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Substitutional Effect of Inorganic with Organic Fertilizer on the Productivity of Pearl Millet in Sandy Loam Soil

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Abstract: *The problems of low soil fertility resulting from continuous mono-cropping, crop residue removal and limited fertilizer use represent key challenges to produce surplus food for the ever increasing population of Nigeria. An on-station experiment was conducted at the Research and Demonstration Farm of Lake Chad Research Institute in Maiduguri (11^0 54' N, 13^0 05' E), to assess the substitutional effect of inorganic with organic fertilizer on the productivity of pearl millet in sandy loam soil. The experimental factors considered in this studies are organic and inorganic fertilizer. The organic (NPK) were at five level, rated (0, 60:30:30, 45:30:30, 30:30:30 and 15:30:30 kg/ha) and inorganic Farm Yard Manure (FYM) were rated at four level (0, 7.5, 5.0, 2.5 t/ha) respectively. These factors were combined and replicated three times to form a total of 60 treatments, that were laid in a Randomized Complete Block Design (RCBD). Nevertheless, the statistical analysis (ANOVA) revealed that T_{18} (7.5t FYM + $N_{15}P_{30}K_{30}$) gave the longest panicle length than all other treatment experimented. The highest grain yield values of 1038.5 - 2000.0 kg/ha, was remarkably observed with T_{11} (2.5t FYM + $N_{60}P_{30}K_{30}$) and the lowest growth and yield attributes were observed mostly within the control plot.*

Keywords: *Drainage, Organic fertilizer, Inorganic fertilizer and Pearl millet*

1.0 Introduction

Cereals and legumes are some of the essential and most consumed food by man (www.fao.org/docrep). About 70 % millet are produced in Asia and Africa is grown in West Africa. Major producing countries in Africa include Nigeria, Niger, Burkina Faso, Chad, Mali, Mauritius and Senegal in the West Africa and Sudan and Uganda in the East Africa (Kamble *et al* 2003). Thus the importance of millet to man cannot be over emphasized. Pearl millet is a cereal family that is widely grown in semi-arid tropics of Africa and produced in 18.50 hectares by 28 countries covering 30 % of the continent (Obilana, 2007). According to DAFF (2011), global production of millet grains probably exceeds 10 million tonnes a year, to which India contributes nearly half. It also said that, at least 500 million people depend on millet for their lives. Approximately one-third of world millets are grown in Asia and Africa. The pearls millet (*Pennisetum glaucum*), on the other hand, is the commonest species of millet planted for food across Africa and India (Kamble *et al.*, 2003). According to Ikwella (2001), pearls millet is second important only to sorghum as a staple food in Nigeria. There are three types of pearls millet based on the maturity dates (Ikwella, 2000). These are *gero*, *maiwa* and *dauro*. *Gero* is photoperiod neutral and early maturing (70 -100 days). It is cultivated in the Northern Guinea, Sudan savanna and in the Sahel. *Gero* is grown on about 80 % of the total area under millet and predominates in Sahel (Ikwella, 2012). Sandy soils are generally low in fertility for agricultural production due to their very low nutrients and organic matter content. The Rainfall pattern in Maiduguri semi-arid region of Nigeria is characterized by limited and undependable rainfall and the rate of moisture loss into the atmosphere through the process of evapotranspiration is high (Abebe, 2012). The soils are generally sandy in nature, poorly structured and inherently low in fertility, organic matter content and water holding capacity (Chiroma, 2004). However, millet does well on such soils, in spite erratic rainfall because of its high tolerance to heat and moisture stress, but the productivity is considerably low. Management of both physical (structure) and chemical (fertility) becomes paramount for attainment of high productivity by farmer living in such environment. Inorganic fertilizers provide rapid replenishment for crop sustenance, while organic fertilizers in addition to nutrient supply also contribute to soil structure improvement. The use of organic fertilizers in millet field is very common with the farmers, as such this project aims at finding a suitable rate of organic fertilizer that will substitute the inorganic fertilizer rate. There is therefore the need to evaluate the effect of inorganic with organic fertilizer on the productivity of pearl millet in sandy loam soil, in other to determine the most effective and optimum substitution rate of inorganic and organic fertilizer on growth and yield of Pearl millet

2.0 Materials and Methods

Experimental Sites

An on-station experiment was conducted at the Research and Demonstration Farm of Lake Chad Research Institute in Maiduguri (11^0 54' N, 13^0 05' E), to assess the substitutional effect of inorganic with organic fertilizer on the productivity of pearl millet in sandy loam soil.

2.1 Treatment and Experimental Design

The experimental factors considered in this studies are organic and inorganic fertilizer. The organic (NPK) were at five level, rated (0, 60:30:30, 45:30:30, 30:30:30 and 15:30:30 kg/ha) and inorganic Farm Yard Manure (FYM) were rated at four level (0, 7.5, 5.0, 2.5 t/ha) respectively. These factors were combined and replicated three times to form a total of 60 treatments that were laid in a Randomized Complete Block Design (RCBD).

2.2 Agronomic Practice

The experimental site was disc-harrowed and marked-out into plots of 5.0 m x 4.5 m in size. The organic fertilizer was procured from Maiduguri livestock market and applied two weeks before sowing. The inorganic fertilizers were applied at planting and the N-requirement was made-up using urea (46%). Millet (Super SOSAT) was sown in the plots at a row spacing of 0.75 m apart and 0.5 m between stands. All other cultural practices for millet production were observed.

3.0 Results and Discussion

Table 1 shows the effect of inorganic with organic fertilizers on the establishment, plant height at 3, 6 and 9 weeks after sowing (WAS), panicle length and grain yield of millet. The result did not show significant ($P<0.05$) difference in the effect of NPK level and FYM on establishment which ranged from 80.0 - 100%. In contrast, growth of millet at all the three periods differed significantly ($P<0.05$). Plant height at 3, 6 and 9 WAS significantly differed from 8.0 - 14.3 cm, 62.7 - 120.0 cm and 196.7 - 274.0 cm, and the best growth consistently occurred in T_5 ($N_{60}P_{30}K_{30}$). Panicle length differed significantly among the different fertilizer treatments, which ranged from 23.2 - 29.9 cm. The longest panicle was obtained from T_{18} (7.5t FYM + $N_{15}P_{30}K_{30}$), followed by T_5 ($N_{60}P_{30}K_{30}$) and T_1 (7.5t FYM). Grain yield in the different fertilizer treatments significantly varied from 1038.5 - 2000.0 kg/ha, with the highest from T_{11} (2.5t FYM + $N_{60}P_{30}K_{30}$) and the lowest from T_4 (Control). Application of T_{11} (2.5t FYM + $N_{60}P_{30}K_{30}$) gave significantly higher yield than all other treatments, followed by T_{18} (7.5t FYM + $N_{45}P_{30}K_{30}$) and T_{19} (5.0t FYM + $N_{45}P_{30}K_{30}$) with similar effects, and significantly higher yield than the remaining treatments. Grain yield obtained with the combine application of T_{11} (2.5t FYM + $N_{60}P_{30}K_{30}$) was also significantly higher than those fertilized with single sources. However, the effects of T_9 (7.5t FYM + $N_{60}P_{30}K_{30}$), T_8 (5.0t FYM + $N_{60}P_{30}K_{30}$) and T_{14} (2.5t FYM + $N_{45}P_{30}K_{30}$) on yield did not differ significantly, as the case also was among T_1 (7.5t FYM), T_2 (5.0t FYM), T_3 (2.5t FYM), T_6 ($N_{45}P_{30}K_{30}$) and the T_4 (Control).

Table 1: The effects of the different levels of organic and inorganic fertilizers on the establishment, plant height at 3, 6 and 9 weeks after sowing (WAS), panicle length and grain yield of millet

Treatments	Establishment (%)	Plant height (cm)			Days to 50% heading	Panicle length (cm)	Grain yield (kg/ha)
		3 WAS	6 WAS	9 WAS			
T_1 -7.5 t/ha	100^{a}	13.3^{ab}	88.3^{b-f}	216.0^{e-h}	57.7^{gh}	28.2^{b}	1038.5^{jk}
T_2 -5.0 t/ha	97.7^{a}	11.0^{b-f}	79.3^{c-h}	220.0^{efg}	56.0^{jk}	25.5^{ef}	1041.5^{jk}
T_3 -2.5 t/ha	97.0^{a}	10.0^{d-g}	66.7^{gh}	211.0^{fgh}	62.7^{b}	24.5^{f}	977.8^{kl}
T_4-control	97.3^{a}	8.0^{g}	72.7^{f-h}	196.7^{h}	58.3^{efg}	23.2^{g}	841.5^{m}
T_5-$N_{60}P_{30}K_{30}$	96.7^{a}	14.3a	120.3^{a}	274.0^{a}	54.3^{m}	29.6^{a}	1577.8^{d}
T_6-$N_{45}P_{30}K_{30}$	96.7^{a}	11.7^{b-d}	77.7^{d-h}	238.7^{b-e}	55.7^{kl}	27.4^{bcd}	1044.4^{jk}
T_7-$N_{30}P_{30}K_{30}$	96.7^{a}	13.0^{a-c}	83.3^{b-g}	215.0^{fgh}	56.7^{ij}	26.8^{cd}	900.7^{lm}
T_8-$N_{15}P_{30}K_{30}$	97.7^{a}	12.7^{a-c}	83.7^{b-g}	251.3^{abc}	62.7^{b}	25.0^{f}	866.7^{m}
T_9-$N_{60}P_{30}K_{30}$ +7.5 t/ha	97.7^{a}	11.3^{b-e}	90.0^{b-f}	223.0^{d-g}	59.7^{d}	26.3^{de}	1703.7^{c}
T_{10}-$N_{60}P_{30}K_{30}$ +5.0 t/ha	80.0^{b}	11.0^{b-f}	79.0^{c-h}	225.3^{d-g}	60.7^{c}	27.3^{bcd}	1748.1^{c}
T_{11}-$N_{60}P_{30}K_{30}$ +2.5 t/ha	96.7^{a}	11.7^{b-d}	84.7^{b-g}	226.0^{d-g}	60.0^{c}	27.3^{bcd}	2000.0^{a}
T_{12}-$N_{45}P_{30}K_{30}$ +7.5 t/ha	94.3^{a}	11.3^{b-e}	91.7^{b-e}	244.3^{bcd}	58.0^{fgh}	27.6^{bc}	1918.5^{ab}
T_{13} -$N_{45}P_{30}K_{30}$ +5.0 t/ha	90.0^{ab}	11.1^{b-d}	76.7^{e-h}	225.3^{d-g}	57.3^{hi}	27.1^{bcd}	1844.4^{b}
T_{14}-$N_{45}P_{30}K_{30}$ +2.5 t/ha	95.3^{a}	10.7^{b-g}	62.7^{h}	205.0^{gh}	64.3^{a}	26.6^{cde}	1700.7^{c}
T_{15}-$N_{30}P_{30}K_{30}$ +7.5 t/ha	98.0^{a}	14.3^{a}	96.7^{bc}	259.3^{ab}	58.7^{ef}	26.8^{cd}	1451.9^{e}
T_{16}-$N_{30}P_{30}K_{30}$ +5.0 t/ha	98.3^{a}	12.3^{a-d}	98.3^{b}	261.0^{ab}	55.3^{kl}	26.8^{cd}	1377.8^{ef}
T_{17}-$N_{30}P_{30}K_{30}$ +2.5 t/ha	94.7^{a}	8.7^{fg}	71.7^{f-h}	225.0^{d-g}	55.0^{lm}	26.5^{cde}	1311.0^{fg}
T_{18}-$N_{15}P_{30}K_{30}$ +7.5 t/ha	97.7^{a}	10.7^{c-g}	77.7^{d-h}	228.0^{c-g}	59.0^{de}	29.9^{a}	1240.0^{gh}
T_{19}-$N_{15}P_{30}K_{30}$ +5.0 t/ha	99.7^{a}	11.0^{b-f}	93.3^{b-e}	230.7^{c-f}	55.0^{lm}	24.7^{f}	1163.0^{hi}
T_{20}-$N_{15}P_{30}K_{30}$ +2.5 t/ha	93.0^{a}	9.0^{e-g}	96.3^{b-d}	228.3^{c-f}	56.0^{jk}	24.9^{f}	1103.7^{ij}
Mean	95.8	11.4	84.5	230.2	58.2	26.6	1342.6

SE±	7.51	0.91	6.54	6.08	0.70	0.42	30.42
CV(%)	4.15	13.84	13.41	8.08	0.23	2.70	3.92

Means bearing similar superscript letter(s) under the same parameter in a column are not significantly different at 5% level of probability of the Duncan's Multiple Range Test.

3.2 Conclusion

The results showed that T_{11} (2.5t FYM + $N_{60}P_{30}K_{30}$) which gave significantly higher yield than all other treatments, followed by T_{18} (7.5t FYM + $N_{45}P_{30}K_{30}$) and T_{19} (5.0t FYM + $N_{45}P_{30}K_{30}$) and have been recommended for use by farmers.

3.3 Recommendations

It is recommended that further studies should be carried out on other soil type, climatic region and millet varieties adopting this approach with a view to re- validating the outcome of this research.

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