MUARIK BULLETIN, Vol. 3. pp. 11-18, 2000

Participatory breeding with advanced potato clones of population A in Southwestern Uganda

J.J. Hakiza, E. Adipala[†], R.M. Kakuhenzire, H.M. Kidanemariam[††], W. Wagoire, B. Mateeka, R. El-Bedewy[†††], M.O. Olanya[†††], P.T. Ewell[††††], B. Lemaga[††††] and A.S. Bhagsari[†††††]

National Agricultural Research Organisation, Kalengyere Research Station, P.O. Box 722, Kabale, Uganda

[†]Department of Crop Science, Makerere University, P.O. Box 7062, Kampala, Uganda

[††]P.O. Box 21988, Addis Ababa, Ethiopia

[†††]International Potato Center, Sub-Saharan Africa Region (CIP-SSA), P.O. Box 25171, Nairobi, Kenya

[††††]PRAPACE, P. O. Box 22274, Kampala, Uganda

[†††††]Fort Valley State College, Fort Valley, Georgia, USA

Abstract

The primary objective of the potato program in Uganda is to develop improved varieties with high yields, late blight resistance, good agronomic characters, acceptable post-harvest qualities and adaptable to many environments. However, development of useful crop germplasm is only beneficial if it is distributed and subsequently utilized. Sixteen advanced potato clones, with Victoria and Kisoro varieties as standard checks, were evaluated in six seasons at Kalengyere Research Station for yield, resistance to late blight, and other agronomic traits. Farmers participated in the on-station evaluation process and selected six genotypes for on-farm and farmer field schools evaluations. As a result, genotypes 382171.4, 381403.8 and 575049 were released in 1999 as NAKPOT 1, NAKPOT 2 and NAKPOT 3 varieties, respectively, and genotypes CIP 381471.18 and CIP 387121.4 are at pre-release level. NAKPOT 1 and NAKPOT 3 were selected for their high yields, early bulking and resistance to late blight. CIP 387121.4 was selected for its resistance to late blight and red skin colour. CIP 381471.18 was selected for its high yields, round tuber shape, white skin colour, culinary qualities and high resistance to late blight, although it has a very long dormancy period and is relatively late maturing.

Key words: Farmer varietal selection, late blight, *Solanum tuberosum*, Uganda

Introduction

Major causes of high cost of potato (*Solanum tuberosum* L.) production in developing countries, Uganda inclusive, continue to be high cost and low quality of seed materials and the control of pests and diseases. Most of these yield-reducing constraints can be overcome by continued emphasis on the development of potatoes with durable resistance to major insect pests and diseases, which can underpin integrated pest management practices (Zandstra, 1996). Host resistance is the most effective way of controlling most plant diseases (French, 1994). Late blight (caused by *Phytophthora infestans* (Mont) de Bary) is the single most important biotic constraint to potato production in sub-Saharan Africa (Hakiza, 1999; Sengooba and Hakiza, 1999). The disease is very severe in the tropical highlands of eastern and central Africa where inoculum is almost continuously present. The problem of late blight

is associated with serious yield loss and costly fungicides; moreover, only a few late blight resistant varieties are available. Farmers have limited income to apply fungicides regularly, and the disease causes serious yield reductions in most years. In Uganda, apart from environmental concerns, chemicals are often not affordable and growers are obliged to accept the losses that the disease inflicts on their potatoes. Continued search for varieties resistant to late blight, therefore, offers hope to the resource-poor farmers who are responsible for production of potatoes in Uganda.

The primary objective of potato research and development in Uganda is to find the most effective means of generating and transferring improved potato production and utilisation technologies. In order to obtain high potato yields, especially in the Southwestern Uganda where late blight is very important, efforts have concentrated on breeding varieties that are resistant to the disease although the use of fungicides is still emphasised. Greater farmer involvement in identification of researchable questions, selection of potential solutions, on-farm evaluation, and validation of results could give a more efficient research process, and creative combinations of farmer wisdom and technical expertise (Francis *et al.*, 1988). Adoption of technologies that have only been tested on research stations has often been poor since it has generally lacked farmer involvement in the selection process and sufficient evidence of their applicability in farmers' environments. Verification of the usefulness of such technologies lies in effectively carrying out multi-locational and on-farm trials while working with farmers in their fields. In this study both on-station and on-farm evaluation of advanced potato genotypes for resistance to late blight and suitable agronomic characteristics was conducted. The major objectives of the study were (i) to obtain information on the performance of improved potato genotypes under a wide range of agro-ecologies in Uganda and assess the adaptability of the improved genotypes; and (ii) to test the promising genotypes on-farm so as to identify those for release.

Materials and methods

On-station evaluation

Tubers of cultivars and breeding lines were obtained from the previous cohorts of potato materials evaluated at Kalengyere Research Station but originally received from the International Potato Center (CIP), Lima, Peru. Most of these materials were introduced into Uganda in 1992 for evaluation for agronomic characteristics and resistance to late blight (Hakiza *et al.*, 1997; 1999). Field experiments were conducted at Kalengyere Research Station during six cropping seasons of 1997B, 1998A, 1998B, 1999A, 1999B and 2000A. The A and B refer to the first (February-July) and second (August-January) seasons, respectively. Sixteen potato clones selected for resistance to late blight were used in the study with Victoria and Kisoro varieties as standard checks.

In 1997B, 1998A and 1998B, planting was done on 10 September 1997, 10 March 1998 and 9 September 1998 while harvesting was done on 12 January 1998, 30 June 1998 and 14 December 1998, respectively. In these three seasons the potatoes were grown in a randomised complete block design replicated four times. Spacing was 70 cm between rows and 30 cm within rows. Plot sizes were 6.3 m^2 based on two rows that were 4.5 m long comprising of 30 plants. A fertiliser rate of 80 kg ha^{-1} of nitrogen, 50 kg ha^{-1} of phosphorus (P_2O_5) and 50 kg ha^{-1} of potash (KCl) was applied in a furrow in each row and mixed with soil using a hand hoe handle. This was followed by placement of seed tubers in these furrows after which the tubers were lightly covered with soil before ridges were made. Two weeding/earthing up operations were carried out; the first one about 25 days after planting and second one about 40 days after planting. Three sprays with Dithane M45 (Mancozeb 80% WP) at the rate of 2.5 kg ha^{-1} were applied at fortnight intervals starting immediately after the first weeding. Four late blight assessments were conducted at 10-day intervals, beginning on the day of the first spraying, using a scale of 0-100% (Henfling, 1987). In the 1999 season, the trial was planted on 27 April 1999. Plot size was 12.6 m^2 with plant spacing of 70 cm x 30 cm. One prophylactic spray of Dithane M45 was applied at 100% crop emergence, 34 days after planting. Four late blight assessments were done.

Harvesting was done on 13 August 1999. During 1999B season, planting was done on 16 August, and two prophylactic sprays of Dithane M45 were applied. Five late blight assessments were carried out at 10-day intervals. Plot size, spacing and agronomic management were similar to those in the previous season. Harvesting was done on 14 December 1999. For the 2000A season, planting was done on 6 March 2000 at similar spacing, plot size, and agronomic practices as those of the previous season. Two prophylactic sprays of Dithane M45 were applied, and harvesting was done on 4 July 2000.

The major attributes evaluated during the four seasons were number of tubers per plant, tuber weight, yield per hectare and late blight severity based on 0-100% score (Henfling, 1987). Area under disease progress curve (AUDPC), computed from the percent leaf area blightled recorded on each late blight assessment time, was the indicator of each clone's resistance to late blight. Mean relative AUDPC (Campbell and Madden, 1990) was calculated for each clone in each year for the Kalengyere Research Station data. Clones were then ranked basing on mean yield and relative AUDPC.

The research team and farmers were present at harvesting time to select, by consensus, genotypes to retain for further stages of testing and multiplication. Two field days were staged at Kalengyere Research Station to give farmers and district agricultural staff opportunity to participate in selection of materials that were likely to be their future varieties.

On-farm evaluation

Basing on the results of the on-station variety selection, six clones were selected for evaluation in the farmers' environments including farmer field schools (FFS). The clones selected for on-farm trials and farmer field schools were 382171.4, 384329.21, 387146.48, 381471.18, 387121.4 and 575049. Victoria, the most widely grown improved variety (and sometimes Rutuku), was used as a standard check during these on-farm evaluations. These farmer-managed trials were carried out with farmers in Kisoro, Kabale, Ntungamo and Mbarara districts. At each farm site the experiments were conducted on plots measuring 12.6 m^2 with a spacing of 70 cm x 30 cm in a randomized complete block design with three replicates. A total of 12 farmer field schools composed of >360 participants were involved in the evaluation of these selected genotypes in 1999B, 2000A and 2000B. In the farmers' field schools the genotypes were evaluated with or without fungicidal sprays. Two field days were held at harvesting in 4 farmer field schools.

Results

Relative AUDPCs for late blight were analysed separately for each season at Kalengyere Research Station. There were significant differences among clones for AUDPCs in each season (Table 1). The results in Table 1 clearly show that in all the five seasons the elite 16 genotypes, selected in previous trials for resistance to late blight, maintained resistance to the disease and were consistently less blighted than the two local checks, Kisoro and Victoria. Victoria had the highest late blight disease severity followed by Kisoro . This implies that among the materials evaluated there were some with better resistance to late blight than the already released varieties.

During 1997B, the five highest yielding genotypes were 387121.4, 381471.18, 382171.4, 384329.21 and 384316.9 (Table 2). In the 1998B season, Victoria had the highest late blight attack (AUDPC) although its yield (31 Mt/ha) was not significantly lower than that registered by genotype 387121.4, the best yielding genotype during the season (Tables 1 and 2). The highest yielding genotypes in 1999A season were 381471.18, 381403.8, 382157.30, Victoria and 387173.12 while the best performing genotypes in 1999B were 382171.4, 381471.18, Kisoro, 382173.12, Victoria and 387114.10. The best yielding clones during the 2000A season were 381471.18 and 387121.4, with yields of 33.4 and 28.9 Mt ha^{-1}, respectively (Table 2). In the 2000A season Victoria was heavily attacked by late

blight which in turn reduced its yield drastically (Tables 1 and 2).

Overall, the highest on-station yields were produced by genotypes 382171.4 and 381471.18 with mean average yields, over the six seasons, of 29.8 and 29.6 Mt ha^{-1}, respectively (Table 2). Although genotype 381471.18 was introduced to Kalengyere Research Station from CIP, Lima, in 1992, it did not gain prominence until farmers participated in on-station evaluations in 1998B and 1999B. Despite the fact that it is white-skinned and most farmers prefer growing red-skinned varieties due to market preferences, clone 381471.18 was selected by farmers based on its high yields, round tuber shape and high culinary quality. This clone has very high level of resistance to late blight but with a long dormancy period of 4-5 months.

Results from the farmer-managed on-farm trials revealed that farmers were able to identify genotypes that were high yielding and resistant to late blight. The highest yielding genotypes in Mbarara were 394329.21, 57049, 382171.4, 381403.8 and 387146.48 (Table 3). In Ntungamo, however, when working with the Nyabugando farmers' group, Victoria was the best yielding genotype followed by 387146.48 with yields of 29.9 Mt ha^{-1} and 23.6 Mt ha^{-1}, respectively (Table 4). In Nyamiyaga village (Kabale district) 387146.48 had the highest yield although not significantly higher than that of Victoria or 381471.18 (Table 4). At four individual farmers' fields in Kisoro district, genotype 382171.4 had the highest yield followed by 575049 and 384329.21. Victoria performed worst on these farms. These advanced clones yielded less at farmers' fields (Tables 4 and 5) compared to the results obtained at research stations (Table 6) but the yield difference between on-station and on-farm trials was much lower than that previously reported (Low, 1997).

Table 1. Relative area under disease progress curves (RAUDPCs) of 16 advanced potato clones during 1997B, 1998A, 1998B, 1999B and 2000A seasons at Kalengyere and their relative ranking starting with the most resistant clone to late blight.

Genotypes	Relative area under disease progress curve (RAUDPC)						
	1997B	1998A	1998B	1999B	2000A	Mean	Ranking
384329.21	5.5	12.3	5	3.4	14.3	6.8	1
575049	3.5	12.3	7	3.2	10.1	7.0	2
387114.10	31.0	23.1	6	6.3	15.7	7.0	3
387121.4	8.6	14.3	5	3.5	10.8	8.4	4
382171.4	11.4	12.0	5	3.9	14.2	9.3	5
381403.8	22.1	28.3	7	3.0	12.7	12.2	6
384316.9	11.1	28.7	7	3.7	13.1	12.7	7
382150.5	13.3	22.4	8	5.6	14.4	12.7	8
381471.18	18.9	22.7	8	5.4	10.7	13.1	9
387199.30[¥]	17.3	23.9	7	4.2	-	13.1	10
382173.12[¥]	-	14.9	6	4.7	17.4	13.1	11
386007.2	11.6	28.6	6	5.6	15.7	13.5	12
387143.37[¥]	-	30.9	3	5.8	15.1	13.7	13
382157.30	20.2	26.4	6	3.5	13.3	13.9	14
384287.12	31.8	18.8	8	4.3	14.4	15.5	15
387146.48	22.6	30.1	9	6.6	13.9	16.4	16
Kisoro	21.6	31.2	11	7.5	21.4	18.5	17
Victoria	49.2	41.9	13	9.8	18.6	26.5	18
$LSD_{0.05}$	9.5	5.2	3.8	2.3	4.3		
CV (%)	30.6	15.6	39.5	31.9	21.1		

[¥]The clones shown by a dash (-) were not evaluated during those particular, seasons.
xCheck varieties

yA and B refer to first (March - July) and second (September - January) seasons, respectively.

Discussion

The national potato breeding program in Uganda is dependent on the materials obtained from the International Potato Center breeding program. Previously, farmers were not actively involved in selection of useful potato genotypes although on-farm trials were being conducted on farmers' fields. Farmers knowledge of late blight was also limited. In this study, farmer participatory breeding was initiated to enable farmers participate actively in variety selection at early stages of variety development, bearing in mind that development of useful germplasm is only beneficial if it is distributed and subsequently utilized. To this effect farmers evaluated 16 advanced clones in researcher managed trials and identified 6 for further evaluation under farmer conditions. This exercise revealed that genotypes 382171.4 and 575049 were the best yielding genotypes and were highly resistant to late blight. These two genotypes were released at the beginning of 1999 as NAKPOT 1 and NAKPOT 3, respectively (Kakuhenzire *et al.*, 1999). Although genotype 384329.21 gave very high yield at Kachwekano and Kalengyere, and had high levels of resistance to late blight, farmers rejected it on the grounds that it produced poorly-shaped tubers.

Host resistance to late blight will continue to play a big role in integrated disease management since the population structure of *P. infestans* is changing (Davidse *et al.*, 1993; Deahl *et al.*, 1995), fungicide resistance is increasing (Fry *et al.*, 1993; Deahl *et al.*, 1995), and farmers are still unable to afford the high cost of fungicides. In this study, most of the elite genotypes exhibited higher levels of resistance to late blight than the current available cultivars. As a result, some of these genotypes have been released. For sustainable potato production, however, integration of host resistance and judicious use of fungicides into the farming systems is needed (Fry and Shtienberg, 1990). Information is also still

Table 2. Average yield of 16 advanced potato clones at Kalengyere Research Station during six seasons and their relative ranking in ascending order.

Genotypes	Yield (Mt ha^{-1})							
	1997B*	1998A	1998B	1999A	1999B	2000A	Mean	Ranking
382171.4	46.5	20.2	29	12.2	46.2	24.5	29.8	1
381471.18	39.9	22.1	24	15.4	42.7	33.4	29.6	2
Victoria†	24.6	21.6	31	14.3	31.9	14.1	27.5	3
387121.4	44.1	8.6	34	13.1	24.4	28.9	25.5	4
384316.9	36.1	31.8	20	8.8	27.6	23.1	24.6	5
Kisoro†	29.7	21.6	25	12.9	35.4	22.3	24.5	6
387146.48	34.5	22.6	19	12.5	28.8	23.1	23.4	7
382173.12¥	-	11.4	23	13.7	34.6	27.6	22.1	8
381403.8	34.5	31.0	25	14.9	13.9	11.4	21.8	9
387114.10	31.7	11.6	27	8.3	29.9	19.7	21.4	10
384287.12¥	33.2	-	18	7.6	29.5	16.2	20.9	11
382157.30	28.9	13.3	22	14.6	25.9	17.3	20.3	12
384329.21	39.4	11.1	21	6.9	23.1	19.4	20.1	13
382150.5	34.5	18.9	16	8.2	20.4	15.3	18.9	14
575049	29.5	3.5	18	9.3	27.7	21.1	18.2	15
387143.37¥	-	-	9	9.3	26.3	17.0	15.4	16
387199.30¥	21.5	17.3	15	5.8	12.4	-	14.4	17
386007.2	17.7	5.5	10	7.8	13.9	11.8	11.1	18
$LSD_{0.05}$	7.0	9.5	8.7	6.6	14.2	4.8		
CV (%)	12.4	30.6	28.5	42.9	36.5	16.4		

¥The clones shown by a dash (-) were not evaluated during those particular seasons.
†Check varieties
*A and B refer to first (March - July) and second (September - January) seasons, respectively.

Table 3. Performance of potato population A genotypes at Thorn Tree Farm, Nyakayojo (Mbarara) in 1998B and 1999B.

Entry	Thorn Tree Farm, Nyakayojo					
	1998B			1999B		
	Mean tuber # per plant	Mean tuber weight (g)	Yield (Mt ha^{-1})	Mean tuber # per plant	Mean tuber weight (g)	Yield (Mt/ha)
382171.4	7	96.4	23.7	6	85.9	22.4
384329.21	5	94.4	22.0	6	114.1	30.1
Victoria	6	39.7	9.8	6	47.2	11.2
381471.18	4	100.5	15.9	5	83.8	16.4
384287.12	4	58.4	9.2	8	66.5	19.3
318403.8	5	54.8	18.6	5	74.1	16.3
575049	6	74.4	19.6	11	63.1	27.7
382150.5	5	99.5	17.4	5	81.3	10.8
387146.48	4	109.8	19.3	6	94.9	22.6
387114.10	4	88.5	9.1	7	63.7	18.6
387121.4	5	60.7	11.1	9	54.7	21.1
382173.12*	-	-	-	7	55.1	14.2
384316.9	4	74.0	9.6	6	99.1	20.6
386007.2*	7	73.3	19.9	-	-	-
Kisoro	6	38.0	8.2	10	35.5	13.5
387143.37*	-	-	-	6	81.4	11.9
382157.30	4	61.1	6.6	8	52.4	13.6
387199.30**	4	68.3	10.4	3	59.7	1.1
$LSD_{0.05}$	3	24.5	4.4	2.4	14.4	6.2
C.V. (%)	26.6	19.7	19.8	22.2	12.1	21.5

*This clone was not planted at this site.
**The poor performance was due to high level of virus infection.

Table 4. Yield of five promising genotypes at four farms and two farmer field schools, in Ntungamo, Kisoro and Kabale districts during the second (B) season of 1998.

Genotype	Yield (Mt ha^{-1}) at farm sites						
	*Rugurira[1] David	Rwakare Justus	Kinahirwe Jeremina	†Munyankiko David	Nyamiyaga Farmers' Group	Nyabugando Farmers' Group	Mean
382171.4**	18.8	33.4	18.7	16.9	29.3	14.2	21.9
381403.8**	14.6	20.4	14.1	18.5	-	-	16.9
387146.48	11.0	24.5	12.4	18.8	36.7	23.6	21.2
575049**	17.6	34.2	15.1	20.1	-	-	21.8
Victoria	5.8	24.0	8.3	17.9	29.9	29.9	19.3
384329.21	13.5	28.3	9.9	24.6	26.2	20.7	20.5
387121.4	-	-	-	-	24.6	19.3	22.0
LSD (5%)	7.4	9.6	3.2	-	8.0	14.5	
C.V (%)	23.9	21.1	12.6	-	15.4	40.6	

[1]The materials from this farm were harvested and bulked and no statistical analysis could be done.
*Damage due to mole rats reduced yield especially for Victoria.
**These varieties were released in 1999. The official names for genotypes 382171.4, 381403.8, 575049 are NAKPOT1, NAKPOT2 and NAKPOT3, respectively.
†Farmer Rugurira, Rwakare, Kinahirwe and Munyankiko are from Kisoro district, Nyamiyaga farmers' group is in Kabale and Nyabugando farmers' group is in Ntungamo district.

Table 5. Comparative yields of six promising potato genotypes at four Farmers' Field Schools during the first (A) season of 2000.

Genotypes	Yield (Mt ha^{-1}) at each Farmers' Field School				
	Karubanda	Kabira	Rukaranga	Nyamiyaga	Mean
387146.48	11.1	15.0	19.7	18.8	16.1
384329.21	11.5	9.5	15.0	18.0	13.5
382171.4	15.6	17.4	17.0	18.0	16.8
575049	7.4	11.7	19.0	21.5	14.9
Victoria	10.6	17.2	19.0	18.2	14.7
Rutuku	7.3	16.1	12.9	20.6	
LSD 0.05	6.9	8.6	8.1	11.7	14.2
CV (%)	25.2	23.0	18.5	23.7	

Table 6. Mean yield of promising varieties at Kalengyere Research Station (Kabale), Maziba Technology Verification Centre (Kisoro), and Kachwekano District Farm Institute (Kabale) during 1998B and 1999B seasons.

Varieties	Yield (Mt ha^{-1})						
	Kalengyere		Maziba		Kachwekano		Mean
	1998B	1999B	1998B	1999B	1998B	1999B	
Victoria	31	31.9	9.1	32.5	53.1	28.0	30.9
387121.4	34	24.4	11.8	23.6	56.1	21.5	23.1
384329.21	21	23.1	13.7	23.8	57.6	25.9	27.5
382171.4	29	46.2	15.1	39.5	54.3	26.5	35.1
387146.48	19	28.8	7.9	18.9	54.1	30.3	26.5
381471.18§	24	42.7	16.5	37.4	-	30.3	30.2
575049§	18	27.7	19.0	21.7	50.4	-	27.4
LSD $_{0.05}$	8.7	14.2	4.3	15.1	12.4	10.9	
C.V. (%)	28.5	36.5	25.5	28.4	12.5	22.1	

§The clones were not evaluated at these locations during these particular seasons.

needed on the relationship between disease susceptibility and crop loss under different environmental and cultural regimes, as an aid to identifying the level of resistance at which the breeder should aim (Umaerus *et al.*, 1983). Additionally, a follow-up study should be made to assess the magnitude of crop losses incurred on varieties with different levels of resistance under judicious fungicide applications.

Acknowledgement

The authors wish to acknowledge the financial support provided by various organizations and programs towards execution of this research work. They include National Agricultural Research Organisation (NARO), Makerere University, the Rockefeller Foundation, International Potato Center (CIP), PRAPACE (the Regional Potato and Sweetpotato Network for Eastern and Central Africa), the Integrated Pest Management-Collaborative Research Support Programme (IPM-CRSP) and the United States Agency for International Development (USAID).

References

Campbell, C.L. and Madden, L.V. 1990. Introduction to plant disese epidemiology. John Wiley & Sons, New York. 532 pp.

Davidse, L.C., Danial, D.L. and Westèn, C.H. 1983. Resistance to metalaxyl in *Phytophthora infestans* in the Netherlands. Netherlands Journal of Plant Pathology 89 : 1-20.

Deahl, K.L., Demuth, S.P. and Rivera-Peña, A. 1995. Identification of mating types and metalaxyl resistance in north American population of *Phytophthora infestans*. American Potato Journal 72 : 35 - 49.

Francis, C.A., King, J.W., Nelson, D.W. and Lucas, L.E. 1988. Research and extension agenda for sustainable agriculture. American Journal of Alternative Agriculture 2 : 23-126.

French, E.R. 1994. Integrated control of bacterial wilt of potatoes. CIP Circular 20:8-11. CIP (International Potato Center), Lima, Peru.

Fry, W.E., Goodwin, S.B., Dyer, A.T., Matuszak, J.M., Drenth, A., Tooley, P.W., Sujkowski, L.S., Koh, Y.J., Cohen, B.A., Spielman, L.J., Deahl, K.L., Inglis, D.A. and Sandlan, K.P. 1993. Historical and recent migrations of *Phytophthora infestans*: chronology, pathways, and implications. Plant Disease 77 : 653-661.

Fry, W.E. and Shtienberg, D. 1990. Integration of host resistance and fungicide to manage potato diseases. Canadian Journal of Plant Pathology 12 : 111-116.

Hakiza, J.J. 1999. The importance of resistance to late blight in potato breeding in Africa. In: Late Blight: A Threat to Global Food Security. Proceedings of the Global Initiative on Late Blight Conference, March 16-19, 1999, Quito, Ecuador 1 : 47-48.

Hakiza, J.J., Kakuhenzire, R.M., Alacho, F. and Mukalazi, J. 1997. The international late blight and coordinated regional evaluation of potato genotypes in Uganda. African Crop Science Conference Proceedings 3 : 981-987.

Hakiza, J.J., Kakuhenzire, R.M., Wagoire, W.W., Mukalazi, J., Kidanemariam, H.M. and Adipala, E. 1999. Performance of late blight-resistant population A potato genotypes in Southwestern Uganda. African Crop Science Conference Proceedings 5 : 451-456.

Henfling, J.W. 1987. Late blight of potato. Technical Information Bulletin 4. CIP (International Potato Center), Lima, Peru. 25 pp.

Kakuhenzire, R.M., Hakiza, J.J., Mukalazi, J., Turyamureeba, G., Kanzikwera, R. Alacho, F., Kidanemariam, H.M. and Sikka. L. 1999. New potato varieties released in Uganda. African Crop Science Conference Proceedings 4 : 61-65.

Low, J.W. 1997. Threats to the sustainability of potato production in Southwest Uganda. African Crop Science Journal 5 : 395-413.

Sengooba, T. and Hakiza, J.J. 1999. The current status of late blight caused by *Phytophthora infestans* in Africa, with emphasis on eastern and southern Africa. Pages 25-28. In: Late Blight: A Threat to Global Food Security. Vol. 1. Proceedings of the Global Initiative Late Blight Conference, March 16-19, 1999, Quito, Ecuador.

Umaerus, V., Umaerus, M., Erjefalt, L. and Nilsson, B.A. 1983. Control of *Phytophthora infestans* by host resistance: problems and progress. Pages 315-326. In: *Phytophthora: Its Biology, Taxonomy, Ecology and Pathology*. Erwin, D.C., Bartnicki-Garcia, S. and Tsao, P.H. (Eds.). The American Phytopathological Society, St. Paul, Minnesota.

Zandstra, H.G. 1996. Twenty five years of international potato research, a retrospective and forward look. Potato Research 39 : 395-401.