Sweetpotato breeding in Uruguay

Rodríguez, G.[1]; Vicente, E.[2]; Vilaró, F.[1]; Pereira, G.[3]; Spina, W.[2]; González, M.[2]; Ibañez F [1], Reggio, A.[1]

1 Instituto Nacional de Investigación Agropecuaria, INIA Las Brujas, Canelones, Uruguay
2 Instituto Nacional de Investigación Agropecuaria, INIA Salto Grande, Salto, Uruguay
3 Instituto Nacional de Investigación Agropecuaria, INIA Tacuarembó, Tacuarembó, Uruguay
INIA National Agricultural Research Institute

Introduction

Sweet potato is the second most important vegetable crop after potato, occupying more than 2.500 hectares in Uruguay (34° S 56° W) and first in number of growers involved (over1500) (Casáres et al., 2009). Approximately 60% of production is obtained in the South and 30% in the North region of the country. Average yield is about 15 tons/ha (Casáres et al., 2009) whereas specialized growers obtain more than 30 tons/ha.

Sweet potato (*Ipomoea batatas* (L) Lam.) is grown through Uruguay mainly as a seasonal cash crop. This product is traditionally consumed mainly for boiling, baking or roasting (7 kg. annually per capita) without further processing. Purple skin, yellow flesh varieties with semi humid texture (boniato type) are mostly preferred, whereas orange flesh, humid texture varieties are gaining in acceptance, mainly for baking or roasting.

In temperate countries like Uruguay, production is started at the end of winter with sweet potato roots planted in seedbeds for obtaining slip plantlets. Approximately two months later (October-November), these plantlets can be transplanted into the field. During December and January, stem vine cuttings with three or four developed nodes could be removed from growing crops for additional transplanting. The harvest period extends from January to June, providing the market with fresh product in this period and from July to December with stored product.

Crop improvement and management experimentation on sweet potato began in 1973 by former CIABB (Alberto Böerger Agronomical Research Center). Local landraces were collected and later evaluated during the 80´ along with several foreign introduced cultivars at Experimental Stations Las Brujas (south), Salto (north) and Tacuarembó (northeast) (Vilaró, 1987). From those introductions, Morada INTA and Jewel were extensively adopted in the south and north regions respectively. Beauregard, introduced in the early 90´s from USA, rapidly replaced Jewel and gained some importance in both regions. Although these varieties out yielded local landraces, they only partially fulfil crop adaptation requirements.

Breeding project was started on 1987 through germplasm introduction by means of botanical seed progenies from AVRDC and USDA-South Carolina and shortly later from North Carolina, Japan and CIP. In 1988 a national survey and workshop was realized about sweet potato production, uses and problems in Uruguay, with methodology supported by CIP (INIA-CIP, 1993). In this workshop, the importance of a local breeding program was stated and objectives discussed. Since then, several successful varieties have been released from this breeding program. They are described in this paper along with breeding methodology and perspectives.

Methodology

First local progenies were developed in 1988 at Las Brujas Research Station through polycross breeding method. Up to 20 progenitors were employed including local landraces, advanced local selections and introduced cultivars. The breeding method employed population improvement through recurrent selection for various traits. Flowering was restricted to South Carolina population, thus grafting with related *Ipomoea* species was performed to improve and promote flowering. Selection criteria was based on multiple disease and insect resistance, short growing cycle (90 to 120 days), high yield in different growing conditions, long storability and quality for diverse markets and uses.

During the last two decades, around 10.000 half sib progenies were annually planted in Salto Grande Research Station and clonally selected through two 90 days growing cycles per season. Selected clones were then

collaboratively evaluated in three INIA Research Experimental Stations involved. Later, grower participatory evaluation is performed for validating the most promising clones at different growing field conditions.

More recently, the program developed three different populations with specific objectives through corresponding polycrosses of up to 20 sweet potato parental lines. A total of 30.000 seedlings are raised annually for initial clone selection. (Rodríguez et al, 2007).

Present specific objectives are focused in developing different kind of populations:

15. A boniato type population with thick purple skin and cream flesh with long storability.
16. An orange flesh population, with high beta carotene content, early harvest, insect resistance and long storability.
17. A population with high dry matter content for different uses, including animal feed.

Two polycross nurseries are established at INIA Las Brujas Research Station, under plastic greenhouses (Figures 1 and 2) for first and third population. Corresponding seedling plants are field transplanted by the end of October and harvested by the end of March.

Figures 1 and 2

Figure 3. Field selection INIA Las Brujas

Thereafter, roots from selected clones are distributed to INIA Experimental Stations at Salto Grande and Tacuarembó for further evaluation at different growing conditions (Figure 3).

The polycross nursery at northern region (INIA Salto Grande) (Figure 4) is established to develop a second breeding population. This polycross is produced under a film shade to avoid frost damage during late autumn. The seedlings are field transplanted in September, and first selection is based on earliness (90 days). Vine cuttings from selected plants are then planted for a second 90 days growing cycle (Figure 5). Roots from selected clones are then distributed to the other Experimental Stations to continue cooperative evaluation.

Figures 4 and 5

High quality initial seed stock is obtained by hill selected plants at harvest. Although virus pressure is not a major issue, some varieties are favoured using in vitro tissue culture for multiplication.

Results

Great progress was made in sweet potato improvement during the 1990s. Several varieties of various types were released and rapidly adopted, remarkably 'INIA Arapey' (Vicente et al., 1999) (Table 1).This is a boniato type cultivar with wide adaptation and short growing cycle (100 days) which replaced Morada INTA and INIA Belastiquí. At the present time it covers about 75 % of the total area and it is being adopted in neighbour countries, reaching a marketable yield that is two or three times higher than older varieties.

In addition, several orange flesh varieties were released such as 'INIA Ayuí ', 'E 9227.1', INIA Itapebí ', and INIA Cerrillos (Vicente et al, 1996), (Rodríguez et al., 2007).

INIA-Ayuí is distinguished by its short growing cycle (90 days). INIA Itapebí and E 9227.1 with purple skin and orange flesh were released because of their long storage ability for north and south regions, respectively.

New cultivars of sweet potatoes, corresponding to different commercial types and adapted to diverse production regions and uses were recently obtained and released:

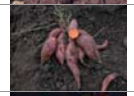
K 9818.1 and Ñ 0401.3 are two new orange flesh varieties with medium late and short growing cycle, respectively. They could replace INIA Ayuí and Beauregard for south and northern region respectively, because of higher yield, longer storability, higher multiplication rate and improved commercial quality. In addition, insect soil damage *(Chaetocnema)* is lower than Beauregard for both of them.

H 9430.23 is a red skin with cream white flesh sweet potato, adapted to northwest production region. Growing cycle is medium late (120 to 150 days) and its productivity is equal or larger than INIA Arapey. It has good storability, longer than INIA Arapey and low insect soil damage.

Finally, K 9807.1 is a sweet potato with dry matter over 30 %, suitable for processing and animal fed. It has a medium to medium late growing cycle (120-150 days) and present low insect soil damage. Its taste is quite unsweet and has a semi dry texture.

New released varieties are registered at INASE (National Seed Institute). The breeding program provides basic seed that is multiplied by grower organizations.

Table 1.

Variety Clone		Year of release or diffusion	Skin color	Flesh color	Productivity	Cycle	Storability	Dry Matter (%) ± SD	mg ß-carotene/ 100g fresh flesh ± SD
Morada Inta		**1980**	**P**	**C**	**medium**	**L**	**L**	**37.9 ± 1.7**	1.68 ± 0.04
Beauregard		**1994**	**O**	**O**	**high**	**M**	**L**	**21.5 ± 1.4**	35.50 ± 0.47
INIA Belastiquí		**1997**	**RP**	**C**	**high**	**E**	**M L**	**29.3 ± 2.5**	0.22 ± 0.01
INIA Cerrillos		**1997**	**R**	**O**	**medium**	**M E**	**P**	**25.7 ± 0.4**	29.4 ± 0.18
INIA Arapey		**1998**	**P**	**C**	**high**	**M E**	**M**	**28.2 ± 1.4**	2.15 ± 0.10
INIA Ayui		**1998**	**O**	**O**	**medium**	**E**	**P**	**20.8 ± 3.4**	23.5 ± 0.77
INIA E 9227.1		**2000**	**P**	**O**	**medium**	**ML**	**L**	**26.3 ± 1.2**	31.55 ± 1.40
INIA Itapebí		**2004**	**P**	**O**	**medium**	**M**	**M**	**23.4 ± 4.3**	30.45 ± 0.85
K 9818.1*		**2009**	**O**	**O**	**high**	**M E**	**L**	**23 ± 1.8**	55.51 ± 1.73
Ñ 0401.3*		**2009**	**O**	**O**	**high**	**E**	**L**	**22.7**	19.63 ± 0.29
H 9430.23*		**2009**	**R**	**W**	**high**	**L**	**M**	**28.9 ± 1.4**	n/d
K 9807.1*		2009	C	C	medium	M L	M L	34.8 ± 3.5	0.11 ± 0.03

Continúa …

Keys

- * Registered varieties under protection

- Skin Color
  - P (purple)
  - O (orange)
  - R (red)
  - C (cream)

  Flesh Color
  - C (cream)
  - W (white)
  - O (orange)

- Cycle
  - S (short 90 days)
  - M (medium 120 days)
  - L (long more than 140)

- Storability
  - P (poor)
  - M (medium)
  - L (long)

- Dry Matter forced air oven at 60 C° for 48 hs.

Perspectives

Polycross breeding system combined with recurrent selection allowed large progress for most traits, while maintaining enough variability. Introducing variable germplasm mainly as seed progenies became major sources for genetic improvement. Research Stations collaborative breeding program allows faster results. Wide adoption of released varieties improves crop and soil practices, having a major impact on national productivity and promotes high quality product supply of the market year around. Varieties with short growing cycle and early harvest help to extend planting season allowing a better soil use.

Through the past two years we have identified genotypes with improved characteristics in each breeding population. The development of three specialized populations is allowing faster progress for each of them.

Yield potential and quality market attributes have been remarkably improved and new processing uses are being validated. Ethanol and flour production and suitability for frozen products (puree and baking or frying) is being considered. Nutritional value such as high carotene content is being evaluated (Ibáñez et al., 2009) (Table 1). Efforts are now focusing on increasing dry matter content by inter crossing identified valuable germplasm from local and introduced accessions.

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Author contact information
Gustavo Rodríguez Lagoutte
Instituto Nacional de Investigación Agropecuaria (INIA)
Experimental Research Station INIA Las Brujas, Ruta 48 km 10 Canelones, Uruguay.
Teléfono (598) 2 3677641, Fax: (598) 2 3677609,
Email: grodriguez@inia.org.uy