilization is very important for increased maize yield in Sierra Leone.
4. The yield of maize was very low without organic or inorganic nitrogen fertilization.
5. The study indicates that PKC and Chicken manure are valuable fertilizer source whose use needs to be encouraged.

7.0 RECOMMENDATIONS

Based on the findings of the study, and due to an increasing cost of chemical fertilizers, it is recommended that Sierra Leonean farmers adopt the use of Palm Kernel Cake and/or Chicken manure as a mean of soil improvement technology and as a source of nitrogen which is one of the major nutrient required for maize production.

For efficient and economic use of PKC and Chicken manure, a rate of 10t/ha and above is recommended for maize production as it will yield the same as the recommended rate of NPK-15:15:15.It is also recommended that the trial be repeated in a rain fed situation on upland soils across various agroecological zones to ascertain the findings of this study.

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