

Research Article

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Yield, Quantity of Stems and Photosynthetic Activity of Early-Ripe Potato Variety

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ABSTRACT

The assimilation surface and the number of stems per hectare are the main factors affecting the yield of potatoes. Field experiments were conducted in a private sector within the central zone of the Perm Territory during 2001-2003. The weather conditions of vegetation periods differed by their heterogeneity during the years of research. The vegetation period of 2001 was characterized as warm and dry, which adversely affected the yield of potatoes. The purpose of the research is the yield of 30 t/ha of early ripe potato variety Zhukovsky early in different weather conditions during the growing season, was achieved in the variants with the planting mass of 30-50 g and the sowing rate of 71.4 thousand, 50-80 g at 40.8 thousand, 80-100 g at 35.7 thousand tubers/ha. This means that small planting tubers with the weight 30-50 g have fewer viable eyes and, accordingly, fewer stems.

Keywords: potatoes, yield, density, leaf area, photosynthetic potential, net productivity of photosynthesis.

INTRODUCTION.

The assimilation surface and the number of stems per hectare are the main factors affecting the yield of potatoes. Therefore, when they establish the rate of planting, it is necessary to rely not on the number of tubers per 1 ha, but on the number of stems [1, 2]. The weight and quantitative method of setting the rate of planting do not make it possible to use the entire harvest for planting. These methods do not take into account the biological characteristics of seed tubers of different weight. Thus, the planting norms are too high, which leads to the overspending of planting material or to a shortage of crops because of sowing sparsity. According to many scientists [3, 4, 5], large tubers of 100 g and more productive than small

30 g ones give more stems and, accordingly, higher assimilation surface, but they fully reveal their potential on highly fertile soils with high moisture provision. Other authors [6] believe that large-tuber plantings and their harvests are more affected by viral diseases than shallow ones. Therefore, it is more rational to use medium-sized potato tubers for planting. There are different opinions of scientists not only on the mass of planting tubers, but also on the number of the optimal number of stems per hectare. Most scientists recommend [7, 8] to create potato plantings for optimal yield - 150-200 thousand stalks / ha. Others [9, 10, 11, 12] recommend 200-300 thousand stalks / ha.

Thus, scientists do not have clear recommendations concerning planting tuber weight, planting rate and, moreover, the rate of planting with the tubers of different size should take into account the achievement of optimal stalk density per unit area, since it was established that seed tubers of different mass form different number of stems in the bush and different areas of leaves.

METHODS.

Field experiments were conducted in a private sector within the central zone of the Perm Territory during 2001-2003. The purpose of the research is to improve the techniques of early ripe potato variety Zhukovsky early cultivation, which ensure the yields at the level of 30 t/ha. Two-factor field experiment was performed on sod-podzolic light loamy soil with low humus content of 2%, a weakly acidic medium ($\text{pH}_{\text{KLC}} - 5.4$), a high phosphorus content and elevated potassium content. The scheme of the experiment is presented in Table 1. The repetition of the experiment is fourfold, the experiment was laid down by the method of split plots, the location of the options in the experiment is systematic, the estimated plot area is 18 m² [13]. The test agrotechnology is generally accepted for the Perm region. Sideral steam was the precursor. Fertilizers were applied in NPK dose: 122: 133: 180 kg of active ingredient per 1 ha. The planting was carried out manually according to the experiment design, into crests of 0.7 m wide, and potato reproduction was elite. Harvesting was done by potato digging when leaves started to become yellow. The weather conditions of vegetation periods differed by their heterogeneity during the years of research. The vegetation period of 2001 was characterized as warm and dry, which adversely affected the yield of potatoes. The weather conditions of 2002 were more favorable for the growth and the development of early ripe potato varieties. The weather was warm and moderate with plenty of rain. In 2003, the beginning of the growing season was favorable for the growth and the development of potatoes, but during the period of intensive tuber

formation the weather was hot and dry, which adversely affected the yield of potatoes.

RESULTS.

The purpose of the research is the yield of 30 t/ha for early ripe potato variety Zhukovsky Early was achieved in the variants with the planting tuber weight of 30-50 g and the thickening of 71.4 thousand tubers, 50-80 g - with the thickening of 40.8 thousand tubers, 80-100 g - with the thickening of 35.7 thousand tubers (Table 1). The thickening limit for different weights of planting tubers differed from each other. Thus, small tubers did not increase the yield over the planting rate of 47.6 thousand tubers (the yield in this variant was 28.6 t/ha, $\text{HCP}_{05} = 3.9$ t/ha), medium and large planting tubers more than the planting rate of 35.7 thousand tubers/ha, the yield of 28.5 and 31.8 t/ha, respectively.

Table 1 - The yield of potato varieties Zhukovsky early, depending on the rate of planting and the mass of planting tubers, t/ha. Average for 2001-2003

Planting rate, thousand tubers/ha (B)	Planting tuber weight, g (A)			Average by factor B
	A ₁ 30-50	A ₂ 50-80	A ₃ 80-100	
B ₁ (35,7)	24.8	28.5	31.8	28.4
B ₂ (40,8)	24.4	30.3	31.9	28.9
B ₃ (47,6)	28.6	31.3	31.0	30.3
B ₄ (57,1)	28.4	30.9	31.5	30.3
B ₅ (71,4)	32.5	31.8	32.2	32.2
Average by	27.7	30.6	31.7	-
NCP ₀₅ of private	According to		8.7	
	According to		3.9	
NCP ₀₅ of main effects	According to		3.8	
	According to		2.3	

The main effects by the mass of planting tubers revealed a significant increase of yield by 4.0 t/ha ($\text{HCP}_{05} = 3.8$ t/ha) for large tubers as compared to small ones. The main effects on the rate of planting revealed the tendency of potato yield increase from 28.4 to 32.2 t/ha from the sparsest 35.7 to the densest planting rate of 71.4 thousand tubers/ha.

The working hypothesis of our research was the assumption that with the same stem of an early

ripe potato variety, seed tubers of any mass will provide the same yield with the right placement. On the average, during 3 years of research, in order to achieve optimal yields, small tubers formed 149 thousand stalks/ha and 47.6 thousand tubers thickened, and the maximum yield of 32.5 t/ha (Table 1) was formed at 206.2 thousand stalks/hectare (tab. 2). Average seed tubers with an optimal thickening of 35.7 thousand formed 131.3 thousand stalks/ha, and with the yield of 30 t/ha - from 157 to 293 thousand stalks. Large tubers formed 164.7 thousand stems to achieve an optimal yield of

31.8 t/ha. The increase of the number of stems to 325 thousand/ha did not increase the yield of early ripe potato varieties. It was noted that small tubers have 14% fewer eyes on a tuber, 5.6 pcs, as compared to large ones - 6.5 pcs., but almost the same as the average tubers - 5.9 pcs. However, the ratio of stems to ocelli in small tubers is 11% less in comparison with medium ones and 15% less in comparison with large ones. This means that small tubers with the weight of 30-50 g have less viable ocelli and fewer stems subsequently.

Table 2 - Stalk stand density development of potato variety Zhukovsky early. Average for 2001-2003

Variant	Planted tubers, Thous./ha	Average number of eyes on a tuber, pcs.	Number of bushes for harvesting, thous./ha	Number of stems		Stalk/eye ratio, %	
				Pcs per 1 bush	thous./ha		
A ₁	B ₁	35.7	5,6	35.3	3.2	111.7	57
	B ₂	40.8		40.5	3.1	124.2	55
	B ₃	47.6		45.8	3.2	149.0	57
	B ₄	57.1		54	3.3	176.8	59
	B ₅	71.4		66.1	3.2	206.2	57
	Average by A ₁			-	3.2	153.6	57
A ₂	B ₁	35.7	5,9	34.6	3.8	131.3	64
	B ₂	40.8		40.6	3.9	157.3	66
	B ₃	47.6		46.4	3.9	182.5	66
	B ₄	57.1		56.3	3.9	222.0	66
	B ₅	71.4		68.0	4.3	292.6	73
	Average by A ₂			-	4.0	197.1	68
A ₃	B ₁	35.7	6,5	35.6	4.6	164.7	71
	B ₂	40.8		40.7	4.9	201.5	75
	B ₃	47.6		47.3	4.5	212.3	69
	B ₄	57,1		57.0	4.9	282.7	75
	B ₅	71.4		69.1	4.7	324.7	72
	Average by A ₃			-	4.7	237.2	72

It has been established that the increase of modern potato variety yields is associated with the photosynthetic potential increase and the outflow of photosynthesis products into tubers. In this case, the best results are achieved during the plantings with optimal leaf areas [14, 15].

The leaf area during the period of maximum development in the optimum yield variants (Table 3) makes 30.9 thous. m²/ha for small tubers, 24.1 thous. m²/ha for average ones, and 25.3 thous. m²/ha for large ones. The maximum yield of 32.5 t/ha for small tubers was achieved with the maximum leaf area of 37.6 thousand m²/ha. Medium and large tubers of 30 t/ha were formed at the leaf area of about 25-26 thousand m²/ha. The leaf area growth to 35-38 thousand m²/ha did not increase the yield of potato tubers of Zhukovsky early variety.

Table 3 - Photosynthetic activity of potato variety "Zhukovsky early". Average for 2001-2003

Variant	Planted tubers,	Leaf area		PSP, Thous. m ² × day	PPF, kg/1000 m ² ×
		For one plant,	Thous. m ² /ha		

		Thous./ha	cm ²		/ha	day/ha
A ₁	B ₁	35.7	4329	23.0	1019	25
	B ₂	40.8	5209	29.1	1176	22
	B ₃	47.6	4950	30.9	1313	23
	B ₄	57.1	4570	33.1	1440	19
	B ₅	71.4	4163	37.6	1623	20
	Average by A ₁			4644	30.7	1314
A ₂	B ₁	35.7	4743	24.1	1119	25
	B ₂	40.8	4485	26.1	1275	24
	B ₃	47.6	4609	30.0	1419	23
	B ₄	57.1	3989	31.6	1551	21
	B ₅	71.4	3729	35.0	1730	19
	Average by A ₂			4311	29.4	1419
A ₃	B ₁	35.7	5098	25.3	1253	27
	B ₂	40.8	5323	29.7	1459	22
	B ₃	47.6	5007	32.5	1564	20
	B ₄	57.1	4306	34.7	1695	19
	B ₅	71.4	3818	37.9	1832	17
	Average by A ₃			4710	32.0	1561

A similar situation with the photosynthetic potential (PSP), the yield of 30 t/ha and more was formed at the PSP of small tubers making 1623 thousand m² × day/ha, average - 1275, large - 1253 thousand m² × day/ha.

On the average, according to the variants, the productivity of photosynthesis (PPF) is almost the same for different planting tubers with the weight of 21-22 kg/1000 m² × day/ha. There is the tendency that the photosynthesis productivity in all planting tubers decreases with thickening.

CONCLUSIONS.

The purpose of the research is the yield of 30 t/ha of early ripe potato variety Zhukovsky early in different weather conditions during the growing season, was achieved in the variants with the planting mass of 30-50 g and the sowing rate of 71.4 thousand, 50-80 g at 40.8 thousand, 80-100 g at 35.7 thousand tubers/ha. The limits of small tuber thickening is 47.6 thousand, medium and large ones - 35.7 thousand tubers/ha. To achieve the goal, small tubers need to form 200 thousand stalks/ha, medium and large planting tubers - about 160 thousand stalks. At the same time, the leaf area of small tubers makes 38 thousand m²/ha (PSP is 1623 thousand m² × days/ha), and medium

and large ones are about 26 thousand m²/ha (PSP makes 1275-1253 thousand m² × days/ha, respectively). The net productivity of photosynthesis is almost the same in terms of options and does not depend on the mass of planting tubers 21-22 kg / 1000 m² × day / ha. It is noted that small planting tubers are 14% less than the eyes on the tuber as compared to large ones and the same with medium ones, but the ratio of stems to ocelli is smaller for small tubers by 11% as compared to medium ones and 15% as compared to large planting tubers. This means that small planting tubers with the weight 30-50 g have fewer viable eyes and, accordingly, fewer stems.

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