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EFFICIENCY AND PRODUCTIVITY OF NIGERIAN CASSAVA CULTIVARS.

BY

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ABSTRACT

Fluorescent measurement technique was adopted in determining the photosynthetic efficiencies (PE) of 10 Nigerian cassava cultivars (CVs) at 6,9,12,18 and 24 months of age using the Hansatech Plant Efficiency Analyşer (PEA). Dry matter production was monitored through 24 months at 3 months intervals starting from the 6th month. The PEs of the 10 CVs ranged from 0.51-0.89 and showed a highly significant correlation (r = 0.892*) with total dry matter yield and dry root yield (r = 0.917**). The PE measurements at 3 months had the best correlation with dry matter production at 12 months. Two CVs-TMS 30040 and TMS 30572 with the best efficiencies produced the highest dry matter. This approach could bridge the long gestation in cassava breeding.

INTRODUCTION

Development of improved cassava (*Manihot esculenta crantz*) lines to address both biotic and abiotic stresses in the diverse tropical ecologies is of top research priority in Nigeria and many other national agricultural research systems where the crop is a major staple food, industrial and export commodity. The long gestation in producing new elite genotype calls for early predictive models for simulating crop growth, management responses and productivity, Spencer (1962) and Eke-Okoro et al (2001) reviewed various measurements of crops growth rate, in particular, leaf area measurements commonly used in estimation of net assimilation rates. Although the regression of leaflet rectangular area on leaf area is recommended as a good estimate of leaf area of the cassava crops, the relationship between leaf area and dry matter production remains speculative as factors such as chlorosis by pathogens ad insect pests, moisture and nutrient stresses impair the efficiency of the photosynthetic efficiency apparatus. To be of use, the method must measure the photosynthetic efficiency (PE) of the index plant part accurately (Okeke, 1978) and rapidly at an early growth stage, and the efficiencies must correlate well with both final dry root yields and total dry matter production.

Information provided by studies in the biophysics of fluorescence induction and its role in the primary processes of photosynthesis has now been accepted as an intrinsic indicator of photosynthetic reactions in chloroplast of green plants (Schreiber and Bilzer, 1986). The plant efficiency analyzer (PEA) of Hanasatech instruments Ltd with its sensor unit of an optical assembly provides powerful illumination of the leaf and detection of the consequent fluorescence signal. Using the operational manual, the PEA enables complex measurements to be carried out with speed and simplicity and is used for measurements of the photochemical efficiency of plants in specific environmental or induced conditions. In this study, the PEA was used to measure the photosynthetic efficiencies of 10 Nigerian cassava cultivars and establish possible

MATERIALS AND METHODS

Ten cassava cultivars; TMS series 5814, 518, 1095-D, 30572, 4092, 4488, 4492, 30040, 4080 and 30337, selected for high performance, were planted in the research farm of the National Root Crops Research Institute (NRCRI), Umudike, Nigeria ($5^0 2^I$N, $7^0 32^I$E; 122m above sea level) in 10 x 8 m plots in a randomized complete block design. Planting was on ridges 1 m apart in June 1998. A blanket application of 60 kg N, 25 kg P, and 50 kg K fertilizer was applied. Ten treatment replicated four times were involved. Samples of 6 plants per plot were taken at 6, 9, 12, 18, and 24 months after planting (MAP) for growth analysis. Samples were dried at 80^{0}C to constant weights.

Fluorescence measurements were made starting at 3 MAP, using the PEA on each of 8 plants/plot before sampling. The mid-lobe of the 4th fully expanded leaf from the apical whorl, established for the measurements and temperature, relative humidity and radiation were recorded at each sampling period from 10 a.m.

In fluorescence measurement, the PEA displays a maximal fluorescence signal (FM) upon excitation of the chloroplasts by an array of high intensity light emitting diodes and a low level signal (FO) giving a difference (FV) known as the variable component of fluorescence. The ratio FV/FM has been shown to be proportional to the quantum yield of photochemistry (Butler and Kitajima, 1975) and shows a high degree of correlation with the quantum yield of net photosynthesis of intact leaves (Bjorkama and Deming, 1987). The ratios were regressed on dry matter production at the various stages to evaluate the productivity of the cultivars.

RESULT

The pattern of dry matter accumulation over time varied with cultivar (Fig. 1). Cultivar TMS 30572 maintained a steady increase in dry matter yield from 6 MAP, peaking at 18 MAP with the highest dry matter yield. Total dry matter production at 12 MAP was highest for TMS 30337 followed by TMS 4092 and TMS 30572. Dry root yield at 12 MAP followed the same pattern as the total dry matter yields at the same age (Fig. 2).

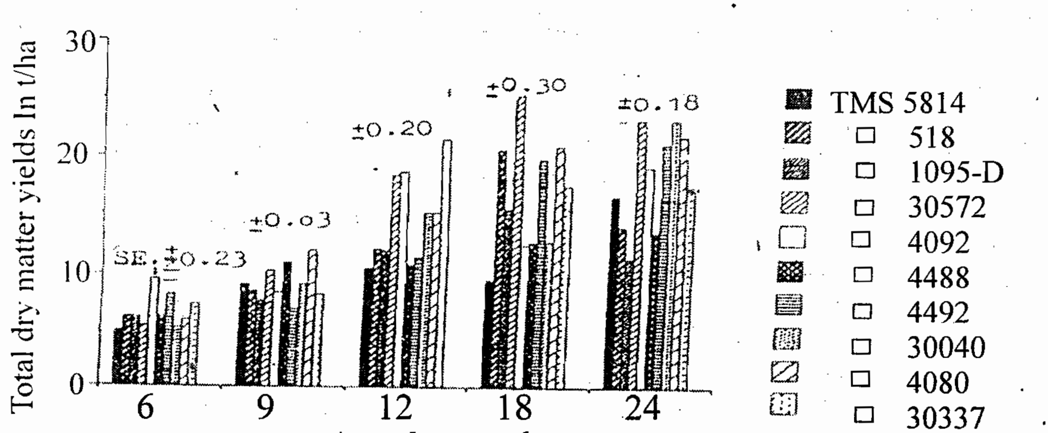
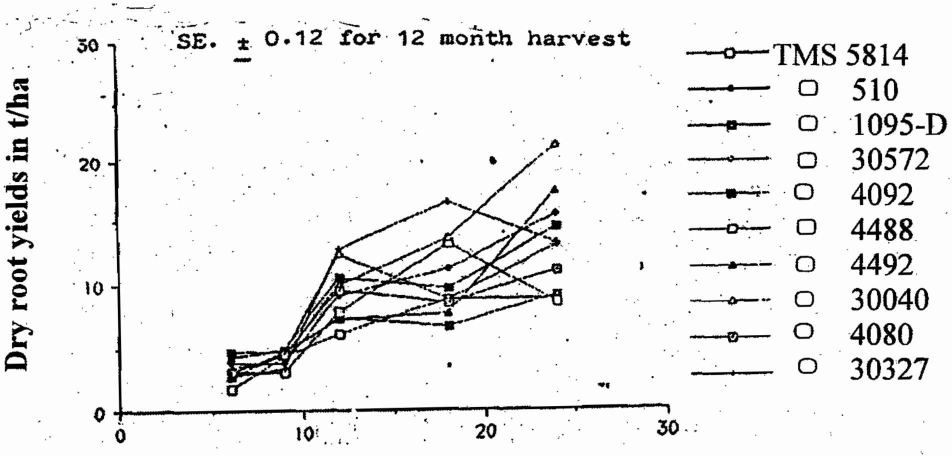


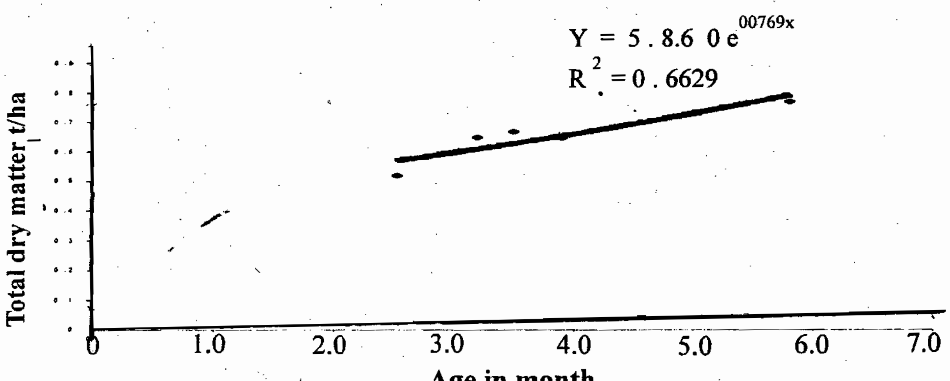
Fig. 1. Total dry matter production over time



Age in months.

Fig. 2 Dry root yields of 10 cassava varieties over time

Dry root yield was highest at 24 MAP for TMS 30040 and lowest for TMS 5814, 1095-D and 4488. The pattern of dry matter production was the same both for dry matter accumulation and that partitioned to storage roots. There was an early exponential rise, depicting the basic concepts of whole-plant growth (Fig. 3, and 4).



Age in month

Fig. 3 . Generalized growth curve of 10 cassava varieties

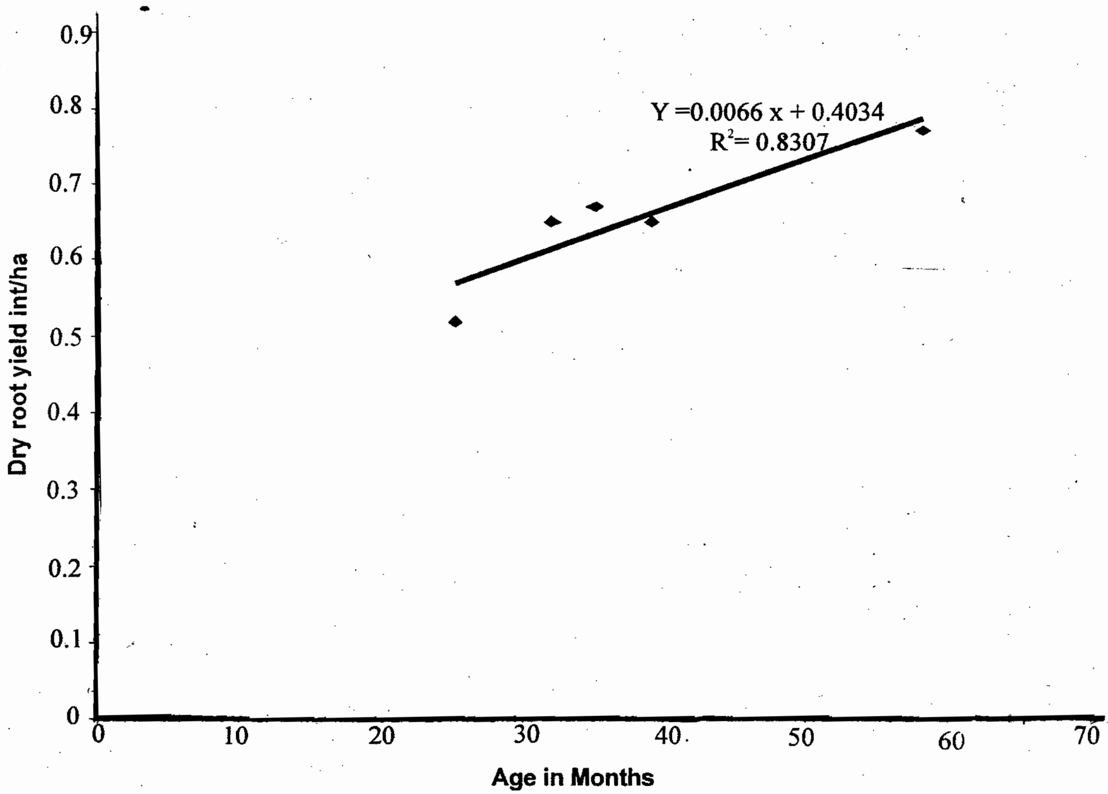


Fig. 4. Dry root yields over time

The photosynthetic efficiencies (PE) of the 10 cultivars regressed on their total dry matter yields at 12 MAP showed that only PE at 3 MAP (Fig. 5) had a highly significant correlation (r=0.891). PEs measured at 6, 9 and 12 MAP had low correlation co-efficient and readings at 18 and 24 MAP had relation with dry matter production. Regression of PE at 3 MAP on dry root yields at 12 MAP (Fig. 6) also showed a significant correlation (r=0.730). the growth rates of the varieties were closely related to their photosynthetic efficiencies (Fig. 7) with PE as high as 0.972.

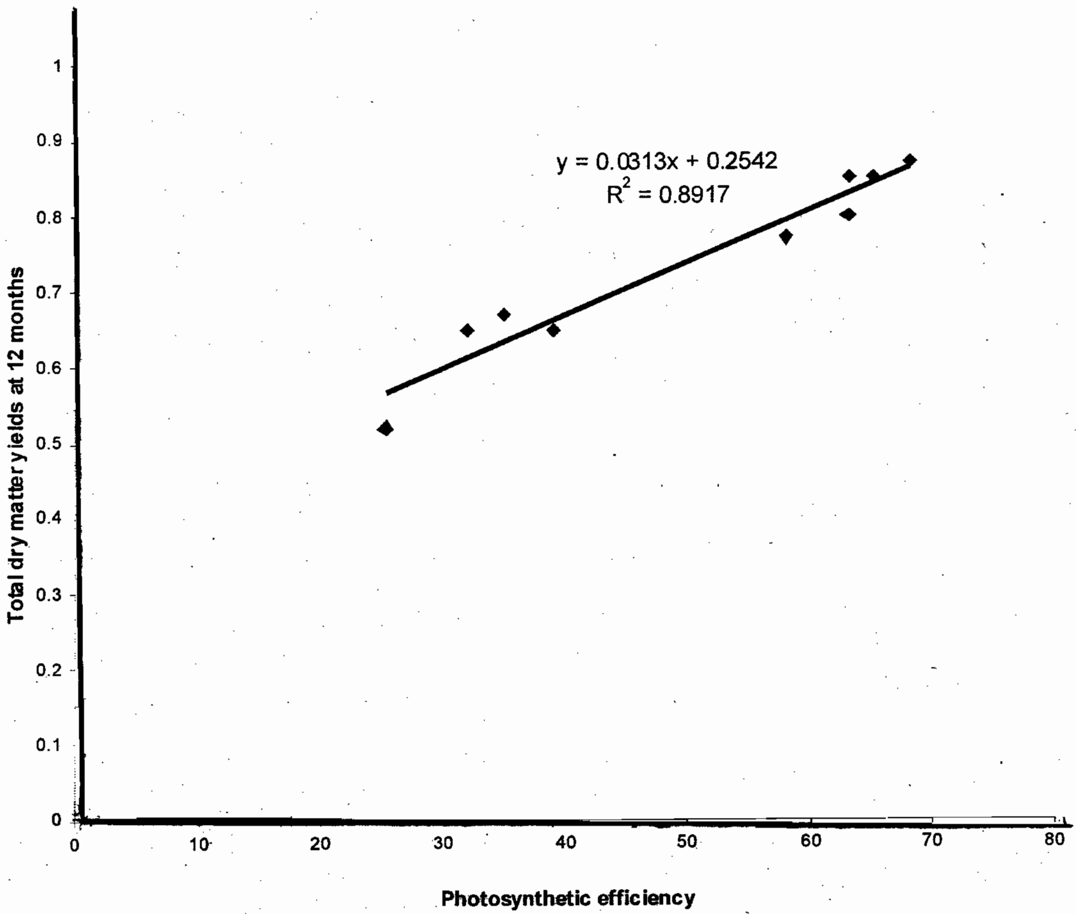


Fig. 5. Photosynthetic efficiency at 3 months

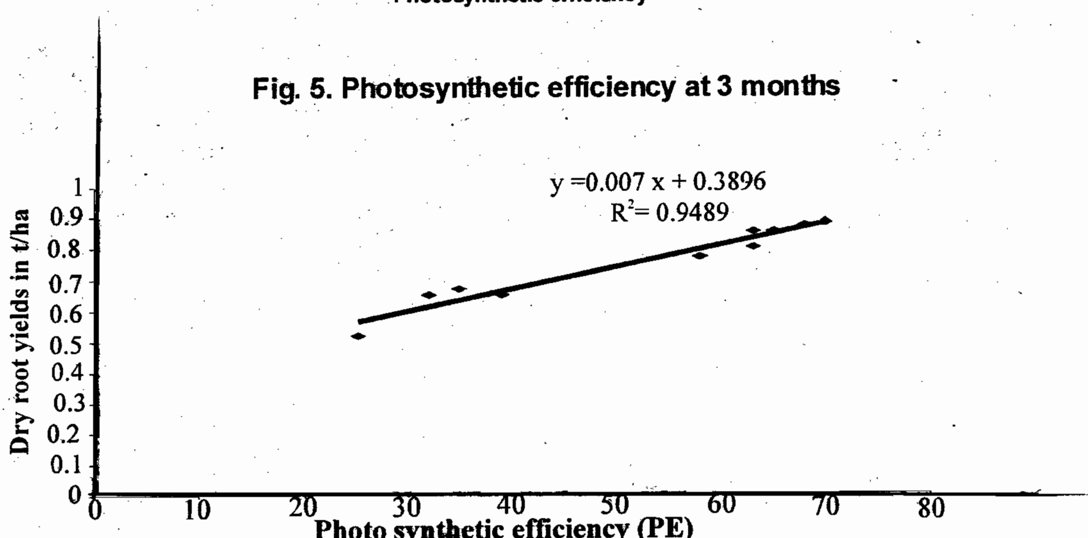


Fig. 6 . Regression of PE at 3 months on dry root yields at 12 months

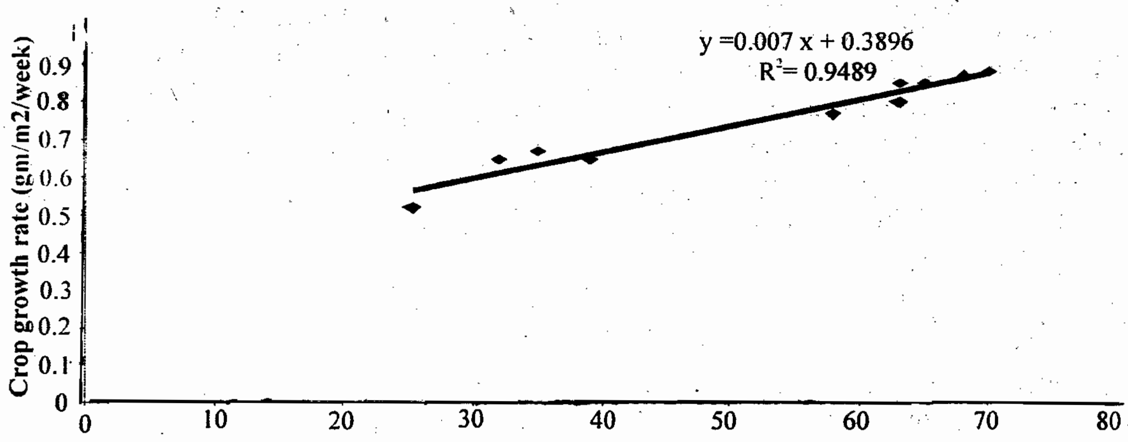


Fig. 7 . Regression of PE on crop growth rate (C G R)

DISCUSSION

The pattern of dry matter accumulation and partitioning to the storage roots shows a gradual rise in the first 9 months for all the cultivars and significantly high increases at the 12th month for cultivars TMs 30337, 4093 and 30572.

Increases beyond this age were not significantly high except in cultivar TMS 30572. the first 9 months of growth included 5 months of dry season with total precipitation of 187. 8 mm. However, the first 3 months of growth was a stage at which growth conditions were optimum (e.g. rainfall was 1232.4 mm for the period) with full development leaf area and other determinants of yield. The PE measured at this time proved more sensitive to subsequent crop performance than later measurements. The resurgence of growth following the return of the rains in March resulted in rapid assimilation and high yields dry matter at the 12th month (June, 1993). Subsequent addition of assimilation was affected by additional 2 months of dry season for the 18 month harvest and 5 months dry season for the 24 month harvest when totals of 53.1 mm and 286.1 mm of rainfall were recorded respectively, although the cultivars responded differently to the conditions. The high correlation between PE measured at 3 months with total dry matter production, dry root yield at 12 MAP and crop growth rate is noteworthy as the simplicity offered by this approach makes screening for high yields in breeding possible at an early stage. Similar observation was recorded by Eke-Okoro (2001). The optimum planting time for cassava in Nigeria is June-July (Okeke, 1981). This affords the crops good growth environment to establish the determinants of yield, which can be monitored using the PEA before the onset of moisture stress. It was evident from the regressions that the yield determinants established in the first 3-4 months of growth sustained through subsequent varying stresses in the environment. The PEA measures directly the inherent photosynthetic capacity of the plant obviating the limitations of other estimations of productivity such as relative growth are, net assimilation rate etc. Its portability and ease of use allow screening measurements of photochemical efficiency to be undertaken in trial plots or glass houses on a repetitive basis.

In conclusion, the highest yielder at 12 months:- TMS 30337. TMS 30572 and TMS 4092 exhibited the highest photochemical activity at the 3 month of growth and the interdependence of these phenomena is exploitable for rapid screening in the development of improved cassava lines.

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