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Influence of agro-ecological zones and plant age on the net assimilation, relative and crop growth rates of cassava

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Abstract: Five cassava genotypes were grown at three agro-ecological zones. Plants were sampled for net assimilation, crop growth and relative growth rates at four, six, eight, ten and twelve months after planting. The genotypes were arranged in a randomized complete block design, with four replicates. Cassava at the wetter agro-ecological zones had higher crop and relative growth rates than those at the drier agro-ecological zone. Plant age, agro-ecological zone and genotype effects were not important factors in determining the net assimilation rate of cassava. The lowest yielding genotype had the highest net assimilation rate demonstrating that a high net assimilation rate does not always result into high yields suggesting that net assimilation rate is not a good indicator of growth performance of cassava. The wetter agro-ecological zones had a positive effect on crop and relative growth rates , while the drier agro-ecological zone had a negative effect suggesting that the agro-ecological zone effect is an important factor in determining them. Cassava crop and relative growth rates were highly positively correlated to root yields. Therefore, breeding and selection for cassava genotypes with the highest crop and relative growth rates and hence yields may be done at the drier agro-ecological zone.

Key Words: Drier, genotypes, growth, indicator, negative, performance, positive, root, wetter, yields

Introduction

Breeding and selection of cassava varieties according to prevailing environmental characteristics can ensure optimal performance (IITA, 1990). A low net assimilation rate will result into low yields and vice versa. Net assimilation rate is a relatively constant index of growth that is independent of cassava plant size (Ekanayake, 1996). Crop growth rate on the other hand gives the rate of dry matter production per unit area of land, an important index of agricultural productivity, or rate of dry matter production. The crop growth rate measures the efficiency of the crop to produce biomass over time (Ekanayake, 1996). Osiru *et al*., (1995) reported that drought stress reduced size, number, and fresh yield of cassava roots. Baker *et al*., (1989) showed that drought reduced cassava dry matter production and yield. The study's objective was to show how agro-ecological zones and plant age affected the net assimilation, crop and relative growth rates of cassava.

Materials and Methods

Five cassava genotypes were planted in 3 agro-ecological zones and sampled for net assimilation rate, crop and relative growth rates at 5 plant ages. Ibadan, Mokwa, and Minjibir received a mean of 1330 mm, 1083 mm, and 679 mm of rainfall per annum, respectively. Ibadan, Mokwa and Minjibir had a mean annual potential evapo-transpiration of 1403-mm, 1553.7-mm 2023-mm per annum respectively. Ibadan had higher mean gravimetric moisture content of 8.7% than Mokwa (4.8%) and Minjibir (4.7%). The 5 genotypes were TMS 30001, TMS 4(2)1425 non-pubescent variant, TMS 50395, TME1 and TME2. the genotypes were arranged in a randomized complete block design net assimilation rate, crop and relative growth rates were measured or computed at 4, 6, 8, 10 and 12 months after planting according to methods described by Ekanayake (1996). The data were subjected to analysis of variance. The SAS computer package was used to process the data. Curves and LSD bars were generated using the Microsoft Excel data processing application.

Results

Net assimilation rate

Genotypes and plant ages significantly affected net assimilation rate (NAR) while agro-ecological zones (AEZ) did not (Table 1 and Fig. 1). At Ibadan, NAR of cassava increased between four and eight months after planting (MAP) and then decreased at 12 MAP. TMS 30001 plants had significantly higher NAR than the other genotypes. At Mokwa, NAR peaked at six MAP and decreased rapidly thereafter. TMS 30001 and TMS 4(2)1425 had significantly higher NAR than other genotypes. At Minjibir, NAR peaked at four MAP, fell at six MAP, rose at eight MAP and decreased rapidly thereafter. TMS 4(2)1425 had the lowest NAR. TMS 30001 had the highest net assimilation rate both within and across agro-ecological zones.

Table 1. The effect of agro-ecological zones and genotypes on the net assimilation rate (g/m^2/day) of cassava plants in Nigeria

Genotypes	Net assimilation rate (g/m^2/day)			
	Ibadan	Mokwa	Minjibir	Means
TMS 30001	6.63	6.58	5.18	6.13
TMS 4(2)1425	4.06	5.88	3.33	4.42
TMS 50395	4.35	4.20	4.84	4.46
TME2	4.07	5.39	4.88	4.78
TME1	3.63	5.23	4.72	4.53
Means	4.55	5.46	4.59	

$LSD_{0.05}$ (agro-ecological zones) = 0.90, $LSD_{0.05}$ (genotypes) = 1.17

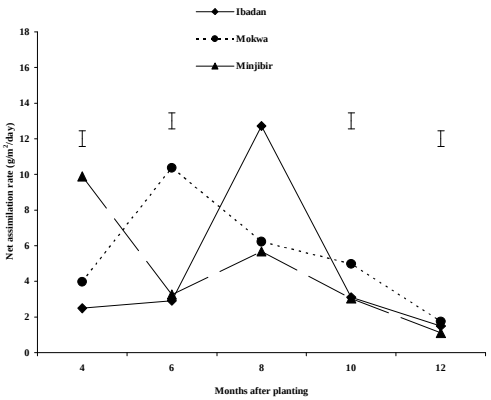

Figure 1. The effect of agro-ecological zones and plant age on the net assimilation rate of cassava planted at Ibadan, Mokwa and Minjibir, Nigeria. Vertical bars represent least significant differences (LSD) between means (P = 0.05)

Crop growth rate

Agro-ecological zones, genotypes and plant age significantly affected the cassava crop growth rates (CGR). Cassava at Mokwa had significantly higher CGR than at Ibadan and Minjibir (Table 2, Fig. 2). TMS 50395 had significantly faster CGR than those of TMS 30001, TMS 4(2)1425, TME2 and TME1. At Ibadan, CGR peaked at six MAP and then dropped gradually to 12 MAP. At Mokwa and Minjibir, CGR rose from four months to peak eight MAP and then fell thereafter. Generally, CGR peaked at 6-8 MAP and fell thereafter. Both within and across agro-ecological zones TMS 50395 plants had the highest CGR.

Table 2. The effect of genotypes and agro-ecological zones on the crop growth rate (g/m^2/day) of cassava plants in Nigeria

Genotypes	Crop growth rate (g/m^2/day)			
	Ibadan	Mokwa	Minjibir	Means
TMS 30001	3.37	4.12	1.40	2.96
TMS 4(2)1425	2.98	4.70	1.52	3.07
TMS 50395	4.13	5.53	3.73	4.46
TME2	3.44	4.86	2.30	3.54
TME1	3.82	5.39	2.55	3.92
Means	3.55	4.92	2.30	

$LSD_{0.05}$ (agro-ecological zones) = 0.77, $LSD_{0.05}$ (genotypes) = 0.44

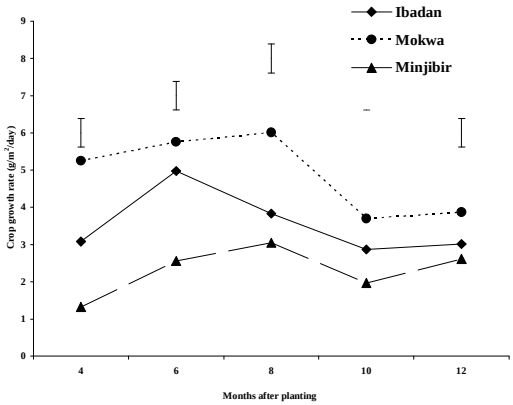

Figure 2: The effect of agro-ecological zones and plant age on the crop growth rate of divergent cassava genotypes planted at Ibadan, Mokwa and Minjibir, Nigeria. Vertical bars represent LSD between means (P = 0.05)

Relative growth rate

Agro-ecological zones, genotypes and plant age significantly affected the relative growth rate (RGR) of cassava (Table 3 and Fig. 3). Cassava at Mokwa had significantly higher RGR than at Ibadan and Minjibir. At Ibadan, all genotypes had similar RGR. At Mokwa, TME1 had significantly higher RGR than TMS 30001 and TMS 4(2)1425 while TMS 50395 and TME2 had an intermediate RGR. At Minjibir, TMS 50395 had significantly higher RGR than those of TME1 and TME2 and TMS 30001 and TMS 4(2)1425. Relative growth rate of cassava plants decreased gradually with age among all genotype at all agro-ecological zones.

Table 3. The effect of agro-ecological zones and genotypes on the relative growth rate (g/day) of cassava plants in Nigeria

Genotypes	Relative growth rate (g/day)			
	Ibadan	Mokwa	Minjibir	Means
TMS 30001	0.031	0.032	0.026	0.029
TMS 4(2)1425	0.030	0.032	0.025	0.029
TMS 50395	0.031	0.033	0.030	0.032
TME2	0.030	0.033	0.028	0.031
TME1	0.031	0.034	0.028	0.030
Means	0.031	0.033	0.027	

$LSD_{0.05}$ (agro-ecological zones) = 0.001, $LSD_{0.05}$ (genotypes) = 0.001

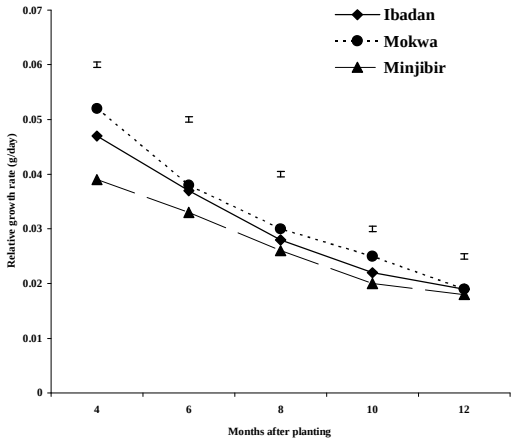

Figure 3: The effect of agro-ecological zones and plant age on the relative growth rate of cassava planted at Ibadan, Mokwa and Minjibir, Nigeria. Vertical bars represent LSD between means (P = 0.0

Discussion

The net assimilation rate in both wet and dry agro-ecological zones was similar. The highest NAR was obtained at the onset of drought stress across agro-ecological zones, which may have been a result of leaf loss rather than an increase in assimilation. The decrease in biomass and an increase in leaf area index at 12 MAP, lead to a reduced NAR. The reduced NAR at this period of rapid growth could have been as a result of enhanced rapid leaf production and expansion rather than biomass production and hence leaves could have been the preferred sinks at this stage. Studies by Akparobi *et al*., (1998) suggested that the NAR of cassava exhibited an irregular pattern and decreased with age, which concurred with our results. The highest yielding genotypes could have been expected to have the highest NAR all things being equal. Similarly, the highest NAR could have been expected during rains, when rapid growth was taking place, rather than during drought. Since the foregoing was not the case, these results had the overall implication that NAR is not a good indicator of productivity of cassava or a good screening criterion. Cassava at Mokwa and Ibadan (wetter zones) had almost twice the growth rate of that observed at Minjibir (drier zone), implying that moisture was playing a significant role in influencing CGR. The results of work by Keating *et al*., (1982) showed that cassava CGR exhibited a linear response to that of temperature that partially agreed with our results. Cassava at Mokwa with a much higher mean temperature and solar radiation than Ibadan had the highest CGR. However, cassava at Minjibir, which received the highest, mean solar radiation and mean temperature, and lowest mean rainfall had the lowest CGR emphasizing the suggestion that moisture significantly influenced CGR. Significantly, lower CGR was recorded during the wet than the drought period, which implied that other factors could have influenced CGR other than moisture. Plants at Mokwa and Ibadan, the wetter agro-ecological zones, had higher relative growth rate than plants at Minjibir, the drier agro-ecological zone. Our results concurred with those of Nwosu and Onofeghara (1992) who observed that the RGR of cassava seedlings decreased under higher and longer drought stress. However, our results contradict those of Akparobi *et al*., (1998) that demonstrated that RGR of cassava subjected to different environments were similar but concurred with their observation that RGR decreased with age. It is possible that sink capacity influenced RGR as most sinks, like cassava roots and leaves, have an optimum capacity. It is also probable that the efficiency of cassava to produce more biomass decreased with age. Crop growth and relative growth rates were positively associated with yield of tuberous roots. This implies that an increase or improvement in any of these parameters means a corresponding increase in tuberous root number and yields. Since crop and relative growth rate of cassava plants changed with agro-ecological zone or environment, breeding and selection of genotypes for the above parameters should be done at the drier agro-ecological zone where they are likely to be subjected to the highest selection pressure.

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