Bridging the Cassava Productivity Gap Between Africa and the World: Identification of Elite CIAT Lines Adapted to Nigerian Agro-ecologies

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INTRODUCTION

Latin America (LA) is the center of genetic diversity of cassava and a source of invaluable germplasm for farmers and plant breeders. Elite LA cassava germplasm with desirable traits introduced from CIAT into Africa via seeds in the 90s were not adapted due to their susceptibility to the devastating cassava mosaic disease (CMD) - the most important cassava disease in Africa. To get around this problem, elite LA materials and CMD resistant cassava clones were used in a recurrent selection breeding scheme to combine useful genes from LA and CMD resistance delaying, (over 10 years is required for crosses and multi-stage evaluation), the desired impact. The discovery and mapping of a single dominant gene for CMD resistance (Akano et al., 2002) provided an opportunity to conduct marker-aided introgression of CMD resistance into LA germplasm in a cost-effective manner and within a short period, about eighteen months. We report here activities to fast-track the transfer and use of LA germplasm for increased cassava productivity in Africa and how this delivery scheme reduces drastically the length of time required for developing new varieties from the time the germplasm are acquired to the release of new varieties and dissemination to farmers.

MATERIALS AND METHODS

Germplasm introduction

Eighteen F_1 progenies of TME 3, a local Nigeria cassava variety having the resistance gene *CMD2*, were established from embryo axes of sexual seeds at IITA and shipped to CIAT in 2000. These CMD resistant progenies were crossed to elite cassava parental lines or BC_1 derivatives of a wild progenitor of cassava having resistance to cassava green mites (CGM). The hybrids combining resistance to CMD, CGM, and other useful traits were screened with simple sequence repeats (SSR) or sequenced characterized amplified regions (SCAR) markers associated with *CMD2* to select for CMD resistance in the absence of the disease.

Field evaluation

One hundred and fifty six genotypes having the *CMD-2* gene and other desirable traits were shipped as embryo axes-derived *in vitro* plants, five to ten copies, to the National Root Crop Research Institute (NRCRI), Umudike, Nigeria. The *in vitro* cultures were introduced through the Nigerian Plant Quarantine Service for the proper phyto-sanitary entry procedures. The clones were hardened and planted in the field using a completely randomized design such that copies of the same genotype are randomly distributed on the field. Disease severity index (SI) for CMD, based on five classes (class 1 = no symptoms; class 5 = severe mosaic distortion of entire leaves), was measured at 3, 6, and 9 months after planting (MAP). The 156 genotypes were evaluated in the 2004/2005 and 2005/2006 growing seasons. Fresh root yield was also determined at harvest.

Table 1: Disease ratings of 156 genotypes introduced as cultures into Africa.

CMD Severity Index*	No. of Genotypes	Proportion (%)
1	84	53.8
2	21	13.5
3	31	19.8
4	19	12.2
5	1	0.6

*1 = no symptoms; 5 = highly susceptible

Table 2: Yield potential of CMD – resistant cassava genotypes undergoing pre-varietal release trials in Nigeria.

Cultivar	Root yields (t/ha)	
	2005 (12 MAP)	2006 (8 MAP)
CR 14A-1	150	37
CR 41-10	100	46
CR 42-4	30	33.3
CR 52A-22	35	41.3
CR 36-2	85	20
CR 52A-41	70	32
CR 52A-25	40	35.4
CR 26-1	50	34.3
CR 36-5	80	31.8
AR 15-5	60	26.7
AR 37-108	30	14
AR 40-17	23	-
AR 38-3	120	33.2
AR 1-85	20	33
AR 12-45	20	40.3

MAP = months after planting

Fig. 1: Latin American cassava genotypes with resistance to CMD integrated into Nigeria breeding programme.

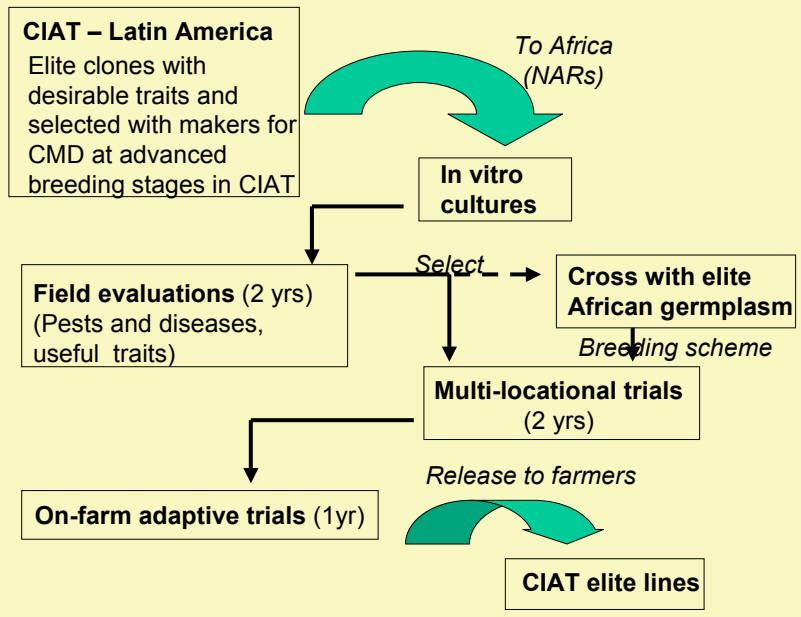

Fig. 2: A five-year scheme for fast delivery of best bet cassava varieties from LAC to African farmers.

RESULTS AND DISCUSSION

CMD evaluation

CMD evaluation for the introduced germplasm indicates that the majority of genotypes (68%) were resistant to the disease with SI of 1 or 2 (Table 1). A higher percentage of the resistant genotypes showed near immunity with SI of 1 (Fig.1). Amongst the resistant genotypes, the mean SI was 1.33 at the peak of disease severity (9MAP), while for susceptible genotypes the SI was 4.05. About 70% of the progenies with resistance to CMD due to the *CMD2* gene have been integrated into the breeding program of NRCRI.

Yield

Results from yield data at 12 month in 2005 indicate that 15 genotypes showed yield ranging from 20 -150 t/ha (Table 2). A second year trial in 2006 indicated that 13 genotypes were found to be early maturing and high yielding with preliminary yield estimates ranging between 20-46 t/ha at 8 MAP. These genotypes are being assessed in the Uniform yield trial (UYT) in the NRCRI breeding program. Three of them (CR 14A-1, AR 38-3 and CR41-10) have been fast-tracked and being evaluated under Nigeria's nationally coordinated regional trials (NCRP) covering 8 sites of diverse agro-ecologies. The NCRP trial is the last evaluation before on-farm adaptation trials preceding official variety release.

CONCLUSIONS AND ONGOING WORK

A systematic and well coordinated approach is required to fully exploit the true potential of cassava germplasm in LA for the benefit of Africa. Since the majority of genotypes obtained by MAS and introduced into Africa were resistant to the disease, there is a great potential to efficiently exploit LA cassava germplasm in Africa for useful traits. At this rate there are high chances of releasing LA genotypes with good yield potential. By using marker to select for CMD resistance in LA germplasm and by combining it with phenotypic data for desirable traits at CIAT, it is now feasible to transfer top elite LA germplasm of high quality to African breeding programs. The advantage with this strategy is that Neo-tropical cassava genotypes are pre-selected for CMD resistance with markers and evaluated for one or two years in the breeding scheme at CIAT before being shipped to Africa. The Neo-tropical genotypes selected for good performance from a two year evaluation in Africa can then be rapidly evaluated in multiple location trials for another two years and subsequently released as varieties. Within 5 years of evaluation, African farmers can have access to elite clones from exotic germplasm (Fig. 2).

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REFERENCES

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