Potato selection achievements in the Central Caucasus

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Abstract. The main selection methods used for potato production are intraspecific hybridization, interspecific hybridization, production of polyploid, special parental, haploid varieties, multiple selection of hybrids. As a result of selection, hybrids 10.11/765 and 10.3/228 named "Ossetian" and "Gorsky 17" were produced. Hybrids 10.11/770, 10.11/926, 10.11/927, 10.11/1136 were tested for cancer and golden potato nematodes and are being prepared for the first field test. Hybrids 10.11/181, 10.4/316, 11.26/274 are being tested for cancer and the second year potato nematodes.

1. Introduction
The right choice of parental varieties is crucial for successful selection. The genotype-based choice of parents is most reliable, however, an accurate analysis of genes is extremely difficult due to the high heterozygosity characteristic of S. tuberosum and polygenic inheritance of the prevailing majority of economically valuable traits [1, 3, 5, 6].

In relation to the majority of valuable traits, a faster method of evaluating the source material is used. It involves an analysis of the first hybrid or self-pollinated generation. The assessment allows us to select the most promising parental varieties with valuable genotypes [2, 4, 7, 12].

The main selection methods currently used for producing virus resistant potato varieties are intraspecific hybridization, interspecific hybridization, production of polyploid and haploid varieties, multiple selection of hybrids within families, and clones within hybrids [8, 9, 17, 18].

2. Methods and materials
Growing seedlings in clay pots reduces the cost of field planting out, irrigation and soil loosening.

Depending on the direction of selection in a particular zone, the timing of sowing seeds can be different. However, seeds are sown early in spring.

Potato seeds are very small, rounded flat, they need to be sown in loose soil. Before sowing, the soil is sieved, leveled, watered, and marked. The width between furrows is 5–6 cm, the depth is 0.5–1 mm. Seeds are sown at a distance of 0.5 cm and sprinkled with moist loose soil. After one month, small plants with 2–3 normal leaves are divided into peat bog cubes and placed in cooked
hotbeds, where they grow before planting out in the field, or in clay pots with a diameter of 11–13 cm, which are set in cold greenhouses for the entire growing season [10, 11, 13, 14]. The sprouted seedlings must be well poured, covered with frames and eclipsed with straw mats for 2–3 days. It is necessary to water, weed, open and close frames to protect them from heat and frost. After about a month, seedlings become well-leafy plants 12–15 cm high. Such plants can be planted out in the field. Under the conditions of the Institute of Potato Economy, seedlings are planted in the field in mid-June.

Longitudinal furrows 20–25 cm in depth are cut with a tractor hiller. The furrows are marked across with an equestrian marker. Plots are cut along marker lines and pegs are placed along the bottom of the furrow. Boxes or baskets with hybrids are brought to the pegs and the club is laid out on the loose bottom of the furrow, plantings are closed across the ridges, the back of the horse furrow. Those tubers that remain unfilled are manually planted. This method can be successfully applied both on light and heavy soils [1, 13, 15, 16].

3. Results

The proper selection process and technique are a prerequisite for successful work. According to the Institute, the best conditions for growing seedlings are ordinary semi-warm or cold greenhouses.

Pickling is carried out in peat-dung cubes or clay pots. When growing seedlings in cubes (7x7x7 cm), additional costs for irrigation and loosening are reduced, since the soil becomes relatively loose and wetter. Peat-humus cubes eliminate a root damage when planting seedlings in the field, ensure normal plant nutrition during vegetation, growth and development of seedlings.

Resistance to late blight was (73 %) 8–9 points in most varieties. The average resistance to late blight for tops and tubers was 6–7 points in 71 varieties (50.1 %). Immunity to various diseases and high productivity (over 35 t/ha) were observed in 73 varieties (50.7 %). According to the results of an enzyme-linked immunosorbent analysis, 55 varieties were free from viral infection; in the remaining samples, the degree of a damage varied from 0.2 to 0.5 %. The depth of the eyes is an important indicator, both in the table value and in the processing technology. In the parental seed-field, varieties and hybrids with medium and shallow eye depths prevailed. 17 varieties had yellow tuber flesh; 19 ones had white tuber flesh.

Phenological observations, visual examinations with subsequent laboratory analyzes – ELISA were carried out in the collection and parental nurseries. According to the methodology of potato selection, all the required observations and analyzes were carried out. In 2018, more than 26 parental pairs were selected and more than 2319 flowers were pollinated, of which 216 berries were obtained in 12 combinations, where the combining ability was 46.2 %. After harvesting the resulting berries, we laid them to ripen and, as they ripened, washed them; 13 thousand pieces of seeds of different combinations were dried. Each parental pair was thoroughly selected.

In the one-year old nursery, for 9 combinations, more than 3268 genotypes were produced, of which 849 or 25.9 % of the one-year-old seedling were selected.

Three-year old seedlings (Table 2) of 08.944 (733-65 x Aurora) were planted under the same conditions: 352 genotypes were planted, of which 338 emerged, the sprout was 96.0 %. Three-fold visual phyto-purification showed that plants are free from viral infection. According to the resistance to late blight, the hybrid progeny of 08.944 was 9 points. During the harvesting of tubers, 130 were culled for diseases and 173 genotypes were selected for further work on morphobiological traits 35, where the percentage of selection was 10.4 %.

The average genotype selection in two nurseries was 65 genotypes (10.7 %).
Table 1. The results of studies of populations of genotypes of various parental forms in the mountain zone of North Ossetia-Alania, 2018

| No of the combination | Origin                  | Number of genotypes | Number of genotypes that have gone through the entire vegetation period | Visual culling, pcs. |
|-----------------------|-------------------------|---------------------|--------------------------------------------------------------------------|----------------------|
| 08.936                | Zhivnitsa × Adora       | 282                 | 270                                                                      | 0                    |
| 08.944                | 733-65 × Aurora         | 352                 | 338                                                                      | 0                    |
| Total                 |                         | 634                 | 608                                                                      | 0                    |

Table 2. Research results for the second-and third year seedlings of the first and second tuberous offspring in the mountain zone of North Ossetia-Alania, 2018

| No of the combination | Origin                  | Resistance to phytophthora, points | Culled due to diseases | Selected due to morphological features | Selected number | Selected % | Overall top assessment, point | Selected |
|-----------------------|-------------------------|-----------------------------------|------------------------|---------------------------------------|----------------|-----------|-------------------------------|----------|
| 08.936                | Zhivnitsa × Adora       | 9                                 | 100                    | 140                                   | 30             | 11.1      | 7                            | 30       |
| 08.944                | 733-65 × Aurora         | 9                                 | 130                    | 173                                   | 35             | 10.4      | 7                            | 35       |
| Total                 |                         | 9                                 | 230                    | 313                                   | 65             | 10.7      | 7                            | 65       |

In a preliminary test nursery in 2018, 32 of 130 hybrids were selected based on economically valuable and morphobiological characteristics. 32 out of 130 hybrids (17.7 %) 2343 selected. Culling was carried out according to 52 characteristics by the models of varieties developed for the North Caucasus region (resistance to late blight, growth, signs of late ripening and ugliness of the tuber shape), etc. 32 hybrids selected in 2018 met the requirements for high-quality source material. According to Table 2, in terms of the mass of tubers, only two – 14.73/18 and 14.73/143 – were inferior to the standard (Nevsky) which formed 0.528 g/plant. Accordingly, their productivity will be above the standard. In terms of marketability of tubers, only 18 hybrids provided a higher percentage, the remaining hybrids were lower, or at the standard level. The tuber shape was dominated by a rounded slightly flattened tuber shape. The peel color was white, only in 14.73/114 hybrid, the peel was pink. The depth of the ocelli was shallow, two hybrids had middle ocelli, and two ones – superficial ones. By the color of their eyes, four hybrid offspring formed pink eyes and the rest of the hybrid 14.73/114 had white eyes. Field resistance to late blight was higher (1–2 points) than in Nevsky variety. One of the main indicators is productivity. In combination 73, 9 hybrids or 39.1 % produced high yields of more than 40 t/ha.

According to the research results in the mountain conditions of the North Ossetia-Alania, all the hybrids produced a yield higher than the standard variety by 13.6-53.8. Eight hybrids produced a yield of more than 1 kg per one plant and only 2 hybrids produced a yield of less than a kilogram per one plant, but they also exceeded the standard variety. The leading position belongs to hybrids 12.58/212 – 1.258 and 13.61/86 – 1.200 kg which exceeded the standard variety by 0.501 and 0.443 kg/plant, respectively. The average weight of a tuber is an important indicator; in hybrid 12.41/7, the weight was 104.6 g. The tuber weight in other hybrids was intermediate between hybrid 12.41/7 and Nevsky variety.

According to the research results confirm the high field resistance of the hybrids to severe forms of viral diseases.

According to the morphobiological parameters (tuber color, flesh color, eye depth, stolon trail depth, etc.), the hybrids preserved indicators of the last years. All hybrids showed the high field resistance to late blight (8–9 points). In 2018, fusarium was not observed. The research results confirm the high field resistance of the hybrids to severe forms of viral diseases.

In the second-year nursery, eight promising hybrids were planted in triplicate according to the scheme of the selection process. Table 5 shows that only four hybrids produced a yield which was larger than in the standard variety (in 11.35/12; 11.26/35; 11.30/26; 11.26/470, it was 5.9; 1.4; 2.3; 11.4 g/plant, respectively). Hybrids 11.26/782 and 11.26/475 produced a standard yield; hybrids 11.26/816 and 11.26/327 were inferior to Nevsky variety by 3.6 and 28.1 t/ha, respectively. The maximum yield of tubers was produced by hybrid 11.26/470 – 53.1 t/ha.
In the third-year test, 6 hybrids were tested which withstood the competition of 19 hybrids. The standard was Nevsky variety. The hybrids retained their dominance in the formation of the number of marketable tubers, marketability and mass of marketable tubers. According to the research results (Table 6), three hybrids differed in their yield, mass of marketable tubers and marketability: 10.4/316, 10.2/56, 10.11/716. White color of tubers, pulp and eyes, medium and shallow depth of eyes predominated. Compared with the standard variety, tuber resistance to phytophthora was higher (9 points each).

Hybrids 10.11/770; 10.11/926; 10.11/927; 10.11/1136 are being prepared for the first field test.

Hybrids 10.11/765 and 10.3/228 are being tested by the State Commission.

For all hybrids, an analysis of the biochemical composition of the tuber, resistance to darkening of the tuber pulp, and taste will make it possible to select new varieties.

4. Conclusion

1. In mountainous conditions, in the parental nursery, 47 out of 110 potato varieties (42.7 %) were selected by yield and resistance to viral and fungal diseases. 35 varieties and hybrids were free from viral infections.
2. In the nursery of first year seedlings, the offspring of combination 106 was examined. 410 samples were selected (38.1 %).
3. In the first-year competitive test nursery, 10 hybrids of combination 26 (87.759/3 × Reserve) and combination 35 (Innovator × Premjer) were studied. Their yield and marketability are over 90 %; have a correct tuber shape.
4. The second-year competitive test nursery included 11 hybrids with indicators exceeding the standard ones: a starch content of 9.8 % in 11.26/816 hybrid and 17.8 in 11.26/475 hybrid. Hybrids 10.11/765 and 10.3/228 are being tested by the State Commission. Hybrids 10.11/770, 10.11/926, 10.11/927, 10.11/1136 were tested for cancer and first- and second-year golden potato nematode and are being prepared for field tests. Hybrids 10.11/181, 10.4/316, 11.26/274 are being tested for cancer and second year nematodes.
5. Potting followed by planting out provided the optimal number of mini-tubers with a maximum yield per unit area.

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