

The Yield of Early Potato Varieties of Domestic Breeding, Depending on the Level of Mineral Nutrition in the Northern Forest-Steppe of the Tyumen Region

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Abstract — Research was conducted in 2013-2016. on the experimental field of the Northern Autonomous Urals SAU in the area of the Instructional Farm. The soil is leached chernozem, heavy loam in particle size, moderately supplied with nutrients, pH-6,7. The study of the mineral nutrition level in early varieties of potatoes Alyona and Severny showed that it is economically advantageous to make mineral fertilizers for a planned yield of 30 and 40 t / ha, which is combined with the quality of tubers. A further increase in the mineral nutrition level increases the yield, but economically it is not profitable. Potato harvest, obtained in variants with high doses of mineral fertilizers, is stored worse than in the control version. Considering the yield and quality of the tubers of the studied potato varieties, it is economically advantageous to apply mineral fertilizers for a yield of 30-40 t / ha. Considering the yield and quality of the tubers of the studied potato varieties, it is economically advantageous to apply mineral fertilizers for a yield of 30-40 t / ha. At the same time, the level of profitability was 86 and 104%, respectively, for comparison in the control variant - 54-59%. A further increase in the level of mineral nutrition in the cultivation of early potato varieties Alyona and Severny is not economically viable.

Keywords — potato, variety, mineral fertilizers, yield, quality of tubers.

I. INTRODUCTION

Over the past decades, the area of sowing varieties of foreign breeding potatoes in the Tyumen region has increased by several times and makes to 60-70% of the sowing area of

the crop. In this regard, the problem of import substitution is very acute [12, 14].

To be frank, it should be noted that among the domestic breeding varieties there are quite competitive [3, 6, 13]. It is necessary to develop a varietal technology for them, and also, using subsidies, to develop seed production.

Of the elements of the varietal technology, special attention is given to mineral nutrition [8, 11], therefore, the purpose of the research is to study the level of mineral nutrition of domestic breeding varieties of early potato in the northern forest-steppe of the Tyumen region.

The yield of potatoes in the Tyumen region, as well as Siberia in general, remains low. One of the reserves to increase it is the use of organic and mineral fertilizers [6, 11]. At the same time, according to the biological characteristics of potatoes, it is important to provide plants with nutrients at the right time. It is known that potatoes consume more phosphorus and potassium during the growing season [11, 14]. The soils of the northern forest-steppe zone of the region in which 70–80% of potatoes are produced are poorly supplied with nitrogen, medium phosphorus and potassium [11].

Nitrogen is mainly needed in the first half of the growing season to form the above-ground plant mass. It is desirable that in the flowering phase it reaches its maximum, and in the second half of the summer it productively “worked” on the formation of tubers. However, in production conditions, for various reasons: not sufficient nitrogen nutrition, drought, heat

in the first half of summer, the formation of above-ground mass of potato plants is delayed until early August and beyond. In this case, two physiological processes are combined - the formation of tops and the formation of tubers. Ultimately, this adversely affects the yield and marketability of tubers.

II. OBJECTS AND METHODS

Research is conducted in 2013-2016. on the experimental field of the Northern Autonomous Urals SAU near the Instructional farm. The soil is leached chernozem, heavy loamy, with a granulometric composition, with average supply of nutrients, pH -6,7 [11]. The predecessor of the early potato, after harvesting which in the third decade of August, the green manure rape was sown. Green mass (120-130 cwt. / ha) was plowed at the end of the first and beginning of the second decade of October. . In the spring, harrowing was carried out in order to retain moisture in the soil, the application of mineral fertilizers by the calculation method for obtaining yield 30; 40; 50; 60 t / ha, cultivation of the soil to a depth of 15-17 cm, cutting ridges. Planting was carried out at the optimum time at a soil temperature of $+ 8 + 10^{\circ} \text{C}$, planting scheme 70x30 cm, plot area 30 m², accounting 25 m², repeated 4 times, systematic placement of plots.

For the object of the study, two early potato varieties of domestic breeding were taken: Alyona and Severny.

Caring for potato crops included two inter-row treatments, hilling and 1-2 chemical treatments against the larvae of the Colorado potato beetle.

Observations and records were carried out according to the methods of the State trials of agricultural crops, All-Russian Research Institute of Potato Farming Named after A. G. Lorch, All-Russian institute of plant protection, photosynthetic activity studied according to A.A. Nichiporovich, yield data processed by the statistical method according to B.A. Dospekhov.

III. RESULTS

The length of the growing season is one of the main economic characteristics of the variety, which can be genetically controlled, and its manifestation largely depends on the climatic conditions of the region and elements of the cultivation technology, including the level of mineral nutrition (table 1).

Analyzing the data in Table 1, it can be seen that, in the control variant, the planting-seedling period over the years of research was 16 days for the Alyona variety, and 15 for the Severny variety. A similar pattern was observed for the duration of interphase periods of seedlings-flowering and flowering-ripeness. In general, the growing season in the studied varieties in the control variant was 85-88 days, in the variants with mineral fertilizers for the planned yield it increased by 4-9 days.

TABLE I. DURATION OF INTERPHASE PERIODS OF EARLY POTATO VARIETIES DEPENDING ON THE LEVEL OF MINERAL NUTRITION, 2013-2016

Variety	NPK on yield, t / ha	Period, days				In relation to control variant, ±
		<i>planting-emergence</i>	<i>emergence - start of blooming</i>	<i>start of blooming - ripening</i>	<i>planting-ripening</i>	
Alyona	Control, no fertilizers	16±2	34±3	35±3	85±3	-
	30	17±2	36±2	37±4	90±2	+5
	40	17±2	36±3	37±4	90±3	+5
	50	18±3	37±4	38±5	93±4	+8
	60	18±4	37±3	38±3	93±3	+8
Severny	Control, no fertilizers	15±1	36±2	37±1	88±1	-
	30	15±2	38±4	39±4	92±3	+4
	40	16±2	38±3	39±3	93±3	+5
	50	15±3	39±5	40±5	94±4	+6
	60	17±3	40±4	40±4	97±4	+9

A well-developed leaf surface is the basis for obtaining high yields of potato tubers [2, 5, 10]. In the variants with the use of mineral fertilizers, the plants had a more developed leaf surface (Figure 1).

When studying photosynthetic activity, along with the leaf area, great importance is given to the position of the leaves in relation to each other. It is important that they shade the lower tiers less and absorb solar energy as much as possible. The potato varieties studied in the experiment have a good design and location of the leaves on the plant. At different levels of mineral nutrition, they showed a high productivity of photosynthesis (Figure 2).

The disadvantage of many varieties of domestic and foreign selection is low resistance to diseases. Annually, diseases take 20-30% of the crop and more [4, 9]. In the

Tyumen region, phytophthora and viral diseases cause the greatest harm to potatoes.

Resistance to diseases is genetically controlled, but in many respects it also depends on the environmental conditions, technology elements, including the level of mineral nutrition (Table 2).

From the data in Table 2 it can be seen that the Severny variety is more disease resistant. In both of the studied varieties, with an increase in the level of mineral nutrition, was observed a decrease in resistance to phytoftor and scab, and in the variety Alyona, also to rhizoctoniosis. Plants of both varieties in the control variant are more strongly affected by viral diseases.

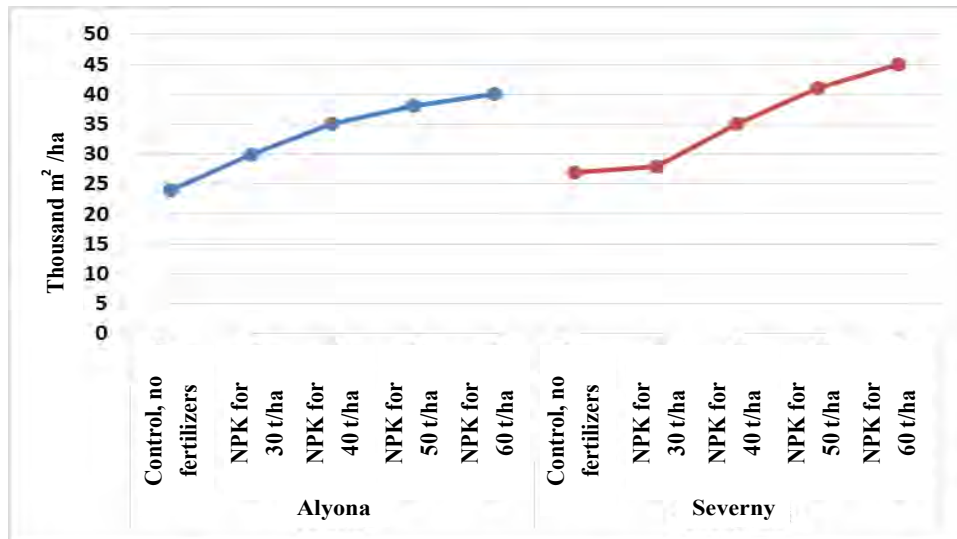


Fig. 1. The impact of the mineral nutrition level on the leaves area of potato varieties, 2013-2016

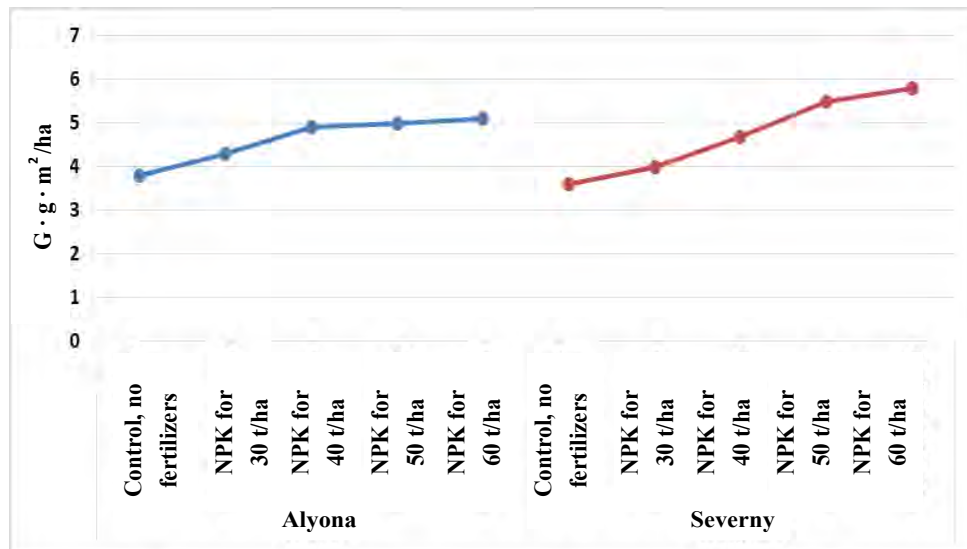


Fig. 2. Productivity of potato varieties photosynthesis depending on the mineral nutrition level, 2013-2016

TABLE II. INFLUENCE OF THE MINERAL NUTRITION LEVEL ON THE RESISTANCE OF POTATO VARIETIES TO DISEASES, 2013-2016

Variety	NPK on yield, t / ha	Resistance (points) to:			
		phytophthora	Virus disease	Brown patch	scab
Alyona	Control, no fertilizers	5	5	7	7
	30	5	5	7	7
	40	5	7	7	5
	50	3	7	5	5
	60	3	9	5	3
Severny	Control, no fertilizers	7	7	7	9
	30	5	9	7	7
	40	5	9	7	7
	50	5	9	7	7
	60	5	9	7	7

In the fertilized variants, both varieties formed a well-developed above-ground plant mass to the flowering phase (Figure 3). In the control variant, in the Alyona variety, the above-ground mass of one plant was 594 g, or 27.9 t / ha, and in the Severny variety, 638 g and 29.9 t / ha, respectively. In the variants with an increase in the level of mineral nutrition, the weight of the above-ground part of one plant increases to 1082 g in the Alyona variety and to 1264 g in the Severny variety.

A close positive relationship was established between the above-ground mass of plants and yield ($r = + 0.81-0.86$), between yield and leaf area ($r = + 0.77-0.84$), between yield and photosynthesis productivity ($r = + 0.89-0.93$).

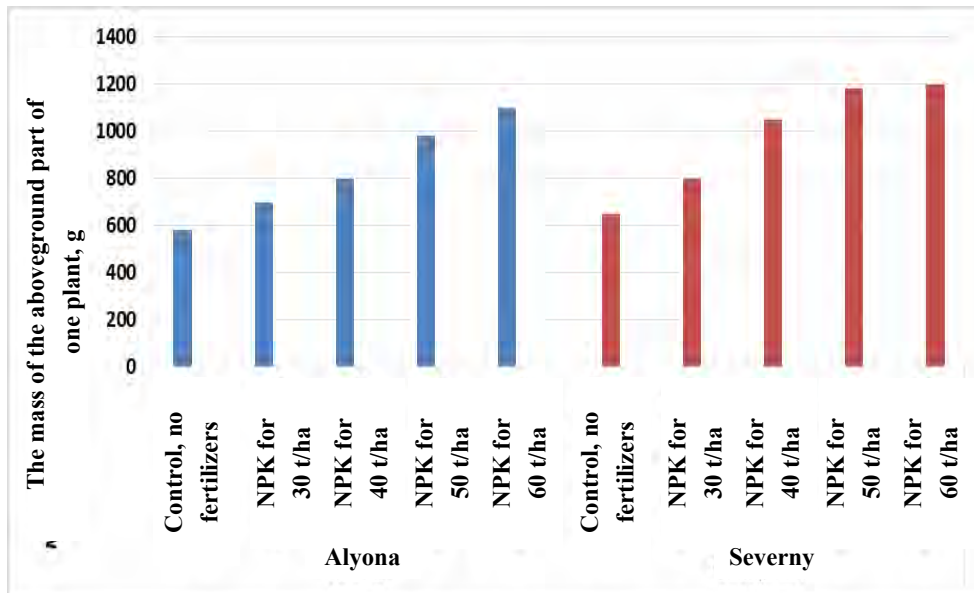


Fig. 3. The mass of the aboveground part of one plant in the flowering phase, depending on the mineral nutrition level, 2013-2016

The main economic characteristic of a potato variety is the yield [1, 3]. In production conditions it varies from 15.8 to 49.3 t / ha. In recent years, the average yield of the crop in the Tyumen region was 22-24 t / ha. Registered varieties react

differently to the use of mineral fertilizers. Studied early potato varieties Alyona and Severny positively responded to the increase in the level of mineral nutrition (Table 3).

TABLE III. DEPENDANCE OF THE PRODUCTIVITY OF THE EARLY POTATOES ON QUANTITY OF MINERAL FERTILIZERS, 2013-2015

Variety	NPK on yield, t / ha	Yield, t/ha				In relation to control, ±	
		2013	2014	2015	average	t/ha	%
Alyona	Control. no fertilizers	23.7	26.2	20.5	23.4	-	100
	30	26.9	30.4	28.1	28.5	+5.1	21,8
	40	35.3	38.6	36.9	36.9	+13.5	57,0
	50	47.0	49.1	50.7	48.9	+25.5	108,9
	60	52.4	55.2	53.5	53.7	+30.3	129,4
Severny	Control. no fertilizers	25.0	26.7	23.1	24.9	-	100
	30	28.3	31.0	27.8	29.0	+4.1	16,4
	40	37.9	38.6	39.4	38.6	+13.7	55,0
	50	48.5	52.0	48.6	49.7	+24.8	99,6
	60	56.2	59.5	57.3	57.6	+32.7	131,3
HCP ₀₅		2.3	1.9	2.6	-	-	-

Analysis of the data in Table 3 allows us to say that, in the control variant, with the natural nutritional background, the yield was 23.4 and 24.9 t / ha, respectively. The use of mineral fertilizers for the planned yield increased it in the Alyona variety by 5.1 - 30.3 t / ha, and in the Severny variety - by 4.1-32.7 t / ha. Moreover, in the variant Alyona, in the variant for the planned yield of 60 t / ha, 53.7 t / ha was obtained, and in the Severny variety - 57.6 t / ha. The latter variety has a higher yield potential.

With the transition to the market, great attention was paid to the quality of tubers [7]. At the same time, the appearance

should be combined with high biochemical indices: dry matter, starch, vitamin “C”. The studied potato varieties are practically not inferior to the varieties of foreign selection for all the noted characteristics.

The quality of tubers is controlled at the genetic level, although the growing conditions also influence its manifestation. The effect of mineral nutrition on the quality of early varieties of Alyona and Severny can be judged from the data in Table 4.

TABLE IV. INFLUENCE OF THE MINERAL NUTRITION LEVEL ON THE QUALITY OF THE TUBERS OF EARLY POTATO VARIETIES, 2013-2016

Variety	NPK on yield, t/ha	Substance quantity, %					Nitrates, mg/100 g of a tuber
		Dry matter	Starch	protein	sugar	vitamin «C», mg/%	
Alyona	Control. no fertilizers	23.1	16.2	1.93	0.38	16.4	136
	30	24.0	16.9	1.87	0.41	16.9	152
	40	24.8	17.4	1.81	0.39	17.5	180
	50	23.2	16.3	1.76	0.44	17.8	209
	60	22.1	15.6	1.72	0.42	18.3	237
Severny	Control. no fertilizers	21.0	14.8	2.06	0.50	17.1	164
	30	23.2	16.3	1.98	0.54	17.6	191
	40	22.4	15.7	1.94	0.61	18.2	226
	50	21.2	14.9	1.86	0.59	18.9	248
	60	20.3	14.2	1.83	0.63	19.3	262
HCP ₀₅		1,2	0,9	0,07	0,05	0,16	19

Analysing the data in Table 4 it follows that the content of dry matter and starch in the tubers of the studied potato varieties increases to a yield level of 40 t / ha. With a further increase in yield, the marked indicators of the quality of tubers decrease. With an increase in yield, the protein content of sugar, vitamin “C”, on the contrary, decreases, the nitrate content increases.

It is important not only to get a high yield of potatoes, but also to keep it in winter. The storage of potato tubers is influenced by many factors: the variety, the conditions of its cultivation, the technology of preparing the tubers for storage and during storage. The studied potato varieties reacted differently to the level of mineral nutrition, both during the growth and development of plants and during storage of tubers (Figure 4).

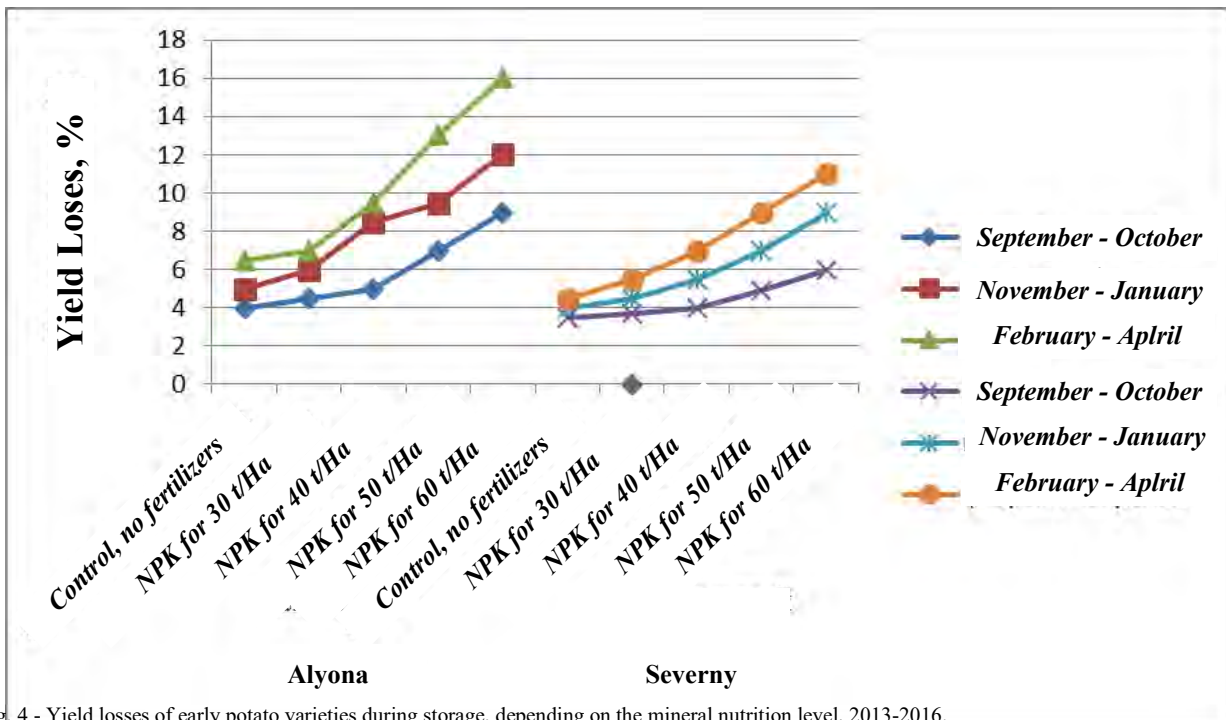


Fig. 4 - Yield losses of early potato varieties during storage, depending on the mineral nutrition level, 2013-2016.

From the data of Figure 4, it can be seen that with both potato varieties, the yield loss during winter storage increases with increasing levels of mineral nutrition. In the variant for the planned yield of 60 t / ha for the Alyona variety, the yield loss by the end of storage was 16.5%, for the Northern variety - 8.7%. With all the experienced variants, the harvest of the North variety was preserved better compared to the Alyona variety.

Considering the yield and quality of the studied potato varieties tubers, it is economically advantageous to apply

mineral fertilizers for a yield of 30-40 t / ha. In this case, the level of profitability was 86 and 104%, respectively, for comparison in the control variant - 54-59%. A further increase in the level of mineral nutrition in the cultivation of early ripe potato varieties Alyona and Severny is not economically viable.

IV. CONCLUSION

Potato varieties Alyona and Severny positively respond to the introduction of mineral fertilizers. Economically viable

options for the planned yield of 30 and 40 t / ha. This yield is connected with high quality tubers. The level of profitability of these options was 86-104%, while the control level was 54-59%. A further increase in the level of mineral nutrition leads to a decrease in the quality of tubers and economic efficiency.

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