Reproduction of the Spring potato variety with botanical seeds as a method of improving planting material

Yury Loqinov, Anastasia Kazak and Andrey Gaizatulin
Northern trans-ural state agricultural university, 7 Republic street, Tyumen, 625003, Russia
E-mail: kazaknastenka@rambler.ru

Abstract. Since 2003, the State Agrarian University of the Northern Trans-Urals has been conducting research on the cultivation of healthy seed tubers of the Vesna variety from botanical seeds. It was found that under the conditions of the northern forest-steppe of the Tyumen region, the marked variety for many years forms berries on plants. After ripening, the seeds washed from them after one to two years of storage have a high germination capacity. When sown in a greenhouse, they produce minitubers, and the next year, normal tubers. Their further reproduction in isolated areas of the taiga zone and the tundra zone makes it possible to obtain healthy seed tubers in the required volume for sale to amateur gardeners and small farms.

1. Introduction
The potential yield of potatoes in Siberia can reach 100 tons per hectare or more [1,2,3]. In 1939, in the Mariinsky District of the Kemerovo Region, the leaders of production under the leadership of A. K. Yutkina received 133.1 t/ha per hectare [4,5,6]. This result still remains a world record. The technology for obtaining such a high yield remains a mystery for many potato growers, although many years have passed since that time [7, 8, 9].

In the last decade, new selection in the State Variety Testing gives 70-80 t / ha. At the same time, in the complex of agrotechnical measures, special attention is paid to the quality of planting tubers. It is well known that each new potato variety is an innovation in crop production, and high-quality planting material is a mechanism for its implementation [9, 10, 11]. All over the world, special attention is paid to the quality of potato seed tubers. A widespread method of healing potato seed tubers is the method of obtaining them from a healthy apical meristem. Along with the mentioned method, it is possible to heal the planting material due to the reproduction of botanical seeds, but this requires varieties with abundant berry formation and favorable weather conditions (moderate temperature and moisture supply) [12,13,14]. As for the Tyumen region, for many years there is abundant berry formation in the varieties Polonez, Sarma, Vesna, Gusar, Adretta, Kuznechanka and others [15,16,17]. At the same time, rather large berries are formed, especially in the Polonez variety, with well-made seeds.

The purpose of the research: to obtain botanical seeds of the Vesna variety, then to obtain minitubers in the greenhouse through seedlings, then, due to reproduction in the northern agricultural zone of the Tyumen region, maintain the planting material in a healthy state.
2. Material and methods
The studies were carried out in 2003-2020, on the experimental field of the GAU of the Northern Trans-Urals, in the northern forest-steppe, as well as in the taiga and tundra zones of the Tyumen region. The soil in the experimental field is leached chernozem, heavy loamy in granulometric composition, moderately supplied with nitrogen and phosphorus, well supplied with potassium, humus content 7.2%, pH - 6.7. In the taiga and tundra zones, the soil is sod-podzolic with an average granulometric composition, with a low content of nutrients, a humus content of 2.3%, pH - 4.9.

The predecessor is annual grasses. Soil cultivation included moldboard plowing, spring harrowing, milling, and cutting of ridges. Organic fertilizers (rotted manure) were applied at the rate of 60 t / ha for fall plowing. Mineral fertilizers at a dose of N90, P90, K90 were applied before milling the soil [18,19,20].

Planting scheme in the field 75x20 cm, in the greenhouse 40x10 cm, plot area in the field 40 m², counting - 30 m², 4-fold repetition, the placement of plots is randomized. Unhealed tubers of the Vesna variety were taken for control.

Planting in the greenhouse consisted of manually removing weeds, watering and loosening the soil; two inter-row treatments, hilling and two chemical treatments against weeds (Zenkor, 1 l/ha + Tilt 30 ml/ha) and phytophthora were carried out in the field. The berries were harvested before harvesting potato varieties, then they were placed in cardboard boxes with holes for air intake and placed in a ventilated room for one to one and a half month for ripening at a temperature of + 18 + 20 °C.

After a noted period of time, the berries became soft, and there was a strawberry smell in the air. At this point, they began to wash the seeds under tap water on a clean sieve. Then the seeds were placed in a thin layer on clean paper and dried at room temperature for two weeks.

3. Results and discussion
The years of research were favorable for the weather conditions for the growth and development of plants, the formation of berries and the yield of tubers. The exception was 2020, which was characterized by dry, hot weather in the second half of summer. This year there were few berries on potato plants, and also there was a low yield of tubers. In addition, the size of the tubers has sharply decreased.

Our studies have shown that a well-developed seedling is obtained from seeds after 2-3 years of storage, in which physiological processes have completely completed. It should also be noted that when growing potato plants of the Vesna variety from botanical seeds, the appearance of non-typical ones with a dark green leaf color, a longer (6-7 days) growing season, altered by the habit of the plant bush is observed. In connection with the above, when harvesting, it is necessary to carefully select typical plants in combination with tubers inherent in the Vesna variety. After such a careful selection of plants in the first year, with further reproduction by tubers, the uniformity of the variety remains stably.

The resulting minitubers are multiplied the next year in a greenhouse, and then we continue to multiply in isolated areas of the taiga and tundra zones for 6-7 years. Every year we sell the necessary part of the seed tubers to amateur gardeners and small farms. After the indicated period, the process of updating the planting material is repeated. Thus, the strength of the Vesna variety is maintained at a fairly high level. It has been cultivated in the private sector for 17 years and remains more in demand among early maturing varieties. From the first to the twentieth of July, the variety gives the highest yield of marketable tubers, which have a regular oval shape, a superficial occurrence of eyes, an attractive red color. Tubers of this variety are readily purchased in the retail network. Unfortunately, after the variety was included in the register of breeding achievements in the Tyumen region, industrial seed production was not organized, so this niche was occupied by foreign varieties.

During the period of state variety testing, the Vesna variety gave a yield at the variety plots of the Tyumen region up to 42 t/ha. After our several heals by sowing botanical seeds, the yield is close to the original. It is interesting to compare the yield of the variety obtained from tubers reproduced in an experimental field without recovery for 13 years and from tubers rehabilitated through botanical seeds (table 1).
Revitalized tubers yielded a consistently high yield annually, which averaged 36.2 t/ha over four years, which is 15.4 t/ha higher than the control.

**Table 1.** The yield of the Vesna variety depending on the quality of the planting tubers, 2017-2020.

| The quality of the planting tubers | Productivity, t/ha | To control ± |
|-----------------------------------|---------------------|--------------|
| Unhealed tubers, control          | 20.9 (2017)         | 25.1 (2018)  | 23.5 (2019) | 16.2 (2020) | 21.4 (Average) |
| Revitalized tubers via botanical seeds HCP<sub>0.05</sub> | 35.6 (2017)         | 38.4 (2018)  | 37.3 (2019) | 33.7 (2020) | 36.2 (Average) +15.4 |

After each healing of tubers through botanical seeds and their reproduction in isolated areas of the taiga and tundra zones, we studied the degree of disease damage to plantings in subsequent reproductions. At the same time, it was found that by the sixth reproduction of the Vesna variety, diseases (late blight, viruses, bacterioses) accumulate as much as possible, which reduce the yield to 20-22 t/ha, and then the yield decreases slowly. The noted situation is explained by the peculiarity of the Vesna variety. It was bred at the North-West Research Institute of Agriculture by the method of distant hybridization using wild species. In its genotype, the variety apparently carries valuable genes from the used potato species. It should be added that under the conditions of the Tyumen region, the marked variety was and remains one of the most reliable in the early maturing group. Today it is unlikely that any registered variety of foreign selection can completely replace the Vesna variety.

When cultivating this variety, 2-3 chemical treatments are used, while the cultivation of foreign varieties Gala, Red Scarlett and others is accompanied by 8-10 treatments or more. Consequently, in terms of environmental safety, the Vesna variety has an undeniable advantage over foreign varieties.

The reliability of the Vesna variety also lies in the winter storage of seed tubers (table 2).

**Table 2.** Loss of yield of potato seed tubers during winter storage, 2018-2020.

| Variety   | Loss of yield,% |
|-----------|-----------------|
|           | September-November | December-January | February-March | April |
| Spring    | 1.8              | 1.5              | 0.8            | 1.2 |
| Red Scarlett | 1.3              | 2.2              | 1.9            | 0.6 |
| Gala      | 0.7              | 1.4              | 2.5            | 0.3 |
| HCP<sub>0.05</sub> | 0.3              | 0.6              | 0.2            | 0.5 |

From the analysis of the data in Table 2, it can be seen that the variety Vesna is not inferior to varieties of foreign selection in terms of storage of tubers in winter. After winter storage before planting, the heated tubers germinate together and give strong shoots, and in the field, after planting in heated soil (+ 10 °C), two weeks later they give amicable shoots. At the same time, field germination is 96-99% of the number of planted tubers annually.

Plants of the Vesna variety quickly form the aboveground mass and by the flowering phase it reaches its maximum, and then fully “works” on the yield of tubers. During this period, the variety is significantly ahead of the other early-maturing varieties in terms of the accumulation of early yield (table 3).

**Table 3.** Productivity and marketability of tubers of early maturing potato varieties at the first digging, 2019-2020.

| Variety   | Productivity, t/ha | Marketability of tubers, % |
|-----------|---------------------|---------------------------|
|           | 10 July | 20 July | 30 July | 10 July | 20 July | 30 July |
| Spring    | 5.9     | 11.3    | 20.7    | 52.4    | 78.2    | 86.9    |
| Red Scarlett | 1.2     | 4.5     | 13.1    | 3.6     | 20.3    | 47.1    |
| Gala      | 0.4     | 1.7     | 8.3     | 1.1     | 14.8    | 32.5    |
| HCP<sub>0.05</sub> | 1.2     | 1.9     | 2.1     | 1.5     | 2.3     | 1.7     |
The cultivation of the early-maturing variety Vesna in the Tyumen region is necessary, because from July 20, it allows to receive and supply to the distribution network early products of local production. During this period of time, the noted variety has an advantage over other early-maturing varieties in terms of economic efficiency (table 4).

**Table 4. Economic efficiency of early-maturing potato varieties in the second half of July, 2019-2020.**

| Variety      | Productivity, t/ha | Gross production cost, rub. | Production costs, rub. | Profit received, rub. | Cost of products received, rub/t | Profitability, % |
|--------------|---------------------|------------------------------|------------------------|----------------------|----------------------------------|-----------------|
| Spring       | 20.7                | 351900                       | 192002                 | 159898               | 9275.4                           | 83.3            |
| Red Scarlett | 13.1                | 222700                       | 169420                 | 53280                | 12932.8                          | 31.4            |
| Gala         | 8.3                 | 182600                       | 166540                 | 16060                | 14236.2                          | 9.6             |

From the analysis of the data in table 4, it can be seen that the profitability of the Vesna variety is 83.3%, which is 51.9 and 73.7% higher in comparison with foreign varieties.

4. Conclusion

Improvement of seed tubers of potato variety Vesna by growing minitubers and normal tubers from botanical seeds in a greenhouse, as well as their further reproduction in isolated areas of the taiga zone and the tundra zone of the Tyumen region, allows maintaining the strength of the variety and obtaining high yields of early production from it. The profitability of the variety in the second half of July is 83.3%, which is 51.9-73.7% higher than the varieties of foreign selection.

Acknowledgments

The work was carried out within the framework of participation in a complex scientific and technical project: "Breeding, seed production and processing of competitive domestic varieties of potatoes in the Tyumen region" together with the customer of the project - LLC "Agrofirma KRiMM" within the framework of agreement No. 30C between the Ministry of Agriculture of the Russian Federation and the customer of the complex scientific and technical project.

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