

The yield of elite potato varieties for primary seed production using precision agriculture technologies in the conditions of Northern Kazakhstan

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Abstract. The article presents the results of conducting primary seed production of virus-free original and zoned potato varieties in the conditions of Northern Kazakhstan. The creation and introduction into the production of new virus-free highly productive potato varieties with a complex of economically valuable traits is a priority for the national economy of any state. Providing potato-growing farms with high-quality seeds of local varieties has been and remains an acute problem for the industry. The data on the yield and quality of tubers depending on the reproduction of potatoes are presented. So, when assessing the yield of virus-free potato varieties, a good indicator was observed in Dunyasha (12.7 t/ha), Zeren (9.2 t/ha), and Sante (6.4 t/ha). When harvesting from an area of 0.6 ha, 3.4 tons of super-elite potatoes were harvested with an average yield of 5.7 t/ha.

1 Introduction

In Kazakhstan, one of the most important tasks is to conduct fundamental and applied research on potatoes and, in particular, to strengthen breeding work and primary seed production [1, 2]. To date, the demand for domestic potato varieties is increasing, but the low multiplication factor under traditional technology hinders the reproduction and introduction of new high-yielding varieties. In the conditions of the hilly-flat zone of Northern Kazakhstan, on the basis of the Kokshetau Experimental Production Farm LLP, seed material recovered from a viral infection was propagated in compliance with phytosanitary requirements. Maintaining the purity of released varieties and original seeds, increasing the productivity and seed qualities of released and promising potato varieties.

Potatoes are one of the important products of everyday human nutrition. One of the main consumers of food products in Northern Kazakhstan (including potatoes) is the tourism industry [4]. The nutritional, fodder, technical and medical value of potatoes is determined by the chemical composition of their tubers [3]. Currently, a huge amount of

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research is being carried out to increase the yield and quality of agricultural products by developing new and improving existing cultivation technologies, obtaining highly productive original potato seeds by micropropagation [5, 6, 7, 8], studying the effect of various fertilizer systems on the content of toxic elements [9, 10, 11, 12].

The solution to the problem of potato seed production is to provide sown areas with high-quality seed material obtained on the basis of biotechnological methods of rehabilitation, clonal selection, and accelerated reproduction. ELISA and polymerase chain reaction methods are used to detect potato viral diseases [13, 14].

Modern potato seed production provides for the production of healthy seed material and its accelerated reproduction using biotechnology methods. Accelerated reproduction of domestic varieties of potatoes by mini-tubers and their introduction into production makes it possible to increase the multiplication factor and the quality of seed potatoes. Due to the high content of starch, proteins, amino acids, and vitamins in tubers, potatoes, and their processed products are widely used for both food and technical purposes [13].

2 Materials and methods

In Northern Kazakhstan, potatoes are cultivated on an area of 18.2 thousand hectares. At the same time, the areas under potatoes are increasing, and the productivity of the crop is on average 14-16 t/ha. The most stable crops are obtained in mid-latitude regions with moderate temperatures during the growing season [14]. In this case, the varietal features of the variety are also of significant importance [16].

In the hilly-flat zone of Northern Kazakhstan, meteorological conditions play a decisive role in the growth and development of potato plants. The main feature of the climate is its sharp continentality, which is manifested by a large amplitude of fluctuations in air temperature, air dryness, and a small amount of precipitation.

The main indicators - precipitation and temperature regime - show that the conditions for the growth and development of potato plants are satisfactory. The average monthly air temperature in May was +16.5 °C, which is 5.0° higher than the average annual data, and precipitation in May amounted to 13.5 mm, which is 23.9 mm lower than the average annual data (Table 1).

Table 1. Comparative characteristics of meteorological conditions, 2018-2020.

Month	Precipitation, mm					Air temperature, °C				
	long-term average	2018	2019	2020	2018-2020	long-term average	2018	2019	2020	2018-2020
April	20,7	17,9	30,7	29,7	78,3	4,2	1,0	4,3	8,8	4,7
May	37,4	46,0	27,9	13,5	87,4	11,5	11,0	12,0	16,5	13,2
June	52,5	61,9	54,9	15,0	131,8	17,3	18,4	15,2	16,3	16,6
July	75,2	125,7	17,8	98,4	241,9	18,2	17,6	20,6	20,4	19,5
August	41,8	132,5	26,8	11,9	171,2	16,4	18,3	17,2	18,8	18,1
For the growing season (May - August)	227,6	384,0	158,1	168,5	236,9	13,5	16,3	13,9	16,2	15,5

In 2020, during the growing season (May-August), 168.5 mm of precipitation fell, which is 59.1 mm lower than the long-term average (table 1). At the same time, the air temperature in August exceeds the average annual norm by 2.4 degrees, which led to a reduction in the growing season and accelerated ripening of potatoes. The air temperature in June was higher than last year's data by 1.1 °C and 1.0 °C higher than the long-term average. June precipitation was at the level of average annual data and amounted to 54.9 mm (table 1). The air temperature in July (20.4°C) was 2.2°C higher than the long-term average, and in August (18.8°C) it was 2.4°C higher than the long-term average. A low amount of precipitation was observed in June (15.0 mm) and August (11.9 mm). Precipitation, which fell during the critical periods of plant development in July in the amount of 98.4 mm, made it possible to form an average level of potato yield for our zone.

Meteorological conditions for the growth and development of potato plants for 2018-2020 should be considered at the level of long-term average data. During the growing season, 236.9 mm of precipitation fell, with an average long-term norm of 227.6 mm. In 2018 the amount of precipitation was 384.0 mm, which favorably affected the yield of potatoes. In the current year, 168.5 mm fell during the growing season, which is below the long-term average (Table 1).

For the three years under study (2018-2020), the first year is favorable, the second and third are dry.

Research work is carried out in accordance with the methodology of field experience B.A. Dospehov, based on the methodological recommendations of the Research Institute of the Potato Industry of Russia, the Research Institute of Plant Production. N.I. Vavilov, Institute of Plant Protection of Russia, LLP Kaz. NIIKO and others [17, 18].

3 Results and discussion

In the period 2018-2020 studies have been carried out on the conduct of primary seed production of virus-free original potato varieties. Nurseries of primary seed production were located on the experimental field of Kokshetau Experimental Production Farm LLP on a bare fallow. The soil is ordinary chernozem, heavy loam in terms of mechanical components.

According to the results of the study in 2020, the Zeren variety was selected for a complex of economically useful traits. In 2020, when harvesting from an area of 0.6 ha, 3.4 tons of potatoes were harvested with an average yield of 5.7 t/ha (Table 4).

In the practice of primary seed production of potatoes, to obtain healthy seed material, biotechnology methods are widely used, including micropropagation, which makes it possible to obtain seed material recovered from viral infections. The induction of microtubes in vitro, accelerated reproduction of tubers by various methods, and their use as planting material are promising in primary seed production [19].

The solution to the problem of potato seed production is to provide sown areas with high-quality seed material obtained on the basis of biotechnological methods of rehabilitation, clonal selection, and accelerated reproduction [20-22].

In this regard, for the propagation of zoned potato varieties of domestic selection in the conditions of the hilly-flat zone of Northern Kazakhstan, domestic potato varieties were transferred to KazNIPO to obtain a healthy potato source material in culture in vitro and in vivo. Further, because of the mass cultivation of potato micro- and minitubers, virus-free domestic and foreign potato varieties were obtained: Shagalaly, Zeren, Fortuna, Akzhol-14, Dunyasha, Sante and Albinka.

Table 2. Potato seed quality, 2018-2020.

Name (variety)	A number of eyes per 1 tuber, pcs.			Number of stems per 1 bush, pcs.			Completeness of germination, %			Plant height, cm					
										full shoots			flowering phase		
	2018	2019	2020	2018	2019	2020	2018	2019	2020	2018	2019	2020	2018	2019	2020
Shagalaly	9	8	8	7	6	6	77,8	75,0	75,0	17,6	17,5	15	36,6	33,1	38,4
Zeren	8	7	7	6	5	5	75,0	71,4	71,4	17,9	14,6	20	37,0	34,6	36,9
Fortuna	6	8	7	5	6	6	83,3	75,0	85,7	17,2	18,8	15	31,1	41,3	33,2
Akzhol-14	8	6	8	7	5	6	87,5	83,3	75,0	13,4	16,4	15	31,7	39,2	29,7
Dunyasha	9	8	8	7	6	6	77,8	75,0	75,0	17,8	17,9	20	36,2	43,1	31,5
Sante	9	7	9	8	5	6	88,9	71,4	66,7	19,2	15,8	16	43,7	41,5	30,6
Albinka	8	8	7	6	6	5	75,0	75,0	71,4	16,5	18,0	25	34,8	40,2	37

In 2018-2020 in the nursery of primary seed production, the reproduction of superelite potato varieties took place: Shagalaly, Zeren, Fortuna, Akzhol-14, Dunyasha, Albinka, and Sante. According to phenological observations, seedlings were noted on the 19th day after planting, and full seedlings on the 24th day. In the flowering phase, cleanings were carried out, where plants with signs of disease and stunting were removed. No admixture of other varieties was found.

When assessing the state of varieties in the flowering phase, the Dunyasha variety had high foliage and a powerful stem, where the height of the plant in the flowering phase averaged 36.9 cm (Table 2). The cultivars Zeren, Fortuna, Akzhol-14, Dunyasha, Sante, Albinka were 1.5-4.3 cm lower than the Shagalaly cultivar in height and had high leafiness. The completeness of germination depended both on the number of eyes on the tuber (5-8 pieces) and on the number of stems (5-7 pieces) (Table 2).

Table 3. Productivity of varieties and crop structure, 2018-2020.

Name (variety, hybrid)	Accounting for yield, t/ha				Marketable tuber weight, grams				Number of marketable tubers, pcs/bush				Marketability, %			
	2018	2019	2020	2018-2020	2018	2019	2020	2018-2020	2018	2019	2020	2018-2020	2018	2019	2020	2018-2020
Shagalaly	11,1	12,4	7,8	10,4	59,2	70,0	56,2	61,8	3,7	4,3	3,4	3,8	95	95	79	90
Zeren	19,5	15,8	13,5	16,3	85,6	97,3	73,1	85,3	4,3	4,8	4,0	4,4	96	91	96	94
Fortuna	21,3	14,7	11,9	16,0	52,0	79,1	66,7	65,9	5,3	3,7	4,0	4,3	97	92	92	94
Akzhol-14	25,7	17,5	6,4	16,5	62,2	61,1	90,0	71,1	4,7	3,7	2,0	3,5	98	80	96	91
Dunyasha	13,1	17,8	11,1	14,0	103,4	92,9	97,5	97,9	6,0	6,0	3,0	5,0	94	86	96	92
Sante	26,2	17,9	7,8	17,3	83,6	69,1	85,0	79,2	4,7	6,3	4,0	5,0	90	95	92	92
Albinka	12,3	11,9	10,2	11,5	81,0	66,3	63,6	70,3	4,3	5,7	3,7	4,6	86	91	93	90

On average, for 2018-2020, taking into account the harvest of the varieties Sante, Zeren, Fortuna, and Akzhol-14, the yield significantly exceeded Shagalaly by +6.9...+5.6 t/ha. At

the same time, the highest yield was observed in the Sante variety and amounted to 17.3 t/ha, and the lowest yield was observed in the Albinka variety and amounted to 11.5 t/ha. According to the mass of marketable tuber, the Dunyasha variety stood out - 97.5 g, exceeding the standard by 36.1 g (Table 3). The varieties Zeren, and Fortuna showed a high marketability of 94%.

Table 4. Productivity of the primary seed nursery, 2019-2020.

Name (variety)	Area, ha			Gross collection,		Productivity, t/ha	
	2019	2020	2019-2020	2019	2020	2019	2020
Shagalaly	0,036	0,102	0,138	0,1069	0,579	3,0	5,7
Zeren	0,009	0,075	0,084	0,06005	0,693	6,7	9,2
Fortuna	0,009	0,075	0,084	0,0503	0,561	5,6	7,5
Akzhol-14	0,015	0,081	0,096	0,0375	0,372	2,5	4,6
Dunyasha	0,003	0,069	0,072	0,0382	0,342	12,7	5,0
Sante	0,015	0,081	0,096	0,0562	0,516	3,7	6,4
Albinka	0,048	0,114	0,162	0,3085	0,339	6,4	3,0
Total	0,14	0,6	0,74	0,71	3,4	6,3	5,7

4 Conclusions

When assessing the state of varieties in the flowering phase, the Dunyasha variety had high foliage and powerful stems, whereas the plant height in the flowering phase was an average of 36.9 cm. On average for 2018-2020, taking into account the harvest of Sante, Zeren, Fortuna, and Akzhol-14 in terms of yield significantly exceeded Shagalaly by +6.9...+5.6 t/ha. At the same time, the highest yield was observed in the Sante variety and amounted to 17.3 t/ha. When taking into account the yield of the varieties Zeren, Fortuna, and Dunyasha, the yield significantly exceeded Shagalaly by +5.7...+3.3 t/ha. When harvesting from an area of 0.6 ha, 3.4 tons of potatoes were harvested with an average yield of 5.7 t/ha.

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