SHORT COMMUNICATION

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Production and multiplication of national potato varieties in family farming systems

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Summary

Potato is the main vegetable in terms of production volume at national level. In Uruguay, two agricultural cycles are carried out every year, in autumn and in spring. Potato small-scale family farmers represent 80% in number and cover only 10% of national area. The current system of seed multiplication allows for two crops in two years, involving the conservation of seed tubers for six months. An alternative scheme for family farmers has been proposed, based on the use of national short dormancy varieties. With proper management, it is possible to obtain four crops in two years. In order to support the insertion of family farmers in a multiplication scheme of national varieties and to identify the main management factors to be improved, the monitoring of seed production was carried out in 2016. Farms were visited every 15 days to assess crop growth and health and support decision making. Total yield was estimated and classified into categories. Critical management factors discussed with farmers were crop design and density, emergence, harvest and post-harvest management. We found harvest date is a bottleneck for family farmers, where delays in harvest are frequent. The delay of the spring harvest would not allow using these seeds for the autumn crop since they would not reach an adequate sprouting state. In spite of the fact that national varieties have short dormancy, for this scheme of seed multiplication, the spring harvest date is a key factor to ensure a proper sprout status for the next planting season.

Additional keywords: family farms; seed tuber production; national varieties; short-dormancy varieties

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Producción y multiplicación de variedades nacionales de papa en sistemas agrícolas familiares

Resumen

La papa es la principal hortaliza en términos de volumen de producción a nivel nacional. En Uruguay se realizan dos ciclos de producción al año; en otoño y en primavera. Los productores de pequeña y mediana escala representan el 80% de los productores totales y cubren el 10% del área sembrada anualmente. El sistema actual de multiplicación de tubérculos semilla permite dos cultivos en dos años, involucrando la conservación en frío de los tubérculos por seis meses. Se ha propuesto un sistema alternativo para productores familiares basado en el uso de variedades nacionales de dormancia corta. Con un manejo adecuado es posible obtener cuatro cultivos en dos años. Con el objetivo de apoyar la inserción de productores familiares en un esquema de multiplicación de materiales nacionales y de identificar factores de manejo a mejorar, se monitoreó la producción de tubérculos semilla durante los dos ciclos del cultivo en 2016. Se visitaron los predios cada 15 días para evaluar el crecimiento y desarrollo del cultivo, monitorear la presencia de enfermedades y plagas y apoyar la toma de decisiones en el cultivo. Se realizaron muestreos destructivos durante el crecimiento del cultivo y se estimó el rendimiento. Los factores críticos de manejo identificados y discutidos con los productores fueron la densidad y marco de plantación, emergencia y el manejo de la cosecha y postcosecha de tubérculos. La fecha de cosecha fue uno de los puntos críticos ya que las demoras en la cosecha son frecuentes. El retraso en la cosecha de primavera no permitiría utilizar estos tubérculos como semilla para el otoño ya que no alcanzarían un estado de brotación adecuado a la siembra. A pesar de que las variedades nacionales tienen dormancia corta, para que este esquema de multiplicación sea viable, la fecha de cosecha de primavera es un factor clave para asegurar un estado de brotación adecuado para la próxima siembra.

Palabras clave adicionales: *productores familiares; producción de tubérculos semilla; variedades nacionales; dormición corta*

Introducción

Potato is the main vegetable in terms of production volume (20%) at national level (DIEA-MGAP, 2011). In Uruguay, two agricultural cycles are carried out every year, one in autumn and one in spring. Potato small-scale family farmers (less than 5 ha cultivated) represent 80% in number and cover only 10% of the national area. The high cost of cultivation is one of the main reasons for this concentration. The cost of seed tubers represents around 30% of the total cost of the crop. Another common problem faced by family farmers is the difficulty of insertion in marketing chains that demand some stability in volume offered.

In the seed market an offer of imported varieties based on varieties developed in the northern hemisphere has prevailed (Hirczak and Rodriguez, 2016). These varieties are adapted to an annual crop cycle, because their dormant period is medium to long (12 to 15 weeks) (Colnago *et al*., 2014 a and b). In general, the varieties of this origin respond better

to cool climate, common in autumn. Also, these varieties are quite susceptible to main diseases that affect the crop, particularly those of systemic transmission such as viruses (PVY, PLRV) (Crisci and Vilaró, 1983; Vilaró, 2001). Virus dissemination is transmitted by insect vectors present during both growing seasons. PVY is particularly difficult to control even with insecticide application (Crisci and Vilaró, 1993), which increases the multiplication costs. In addition, varieties offered from abroad are increasingly protected by the seed breeding companies which restrict their local multiplication.

Three varieties have recently been released by the National Program on potato breeding: INIA Guaviyú, INIA Daymán and INIA Arequita. These varieties are characterized by their high resistance to PVY (Dalla Rizza and Vilaró, 2006; Vilaró *et al.,* 2013) and their tolerance to PLRV and major fungal diseases. They have shown better relative behavior during spring season, with respect to varieties of the Northern Hemisphere and greater yield stability between seasons and years. INIA Guaviyú and INIA Daymán present short dormancy and are multiplied by two organizations of family farmers.

The production of national certified seed tuber reaches around 15% of the annual growth area, 20% of this is national cultivars. There is wide room to increase local seed production, at the company level and for family farmer organizations. The current system of seed multiplication with the use of traditional varieties allows for two crops in two years, involving the conservation of seed tubers for a period of approximately six months. An alternative scheme for family farmers has been proposed, based on the use of short dormancy varieties. The national varieties have a dormancy period of 9 to 10 weeks.

Tubers harvested in autumn (end of May, beginning of June), must be conserved in a shed, without refrigeration. The scheme proposed involves early sowing in the spring (August) since the foliage must be removed at the end of November or early December. The tubers harvested at this time would reach a suitable sprouting state to be sown at the beginning of February, autumn season. With proper management, it is possible to obtain four crops in two years, on an ongoing basis. This alternative scheme eliminates the cost of refrigerated conservation and enables the acceleration of annual multiplication. The possibility of double cultivation with national varieties is an opportunity for small and medium scale farmers, lowering cultivation costs and ensuring quality seed at the right time. In order to achieve these objectives, it is necessary to adjust crop management (sowing dates, fertilization and management of diseases and pests, date of burning or foliage removal) and seed-storage management (storage conditions, monitoring of the physiological state of the seed), in order to obtain seeds of high sanitary quality and a suitable sprouting state for each growing season.

In order to support the insertion of family farmers in a multiplication scheme of national varieties, the monitoring of seed production in family farming systems was carried out during the two cultivation seasons of 2016. A specific objective was to identify the main technological and management factors to be improved, which will enable the continuous multiplication of these varieties. A case study of the CALSESUR cooperative is presented in this communication.

Materials and methods

During both growing seasons, autumn (February-June) and spring (September-December) of 2016, seed crop of the CALSESUR cooperative was monitored. Periodic visits were made every 15 days to assess crop growth and support decision making. Crop management made by the farmer (fertilization, irrigation and phytosanitary interventions) was recorded. Tuber sprouting state was evaluated before planting (February 3 and September 22, 2016). The evaluation was carried out on tubers already classified for planting, two repetitions of 20 tubers of each variety: Guaviyú and Daymán. Length and vigor of the shoots were determined. The tubers were weighed to determine the average tuber-seed size.

For each growing season, four destructive samplings were carried out to evaluate growth and development. The variables evaluated were: number of leaves, haulm and branches, number of stolons, tubers, and dry weight of the different organs throughout the crop cycle. The yield was estimated, and harvest was classified into categories according to tuber size. The main diseases and pests were monitored. Each plot was divided into four quadrants, and five plants were taken at random to make the observations. A temperature and humidity sensor were installed in order to characterize the climate during the growing season.

Results and discussion

The crops were established between February 24th and March 4th for the autumn sowing and October 7 in the spring. Delayed planting in both seasons was due to the low humidity of the soil due to the scarcity of rainfall during the summer (sowing in February), and to the excess moisture in the spring. The varieties used were Daymán and Guaviyú. The crop design used by farmers was in raised beds, with a density of 2.1 pl m^{-2} in autumn and sown in ridges in spring, with a density of 3.4 pl m^{-2}.

As recorded in the evaluation of seed sprouting status for autumn sowing, both varieties were beginning to sprout. 15% of the Guaviyú tubers evaluated had a sprout larger than 5 mm, 75% were beginning sprouting (visible shoot, less than 3mm) and 10% had not started to sprout yet. In the case of Daymán, these values were 20, 75 and 5% respectively. The average size of the seed was 80 g. The spring crop was installed from tubers harvested in autumn and kept in sheds. At the end of July the tubers had started to sprout. The climatic conditions prevented the installation of the crop on the anticipated date, which led to having very sprouted tubers, with very long shoots and little vigor, which came off or broke spontaneously at the time of sowing.

Some important management factors discussed with farmers were crop design and density, emergency, nutritional status and pest and disease management.

Density and crop design. The density in autumn was very low due to crop design in raised beds. Another drawback of growing potatoes in raised beds is the impossibility of hilling, which often leaves tubers exposed on the surface, increasing discarding (greening and sunburn).

Emergence. The delay in the crop emergence in autumn (20 days after sowing) even with favorable temperatures was linked to the sprouting state of the seed. The very young seed not only caused delay in the emergence, but it was also uneven. Dayman delayed more in emerging and did it in a more heterogeneous way in regard to Guaviyú. Daymán plants had one or two stems while Guaviyú had two or three.

Crop nutritional status. It was adequate to a seed crop. No nutritional deficiencies or excesses (N), which could have caused problems or defects in the tuberization, were detected. Tuber initiation did not differ among varieties in any of the seasons; it was associated to climatic conditions.

Crop protection. Cops presented a very good health status. No plants with viruses were observed. Some aphids and thrips with very low population were observed. The control of diseases during cultivation was mainly oriented to the prevention of *Phytophthora infestans* in autumn and to *Alternaria solani* in spring.

Harvest. The fall harvest took place on June 8th and the spring harvest on January 19th. Total yield was estimated and classified according to categories: 40 to 80 grams (seed), 80 to 200 and larger than 200 grams. Discards were mainly due to size (<40g) in autumn.

There were important differences in the yield of the two varieties in autumn.

Total yield of Guaviyú was 22, 6 MG responding to seed size. Crop yield in Daymán was significantly lower: 9 total MG, 1.9 MG responding to seed size. In spring, the yield of the two varieties was similar, reaching 23 MG, with a seed yield of 5.3 and 2.7 MG for Guaviyú and Daymán respectively. The delay of the spring harvest does not allow using these seeds to install the next autumn crop since it does not reach an adequate sprouting state for sowing in February. A very late installation of the autumn crop would lead to a significant reduction of its cycle and therefore a reduction in yields.

Growing seasons in Uruguay are short, so a delay in the sowing date leads to even shorter cycles. In spite of the fact that national varieties have short dormancy, for this scheme of seed multiplication the spring harvest date is a key factor to ensure a proper sprout status in each season and therefore, a successful crop.

All these aspects were discussed with farmers as needing improvement.

The work experience demonstrates the need to support family farmers to adapt this proposal of seed multiplication with local varieties to their own production systems. Adjustments are needed in the management of the crop and post-harvest for an adequate state of sprouting of seed tuber at each growing season. With this work background a research project has recently been approved, seeking to promote the adoption of improved cultivation practices adapted to specific varieties to improve the competitiveness and sustainability of potato cultivation in family farmers and to strengthen the production of certified seed (2018-2020) with local potato varieties. At the same time, the aim of this project is to identify, through participatory evaluation and selection, new varieties from advanced clones of the breeding program of the National Agricultural Institution Research (INIA). Finally, a higher availability of highquality seed in local varieties is expected for both growing seasons.

Conflict of interest

The authors declare no conflict of interest.

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