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Advances in breeding for sweetpotato virus resitance in Uganda

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Abstract

Six sweetpotato [*Ipomoea batatas* (L.) Lam.] cultivars, 'Bwanjule,' 'New Kawogo,' 'Tanzania,' 'Tororo 3', 'Wagabolige' and 'Sowola' were officially released by the Variety Release Committee. These were the first sweetpotato cultivars to be officially released in Uganda, where sweetpotato is an important food crop. The newly released cultivars, five of them selections from the landrace germplasm, and one, 'Sowola' a newly-bred variety, were selected on the basis of consistently superior yield performance and disease resistance in multilocational yield trials in Uganda, and their excellent consumer acceptance in taste tests. Success in the release of these superior . Running Title: Advances in breeding for sweetpotato virus resitance in Uganda cultivars has depended a lot on effectively screening and breeding for sweetpotato virus disease (SPVD) resistance. SPVD causes up to 98% storage root yield loss in Uganda. The procedures used to make advances in breeding for SPVD resistance in Uganda have included germplasm screening, polycross, modified recurrent selection, using very large base populations coupled with high selection rates, 0.2-11%, and serological tests to confirm the presence of the causal agents of SPVD. Efforts have been initiated to investigate the potential for using molecular markers for detecting SPVD resistance.

Key words: Sweetpotato, breeding, sweetpotato virus disease, resistance, Uganda

Introduction

Six sweetpotato [*Ipomoea batatas* (L.) Lam.] cultivars, 'Bwanjule,' 'New Kawogo,' 'Tanzania,' 'Tororo 3', 'Wagabolige' and 'Sowola' were released by the Variety Release Committee in 1995 (Mwanga and Sengooba, 1996). These were the first sweetpotato cultivars to be officially released in Uganda, where sweetpotato is an important food crop with estimated annual production in 1995 of 2,235,000 tonnes on 497,000 hectares (FAO, 1996). Uganda's human population is roughly 18 million (World Bank, 1995) indicating an annual per capita production of sweetpotato of around 124 kg per year. A large number of landrace sweetpotato cultivars are grown by Ugandan sweetpotato farmers, many of them relatively low yielding, narrowly adapted and susceptible to diseases, especially sweetpotato virus disease (SPVD) and pests (Bashaasha *et al.*, 1995). The newly released cultivars, five of them selections from the landrace germplasm, and one, Sowola, a newly-bred variety, were selected on the basis of consistently superior yield performance and disease resistance in multilocational yield trials in Uganda, and their excellent consumer acceptance in taste tests. Success in the release of these superior cultivars has depended a lot on effectively screening and breeding for SPVD resistance. SPVD causes up to 98% storage root yield loss in Uganda (Karyeija *et al.*, 1997). The procedures used to make advances in breeding for resistance to SPVD in Uganda are outlined, results highlighted, and initiated efforts for further refinement to shorten the breeding cycle which takes about six to eight years are mentioned.

Materials and methods

The following strategies were used to achieve gains in increasing resistance to SPVD:

Germplasm screening and breeding

A total of 380 landrace accessions at NAARI were screened in 1987-89 and superior entries were subsequently evaluated with clones screened from base populations in Uganda's major agroecologies. The base populations were created by generating large numbers of populations by polycrosses that are open pollinated mainly by bees and hand crosses of specific male and female parents to combine virus resistance with other desirable traits. A modified method of recurrent mass selection coupled with sequential selection schemes developed by Jones *et al.* (1986) was

used to handle the generated populations.

The base populations (BPs) at the start of each selection cycle at NAARI where virus pressure is high were increased from the conventional numbers (3,000-10,000) in sweetpotato breeding programs elsewhere to over 100,000 seedlings to increase the frequency of genotypes with SPVD resistance genes in the BPs. Rigorous screening for SPVD resistance, 0.2-11% selection rate was used in the early cycles of selection (seedling nursery, clonal evaluation and preliminary yield trials).

Detection of SPVD

SPVD is due to dual infection by sweetpotato feathery mottle potyvirus (SPFMV) transmitted non-persistently by aphids (*Myzus persicae, Aphis gossypii and A. craccivora*) and sweetpotato chlorotic stunt crinivirus (SPCSV), transmitted semi-persistently by the whitefly (*Bemesia tabaci*). Field resistance to SPVD was confirmed in the screenhouse by insect-transmission of SPFMV and SPCSV or by graft-inoculation using SPVD-infected scion and the test genotype as stock. SPVD symptoms include stunted plants with small leaves (strap-like) which are often distorted coupled with mosaic or vein clearing exhibiting a general pale appearance (Gibson *et al.*, 1998). Double antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA) and double antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA) were used for SPFMV and SPCSV, respectively. Test plants giving negative results in the serological tests were grafted on the indicator plant, *Ipomoea setosa*, to confirm freedom from viruses.

Results and discussion

Germplasm screening and breeding

Germplasm was screened 1987-89, and superior entries were evaluated with superior clones from seedling selections in advanced multilocational trials. Five landrace varieties screened from 380 accessions and one seedling selection were officially released by the Variety Release Committee in 1995 (Mwanga and Sengooba, 1996). About 300,000 seedlings were screened between 1989-1995 of which 'Sowola' was the only cultivar released. In all the multilocational and on-farm trials the six released cultivars gave superior root yields, 5-79 tha^{-1}, (Mwanga and Sengooba, 1996) compared to the national average 4 tha^{-1} (World Bank, 1993). Outstanding characteristics of the released cultivars are shown in Table 1.

Table 1. Main attributes of 6 released sweetpotato cultivars

Cultivar	Attribute		
	SPVD resistance	Root yield in trials (tha^{-1})	Consumer/Farmer acceptability
Sowola	High	9-41	High
New Kawogo	High	6-45	High
Tanzania	High	5-58	High
Tororo 3	Moderate	5-52	High
Bwanjule	High	7-49	High
Wagabolige	High	6-79	High

Table 2. SPVD incidence in an on-farm trial, October 1996 - May 1997 planted in Kanoni, Mpigi District (Aritua *et el.*, 1998)

Cultivars	SPVD incidence (%)
Nationally released cultivars:	
New Kawogo	2.3
Bwanjule	6.2
Sowola	1.4
Tororo 3	23.6
Wagabolige	11.7
Local cultivars:	
Old Kawogo	23.4
Kalebe	28.9
Buliliri bwamesse	44.2
Kimotoka	60.8
Kiriya	21.9
SED(df=50)	6.53

Over 95% of the seedlings screened in the base population and most of the landraces were highly susceptible to SPVD. The released cultivars, however, had moderate to high resistance (Table 1) and had lower SPVD incidence in on-farm trials (Table 2). Performance of the six cultivars in standard yield trials was superior in the different agroecologies leading to their official release (Mwanga and Sengooba 1996). The modified breeding schemes and the high selection rate of 0.2-11% in the early cycles of selection increased the efficiency of advancing more genotypes with SPVD resistance at each selection cycle compared to the conventional sweetpotato breeding procedure.

Detection of SPVD

Screening for resistance to SPVD was based on visual symptoms using a standard scale rating of 1-5 (1 = no apparent damage, 2 = very little effect, 3 = moderate damage 4 = considerable damage, 5 = severe damage). In the last

two years serology tests and *Ipomoea setosa* have been used to confirm presence and absence respectively, of the components of SPVD (SPFMV and SPCSV) in superior genotypes and hence resistance of the tested genotype. In all cases cultivars infected with SPVD had greater virus titre of both (SPFMV and SPCSV) compared to plants infected with only one of the components and healthy controls. Plants infected with only SPFMV had very low titre indicating that resistance to SPVD seems largely to be resistance to being infected with SPCSV and resistance to infection by SPCSV should be the target (Aritua *et al.*, 1998).

The current sweetpotato breeding scheme at NAARI leading to official release of a cultivar with virus resistance and other desirable traits takes 7-8 years. The period it takes to release a cultivar is very long. Although methods for SPVD detection at NAARI have improved in recent years field and screenhouse methods for detecting and evaluating resistance need further refinement to lower the cost for field screening and to reduce the period for evaluation. Collaborative research efforts (NAARI/ International Potato Center/North Carolina State University) funded by the McKnight Foundation have been initiated to investigate the potential for using molecular markers for detecting sweetpotato virus resistance. Single dose polymorphism, Bulked Segregation Analysis (BSA) and selective genotyping approaches will be used to detect marker loci linked to SPVD resistance. The use of marker selection breeding will enable detecting resistance to SPVD during seedling screening in the presence or absence of the disease hence reducing the number of years of field testing to confirm virus resistance currently done only in locations with high virus pressure.

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