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DEVELOPMENT OF QUALITY POTATO SEED PRODUCTION SYSTEM IN RUSSIA

Boris V. Anisimov*, Evgeny A. Simakov, Alexey V. Mityushkin, Alexey A. Zhuravlev and Sergey N. Zebrin

ABSTRACT: The modern system of seed potato production and commercial quality control was developed by Russian Research Centre of Potatoes and approved further by Interstate Council for Standardization, Metrology and Certification. The major aspects concerning the common terminology, classification, specifications and methods for determining the quality adopted in Russia and unified with international systems and UNECE-Standard. In the present study minimum requirements for early generation seed production (original seed), further multiplication (elite seeds) and for end-use ware potato production (reproductive seed) is presented. Which includes: varietal identity and purity, diseases and pests, external tuber quality, sizing and labeling. The modern system of seed potato quality control includes field surveys during crop growth, post-harvest control (tuber analysis) and comparative field trial of seed potato samples. The major objective of comparative field trial in 2020-2021 crop seasons with the normative tolerances of the standard requirements related to varietal identity and purity and the level of viral and bacterial diseases transmitted through seed material. 288 samples of original seed potatoes were evaluated on the test-plot of the experimental base located at «Korenevo» of the Russian Research Centre of Potatoes (Moscow region) to determine their varietal identity, the presence or absence of other variants and plants affected by virus and bacterial diseases. Results of comparative field trial of original seed potato samples are considered in this article.

KEYWORDS: seed potato, quality requirements, varietal samples, comparative trial.

INTRODUCTION

The potato is one of the main food stuff product in Russia. The average potato yield 17-18 t/ha is below than that of many potato producing countries. Requirement of good quality seed is universally considered for high productivity in all potato production systems (Forbes *et al*., 2020; Singh and Sharma, 2018; Haverkort and Anisimov, 2007). One of the main factors determining the low level of potato yields in Russia is production and usage of low quality seeds. The total demand of potato planting material is therefore evaluated at more than 3 million tons (15% above than the total volume of potato production), but the volume of certified seed potato is not sufficient now. As a result many potato producers including agricultural enterprises, peasant farms and especially small private family farms use non-certified seed potato which is badly affected by virus, bacteria and fungus infections. That is why one of the most important factors of yield increase and efficiency of potato production is to form the best seed growing system and improved quality of seed potato in Russia (Simakov *et al*., 2008; Anisimov *et al*., 2018).

Global potato trade is increasingly developing; therefore, it is necessary to unify and harmonize the Russian Potato seed quality control system with the international one, which is adopted by United Nations Economic Commission for Europe (Anonymous, 2017; UNECE Standard S-1, 2017).

MATERIALS AND METHODS

The field trial was conducted by taking basic clones selected from the bank of healthy potato varieties with optimized norms and

Russian Research Centre of Potatoes, 23, Lorch Street, Kraskovo, 140051, Moscow region, Russia
*Corresponding author; email: anisimov.bv@gmail.com

minimum requirements of diseases, and defects in crop and lots for three categories of seed potatoes: Original seed material (OS), Elite seed classes (ES) and Reproductive seeds (RS). Classes/generations of OS can be represented by following: healthy mother potato plants selected in the field or obtained through techniques of tissue culture; mini-tubers which are grown in the greenhouses, aeroponic and hydroponic facilities; 1st field generation from mini-tubers and super-super-elite class. ES is derived from original seed material. The super-elite and elite seed classes are included in this group. RS is the next field generation derived from the elite seed. The seed material of 3rd and following field generations after elite cannot be certified.

In 2020-2021 crop season, at the Russian Research Centre of Potatoes (Moscow region), the comparative field trial of original seed potato samples was carried out. The Comparative test material, of 288 samples, were obtained from original seed potato growers and were planted on the test plot in sequential order according to categories and classes (generations) of seed, starting with mini-tuber samples, then the first field generation and super-super-elite. Plots with samples of the same generation within each cultivar were placed side by side, so that the samples with the presence of atypical plants or with external symptoms of diseases were clearly visible during observations and convenient for their detailed comparative analysis with reference samples obtained directly from the originator of the cultivar.

During the growing season, the samples on the plots were examined to identify signs that deviated from the official description of the variety, as well as external symptoms of the diseases transmitted through the seed material. Since many varietal traits can appear in different phases of plant growth and development, at least 3 assessments were carried out immediately before and after the flowering. Viral diseases were controlled by external symptoms of moderate and severe mosaic (PVM and PVY), as well as by the method of immunodiagnostics of leaf samples taken at the emergence of full shoots. Finally a joint survey of the samples was carried out during the flowering period of plants on the test plot, and the results of the observations were discussed with the participation of the originators of the varieties and producers who had submitted their samples for comparative verification tests.

RESULTS AND DISCUSSION

Sequential potato seed production process in Russia is represented by three structure blocks, which include production of original, elite, and reproductive seeds The original potato seed production block includes the production of virus-free seed from sterile *in vitro* crop (microplants and microtubers), growing minitubers in a controlled environment protected from vectors of infection, as well as growing the first field generation seed from minitubers and super-superelite potato under the conditions of pure phyto-hygiene and spatial isolation from lower classes/generations of potato seed and commercial potato.

Elite seed categories includes production of classes of superelite and elite potato by sequential propagation of original potato seed while preserving and maintaining its high purity of a variety, productivity and sowing qualities.

Lots of elite potato varieties which comply with standards in terms of their sowing and varietal properties enters the trade turnover and are sold to agro-enterprises producing commercial potato, private farms, as well as farms of individual entrepreneurs and individual farms for variety transformation and variety change.

The general view of the innovative flow chart of the potato seed production process developed based on research of the Russian Research Centre of Potatoes is presented in **Fig. 1**.

Production of reproductive seeds includes seed produced from the first and second field generations intended for sale to farms producing commercial potato, farmers and common people. The third generations is the last stage in potato seed propagation and the yield is used for food, technical and feed purposes.

Based on the comparison of classification systems adopted in Russia and EU countries, the category of original potato seed may be conditionally made equivalent to the category of prebase (PB) potato seed. Accordingly, the category of elite potato seed is equivalent to the category of base potato seed (classes SE and E) and the category of reproductive potato seed is equivalent to the category of certified potato seed (classes A 1-2).

According to standards the maximum number of field generations should not exceed 6, including 2 generations each for OS, ES and RS categories. In the EU countries, as recommended by the European Seed Association (ESA), up to a maximum of 9 generations are allowed, including in the category of prebase seeds – 4, base seeds – 3 and certified seeds – 2 field generations.

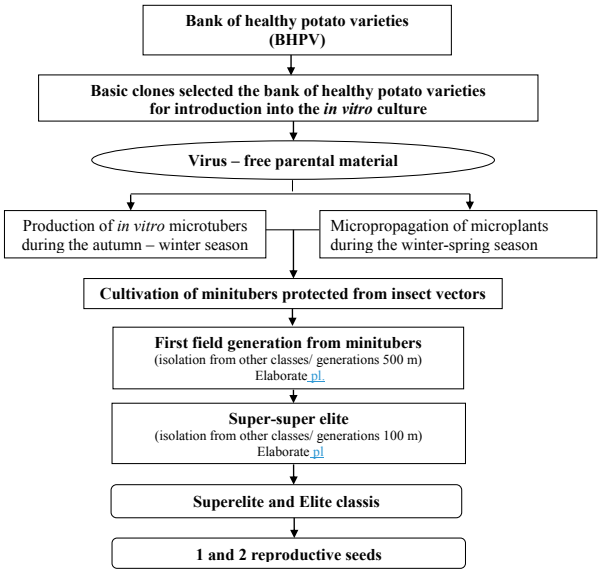

Fig. 1 The modern potato seed production system developed by Russian Research Center of Potatoes

Experiences gained over the previous years has shown that the use of the innovative flow chart (Fig. 1) of the original seed production opens the potential for the expansion of time frames and more productive use of growing houses/ net houses/ poly houses and production equipment in the process of producing microtubers in *in vitro* crop plant during the fall-winter season (September-January) and clonal propagation of microplants to the necessary size and sufficient number during the winter-spring season (January-May). This makes it possible to substantially increase the volume of growing minitubers and the total quantitative yield of seed stock when growing the first field generation seed from minitubers and super-superelite potato varieties, which ensures 25-30% increase in profitability of production.

The modern system of seed potato quality control includes the following elements:

- Field inspection Haulm killing dates on the basis of aphid monitoring
- Visual and laboratory postharvest control (PCR and ELISA laboratory test)
- Lot inspection
- Comparative field trial of original seed potato samples for detailed check of the varietal identity and purity.

The tolerances established by the standard take into account the possible reduction of individual quality indicators during the production of OS, ES and RS categories. The tolerances for different categories of seed potato are reflected and also had - made

changes in seed production and further marketing, with development of new methods for defection of harmful organisms.

The standard specifies minimum tolerance acceptable limits for the proportion of growing plants not true to the variety, affected by blackleg and showing symptoms of virus diseases. For example, the percentage of growing plants affected by PVY and PLRV should not exceed: 0 per cent for tissue culture and mini-tubers, 0.4 per cent for original field generation, 1 per cent for elite classes and 2 per cent for reproductive seed. Plants affected by Black leg should not exceed: 0 per cent for OS and ES categories and 1 per cent for RS crops.

For lots of seed potato tubers affected by wet rot are tolerated up to 1 per cent for class ES and RS only. Dry rot is tolerated up to 0.5 per cent for OS and 1 per cent for ES and RS categories. No rots are allowed in TC and mini-tubers. Common and netted scabs are allowed in all categories and classes except TC and mini-tubers no more than 5 per cent of tubers may exceed. Powdery scab is allowed in OS, ES and RS categories except TC and mini-tubers; no more than 1 and 3 per cent of tubers may exceed. Rhizoctonia is allowed OS, ES and RS categories except TC and mini-tubers no more than 1,3 and 5 per cent of tubers may exceed respectively. External defects (e.g. misshapen or damaged tubers) are tolerated up to 5 per cent in OS, ES and RS categories. Shriveled tubers are tolerated up to 1 per cent in OS, ES and RS categories. Shriveled tubers are not allowed in TC and mini-tubers(table1).

The seed potatoes shall be free from *Globodera rostochiensis* and *Globodera pallida, Synchytrium endobioticum, Clavibacter michiganensis* spp. *sepedonicus, Ralstonia solanacearum,* Potato spindle tuber viroid and *Ditylenchus destructor.*

The results of comparative field trial of original seed potato samples conducted at Russian Research Centre of Potatoes during the 2020-2021 growing season are presented in table 2.

Table 1. Tolerances for different categories of seed potato

	Tissue culture (TC)	Mini-tubers	OS	ES	RS_{1-2}
Crop tolerances(per cent of plants					
Other varieties and of types	0	0	0	0	0.5
Viral diseases*	0	0	0.4	1	2
Black leg (*Dickeya and Pectobacterium*)	0	0	0	0	1
Lot tolerances (per cent of tubers)					
Wet rot (*if not caused by Ralstonia s.*)	0	0	0	1	1
Dry rot	0	0	0.5	1	1
Common and netted scab**	0	0.5	5	5	5
Powdery scab**	0	0	1	3	3
Rhizoctonia**	0	0	1	3	5
External defects (misshapen and damaged tubers)	0	0	5	5	5
Shriveled tubers	0	0	1	1	1
Damaged tubers by pests	0	0	2	2	2

*Only severe mosaic (PVY) and potato leaf roll (PLRV) symptoms are considered.
**The tuber is considered as diseased in that case, if the proportion of the affected surface scab (common and netted)=33.3%; Surface powdery scab = 10%; Rhizoctomia = 10%.

Table 2. Results of comparative field trial of original seed potato samples (2020-2021)

Parameters	Mini-tubers	1st generation from mini-tubers	Super-super Elite	Total
Samples evaluated	91	106	91	288
Conforms to standard tolerances:				
- by true to type	90 (98.9%)	100 (94.3%)	89 (97.8%)	279 (96.8%)
- for viral diseases (PVY) and PLRV	81	82	67	230
- for bacteriosis (black leg)	91	106	87	284
Exceeded standard tolerances:				
- true to type	1	6	2	9
viral diseases (PVY) and PLRV	10	24	24	58
- bacteriosis (black leg)	0	0	4	4

Based on the observations and assessments on the totality of the varietal distinctive characteristics of the plant, stem, leaf, inflorescence, the presence of plants with deviations in the typicality of varietal characteristics plant height and tuber shape was revealed on 6 samples of 1st generation and 2 samples of super-super elite. 6 samples of the first field generation, were identified as an admixture of another variety. Exceeding the established tolerances Symptoms of viral diseases (PVY) was found on 10 samples of mini-tubers, 24 samples of the first field generation and 24 samples of super-super-elite. External signs of bacterial diseases of plants (black leg) were found only in 4 samples.

The indicators of plant productivity and the structure of the yield differed depending on the conditions of the season, maturation period of the varieties and mainly corresponded to their varietal characteristics.

CONCLUSION

The development of Russian systems of seed potato and quality control facilitates the conditions to improve the quality of potato seed material, to increase potato production and to integrate the Russia into the international potato market. Unification and harmonization with international requirements of Russian system of seed potato, quality control as well as transfer of modern potato technology is very important for the development of potato production in Russia. Now It is expected that Russia will lead with an overall improvement of potato yields on farms to a level of 25-30 tones/ha, reduction of losses from diseases and pests and improvement in economic parameters of potato production. That will enable us to attract investments from various sources (venture capital, entrepreneurs, interested breeding and seed potato company) for the development of the infrastructure, renovation and modernization of technical and technological levels of potato production.

CONFLICT OF INTEREST

The authors confirm that this manuscript has no conflict of interest

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