Improved Potato Tubers from Botanical Seeds

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Abstract. The potential yield of potatoes in Siberia can reach 100 tons per hectare or more. 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. This result is still a world record. The technology for obtaining such a high yield remains a mystery to many potato growers, although many years have passed since that period of time. In the last decade, selection novelties in the State Variety Test give 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. All over the world, special attention is paid to the quality of potato seed tubers. A widely used method for improving the health of potato seed tubers is the method of obtaining them from a healthy apical meristem. Along with the noted method, it is possible to heal planting material by propagating botanical seeds, but this requires varieties with abundant berry formation and favorable weather conditions (moderate temperature and moisture). In the northern forest-steppe of the Tyumen region, the noted varieties form well berries with seeds on plants, from which microtubers are obtained in the greenhouse. Their further reproduction in tunnels covered with a fine-mesh net and in isolated areas made it possible to obtain a healthy planting material for amateur gardeners and small farms.

Keywords: Potatoes · Variety · Botanical seeds · Healthy tubers · Productivity

1 Introduction

From the history of the development of seed production and crop production in general, it is known that vegetatively propagated crops can be grown from botanical seeds. These include onions, potatoes and others [1–4]. One of the authors of the article for 30 years heals winter garlic through botanical seeds and several varieties of potatoes in the conditions of the northern forest-steppe of the Tyumen region form berries with seeds on plants [5–8].

Our long-term observations have shown that the varieties Adretta, Polonaise, Gusar, Gala abundantly set berries in favorable weather conditions, as well as in dry, hot years (2010; 2012; 2021) they also form a moderate amount of berries with seeds [1, 9–11]. All this served as an impetus for obtaining a healthy seed from botanical seeds. At the same time, it is necessary to pay attention to the fact that when obtaining healthy microtubers

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from botanical seeds, splitting of plants according to economic characteristics is observed [12–15]. Plants can split better than the original variety in terms of yield and quality of tubers, which can give rise to new varieties. In connection with what was noted during the improvement of tubers, it is necessary to select plants with the same morphological characteristics and biological properties characteristic of the original variety.

The noted potato varieties, with the exception of the Gala variety, can be grown on farms and in the private sector with an average level of farming culture and receive a yield of 25–30 t/ha, but the production of seed material from a healthy meristem for these varieties is strongly constrained [16–19].

The purpose of the research: to obtain a healthy seed for the varieties Adretta, Gala, Gusar and Polonaise through botanical seeds and develop a technology for its reproduction.

2 Material and Methods

The studies were carried out in 2012–2021. On the experimental field of the State Agrarian University of the Northern Trans-Urals. The soil is leached chernozem, heavy loamy in granulometric composition, moderately provided with nitrogen and phosphorus, well – with potassium, the reaction of the soil solution is 6.7, the humus content is 7.2%. The predecessor is annual grasses, tillage is generally accepted in the northern forest-steppe zone of the Tyumen region. Mineral fertilizers in doses N60P60K40 were applied for cultivation in spring. Berries were collected from the studied varieties before harvesting the tubers. They were scattered in lattice boxes with a layer of 5–6 cm and placed in a cool, ventilated room for maturation. After 1.5–2 months, when the strawberry smell appears, we proceed to the isolation (washing of the seeds). Washing of seeds is carried out under running water using a fine-mesh sieve. Next, the seeds are dried at room temperature and placed in paper bags, which are stored in a dry place.

In spring, when the air temperature steadily reaches + 10 °C, we sow the seeds in a film or polycarbonate greenhouse to obtain microtubers. After harvesting, the microtubers are stored during the winter period in a refrigerator at a temperature of + 2 + 3 °C. In the spring we germinate the microtubers and plant them in the field, tunnels covered with a fine mesh. During the summer, we carry out three irrigations: the first – a week after germination, the irrigation rate is 300 m^3/ha, the second – during the flowering phase, the third – during the tuber formation period. In the last two irrigations, we apply a water rate of 400 m^3/ha. Each watering is combined with fertilizing with mineral fertilizers and growth regulator Rostock at a concentration of 0.001%.

The resulting seed tubers are sown next year in a naturally isolated area and the resulting seed material is sold to small farms, as well as to amateur gardeners.

We carry out observation and accounting according to the methods of the State variety testing[1], All-Russian Research Institute of Potato Farming named after A.G. Lorch[2]. Statistical processing of experimental data was carried out according to the method of B.A. Dospekhov[3].

3 Results and Discussion

Years of research on weather conditions were contrasting. So, 2012; 2016; 2021 were characterized as very dry and hot, which inhibited the growth, development of plants and the formation of tuber yields. In 2018 and 2019 uneven precipitation and frequent changes in air temperature were noted. Favorable weather conditions developed in 2013 – 2017; 2020 such a variety of weather conditions during the years of research allowed us to study the tasks in full.

The observations and records showed that not all plants in the studied potato varieties set berries (Table 1). The reason for this phenomenon is not yet clear to us, so in the future it is necessary to use physiological studies. From the analysis of the data in Table 1, it follows that, on average, over 5 years, the minimum percentage of plants 33.5% that set berries was in the Adretta variety, and the maximum (51.4%) was in the Polonaise variety. The difference between the noted varieties was 17.8%. Within each variety, the difference between years was 31; 29; 26; 37% respectively. At the same time, the analyzed indicator changed more strongly in the Polonaise variety, weaker in the Gusar variety. It should also be noted that the percentage of variation between years is higher than between the studied years.

Table 1. The number of plants of potato varieties that formed berries, 2012–2016

Variety	Origin	Percentage of plants that formed berries						V (%)
		2012	2013	2014	2015	2016	Average	
Adretta	Germany	26	41	49	34	18	33.6	36.25
Gala	Germany	37	42	50	39	21	37.8	28.09
Gusar	Research Institute of Agriculture of the Northern Trans-Urals	39	46	53	41	27	41.2	23.30
Polonaise	Bryansk Agricultural Experiment Station	45	59	68	54	31	51.4	27.47
Least significant difference $_{05}$		1.8	2.5	2.2	3.1	1.4	–	–

The studied potato varieties differed in the number of seeds in the berry and their size. The number of seeds in a berry varied from 47 seeds in the Gala variety to 65 seeds in the Adretta variety. The largest seeds (weight of 1000 pieces – 0.7 g) were in the Polonaise variety, in other varieties – from 0.4 to 0.6 g.

The seeds had a high germination capacity and when sown in the spring in a greenhouse, they gave friendly shoots, and at the end of the growing season, fully formed microtubers. The following year, microtubers were planted in the field, in tunnels on prepared garden-type soil. The tunnels were covered with fine mesh to protect the potato plants from insect vectors of viral diseases. The created diet and moisture supply, as well as the high-quality implementation of other technical measures, made it possible to obtain a high yield of tubers (Table 2).

Table 2. The yield of seed tubers of potato varieties grown in tunnels, 2017–2019

Variety	Total yield, t/ha				V, %	Productivity of seed tubers, t/ha				V, %
	2017	2018	2019	Average		2017	2018	2019	Average	
Adretta	43.7	39.4	45.2	42.7	7.05	34.1	30.8	37.5	34.1	9.82
Gala	51.6	49.3	54.1	51.6	4.65	40.6	36.3	44.0	40.3	9.58
Gusar	58.4	52.0	60.7	57.0	7.91	37.2	32.7	40.4	36.7	10.54
Polonaise	47.9	44.3	50.6	47.6	6.64	31.9	28.0	33.8	31.2	9.49
Least significant difference 05	2.9	2.3	2.7	–	–	2.1	1.9	2.5	–	–

The total yield of tubers varied from 39.4 t/ha for the Adretta variety in 2018 to 60.7 t/ha for the Gusar variety in 2019. On average, over three years, the yield between varieties varied from 42.7 to 57 t/ha. For each variety during the years of research, the yield varied in different ways. This is more pronounced in the varieties Gusar, Polonaise, Adretta.

In this experiment, the yield of seed tubers was high. The average yield for three years varied from 31.2 t/ha for the Polonez variety to 40.3 t/ha for the Gala variety. The tubers had a well-formed skin and a large number of eyes (8–10 pieces), as well as a high content of starch (16–22%) and protein (2.1–2.5%). The tubers were well stored in the winter period, the natural waste amounted to 3.8–4.6%.

In the spring of the following year, the tubers were unloaded from storage and germinated in the light. Then they were planted in the field in an isolated area according to the scheme 75 × 20 cm. It should be noted that the seedlings were friendly and strong. By the flowering phase, the above-ground mass of one plant, depending on the variety, was 1324–1510 g. Each plant formed from 6 to 9 stems. For comparison, in the mass plantings of the noted varieties, the given indicators are 1.5–2 times lower.

In an isolated area, potato plants had a healthy appearance and by harvesting under a bush formed 13–17 seed tubers and a high yield per hectare (Fig. 1).

It has not been applied in an isolated area in the field, so the yield of seed tubers is lower compared to the previous nursery. In order to increase the multiplication factor of seed tubers, it is necessary to solve the issue of irrigation, as well as to further improve the cultivation technology.

4 Conclusion

Registered varieties of potatoes that form berries can be grown from botanical seeds, which makes it possible to improve planting material. This requires a greenhouse, tunnels covered with fine mesh, isolated areas and irrigation. Improvement of potato planting material through botanical seeds can be used in the private sector and small farms.

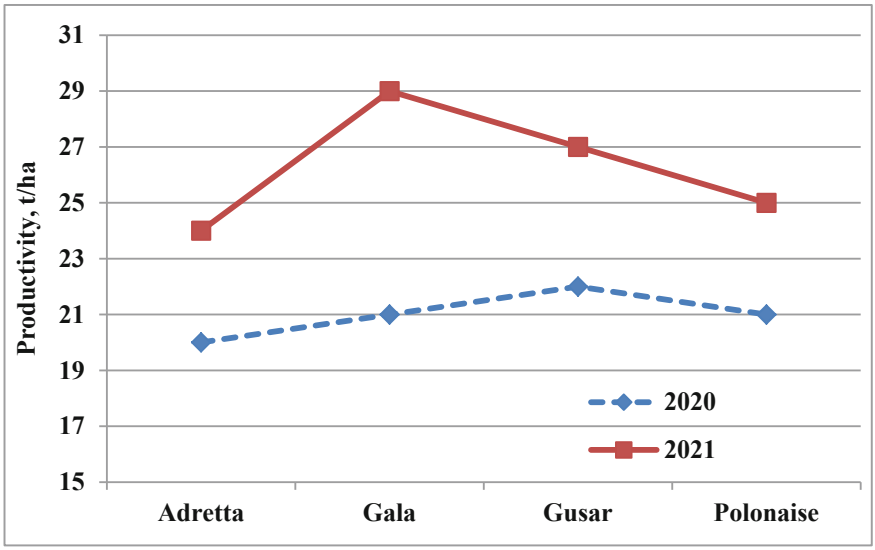

Fig. 1. The yield of seed tubers of potato varieties in a naturally isolated area, 2020–2021

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