Extra-early maturing cassava varieties: breeding status and progress

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Introduction

Cassava is the most important of the root crops in the tropics and ranks fourth after rice, sugarcane and maize as a source of calorie for human needs (CIAT, 1992; IITA, 2000). It is a major staple for about half of the Nigerian population and nearly 50 million tonnes of fresh cassava is produced annually in the country (FAOSTAT, 2008). Cassava's long growth cycle makes it relatively difficult for the crop to be readily available on time to farmers and consumers for food and income. Rainfall pattern in some parts of the tropics where rain lasts for about 6 months or less provides distinction between rainy and dry seasons. Early maturing (EM) varieties shorten the growth period from planting to harvesting and better fit into environments with short rainy season, reduce exposure to biotic and abiotic stresses thereby increasing productivity (Nweke *et al*., 1994). The importance of cassava to humanity in ensuring food security; the ever increasing economic importance of cassava as an industrial crop; and the problem of drought spell in the savannah justify the need to improve cassava for high and early root yield (early maturity).

Bulking in cassava

Bulking refers to the secondary swelling or thickening of the storage roots as they are filled with excess assimilates after the plant might have satisfied the needs for respiration and vegetative growth. The cyclical accumulation of dry matter in storage roots of cassava is responsible for the increase in yield experienced over the growth period. Wholey and Cock (1974) stated that bulking commences in cassava after 2 months of growth while Okogbenin and Fregene (2002) reported starch initiation as early as 6 weeks after planting (WAP) and rapid differentiation in root size at 9 WAP. Root yield is directly influenced by the rate and duration of bulking with highest yielding genotypes having the highest rate of bulking for the longest period of time (Okogbenin and Fregene, 2002). Early bulking (EB) cassava varieties start bulking early and bulk more rapidly than the late bulking (LB) varieties, hence, the EM variety (A) gives higher yield than the late maturing one (C) at early stage of development (Figure 1). All the three varieties are high yielding but the LB variety leaves it late before rapid bulking. Variety B is an intermediate between LB and EB varieties.

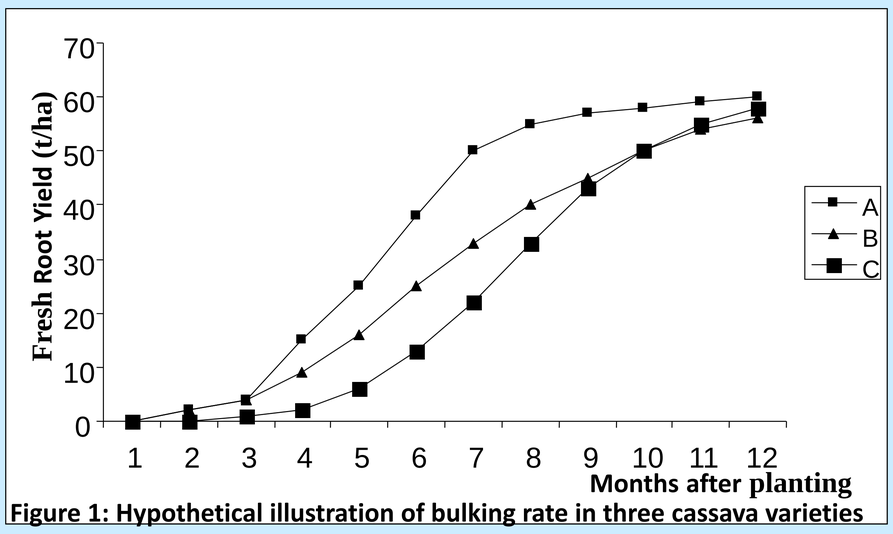

Figure 1: Hypothetical illustration of bulking rate in three cassava varieties

The breeding status for early maturity in cassava

Crop breeding can be successfully carried out when there is an ample availability of germplasm resources and thorough understanding of such available germplasm resources. Cassava germplasm is characterized by a wide genetic diversity which is used by breeders to improve cassava yield, quality and adaptability to biotic and abiotic stresses (Hershey and Jennings, 1992; El-Sharkawy, 1993). A cassava germplasm containing nine hybrid populations (COB-1 to COB-9) is currently maintained by Department of Agronomy, University of Ibadan, Nigeria. Each of the nine populations were developed through hybridization between an EB and a LB parents at National Root Crops Research Institute (NRCRI), Umudike, Nigeria. The progenies were evaluated for root yield, fresh shoot weight, number of storage roots and harvest index at seedling, clonal and preliminary evaluation stages seven months after planting (MAP) at Umudike to identify early maturing (EM) genotypes. Thirty-two selected EM genotypes and 2 check varieties (TMS 98/0505 and TMS 30572) were evaluated further for early maturity and associated traits at three locations in Nigeria (Figure 2) in two seasons. Top EM genotypes with mean higher dry root yield (DRY) than the check varieties were identified after the multilocational trial (Figure 3). COB-7-25 gave significantly higher DRY than the best check variety (TMS 98/0505) across the 3 locations while other 5 genotypes gave relatively higher DRY than the check. The EM cassava genotypes had significantly higher mean DRY at 7 MAP at Otobi than Ibadan and Umudike (Figure 3). The top genotypes at different locations are to be assessed in the pre-release trial in Nigeria so that the best genotypes can be nominated for release to farmers. However, there is need to develop extra-early maturing cassava varieties using the available germplasm resources through selfing and hybridization among the best EM cassava varieties.

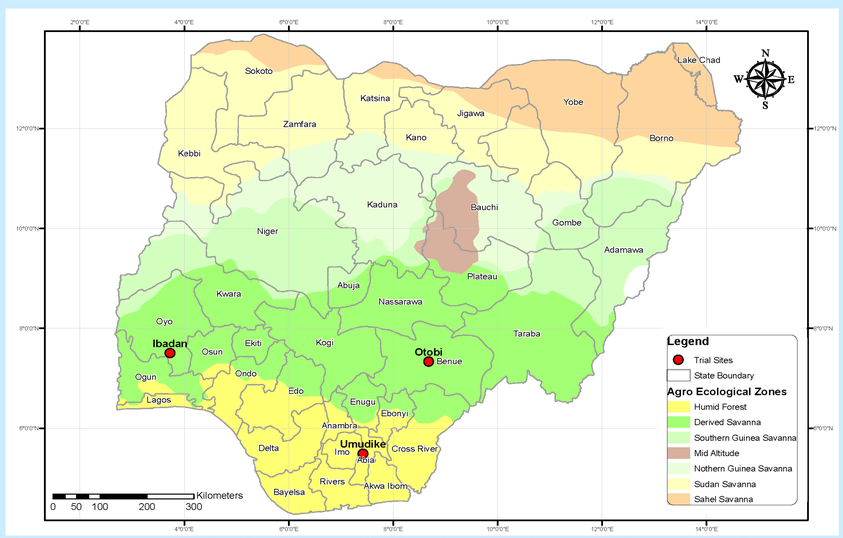

Figure 2: Agro-ecological map of Nigeria showing the three locations used for multilocational trial of the selected early maturing cassava genotypes.

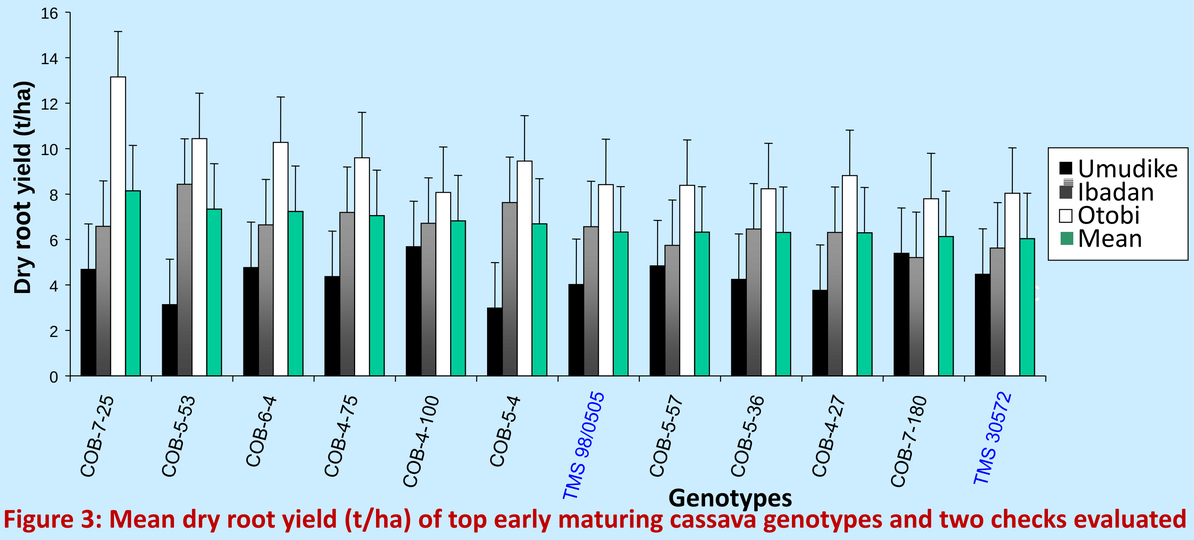

Figure 3: Mean dry root yield (t/ha) of top early maturing cassava genotypes and two checks evaluated at three locations in Nigeria 7 months after planting

MAS in breeding for early maturing cassava varieties

Different favourable alleles are involved in the control of most important agronomic traits, hence, phenotypic selection for such traits may be less efficient compared to marker-assisted selection (MAS). MAS is much more important in selecting for traits that are difficult to evaluate or which are expressed late in the growth cycle. Thus, MAS should significantly reduce the costs associated with breeding schemes frequently used in cassava improvement programmes (Okogbenin, 2004). Biotechnology cannot replace conventional breeding methods but the two tools can complement each other to facilitate improvement in crop yield and quality. Some 542 simple sequence repeat (SSR) markers were used to screen nine cassava hybrid populations (COB 1 to 9) for molecular markers associated with early maturity (early bulking and high yield) in cassava. Nine SSR markers were found to be closely associated with EM in six of the nine populations. Seven of the nine QTLs to which the markers are linked explained for 10% or more of the phenotypic variation indicating that the seven markers are linked to major QTLs associated with EM in cassava. However, there is need to identify SNP markers associated with the trait because SNPs are more reliable molecular markers. This will enable transformation of genotyping for EM in cassava from use of SSR markers to that of SNP markers platforms thereby encouraging use of high throughput technology.

Planting material for propagation

Harvesting of cassava towards the end of rainy season at about 7 to 8 MAP in an environment with distinct rainy and dry seasons may constitute problem in terms of planting material for propagation at the beginning of next rainy season. The farmer cannot establish a new field at the beginning of dry season under rain-fed agriculture and cassava stems can hardly be stored for more than 2 weeks under natural condition before drying up. Also, storage of stems for months in a conditioned environment may not be practicable for cassava production due to the magnitude of work involved. There is therefore need to develop a strategy that will ensure availability of enough planting materials during the following planting season for the farmer to establish a new field. The strategy being proposed to solve this problem is termed "Tithing in cassava production". This strategy requires that each farmer reserves about ten percent of his/her farmland for stem multiplication. The farmer can harvest this portion of the field when he/she is ready to establish new field the following season, sell/process the roots and use the stems for propagation. However, there is need to test this proposal with some farmers and perfect the strategy.

Conclusion and Future Perspectives

The extra-early maturing (EEM) cassava genotypes with higher DRY offer cassava growers high productivity 7 – 8 MAP. EEM cassava genotypes will ensure shortened production period and thereby solve the problem of drought spell and short rainy season experienced in the dry savannah. This is important for cassava regarding the recent global climatic changes. Cultivation of the EEM cassava genotypes will also reduce the period over which farmers wait before they can get some food or income from their farms and thereby improve the role of cassava as a food security crop. In addition, extra-early maturing variety may be important to young farmers starting their own farm and requiring early harvest. There is need to demonstrate the early maturity trait to farmers through participatory on-farm evaluation across the country.

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