Technology for producing healthy seed potatoes from botanical seeds

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Abstract. The presented material on the improvement of seed potatoes through botanical seeds will improve the varietal and sowing qualities of potatoes. The selected varieties are capable of forming berries on plants in the conditions of the Lower Volga region, and the selected seeds have high germination capacity. The technological process allows us to work out agricultural techniques that ensure the production of microtubers at every stage, from sowing seeds and growing high-quality seedlings.

1 Introduction

A new paradigm for growing and breeding potatoes, designed to solve the problems mentioned above, was developed by Dutch scientists [1]. Its essence is to switch from vegetative to seed propagation.

In recent years, potato seed production has been based on technologies that speed up the process of obtaining high-quality planting material through the use of botanical seeds. Therefore, varieties that are capable of setting berries with seeds under any conditions deserve special attention. The method of reproduction of vegetatively propagated plants through botanical seeds has been known for a very long time, and potatoes in this case are no exception. This method is quite widely used for improving the health of potato planting material [2]. According to Logvinov Yu.P. [3] for 30 years it has been possible to maintain potato productivity through the selection of varieties with the same morphological and biological characteristics characteristic of the original variety.

As a result of infection with viral, bacterial and fungal diseases, potato yields are significantly reduced. The biological characteristics of potatoes contribute to the rapid accumulation of infections during the reproduction of seed tubers. Potato viruses pose a particular danger due to vegetative propagation of the crop, resulting in complete transmission of the infection to offspring [4-5].

Improving the seed tubers of the Vesna variety potato by growing minitubers and normal tubers in a greenhouse from botanical seeds, as well as their further propagation in isolated areas of the taiga zone, makes it possible to maintain the strength of the variety and

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obtain high yields of early products from it. The profitability of the variety in the second half of July is 83.3%, which is 51.9-73.7% higher than varieties of foreign selection [6].

When harvesting young hybrid plants with green tops, the formation of tubers is not completed, but is interrupted at an early stage of development with a high intensity of photosynthesis and an accelerated rate of outflow of plastic substances produced by the vegetative phytomass. According to I.M. Kiper [7], this has a positive effect on consolidating the trait of early ripeness, which is determined in the second year of life, during the selection of the first tuber offspring.

2 Materials and methods

The technological process of seed production using botanical seeds is aimed at maintaining an optimal level of yield, the quantitative composition of the seed fraction corresponding to the quality of the category of planting material (microplants, micro- and minitubers, basic clones), as well as growing the first field generation from minitubers.

Since 2020, we have been conducting research aimed at selecting varieties adapted to the weather conditions of the Lower Volga region with stable berry production, producing micro- and minitubers using the seedling method, and developing regulations for accelerated seed production of potatoes.

Field and laboratory studies are carried out on the basis of the Volgograd State Agrarian University, the Scientific and Production Center "Gornaya Polyana" is located in the dry steppe zone of the Volgograd region, the soil cover of the experimental site is represented by light chestnut, heavy loamy soils. The humus content in the arable layer ranges from 1.68 to 1.82%, the reaction of the soil solution is slightly alkaline pH 7.5-8.0. The structure of varieties of heavy loamy and clayey granulometric composition is water-resistant. The content of physical clay (sum of fractions 0.01) in clay varieties is 49-52%.

Nutrient content: N-NO₃ – 38.7 mg/kg, P₂O₅ – 69.0 mg/kg, K₂O – 420 mg/kg, S – 4.0 mg/kg.

According to Tyurin, the content of hydrolyzable nitrogen refers to a very low degree of provision. Mobile phosphorus (P₂O₅) according to Machigin is characterized by an average content.

Mobile forms of potassium belong to the fourth class with high availability. The predecessor was melons; in the experiment, ridge technology with elements of Dutch technology was used. Mineral fertilizers were applied in the spring before cultivation at a dose of N₉₀P₇₀K₉₀. Before planting, deep loosening was carried out followed by milling. Planting took place in the 3rd decade of April. The collection included varieties of domestic and foreign selection such as Udacha, Bellarosa, Vineta, Gulliver, Ricarda, Ariel, Indigo, from which berries were collected at the end of the growing season; the zoned variety Udacha, recommended for vegetative and generative propagation in the Lower Volga region, was taken as a control. Potatoes were grown under irrigation with maintaining a pre-irrigation threshold of at least 80% NV in a layer of 0.4 m.

To maintain the phytosanitary condition of potato plantings, integrated plant protection was used using microbiological preparations produced by Biotekhagro LLC. Weed control was ensured by applying the herbicide Artist, the consumption rate of the drug was 2.0 kg/ha, with a working fluid consumption of 300 l/ha. Treatment was carried out on single shoots in the second ten days of May. Three times during the growing season, phytocleaning was carried out with the disposal of sick and affected plants. The berry production of the studied varieties was recorded manually before mowing the tops two weeks before harvesting the tubers.
The selected material was scattered in one layer into plastic boxes and left to ripen in a well-ventilated cool room. After 2-2.5 months, the seeds were washed. After which the seeds were dried and poured into linen bags. Further storage proceeded while maintaining optimal temperature and humidity conditions.

Further studies were carried out in a heated rack greenhouse for year-round use. Sowing of seeds was carried out in the 1st-2nd decade of November using plastic containers. The soil was prepared in advance and included river sand, turf soil and universal high-moor peat. After filling the containers with soil, the substrate was watered with biological preparations Geostim Fit A, Geostim Fit Zh and Bska-3 in order to destroy pathogens, after which the seeds were sown. The temperature in the greenhouse before microplant germination was maintained during the day and night at no lower than 25°C. Subsequently, two dynamics were carried out 90 and 120 days after sowing. From the moment the seedlings appeared, the temperature was reduced by one degree during the daytime and by two degrees at night. Caring for plants after germination consisted of watering with small irrigation rates; waterlogging is not allowed since it can provoke the death of the first pair of leaves due to the manifestation of diseases and mold in the root zone. At intervals of 10 days, fertilizing was carried out with liquid mineral fertilizers Helios Super, which contains all the necessary micro and macroelements in combination with biological products. Geostim Fit Zh, BFTIM and Insetim were used for vegetative plants.

### 3 Results and Discussion

The developed system of fertilizing and preventive treatments made it possible to avoid the manifestation of fungal and bacterial diseases, and for the plants to form healthy biomass and establish the maximum number of microtubers.

**Table 1. Structure of seed yield per plant, 2022.**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Berry</th>
<th>Seeds</th>
<th>Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity, pcs</td>
<td>Weight, g</td>
<td>Quantity, pcs</td>
</tr>
<tr>
<td>Udacha st</td>
<td>5</td>
<td>16.3</td>
<td>450</td>
</tr>
<tr>
<td>Belorosa</td>
<td>7</td>
<td>23.0</td>
<td>1050</td>
</tr>
<tr>
<td>Vineta</td>
<td>6</td>
<td>20.5</td>
<td>840</td>
</tr>
<tr>
<td>Gulliver</td>
<td>3</td>
<td>9.0</td>
<td>369</td>
</tr>
<tr>
<td>Ricarda</td>
<td>9</td>
<td>30.0</td>
<td>1593</td>
</tr>
<tr>
<td>Ariel</td>
<td>3</td>
<td>7.5</td>
<td>256</td>
</tr>
<tr>
<td>Indigo</td>
<td>3</td>
<td>7.1</td>
<td>200</td>
</tr>
</tbody>
</table>

In 2022, botanical seeds were selected from the varieties that formed the berries and, as can be seen from the table, the greatest potential for generative propagation was noted in the varieties Ricarda and Bellarosa, where 9-7 berries with a diameter of 1.5-2.0 cm were collected from the bush, the smallest number of berries was formed on the varieties Indigo, Ariel and Gulliver, three berries with a diameter of 1.0-1.5 cm each. The same pattern was noted in the number of seeds in the berry, the largest number of 1593-1050 pcs/plant was formed on the varieties Ricarda and Bellarosa. The resulting seeds had a fairly high germination rate of 84-92%, with the exception of the Indigo variety where the germination rate was 75%.

The table shows quite significant differences in the passage of interphase periods in the studied varieties. The pre-emergence period varied from 8 to 17 days. The earliest shoots appeared on the domestic varieties Ariel and Udacha, which were 2-9 days ahead of other varieties. Although it is worth noting that these varieties are significantly delayed in the...
onset of the phase of the first true leaves in comparison with other varieties by 4-6 days, and this trend was observed until the end of the growing season. However, by the time of tuberization, the interphase periods are shortened by 2-3 days due to the intensive average daily growth of tubers and the death of the vegetative part of the plants. In other varieties, the passage of phenophases was quite smooth without noticeable jumps. The duration of the growing season on the studied varieties was 98-109 days. The Indigo variety vegetated the least, in which 98 days passed from the moment of germination to the death of the tops.

Table 2. Duration of interphase periods of potato seedlings, days.

<table>
<thead>
<tr>
<th>Option</th>
<th>Shoots</th>
<th>First pair of true leaves</th>
<th>6 leaves</th>
<th>8 leaves</th>
<th>10-12 leaves</th>
<th>Tuberization</th>
<th>Dieback of vegetative mass</th>
<th>Duration of growing season, days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Udacha st</td>
<td>8</td>
<td>19</td>
<td>10</td>
<td>22</td>
<td>11</td>
<td>5</td>
<td>40</td>
<td>107</td>
</tr>
<tr>
<td>Belorosa</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>24</td>
<td>8</td>
<td>8</td>
<td>42</td>
<td>109</td>
</tr>
<tr>
<td>Vineta</td>
<td>12</td>
<td>13</td>
<td>10</td>
<td>24</td>
<td>8</td>
<td>8</td>
<td>42</td>
<td>107</td>
</tr>
<tr>
<td>Gulliver</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>24</td>
<td>8</td>
<td>8</td>
<td>42</td>
<td>109</td>
</tr>
<tr>
<td>Ricarda</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>24</td>
<td>8</td>
<td>8</td>
<td>42</td>
<td>109</td>
</tr>
<tr>
<td>Ariel</td>
<td>8</td>
<td>19</td>
<td>10</td>
<td>22</td>
<td>11</td>
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<td>17</td>
<td>14</td>
<td>12</td>
<td>22</td>
<td>11</td>
<td>5</td>
<td>40</td>
<td>98</td>
</tr>
</tbody>
</table>

Fig. 1. Dynamics of green mass accumulation, grams/plant.

The results of the first accounting of the productivity of microplants after 90 days of growing season showed the greatest accumulation of green mass for the Vineta variety - 3.6 grams, the smallest increase in green mass was for the Indigo variety - 0. grams, for other varieties the tops weight was in the range of 0.9-1. 8 g. By the end of the growing season, significant increases in biomass were noted; the highest indicators were also in the Vineta variety, but the tops were in the stage of dying off. A significant increase in green mass was noted on the varieties Indigo, Bellarosa and Ariel.

90 days after sowing, the most intensive process of tuber accumulation occurred in the zoned variety Udacha, and after 120 days there was almost no increase in the number of tubers on this variety. Similar dynamics were observed in the varieties Ariel, Ricardo and Indigo.

In the second dynamics, high tuber accumulation was noted for the Vineta variety, so by the second count the increase was 2.2 pcs/plant. or 61.1%. For the varieties Belorosa and Gulliver, the increase was 31%.
Thus, for the varieties Udacha, Ricardo Indigo and Ariel, 90 days are enough for tuber accumulation, and for the varieties Bellarosa, Vineta and Gulliver, 120 days are needed to form the maximum number of tubers.

In the first dynamics, the largest minitubers by weight were formed in the Vineta variety, but later their weight decreased as the number of tubers under the bush sharply increased. In other varieties, average daily growth occurred quite intensively and by the end of the growing season the tuber weight ranged from 0.6 to 1.4 g.

The maximum minituber weight was found in the varieties Udacha, Ricardo, Indigo and Bellarosa and amounted to 1.4-1.1 g. Thus, when sowing with botanical seeds, 3-4 minitubers are formed per plant weighing about 0.6-1.4 grams.

**4 Conclusion**

Research shows that all studied varieties can be used for generative propagation of potatoes, but the greatest reproductive potential was noted for the Ricardo and Bellarosa varieties. In terms of the formation of minitubers, the highest productivity was noted for the Vineta variety; it is also worth noting the Gulliver and Bellarosa varieties.
Acknowledgement

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