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Yam Yield Variations From Three-Year Continuous Cultivation Under Sole And Mixed Cropping Systems In An Alfisol Of Eastern Nigeria

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Key words

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A B S T R A C T

Sole Yam (SY) and Yam+ Cassava + Maize + Pigeon Pea (Y+C+M+P) mixture were grown continuously for three years in an ultisol brought into cultivation as a virgin forestland. The objective was to compare yam yield variations as affected by residue management without external input of nutrients (Zero external input).All the crop residues especially the above ground vegetation (leaves from yam, cassava and pigeon pea and the entire for maize except the cob) were incorporated into the soil as a sources of nutrients. The tuber yields from SY plots were in 1999 and 2000 significantly higher ($p < 0.05$) than those obtained from Y+C+M+P but in 2001 there was no significant difference between the yields. Again decreases in tuber yield were above 45% between 1999 and 2000 in SY and Y+C+M+P. Between 2001 and 2000 yield decrease in Y+C+M+P was < 5% but in SY plots it was ≈25%. The shape index of tubers was neither significantly affected by cropping systems nor over the three years as the overall variations ranged from 0-9%. Thus variation in yam tuber yields from sole yam plots and mixtures tended to narrow down with time.

Introduction

Yams constitute the largest genus of the Dioscoreaceae with over 600 species but only a few are cultivated for food or medicine out of which six are economically important staple species (Purseglove, 1972; Orkwor et al., 1999). The economically important species are D. rotundata, D. alata, D. cayenensis, D. bulbifera, D. dumetorum, and D. esculenta. These six species constitute over 90% of the food yams produced in the tropics (Hahn, 1995).

More than 90% of the worldwide yam production comes from the West African subregion (FAO, 2009) though Nigeria alone; accounts for over 70% of the world production (Okoh, 2004). They are food security crops in this subregion Besides their importance as food source, yam plays a significant role in the socio-cultural lives of people in some producing regions like the celebration of New Yam Festival in West Africa (Osunde and Orhevba, 2009) and wedding ceremonies in Oceania (O'Sullivan, 2008). Yam is second to cassava as the most important and cultivated tropical root crop. It is widely cultivated in Nigeria, and because of its multi-purpose uses, it occupies a principal place in farming system of the humid tropical region.

White yam (Dioscorea rotundata) is one of the major food yam species produced in the yam zone of Nigeria mainly by traditional farmers. Coursey (1984) stated that in all societies where yams are major crops specifically West Africa, Melanesia and the Caribbean, they are crops of prestige and have acquired heavy burden of religion and magical significance that hardly applies to any other tropical crop. The cultivation of white yam is indigenous to West Africa and is not known elsewhere except as a comparatively recent introduction (Coursey, 1971).The most widely grown and eaten species in West Africa is Dioscorea rotundata Poir popularly known as white yam or white guinea yam and is of African origin.

Yam tubers may be eaten with sauce directly after boiling, roasting, or frying in oil. The cultivation of yams not only antedates European contacts, but also the beginning of the use of iron tools in Africa around 2000 years ago (Coursey and Booth, 1997).

Yams are often grown in mixtures by smallholder farmers and each crop mixture is often designated Yam-based. Yams demand a lot of nutrients from the soil; hence they are always the first crop in a fallow rotation (Asadu 1989; Are et al. (2010). Very often mineral fertilizers are not available for farmers to use; hence the need to have alternative technology especially under continuous cultivation of yam cropping systems. The objective of the study was assess yam yield variations under continuous cultivation of sole and mixed cropping systems with zero external nutrient input in an alfisol in Nsukka, Eastern Nigeria

Materials and Methods

Location of the study

Nsukka is located by Lat. 06^0 52'N, Long. 07^0 24'E within the derived savanna zone of Eastern Nigerian. It is on an average elevation of 447 m above sea level. It has two seasons namely the rainy and the dry seasons. The former lasts from April to October with a short break (August Break) in the month of August. Average annual rainfall is about 1550 mm and more than 85% of this rain falls within the rainy season. The average minimum and maximum temperatures are about 22 and 30 ^oC respectively while the average relative humility is rarely below 60% (Asadu, 2002). The soil was formed from the residua of false–bedded sandstone and has been classified by Asadu et al. (2002) as Rhodic Kandustalf (Haplic Lixisol). The study was carried out at a virgin forestland cleared in 1998 for the study.

Experimental design, field sampling and data analysis

The design was a randomized complete block design (RCBD) with three cropping systems as treatment factors. The cropping systems were selected included yam + cassava + maize + pigeon pea (Y + C+M+P), and sole yam (SY). The cropping systems were replicated three times. The trials were established between May 15 and 18, each year from 1998 -2001. Each crop was planted at a spacing of 1 m x 1m on the ridges. The plot size was 5 m x 8 m. Maize and pigeon pea were planted by the sides of the ridges in mixtures. However, two grains of maize and two seeds of pigeon pea were planted per hole as is done by the local farmers in the area. This population was maintained in both plots of the sole and crop mixtures. The ridges were made with local hoes.

Fresh tuber yields of yam were taken from an area 20 m^2 at the centre of the plots seven months after planting, harvesting being in the years 1998, 2000, and 2001

Analysis of Variance (ANOVA) for the yield data was done using SAS (1985) window package. The differences in means were compared using the least significant difference at 5% level of probability

Results and Discussion

Table 1 shows that the mean tuber yields from sole yam plots in 1999 and 2000 cropping seasons were significantly (p= 0.05) higher than those yields from mixture. However, the difference obtained from the two cropping systems was not significant in 2001. The higher mean yield obtained from sole yam plots was attributed to competition among the four crops in the mixture for growth factors especially soil nutrients and light. This is a well identified and documented disadvantage of mixed cropping (Andrew, 1972; Okorji, 1986; Asadu, 1997; Kantor, 1999). However, the cumulative yields from the mixture often exceeded that from the sole crop plots and the land equivalent ratio (LER) has been reported to be significantly higher for mixtures than sole crops (Dixon and Asadu, 2001).

The non-significant effect of crop mixture obtained in 2001 was an indication that zero external nutrient input with incorporation of crop residue supports growing crops in mixtures rather than sole. This is an added benefit from mixed cropping apart from those earlier outlined (Finlay, 1975; Kantor, 1999). It is possible that in the year 2001 some of the residues from the four crops that were incorporated into the soil had decomposed and mineralized so that the nutrients were able to add to those available to the four crops while in the case of sole yam the quantity of residue added would be limited to that from yam alone. This could not match those from the four crops.

Table 1. Mean effects of cropping systems on yam tuber yield for three years

Cropping system	1999	2000	2001	Yield decrease (%)	
	Tuber yields (tha^{-1})			2000 vs 1999	2001 vs 2000
Y+C+M+P	14.18	7.58	7.3	46.5	3.7
SY	21.59	10.68	8.0	50.5	25.1
LSD ($_{0.05}$)	3.19	2.33	1.70	-	-

Note: Y+C+M+P = Yam+ Cassava + Maize + Pigeon Pea; SY = Sole Yam

The decreases in tuber yields in both cropping systems between 1999 and 2000 (Table 1) were ≈ 47% and ≈ 51% respectively while their respective values between 2001 and 2000 was ≈ 4% and ≈ 25%. These trends tend to support the inference on the effect of crop residue incorporation on closing the gap between the yields from sole and intercrops of yam under continuous cultivation system. The implication is that with crop residue incorporation under continuous cultivation, yield drop is minimized and this can lead to yield stability. However, the likelihood of obtaining the equivalent of the original yield at the beginning of cultivation is very remote.

Table 2 shows that the two cropping systems did not significantly influence other yield parameters: number of tubers, tuber length, tuber girth and shape index of tubers. Their trends over the years were not also consistent. except in the case of number of tubers that increased from 1.52 to 1.8 between 1999 and 2001. Again between 1999 and 2000 there were increases in tuber length and girth as well as shape index but all the values decreased in 2001. These variations can not easily be discernible from the data obtained.

Table 2. Mean effects of cropping systems on yam yield parameters for three years

Cropping system	1999	2000	2001
	Number of Tuber per stand		
Y+C+M+P	1.52	1.48	1.8
SY	1.79	1.64	1.77
LSD $_{(0.05)}$	0.45	0.35	0.29
	Length of tuber (cm $tuber^{-1}$)		
Y+C+M+P	20.83	26.80	21.10
SY	25.20	28.40	23.00
LSD $_{(0.05)}$	7.95	8.6	1.42
	Girth of tuber (cm $tuber^{-1}$)		
Y+C+M+P	20.13	22.0	19.1
SY	21.22	23.6	20.3
LSD $_{(0.05)}$		6.9	0.92
	Shape index of tuber (cm $tuber^{-1}$)		
Y+C+M+P	1.06	1.21	1.11
SY	1.19	1.22	1.13
LSD $_{(0.05)}$	0.17	0.06	0.06

Note: Y+C+M+P = Yam+ Cassava + Maize + Pigeon Pea; SY = Sole Yam

Conclusion

Continuous cultivation of Sole Yam (SY) and Yam+ Cassava + Maize + Pigeon Pea (Y+C+M+P) mixture for three years in an alfisol brought into cultivation as a virgin forestland with crop residues incorporation into the soil showed that the tuber yields obtained from SY plots were in 1999 and 2000 significantly higher ($p < 0.05$) than those obtained from Y+C+M+P but in 2001 there was no significant difference between the yields. Again decreases in tuber yield were above 45% between 1999 and 2000 in SY and Y+C+M+P. Between 2001 and 2000 yield decrease in Y+C+M+P was < 5% but in SY plots it was ≈25%. The study showed that zero external nutrient input with incorporation of crop residue supports growing crops in mixtures rather than sole.

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