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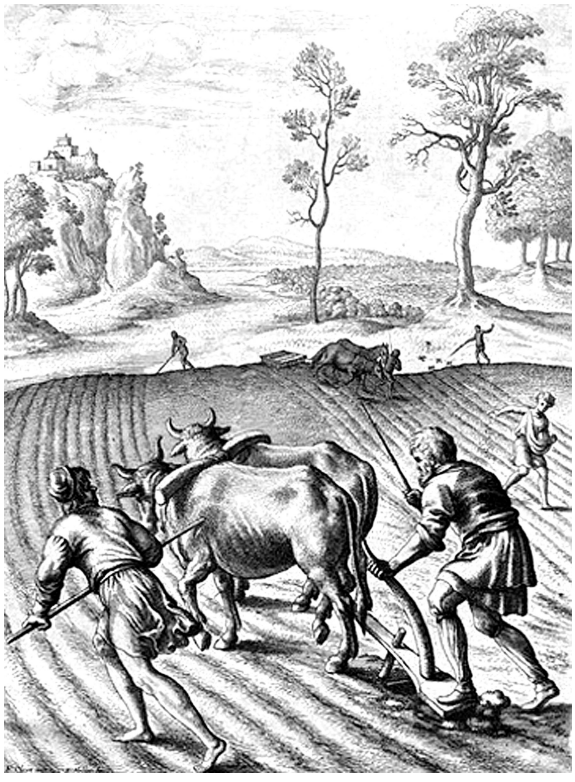

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Yield Performance and Release of Four Late Blight Tolerant Potato Varieties in Kenya

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Abstract: To improve yield potential, potato varieties Kenya Faulu, Kenya Karibu, Kenya Mavuno and Kenya Sifa have been approved for variety release by the Kenya Variety Release Committee. The varieties are medium late to late maturing, high yielding with good tuber and culinary characteristics. The released varieties were selections from advanced potato clones KP90142.7, KP90172.34 and KP91301.10 derived from Population A (high levels of late blight resistance) in which materials for original crosses were obtained from the International Potato Center (CIP). The clone 720097.1 is a derivative of ex-Mexican origin, obtained from germplasm collections at CIP. In multi-location experiments conducted in various agro-ecological regions of Kenya, tuber yield of the newly released varieties were significantly greater than the resistant check variety Tigoni, as well as the other clones evaluated. The released varieties had good agronomic characteristics, high late blight tolerance and acceptable culinary properties. Deployment and utilization of the newly released varieties can greatly improve yield performance in the low input farming systems of Kenyan highlands.

Key words: *Solanum tuberosum*, potato, late blight tolerance, variety release, utilization, Kenya

INTRODUCTION

Potato is one of the most important cash and food crops in the highlands of central, western and the Rift Valley regions of Kenya. Potato cultivation in Kenya is an important agricultural activity and it is estimated that about 120,000 ha are harvested and 900,000 metric tons are produced on an annual basis (FAO, 2002). The average production by small-scale farmers is approximated at 10 tons ha^{-1}, while the per capita consumption is at 40 kg/person. The average field acreage ranges from 0.5 to 5 ha. Potato is cultivated twice per year during the long-rain (March to August) and the short-rain seasons (September to December). The major constraints of potato production in the tropical highlands of Kenya include diseases such as late blight (*Phytophthora infestans*) and bacterial wilt (*Ralstonia solanacearum*) (Olanya *et al*., 2001). Limited availability of good quality seed-potato or planting material, low yield and storability are additional production constraints experienced by potato farmers.

Many potato varieties are currently grown in Kenya (Guyton *et al*., 1994; McArthur Crissman, 1989), however, very low tuber yield which is attributed to low use of inputs, inadequate resistance or tolerance to late blight with the exception of varieties Tigoni and Asante, as well as seed-tuber degeneration are prominent. The late blight susceptible potato varieties require periodic application of fungicides which are often not economically feasible for small-scale potato producers (Olanya *et al*., 2001). In other cases, tuber quality characteristics such as skin color and variety maturity have often been a key factor on variety acceptability due to local consumer preferences and variable product utilization criteria (McArthur Crissman, 1989). In view of increasing trend in potato consumption in Kenya and the need for disease tolerant, high yielding and wide adaptation, development of new potato varieties is of great significance (Lung'aho *et al*., 2002; El-Bedewy *et al*., 2001).

The crosses yielding potato varieties Kenya Faulu, Kenya Karibu, Kenya Mavuno and Kenya Sifa were made at the field research facility of the International Potato Center, Sub-Saharan Africa Region and the National Potato Research Center, Tigoni. The varieties were derived from superior advanced potato clones KP90142.7, KP90172.34, KP91301.10 and 720097.1, respectively. These clones were selected from multi-location trials coordinated by the National Potato Research Center, Tigoni in Kenya. The pedigrees of the above clones were selections derived from several crosses made between advanced clones from Population A (major resistant genes) derived

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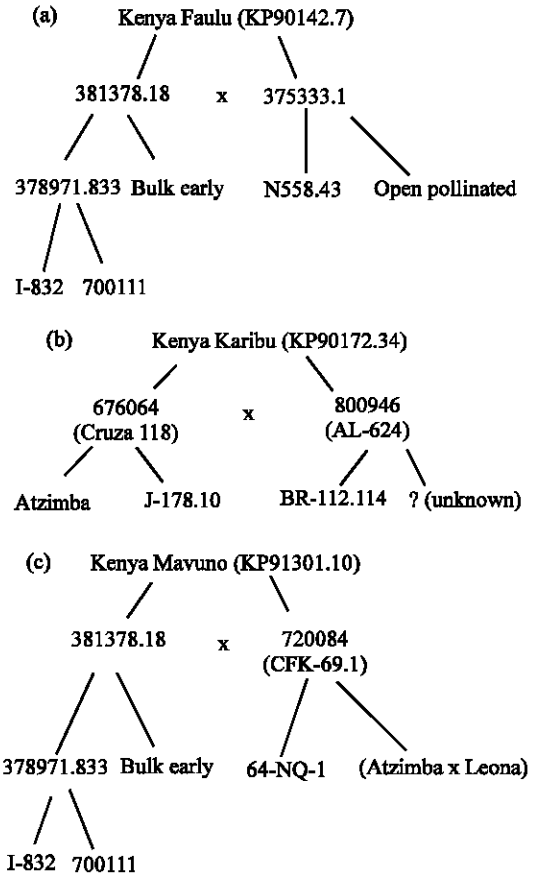

Fig. 1: Pedigrees of the released varieties

from CIP (Fig. 1a, b and c), which has improved resistance to late blight in the potato genotypes (FAO, 2002; El-Bedewy *et al*., 2001). The pedigrees of the clone KP90142.7 is a cross between CIP 381378.18 x CIP 375333.1 (Fig. 1a); KP90172.34 is a cross of CIP 676064 x CIP 800946 (Fig. 1b); KP91301.10 is a cross of CIP 381378.18 x CIP 720084 (Fig. 1c). The clone 720097.1 is ex-Mexican, obtained from the core collection at CIP in Lima, Peru and its pedigree is not known.

MATERIALS AND METHODS

The multi-location experiments were conducted during 1998 (short rain - October to December), 1999 (long rain-May to August and short rain seasons) and 2000 long rain period at four locations which represented the major agro-ecological zones of Kenya (Nderitu *et al*., 2001). The testing locations were: Tigoni, 2,100 m above sea level (m.a.s.l) and a soil type of humic nitosols; Nyandarua (2,852 m.a.s.l andoluvi pharozems); Molo (2,700 m.a.s.l, Plinthic ferralsols) and Mai Mahiu (1,890 m.a.s.l, Eutric planosols). The experiment was established as a Randomized Complete Block Design with three replications. The field plots consisted of five rows of twenty tubers per row. The plant spacing was 75 cm between rows and 35 cm between plants. Standard agronomic practices and weed control were utilized. The potato seed for all experiments were obtained from diseased-free seed lots. A total of 10 clones and check varieties were evaluated in four cropping seasons.

Late blight disease was initiated from natural infections in field experiments and evaluations were conducted at distinct locations representing diverse agro-ecological conditions. The severity of late blight was assessed at weekly intervals by using a visual rating of 0 to 100%, where, 0 = no disease and 100% = total leaf area affected by blight (Henfling, 1987). The wet humid and low temperatures during the cropping season provided ideal conditions for pathogen infection. At harvest, tuber yield was determined from three rows of each plot.

The potato clones were also evaluated for cooking and sensory characteristics after harvest. Sensory evaluation of french fries, crisps, boiled and baked potatoes involved the use of untrained panel. Samples for french fries and crisps were evaluated for color and texture by using a color index. Overall acceptability was determined on a scale of 1 to 9, where; 1= unacceptable and 9 = extremely good acceptance. Samples of the tubers from the clones designated as new varieties were also subjected to glycolalkaloid analysis, dry matter content and specific gravity determination.

The weekly disease data for each clone were used to compute Area Under Disease Progress Curves (AUDPC -% disease days), a measure for disease progress on different varieties. Analysis of variance was used to compare late blight reaction and tuber yield of clones earmarked for variety release in comparison to other potato clones by using Statistical Analysis System (SAS, 2002). The analysis of variance was computed across years and locations by using a mixed model. Locations and years were designated as random effects while clones were considered fixed effects in order to generalize the results of tuber yield and disease effects for the various regions of Kenya.

The seed of released potato varieties are available upon request from the National Potato Research Center (NPRC), Tigoni and from the International Potato Center (CIP), Regional Office for Sub-Saharan Africa, Nairobi, Kenya. The seed for the varieties are maintained as tuberlets and *in vitro* plantlets (pathogen-tested lists) at the Tissue Culture Unit of the Plant Quarantine Station, Muguga, Kenya. Therefore, request for planting materials should be addressed to: The Seed Unit, NPRC-Tigoni, P.O. Box 338, Limuru, Kenya or to International Potato Center (CIP), Regional Office for Sub-Saharan Africa, P.O. Box 25171, Nairobi, Kenya.

Table 1: Morphological description and characteristics of four late blight tolerant potato varieties released in Kenya

Descriptor*	Varieties: Kenya Faulu	Kenya Karibu	Kenya Mavuno	Kenya Sifu
Plant height	Tall	Tall	Tall	Tall
Flower color	Purple	Light purple	White	Purple
Days (50%) flowering	70	60	65	60
Leaf shape	Broad	Narrow sharp-pointed	Broad	Broad
Leaf color	Light green	Slight dark-green	Green	Light green
Leaf hair	Slight	Medium haired	Light haired	Heavy haired
Stem shape	Triangular	Rectangular	Rectangular	Triangular
Stem color	Purple	Purple	Green	Green
Stem hair	Slight	Medium	Lightly haired	Slight haired
Stem thickness	Thick	Small	Medium	Thick
Skin color (tuber)	Red	Deep red	White	Pink
Eye depth	Shallow	Medium	Shallow	Medium
Flesh color	Cream	Yellow	Cream	Cream
Sprout color	Pink	Reddish	Light green	Red
Tuber shape	Long oval	Round	Oval	Flat/round
Maturity days	>120 (Late)	>110 (Late)	>120 (Late)	90-110 (Medium Late)

*Selected descriptors for potato variety registration

RESULTS AND DISCUSSION

In the multi-location tests conducted in Kenya over several years (Lung'aho *et al*., 2002; Nderitu *et al*., 2001), the performance of the four varieties were more superior to Nyayo, the most widely grown local variety. The morphological description of the newly released potato varieties (Mackay *et al*., 1985) and post harvest characteristics (Table 1 and 2) showed that the varieties were better or comparable to tolerant check variety. The potato varieties had similar flower color ranging from light purple to purple with the exception of Kenya Mavuno which has white flower. The varieties had good stem and leaf characteristics and has medium late to late maturity duration. The medium-late to late maturity index suggests that it can be effectively utilized in the existing potato production systems in Kenya which has already some early maturity varieties in use. The potato variety Kenya Sifu however, has a long dormancy period. Therefore, its utilization by farmers in potato-based cropping systems will require careful planning. The long-dry season and the variety requirement for a long period of storage prior to completion of dormancy suggests that Kenya Sifu can be effectively utilized for increased potato production.

The released varieties have good tuber characteristics in which the skin color ranged from pink to deep red except the variety Kenya Mavuno which has white skinned color. The skin color as an acceptability attribute is quite variable among consumers in Kenya, with some consumers preferring pink or red skinned varieties; while others prefer white-skinned color (McArthur Crissman, 1989). The four newly released potato varieties have a relatively high dry matter (%)

Table 2: Late blight resistance, agronomic and post-harvest characteristics of potato varieties released in Kenya

Characteristics	Varieties: Kenya Faulu	Kenya Karibu	Kenya Mavuno	Kenya Sifu
Late blight* (AUDPC)	MT	T	T	HT
Specific gravity	1.079	1.076	1.085	1.083
Tuber yield (mg ha^{-1})	26	29.5	25	25.1
Chip quality**	4.5	5	5	4.5
DM***	19.9	19.5	21.3	20.8
Glycoalkaloid****	12	12	7.6	7.6
Utilization	Chips	Boiling, crisps	Chips, crisps	Chips, boiling

*Late blight resistance was quantified by calculating disease progress (area under disease progress curves). MT = Moderately Tolerant, T= Tolerant, HT= Highly Tolerant

**Chipping quality was evaluated on a visual color scale of 1 to 10, where 1=unacceptable and 10=best.

***Refers to percentage of tuber dry matter content

****Glycoalkaloid content were recorded in mg/100 g of tuber fresh weight

qualities during simple ambient air storage for up to 12 weeks (Kabira, 2002). Kenya Karibu and Kenya Sifu produced acceptable chips following simple air storage. Kenya Faulu produced excellent French fries subsequent to low temperature freeze storage and Kenya Mavuno resulted in excellent French fries from fresh tubers. Good potato storability in simple storage facilities similar to that used by many low-input potato farmers is very useful indeed since modern storage systems are quite expensive.

The newly released varieties showed very good levels of tolerance to late blight infection (Table 3) in spite of the wet humid and low temperature conditions during cropping season which provided ideal conditions for pathogen infection. Significant differences in Area Under

Table 3: Average tuber yield (t/ha) and late blight severity (AUDPC) of potato clones evaluated at four locations and cropping seasons in Kenya

Clones/genotypes	Tuber yield (t/ha)**	Disease severity (AUDPC)
382155.2	32.95a	822d.0
Tigoni***	28.7ab	992.8b
720097.1*	28.06	832.7d
KP91301.10*	30.24	826.7d
KP90172.34*	29.79a	823.0d
KP90142.7*	29.96a	946.0b
KP92387.5	28.30ab	1052.0c
Asante	26.58b	1001.0b
KP90150.4	24.99c	910.8c
382651.24	24.25c	938.4c
720122	23.57c	984.0c
Nyayo****	20.65d	1559.0a
Means	27.34	974.0
LSD (0.05)	1.57	80.30

*Clones from which varieties were released.
**Means followed by the same letter are not significantly different
***Resistant and ****susceptible check

content making them very suitable for processing into chips, frozen fries and cooking quality. These varieties were observed to maintain some of their processing Disease Progress Curves (AUDPC) were recorded among years, clones, locations by years, years by clones as well as locations by years by clones (Table 3). Late blight ratings in released varieties were generally lower than that of the resistant check variety, Tigoni. The high tolerance levels of these varieties may be attributed to their parentage from Population A (International Potato Center, Lima, Peru) which contains major resistant (R) genes (El-Bedewy, 2001; Landeo *et al*., 1995). Therefore, small-scale potato farmers can effectively utilize these varieties for their host-tolerance and maximize their yield by reducing the use of fungicide inputs as a management option. The significance of locations x years, years x clones and locations x years x clones interactions observed for late blight suggest that variation in environmental conditions may account for differences in late blight observed in the fields.

Tuber yield also differed significantly among testing locations, however, in the presence of late blight, the yield of the newly released varieties (Lung'aho *et al*., 2002) were consistently better than the resistant check variety (Table 3). Tuber yield performance of released varieties ranged from 28.1 to 29.9 m tons ha^{-1}. This is acceptable in the potato-based cropping systems of the Kenyan highlands, where the tuber yield under farmers' conditions has an average of 10 m tons ha^{-1} (NPRC, 2002). The results showed that tuber yield was stable across locations and years. The interactions of locations x years and years x clones for tuber yield were significant. These interactions imply that variation in environmental conditions in some locations and years may account for differences in tuber yield.

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