AN EVALUATION OF THE YIELD AND QUALITY OF SOME NIGERIAN CASSAVA VARIETIES AS AFFECTED BY AGE AND NITROGEN FERTILIZER APPLICATION

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SUMMARY

Dry matter and starch contents were highest fifteen months after planting, while cyanide titre tended to decrease with age. Fresh tuber yields ranged between 16-40 tons/ha over growth periods of 12-24 months. There were differences in response to N between cultivars tested. Increasing N fertilizer tended to increase the cyanide content of cultivar 53101 but lowered it in cultivar 60506. For industrial starch production harvesting during the period 12-15 months was optimum. Cultivars show differential physiological responses and generalizations for the species can be misleading.

RESUME

La teneur en matière sèche et en amidon atteignent leur niveau le plus élevé quinze mois après le semis, tandis que le titre de cyanure tend à décroître avec l'âge. Les rendements en tubercules fraîches se situent entre 16-40 tonnes à l'hectare sur une période de croissance de 12 à 24 mois. Les cultivars testés présentent des variations en réponse à N. L'accroissement de l'engrais azoté tend à augmenter la teneur en cyanure du cultivar 53101 et à décroître celle du cultivar 60506. Pour la production d'amidon industriel, le récolte entre 12 et 15 mois est optimale. Les cultivars présentent des réponses variables d'ordre physiologiques et toute tentative de generalisation de ces especes eput induire en erreur.

RESUMEN

Los contenidos más altos de almidón y materia seca ocurrieron quince meses después de la siembra, en tanto que la concentración de cianidas tendió a decrecer con la edad. Los rendimientos de tubérculo fresco variaron entre 16-40 ton/ha en períodos de crecimiento de 12-24 meses. Hubo diferencias en respuesta a N en los cultivares probados. El incremento de fertilizante nitrogenado tendió a aumentar el contenido de cianida del cultivar 53101 y a bajarlo en el 60506. La cosecha durante el período de 12-15 meses fue óptima para la producción industrial de almidón. Los cultivares muestran repuestas fisiológicas diferentes por lo que hacer generalizaciones puede conducir a conclusiones erróneas.

INTRODUCTION

Nigeria contributed about 7.9% of recorded world cassava production in 1970 (15) ranking fourth after Zaire with 7.5 million tons. The national average yield of cassava is 8 tons/ha obtained from peasant farms where it is grown as a subsistence crop on poor soils at the end of a crop sequence. Peasant farmers do not harvest at any fixed stage of growth but at their convenience because the crop can remain in the field for more than 24 months without deterioration. Cassava has received little research attention in Nigeria, although mosaic virus disease is known to reduce cassava yields here by about 39% and by up to 43% in East Africa[10].

Research on cassava in Nigeria began in 1932 when Faulkner studied the yield, disease resistance and general utility of local cultivars and introductions from the Gold Coast (Ghana), Sierra Leone and Trinidad.[5] In 1954, cassava improvement was restarted at the Federal Department of Agricultural Research, Moor Plantation, Ibadan. The objectives were to select mosaic disease resistant strains with high root yields, high starch and protein content, but low in cyanide content. Not less than 40,000 cassava clones were assembled during the first three years of this programme. Selected and local cultivars were compared in zonal variety trials throughout the cassava growing areas of the country. As a result the cultivars 60444, 60447, 60506 and 53101 as well as the 'sweet' cassava cultivar 44086 received 'recommended' status.

All these cultivars are, nevertheless, susceptible to mosaic disease and are now regarded as low yielding[7]. These recommended cultivars are also mostly highly cynogenic. Both IITA in Ibadan and CIAT in Colombia are now undertaking full-scale research on cassava to increase yields, evolve insect and mosaic disease resistance and reduce cyanide content. We decided to reassess those already widely distributed clones previously recommended as a background for assessing the merits of any new introductions.

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Investigations have been made of the effects of N, P and K fertilizers on the yield of cassava in Nigeria[1,4,6], but not previously on the effects of these nutrients on chemical composition. Cultivars have been tested for cyanide content[24], carbohydrate fractions[18] and food value, including the chronic effects of cyanide in cassava-containing diets[14,22,23].

RESULTS

Effect of length of growth period

Mean yields of cassava in the regions of Nigeria vary over a range of about 7.5-10 tons/ha. On poor sandy soils in Eastern Nigeria, individual field yields may reach11 tons/ha while on soils of moderate fertility yields lie between 12.5-24 tons/ha[3]. About 20 ton tuber/ha has been recorded from experimental plots in Northern Nigeria[12]. The average yield over a ten year study in a forest location in Western Nigeria was 15.6 ton/ha fresh tubers[2]. In the savanna zone tuber yields were between 8.2 ton and 18.9 ton/ha[6]. From 21 demonstration plots in Western Nigeria, Lampe[19] reported an average yield of 11.9 ton/ha without the use of fertilizer compared with 16.6 ton/ha with fertilizer. All these yield data were obtained from 12 month growth of the standard cassava cultivar 53101.

The results of a series of trials conducted by the Federal Department of Agricultural Research between 1958 and 1965 on the effect of the length of growth periods on the yield of a standard variety, 53101, and 13 local cassava cultivars showed that there were large yield increases during the periods 12-18 months and 18-24 months after planting. (Table 1). After the sixth month of growth there was no further increase however in the number of roots per plant. Thus increase in yield after this time results from further deposition in existing root tubers of starch produced by the photosynthesis.

The cultivar 53101 significantly out-yielded the best 'local' selection in almost all the locations at any growing period, the mean tuber yields of the standard cultivar being 23.5, 29.5 and 39.3 ton/ha while those of the local cultivars average 18.8, 24.8 and 31.5 ton/ha at 12, 18 and 24 months respectively. The tuber composition of the currently recommended cultivars are shown by an analysis of cassava tubers from a variety trial at Umudike, Eastern Nigeria (Table 2). In other locations starch content of up to 32.5 percent and cyanide concentrations of 350 ppm (53101) and 165 ppm (44086) are on record.

The results of experiments on changing the period from planting to harvesting begun in 1960 by the Federal Department of Agricultural Research and continued until 1972 are summarized in Figures 1-3. The fresh tuber yields, the dry matter, starch and cyanide content were all significantly affected by the age of the crop. Although the fresh tuber yield continued to increase up to 24 months, the dry matter content reached a peak at 15 months, and thereafter began to decline (Figure 1). At 12 months, the fresh tuber yield was 22.5 ton/ha and the dry matter content was 31% giving a total dry matter yield of 6.98 ton/ha. At 15 months the total dry matter yield was11.25 tons/ha, while at 24 months only 9.0 ton/ha dry matter was obtained.

Figure 2 shows that the starch percentage of fresh weight also reached a peak at 15 months, after which it decreased with age. It would appear therefore that no benefits would derive from growing the variety (53101) beyond 15 months.

The cyanide content of the cultivar 53101 was highest (310 ppm) at 15 months, and then decreased with increasing age of the plant, falling to 250 ppm at 24 months (Figure 3). This finding is analogous to results on cyanogenesis in forage sorghum in which cyanide also decreased as the plant approached maturity (16, 26, 29). The present studies indicate that if 53101 cassava is cultivated for industrial starch, it should not be harvested earlier than 12 months, but could be harvested for consumption as early as ten months since cyanide is removed in processing for human consumption.

Effect of fertilizers on yield and quality of cassava

Fertilizer application was not considered economic in the savanna zone of Western Nigeria when the market price was only N10 per ton. Fertilizer investigations carried out in the forest (Agege) and savanna (Ilora and Ogbomoso) locations of Western Nigeria indicated that 28 kg N, 11 kg P_2O_5 and 68 kg K_2O per hectare should be applied in the savanna zone, while 50 kg N, 11 kg P_2O_5 and 67 kg K_2O per hectare was indicated in the forest soils at Agege[2]. It was apparent (Fig. 4) that the yield potential of the variety 53101 did not exceed 19.0 ton tuber/ha. The data in Fig. 4 also suggest that optimum requirements of cassava are 67 kg K_2O, 30 kg N and 11 kg P_2O_5 per hectare. However, there is no official fertilizer recommendation for cassava production in Nigeria.

To study the effects of different nutrients on tuber quality cultivars 53101 and 60506 were chosen. Random samples were taken at 9 and 12 months of age for laboratory analysis. Basal dressing of 56 kg P_2O_5 and 68 kg K_2O per hectare were applied at planting. The crops were top dressed with sulphate of ammonia at the rates of 0, 67, 100, 134 and 168 kg N/ha three months after planting. There were four replicates of treatments for each cultivar.

At each sampling, four representative tubers were selected from 18 plants harvested and immediately taken to the laboratory for analysis. After washing, two tubers were peeled and split longitudinally. One half was grated for starch and cyanide determination, and the other half was cut into pieces and dried at 105° C. The grated samples were weighed, sealed up with cellophane film in conical flasks and stored in a deep freezer (-20° C) untii analysis[9]. Starch was determined by the specific gravity method as recommended by the Tropical Products Institute and HCN by the A.O.A.C. titration method.[8]

Tubers of both cultivars contained higher amounts of cyanide at 9 months than at 12 months in these experiments and the cyanide concentration decreased with the age of the plant (Fig. 5), except that between 9 and 12 months, the unfertilized cultivar 53101 given no fertilizer did not show any reduction in cyanide content (297 and 298 ppm respectively. Cultivar 60506 however, even with no fertilizer, showed a considerable reduction from 324 ppm to 199 ppm. The cyanide content of cultivar 53101 was increased with increasing N application, whereas this tended to reduce the cyanide concentration in cultivar 60506.

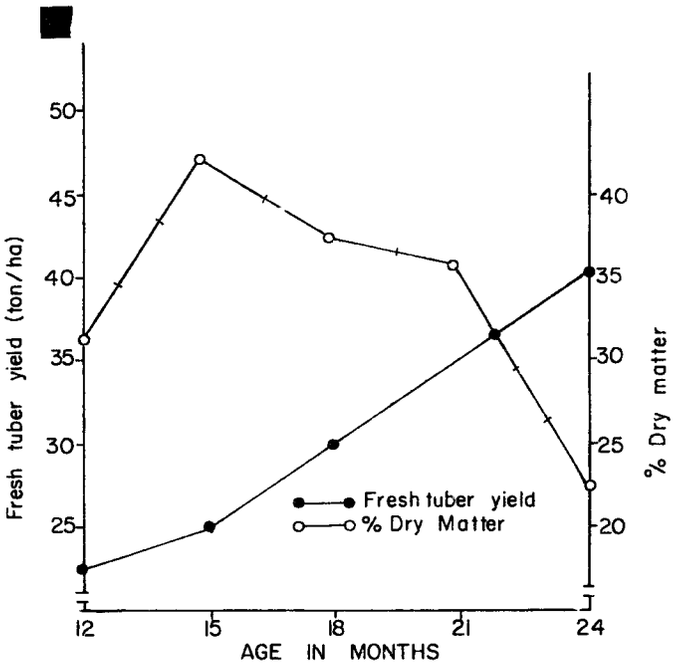


Fig.1.Cassava var. 53101: The relationship between the age of the crop, fresh tuber yield and dry matter content.

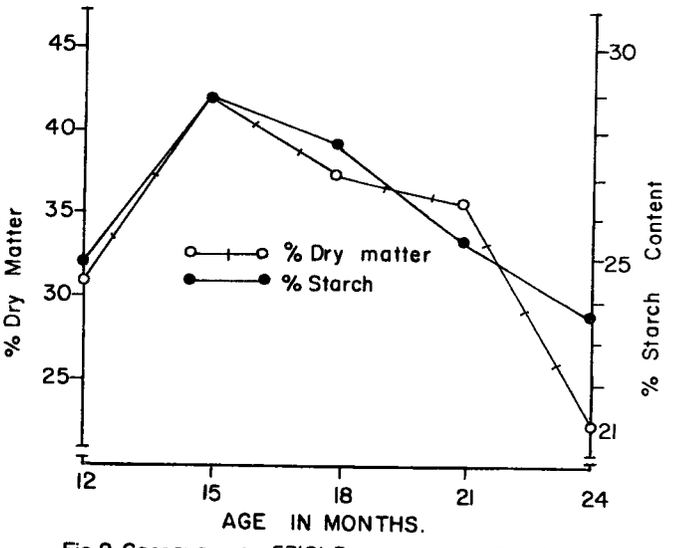


Fig.2. Cassava var 53101: Dry matter and Starch content as affected by age of the plant

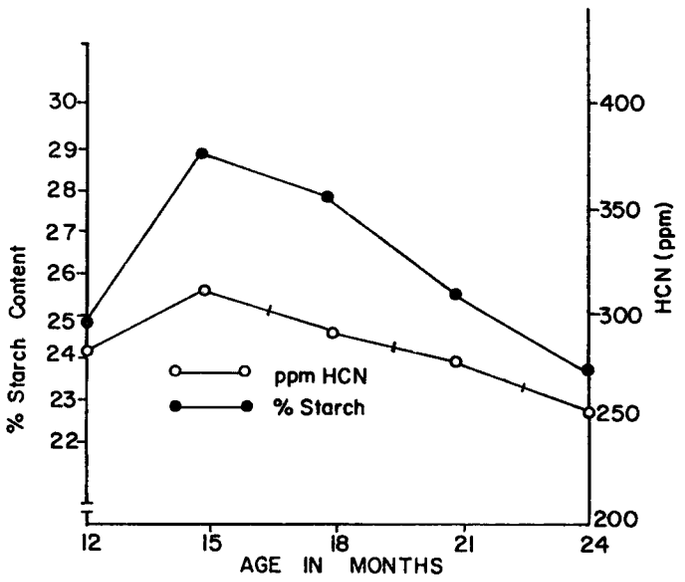
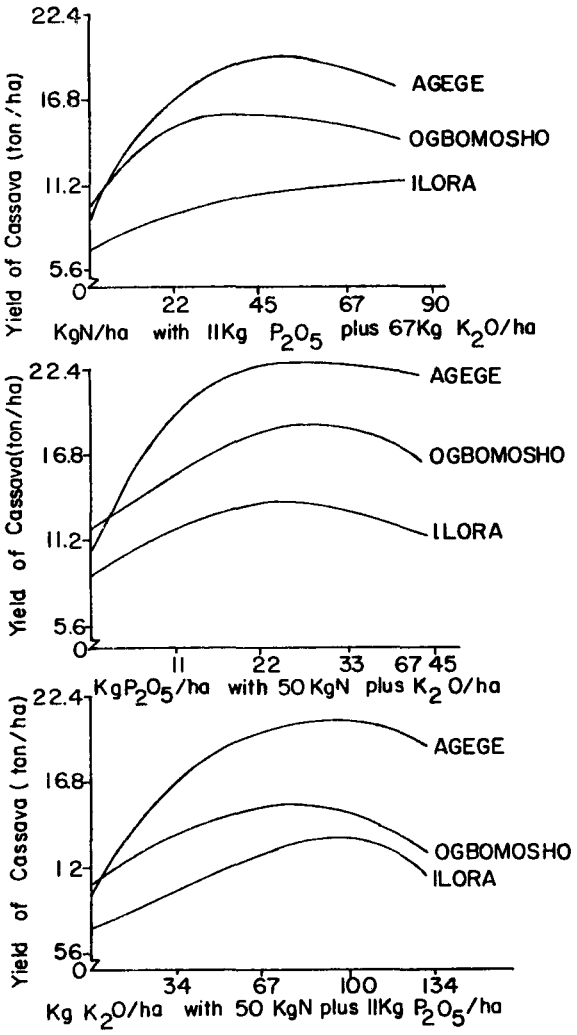


Fig.3. The relationship between % Starch HCN content and age at harvesting.



Figs.4. Response of Cassava to N,P&, K-Fertilizers(2)

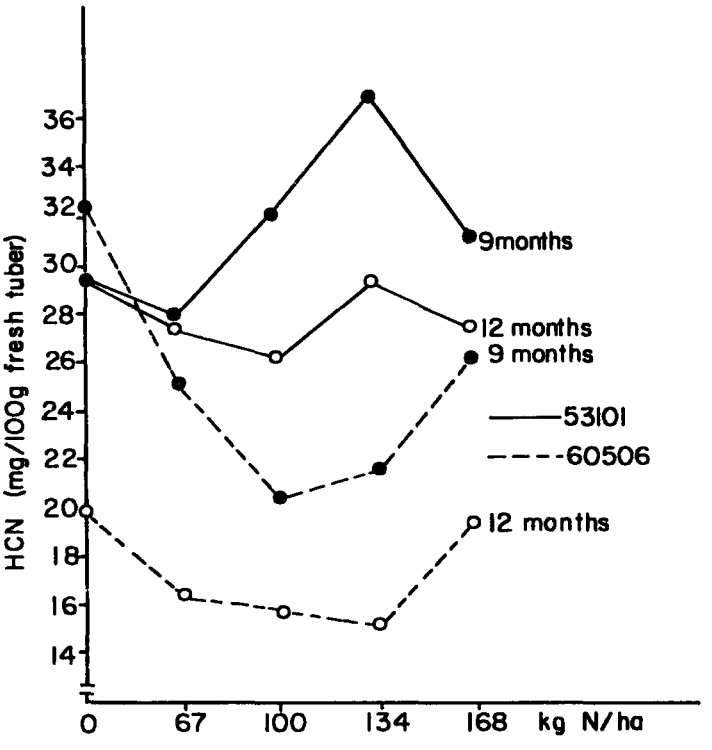


Fig.5. The influence of Nitrogen and length of growing periods on HCN content of Cassava varieties

DISCUSSION

The possible reduction of cyanide content of the cassava cultivar 60506 with increasing nitrogen application suggests that tubers of low toxicity might be produced from a 'bitter' cultivar by appropriate applications of N fertlizer. Sinha[26] observed that cyanide in cassava tubers of particular cultivars was markedly decreased by 100 mg n/ha applied as a foliar spray. The reported increase in the glucoside content of the leaves and roots of cassava[9] by N application may have been only a cultivar, and not a specific characteristic. Nitrogen dosage above 67 kg N/ha reduced starch yield of the cultivar 53101, while N levels up to 100 kg/ha tended to increase the starch yield of the cultivar 60506.

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TABLE 1

Effect of length of growing periods on the yields (ton/ha) of standard and local cassava varieties (1 ton/acre = 2.5 ton/ha)

Trial location	Variety: 53101 — Crop age in months 12	18	24	Variety: Best local — Crop age in months 12	18	24
Akure	27.5	33.8	46.0	28.3	39.8	50.5
Ilora	23.0	30.3	40.3	21.3	31.8	39.0
Agege	29.0	34.0	34.3	17.5	16.3	24.5
Benin	23.3	31.0	40.0	22.5	34.0	39.5
Badegi	22.3	20.3	31.5	15.3	14.8	19.5
Ilorin	15.8	26.3	40.5	9.3	15.3	22.8
Osara	21.5	31.8	44.0	18.3	22.5	22.3
Mean yield	23.3	29.5	39.3	18.8	24.8	31.5

(Source: FDAR Memo 103 p. 15)

TABLE 2

Analysis of cassava tubers, Umudike 1965 variety trial

Variety	Dry matter	Starch content	% HCN per 100 peeled roots	Kg gari from 1 ton unpeeled roots
53101	40.45	15.40	0.031	323.5
60444	39.31	15.40	0.033	252.8
60447	41.39	13.20	0.021	252.8
60506	41.89	15.66	0.023	252.8
44086	39.08	14.20	0.026	305.3

(Source: FDAR Memo. 103)