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Optimizing the Productivity of Plantain/Cocoyam Mixture by Mulching and Fertilizer Application

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Abstract: Plantain and cocoyam are traditionally cultivated in the humid agro-ecological zone of southern Nigeria. Their production has expanded from the fertile backyards or compound gardens to the field where the soil fertility can not sustain continuous cropping without external inputs. A field trial was conducted in Calabar in the rainforest zone of Nigeria, from 2000 to 2002, to assess the effect of mulching with sawdust at 20 MT/ha and NPK (20:10:10) fertilizer at 50, 100 and 150kg/ha, on the productivity of plantain/cocoyam mixture. The fertilizer was applied sole or in combination with sawdust mulch and treatments were laid out in a randomized complete block design in three replications. The highest intercrop productivity was found in mulched plots fertilized at 150 kg/ha NPK. The highest plantain bunch and cocoyam yields in 2000/2001 were 21.0 and 4.6 tonnes/ha respectively, while in 2001/2002, their respective yields were 22.0 and 4.80 tonnes/ha. Plantain bunch yield in 2000/2001 in mulched fertilized plots exceeded those of the control by 45, 58 and 61%, at the fertilizer rates of 50,100 and 150 kg of fertilizer/ha respectively. The yield increases in the corresponding treatments in 2001/2002 were 62, 73 and 74%, respectively. For Cocoyam, the yield increases (2000/2001) in the same treatments were 72, 76 and 83 %, in 2001/2002, the increases were 79%, 84% and 88%, respectively. The peak aggregate yields of the crops were 25.6 and 26.8 tonnes/ha in 2000/2001 and 2001/2002, giving the highest cumulative intercrop yield of 52.4 tonnes/ha at 20 tonnes/ha sawdust mulch (SDM) + NPK at 150 kg/ha. Thus, this level of crop management could enhance the sustainable productivity of plantain/cocoyam intercrop under field conditions.

Key words: Cocoyam, Fertilizer, Plantain, Productivity, Sawdust

INTRODUCTION

Plantain and cocoyam are traditionally cultivated in compound or backyard gardens where they benefit from copious addition of organic matter and household refuse which maintain soil fertility and sustain their productivity continuously [1-4].These crops are typically cultivated under peasant production systems and they feature prominently in the farming systems of the rain forest belt of Southern Nigeria where there is good rainfall of about 1000-3000 mm annually to sustain their growth [2,4]. Plantain and cocoyam are widely cultivated in the southeastern agro-ecological zone of Nigeria with high concentrations in Cross River, Akwa Ibom, Imo, Anambra, Abia and Edo States [5-7]. (Unamah and in the *Fadama* areas in some states of northern Nigeria.

The two crops under study have high potential for national food security in Nigeria due to the global food crisis and the fast transformation of cassava, a common staple food in Nigeria, into an industrial and a cash crop. This has necessitated intensive agronomic investigations into increasing the productivity of some relatively obscure and localized crops like cocoyam and plantain as alternative food sources. However, the expansion of the cultivation of plantain and cocoyam in the backyard system is limited and can not meet the expected increase in demand for the crops [8,9]. This has led to field cultivation of the crops under continuous cropping where crop productivity usually declines after the first two or three years due to rapid reductions in soil fertility under the humid tropical conditions [10,11].

Most agronomic and nutritional investigations on the crops have largely been under mono-cropping [12,13] with little attention to mixed cropping systems which account for about 80% of plantain and cocoyam produced in Nigeria [7]. Thus there is little information guiding the

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profitable production of plantain/cocoyam mixture in tropical farming systems. The objective of our study was to determine the contributions of mulching and appropriate fertilizer use on plantain + cocoyam intercrop.

MATERIALS AND METHODS

A field experiment was conducted from 2000 to 2002 on a pre-fallowed plot in the high rainforest zone of Cross River State, Nigeria. The top soil had a pH (H_2O) of 5.06 and contained 1.92% organic carbon, 0.17% total N, 66.2mg/kg available P and (cmol/kg), 0.19 Na, 0.37 K, 2.0 Ca, 1.0 Mg and 7.47 E C E C. The mean annual rainfall and relative humidity at the site were 2000 mm and 80 %, respectively, while minimum and maximum temperatures were 23 and 33 °C, respectively. Treatments evaluated were: 1. control (no mulching, no fertilizer) 2. sawdust mulch (SDM) at 20 tonnes/ha 3. NPK(20:10:10) at 50kg/h 4.NPK at 100 kg/ha 5.NPK at 150 kg/ha 6.SDM+ NPK at 50 kg/ha 7.SDM +NPK at 100 kg/ha 8.SDM+NPK at150 kg/ha. Each treatment was replicated three times and arranged into a randomized complete block design.

The plots of plantain/cocoyam mixtures were established on 10.0 m x 3.0 m plots on 15 June, 2000. Cocoyam was replanted on 10 April, 2001. Plant densities were 1666 plants/ha and 10,000 plants/ha for plantain spaced 2.0 m × 3.0 m and cocoyam spaced 1.0 m × 1.0 m, respectively during both seasons.

Mulched plots were completely covered with 3±1.0 cm thick coarse sawdust layer throughout the period of the experiment. Fertilizer was applied using the ring method three months after planting in fertilized plots.

All plots were maintained weed-free by manual weeding during which soil was added to the base of cocoyam and plantain to promote cormel formation in cocoyam and to control high mat in plantain. Plantain was managed such that only one follower sucker was maintained to succeed the mother plant after harvesting. Bearing plantains were staked with bamboo poles to control lodging. Harvesting of plantain was done as the bunches matured, while cocoyam was harvested seven months after planting when all the leaves had withered.

Corms and cormels were separated and only cormel yield is reported here. Data collected were analyzed using analysis of variance techniques (ANOVA) and treatment means were compared using Duncan's multiple rang tests at 5% level of probability [14].

RESULTS

The bunch and cormel yields of plantain and cocoyam were significantly (P=0.05) influenced by sawdust mulch and fertilizer. During the 2000/2001, SDM +NPK at 150 kg/ha produced the highest bunch and cormel yields and hence, highest total productivity and aggregate yield (Table 1). Sole NPK at 100 kg/ha had similar effect on the intercrop yield as SDM + NPK at 50kg/ha. Applying sawdust mulch alone to the intercrop increased bunch yield by 2.6 tones/ha or 24 %, over the control. By combining sawdust mulch with fertilizer at 50,100 and 150 kg/ha, plantain yield (t/ha) increased substantially by 6.6 (45 %), 11.5 (58 %) and 11.8 (61 %), respectively. The highest cormel yield was obtained with SDM + NPK at 150 kg/ha (Table 1) which was statistically similar to that obtained with sole NPK at 150 kg/ha. Sawdust mulch alone increased cormel yield by 33 %, indicating that mulching cocoyam even without applying fertilizer would enhance productivity The combination of sawdust and fertilizer at 50, 100 and 150 kg/ha further increased cormel yield (t/ha) by (72 %), 2.6 (76 %) and 3.8 (83 %), respectively in 2000/2001.The total intercrop productivity in 2000/2001 varied similarly with yields of individual crops (Table 1).

Table 1: Influence of NPK fertilizer rates and sawdust mulch (20 t/ha) on productivity of plantain/cocoyam mixture in 2000/2001 cropping season at Calabar

	Mean yield of mixture species (t/ha)		
Treatment	Plantain	Cocoyam (cormel only)	Total productivity (t/ha)
Control	8.2f	0.8e	10.0e
SDM	10.8e	1.2d	12.0d
F_{50}	11.3d	2.3d	13.6d
F_{50} + SDM	14.8c	2.9c	17.7c
F_{100}	13.7c	2.7c	16.4c
F_{100} +SDM	19.7a	3.4b	23.1a
F_{150}	16.7b	4.2a	21.9b
F_{150} + SDM	21.0a	4.6a	25.6a

Figures followed by the same letters in the same column are not significantly different at 5% level of probability according of Duncan Multiple Rage Tests.

Table 2: Influence of NPK fertilizer rates and sawdust mulch (20 t/ha) on productivity of plantain/cocoyam mixture in 2001/2002 cropping season at Calabar

Treatment	Mean yield of mixture species (t/ha)		Total productivity (t/ha)	Cumulative productivity for 2000/2001 and 2001/2002
	Plantain	Cocoyam (cormel only)		
Control	5.8g	0.6e	6.4e	15.4g
SDM	11.3f	1.3d	13.6d	24.6f
F_{50}	10.0f	2.0c	12.0d	25.6f
F_{50} +SDM	15.3d	2.8c	18.0c	35.8d
F_{100}	13.3e	2.9c	16.2c	32.6e
F_{100}+SDM	21.3a	3.8b	25.1a	48.2b
F_{150}	17.0c	4.4a	21.4b	42.3c
F_{150}+SDM	22.0a	4.8a	26.8a	52.4a

Figures followed by the same letters in the same column are not significantly different at 5% level of probability according of Duncan Multiple Rage Tests.

The intercrop yield in 2001/2002 was similar to that in 2000/2001 and also varied significantly (P =0.05) among the treatments (Table 2). Plantain and cocoyam yields were highest in mulched plots fertilized with 150 kg NPK per hectare followed by mulched plots fertilized with NPK at 100 kg/ha. Yields of ratoon plantain crop increased by 62, 72 and 74 when treated with sawdust mulch + NPK at 50,100 and 150 kg/ha, respectively cormel yield (Table 2) in the corresponding treated plots exceeded that in the control plot by 79, 84 and 88 %, respectively.

The cumulative or aggregate intercrop productivity in 2001/2002 followed a similar trend with individual intercrop yields and total productivity, being similarly highest in mulched plots fertilized with 150 kg NPK per hectare and lowest in control plots.

DISCUSSION

The mulched and fertilized plantain had better yields in the ratoon crop than plantain in the control plots and plantain fertilized but not mulched, which had a yield loss in the second cycle crop. Bunch yield declined by 2.4 tonnes/ha or 29 % in the control plots in the first ration crop but increased somewhat marginally by 0.5 tonnes/ha in sole mulched plots. The application of fertilizer alone did not prevent plantain yield decline irrespective of the rate and the highest yield decline of 1.3 tonnes/ha was recorded in plots that received the lowest fertilizer rate (50 kg/ha). Yield decline was however less severe as the fertilizer rate increased and was only 0.3 tonnes/ha at the highest sole fertilizer rate (150 kg/ha).

For each rate of fertilizer applied, mulched plantains substantially out-yielded those in unmulched plots possibly due to improvements in soil conditions [2,8,15]. In similar nutritional studies elsewhere on banana, a close relative of plantain, [2, 16-18], increases in bunch in mulched plots were attributed to favourable soil physico-chemical and biotic conditions. On the other hand, yield decline observed in control and the non-mulched fertilized may be a direct response to soil fertility decline. The downward intercrop yield in non-mulched plots is consistent with earlier reports of [19-21] who noted reduced crop yields in bare plots despite adequate NPK fertilization.

Cocoyam also responded positively to sawdust mulch and fertilizer. Mulch alone increased cocoyam cormel yields by as mulch as 54%. Combining fertilizer at any rate with mulch produced higher yields than when the corresponding fertilizer rate was applied without mulching. The productivity of the intercrop was higher and more stable in mulched fertilized plots. Yields however were higher in 2001/2002 than in 2000/2001. This might be due to the decomposition of the mulch material which released nutrients for crop uptake. Furthermore, the slowly decomposing sawdust protected the soil surface and created favourable soil l conditions for enhanced development of the soft corms/cormels which are usually prone to damaged by excessive solar heat under upland conditions.

The best intercrop yield observed under an application of sawdust mulch plus 150 kg NPK/ha may imply that a high nutrient efficiency was achieved under this treatment combination, or that higher yields were still possible by increasing the fertilizer rate further.

CONCLUSION

From this study, the optimum fertilizer rate for high yield was 20 tonnes of sawdust plus 150 kg NPK/ha. The adoption of this combination would enhance productivity of the intercrop mixture but higher fertilizer rates than used in this study may be tested in future trials.

REFERENCES

1. Nweke, F.I., J.E. Njoku and G.F. Wilson, 1988. Productivity and limitations of plantain (*Musa spp cv*. AAB) Production in compound gardens is southeastern Nigeria. Fruits, 43(3): 161-166.
2. Swennen, R., 1990. Plantain cultivation under West African Conditions (A Reference Manual). IITA, Ibadan, Nigeria, pp: 12.
3. International Institute of Tropical Agriculture (IITA), 1995. IITA Research No. 11, September, 1995, Ibadan, pp: 7-9
4. Robinson, J.C., 1996. Bananas and plantains. CAB Intl., U.K., pp: 238 .
5. Unamah, R.P.A., S.O. Odurukwe, H.E. Okereke, L.S.O. Ene and O.O. Okoli, 1985. Farming Systems in Nigeria. A Report of the Benchmark Survey of the Farming Systems of the Eastern Agricultural Zone of Nigeria. AERLS/NRCRI., pp: 134.
6. FMAWRRD, 1989. Fertilizer use and Management practices for crops in Nigeria. Federal ministry of Agriculture, Water Resources and Rural Development, Lagos, pp: 112.
7. Adelaja, B., 1997. The State of *Musa* Research, Development and Production in Nigeria. *In*: Akyeampong, E. (Ed.). *Musa* Network for West and Central Africa (MUSACO). A Report of the First Steering Committee Meeting, Douala, Cameroon, 8-10 December, 1997, pp: 15-16.
8. Obiefuna, J.C., 1986. The effect of sawdust mulch and increasing N levels on growth and yield of False Horn plantains (*Musa* AAB). Biol. Agric. Hortic., 3: 353-359.
9. Obiefuna, J.C., 1987. Raising the productivity of plantain/cocoyaminte rcropping system through supplementary fertilization. A paper presented at the 1st National Workshop on cocoyam. August 16-21, 1987. NRCRI, Umudike, pp: 5.
10. Devos, P. and G.F. Wilson, 1978. Productivity and efficiency of plantain/cocoyam intercropping. Paradisiaca, 4:6-11.
11. Braide, J. and G.F. Wilson, 1980. Plantain decline: a look at possible causes. Paradisiaca, 4: 3-7.
12. Obiefuna, J.C. and P.O. Onyele, 1985. The effect of nitrogen and potassium imbalance on the growth and yield of plantain. *In:* Proceedings of IARP/ICEPBR. Abidjan, Cote D' Ivoire, 22-31st May, 1985. pp: 112-114.
13. Ndubizu, T.O.C., 1983. Variations in the foliar content of certain essential nutrients in plantain (*Musa acuminate*, AAB). Beitrage Tropical Landwich Veterinamed, 22(3): 279-288.
14. Wahua, T.A.T., 1999. Applied Statistics for Scientific Studies. Africa Link Books, Ibadan, Nigeria, pp: 354.
15. Wilson, G.F., R. Swennen and E.A. Delaughe, 1985. Effect of mulch and fertilizers on yield and longevity of a medium and giant plantain and banana cultivars. pp: 109-111. *In*: Proc. 3rd Meeting on International Co-operation for effective plantain and Banana Research. Abidjan, Cote d'Ivoire May, 1985. IARPB/INIBAP.
16. Kotoky, U. and R.K. Bhattacharyya, 1992. Harvest Index of Three Organic Mulches. Banana News Letter (Australia), 15: 19-2.
17. Blomme, G., R. Swennen and A. Tenkouano, 2002. The effect of soil bulk density on root and overall plant development in six banana varieties. *INFOMUSA*, 11(2): (December, 2002): pp: 38-40.
18. Ngongo, P.M.K., 2002. Integrated pest Management strategies for plantain production and control of black leaf streak (black sigatoka) disease in the DRC. *INFOMUSA*, 11(1): 3-6.
19. Sanchez, P.A., 1976. Properties and Management of Soils in the Tropics. John Wiley and Sons, New York, USA. pp: 618.
20. Stifel, L.D., 1989. IITA Research for Sustainable Agriculture in Africa. A paper presented at the CGIAR at international Center's Week. Washington D.C., USA., pp: 16.
21. Kang, B.T. and V. Balasubramania, 1990. Long Term Fertilizer Trials on Alfisols in West Africa. Transactions of the 4th International Congress on Soil Science, Japan. 4: 20-25.