EFFECT OF TILLAGE, CROPPING SYSTEM AND FERTILIZER ON ROOT ROT AND YIELD COMPONENTS OF CASSAVA (*Manihot esculenta* Crantz)

[1]Taiwo, A P., [2]Akinbile, O. O., [2]Daniel, A. I., [3]Dama, A. Z., [4]Elumalero, G. O., [4]Olalekan, O. J., [5]Adiamo, I. A., [1]Erinle, K. S.
Department of Crop Protection. Federal University of Agriculture, Abeokuta.
Department of Soil Resources Management, University of Ibadan.
Department of Crop Production and Horticulture, Modibbo Adama University, Yola, Adamawa.
Forestry Research Institute of Nigeria (Forest Based Rural Resource Centre, Ikija, Ogun State).
Department of Soil Science and Land Management, Federal University of Agriculture, Abeokuta.

Corresponding Author Email: olamideodunayoakinbile@yahoo.com
Tel: +2347062188613

Abstract
Cassava (*Manihot esculenta* Crantz) is regarded as a subsistence crop of low-income families or as a famine-reserve crop that is affected by root rot disease which affects its yield component. This study was carried out to evaluate the effect of tillage, planting system and fertilizer application on cassava root rot and yield component. The cassava variety used was TME 419. Cassava roots showing symptoms of rot disease were collected from the experimental field in FUNAAB. There were two (2) tillage levels (flat and ridge), two (2) cropping systems (sole cassava and cassava intercropped with maize), two (2) fertilizer levels (Control and NPK 15-15-15). The experiment was laid in split-split plot design with four replications. The main plot was tillage; sub plot was planting system, while the sub-sub was fertilizer. Data were taken on number of good roots, number of bad roots, number of small roots, weight of small roots (Kgha^{-1}) and weight of rotten roots (Kgha^{-1}) and weight of bad roots (Kgha^{-1}).Data collected were subjected to analysis of variance at $P<0.05$. The results from Table 1 shows that ridging had the highest number of good tubers, weight of good tubers and number of small tubers than planting on flat tillage. It was observed that, cassava planted solely on ridge was significantly different from others in number of good tubers and its weight as seen in Table 2. In conclusion, cassava can be planted solely on ridge with fertilizer application because it increased the number of good roots and the weight of good roots than planting on flat ridge with fertilizer, even though this does not increase the root rot disease of cassava.

Key words: Cassava, Fertilizer, NPK 15-15-15, Rot disease, TME 419

INTRODUCTION

Cassava (*Manihot esculenta* Crantz), a major staple food crop of the people in most parts of Africa, it plays a significant role in terms of food security, employment and income generation for farm families in parts of the humid tropics. It derives its importance from the fact that it produces more calories/unit area from its starchy tuberous root which is a valuable source of cheap calories especially in developing countries (Som, 2007). Apart from its use as food, it is also an important industrial raw material for the production of starch, alcohol, pharmaceuticals, gums, confectioneries and livestock feed (Nnodu *et al.,* 2006). Cassava is one of the most important food crops widely consumed in Nigeria. It plays a key role in the nation's food security as majority of Nigerians eat cassava at least once a day (Sanni *et al.,* 2007) . It can be processed into different forms utilizable by man. IITA (2002) identified and highlighted the characteristics of the common forms of cassava products available in Nigeria; these include garri, fufu, cassava chips, cassava flour, starch, farina, tapioca, macaroni, cassava bread and pudding. Apart from its use as a staple food to human beings other uses include animal feed formulation, agro-industrial uses (e.g. starch, ethanol, adhesive, and fructose/glucose syrup), the peels in organo-mineral fertilizers formulation (Ojeniyi, 2001; Akanbi *et al*., 2007; Iyagba, 2010). Cassava account for approximately a third of the total staples produced in sub- Saharan Africa (Akoroda and Arene, 1989).In Africa, which is the continent with largest cassava production, about 93% of the produce is used as food (Nweke *et al.,* 2002). Nigeria is at present, the largest producer of cassava in the world. The annual yield production per hectare increased in 1978 from 12 to 33 million t/ha, ranking Nigeria first in the world production. Currently, the total harvested crop in 2003 was 21 million hectares with an average yield of about 11 t/ha. In 2006, its total production was about 34 million metric tonnes per hectare. Cassava, a widely-spaced, long duration crop is often intercropped with short duration crops such as cereals and grain legumes. Among intercrops, legumes have been considered to be compatible crops for intercropping with cassava (Goss and Russel, 1980) as they supply a sustainable amount of nitrogen (N) into lower input agro-ecosystems (Fustec *et al*; 2010). The fertility of Africa's soil is inherently low since African soils are very old and lack volcanic rejuvenation (Bationo, 2009) with nitrogen (N) and phosphorus (P) commonly deficient in these soils. The population pressure coupled with limited land forces the farmers to grow crop after crop, over-burdening the soils leading to depletion of soil nutrients in Central Africa (UNEP, 2000). Cassava plant is well adapted to low levels of available P (on account of its mycorrhizal association which makes P available to but requires fairly high levels of N and K, especially when grown for many years on the same plot or continuously cultivated plots (Howeler *et al*., 2000; Ayoola and Makinde, 2007). .Despite the Importance of this crop to families and industries, It is however affected by root rot disease which affects its yield component.Thus, this study was carried out to observe the effects of tillage, cropping system and fertilizer application in the root rot of cassava and its yield component.The objectives of this study were to determinethe effects of tillage on cassava root rot and yield component, the effects of cropping system on cassava root rot and yield component and the effects of fertilizer application on cassava root rot and yield component.

MATERIALS AND METHODS Experimental Site

The experiment was carried out on a farm at FUNAAB and in the Crop Protection Department's Laboratory of Federal University of Agriculture Abeokuta, Ogun State

Source of Plant Materials

The variety of cassava cutting used was TME 419 which was sourced from IITA. Length of cassava stem cutting was 20 cm.

Experimental Design

An experimental site was ploughed, harrowed and ridged. It was laid in split-split plot design with four replications. The main plot was tillage; sub plot was planting system, while the sub-sub was fertilizer. The main plot measured 18m by 14m, sub plot was 18m by 4m, while sub-sub plot was, while plant spacing was1m x1m, 1 m x 0.9 m, 1 m x 0.8 m, 1 m x 0.7 m, 1 m x 0.6 m, 1 m x 0.5 m respectively.

Experimental Materials

Incubator (gallenkamp), autoclave, pipettes, potato dextrose agar, distilled water, cotton wool, 98% ethanol, streptomycin, conical flask, beakers, petri dishes, aluminum foil, spirit lamp, forceps. Glass petri dishes were sterilized in a hot air oven at 121 ^{0}C for 2 hours to ensure proper sterilization. Forceps was sterilized in 98% ethanol and in red hot flaming of the spirit lamp.

Isolation of Fungi

Each infected root sample was washed in clean running water and sections were cut from the tissue, using a sterile knife, at the interphase between healthy and infected portions of the tuber.The pieces of tissue were surface-sterilized with 10% sodium hypochlorite for 1 min, and rinsed in three changes of sterile distilled water. The roots were blotted dry in paper towel. Seven sections of the dried root were plated out on an acidified potato dextrose agar (PDA). The inoculated petri dishes were sealed with paraffin to prevent contamination and then incubated in a Gallenkamp incubator at 28 ^{0}C for 2-3 days after which they were sub-cultured onto fresh sterilized PDA to obtain pure culture.

Cultural Practices

Fertilizer applied was NPK 15-15-15 at the rate of 212 g per ridge, weeding was done 4 times and it was carried out at 4, 8, 12 and 24 weeks after planting. Harvesting of tubers was done after maturity at 12 months after planting

Data Collection

The following data were recorded after planting

Number of good/largetubers per plot: These are tubers that are marketable; their total number was taken and recorded. A good and healthy tuber is assessed by their firmness (determined by touch) and have very small or no cracked. It shouldn't have a wrinkled skin.

Number of small tubers per plot: These are marketable tubers but are small in size; total number of small tubers was taken and recorded.

Number of rotten tubers per plot: The rotten tubers are those which are uneconomical or can't be consumed due to the rot, their total number was taken and recorded. Symptoms of a rotten tuber includes presence of hole and having a soft spot on the skin, they also have a cracked skin.

Weight of good tubers per plot(kg/ha): The total weight of harvested good tubers was taken and recorded.

Weight of small tubers per plot(kg/ha): The total weight of harvested small tubers was taken and recorded.

Weight of rotten tubers per plot(kg/ha): The total weight of harvested rotten tubers was taken and recorded.

Data Analysis

Data collected was subjected to analysis of variance. Significant means were separated using Duncan's Multiple Range Test at $p<0.05$

RESULTS

Table 1 shows the main effects of tillage, cropping system and fertilizer on cassava root rot and yield components. Ridging had the highest number of good tubers (22.55 kg/ha), weight of good tubers (9.85 kg/ha) and number of small tubers (8.01 kg/ha) than planting on flat tillage. The differences in the number of rotten tubers, the weight of rotten tubers and the weight of small tubers were however not significantly ($P < 0.05$) different. Cassava planted solely had higher number of good tubers (22.18 kg/ha) and its weight (10.17 kg/ha) than cassava intercropped with maize which is 16.33 kg/ha for good tubers and 7.41 kg/ha for weight of good tubers. The cropping system however does not have any effect on the numbers of rotten tubers, numbers of small tubers and weight of rotten tubers and the weight of small tubers. However the number of good tubers, number of rotten tubers, number of small tubers, weight of good tubers, weight of rotten tubers and weight of small tubers were not affected by fertilizer application.

Table 1: Effects of tillage, cropping system and fertilizer on cassava root rot and yield components

Tillage	Number of good tubers	Number of rotten tubers	Number of Small tubers	Weight of good tubers	Weight of rotten tubers	Weight of small tubers
				(kg/ha)		
Flat	15.96[a]	2.44[a]	4.12[b]	7.74[b]	0.36 [a]	0.48 [a]
Ridge	22.55[b]	1.62 [a]	8.01[a]	9.85[a]	0.38 [a]	0.64 [a]
SEM	1.51	0.37	0.87	0.74	0.05	0.10
SYSTEM						
Solely Cassava	22.18[a]	2.36	6.12	10.17[a]	0.41	0.56
Intercrop of Cassava and Maize	16.33[b]	1.70	6.01	7.41[b]	0.34	0.56
SEM	1.52	0.40	1.02	0.68	0.05	0.11
FERTILIZER						
Fertilizer	18.58	2.14	6.33	8.33	0.43	0.58
No Fertilizer	19.93	1.93	5.80	9.25	0.32	0.54
SEM	1.73	0.41	1.02	0.78	0.05	0.11

Means with the same letter(s) are not significantly different at ($P < 0.05$). SEM – Standard Error Means

Table 2: Interactions between Tillage and Cropping System on Cassava Root Rot and Yield Component

Tillage	Cropping System	Number of good tubers	Number of rotten tubers	Number of small tubers	Weight of good tubers	Weight of bad tubers	Weight of small tubers
				(kg/ha)			
Flat *	Cassava	18.14[b]	2.67	3.65[a]	8.64[b]	0.39	0.42
Flat *	Cassava and Maize	13.78[b]	2.22	4.59[ab]	6.83[b]	0.34	0.54
Ridge *	Cassava	26.22[a]	2.06	8.59[a]	11.70[a]	0.43	0.70
Ridge *	Cassava and Maize	18.89[b]	1.19	7.42[ab]	7.99[b]	0.33	0.58
SEM		1.82	0.51	1.26	0.86	0.08	0.15

Means with the same letter(s) are not significantly different

SEM – Standard Error Means

Table 2 shows the interaction between tillage and cropping system on cassava root rot and yield component. It was observed that, cassava planted solely on ridge was significantly ($P<0.05$) different from others in number of good tubers and its weight. Tillage and cropping system does not have any effect on number of rotten tubers, weight of rotten tubers and weight of small tubers.

Table 3: Interaction between Tillage and Fertilizer on Cassava Root Rot and Yield Component

Tillage	Fertilizer	Number of good tubers	Number of rotten tubers	Number of small tubers	Weight of good tubers	Weight of bad tubers	Weight of small tubers
				(kg/ha)			
Flat *	Fertilizer	14.11^{b}	2.52	4.86^{ab}	6.96	0.42	0.64
Flat *	No fertilizer	17.81^{ab}	2.37	3.39^{b}	8.52	0.31	0.32
Ridge *	Fertilizer	23.06^{a}	1.75	7.81^{a}	9.71	0.44	0.53
Ridge *	No fertilizer	22.05^{a}	1.50	8.21^{a}	9.99	0.33	0.75
SEM		2.13	0.53	1.25	1.06	0.07	0.14

Means with the same letter(s) are not significantly different. SEM – Standard Error Means

Table 3 shows the interaction between tillage and fertilizer on cassava root rot and yield component. Ridging with fertilizer has higher effect on number of good tubers 23.06 kg/ha while ridging with no fertilizer increases the number of small tubers 8.21 kg/ha.

Table 4: Interaction between Planting System and Fertilizer on Cassava Root Rot and Yield Component

System	Fertilizer	Number of good tubers	Number of rotten tubers	Number of small tubers	Weight of good tubers	Weight of bad tuber	Weight of small tubers
				(kg/ha)			
Cassava *	Fertilizer	21.36^{ab}	2.18	6.46	9.76^{ab}	0.47	0.53
Cassava *	No fertilizer	23.00^{a}	2.54	5.79	10.58a	0.36	0.59
Cassava & Maize*	Fertilizer	15.81^{b}	2.09	6.21	6.90^{b}	0.39	0.63
Cassava & Maize *	No fertilizer	16.86^{b}	1.32	5.81	7.92^{ab}	0.28	0.49
SEM		2.20	0.54	1.43	0.97	0.07	0.15

Means with the same letter(s) are not significantly different. SEM – Standard Error Means

Table 4 shows the interaction between cropping system and fertilizer on cassava root rot and yield component. For the number of good tubers, cassava planted with no fertilizer (23.00 kg/ha) was significantly ($P < 0.05$) different from the cassava planted with fertilizer (21.36 kg/ha). Cassava intercropped with maize with fertilizer application and that without fertilizer were however not significantly affected.

Table 5: Interaction Effect of Tillage, Planting System and Fertilizer on Cassava Rot and Yield Component

Tillage	System	Fertilizer	Number of good tubers	Number of rotten tubers	Number of small tubers	Weight of good tubers	Weight of rotten tubers	Weight of small tubers
					(kg/ha)			
Flat *	Cassava *	Fertilizer	15.94^{b}	2.23	5.59^{ab}	8.25^{ab}	0.46	0.65^{ab}
Flat *	Cassava *	No fertilizer	20.34^{ab}	3.12	1.72^{b}	9.04^{ab}	0.32	0.20^{b}
Flat *	Cassava and Maize*	Fertilizer	12.28^{b}	2.82	4.13^{ab}	5.67^{b}	0.37	0.63^{ab}
Flat *	Cassava and Maize*	No fertilizer	15.27^{b}	1.62	5.06^{ab}	7.99^{ab}	0.31	0.45^{ab}
Ridge*	Cassava*	Fertilizer	26.78^{a}	2.14	7.32^{ab}	11.28^{a}	0.47	0.42^{ab}
Ridge*	Cassava*	No fertilizer	25.65^{a}	1.97	9.86a	12.12^{a}	0.40	0.98^{a}
Ridge*	Cassava and Maize *	Fertilizer	19.33ab	1.36	8.29^{a}	8.14^{b}	0.41	0.64^{ab}
Ridge*	Cassava and Maize *	No fertilizer	18.46ab	1.02	6.56^{ab}	7.85^{ab}	0.26	0.53^{ab}
SEM			2.65	0.71	1.65	1.25	0.11	0.19

Means with the same letter(s) are not significantly different. SEM – Standard Error Means

Table 5 shows the interaction between tillage, cropping system and fertilizer on cassava root rot and yield component.For the numbers of good tubers, cassava planted on ridges with no fertilizer (25.65 kg/ha) is significantly diffent from that planted on a flat land with fertilizer (15.94 kg/ha). Cassava intercropped with maize on a flat land with fertilizer were not significantly different from cassava intercropped with maize on ridges without fertilizer.

DISCUSSION

Olasantan *et al.* (1994) reported that inclusion of maize with cassava increased plant height reduced Leaf Area Index and decreased nutrient uptake in cassava. It has been found that though higher yields could be obtained by planting cassava or maize in monoculture, the benefits derivable in terms of shared labour costs could not make sole cropping sustainable.Cassava and maize when grown in intercrop, could better utilize environmental resources (light, nutrients and moisture) at different periods of the growing season. This cropping system could also improve the nutrient intake of the farm family by providing adequate protein levels needed in their diets with the inclusion of grain legume in accordance to Ayoola and Makinde (2008).In general, yields of the associated maize are not affected while those ofcassavamay be significantly reduced (Okigbo and Greenland, 1976; Ezumah and Ikeorgu, 1986). This lack of response to fertilizer is either due to the fact that there were adequate nutrients in the soil or because water rather than nutrient supply was limiting yield. However, fertilizer requirement for optimum yield in cassava is determined by the following factors, soil fertility status of the farmland, cropping 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 (Sanchez, 1976;Onwueme and Charles, 1994, 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, 1984).

Conclusion

The findings of this study showed that tillage, cropping system and fertilizer does not affect the rotten cassava as well as the weight of the rotten tuber. Cassava planted solely with fertilizer on ridge has significant effect on the numbers of good tubers and the weight of good tubers. Fertilizer application does not have any effect on the number of good tubers, rotten tubers, small tubers and their respective weight.

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