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Effects of Combined Application of Plant Residues and NPK Fertilizers on the Yield of Yam (Dioscorea rotundata 'c'v' Ewura) in the Derived Savanna of Ogbomoso

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Abstract

The field experiment was carried to determine the effect of Pueraria, Soyabean and NPK fertilizer combination with urea and Muriate of potash on the performance of yam (*Dioscorea rotundata*). The gap between plots was 1m while that between replicates were 2m.The plant residues were incorporated two weeks before planting, fertilizer rate of 90-50-75kg N.P.K/ha and 45-25-37.5kg N.P.K/ha was achieved using NPK 15-15-15 compound fertilizer and excess N and K rates were met using urea and muriate of potash respectively. The fertilizer was applied in ring method to the growing yam at 2 months after sprouting. The experimental design was Randomized Complete block design with 4 replicates. There were nine treatments namely; Control (no residue, no fertilizer), No residues + 45-25-37.5kg N.P.K/ha (50% of the recommended NPK rate for yam in the zone),No residues + 90-50-75kg N.P.K/ha (Recommended NPK rate for yam in the zone), Incorporation of soybean residue alone, Soybean residue + 45-25-37.5kg N.P.K/ha, Soybean residue + 90-50-75kg N.P.K/ha, Incorporation of pueraria residue alone, Pueraria residue + 45-25-37.5kg N.P.K/ha, Pueraria residue + 90-50-75kg N.P.K/ha. There were significant differences between 90-50-75kg N.P.K/ha rate fertilizer application compared with control alone (no residue, no fertilizer) in terms of % N of yam leaves. Incorporation of pueraria with 45-25-37.5kg N.P.K/ha rate increased % N of yam leaves compared with pueraria alone and pueraria with 90-50-75kg N.P.K/ha. Analysis of variance indicate that Soybean incorporated into the soil alone and soybean with 90-50-75kg N.P.K/ha recommended rate fertilizer slightly increased %P compared with soybean with 45-25.37.5kg N.P.K/ha (50% recommended rate).

Keywords: NPK Fertilizer, Pueraria, Soybean, Yam, Plant residues, Soil Fertility.

Introduction

Yam (Dioscorea species) is an important tuber crop of the West Africa region, particularly Nigeria; that remains by far the principal yam producer in the word (Norman et al., 1996). Yam is rich in carbohydrate and it is a staple food in Africa. Yams are a major staple food crop and an important source of income farmers in West Africa. They require good fertile soil, adequate and well distributed Rainfall and considerable labour inputs for agronomic operations such as land preparation, planting, staking, weeding, training the vines, harvesting and post-harvesting, handling and storage (Njoku, 1963, Onwueme 1975, Orkwor 1990, Ezeh, 1991). They require large quantities of planting material. In spite of the fact that yam has been a staple food of Nigerians, most especially in southern, middle belt and guinea savannah zones; Soil fertility has been an overriding constraint to yam productivity in Nigeria. And this is due to the nature of the climate, farming practices that causes leaching, erosion, volatilization, degradation in soil physical condition and farmers' inability to replenish nutrient loss in the continuous and intercropping cultivation (Okigbo, 1982) which has replaced the traditional bush fallow system which could have been an efficient and balanced way of restoring soil fertility in the tropics. The benefits derivable from the use of organic material have however not be fully utilized in the tropics due the huge quantities required to satisfy yam needs, transportation, low or imbalanced nutrient content (Palm et al., 1997). Nitrogen is one of the most important nutrient element required by yam, its deficiency can be recognized by stunted growth, narrow and pale green leaves which start at the tips and margins (Ubakamma et al., 2000).

Potassium is highly needed by yam and its deficiency leads to a depression of yield as well as reducing starch content. The N and P reaches a maximum about two months after the unfertilized D rotundata 'cv' Ewuru germinated while entire speed of absorption reduces. In West Africa, generally, the order of frequency and the degree of response is also N>K>P.

Hence, fertilizer application is considered as quick way of meeting the nutrient requirement of yam. Yam growers can manipulate the supply of nutrient to control yield and quality through application of appropriate fertilizer type. Nevertheless, the use of inorganic has not been helpful under intensive agriculture because it is often associated with low crop yield, soil acidity and nutrient imbalance (Kang and Juo, 1980; Obi and Ebo, 1995; Ojeniyi, 2000). Continuous use of inorganic also leads to loss of organic matter, some farmer are of the opinion that application of fertilizer has deleterious effects on the pounding and storability of yam tubers (Aduayi and Okpon, 1980; Asadu,

1995).Regardless of these, complementary use of organic manures and mineral fertilizers has been proved to be a sound soil fertility management strategy in the tropics and many countries of the world (Lombin et al., 1991). High and sustained yam yield can be obtained with judicious and balanced NPK fertilization combined with organic matter amendment (Kang and Balasubramanian, 1990).

Materials and Method

The field experiment was carried out between November 2010 and September 2011 at Teaching and Research farm, Faculty of Agricultural sciences, Department of Agronomy, Ladoke Akintola University of Technology, Ogbomoso, Oyo state, Nigeria. Ogbomoso lies on latitude 8°1'N on the equator and longitude 4°1' East and the climate is mostly influenced by the North/East trade wind which is characterized with cold wind, with a drying effect starting from April to October. The temperature ranges between 28°C – 33°C with about 74% relative humidity all year round except in January, rainfall is over 1000mm per annum.

The farm site for the experiment has been previously cropped to soybean and pueraria for some month's prior the commencement of the experiment. Soil of the experimental site has the following characteristics; pH 6.1, %N 0.032, % Organic carbon 0.04, 10.67ug/g P, Ca 1.44, Mg 0.38, K 0.22, and Na 0.08 in cmol/kg soil. The test crop was white yam Dioscorea rotundata 'cv' ewuru and the plant residues were soybean and pueraria while NPK fertilizer rates were achieved through the use of NPK 15-15-15 compound fertilizer in combination with urea and Muriate of potash. The site cleared and ridged and the plots were laid out in RCBD with 4 replicates. The gap between plots was 1m while that between replicates were 2m.

The plant residues were incorporated two weeks before planting, fertilizer rate of 90-50-75kg N.P.K /ha and 45-25-37.5kg N.P.K /ha was achieved using NPK 15-15-15 compound fertilizer and excess N and K rates were met using urea and muriate of potash respectively. The fertilizer was applied in ring method to the growing yam at 2 months after sprouting. The experimental design was Randomized Complete block design with 4 replicates. There were nine treatments namely; Control (no residue, no fertilizer),No residues + 45-25-37.5 kg N.P.K/ha (50% of the recommended NPK rate for yam in the zone),No residues + 90-50-75 kg N.P.K/ha (Recommended NPK rate for yam in the zone),Incorporation of soybean residue alone, Soybean residue + 45-25-37.5kg N.P.K/ha, Soybean residue + 90-50-75 kg N.P.K/ha, Incorporation of pueraria

residue alone, Pueraria residue +45-25-37.5 kg N.P.K /ha, Pueraria residue + 90-50-75 kg N.P.K/ha.

Planting was done on December 23 by opening a hole on the ridge and one yam sett is placed with cut surface turned upward at an angle of 45^0 and covered with soil, and capping was carried out 2 weeks after planting. Staking began 3 months after planting with 2m-4m long gliricidia and bamboo stakes. The plots were weeded 3-4 times manually throughout the experimental period at 5, 6 and 8 months after planting. The data collected were subjected to analysis of variance. Means were compared using least Significant difference (LSD) at 5% probability level.

Result and Discussion

The results of the study obtained indicate that cultivation of pueraria and soybean before the commencement of the yam trial reduced nematode counts significantly compared with the control (no previous legumes).(Table 1)

Table 1: Effects of previous leguminous crops on soil nematode

Treatments	Nematode Counts
Control	125.3a
Pueraria	39.3b
Soybean	37.1b
L.S.D (0.05)	57.6

Generally, there was no significant difference among the treatments in terms of tuber yield of yam (Table 2). However, fertilizer application slightly increased yam tuber yield. Application of 50% of the recommended N.P.K rate produce slightly higher tuber yield compared with the application of the recommended N.P.K rates.

Table 2: Effects of plant residues and N.P.K fertilizer on yam yield

Treatment	Yield t/ha
Control	10.3
No residue + 45-25-37.5kg N.P.K/ha	12.2
No residue +90-50-75kg N.P.K/ha	10.8
Incorporation of soybean alone	9.0
Soybean + 45 – 25 – 37.5 NPKkg/ha	11.6
Soybean + 90 – 50 – 75kg NPK/ha	10.3
Incorporation of pueraria alone	9.5
Pueraria + 45 – 25 – 37.5kg NPK/ha	11.3
Pueraria + 90 – 50 – 75kg NPK/ha	10.4
L.S.D $_{(0.05)}$	ns

There were significant differences between 90-50-75kg N.P.K/ha rate fertilizer application compared with control alone (no residue, no fertilizer) in terms of % N of yam leaves. Incorporation of pueraria with 45-25-37.5kg N.P.K/ha rate increased % N of yam leaves compared with pueraria alone and pueraria with 90-50-75kg N.P.K/ha Soybean incorporated into the soil alone and soybean with 90-50-75kg N.P.K/ha recommended rate fertilizer slightly increased %P compared with soybean with 45-25.37.5kg N.P.K/ha (50% recommended rate).There were no significant differences among pueraria treatments in terms of %P Incorporation of soybean with 45-25-37.5kg N.P.K/ha (50% recommended rate) increased % K of yam leaves significantly compared with soybean alone. There was no significant differences among control alone and no residue with 90-50-75kg N.P.K/ha and 45-25-37.5kg N.P.K/ha in % K of yam leaves. Incorporation of pueraria with 45-25-37.5kg N.P.K/ha (50% recommended rate) had highest % K than pueraria alone and pueraria with 90-50-75 kg N.P.K/ha (100% recommended rate) (Table 3).

Table 3: Effects of plant residues and NPK fertilizer on nutrient Concentration of yam leaves

Treatments	%N	%P	%K
Control	1.85	0.15	0.49
No residue + 45-25-37.5kg NPK/ha	2.53	0.20	0.46
No residue + 90-50-75kg NPK/ha	2.74	0.19	0.49
Incorporation of soybean alone	2.05	0.19	0.51
Soybean + 45 – 25 – 37.5kg NPK/ha	2.21	0.15	0.59
Soybean + 90-50-75kg NPK/ha	2.63	0.19	0.57
Incorporation of pueraria alone	1.79	0.19	0.50
Pueraria + 45 – 25 – 37.5kg NPK/ha	2.55	0.21	0.53
Pueraria+90-50-75kg NPK/ha	2.42	0.19	0.49
L.S.D (0.05)	0.71	0.04	0.07

Several researchers have shown that nitrogen and potassium are the main nutrients limiting yam yields (Irving, 1956; Obigbesan and Agboola, 1978). Degras (1993) showed that the order of frequency and degree of response in West Africa is N greater that K, greater than P. Also, limited research on yam fertilizer response in Ghana (SRI, 1990, 1991, 1992) indicated that mineral fertilizers improved fresh tuber yields of yam. Obigbesan (1981) reported that N supply primarily determines the level of production of root crops and that an ample supply of nitrogen is essential for high yields.

In contrast to the works quoted above, there was no positive effects of N.P.K fertilizer application on fresh tuber yields of yam in the present study thereby confirming the findings of (Irving, 1950; Obihama, 1962; Amon, 1972) who reported that the response of yam to N.P.K was dependent on the soil type and location based on the experiments carried out in early 1950's in Nigeria. So, the result suggested that the recommended N.P.K rate (90-50-75 kg N.P.K/ha) was not justified in Ogbomoso because yield increase was not significant higher than the control (no fertilizer) except 50% of the recommended N.P.K rate with pueraria, which slightly increased the fresh tuber yield. The cultivation of previous legumes of pueraria and soybean greatly decreased nematode counts which was similar to the report by MCSorley et al., (1994) who noted that several cover crops may provide a means for depressing M. arenaria (root-knot nematode) population density on a short term basis to enhance yields in a subsequent susceptible crop.

The percentage elements NPK increased with the increasing rate of application of N.P.K fertilizer in yam leaves. But the best treatments observed for % N of yam leaves in the experiment was the application of 90-50-75-kg N.P.K/ha with no residues and soybean while 45-25-37.5kg N.P.K /ha with pueraria. The best treatments observed for % P in yam leaves was the application of 45-25-37.5kg N.P.K/ha with no residue and with pueraria while in % K, application of 45-25-37.5kg N.P.K/ha and 90-50-75kg N.P.K/ha with soybean performed better in yam leaves.

Conclusion

The cultivation of legumes should be enhanced for depressing nematode population density on a short-term basis to improve yields in a subsequent crop. Furthermore, NPK fertilizer application increases yam yield but 45-25-37.5 kg NPK/ha (50% recommended rate) seems adequate in this area as this will reduce cost of production and environmental pollution.

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