

Performance of CIP-derived population B3 potato (*Solanum tuberosum* L.) clones under Malawi conditions

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Abstract

From 2007 to 2009, experiments were conducted at multiple locations in the central and southern regions of Malawi to evaluate the performance of ten potato advanced clones bred at the International Potato Center in Peru for durable resistance to late blight (Population B3 clones). Two local cultivars were used as control treatments. Main objective of the experiments was to select high yielding potato clones resistant to late blight disease and suitable for boiled, French fries and Crisps products. Experiments were laid out in Randomized Complete Block Design with three replications. Data collected included late blight damage on crop, number of plants harvested per plot, number and weight of marketable and unmarketable tubers, quality of boiled and processing products after harvests. Analysis of variance was performed and treatment means were compared using the Duncan Multiple Range test.

Results showed that there were significant differences among potato genotypes with respect to total and marketable tuber yields and resistance to late blight ($p < 0.05$). In 2008-2009 rain fed crop, all clones from CIP's population B3 germplasm were more resistant to late blight than local cultivars. In the winter crop of 2008, commercial tuber yields at Bembeke site ranged from 19.9 tonnes/ha for variety Lady Rosetta to 31.7 tonnes/ha for CIP-396036.201. High yielding B3 clones with resistance to late blight and good cooking and processing qualities included CIP-395015.6, CIP-396027.205, CIP-396035.107, and CIP-396036.201.

Keywords: Potato clones, late blight, tuber yield, processing qualities, Malawi.

Introduction

Chronic poverty is recognized as the major underlying cause of food insecurity in Malawi, with over 86% of those below the poverty line living in rural areas (MEPD, 2005). For over five years, the Government of Malawi pursued a policy of crop diversification to reduce their dependency on maize and tobacco. Root and tuber crops (cassava, sweet potatoes and potatoes) have been at the forefront of the diversification effort (FAO/WFP, 2005). Potato has emerged as an important food and cash crop in Malawi. The annual national production reported by FEWSNET (Food Early Warning System Network) for 2006 was 527,830 tons produced on about 40,601 ha of land, with potato ranking fourth nationally in terms of production compared to other major food crops. In the major growing high land Districts of Dedza and Ntcheu, potato is the second major food crop after maize. Potato is generally consumed in three forms: French fries, boiled and crisps (Demo *et al.*, 2007a, 2007b). Almost all potato growers are small scale farmers. 90% of them apply fertilizer on the potato crop. Late blight (*Phytophthora infestans*) disease is one of the major production constraints (CIP, 2008). The disease is typically combated with fungicides and non-resistant materials are sprayed four to seven times a season depending on the intensity of the attack. Small scale resource poor farmers in Malawi hardly own a sprayer or buy fungicide required for control of the disease. This implies that there is a very high risk of crop failure due to late blight during rain fed production season if susceptible varieties are planted. To increase productivity and reduce risk of crop failure caused by late blight, high yielding pro-poor varieties that can be grown without or with minimum spray of fungicide needed to be developed. Taking advantage of the potato genetic materials bred by the International Potato Center (CIP) for durable resistance to late blight (Population B3 potato clones), the objective of the study was to evaluate and select from germplasm introduced from CIP high yielding materials with resistance to late blight, good cooking and/or processing qualities.

Materials and methods

Between 2007 and 2009, ten potato genotypes from CIP's Population B3 clones were evaluated under field conditions at three different locations together with two checks made of one local cultivar (Rosita) and one imported variety (Lady Rosetta). The three locations were Bembeke research sub-station in Dedza District, Tsangano research sub-station in Ntcheu District in Central Region, and Njuli-farm situated at 25 km from Blantyre city in the Southern Region. The trials were conducted during dry winter (April-September) and wet summer (December-April) seasons of 2007/2008 and 2008/2009. The dry winter season trials of 2007 at Bembeke and Njuli-farm were planted with mini-tubers of very small size with diameter between 10 and 20mm that were produced under screen house conditions. For all trials, the Randomized Complete Block Design was used with three replications. Twenty tubers per genotype were planted per experimental unit that consisted of one ridge of 5 m long during the wet season of 2007/2008. The planting spacing was 80cm between ridges and 25 cm between plants within ridge. With increase availability of planting materials, starting from the dry season of 2008, 48 tubers were planted per experimental unit which consisted of 4 ridges of 4 m long each. The planting spacing remained unchanged. Data were collected on the two middle ridges (net plot). At planting, 600 kg of the fertilizer NPK 8-18-15 +6S was applied to supply 48 kg N, 108 kg P₂O₅, 90 kg K₂O and 36 Kg S per hectare. At hilling up which took place 3 to 4 weeks after planting, additional nitrogen was applied at the rate of 60 kg N per hectare through CAN (Calcium Ammonium Nitrate) fertilizer. Trials were kept weed free from planting to harvest. Data were recorded on number of plants emerged from the ground at 4 weeks after planting, % of crop foliage damaged by late blight, tuber yield and yield parameters. After harvest, sample tubers were used to assess qualities of boiled and process product (crisps). Analysis of variance was conducted and where significant differences were detected among treatment means, the Duncan Multiple Range test was used to separate them.

Results and discussion

Tuber yield and yield parameters

Total tuber yield, total number of tubers per plant and average weight of individual tubers obtained from the first trials grown during the dry season of 2007 showed significant differences ($P < 0.05$). Total tuber yield ranged from 20.2 tons/ha at Njuli-farm to 10.9 tons/ha at Bembeke. This relatively low yield could be explained by the fact that seed tubers planted were of screen house mini-tubers. Top yielding clones at Bembeke were equally high performers at Njuli-farm. The second field evaluation was conducted at the above two sites during the summer rain fed season in the period February – June 2008. It should be noted that the crop received rain fall for only 7 weeks out of a normal crop cycle of 12 to 14 weeks. Supplementary water supply to the crop was by irrigation after stoppage of rains. At Bembeke, total tuber yields ranged from 24.8 tons/ha (clone number 395111.2) to 13.7 tons/ha (clone 393075.54). The imported variety Lady Rosetta produced total tuber yield of 16.9 tons/ha (Table 1). Marketable tuber yield ranged from 18.0 tons/ha (clone 395111.2) to 7.8 tons/ha (clone 395011.2). The top performing clone at Bembeke was 395011.2. At Njuli-farm, tuber yields were generally higher than those recorded at Bembeke (Table1). Total tuber yields ranged from 39.5 tons/ha (clone 395112.19) to 21.4 tons/ha (clone 396027.205). On the basis of marketable yield, 2 of the 10 tested CIP's clones statistically out yielded the currently grown variety Lady Rosetta.

Trial conducted during the dry winter season of 2008. Results from this trial showed that all clones evaluated had marketable tuber yields ranging from 19.9 Mt/ha with Lady Rosetta to 28.1 Mt/ha with the B3 clone 395011.2. Best clones in terms of palatability taste were 393075.5, 395111.13, 391691.96, 3966027.205, and 395015.6. These clones were classified as having good taste of boiled product using a scoring scale of 1 (very poor taste) to 5 (very good taste).

Evaluation of Population B3 potato clones during the rainy season from December 2008 and March 2009. At Bembeke as well as at Tsangano, significant ($P < 0.05$) yield differences were recorded with total tuber yield ranging from 33.6 tons/ha (clone 395015.6) to 18.1 tons/ha for 396033.102 (Table 1). In terms of marketable yield, five CIP derived clones out yielded the two checks Lady Rosetta and Rosita. At Tsangano, all CIP clones and Lady Rosetta out yielded the widely grown local cultivar Rosita. The cultivar Rosita generally produces a large proportion of sub-standard tuber size that contributes to lower the yield of marketable size tubers (tubers with diameter ≥ 35 mm). Crisps processing evaluation was done by a potato processing factory and clones/varieties with good crisping qualities were identified.

Table 1. Total and marketable tuber yield of CIP-derived potato clones with genetic traits for durable resistance to late blight evaluated under field conditions at three different sites (Njuli-Farm, Bembeke and Tsangano) in Malawi during the summer rain fed seasons of 2008 (February-June) and 2009 (December 2008-March 2009)

Clones identities	Total and marketable tuber yields (Tons/ha)					
	2008		2008/2009			
	Njuli-Farm	Bembeke	Bembeke		Tsangano	
	Total yield	Total yield	Total yield	Marketable yield	Total yield	Marketable yield
395015.6	34.4ab	21.3 abcd	33.6 a	28.5 a	29.3 a	25.5 a
395111.13	32.7abc	18.9 abcd	19.6 de	17.4 c	19.3 ab	17.2 ab
395011.2	31.4 bc	24.8 a	28.5 abc	24.4 ab	21.1 ab	18.4 ab
396036.201	29.0 bcd	17.7 abcd	26.9 abc	24.4 ab	26.4 ab	22.0 a
391691.96	27.8 bcd	16.8 abcd	32.5 ab	27.8 a	19.6 ab	16.3 ab
396033.102	25.9 cd	15.5 abcd	18.1 e	15.7 c	17.9 ab	15.2 ab
396027.205	21.4 de	19.4 abcd	23.3 cde	21.2 bc	28.3 a	26.3 a
396035.107	-	-	33.3 a	30.7 a	28.0 a	25.2 a
395112.19	39.5a	15.6 abcd	-	-	-	-
393075.54	28.9 bcd	13.7 cd	-	-	-	-
Lady Rosetta (check)	25.9 cd	16.9 abcd	23.3 cde	20.4 bc	16.5 ab	14.2 ab
Rosita (check)	-	-	26.1 bcd	18.2 bc	14.0 b	6.6 b
CV (%)	13.36	20.60	13.82	15.09	29.87	35.27

Means in the same column with the same letter are not significantly different at 5% level of significance
DAP= Days after planting

Level of resistance of B3 clones to late blight disease

One late blight reading was done on the trial at Bembeke during summer 2007/2008. Results presented in Table 2 revealed that the variety Lady Rosetta suffered a severe late blight attack with 87.5% of leaves damaged by the disease. Only one late blight reading was made because the disease started late in the cropping cycle and rains stopped prematurely. All CIP's B3 clones showed good resistance to Late blight with levels of damage on crop leaves between 0.2% and 17.5 % (Table 1). It should be noted that weather conditions were not very favourable for late blight development during the entire vegetative period of the crop. While it was certain that Lady Rosetta was very susceptible to late blight disease, further evaluations were necessary. Results obtained at both Bembeke and Tsangano during 2008/2009 season showed that CIP-derived clones were significantly ($P < 0.05$) more resistant to late blight than both the dominant local cultivar Rosita and the variety Lady Rosetta (Table 2). The disease caused 48.33% to 100% damage to the variety Lady Rosetta at 60 and 70 days after planting (DAP) at Bembeke. A similar level of damage was recorded on this variety at Tsangano. At Bembeke, the cultivar Rosita had a damage level of 0.0% and 63.3% at 60 and 82 DAP, respectively (Table 2). Over the two sites and scoring dates, damage level with CIP's B3 clones was between 0% and 26.7% in the period from 60 to 82 DAP. (Table 2).

Conclusions

The introduced CIP-derived potato clones developed for durable resistance to late blight showed higher field resistance to late blight compared to the local cultivar Rosita and the imported variety Lady Rosetta. Top five High yielding B3 clones that combined resistance to late blight, good cooking and good processing qualities were CIP-395015.6, CIP-396027.205, CIP-396035.107, CIP-396036.201 and 391691.96. These clones will undergo on-farm trials in collaboration with farmers prior to eventual release.

Table 2. Proportion (%) of crop foliage damaged by late blight disease for different CIP-derived potato clones with genetic traits for durable resistance to late blight evaluated under field conditions at two sites (Bembeke and Tsangano) in Malawi during the summer rain fed seasons of 2008 (February-June) and 2009 (December 2008-March 2009)

Clones identities	Proportion (%) of crop foliage damaged by late blight disease					
	2008	2008/2009				
	Bembeke	Bembeke			Tsangano	
	75 DAP	60 DAP	70 DAP	82 DAP	60 DAP	75 DAP
395015.6	17.5 c	0.0 b	2.3 cd	14.7 cde	0.0 b	6.7 c
395111.13	0.2 c	0.0 b	0.7 d	20.0 cd	3.0 b	1.7 c
395011.2	4.0 c	3.3 b	4.0 cd	10.0 cde	0.0	2.3 c
396036.201	2.5 c	1.0 b	1.7 d	13.3 cde	1.0 b	4.0 c
391691.96	1.5 c	0.0 b	0.0 d	0.0 e	0.0 b	1.7 c
396033.102	0.5 c	0.0 b	11.7 bc	26.7 c	0.0 b	1.3 c
396027.205	1.0 c	7.3 b	6.7 bcd	16.7 cde	0.0 b	3.3 c
396035.107	-	0.0 b	0.0 d	3.3 de	0.0 b	2.3 c
395112.19	0.5 c	-	-	-	-	-
393075.54	2.5 c	-	-	-	-	-
Lady Rosetta (check)	87.5 a	48.3 a	100.0 a	100.0 a	26.7 a	100.0 a
Rosita (check)	-	0.0 b	13.7 b	63.3 b	2.0 b	63.3 b

Means in the same column with the same letter are not significantly different at 5% level of significance.
DAP= Days after planting

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