2012 2nd International Conference on Environment Science and Biotechnology
IPCBEE vol.48 (2012) © (2012) IACSIT Press, Singapore
DOI: 10.7763/IPCBEE. 2012. V48. 12

The Effect of Incorporation of Saw Dust into Two Types of Organic Manure on the Growth and Yield Of Pearl Millet at Njimtilo Village in the Dry Sud-Humid Region of Borno State of Nigeria

K.A Sadiq[1, +], I.S. Dalatu[2] and A.B. Mustapha[1]

[1]Department of Agricultural Technology, Ramat Polytechnic Maiduguri, Borno State, Nigeria
[2]Department of Agricultural Engineering, Ramat Polytechnic Maiduguri, Borno State, Nigeria

Abstract. Most farmers are not aware of soil fertility gradients within their farms. The purpose of this study was to assess the effect of soil amendments on the growth and yields of pearl millet using; saw dust with cow, saw dust with poultry droppings, cow dung, and poultry droppings. Soil sampling was done in 20 small scale millet farms in Njimtilo in Konduga Local Government Area of Borno State at 0-20 cm depth in addition to soil profile description. Results of a structured questionnaire showed that 51% of the farmers used inorganic fertilizers predominately (NPK and Urea), 17% used only farmyard manure, 26% used both organic and inorganic fertilizer, while 7% did not use any soil amendments. Most of the farms had a pH of less than 5.2 within the 20cm depth but increased to 7.02 at the AB horizon. Organic carbon (C) ranged linearly from 2.4 at lower horizon to 6.8gkg^{-1} at the surface with a mean value of 4.04. Most of the farms were phosphorus (P) deficient. All farms had sufficient amounts of extractable potassium (K). Total nitrogen (N) ranged from 0.07 to at the lower horizon to 0.2gkg^{-1} at the surface with a mean value of 0.15. Cow dung incorporated with saw dust (CS) showed significant effect on the number of panicle, panicle length, chaff weight, grain weight and stover weight indicating that saw dust improves the soil and thereby increases yield of pearl millet. Poultry droppings incorporated (PS) with saw dust and Poultry droppings without the saw dust (PD) have statistically similar yields but (PS) has higher yields.

Keywords: Dry Sub-Humid, Growth, Incorporation, Organic Manure, Pearl Millet, Saw Dust, Yield

1. Introduction

The need to intensify agricultural production for food security and poverty reduction in rural areas of Borno state of Nigeria is a step ahead in addressing youth unemployment. Rural communities are predominantly composed of small scale resource poor farmers who have access to various organic inputs but often in insufficient quantities to provide the necessary soil nutrients required for improved production. On the other hand, many small scale farmers apply inorganic fertilizer at low doses, primarily for lack of capital and information on appropriate recommendation rates. The farmers are therefore in a vicious cycle of under-production which is results of low capital resulting in less soil inputs. Some of the ways to address these problems include supplying fertilizer at appropriate time and at affordable rates to encourage none-users to start using fertilizers. Information on the need to apply appropriate quantities based on the yield goals and integrated use of organic and inorganic nutrient sources. Use of soil amendments is mainly intended to improve crop yields. Improved yields results from improved nutrient status in soil and other soil properties such as soil organic matter and soil moisture retention capacity. Long term (20 years) use of manure was shown to significantly reduce bulk density and increase SOC concentration under an intensive rice cropping system (Zhangliu *et al.*, 2009). In the same study, combined application of crop residue and mineral fertilizer also improved soil physical properties, but the improvement by mineral fertilizer alone was limited. Ayoola

[+] Corresponding author. Tel: +2347066506787
E-mail address: kaka113mag@gmail.com

and Makinde (2009) reported that after two years of application and cropping, enriched poultry manure increases soil N, P and K contents by 42, 2 and 21%, respectively. While, fortified cow dung increases the nutrients by 25, 0.3 and 3%, respectively in the degraded tropical rain forest zone in Nigeria. Similarly, Mucheru-Muna *et al*. (2007) reported improved total soil carbon and nitrogen contents with the application of organic residues and manure in particular improved soil calcium content after 2 years in Eastern Kenya. Use of gliricidia prunings for 11 years resulted in a 24% increase in organic C in surface soils (0-20 cm) (Makumba *et al*., 2006). Research about the effects of specific soil amendment practices on soil properties has mostly been done on research plots. The purpose of this study was to assess the effect of incorporation of saw dust into two different types of organic manure as a soil amendment strategy on the growth and yield of pearl millet.

The experiment was conducted at Njimtilo village near Maiduguri along Kano road in Konduga Local Government Area of Borno State in Nigeria during 2011 rainfed millet cropping season. The climate is dry sub-humid in nature as described by Ojanuga (2006). The mean daily minimum and maximum temperatures during the cropping season (between June and October) were 23.2 and 34.3^{o}C. The soil in the study area was classified as Typic Ustipsamment.

The land area of 500m^2 was marked out and was divided into 15 plots of 20m^2 (5m x 4m) with 1m spacing between plots. Four treatments were laid out in randomized complete block design with three replicates consisting of:

(i) Cow dung with saw dust (CS).
(ii) Poultry droppings with saw dust (PS).
(iii) Cow dung only (CD).
(iv) Poultry droppings only (PD)
(v) No soil amendment (NA)

A profile was dug and the morphological characteristics of the soils were described according to the profile description manual of the FAO (2006). Soil samples were collected from each horizon for the following analysis. Soil pH was determined using pH meter and available phosphorus (P) was determined by Bray Method 1 (Bray and Kurtz, 1945). The macro-Kjedahl digestion method was used to estimate total Nitrogen (N) (Bremner and Mulvaney, 1982).

Particle size distribution was determined using the Bouyoucos hydrometer method (Kurtz, 1986). Percentage soil moisture content (%) was determined gravimetrically and the bulk density (Bd) of the soil was calculated as the ratio of the oven dry weights of soil to effective internal volume of empty can (Kumar, 2004).

Sowing was done on 19th July, 2011 immediately the rain was fully established. Five to ten seeds were planted per hole at a spacing of 75 by 50cm and thinned to two plants per hole a week after germination. Weeding was done manually at two and five weeks after germination (Gwadi *et al.,* 2004).

Data on tiller count was recorded at six weeks after germination when the plants were fully developed. The number of leaves, plant height, girth thickness, number of panicles per square metre, panicle length and panicle thickness were recorded in the twelfth week when the plant was fully matured. Harvesting was done on the 91st day after planting when the seeds could not be crushed between two fingers by cutting the panicles with sharp knife and dried for threshing (Gwadi *et al.,* 2004). The grain yield was weighed and then extrapolated to kg/ha. The data generated were subjected to analysis of variance (ANOVA) using the F-test as described by Gomez and Gomez (1984) and Akindele (2004). Differences among the treatment means were separated using the Duncan's New Multiple Range Test (DMRT).

2. Results and Discussion

Weakly developed soils in unconsolidated material with no clear diagnostic horizons and homogenous sand were observed. The profile development is minimal; this could be as a consequence of young age. Maduakor (1991) using the legend of D'Hoore (1964) identified the soil in the study area as juvenile soils. The soils in the north central part of Borno as described by Blench (2004), are largely Aeolian sands, formed by wind-drift from the desert and in a more general term, Ojanuga (1987) confirmed that Aeolian deposits constitute the most extensive parent material in the northern part of the region.

The studied soil do not have a distinct horizon, not very shallow or very rich in gravels as Leptosols, sandy as Arenosols or with fluvic materials as Fluvisols. Relatively young soils or soils with very little or no profile development, or with very homogenous sands has matched the description of Rogosols and could therefore be classified as Regosols according to World reference base for soil resources (WRB, 2006) or Entisols (United States of America).

In tropical and subtropical regions that have one or two dry seasons, the soil moisture regime is ustic if there is at least one rainy season of three months or more. The Entisols with ustic moisture regimes are classified as Ustipsamments.

2.1. Soil physical Analysis

The particle size distribution and textural class designation are presented in table 1. The sand content was 86, 80, 84, 90 and 94 while the silt content was 12, 18, 15, 9 and 5 for A_1, A_2, AB, B_1 and B_2 respectively. The average values for sand and silt contents were 86.6% and 9.8% respectively. The three lower horizons have equal clay contents 1% while A_1 and A_2 have 3 and 2% respectively. The soils have higher sand content in the sub surface (131 to 200cm depths) than in the surface which is similar to the finding of Maduakor (1991) on the physical and hydraulic properties of soils of the dry sub humid regions of Nigeria. Brady (1999) graded soils with sand components of 70 % and above under the broad textural class of sandy. In soils formed from aeolian deposits, the fine sandy fractions dominate (Maduakor 1991). The soil studied is sufficiently deep indicating that it is good for the growth of arable crops such as millet.

Table 1: Physical and chemical properties of the soil at the site

Horizon	Depth (cm)	pH (H_2O1:1)	O C gkg^{-1}	N gkg^{-1}	C:N	Avl.P mg kg^{-1}	sand%	silt%	clay%	TC
$_1$	0-26	6.45	7.00	0.18	39	0.78	85	12	3	SL
A_2	26-60	6.71	4.60	0.18	26	0.78	80	18	2	SL
AB	60-92	6.92	3.60	0.14	26	0.64	84	15	1	SL
B_1	92-131	6.51	2.60	0.11	24	0.44	90	9	1	S
B_2	131-200	6.26	2.40	0.07	24	0.25	94	5	1	S
	Mean	6.57	4.04	0.14	28	0.58	86.6	9.8	1.6	SL

NB: SL = Sandy loam

2.2. Soil Chemical Analysis

Surface horizon (0 to 26cm) was acid when ranked according to the classification of Soil Science Society of America (1987) with pH value of 5.45. The result of the organic carbon showed the values of 6.8g kg^{-1} within the surface A_1 horizon and as low as 4.6 g kg^{-1} in A_2 and declined linearly to 2.4. Organic matter content of the tropical soils of dry zones according to FAO (2006) can range from less than 1 percent. The low organic matter content as suggested by Esu (1991) is indication of soil deterioration and low plant nutrient reserves. Ismaila *et al.*, (2010) concluded that, soils of the Nigerian Savannah, where the bulk of the cereals are produced, have low organic matter content as a result of high rate of chemical and biological actions as well as the abundance of micro organic activity. Total nitrogen content was in the medium range in the surface horizons in the farm where organic manure or organic and inorganic fertilizers are used. The mean values were 0.18 g kg^{-1}, in A_1 and A_2, 14 g kg^{-1} in AB and 11 g kg^{-1} in B_1 with a mean of 0.14 g kg^{-1}. In general, under semi-arid conditions nitrogen is hardly lost by leaching and denitrification, so that the recoveries are high. With increasing dryness, the soil solution becomes more concentrated and there is an increased immobilization of nutrients into only moderately available forms (FAO, 2006).

The mean value of available phosphorus was 0.58 mg kg $^{-1}$ which is categorized as low as per the nutrient rating scale (Esu, 1991). Available phosphorus recorded was 0.78 mg kg $^{-1}$ within 0 to 60cm depth in most farms. Pearl millet production in the West African in general is not only constrained by low and erratic rainfall but also by low soil nutrient particularly P availability (Payne *et al.,* 1992). High K content was observed in the soil studied. This is in agreement with the findings of Mengel and Rahmatullah, (1994) that associated young less-weathered soils such as entisols with of release interlayer K in remarkable quantities. The K requirements of millet are high (Bationo *et al.,* 1990; Christianson *et al.,* 1990; Christianson and Vlek, 1991; Bationo *et al.,* 1992) this means the K level of the soil is favourable for growing millet crop.

2.3. Effect of Soil Amendment on Tiller-count, Number of Leaves, Leaf Length and Leaf Width

The effect of soil amendment could be observed during the early stage of development. As presented in table 2, pearl millet that supplied with Poultry droppings with saw dust had highest number of tillers with mean tiller count of 17 which is 55% higher than the control (NA). Soil incorporated with cow dung plus saw dust also had significant effect on the number of tillers producing 15 tillers each which is 27% more than the control.

Table 2: Effect soil amendment on tiller count, number of leaves, leaf length and leaf width of pearl millet

Parameter	CD	PD	CS	PS	NA	GM	SE
Tiller count	13^{b}	13^{bc}	14^{b}	17^{a}	11^{c}	14	0.910
No of leaves	12	12	12	12	12	12	0.632
Leaf length	72	76	76	75	73.00	74.59	2.739
Leaf width	4.96^{ab}	5.61^{a}	4.60^{bc}	4.33^{bc}	4.47^{bc}	4.80	0.274

Note: Means followed by the letters are not significantly different

Although leaf number per plant was not statistically affected by soil amendments the number of tillers increased with incorporation of manure. Deficit irrigation has been reported in a number of studies to be reducing of tiller number (Ludlow and Muchow, 1990; Mahalakshmi and Bidinger, 1985). The reduction in number of tillers is an adaptive mechanism according (Seghatoleslami *et. al.,* 2008) that has been induced in response to water stress. The increase in the number of tillers in this study as a result of incorporation of organic manure could also be related to increase in water retention capacity of the soil.

2.4. The Effect of Soil Amendment on Plant Height, Girth Thickness, Number of Panicles and Panicle Length

Table 3 shows the result for plant height, girth thickness, number of panicles and panicle length. Although there is no statistically significant difference ($P>0.05$) between the heights of the plants with different soil amendments, the tallest plant was recorded under BGR (310cm) and the shortest (265cm) when no manure was applied to the plots. Statistically significant difference was observed on the girths thickness of the plants that were supplied with manure from the one that received no soil amendment.

The panicles were counted after harvest and it was discovered that the plots that were supplied with cow dung with saw dust (CS) produced 155321 panicles. The number of panicle in CS is statistically different ($P>0.05$) from other plots followed by the plot that received poultry droppings with saw dust (PS) having 144786 panicles. Both PS and CS had statistically significant effect ($P>0.05$) on the panicle length of pearl millet where CS producing the longest panicles (36cm) (Table 3).

3. Summary

The experiment investigated the effect of soil amendment on the growth and yield of pearl millet at Njimtilo village near Maiduguri, in dry sub-humid region of Borno State. The soil of the study area is deep and well drained with high infiltration rate. The soil is sandy loam from 0 to 92cm and slightly acid at the surface horizon (A) of 0 to 26cm and appeared neutral from 26cm depth to 131cm. From the depth of 92 to 200cm sandy soil was discovered. The organic carbon was low in all the layers, descending from 6.8g kg $^{-1}$ in the surface layer to 2 g kg $^{-1}$ below 131cm layer. Nitrogen content was 0.18 g kg $^{-1}$ within the upper 60cm depth, 0.14 g kg^{-1} and 0.11 g kg^{-1} from 60 to 92cm and 92 to 131cm respectively. These values fall within the moderate level. Nitrogen was low within 131 to 200cm with a value of 0.07 g kg^{-1}. The potassium content was rated moderate with values of 0.23Cmol $kg^{-}1$, 0.18Cmol kg^{-1} and 0.28Cmol kg^{-1} within 60 to 92cm, 92 to 131cm and 131 to 200cm respectively.

Provision of soil amendment with cow dung incorporated with saw dust (CS) showed significant effect on the number of panicle, panicle length, chaff weight, grain weight and stover weight indicating that saw dust improves the soil and thereby increases yield of pearl millet. The treatment has the highest water use efficiency as compared with others. Poultry droppings incorporated (PS) with saw dust and Poultry droppings without the saw dust (PD) have statistically similar yields but (PS) has higher yields.

It could be concluded that soil amendments with organic manure is highly efficient practice with great potential for increasing agricultural production and improving livelihoods in the dry sub-humid rainfed areas especially when the organic manure is incorporated with saw dust. Droughts would have lesser impact if farmers are equipped with the knowledge of saw dust incorporation since that the incorporation of saw dust improves the water retention capacity.

Soil amendment should be adopted in dry sub-humid agroecological conditions of Maiduguri. Its adoption can bring about substantial yield of pearl millet per unit of water and land area. This will go a long way to increase farm income thus, reducing hunger and poverty which is the Millennium Development Goal number 1 priority.

Efforts should therefore be made at Local, State and Federal government levels to encourage millet farmers in the study area to make use of modern techniques such as the usage of abundant organic materials such as cow dung and poultry droppings to enhance pearl millet production.

Table 3: Effect supplementary irrigation on plant height, girth thickness, panicle number and length of pearl millet

Parameter	CD	PD	CS	PS	NA	GM	SE
Plant height	262	280	310	265	279	278.53	14.89
Girth thickness	2.5	2.6	2.7	2.6	2.7	2.62	0.049
Panicles No.	100012^{b}	107113^{b}	155321^{a}	144790^{a}	841113^{b}	118121	10296
Panicle length	31^{b}	32^{b}	36^{a}	31^{b}	26^{c}	30.91	0.857

Note: Means followed by the letters are not significantly different

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