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Full Length Research Paper

Qualities of yam tubers grown on typic paleudults: hybrid yam and fertilizer effects

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Most fertilizer studies on yam are concerned with its effect on tuber yields. In this study yam tuber moisture, starch, ash and dry matter contents of three hybrid yams *Dioscoreae rotundata* (TDr 89/02677, TDr 89/02565 and TDr 89/02665) grown with nine combinations of N, P and K fertilizers (F_0, F_1, F_2, F_3, F_4, F_5, F_6, F_7, and F_8) on a Typic Paleudult in southeastern Nigeria were evaluated after harvest. The soil was characterized. Results showed that the soil was acidic with a pH (H_20) of 4.96 and deficient in total N (0.11%) and exchangeable K (0.06 cmol/kg) . The quality parameters were not significantly influenced by hybrid yams. Fertilizer rates increased dry matter and starch contents of yam tubers except at 90 kg N, 8 kg P and 25 kg K/ha which had 0.83 and 0.56% depressant effects on starch and dry matter, respectively. Highest significant improvement (9.5%) in starch content was achieved at a fertilizer rate of 60 kg N, 8 kg P and 50 kg K/ha, indicating the potentials of fertilizer in improving qualities of yam tubers on acid soils of soils of southeastern Nigeria.

Key words: Fertilizer, hybrid yam, starch, dry matter, Typic Paleudult.

INTODUCTION

In coastal West Africa, more than 60 million people obtain over 200 dietary calories per day from yam (Chukwu and Ikwelle, 2000). Proximate analysis of yam tubers provides information about biochemical nutritional qualities of yam tubers. High starch contents would improve mealiness, a characteristic which, according to Oyenuga (1968), could replace the undersirable texture characteristics of waxiness, gun mines and jelliness found in some *Dioscoreae rotundata* species. Variability in mineral contents of yam tubers is a function of the chemical composition of the soil on which the tubers are grown, cultural practices, time of planting and harvesting, as well as amount of water available in the soil (Osagie, 1992). Moisture content and dry matter could range from 60 – 80% and 7 – 40% respectively (Eka, 1985). The dry matter content is a measure of the photosynthates, which influence the quality of yam tuber for industrial uses. Similarly, starch content reflects its amylases and starch grain content. The smaller the grains are, the better the quality of the starch (Onwueme and Sinha, 1991).

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Although, the amount of starch in yam tuber depends, principally on age of tuber at harvest (Martin, 1979), treatments such as fertilizer applied to crops could also influence the starch content of tubers. The percentage starch content of matured yam tubers ranges from 15 - 23% (Romain, 2001). Ash content provides an estimation of the mineral present. Percentage ash in yam is highly variable, ranging from 0.7 – 2.6 (Onwueme and Sinha, 1991).

The objective of the study was to assess the influence of hybrid yams and fertilizers on the qualities of yam tubers grown on a Typic Paleudult of southeastern Nigeria.

MATERIALS AND METHODS

Experimental design

The trial was conducted on a Typic Paleudult at Umudike (05029’N; 7033’E) in southeastern agro- ecological zone of Nigeria. Some properties of the soil are shown in Table 1. The agronomic trial was a 3 x 9 factorial with three replications laid in a randomized complete block design. Treatment details are shown in Table 2. After harvest, yam tubers from the 71 plots (3 x 9 factorial x 3 replicates) were used for the post-harvest studies.

Table 1. Statistical summary of the soil properties at 0 – 20 cm depth.

Property	Mean	Standard Development	Range	CV (%)	Minimum	Maximum
pH ($H_2$0)	4.96	0.43	1.10	8.56	4.40	5.50
Sand (%)	77.8	5.25	17.0	6.74	68.0	85.0
Silt (%)	4.0	1.25	4.0	31.2	2.00	6.00
Clay (%)	18.2	4.49	15.0	24.7	12.0	27.0
Organic C. (%)	1.54	0.40	1.10	26.2	1.20	2.30
N (%)	0.11	0.02	0.06	21.0	0.09	0.15
P (mg/kg)	18.1	5.45	18.0	30.1	10.0	28.0
K (cmol/kg)	0.06	0.02	0.06	34.7	0.04	0.10
Ca (cmol/kg)	1.65	0.39	1.20	23.4	1.15	2.35
Mg (cmol/kg)	0.70	0.26	0.68	36.9	0.48	1.16
Na (cmol/kg)	0.08	0.02	0.06	27.0	0.05	0.11
EA (cmol/kg)	3.30	0.20	0.51	5.94	3.00	3.51
BS (%)	43.8	6.58	21.3	15.0	33.9	55.5

Table 2. Detail of treatments applied in the study.

Symbol	N	P	K (kg/ha)
F0	0	0	0
F1	90	8	50
F2	0	8	50
F3	90	0	50
F4	90	8	0
F5	30	8	50
F6	60	8	50
F7	90	8	25
F8	90	10	75

Factor A Hybrid yam: (i) TDr 89/02677; (ii) TDr 89/02565; (iii) TDr 89/02665.Factor B Fertilizer

Post-harvest studies

The post-harvest studies involved 21 samples laid in a completely randomized design with three replications, to constitute 71 samples. Three healthy yam tubers (large, medium, and small) were randomly selected from each of the samples, to maintain homogeneity in experimental yam samples used for the study. The yam tubers samples were peeled, cut into thin slices and mixed. Moisture, dry matter, starch and ash contents were determined according to AOAC (1990). In moisture and dry matter determination, 10 g were weighed into dried metallic Petri dishes of known masses and dried at 100 C for four hours. The dried samples were removed, cooled in desiccators and weighed. Each sample was reheated, cooled and re-weighed until constant mass was obtained. The percentage moisture content was calculated as 100 (Mass of fresh sample – Mass of oven dry sample) /Mass of fresh samples. Percentage dry matter was obtained as the difference between percentage moisture content and 100. Percentage starch was determined by specific gravity method using 100 g of the sliced samples transferred into a blender. 200 ml of water was added. The samples plus water mixture was blended for five minutes and transferred quantitatively into a 150 µm mesh sieve attached to a four-litres container. The blended samples were washed with two-three litres of water through the sieve. The sediments were allowed to settle and the supernatant decanted. The sediments in dishes of known masses were dried in oven at 60 C to a constant mass.

Percentage starch was calculated as the difference between the sum of mass of evaporating dish + starch before and after drying and mass of evaporating dish, multiplied by 100. In ash determination, one gram of the samples was heated gently in a crucible over a Bunsen flame until the food is charred. The crucible was then transferred to a muffle furnance set at 550 C and left until a while or light gray ash resulted. The ash was cooled in a desecrator and reweighed. The percentage ash was calculated as: Mass of ash = $[(W_3 – W_1) / (W_2 – W_1)] \times 100$ where W_1 = mass of empty crucible, W_2 = mass of crucible + yam before ashing, and W_3 = mass of crucible + ash.

Data collected were subjected to analysis of variance. Significant differences between treatment means were detected using standard error.

RESULTS AND DISCUSSION

The soil was very strongly acidic (pH 4.96). The dominant soil separate is sand (> 75.0%) followed by clay (< 19.0%) and 4.0% silt. The soil was deficient in primary nutrients, especially N and K, but the available P and organic carbon were medium.

The interaction (fertilizer x yam) effects on the quality parameters did not differ significantly. Discussions were therefore, centered on the main effects on yam tuber quality. The effects of fertilizer and yam on percentage moisture, starch, ash and dry matter contents of the yam tubers are presented as Tables 3 – 5. Generally, moisture, starch, ash and dry matter contents ranged from 61.2 – 65.7, 23.9 – 25.8, 2.00 – 2.50 and 35.6– 38.0% respectively, as a result of fertilizer application (Table 3). Application of fertilizer did not increase moisture content relative to the absolute control, except at 90 kg N, 8 kg P and 25 kg K /ha, where 2.34% increase in moisture was obtained. The lowest moisture content was obtained

Table 3. Percentage moisture, starch, dry matter, and ash contents of the yams tuber due to fertilizer.

N	P	K (kg/ha)	Moisture (%)	Starch (%)	Dry matter (%)	Ash (%)
0	0	0	64.2	24.1	35.8	2.20
90	8	50	62.2	25.6	37.8	2.87
0	8	50	63.3	25.5	36.7	2.53
90	0	50	63.2	24.4	36.8	2.57
90	8	0	61.2	25.6	38.8	2.77
30	8	50	63.4	24.3	37.2	3.40
60	8	50	63.4	26.4	35.8	2.47
90	8	25	65.7	23.9	35.6	3.50
90	10	75	63.4	25.8	36.6	2.00
		Mean	63.4	25.1	36.8	2.51
		SE	1.79	2.64	1.751	0.23

Table 4. Yam effect on moisture, dry matter, starch and ash contents of hybrid yam tubers.

Hybrid	Moisture (%)	Dry Matter (%)	Starch (%)	Ash (%)
TDr 89/02677	64.9	34.9	24.3	2.69
TDr 89/02565	62.3	27.9	26.1	2.77
TDr 89/02665	62.9	37.6	24.8	2.64
Mean	63.4	36.8	25.1	2.70
SE	1.79	175	264	0.25

Table 5. Improvement on the quality of yam tubers grown with fertilizer on a haplic acrisol relative to the control.

N	P	K (kg/ha)	Dry matter (%)	Starch (%)	Ash (%)
0	0	0	-	-	-
90	8	50	5.59	6.22	30.5
0	8	50	2.51	0.81	15.0
90	0	50	2.79	1.24	16.8
90	8	0	23.4	6.22	25.9
30	8	50	3.91	0.83	54.5
60	8	50	0	9.54	12.3
90	8	25	-0.56	-0.83	59.1
90	10	76	3.07	7.05	-9.09
Mean			5.09	3.89	25.6
SE			2.62	1.35	7.96

when fertilizer was applied at the rate of 90 kg N, 8 kg P and 0 kg k/ha. Percentage starch did not follow any trend. Fertilizer use increased the ash and dry matter contents, except where 90 kg N, 10 kg P and 75 kg k/ha were applied. A combination of 25 kg K/ha with N and P resulted in the lowest dry matter content. The effect of yam (Table 4) on the quality attributes assessed did not differ significantly among the hybrids tested. However, hybrid yam (TDr 89/02677) contained 4.17 and 3.18% higher moisture than TDr 89/02565 and TDr 89/02665 respectively. It is worthy of note that TDr 89/02565 gave the highest starch, ash and dry matter contents relative to other hybrids (TDr 89/02677 and TDr 89/02665).

Improvement or otherwise on the quality parameters by fertilizer to the absolute control treatment (no fertilizer) is shown in Table 4. Generally, it was observed that a combination of N and P with the lowest K rate (25 kg/ha) depressed starch and dry matter contents of the yam tubers by 0.83 and 0.56%, respectively. This, probably, suggests that in soils deficient in K; combining 25 kg K/ha with N and P could be detrimental to starch and dry matter contents. That could be an indication of nutrient imbalance in yam nutrition. Similarly, application of 90 kg N, 10 kg P and 75 kg k/ha depressed ash content by 9.09%. Other fertilizer rates also improved the quality parameters relative to the absolute control (Table 5). Highest significant improvement in starch (9.54%) among the fertilizer treatments was obtained when a fertilizer combination of 60 kg N, 8 kg P and 50 kg k/ha was applied. This fertilizer rate was found economical for seed yam production (Chukwu, 2007).

Absence of N, P or K as in PK, NK and NP did not result in significant differences among the fertilizer treatments, in any of the qualities (moisture, starch, ash and dry matter). Although landraces were not included in the study, information from literature (Romain, 2001; Eka, 1985) when compared with the results obtained suggest that the hybrids yams used have higher starch, ash and dry matter contents than landraces. Since the yam tubers were of the same age and grown on the same soil, therefore, improvements in tuber quality on fertilized plots over the control (no fertilizer) plots could be attributable to the fertilizer factors. This observation proved that agronomic practice of fertilizer use could be a strategy to improve yam tuber quality on acid sands that suffer multi-nutrient deficiencies.

Conclusion

This study, therefore, suggests that judicious use of inorganic fertilizers (60 kg N, 8 kg P and 50 kg k/ha) could be an approach to improve the quality of yam tubers grown on acid soils.

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