Seed-potatoes production using biotechnology methods under the conditions of East Kazakhstan

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Abstract. The production of potato varieties for a long period of time largely contributes to a decrease in the initial productivity and quality indicators of potato tubers, this is the result of a progressive accumulation of viral, viroid, fungal and bacterial pathogens during plant reproduction. The system of virus-free seed production, based on the improvement of varieties and accelerated multiplication of the original seed material in conditions that exclude re-infection, successfully solves many problems of potato seed production. Biotechnological methods play a key role in this process. Micropropagation method allows for the rapid propagation of healthy seed material. We in 2016-2019. Investigations were carried out to obtain seed material of potato varieties of different ripeness groups using the in vitro method in the conditions of East Kazakhstan. After analyzing the conditions for the selection of seed production schemes, data on soil and climatic conditions, phytopathogenic conditions in the zone of potato production, we have selected a four-year seed production scheme in the methodology of original and elite seed production introduced in Ulan Zhemis LLP. Adaptation to production conditions was carried out in 2018-2019. All varieties by the method of accelerated in vitro reproduction were cloned by microcutting in four repetitions in the offspring in the laboratory of plant biology and biotechnology of the V. S. Amanzholova. All tested varieties, cut and adapted to soil and climatic conditions, were planted in a closed area from May 15 to June 1. As a result, the most productive varieties using the in vitro method were identified: Gulliver (Russia), Juvel (Germany), Colomba (Holland), Queen Anna (Germany), Rodrigo (Germany), Riviera (Holland), Darenka (Russia), Luck (Russia), Artemis (Holland), Red Lady (Germany).

1. Introduction
Agricultural producers of the East Kazakhstan region annually grow potatoes on an area of 23-25 thousand hectares. The average crop yield ranges from 100 to 150 kg/ha. Such a range in yield indicators depends on the cultivation conditions, agricultural technology used and the variety. In the region, 10 varieties of potatoes have been zoned, which is clearly not enough in modern conditions of intensive development of agricultural production. The loss of the variety over time of its initial productivity and other economically valuable properties is the result of the progressive accumulation of viral, viroid, fungal and bacterial pathogens during plant reproduction due to new infections. The system of virus-free seed production, based on the improvement of varieties and accelerated
multiplication of the original seed material in conditions that exclude re-infection, successfully solves many problems of potato seed production. The key role in this is assigned to the creation of a bank of healthy varieties [1,2,3].

Clonal micropropagation of plants has a number of advantages, since living of a wide variety of specialized tissues placed on a nutrient medium under sterile conditions realize their totipotency and give rise to a whole plant. In this case, clonal micropropagation is asexual reproduction in tissue and cell culture in which plants genetically identical to the original specimen appear. This method has a number of advantages over the conventional method of vegetative propagation - it is a high multiplication factor and the recovery of plants from viruses and pathogenic microorganisms. This method, like no other used in agricultural seed production, makes it possible to obtain a healthy planting material [4,5,6].

The food security of any country largely depends on the variety of crops cultivated, the quantity of products produced and their quality. Potatoes are a multipurpose crop, a valuable food, feed and industrial crop. Currently, the increase in the gross harvest of potato tubers is mainly due to an increase in the sown areas of the crop (Shabanov et al., 2016). The solution to the problem of potato shortage, an increase in yield indicators can contribute to improving the quality of planting material, through the use of biotechnological methods.

2. Materials and methods

The research goal is obtaining seed material of potato varieties of different ripeness groups using the in vitro method in the conditions of East Kazakhstan.

The objects of the study were potato varieties of different ripeness groups that are promising for the conditions of East Kazakhstan. In the research work, potato varieties of domestic and world selection were used, grown by agricultural producers in the conditions of East Kazakhstan. High quality, healthy seed is essential for their successful cultivation. Work on the production of healthy potato seed material using biotechnological methods of microclonal reproduction of tubers and work on adaptation of the obtained test-tube material to field conditions was carried out by us in the conditions of Eastern Kazakhstan.

The subject of the study was the economically valuable traits of potato varieties, which were grown from tubers obtained using microclonal reproduction. The work was carried out in laboratory and field conditions in several breeding nurseries. During the work, negative selection was carried out at all stages of plant development.

The organization of industrial production of original and elite seed potatoes based on the achievements of biotechnology, using clone selection for productivity, developed seed-growing schemes and selected varieties for the conditions of East Kazakhstan was carried out by us under the 019 program of the Ministry of Agriculture of the Republic of Kazakhstan "Services for the dissemination and implementation of innovative experience" for grant projects on the basis of two enterprises: the biotechnology laboratory of the East Kazakhstan State University and the Ulan Zhemis LLP located in the climatic zone of the Ulan region in 2015-2017.

After analyzing the conditions for the selection of seed production schemes, data on soil and climatic conditions, phytopathogenic conditions in the zone of potato production, we have selected a four-year seed production scheme in the methodology of original and elite seed production introduced in Ulan Zhemis LLP. Adaptation to production conditions was carried out in 2018-2019.

For the period 2016-2018 We studied the collection in vitro, and then in the closed area of the first nursery of original seed production, when the first meristem offspring were obtained, in clones of the 1st year in 2018 and clones of the 2nd year in 2019.

All varieties according to the method of accelerated in vitro reproduction were cloned by microseeding in a fourfold repetition in the offspring in the laboratory of plant biology and biotechnology, EKSU im. S. Amanzholov and prepared for landing in a closed area of open ground by May 15. Planting was carried out manually, on a high agricultural background with irrigation.
During the growing season, phenological observations, registration of diseases by external signs and latent forms were carried out using enzyme-linked immunosorbent assay (ELISA). In the period when the tops began to wilt, the tops were cut and removed from the planting area. 15 days after the removal of the tops, harvesting, accounting for the harvest and selection of clones of the 1st year were carried out for transferring them to the nursery of the 2nd year (2019) and further study.

All tested varieties, cut and adapted to soil and climatic conditions, were planted in a closed area from May 15 to June 1. Plants in vitro were selected from test tubes and planted in prepared wells according to a 70x25 cm scheme. The survival rate was high and amounted to 90-98% for varieties. A total of 1040 plants were planted.

3. Research results
In 2019, in vitro microplants developed slowly and decreased productivity, which can be seen from the data shown in table 1.

Table 1. Productivity of in vitro cultivars of very early maturity.

| Grade      | Number of tubers pcs/bush | Tuber weight, g/bush | Absolute weight of tubers, g | Productivity g/Bush | Productivity t/ha |
|------------|----------------------------|----------------------|------------------------------|---------------------|-------------------|
|            | *  | ** | *** | **** | *  | ** | *** | *** | *  | ** | *** | **** | *  | ** | *** | **** | *  | ** | *** | **** |
| Arosa      | 3  | 3  | 1   | 6    | 362 | 95 | 11  | 121 | 32  | 8   | 467 | 19   |      |    |     |     |    |
| Colonna    | 4  | 3  | 4   | 7    | 735 | 191| 29  | 184 | 64  | 8   | 955 | 38   |      |    |     |     |    |
| Riviera    | 3  | 5  | 5   | 8    | 340 | 183| 33  | 126 | 37  | 6   | 556 | 22   |      |    |     |     |    |
| Queen Anne | 4  | 5  | 5   | 9    | 382 | 205| 78  | 96  | 40  | 15  | 665 | 26   |      |    |     |     |    |
| Lady Claire| 4  | 4  | 2   | 8    | 508 | 198| 26  | 127 | 46  | 15  | 732 | 29   |      |    |     |     |    |
| Felix      | 3  | 2  | 0.0 | 5    | 263 | 55 | 0.0 | 80  | 27  | 0   | 318 | 13   |      |    |     |     |    |
| Rodrigo    | 5  | 3  | 3   | 8    | 572 | 169| 33  | 121 | 51  | 12  | 773 | 31   |      |    |     |     |    |
| Gala       | 3  | 1  | 1   | 4    | 145 | 53 | 3   | 48  | 41  | 5   | 201 | 8    |      |    |     |     |    |
| Red Scarlet| 6  | 4  | 0.3 | 10   | 662 | 166| 13  | 116 | 45  | 44  | 841 | 34   |      |    |     |     |    |
| deviations | ±0.2| ±0.2| ±0.1| ±0.4 | ±22.1| ±7.3| ±1.3| ±5.7| ±2.1| ±1  | ±31 | ±1.2 |      |    |     |     |    |

2019

| Grade      | Number of tubers pcs/bush | Tuber weight, g/bush | Absolute weight of tubers, g | Productivity g/Bush | Productivity t/ha |
|------------|----------------------------|----------------------|------------------------------|---------------------|-------------------|
|            | *  | ** | *** | **** | *  | ** | *** | *** | *  | ** | *** | **** | *  | ** | *** | **** | *  | ** | *** | **** |
| Arosa      | 1  | 2  | 2   | 3    | 30  | 28 | 14  | 30  | 14  | 7   | 72  | 3    |      |    |     |     |    |
| Colonna    | 3  | 1  | 1   | 4    | 390 | 66 | 26  | 130 | 66  | 26  | 482 | 19   |      |    |     |     |    |
| Riviera    | 2  | 1  | 0   | 3    | 120 | 46 | 0   | 60  | 46  | 0   | 166 | 7    |      |    |     |     |    |
| Queen Anne | 3  | 2  | 5   | 5    | 158 | 38 | 30  | 53  | 19  | 6   | 226 | 9    |      |    |     |     |    |
| Lady Claire| 1  | 1  | 4   | 2    | 82  | 56 | 16  | 82  | 56  | 16  | 154 | 6    |      |    |     |     |    |
| Felix      | 1  | 2  | 0   | 3    | 34  | 20 | 0   | 34  | 10  | 0   | 54  | 2    |      |    |     |     |    |
| Rodrigo    | 1  | 1  | 1   | 2    | 66  | 42 | 4   | 66  | 42  | 4   | 112 | 5    |      |    |     |     |    |
| deviations | ±0.1| ±0.1| ±0.1| ±0.2 | ±6.3| ±2.1| ±0.6| ±3.3| ±1.8| ±0.4| ±9.0| ±0.4 |      |    |     |     |    |

* large; ** medium; *** small; **** standard

In 2019, the varieties Udacha, Ilyinsky and Darenka retained their productivity (table 2).

Table 2. Productivity of in vitro varieties of early ripening.

| Grade   | Number of tubers pcs/bush | Tuber weight, g/bush | Absolute weight of tubers, g | Productivity g/Bush | Productivity t/ha |
|---------|----------------------------|----------------------|------------------------------|---------------------|-------------------|
|         | *  | ** | *** | **** | *  | ** | *** | *** | *  | ** | *** | **** | *  | ** | *** | **** | *  | ** | *** | **** |
| Luck    | 2  | 1  | 1   | 3    | 693 | 171| 40  | 346 | 132| 40  | 904 | 36.2 |      |    |     |     |    |
| Alyona  | 4  | 4  | 1   | 8    | 440 | 144| 13  | 119 | 36  | 13  | 597 | 23.9 |      |    |     |     |    |
| Rosara  | 5  | 2  | 3   | 7    | 441 | 60 | 27  | 94  | 35  | 10  | 529 | 21.1 |      |    |     |     |    |
| Daryonka| 7  | 2  | 0.3 | 9    | 1240| 143| 13  | 185 | 62  | 42  | 1395| 55.8 |      |    |     |     |    |
| Merchant | 5  | 4  | 1   | 9    | 501 | 189| 9   | 100 | 51  | 13  | 699 | 28.0 |      |    |     |     |    |
The plants had a well-developed shrub habit. All varieties have formed the first offspring of tubers. Despite the wide variety of soil composition and fertility, the amount and even distribution of precipitation, the sum of effective temperatures, the duration of the frost-free period, the moderate background of the infectious load of viral disease vectors, East Kazakhstan can be considered as a rather favorable area for organizing its own production of high-quality seed potatoes of various ripening periods.

Table 3. Productivity of in vitro varieties of mid-ripening period.

| Grade            | Number of tubers pcs/bush | Tuber weight, g/bush | Absolute weight of tubers, g | Productivity g/Bush | Productivity t/ha |
|------------------|---------------------------|----------------------|-----------------------------|---------------------|-------------------|
|                  | * | ** | *** | **** | * | ** | *** | * | ** | *** | * | ** | *** | * | ** | *** |
| **2018**         |   |   |     |     |   |   |     |   |   |     |   |   |     |   |   |     |
| Alliance         | 4 | 4  | 1   | 80  | 354 | 129 | 15  | 96 | 30 | 12  | 498 | 20 |
| Victoria         | 4 | 3  | 1   | 7   | 323 | 85  | 4   | 87 | 32 | 6   | 412 | 16 |
| Red Lady         | 6 | 2  | 1   | 8   | 1041| 96  | 9   | 174| 42 | 9   | 1146| 45 |
| Grandee          | 3 | 5  | 1   | 8   | 321 | 162 | 13  | 107| 34 | 13  | 497 | 20 |
| Bryansk Delikacy | 4 | 6  | 1   | 10  | 307 | 219 | 20  | 71 | 38 | 15  | 545 | 22 |
| Pretty boy       | 3 | 2  | 3   | 5   | 601 | 113 | 40  | 182| 49 | 13  | 754 | 30 |
| deviations       | ±0.2|±0.2|±0.1|±0.4 | ±24.6|±6.7|±0.9 |±6.0|±1.9|±0.6 |±32.1|±1.3 |
| **2019**         |   |   |     |     |   |   |     |   |   |     |   |   |     |   |   |     |
| Alliance         | 1 | 2  | 0   | 3   | 100 | 96  | 0   | 100| 48 | 0   | 196 | 8  |
| Victoria         | 1 | 5  | 0   | 6   | 74  | 30  | 0   | 74 | 6  | 0   | 104 | 4  |
| Red Lady         | 3 | 1  | 0   | 4   | 180 | 30  | 0   | 60 | 30 | 0   | 210 | 8  |
| deviations       | ±0.1|±0.1|±0.0|±0.2 | ±5.9|±2.6|±0.0 |±3.9|±1.4|±0   |±9  |±0.3 |

* large; ** medium; *** small; **** standard

4. Discussion

For the conditions of East Kazakhstan, a 4-year system of elite and original seed production was developed. Despite the wide variety of soil composition and fertility, the amount and even distribution of precipitation, the sum of effective temperatures, the duration of the frost-free period, the moderate background of the infectious load of viral disease vectors, East Kazakhstan can be considered as a rather favorable area for organizing its own production of high-quality seed potatoes of various ripening periods.

Under the conditions of 2018, the duration of the growing season of the studied varieties corresponded to their groups in terms of ripening. The development of diseases by external signs was practically not observed, and the plants with latent infection according to the results of ELISA were single, and they were immediately removed from the field. The plants had a well-developed shrub habit. All varieties have formed the first offspring of tubers.
Testing a group of varieties, early ripening is represented by 9 varieties: Arosa; Gala; Colombo; Queen Anna; Lady Claire; Riviera; Rodrigo; Red Scarlet; Felox.

Under the conditions of research on the ripening period, all varieties showed themselves as early. Individual productivity of varieties ranged from 201.3 to 954.7 g/bush, grown from a test tube plant. The maximum productivity was formed by the variety Colombo (Holland); its productivity was 954.7 g/bush. The variety formed, on average, 7 standard tubers in a bush. The number of large tubers was 4, with an absolute weight of 183.7 g, medium tubers - 3 with an absolute weight of 63.8 g and 3.7 small ones - an absolute weight of 28.7 g. This suggests that the variety is very large-fruiting and should be used for him a denser planting of microplants (75x10x15 cm) (table 1).

The individual productivity of the Koroleva Anna variety was 664.7 g/bush, had 9 tubers in the bush, 4 large ones with a weight of 95.5 g, 5 medium ones - 40.1 g, and 5.3 - small ones with a weight of 14.7 g. Quantity of small tubers is an undesirable trait, but all tubers had a beautiful appearance and high marketability. The rest of the varieties had a productivity of 556.0 grams and below. The potato variety Lady Claire (Holland) gained 732.0 g/bush. The variety is moderately demanding on soil and climate, grows best on loose fertile soils in mild climatic conditions. Subject to agricultural technology, it can give two crops per season.

The next most productive variety was Red Scarlet and weighed 841.3 g/bush. The total number of tubers in the bush is 9.4 with 5.7 large ones with an absolute weight of 116.1 g, an average of 3.7 with an absolute weight of 44.6 g. The tubers are aligned and have a good presentation. On average, the maximum productivity per season is 700 g/bush. and higher received on grades: Lady Claire 732 g/bush and Rodrigo 773.4 g/bush.

The group of medium early varieties included 9 varieties (table 2): Udacha; Alena; Rozara; Darenka; Kupets; Artemis; Colette; Ilinsky; Skoroplodny.

The most promising variety turned out to be Darenka (Russia), which, when obtaining the first meristem progeny from microplants in vitro, formed an average productivity of 1395.4 g/bush. The bush contained 9 standard tubers, including 6.7 large ones. with an absolute weight of 185.1 g; medium - 2.3 pcs. with an average weight of 62 g and 0.3 pcs. small tubers with a weight of 42.3 g per tuber, which can be equal in weight to the seed fraction.

The second most productive variety in this group of varieties is the Udacha variety. In 2018, its productivity was 904 g/bush. He had a small number of tubers in the reporting year, which is what distinguished himself in comparison with previous years. There were two large ones, with an absolute weight of 346.4 g, a medium 1.3 with a weight of 131.8 g, and small ones - 1 with a weight of 40 g. This variety, also in the nursery of the first year, like the Colombo variety, should have a dense planting).

The third variety, which had a high yield, showed the Dutch variety Artemis, its productivity was 784.0 g/bush. According to the results of tests for the further work of the group of varieties in nursery II years were selected varieties: Colombo, Scarlet Red, Lady Claire, Rodrigo and Queen Anna.

The group of mid-season varieties byolo includes 6 varieties: Alliance, Victoria, Red Lady, Bryansk Delikates, Krasavchik (table 3). In 2019, the tested varieties also reduced productivity in the first year nursery, but Red Lady (8.4 t/ha) and Alliance (7.84 t/ha) varieties retained their superiority.

The most promising of them is Red Lady, it has an individual productivity of 1146.6 g/bush. The number of standard tubers is 8.3; with 6 large ones with an absolute weight of 173.6 g; 2.3 medium, with a corresponding weight of 41.7 g; 1 small, weighing 9.3 g. Main advantages of the variety: early ripening and extended growing season; suitable for industrial and hobby cultivation; great taste of ready meals. Alliance and Victoria varieties have individual productivity of 497.9 and 412 g/bush, respectively. Variety Grand (Russia) had an individual productivity of 496.6 g/bush. It has a good taste, the pulp does not darken when sliced and cooked. The rest of the varieties Alliance and Victoria have individual productivity of 497.9 and 412 g/bush, respectively.
5. Conclusion
The results of studies to identify potato varieties of different ripeness groups that are the most productive in the system of elite and original seed production in the conditions of East Kazakhstan using the in vitro method showed that in the nursery of the first year, where the first meristem progeny of tubers from microplants in vitro was obtained, varieties were distinguished: ripening time in the group of early varieties - Colomba (Holland), Queen Anna (Germany), Rodrigo (Germany) and Riviera (Holland); in the mid-early group - Darenka (Russia), Luck (Russia), Artemis (Holland); in the mid-season group - Red Lady (Germany). In the conditions of 2018, varieties of all ripeness groups formed a higher productivity than in 2019. The maximum yield was shown by varieties in the early group: Colombo (38 t/ha), Red Scarlet (34 t/ha), Rodrigo (31 t/ha) Lady Claire (29 t/ha); in the mid-early group: Daryonka (56 t/ha), Success (36 t/ha), Artemis (31 t/ha); in the mid-season group: Red Lady (45 t/ha), Krasavchik (30 t/ha), Bryansk delicacy (22 t/ha).

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