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Weekly performance of maize plant under sandy soil managed with dissimilar organic materials

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Abstract: *Organic materials bring many benefits to plant growth and yield performances in crop production. The objective of this study was to know the performance of maize plant from germination period to maturity period under sandy soil condition manage with different organic materials, on weekly basis. The experiment was initiated under poor sandy-soil site, just 5 km away from the Argungu town, Kebbi State Nigeria, located within latitude 12° 24"N and longitude 4° '12"E. The study confirms the assumption that crop plant is very likely to perform better under poor sandy-soil condition if sustainable management requirements are provided. Plant growth and yield performances were observed positively well in the first, second, third, fourth, fifth, seven and tenth week after germination. It is concluded that sandy soil managed with organic materials provides good soil atmosphere for maize plant growth in crop production. Likewise, the results suggested that crop grown under sandy soil managed with organic materials perform better in term of plant growth and yield performances.*

I. Introduction

It has been widely accepted that organic materials (plant and animal sources of organic matter) from plants and animals play important role in sustaining and improving soil structure, soil quality, soil function, soil health, soil fertility, and overall crop performance (growth and yield) in agricultural production. Organic materials affect physical, biological, chemical, and ecological processes in soil. They improve soil structural quality, soil water holding capacity, soil infiltration, soil organism biodiversity and soil nutrient availability (FAO, 2005). However, most of the agricultural soils in sub-Saharan Africa (SSA) are poorly fertile due to erosion, desertification and climate change impact and other related problems (Put *et al.,* 2004; Usman, 2007). Because of these soil problems, farmers complained much about the annual yield reductions of their farm produce (Usman *et al.,* 2012). While it is the goal of sound soil management in crop production to create a healthy soil environment which may retain balance nutrient status such that its fertility is maintained over time (Omotayo and Chukwuka, 2009). To improve the standard balance of the available soil nutrients in low fertile soils of SSA, it is necessary to be able to improve the fertility of poorly fertile soils under sustainable soil management package. This demands the use of available organic materials that are important sources of essential soil nutrients. Because when organic materials are applied in soil, they experience decomposition processes – humification and mineralization. The decomposed organic materials in soil, protect soil against runoff, erosion, mass movement of fine soil particles and enhance soil water, soil air (pore spaces), and soil productivity for wide range of crop benefit (Tieszen *et al.,* 2001; Masri and Ryan, 2006). Indeed, organic materials are the storehouse of all essential soil and plant nutrient in soil. They are important components of soil fertility and are associated with a variety of other important soil physical, chemical, and biological characteristics (McDonald, 2010; Usman, 2013).

Use of organic materials in crop production offers numerous benefits to the agricultural development (Mäder *et al.,* 2002; Usman, 2013). Investigating the performance of maize plant under soil treated with different organic materials could provide sustainable way of improving soil quality and high crop yield in agriculture (Usman, 2013). Problems of poor plant and yield performances are difficult to avoid under low fertile soil condition. Few studies have been conducted to investigate the weekly performances of maize plant under sandy soil condition in Kebbi State, Nigeria. This is important because of the high population increase, which demand high crop yield for better sustainable livelihood, particularly among the rural people (Usman, 2013). Our objective was to know the performance of maize plant from germination period to maturity period under sandy soil condition managed with different organic materials, on weekly basis.

II. Materials and methods

2.1 Site description

The study site, is 5 km away from the town city of Argungu, Kebbi State Nigeria; located within latitude 12° 24"N and longitude 4° '12"E. The common agricultural activity is mono-cropping under poor land, characterised by aridic (dried) and hot soil moisture and temperature characteristics. The topography of the site is flat (visible at 1–10 m) belonging to soil group Aridisols under FAO-USDA classification systems (FAO, 2006; Soil Survey Staff, 2010). The surface soil of the site is physically characterised by few indication of sheet erosion under scattered tree vegetation cover. The geo-physical properties and dynamic conditions of the soil of the farm site are presented in Table 1.

Table 1: The summary of geo-physical properties and dynamic condition of study site

Physical		**Biological**		**Soil conditions**	
Characteristics	**Proportion**	**Properties**	**Observed**	**Properties**	**Extent**
Sand	66%	Crust	Mat-like	Water erosion	Slight
Silt	16%		Termite-build	Wind erosion	Moderate
Clay	10%		Ant-build	Surface soil damages	Moderate
Organic matter	8%			Vegetation cover	Poor
Bulk density	1.43cm/g	Soil biota	Arthropods	Desertification	Less
Soil colour	Light-ash		Termite	Overgrazing	Moderate
Soil structure	Granular			Deforestation	Severe
Soil texture	Loam-sand	Other	Insect cast	Sand-stony	Absent
Soil consistence	Loose		Discrete bodies	Rock-outcrop around	Absent

2.2 Experimental soil management exercise

A field-crop experiment was designed to test the plant growth and yield performance of local maize seeds under 12 different soil strata which have been sustainably managed with different organic materials. In the process of this soil management exercise, a stratified random sampling was used (Upton, 1987). The field site was divided into a number of strata (groups); each stratum consists of the same soil and climate conditions, the same agricultural and management activities under poor sandy-soil condition. There are 12 different soil strata, which were designed and each has five representative soil units. These strata were provided with specific field codes as: S-cow01, S-sheep02, S-goat03, S-donkey04, S-rice-husk05, S-millet-husk06, S-albida07, S-nilotica08, S-wood-ash09, S-wood-husk10, S-house-refuse11, and S-ani-cro-ber12. The control strata unit has no code. Still, all the strata were treated separately with specific organic sample. Soil holes were dug (40 cm length x 30 cm depth) in each soil unit. Organic samples were supplied to these holes and about 1000 ml of water was poured twice every day (morning and evening) for one week. This is to enhance the proper decomposition of organic materials in soil. The experiment lasted for a period of three weeks, consecutively.

2.3 Field-crop direct observation test

Direct Observation Method (DOM) that involves regular visiting of every number of plant cultivar was used (Upton, 1987). The control soil unit was taken separately. However, a sample representative of each stratum was measured on weekly basis. The parameters used in this measurement exercise are: stem height, stem size, leaf size, leaf length and number of leaf for plant growth performances (Figure 1). While the number of seed per corn, number of lines per corn, and shapes of seed in each corn were used for yield performances' assessment as designed (Figure 1). Besides, the measurements of plant parameters were made by means of plastic ruler, and data were recorded accordingly. The intervals for all the measurements are: after 1 week (19/07/2011–26/07/2011), after 3 weeks (19/07/2011–10/08/2011), after 5 weeks (19/07/2011–24/08/2011), after 7 weeks (19/07/2011 – 07/09/2011), and after 10 weeks (19/07/2011–28/09/2011). Corn yield was finally harvested on 30 October, 2011 after 102 days (15 weeks). The corn harvested was used to determine the number of seed per each corn as well as the number of seeds on each corn. The complete data may be seen in Appendix.

Figure 1: Typical illustrations of crop direct observation method used

2.3 Data analyses

All data collected on plant growth and yield performance were analysed by ANOVA and regression analysis R^2 (Verzani, 2002; Nacson, 2007). The first analysis is grouped into1st, 2nd, 3rd, 4th and 5th. Variance (VAR) was used as measure of the entire plant growth's variability, standard deviation (SD) as the square root of this variability and mean as a measure 'precision' of an estimate of the true population average. The differences in term of VAR and SD on weekly bases were determined and defined as: ¥ 'significant differences', Ψ 'non-significant differences' and ɏ 'minor differences'. In the second analysis, R^2 was used to show the proportion of common variation in all the plant performances for future prediction of the results outcome. R^2 value called the coefficient of determination was calculated. This value was also used to show the "strength" or "magnitude" of the relationship between all the parameters measured.

III. Results

The analyses of the results of weekly plant growth performance of maize cultivar under 12 different soil strata are given in Tables 2, 3, 4, 5 and 6 covering 1st, 2nd, 3rd, 4th and 5th analysis. In the 1st analysis (Table 2), the VAR (2.511730057ψ) and SD (2.511730057ψ) show no differences in term of plant height under all the soil strata, however, these plants were differ significantly for plant leaf length (SD = 7.264963659¥, VAR = 52.77969697¥). Similarly, they are not significantly different for plant leaf size (SD = 0.498907898ɏ , VAR = 0.248909091ɏ), and number of leaf per plant (SD = 1.678744119 ɏ , VAR = 2.818181818 ɏ).

Table 2: Performances of maize plant growth after 1 week of seeds germination

1st Analysis	Stem height (cm)	Leaf length (cm)	Leaf size (cm)	No. of leaf $plant^{-1}$ (cm)
Sum	61	179.8	14.2	42
Mean	5.083333333	14.98333333	1.290909091	3.5
SD	2.511730057ψ	7.264963659¥	0.498907898ɏ	1.678744119 ɏ
VAR	2.511730057ψ	52.77969697¥	0.248909091 ɏ	2.818181818 ɏ
MAX	8.1	22.2	1.8	5
MIN	5.1	15.6	1.1	4

Reminder note: Ψ means no significant different, ¥ means there is significant different, ɏ means there is different but not significantly

In the 2nd and 4th analyses (Tables 3, 4), all the four parameters (i.e. stem height, stem size, leaf length, and number of leaf per plant) show significant differences (¥) after three and seven weeks of plant's growth development. In these two analyses, only the plant's leaf sizes show a kind of relationship with each other, although, there is a difference of 0.1 cm between the value of SD (0.872648355ɏ) and that of VAR (0.761515152ɏ) in the 2nd analysis, as well as in the 4th analysis (SD = 0.886873979 ɏ and VAR = 0.786545455 ɏ). During these seven weeks periods, the leaf sizes of maize plants were grown on the same performances.

Table 3: Performances of maize plant growth after 3 weeks of seeds germination

2nd Analysis	Stem height (cm)	Stem size (cm)	Leaf length (cm)	Leaf size (cm)	No. of leaf $plant^{-1}$ (cm)
Sum	101.9	8	362.1	29.8	77
Mean	8.491666667	0.666666667	30.175	2.483333333	6.416667
SD	3.116950238¥	0.253460893¥	10.59108759¥	0.872648355 ɏ	2.234373¥
VAR	9.715378788¥	0.064242424¥	112.1711364¥	0.761515152 ɏ	4.992424¥
MAX	11.8	0.9	38.8	3.1	8
MIN	6.1	0.4	22.6	1.8	5

Reminder note: ¥ means significant different, ɏ means there is different but not significantly

Table 4: Performances of maize plant growth after 7 weeks of seeds germination

3rd Analysis	Stem height (cm)	Stem size (cm)	Leaf length (cm)	Leaf size (cm)	No. of leaf $plant^{-1}$ (cm)
Sum	427.2	19.9	710.5	67.8	117
Mean	38.83636364	1.809090909	64.59090909	6.163636364	10.63636364
SD	6.539613555¥	0.326969557 ɏ	6.619283125¥	0.886873979 ɏ	1.361816968 ɏ
VAR	42.76654545¥	0.106909091 ɏ	43.81490909¥	0.786545455 ɏ	1.854545455 ɏ
MAX	52.6	2.4	76.2	7	12
MIN	33	1.5	56.8	5	9

Reminder note: ¥ means significant different, ɏ means there is different but not significantly

In the 3rd and 5th analyses (Tables: 5, 6), the differences between all the maize plants on leaf size and number of leaf per plant performances are also not significant. Considerably, in 3rd analysis, the SD is 0.506503163¥ and VAR is 0.256545455¥ for leaf sizes, and SD is 0.750757194ɏ and VAR is 0.563636364ɏ for number of leaf per plant. In this regard, difference of 0.2 cm was observed on plant's leaf sizes as well as number of leaf per plants accordingly. While in the 5th analysis, where the value of SD is 0.599090219ɏ , VAR is 0.358909091ɏ for leaf size, and SD is 0.8202ɏ , VAR is 0.672727ɏ for number of leaf per plant, the difference of 0.2 and 0.1 cm were observed for all the plants. This shows that there is significant relationship between all the organic materials used in this experiment in respect to soil quality management and crop growth performances as well.

Table 5: Performances of maize plant growth after 5 weeks of seeds germination

4th Analysis	**Stem height (cm)**	**Stem size (cm)**	**Leaf length (cm)**	**Leaf size (cm)**	**No. of leaf plant^{-1} (cm)**
Sum	159.6	14	558.6	50.2	90
Mean	14.50909091	1.272727273	50.78181818	4.563636364	8.181818182
SD	1.789108463¥	0.179392916 ɏ	4.510613746¥	0.506503163¥	0.750757194 ɏ
VAR	3.200909091¥	0.032181818 ɏ	20.34563636¥	0.256545455¥	0.563636364 ɏ
MAX	18.1	1.6	58.6	5.3	10
MIN	12.3	1	43.7	3.8	7

Reminder note: ¥ means significant different, ɏ means there is different but not significantly

Table 6: Performances of maize plant growth after 10 weeks of seeds germination

5th Analysis	**Stem height (cm)**	**Stem size (cm)**	**Leaf length (cm)**	**Leaf size (cm)**	**No. of leaf plant^{-1} (cm)**
Sum	884.6	25.1	763.6	73.8	126
Mean	80.41818182	2.281818182	69.41818182	6.709090909	11.45455
SD	20.82593663¥	0.31246818 ɏ	6.843656652¥	0.599090219 ɏ	0.8202 ɏ
VAR	433.7196364¥	0.09763636ɏ	46.83563636¥	0.358909091 ɏ	0.672727 ɏ
MAX	120	2.8	79.7	7.8	12
MIN	54.4	1.9	60.8	6.1	10

Reminder note: ¥ means significant different, ɏ means there is different but not significantly

However, in comparison, after 1st week, the maximum stem height is 8.1 and was increased to 11.8, 18.1, 52.6 and 120 cm after 3rd week (Table 3), 5th week (Table 5), 7th week (Table 4) and 10th week (Table 6), respectively. This means the differences of 3.7, 6.3, 34.5 and 67.4 cm were observed after week 1, week 3, week 5, week 7 and week 10 of plant growth respectively. The minimum of 5.1, 6.1, 12.3, 33 and 54.4 cm were recorded for the entire stem height in which the mean of 5.1, 8.5, 14.5, 38.8 and 80.4 cm were determined. Similarly there were differences in term of maximum and minimum values between week 1, week 3, week 5, week 7 and week 10 for all the stem size, leaf length, leaf size and number of plant leaf parameters (Tables: 2, 3, 4, 5 and 6). However, the yield performances of all the plants growths are shown in Table 7.

Table 7: Yield performances of maize plants under 12 different soil strata

Soil strata	**Number of seed lines on corn**	**Number of seed per corn**	**Shapes of seeds on corn[1]**
S-cow01	13	581	Reticulate (medium size)
S-sheep02	12	576	Reticulate (medium size)
S-goat03	16	608	Rounded ball (big size)
S-donkey04	14	616	Rounded spherical (big size)
S-rice-husk05	12	564	Plate-like (big size)
S-millet-husk06	20	700	Spherical crudely (small size)
S-albida07	13	611	Reticulate (medium size)
S-nilotica08	10	440	Plate-like (big size)
S-wood-ash09	14	518	Dentrictic branched (small size)
S-wood-husk10	-	-	-
S-house-refuse11	12	696	Cylindrical (medium size)
S-ani-cro-ber12 Control	18	846	Reticulate (medium + big sizes)
	8	281	Plate-like (small size)

According USDA-NRCS (2002) guidelines (see Appendix No. 1)

According to Table 7, S-ani-cro-ber12, S-millet-husk06 and S-house-refuse11 show high positive yield performance of 846, 700 and 696 number of seed on corn respectively. However, 616, 611, 608, 581, 576, 564, 518 and 440 are recorded under S-donkey04, S-albida07, S-goat03, S-cow01, S-sheep02, S-rice-husk05, S-wood-ash09 and S-nilotica08 respectively. In this regard, S-millet-husk06 has the highest number of seed line on each corn and S-nilotica08 has the lowest number (Table 7). By comparison, all the soil stratum units show better performance than the control strata unit, although some similarity was noted in term of seed shape. The shapes and sizes of all the seeds on the corns differ greatly and classified as reticulate (medium size), rounded ball (big size), rounded spherical (big size), plate-like (big size), spherical crudely (small size), dentrictic branched (small size), and cylindrical (medium size). The different accounted for by the seeds shapes and sizes under this assessment would be use in farm labour cost analysis, farm profit analysis, weight (kg) measurement in market business analysis, quantity yield analysis, and storage management system. Generally, no record was taken under S-wood-husk10 because of seed failure to germinate after planting. The reason behind this failure is unknown but after 2 weeks of planting, the seeds planted were found infected (no evidence has been seen but it appeared that the seed look like-burnt). There are significant improvements for all the soil strata treated with organic materials if compared with control treatment (8, 281 for number of seed lines on corn and number of seed per corn).

Examining the degree of relationships between the parameters measured, further observation is possible using regression analysis. The analysis shows that the numbers of stem height, stem size, leaf length, leaf size and number of plant leaf for all the maize plants growth under 11 soil strata are deviated in the same directions but behave in different ways. Partly this was due to the function of organic materials used under the soil strata in which all the plants was grown. It appeared that after one week of plant growth, the numbers of leaf length for all the plants measured are positively same ($y = 1.1494x + 9.2398$ $R^2 = 0.5103$). There are also positive performance on stem height ($y = 0.4205x + 2.9461$ $R^2 = 0.5562$) and number of leaf per plant ($y = 0.2034x + 2.9461$ $R^2 = 0.304$), but the extent of these performances is difficult to verify (Figure 60). Reasonably, there is no relationship between the numbers of leaf size for all the plants ($y = 0.0176x + 1.3022$ $R^2 = 0.0472$). Similarly there was also positive performances in term of stem height ($y = 0.1998x + 5.8611$ $R^2 = 0.3996$), leaf length ($y = 1.178x + 26.425$ $R^2 = 0.5907$) and number of leaf per plants ($y = 0.3257x + 7.2437$ $R^2 = 0.4203$) after 3 weeks of plant growth. However, in the case of leaf size ($y = 0.0729x + 2.2843$ $R^2 = 0.3246$) and stem size ($y = 0.0356x + 0.5172$ $R^2 = 0.5862$) this positive performance is lacking. In contrast, some deviations were observed in term of leaf sizes and number of plant leaf after week 5 and week 7 of plant growths. However, a rapid growth has been seen for all the plant growth components throughout the 7 week period but remained positively fixed after 10 week. Generally, over all the soil strata, the regression analysis for plant growth performance can be categorised into four linear relationships (Table 8): week linear relationships, very week linear relationships, poor linear relationships and very poor linear relationships.

Table 8: Statistical data on correlation analysis of maize plant growth performances

Test	Stem height (cm)	Stem size (cm)	Leaf length (cm)	Leaf size (cm)	No. of leaf per plant (cm)
After week 1	$R^2 = 0.5562$	–	$R^2 = 0.5103$	$R^2 = 0.0472$	$R^2 = 0.304$
After week 3	$R^2 = 0.3996$	$R^2 = 0.5862$	$R^2 = 0.5907$	$R^2 = 0.3246$	$R^2 = 0.4203$
After week 5	$R^2 = 0.4196$	$R^2 = 0.1504$	$R^2 = 0.4507$	$R^2 = 0.0538$	$R^2 = 0.0559$
After week 7	$R^2 = 0.0593$	$R^2 = 0.0079$	$R^2 = 0.2453$	$R^2 = 0.1041$	$R^2 = 0.1545$
After week 10	$R^2 = 0.0922$	$R^2 = 0.0493$	$R^2 = 0.0453$	$R^2 = 0.0171$	$R^2 = 0.1635$

The values of > 0.5 under stem height ($R^2 = 0.5562$), stem size ($R^2 = 0.5862$) and leaf length ($R^2 = 0.5103$, $= 0.5907$) show a week linear relationships. However, values < 0.5 to 0.1 under stem height ($R^2 = 0.4196$, $= 0.3996$), stem size ($R^2 = 0.1504$), leaf length ($R^2 = 0.4507$, $R^2 = 0.2453$), leaf size ($R^2 = 0.3246$) and number of plant leaf ($R^2 = 0.4203$, 0.1635, 0.1545) show very week relationships. While values < 0.1 under stem height ($R^2 = 0.0922$, $= 0.0593$), stem size ($R^2 = 0.0493$), leaf length ($R^2 = 0.0453$), leaf size ($R^2 = 0.0171$) and number of plant leaf ($R^2 = 0.0559$), shows poor linear relationships. The last type of linear is very poor relationship and was observed under stem size ($R^2 = 0.0079$) at 7 week of plants growth. Over all the crop yield performances, the regression analysis shows positive correlation in for number of seed in corn ($y = 11.182x + 547.09$ $R^2 = 0.1222$) and negative correlation for number of line in corn ($0.1091x + 13.345$ $R^2 = 0.0152$).

IV. Discussion

While it was expected that only few organic materials are likely to be the best sources of organic matter for soil quality and soil fertility functions, however, the results of field test carried out in Kebbi State Nigeria show that there are many important sources of soil organic matter in the region. The results of this finding have further confirm the better performance of plant growth and yield productivity under soil treated with organic materials as similarly reported in previous studies (e.g. Janssen and van der Weert, 1977; Basu *et al.*, 2007; Fan *et al.*, 2012). Throughout the period of pant growth (106 days), all the plants seem to have grown perfectly without any physical deformity. The parameters measured conformed very well with the work of Basu *et al.* (2007). The performances of plant growth in term of stem height and leaf length show a remarkable attraction for using plant and animal organic materials under poor soil conditions. There was rapid improvement in term of stem height, stem size, leaf length, leaf size and number of plant leaf from germination to maturity period. The analyses of variance and standard deviation show clear differences of all the plants (Tables 2–6). In the 1st analysis, the average mean for stem height, leaf length, leaf size and number of plant leaf are approximately 5.1, 14.9, 1.3 and 3.5 cm respectively. Absolutely there were rapid increased of plant growth performance in the 3rd week (mean = 8.5, 30.1, 2.5 and 6.4 cm), 5th week (mean = 14.5, 50.8, 4.6 and 8.2 cm), 7th week (mean = 38.8, 64.6, 6.2 and 10.6 cm) and 10th week (mean = 80.4, 69.4, 6.7 and 11.5 cm). This also has reflected the sum, variance, standard deviation, minimum and maximum number of stem height, stem size, leaf length, leaf size and number of plant leaf accordingly (Figures 2, 3).

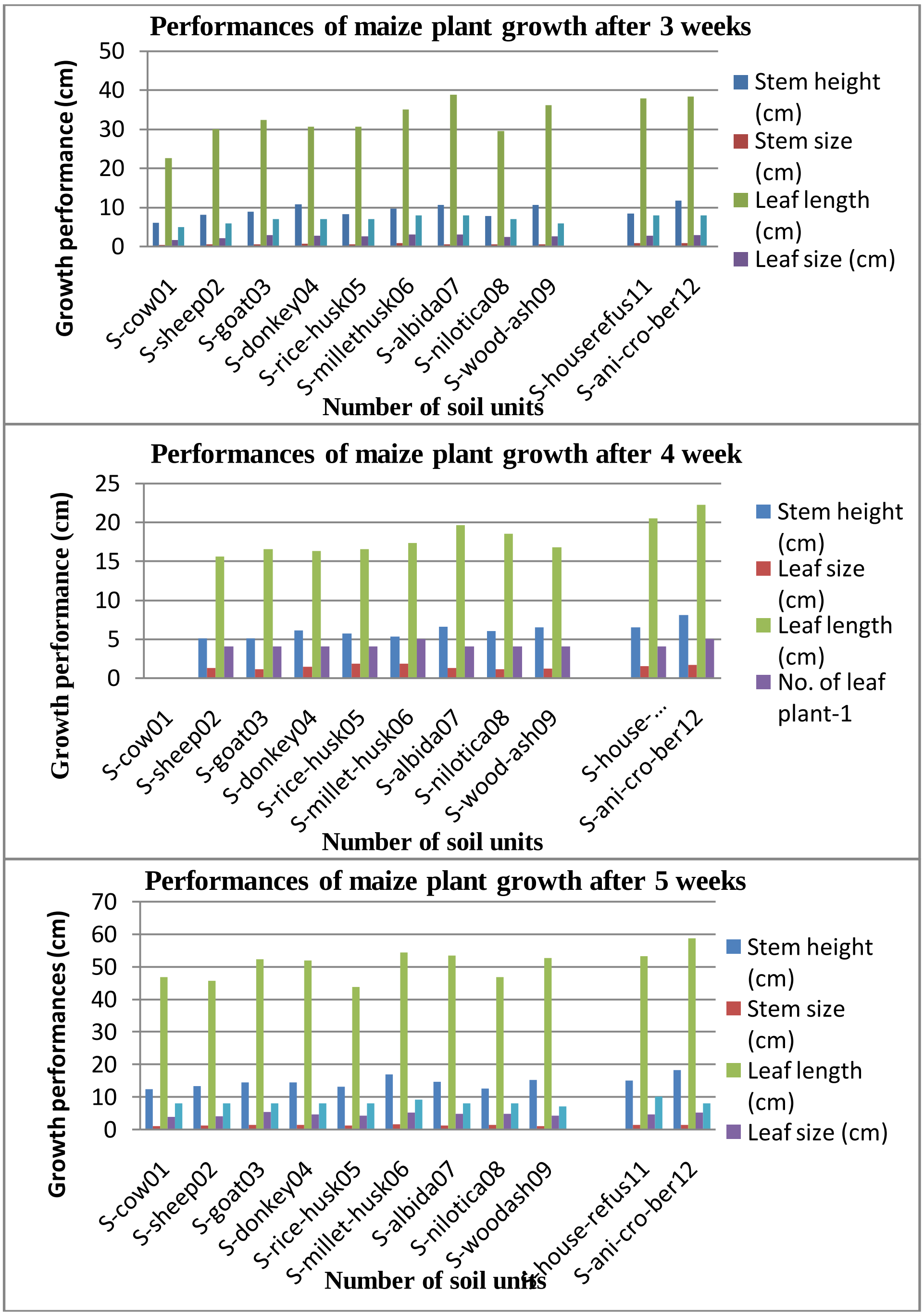

Figure 2: Differences of maize plant growth performances under 11 different soil units

Initially after 1st week, 3rd week and 5th week of planting, the plant growth performances under 11 soil strata remained the same for all the parameters except for the stem height and leaf length (Figure 2). The highest positive performance in term of these two parameters by ranks is soil strata 12 and 11. The probable reason for their high performance was due to high concentration of nitrogen uptake which is high in ani-cro-ber and house refuse organic materials (Table 6). Absolute growth performance of leaf size and number of plant leaf was positively the same in all strata. Basu *et al*. (2007) have reported higher leaf area index and nodule numbers under soil treated with integrated application of three organic materials. FAO (2005) theorized that well-integrated organic materials provide as many essential nutrients for proper plants growth compared with the single organic (plant/animal) material. In contrary, after 7th and 10th weeks of planting, optimum increase of high growth performances in term of stem height and leaf length was also positive in soil strata 4 and 6 but not as high as soil strata 12 and 11 (Figure 3). However, no considerable changes in respect of leaf size, stem size and number of plant leaf were observed for all the 11 soil strata.

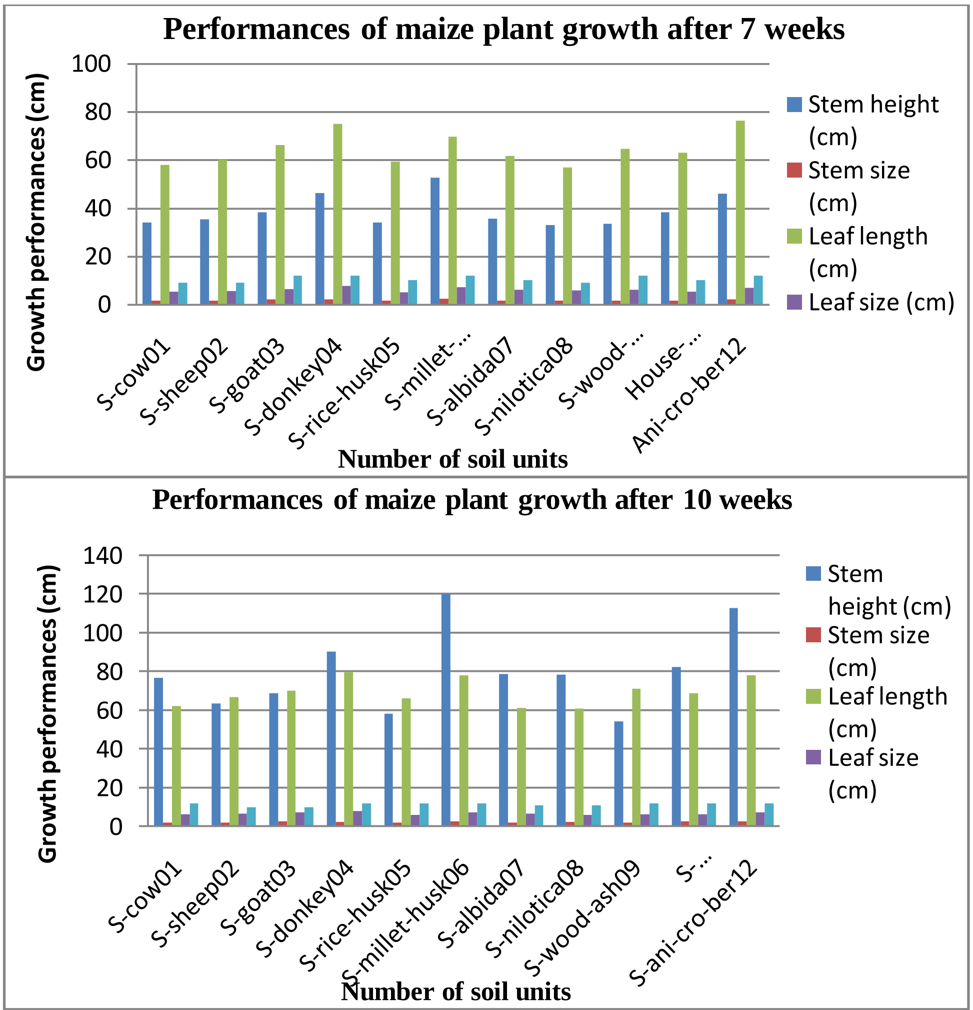

Figure 3: Performances of maize plants growth under soil strata 7th and 10th week

On the other hand, high yield in crop production has been of great priority to all farmers in the Kebbi State (KARDA, 2009). In the present study, it has been shown that yields have differed between the soil strata. Positively, the result will be of consideration to farmers in Kebbi State because of its economic importance in term of yield performance (Table 7). This yield performance has been used in the interpretation of the functions of different organic materials in crop production (Basu *et al.*, 2007). Janssen and van der Weert (1977) reported that the use of organic materials under soil quality management in crop production provided a high yield performance than long term inorganic fertilizer application. Although, the present study has not been design to compare the crop yield performance under soil treated with organic materials and inorganic fertilizers, however, it is believe that plant grown in soil treated with organic materials performed well in term of crop yield, seed healthy and seed vigour (Jeffery, 2008; Caires, *et al.*, 2011). Besides performed well, it is also believe that maize yield under soil treated with different organic materials is rewarding, economic and long term benefits

(Jeffery, 2008). In the present study the effect of maize yield under different soil strata shows an economic benefit of organic materials in crop production. This benefit of organic contributions was reported to improve maize growth and also provide long term recovery for the proper crop performance under drought condition (Vanlauwe *et al.*, 2001). In line with this advantages of organic materials in agriculture, it is important to note that plants grown in soils treated with bulked of all organic materials (ani-cro-ber), millet husks and housed refuse have performed better (number of seed on corn = 846, 700 and 696 respectively) compared with plant grown in soil treated with animal dung (number of seed on corn = 616, 608, 581 and 576 for Soil strata 04, 03, 01 and 02 respectively (Figure 4). One of the possible reasons of the high number of seeds per each corn is long-term effects such as weed competitions, which remain unknown in the last three weeks to crop maturity. Berner *et al.* (2002) have similarly noted low weed competition with reduce tillage under soil organic management. The present study was completely carried out under zero tillage as in line with observation made by Berner *et al.* (2002).

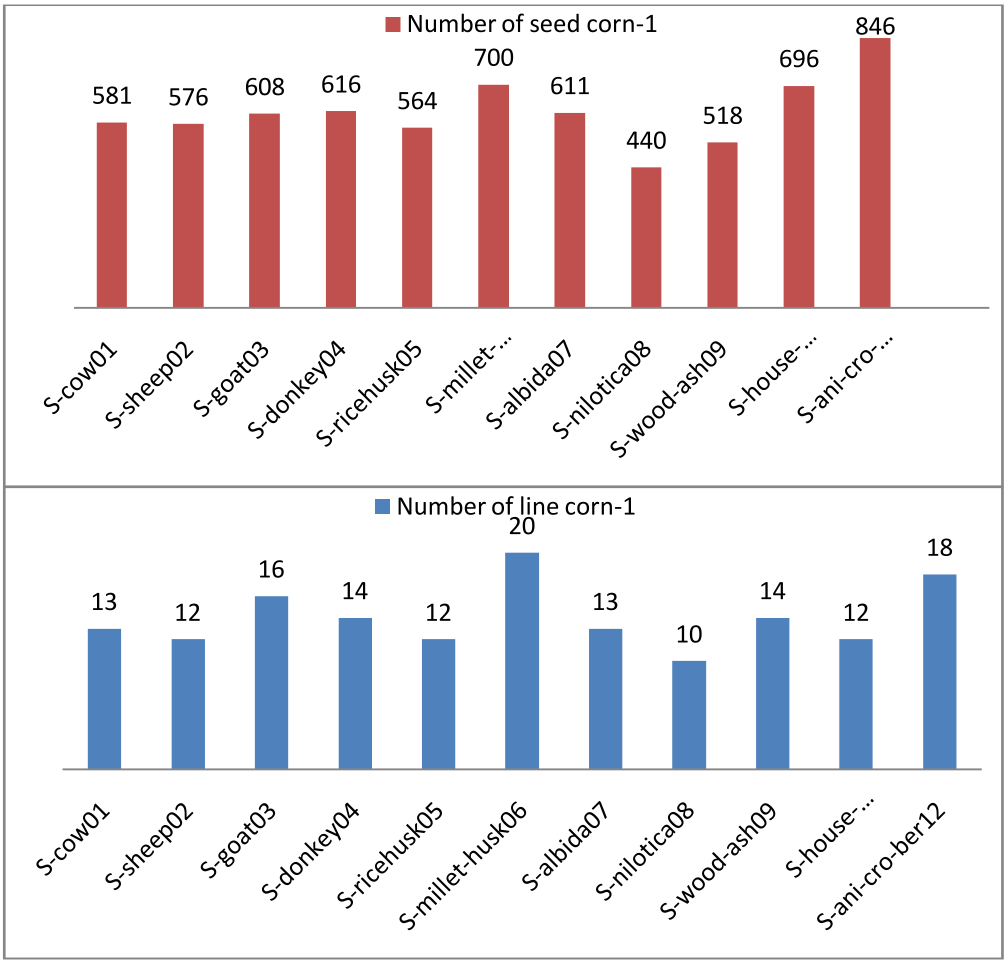

Figure 4: Yield performance of maize plant under different soil units after 106 days

There is a close relationship between the maize yield performance observed from soil stratum treated with donkey dung and the one treated with *Acacia albida*. The number of seed line on corn for these two soil strata is 14 and 13 whereas the number of seed on corn is 616 and 611 respectively. However, they differed significantly in term of seed shape, rounded spherical (big size) for S-donkey04 and reticulate (medium size) for S-albida07. Similarly, 0the reticulate seed shape was also observed for S-ani-cro-ber12, S-cow01 and S-sheep02. This type of seed classification was considered as important factor in shaping the geographical distributions of crop diversity (van Etten and de Bruin, 2007), as well as the foundation of farmers practice of selecting seed from the previous harvest and saving it for the next planting season (Badstuea *et al.*, 2007).

V. Conclusion

In conclusion, the present study confirms the assumption that crop plant is very likely to perform better under poor sandy-soil condition if management requirements are provided. Plant growth and yield performances were reported positively well in first, second, third, fourth, fifth, seven and tenth week after germination. We conclude that sandy soil managed with organic materials provides a good soil atmosphere for maize plant growth in crop production. Likewise, the results suggested that crop grown under sandy soil managed with organic materials perform better in term of plant growth and yield development. However, because of the fact that this study has not provide an account of dry matter and yield weight of the maize crop at the end of the experiment, we are unable to suggest the best organic material for economic crop production under soil quality and soil fertility benefits to crop production. However, it is believe that all the organic materials used are important source of essential soil nutrients for plant growth and yield performances.

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Appendix

1 week (1st measurement)	Stem height (cm)	Leaf size (cm)	Leaf length (cm)	No. of leaf plant-1
S-cow01	0		0	0
S-sheep02	5.1	1.3	15.6	4
S-goat03	5.1	1.1	16.5	4
S-donkey04	6.1	1.4	16.3	4
Rice husks05	5.7	1.8	16.5	4
S-millethusks06	5.3	1.8	17.3	5
S-albida07	6.6	1.3	19.6	4
S- nilotica08	6	1.1	18.5	4
S-ood-ash09	6.5	1.2	16.8	4
S-Wood-husk10	0	0	0	0
S-house refus11	6.5	1.5	20.5	4
S-ani-cro-ber12	8.1	1.7	22.2	5
SUN	61	14.2	179.8	42
AVERAGE	5.083333333	1.290909091	14.98333333	3.5
SD	2.511730057	0.498907898	7.264963659	1.678744119
VARIANCE	2.511730057	0.248909091	52.77969697	2.818181818
MAX	8.1	1.8	22.2	5
MIN	5.1	1.1	15.6	4

3 weeks (2nd measurement)	Stem height (cm)	Stem size (cm)	Leaf length (cm)	Leaf size (cm)	No. of leaf plant-1
S-cow01	6.1	0.4	22.6	1.8	5
S-sheep02	8.2	0.6	30.1	2.2	6
S-goat03	9	0.7	32.4	3	7
S-donkey04	10.9	0.8	30.7	2.8	7
S-rice-husk05	8.4	0.7	30.6	2.7	7
S-millet-husk06	9.8	0.9	35	3.1	8
S-albida07	10.7	0.7	38.8	3.1	8
S-nilotica08	7.8	0.7	29.5	2.5	7
S-wood-ash09	10.7	0.7	36.1	2.7	6
S-wood-husk10	0	0	0	0	0
S-ouse-refuse11	8.5	0.9	37.9	2.9	8
S-ani-cro-ber12	11.8	0.9	38.4	3	8
SUN	101.9	8	362.1	29.8	77
AVERAGE	8.491666667	0.666666667	30.175	2.483333333	6.416667
SD	3.116950238	0.253460893	10.59108759	0.872648355	2.234373
VARIANCE	9.715378788	0.064242424	112.1711364	0.761515152	4.992424
MAX	11.8	0.9	38.8	3.1	8
MIN	6.1	0.4	22.6	1.8	5

5 weeks (3rd measurement)	Stem height (cm)	Stem size (cm)	Leaf length (cm)	Leaf size (cm)	No. of leaf plant-1
S-cow01	12.3	1	46.7	3.8	8
S-sheep02	13.2	1.2	45.5	4	8
S-goat03	14.3	1.4	52.2	5.3	8
S-donkey04	14.4	1.4	51.8	4.5	8
S-rice-husk05	13.1	1.2	43.7	4.2	8
S-millet-husk06	16.9	1.6	54.3	5.1	9
S-albida07	14.6	1.2	53.4	4.8	8
S- nilotica08	12.5	1.3	46.7	4.7	8
S-wood-ash09	15.2	1	52.6	4.1	7
S-wood-husk10	#	#	#	#	#
S-house-refus11	15	1.3	53.1	4.5	10
S-ani-cro-ber12	18.1	1.4	58.6	5.2	8
SUN	159.6	14	558.6	50.2	90
AVERAGE	14.50909091	1.272727273	50.78181818	4.563636364	8.181818182
SD	1.789108463	0.179392916	4.510613746	0.506503163	0.750757194
VARIANCE	3.200909091	0.032181818	20.34563636	0.256545455	0.563636364
MAX	18.1	1.6	58.6	5.3	10
MIN	12.3	1	43.7	3.8	7

7 weeks (4th measurement)	Stem height (cm)	Stem size (cm)	Leaf length (cm)	Leaf size (cm)	No. of leaf plant-1
S-cow01	34.1	1.7	57.9	5.3	9
S-sheep02	35.4	1.6	60	5.6	9
S-goat03	38.2	2.1	66.3	6.5	12
S-donkey04	46.3	2.1	75	7.8	12
S-rice-husk05	34	1.5	59.4	5	10
S-millet-husk06	52.6	2.4	69.8	7.2	12
S-albida07	35.7	1.5	61.6	6.1	10
S-nilotica08	33	1.5	56.8	5.8	9
S-wood-ash09	33.6	1.7	64.5	6.2	12
S-wood husk10	#	#	#	#	#
S-house-refus11	38.2	1.6	63	5.3	10
S-ani-cro-ber12	46.1	2.2	76.2	7	12
SUN	427.2	19.9	710.5	67.8	117
AVERAGE	38.83636364	1.809090909	64.59090909	6.163636364	10.63636364
SD	6.539613555	0.326969557	6.619283125	0.886873979	1.361816968
VARIANCE	42.76654545	0.106909091	43.81490909	0.786545455	1.854545455
MAX	52.6	2.4	76.2	7.8	12
MIN	33	1.5	56.8	5	9

10 weeks (5th measurement)	Stem height (cm)	Stem size (cm)	Leaf length (cm)	Leaf size (cm)	No. of leaf plant-1
S-cow01	76.7	2	62.2	6.2	12
S-sheep02	63.5	2.1	66.8	6.7	10
S-goat03	69	2.7	70.3	7.2	10
S-donkey04	90.3	2.2	79.7	7.8	12
S-rice-husk05	58.2	2	66.2	6.1	12
S-millethusk06	120	2.8	78	7.4	12
S-albida07	78.8	2.1	61.3	6.6	11
S-nilotica08	78.4	2.2	60.8	6.1	11
S-wood-ash09	54.4	1.9	71.2	6.3	12
S-woodhusk10	#	#	#	#	#
S-houserefus11	82.3	2.5	69	6.2	12
S-ani-cro-ber12	113	2.6	78.1	7.2	12
SUN	884.6	25.1	763.6	73.8	126
AVERAGE	80.41818182	2.281818182	69.41818182	6.709090909	11.45455
SD	20.82593663	0.31246818	6.843656652	0.599090219	0.8202
VARIANCE	433.7196364	0.097636364	46.83563636	0.358909091	0.672727
MAX	120	2.8	79.7	7.8	12
MIN	54.4	1.9	60.8	6.1	10

Yield assessment (after harvest)	Number of line corn-1	Number of seed corn-1
Cow	13	581
Sheep	12	576
Goat	16	608
Donkey	14	616
Rice husks	12	564
Millet husks	20	700
Acacia albida	13	611
Acacia nilotica	10	440
Wood ash	14	518
Wood husk	#	#
House refused	12	696
Ani-cro-ber	18	846
SUN	154	6756
AVERAGE	14	614.1818182
SD	2.93257566	106.0743307
VARIANCE	8.6	11251.76364
MAX	20	846
MIN	10	440