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Full Length Research Paper

Influence of NPK fertilizer on tuber yield of early and late-planted cassava in a forest alfisol of south-western Nigeria

Agbaje G. O.* and Akinlosotu T. A.

Institute of Agricultural Research and Training Obafemi Awolowo University,Moor Plantation, P.M.B. 5029, Ibadan, Nigeria.

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Four new cassava varieties (NR 8082, TMS 00033, TMS 91/ 453 and TMS 00447) were fertilized with NPK (20- 10-10) at the rates of 0, 200, 400, and 800 kg/ha in an experiment with the crop planted early (April) in 1999 and then late (September) in 2000. Tuber yield was 28% higher in early-planted cassava than in the late cultivation. Yield was reduced by 44% in NR8082, 15% in TMS 00033 and 45% in TMS 00447 as a result of late planting. Tuber yield from NR 8082 (44t /ha) was the highest for early-planting while TMS 00033 gave the highest yield (31 t/ha) in late planting. Fertilizer influence on tuber yield was not significant in early-planted cassava. In late-planted cassava, significant reduction in yields was observed from the application of 400 and 800kg/hectare of fertilizer. Incidence of tuber rot was influenced by varietal differences rather than fertilizer rates. Incidence of rot was lowest in NR8082 (9-10%) and TMS 00033 (10-11%) in both plantings and the severity was mild in all the varieties. TMS 00033, a low cyanide variety, have tuber yields above 30 t/ha in both early and late plantings and is therefore recommended for adoption trials by farmers.

Key words: Early and late planting, cassava varieties and tuber rot.

INTRODUCTION

Cassava is planted throughout the rainy season in south-western Nigeria. The early plantings have enough moisture for growth, and the tubers partly mature into the dry season. Cassava planted late often experience water stress during vegetative and tuber development stages and the tubers mature within the rainy season. Water stress has negative influence on cassava tuber yield. El-Sharkawy et al. (1998) reported that early and mid-season stress significantly reduce top and root biomass than late or terminal stress which occurred during tuber maturity in cassava

To increase the yield potential of cassava, the crop had been reported to respond to good soil fertility and adequate fertilizer (Gomez et al., 1980; Wilson and Ovid, 1994; Howeler, 1996). Farmers do not fertilize cassava because they are contented with the minimal yields obtained from using limited inputs or even from their infertile soils. The indifference towards low productivity can be attributed to the low and unstable prices of cassava tubers. However, fertilizer requirement for optimum yield in cassava is determined by the following factors, soil fertility status of the farmland, cropping

*Corresponding author. E-Mail: drbunmiagbaje@yahoo.com.

Table 1. Soil nutrient composition of trial sites obtained from 15 cm soil depth.

Soil Properties	1999	2000
pH	6.1	6.0
Sand %	74	77
Silt %	15	12
Clay %	11	11
Organic C.g/kg	6.2	6.7
Exchange Bases Cmol / kg		
Ca	1.67	1.50
Mg	0.85	0.89
K	0.23	0.24
Na	0.18	0.13
H^+	0.10	0.11
ECEC, Cmol/kg	3.03	2.97
Total N , g/kg	0.69	0.81
Available P, mg/kg	5.32	6.31

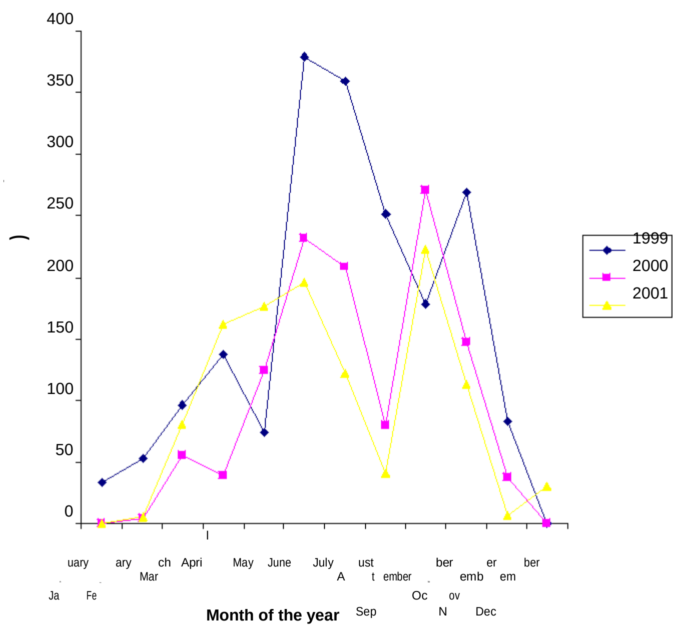

Figure 1. Rainfall data at Ikenne during the period of trial, 1999 – 2001.

system adopted, and the rainfall pattern during the growing season. Rainfall in the rain forest areas of Nigeria is erratic, unpredictable and it is the most critical factor that determines yield in rain-fed agricultural system. Rainfall is usually high and this washes fertilizers away making them unavailable to plants (Ofori, 1976).

The major nutrients required by cassava for optimum top growth and tuber yields are nitrogen (N) and potassium K (Obigbesan and Fayemi 1976, Howeler, 1991). Soils that have low N (<0.10% total N) and K (< 0.15 meq/100g) will require an additional fertilizer for optimum tuber yield (Kang and Okeke, 1991). Adequate K levels in soil stimulate response to N fertilizers but excess amount of both nutrients leads to luxuriant growth at the expense of tuber formation (Sanchez1976, Onwueme and Charles1994, Wilson and Ovid 1994, Rao et al., 1986).

Cropping systems influence fertilizer requirements of cassava. For example, the continuous cropping of cassava leads to fast depletion of major nutrients especially N and K and will require fertilizer supplement to give stable yield (Kang and Okeke, 1991). Farmers seldom cultivate cassava continuously on the same land in south-western Nigeria but plant yam as the first crop after a two or three year fallow. Yam is then followed by cassava and or maize as a second crop. Yam and cassava extract large amounts of soil N and K for top and root development respectively (Kayode, 1985; Odurukwe, 1986; Norman et al., 1995).

The objective of this study was to evaluate the yield response of some new cassava varieties to fertilizer when planted late or early in the season. The new varieties are noted for their high tuber yield potential and resistance to pests and diseases. Cassava varieties with stable yield will then be selected for on-farm trials by the farmers.

MATERIALS AND METHODS

Experiments were carried out for two years between 1999 and 2001 at Ikenne rain forest research station of the Institute of Agricultural Research and Training, Ibadan. The soil type was Alagba series classified as Rhodic luxisol (USDA). The soil and rainfall data are shown in Table 1 and Figure 1, respectively. Four elite cassava varieties: TMS 91/453, NR 8082, TMS 00033 and TMS 00447 were fertilized using four rates of NPK (20-10-10) compound fertilizer at 0 (control), 200, 400 and 800 kg/ha respectively. The experiment was a 4 X 4 factorial in a randomized complete block design with three replications. Each plot had four rows of 5 m length with a planting distance of 90 cm x 90 cm. Planting was done at the onset of rainy season in April 1999 and fertilizer was applied at one month after planting (1MAP) and three months after planting (3MAP). In 2000, planting was done early September towards the onset of dry season. Fertilizer was applied twice at 1 MAP and in 2001 during the onset of rains at 6MAP in a 40 to 60 ratio respectively. Tubers were harvested in April 2000 and August 2001 for both trials. The plots were previously put to yam before cassava was planted in 1999 and 2000.

Data on tuber yield, number of tubers per plant and number of rotten tubers were collected from the two innermost rows. The percent tuber rot was transformed angularly as (x + 1) % where x is the number of rotten tubers/total number of harvested tubers per plot * 100. Severity of root rot was assessed physically and rated using a scale of 1 to 5 (1 as no rot, 2- mild rot, 3- moderate rot, 4 - severe rot, 5- very severe rot). The statistical analyses were done using ANOVA and means compared at LSD 0.05.

RESULTS

Tuber yield was higher in 1999 early season planting than in 2000 late season planting by 28 percent. Late

Table 2. Fresh tuber yield and number of tubers per plant in early (April, 1999) and late (September, 2000) planting seasons.

	1999		2000	
Varieties	**Tuber yield t/ha**	**Number of tubers Per plant (n)**	**Tuber yield t/ha**	**Number of tubers Per plant (n)**
TMS 91/453	18.75	4.0± 0.52 (2–7)	21.93	5.0± 1.77 (3 – 8)
TMS 00033	36.10	7.0± 0.9 (5 – 7)	30.78	6.0± 1.92(4 – 11)
TMS 0447	34.10	5.0± 1.08 (3 – 6)	18.81	5.0± 1.59 (3–9)
NR8082	44.34	7.0± 1.46 (5–10)	25.11	6.0± 1.52 (3– 9)
Fertilizer rates				
0 kg NPK/ha	33.99	5.0± 1.95 (2 – 8)	28.66	6.0± 1.50 (3– 8)
200 ,,	31.95	6.0± 2.03 (3 – 10)	26.47	6.0± 1.88 (3– 9)
400 ,,	34.25	6.0± 1.62 (3 – 8)	22.56	5.0± 1.4 (3–8)
800 ,,	33.10	5.0± 1.4(3 – 7)	18.90	5.0± 2.19 (3– 11)
Lsd 0.05				
Variety (V)	8.46	3.0	2.73	NS
Fertilizer (F)	NS	NS	2.73	NS
Interaction (VxF)	NS	NS	NS	NS
CV (%)	43.14	21.26	19.17	27.83

Table 3. Influence of variety and NPK fertilizer rates on tuber rot incidence (%) and severity in cassava tubers.

Varieties	1999 Incidence (%)	Severity (1-5)	2000 Incidence (%)	Severity (1-5)
TMS 91/453	20.35	2.25	12.97	1.75
TMS 00033	10.14	2.00	11.22	1.63
TMS 0447	17.42	2.25	17.60	2.16
NR8082	8.79	1.91	9.78	1.41
Fertilizer rates				
0 kg NPK/ha	17.23	2.08	11.48	1.58
200 ,,	12.03	1.91	12.36	1.75
400 ,,	13.06	2.25	15.97	2.08
800 ,,	14.39	2.16	11.76	1.75
Lsd 0.05				
Variety (V)	3.26	NS	3.59	0.34
Fertilizer (F)	NS	NS	NS	0.34
Interaction (VxF)	NS	NS	NS	0.69
CV (%)	29.20	20.27	27.21	23.07

planted cassava tuber yields were reduced by 44% in NR 8082, 45% in TMS 000447 and 15 % TMS 00033. It was, however, increased in the lowest yielding variety TMS 91/453 by 17%. Tuber yield differ significantly between varieties (Table 2). Yields were highest from NR 8082 and TMS 00033 planted early or late. The yield reduced from 44 t/ha to 25 t/ha in NR 8082 due to late planting but TMS 00033 was stable and varied from 36 to 31 t/ha. Varietal differences in number of tubers per plant was significant for early planting with TMS 91/453 having the lowest number of tubers and yield during this period. For late planting, the numbers of tubers were similar among the varieties and ranged between 5 and 6 per plant. The incidence of tuber rot in 1999 early plating was 17 and 20% in TMS 00447 and TMS 91/453, respectively. For the 2001 late planting, TMS 00447 had the highest incidence of rot (17.60%) but in both periods of planting, NR 8082 and TMS 00033 had the lowest tuber rot of 8 - 11%.

The addition of fertilizer did not improve the tuber yield of early- planted cassava varieties but the late cultivation showed negative yield response to fertilizer. Reduction in tuber yield was significant with the addition of 400 and 800 kg NPK per hectare. Fertilizer application did not have influence on the number of tubers per plant and the incidence of tuber rot (Tables 2 and 3). Across the fertilizer rates, number of tubers per plant was between 5 and 6 and the incidence of rot varied from 12-17% and 11-15% of tuber harvested in early and late planted cassava, respectively. Severity of rot was mild for variety and fertilizer in both early and late planting despite the significant interaction observed during late planting. At this period, NR8082 showed higher resistance to rot than other varieties except TMS 00033 at 800 kg/ha fertilizer rate.

DISCUSSION

Time of planting influenced the tuber yield of cassava. Planting cassava at the onset of rains in 1999 gave higher yield than late season planting in 2000. The vegetative stage and tuber initiation of late planted cassava suffered severe stress due to cessation of rainfall for three to four months of the dry season period (November – February) in south-western Nigeria.The dry season is characterized by low soil moisture and high soil temperature. Stress was experienced in early-planted cassava only at maturity period. Water stress during root and tuber formation reduced cassava yield significantly while that after seven months of planting had no influence on yield (Oliveira et al., 1982; Villamayor et al., 1985; El-Sharkawy et al., 1998). This indicated that stress at vegetative and growth stages rather than at post maturity stage caused lower yield in cassava.

The addition of fertilizer did not influenced tuber yield in 1999 due to the influence of rainfall on fertilizer during early planting. There was excessive rainfall in 1999 and a total of 990 mm was recorded in the first three months after fertilizer was applied in the early planting season. This had negative influence on fertilizer retention and availability to plants. In late planted cassava (2001), the total rainfall in the first three months after fertilization was low (284 mm) and also in the second fertilizer application, total rainfall for three months was 417 mm. Rainfall pattern and intensity influenced inorganic fertilizer efficiency in cassava yield. The excessive rainfall washes applied nutrient and soils in agricultural lands in rainforest areas making fertilizers unavailable for plant use (Ofori, 1976). The onset of rains after the dry season encouraged the rapid development of the above ground biomass in late planted cassava. With the combined effect of applied fertilizer and low rainfall in a soil with average N and K levels, a luxuriant top growth was enhanced at the expense of tuber growth. During this period a high nutrient concentration of fertilizers at 400 kg and 800 kg NPK/ha depressed the cassava tuber yield. A similar influence of excessive nutrient on cassava top biomass at the expense of tuber yield had been reported (Sanchez, 1976).

Tuber rot was lowest in TMS 00033 and NR 8082 and this accounted for their higher yields in both planting periods. Also, TMS 91/453 yield was depressed due to high rot incidence in early planting but the yield increased by 17% in late planting season as a result of lower incidence of rot. These indicated that genetic improvement and selection for rot resistance will enhance yield in cassava varieties cultivated in south-western Nigeria.

From the study, early-planted cassava gave better yield than late planted ones. Late season cassava also gave lower yield in south-western Zaire due to low moisture regime and high soil temperature during the vegetative stage. Tuber yield increased with the use of mulch during the dry season (Lutaladio et al., 1992). The application of supplemental irrigation during late season cassava production will increase yield and productivity of cassava in south–western Nigeria. With the high cost of irrigation, introduction of drought resistant varieties for late season cultivation will improve the yield of cassava significantly among peasant farmers in south- western Nigeria. The response of cassava to fertilizer will improve in late season cultivation where a controlled irrigation system is used but the application of fertilizer to early-planted cassava will remain uneconomical and wasteful in season of excessive rainfall.

Among the varieties, NR 8082 was better planted early than in late season while TMS 00033 which gave stable yields in both early and late planting is recommended for adoption trials by farmers.

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REFERENCES

Conor DJ, Cock JH, Parra GE (1981). Response of cassava to water shortage 1. Growth and yield. Field Crops Res. 4(3): 181-200.

El-Sharkawy MA, Cadadis LF, Tafur SM, Caicedo JA (1998). Genotypic differences in productivity by prolonged water stress. Acta-Agronomica 48 (1-2): 9-22.

Gomez JC, Howeler RH, Webber EJ (1980). Cassava production in low fertility soils. In: Toro MJC, Graham M (eds) Cassava cultural practices. Bowker Publ. Co Ltd, Epping, U. K.

Howeler RH (1991) . Long term effects of cassava cultivation on soil productivity. Field Crop Res. 26 (1): 1-18.

Kang BT, Okeke, JE (1984). Nitrogen and potassium responses of two cassava varieties grown on an alfisol in southern Nigeria. In: Proceeding, 6th symposium of the Int. Soc. Tropical Root Crops, 1984, Lima, Peru. pp. 231-234.

Kayode O (1985). Effects of NPK fertilizer on tuber yield, starch contact and dry matter accumulation of white guinea yam (*D. rotundata*) in a forest alfisol of South Western Nigeria. Experimental Agric. 21: 389-393.

Norman MJT, Pearson CJ, Searle PGE (1985). Yam: In the ecology of tropical food crops 2nd ed. Cambridge University Press pp. 305-18.

Lutaladio NB, Wahua TA Hahn SK (1992). Effects of mulch on soil properties and on the performance of late season cassava(Manioth esculenta Crantz) on an acid ultisol in south-western Zaire. Tropicultura 10 (1): 20 – 26.

Ofori CSC (1976). Effect of various nitrogen sources on the yield of cassava (*Manihot esculata* Crantz). Ghana. J. Agric. Sci. 9: 99-102.

Obigbesan GO (1977). Investigations on Nigeria root and tuber crops: Response of cassava cultivars to potassium fertilizer in Western Nigeria J. Agric. Sci . 89: 23-27.

Obigbesan GO, Fayemi AA (1976). Investigations on Nigeria root and tuber crops: Influence of nitrogen fertilization on the yield and chemical composition of two cassava cultivars J. Agric. Sci. 86: 401-406.

Odurakwe SO (1986). Yam – Maize intercropping investigation in Nigeria. Tropical Agriculture (Trinidad) 63: 17-21.

Oliveira SL, Macedo MMC, Porto MCM (1982). Effect of water stress on cassava root yield. Pesquisa-Agropecuaria- Brasileira 17(1): 121-124.

Onwueme IC, Charles WB (1994). Tropical root and tuber crops: Production perspectives and future prospects. FAO Plant Production and Protection Paper, p. 126. FAO, Rome.

Rao DM, Rao MS, Reddy KVS (1986). Nitrogen and potassium requirements of cassava. J. Res. – APAU. 14(2): 157-161.

Villamayor FG Jnr., Destriza T (1985). Moisture stress and its effect on cassava yield. Radix 7(1): 5-6.