Volume 16(4), 136- 141, 2012
JOURNAL of Horticulture, Forestry and Biotechnology
www.journal-hfb.usab-tm.ro

Production of seedling tubers from true potato seed (TPS) in protected area

Cioloca Mihaela[1*], Baciu Anca[2], Nistor Andreea[1], Popa Monica[1]

[1]National Institute of Research and Development for Potato and Sugar Beet Brasov; [2]Potato Research and Development Station Târgu Secuiesc

*Corresponding author. Email: mihaela.cioloca@potato.ro

Abstract The potato *(Solanum tuberosum)* can be propagated both vegetatively (clonally) and sexually. True potato seed (TPS) technology is based on the natural ability of the potato to produce flowers, which are then fertilized and set berries that contain potato seeds, which will be used later as planting material. Initially, the main problem of potato hybrids derived from true seed was related to the difficulty of producing uniform potatoes in terms of shape, color, size and seed quality. Currently there are companies that produce true potato seed, rigorously tested qualitatively superior (free from diseases and pests).

Key words

true potato seed, seedlings, minitubers, greenhouse

Because potatoes are harvested, stored and replanted year after year, several pathogens can be transmitted by the vegetative multiplication of the crop and therefore the production is greatly affected. To achieve higher production, growers are able to purchase disease-free planting material from authorized suppliers who apply the most rigorous methods for obtaining a healthy starting material. These are called "certified seed potatoes". Unfortunately, in many countries certified seed potato may be available only through import. There is however a major drawback: because potato tubers are bulky, heavy and perishable, so transportation costs to import potatoes and then deliver to the farmer are considerable. To solve this problem, researchers have tried to exploit the ability of potato plants to produce seeds. To distinguish these from "seed potatoes" the seeds are called "true potato seeds" (TPS).

Compared with the clonally propagation, TPS technology involves different operations, as a tuber weight is 70,000 bigger than a seed. A single tuber or a portion of it typically weighs 40 to 50 grams, but 40 grams of TPS corresponds to approximately 56,000 seeds. It takes only 160 grams of TPS to seed one hectare (compared to 2,000-3,000 kg of potato tubers), or 80 grams if seedlings are transplanted. Another advantage of TPS technology is that botanical seed is always available to be planted. Using true potato seed has many advantages compared to the classic system.

Based on these advantages, in 2005, the INCDCSZ Brasov initiated a series of experiments that were aimed at obtaining alternative planting material, biologically and phytosanitary appropriate, that can be a complement to seed requirements.

Research methods and materials

Using true potato seed we can obtain: minitubers, seed or ware potatoes. There are several ways to cultivate potatoes based on TPS:

- direct seeding in the field;
- breeding seedlings in protected areas, followed up by their transplanting in the field;
- cultivation in protected areas (from seeding to tuber harvesting).

The entire crop cycle was conducted in a protected area (greenhouse), at the National Institute of Research and Development for Potato and Sugar Beet Brasov (Center for Clonal Material Production for Potato Lazarea). Biologic material is represented by four isogenic potato lines: Mindy, Zolushka, Gilroy and Catalina provided by Bejo Zaden, Netherlands. The breeding of these lines is based on a potato research programme, aiming at promoting the varieties obtained of true potato seed, adaptable to the different climatic conditions in the different parts of the world.

The properly stored seeds were sown in the greenhouse on germination beds, into a well-prepared soil free of large clumps. After placing seeds at high density (Fig. 1a), the seeding depth being of 1 cm, they are covered with a thin layer of fine soil and sprinkled. An optimum sowing was provided, namely temperatures of 15º to 20 ºC and relative humidity of air 60% to 80%.

These small seeds have very little food reserves to maintain the developing seedling after germination. Therefore, this new technology requires different agronomic practices compared to a seed tubers planting. Most important differences related to:

- seed bed preparation,
- pre-plant pesticide/herbicide and fertilizer application,
- seed spacing,

- depth placement
- irrigation
- post emergent fertilization
- weed control.

Most operations described above are characteristic to plant species with small seeds. Once the seedlings reach the age of 8 - 10 weeks, they can be treated as a common potato crop.
The first true leaves began to appear 2 weeks after sowing. At the end of its emergence, preventive treatments were made against late blight using Ridomil Gold (systemic fungicide).

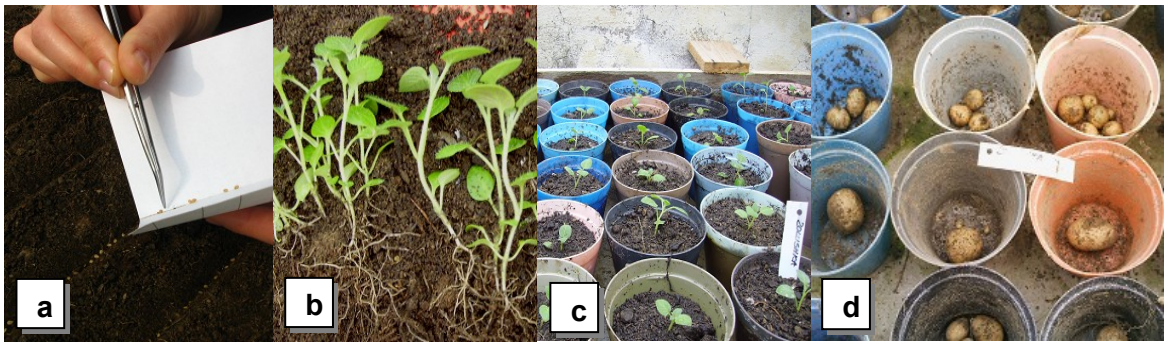

Fig.1 Sowing and harvesting potato minitubers

After 4-8 weeks from sowing, when the seedlings were about 5-10 cm height (Fig. 1b), these were transplanted into pots with tapered form with the following characteristics: large base diameter 10 cm, small base diameter 7 cm, height 9 cm (Fig. 1c).

During the vegetation treatments were applied - fungicide (Ridomil Gold) with insecticide (Mospilan) approximately every 3 weeks. Complex fertilizer NPK 15 15 15 was also used in the form of granules applied to the soil surface. Appropriate conditions of light, temperature and humidity were provided for the harmonious growth of plants.

During the vegetation period potato plants were cared for like other vegetables grown in protected area. The following aspects were taken into account:
-ensuring optimal growth conditions (temperature, humidity, light, substrate quality);
-adequate and timely fertilizer applications (in the soil and/or foliage);
-effective control of pests and diseases.
About 175 days after planting, the tubers that have reached full maturity were harvested (Fig. 1d). Two weeks before harvest chemical haulm destruction was carried out to reduce losses caused by uneven maturation of tubers. This technique is indicated in TPS technologies, considering that progenies derived from true potato seed are made up of individuals with different genotypes, which can lead to some differences regarding tuber maturation. Each plant was harvested separately in labeled paper bags. Shortly after harvest, all tubers were analyzed individually, aiming at uniformity of first vegetative generation.

Results and Discussions

In the TPS technology the main barrier, but also a challenge for science is the production of seeds that produce uniform tubers despite the great genetic variability of potato. Potato plants obtained from botanical seed have genetic characteristic completely different from those of the parents in terms of phenotype, maturity group and tuber characteristics. These features of the heterozygote are considered major disadvantages of potato hybrid progenies. But on the other hand, there is the advantage of variability in the population, which makes it less vulnerable to the action of natural selection than clonal varieties (yield, pest and disease resistance, adaptability to different environmental conditions).

When working with true potato seed, one of the most important pursued aspects is the analysis of the uniformity of the first vegetative generation. In this experience, after harvesting minitubers for each of the four genotypes, plants were individually marked in terms of the following characteristics: number of tubers/plants, skin colour, eye depth. Furthermore, observations were made on seed germination and seedling survival rate after transplanting, depending on genotype.
The first true leaves appeared about 2 weeks after sowing. Regarding the dynamics of potato seedlings emergence, the best results were registered in the case of Zolushka and Gilroy (Fig.2).

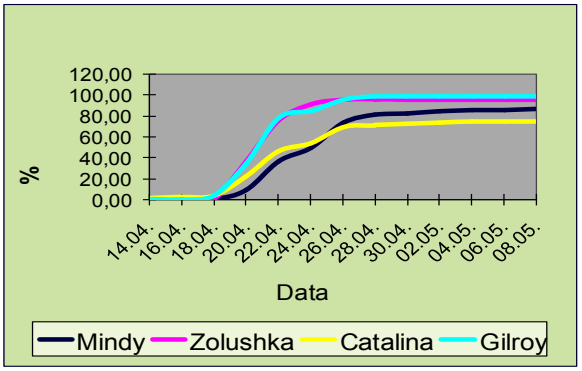

Fig.2. The dynamics of potato plantlets emergence

Seeds germinated in percentage of 96.4% and 98.7% respectively, in a short time (10 days from sowing) and seedlings were vigorous (Table 1). About a month and a half after sowing, the seedlings were transplanted into pots. Regarding the survival rate of seedlings following transplanting, the Gilroy line was noted again, recording the best percentage (89.18%).

Table 1

Data on the initiation of potato crop and seedlings trasplanting

Line	**Emergence percentage (%)**	**Seedlings vigour**	**Survival rate following transplanting (%)**
MINDY	87,2	satisfactory	79,81
ZOLUSHKA	96,4	very good	77,17
GILROY	98,7	very good	89,18
CATALINA	74,7	good	83,03

On the average number of tubers/plant (Fig. 3), the best results were obtained in the case of Catalina line (3.53), followed by Mindy (3.22), Gilroy (3.08) and Zolushka (2.71).

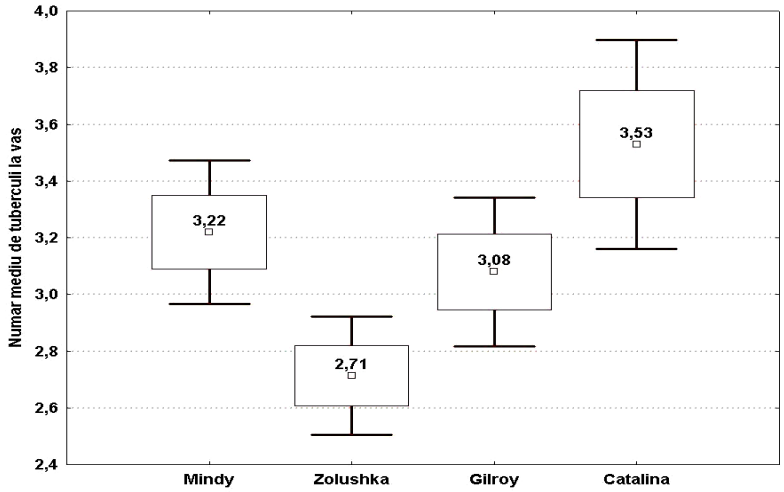

Fig.3 Comparing the average number of tubers/plant in studied lines

It can be seen that, between the lines Mindy, Gilroy and Zolushka there are no significant differences in the average number of tubers/plant, while the Catalina is significantly different from Zolushka (Fig.3).

For characterization of potato genotypes in terms of the eyes depth, we used a 1 to 5 rating scale, as follows: shallow eyes (1), semi-superficial (2), medium depth (3), deep (4) and very deep (5). Regarding this character, unlike the others, for statistical interpretation of the results we used Chi^2 tests and we noted that there are no significant differences between the studied genotypes (Fig. 4).

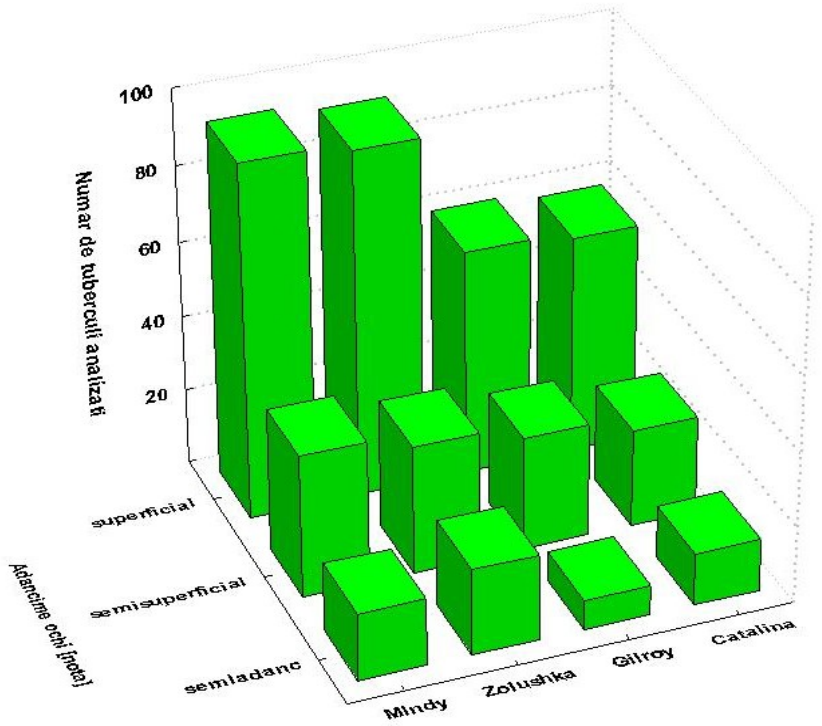

Fig.4 Comparing studied lines regarding depth eyes

It is noted that in all four studied genotypes shallow eyes tubers predominate. This feature is important for fresh consumption and potato industrialization. Tubers with thin skin and shallow eyes have minimal peeling loss (10% to 12%), while varieties with thick skin and deep eyes reach 25%.

Regarding the average weight of tubers, using Duncan test, the four lines were divided into three homogeneous subsets (Fig. 5).

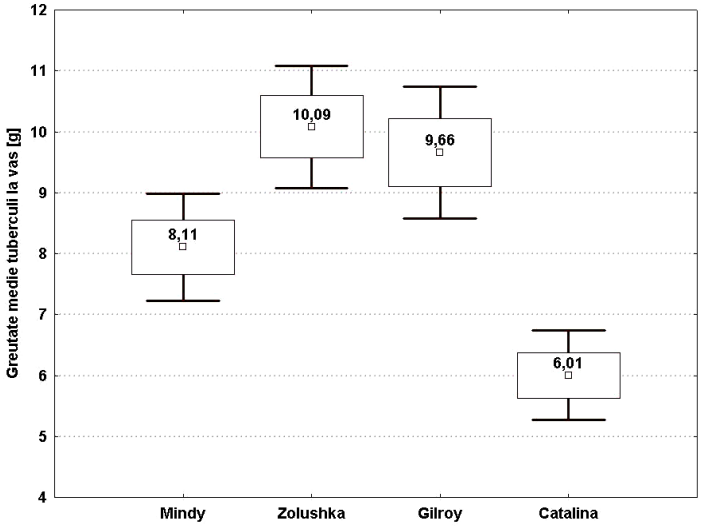

Fig.5 Comparing the average weight of tubers from studied lines

Thus the lowest value was recorded in the case of Catalina (6.01 g), in an intermediate position is the Mindy (8.11 g) and the best results were registered at Zolushka (10.09 g) and Gilroy (9.66 g), with no significant differences, but Zolushka differs significantly from Catalina.

On total average weight of tubers/plant, the best results were obtained in the case of Gilroy (24.50 g), followed by the Zolushka (21.35 g), Mindy (20.77 g) and Catalina (18.16 g). Using the Duncan test the four lines were grouped into three subsets. It can be observed that between Zolushka and Mindy there are no significant differences regarding the total average weight of tubers/plant, but the Gilroy differs significantly from Catalina (Fig. 6).

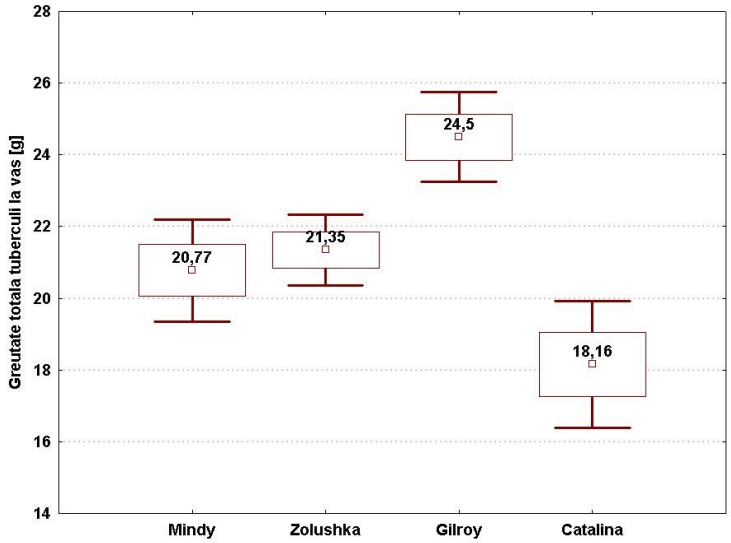

Fig.6 Comparing the total average weight of tubers/plant from studied lines

In the case of all four studied genotypes, the plants were uniform in terms of skin color, tubers having white skin.

Conclusions

In the TPS technology the main barrier, but also a challenge for science, is the production of seeds that produce uniform tubers despite the great genetic variability of potato. From botanical potato seed can be obtained: minitubers, seed or ware potatoes. There are many possibilities to grow potatoes from true seed:

- Sowing directly at well-defined distances from the beginning, and harvesting the tubers for consumption (larger) and/or seed potatoes (smaller);
- Sowing at higher densities in seedbeds and harvesting minitubers (small size) and seed tubers (larger size);
- Growing seedlings and then transplanting them at high density to produce minitubers or seed potatoes;
- Growing seedlings and then transplanting them to produce potatoes for consumption.

Currently are sold large amounts of potatoes produced from TPS, both for consumption and as planting material but also for industrialization. In many regions around the world, recently even in our country, consumers show an important interest in so-called *"baby potatoes"*. They are willing to pay a high price for these small tubers grown from true potato seed.

In protected area conditions the Zolushka and Gilroy behaved the best. Botanical potato seed from both lines had the highest percentage of germination 98.7% and 96.4% respectively, in a short time (10 days from sowing) and the seedlings obtained were very vigorous. The Gilroy was remarked also for the positive behavior of seedlings after transplanting.

On the average number of tubers/plant, the best results were obtained at Catalina (3.53) followed by Mindy (3. 22).

The total average weight of tubers/plant was 21 g. Gilroy is on the first place with an average of 24.5 g, followed by Zolushka with 21.35 g. The average weight of tubers varied between 6.01 g in the case of Catalina and 10.09 g in the case of Zolushka.

There were no significant differences between the studied genotypes regarding the eyes depth. It notes, however, that the largest share had plants which tubers with shallow eyes. At all the four studied genotypes the plants were uniform in terms of skin color, tubers having white skin.

References

1.Adhikari R.C., 2010. True potato seed for commercial potato production and food security in

Nepal. Proceedings of the Potato AgroPhysiology. Nevsehir, Turkey,
2.Adhikari R.C., Rai G.P., Upreti K.C., Gautam I.P., Chaudhary D.K., Chapagain T.R., Bhandari K.B., 2004. 3.Evaluation of true potato seed families for seedling tuber production in Nepal, p. 158-166. In: Proceedings of the Fourth National Horticulture Workshop, 2-4 March 2004. Nepal Agricultural Research Council National Agriculture Research Institute and Horticulture Research Division, Khumaltar. p. 216-223.
4.Almekinders C.J.M., Chujoy E., Thiele G., 2009. The use of true potato seed as pro-poor technology: the efforts of an International Agricultural Research Institute to innovating potato production. Potato Research, 52: 275-293.
5.Bozeşan I., Prodan M., 2003. Utilizarea seminţei botanice – o alternativă a asigurării necesarului de material de plantat la cartof. Cartoful în România, vol. 13, nr. 4.
6.Carlson H.L., Kirby D., 2005. Development of cultural techniques for production of baby potatoes. Research progress, no. 110. University of California Intermountain Research and Extension Center, Tulelake, California.
7.Chujoy E., Cabello R., 2007. The Canon of Potato Science: 29. True potato seed (TPS). Potato Research 50: 323-325.
8.Cioloca Mihaela, 2011. Cercetări privind comportarea unor genotipuri de cartof rezultate prin înmulţire generativă cu privire la performanţele de producţie, calitate şi uniformitate. Teză de doctorat, Universitatea de ştiinţe Agricole şi Medicină Veterinară a Banatului din Timişoara.
9.Fuglie K.O., 2001. Performance and prospects of hybrid true potato seed in south and southeast Asia. Proceedings of the CIP-ADB Symposium "Field-Testing Hybrid TPS in the Lowland Tropics of Asia", Bogor, Indonesia.
10.Gopal J., 2004. True potato seed: breeding for hardiness. Proceedings of the Sixth Triennial Congress of the African Potato Association, Agadir, Morocco 5-10 April 2004, p. 39-57.
11.Nazirzadeh A., Hassanpanah D., Yildiz M., Celal E., 2010. Analysis of quantitative and qualitative properties of base seeds from true potato seeds (TPS). Proceedings of the Potato AgroPhysiology. Nevsehir, Turkey, p. 210-215.
12.Pande P.C., Girish B.H., Kadian M.S., Ilangantileke S.G., 2003. Evaluation of true potato seed families for adaptability and yield characteristics. Journal of the Indian Potato Association, vol. 30 (1-2).