



The effect of planting rate and weight of seed tubers on yield and stem-forming ability of mid-season potato variety

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Abstract

The article presents the yield of mid-season potato of the Lugovskoi variety, depending on the tuber planting rate and weight. The objective of the research is the adjustment of techniques in the cultivation of a mid-season potato variety with a yield of 30 t/ha. The experiment was conducted on a farm in the Middle Urals region in 2001-2003. The soil of the experimental plot is sod-podzolic, light loamy with a low humus content, with slightly acidic reaction, a high content of phosphorus and medium potassium. Weather conditions during the years of research were contrasting and affected potato productivity in different ways. The planned yield was achieved in small seed tubers with a thickening of 47.6 thousand, medium and large 35.7 thousand tubers/ha. To achieve the goal, small tubers formed 137.7 thousand stems, medium tubers - 146.5 thousand stems, and large tubers - 181.1 thousand stems.

Keywords: potato, yield, planting rate, stems, leaf surface area

Introduction

In modern potato farming, researchers recommend using medium-sized tubers (50-80 g) for planting. However, in the yielding years, the question arises of using large tubers for planting, and in unfavorable years - small ones. According to scientists [1, 2], tubers weighing 100 g are more productive, with earlier productivity. However, the full potential of large tubers is revealed on fertile soils with good moisture supply [3, 4]. They form a bush with a powerful root system and a developed leaf surface, better absorb moisture, and nutrients. Large tubers form a bush with a large number of stems [6, 7]. The increased stem-forming ability is associated with a larger surface of a large tuber and a larger number of buds on it [8]. Other scientists believe [9] that increased tuber weight plays an important role in the initial stages of growth, and then turn into an inhibitory factor in photosynthesis. The lack of organic matter in small tubers is further compensated by the increased intensity of photosynthesis. There is an opinion [10] that there is no difference in the size of the seed material, but there is a difference in how many buds can grow and how many of them will further become stems. The same number of stems is able to give the same yield [11, 12]. It was found that the optimal potato yield for different ripeness groups was obtained with a stem density of 200 thousand stems/ha [13]. Thus, when calculating the planting rate, we should consider the optimal number of stems for harvesting and use it for tubers of different sizes.

Methods

The studies were conducted on a farm in the central zone of the Middle Urals in 2001-2003. The goal of the experiment was the adjustment of techniques in cultivation of mid-season potato of the Lugovskoi variety yielding 30 tons/ha. A two-factor field experiment was carried out on sod-podzolic light loamy soil with a low humus content of 1.7%, a slightly acidic reaction (pH_{KLC}-5.2), a high phosphorus

content of 266 mg/kg and an average potassium concentration of 140 mg/kg. The experimental design is presented in Table 1. The experiment was carried out in quadruplicate using the split plots method, the arrangement of the variants is systematic, the accounting area of the second plot is 18 m² [14]. The agricultural technique used in the experiment is generally accepted for the Middle Cis-Urals, apart from its predecessor - green manure (winter rye green manure). Mineral fertilizers were introduced at a dose of N₁₂₂P₁₃₃K₁₈₀ kg of active substance. Potato were planted manually according to the scheme of experience. Space width was 70 cm. Reproduction of Lugovskoi potato variety - elite. If the lower leaves went yellow, they were harvested with a continuous potato digger. The weather conditions of vegetation periods were contrasting and affected potato productivity in different ways. The weather conditions of 2001 were dry, 50% of precipitation of the average annual norm - 97 mm instead of 206 mm. The temperature was close to long-term average values. Lack of precipitation negatively affected the yield of mid-season potato varieties. The vegetation period of 2002 did not differ much from the average long-term indicators, which positively affected the yield of potato. The temperature on average during the growing season was 16°C, precipitation in June-August - 219 mm. The climatic conditions of 2003 were very contrasting and adversely affected potato yields. The average temperature of 17.3°C during the growing season was close to long-term average values, however 333 mm of precipitation fell, which is 60% higher than normal.

Results

On average for three years, the goal of the research - the yield of 30 t/ha of Lugovskoi mid-season potato variety was achieved in small (30-50 g) tubers with a thickening of 47.6 thousand planting tubers, medium (50-80 g), and large (80-100 g) 35.7 thousand tubers (Table 1).

Table 1: The yield of Lugovskoi mid-season potato variety, depending on the planting rate and the mass of the planting tuber, t/ha. Average for 2001-2003

Planting rate, thousand tubers/ha (factor B)	Tuber weight, g (factor A)			Planting rate average
	A ₁ 30-50	A ₂ 50-80 (control)	A ₃ 80-100	
B ₁ (35.7)	26.6	32.4	34.0	31.0
B ₂ (40.8)	29.6	33.4	36.0	33.0
B ₃ (47.6) (control)	30.7	34.7	35.5	33.6
B ₄ (57.1)	32.5	36.5	36.2	35.1
B ₅ (71.4)	32.9	36.1	37.1	35.4
Seed tuber weight average	30.4	34.6	35.8	-
HCP ₀₅ of particular differences	by tuber weight			4.3
	by planting rate			3.1
HCP ₀₅ of major effects	by tuber weight			1.9
	by planting rate			1.8

Further thickening up to 71.4 thousand in these variants did not cause a significant increase in productivity (HCP₀₅ = 3.1 t/ha). However, there is a tendency to increase yields by 3.1–4.1 t/ha with an increase in thickening from 35.7 to 71.4 thousand tubers in medium and large tubers, but only between the extreme experimental variants.

The major effects on the weight of seed tubers revealed a significant decrease in yield of 4.2 t/ha in small tubers compared with the control - average tubers (HCP₀₅ = 1.9 t/ha). The main effects on the planting rate did not reveal a significant increase in yield when seedlings were thickened more than 40.8 thousand (HCP₀₅ = 1.8 t/ha). Similarly, with partial differences in the planting rate, there was a tendency to increase yields by 2.1-2.4 t/ha with thickening from 40.8 to 71.4 thousand tubers, but a significant difference in yield was only between the extreme variants.

The photosynthetic surface and the number of stems per 1 ha are the main factors in the structure of crops, affecting

yield. Therefore, when determining the planting rate, the key role should be played not by the number of planting tubers per 1 ha, but by the number of stems. Accordingly, for planting, it is necessary to prepare seed material with a maximum number of sprouts that will ensure full-fledged stems.

On average, over three years of research, small tubers yielded 30 t/ha at 137.7 thousand stems in the control variant with a planting rate of 47.6 thousand tubers (Table 2). An increase in the number of stems to 206.0 thousand in the variant with the maximum planting rate ensured a yield of 32.9 t/ha (Table 1), however this yield was the same with a yield of 30.7 t/ha and density of 137.7 thousand stems. On average, small planting tubers had 5.2 buds per seed tuber, which formed 3.1 stems per bush, and the stem/bud ratio was 59%.

Table 2: The stem density of Lugovskoi potato. Average for 2001-2003

Variant	Tubers planted thousand pcs/ha	Average number of buds per tuber, pcs.	Number of bushes to be harvested, thousand pcs/ha	Number of stems		Stem/bud ratio, %	
				pcs per bush	Thousand pcs/ha		
A ₁	B ₁	35.7	5.2	34.5	3.2	111.5	62
	B ₂	40.8		39.8	2.9	114.5	56
	B ₃	47.6		45.6	3.0	137.7	58
	B ₄	57.1		53.8	3.1	163.4	60
	B ₅	71.4		66.7	3.1	206.0	60
	average for A ₁				-	3.1	146.6
A ₂	B ₁	35.7-	5.3	34.9	4.2	146.5	79
	B ₂	40.8		39.8	4.2	165.5	79
	B ₃	47.6		46.2	4.0	183.1	75
	B ₄	57.1		54.5	3.8	206.4	72
	B ₅	71.4		67.9	3.9	263.2	74
	average for A ₂				-	4.0	192.9
A ₃	B ₁	35.7	6.6	34.9	5.2	181.1	79
	B ₂	40.8		40.2	4.7	188.3	71
	B ₃	47.6		46.0	4.9	225.3	74
	B ₄	57.1		54.7	4.6	252.4	70
	B ₅	71.4		68.2	4.7	314.7	71
	average for A ₃				-	4.8	232.4

The medium seed tubers yielded 32.4 t/ha with a stem density of 146.5 thousand in the variant with a planting rate of 35.7 thousand. The increase in the stem density up to 263.2 thousand in the variant with the maximum planting rate, the potato yield of 36.1 t/ha was the same with the yield of 36.5 t/ha obtained with the stem density of 206.4 thousand in the variant with a planting rate of 57.1 thousand. The medium seed tubers had 5.3 buds, which was

almost the same with small tubers, but already formed 4 stems per bush, and the stem/bud ratio was higher - 76%.

Large seed tubers already had 6.6 buds per tuber and formed an average of 4.8 stems per bush, which allowed to form 181.1 thousand stems per ha and get a yield of 34.0 t/ha in the variant with a minimum planting rate of 35.7 thousand. Similarly, with medium tubers, an increase in the stem number to 314.7 thousand stems provided the maximum

yield in the experiment of 37.1 t/ha, however this yield was the same with the yield of 34.0 t/ha ($HCP_{05} = 3.1$ t/ha) obtained with a stem density of 181.1 thousand.

Scientists ^[15] believe that the process of photosynthesis is fundamental in plant nutrition. All other processes, such as mineral nutrition, soil, water, are needed and effective to the extent that they improve the results of photosynthesis. The

formation of crops capable of using the energy of photosynthetically active radiation with a minimum efficiency is the key factor in increasing the yield of potato. The planned yield of 30 t/ha and more was achieved with a leaf area of 21.7-22.5 thousand m^2/ha during the period of maximum plant development (Table 3).

Table 3: Leaf surface area, photosynthetic potential and net photosynthetic productivity of Lugovskoi potato. Average for 2001-2003

Variant	Tubers planted thousand pcs/ha	Leaf surface area		PSP, thousand $m^2 \times day/ha$	NPSP, kg/1000 $m^2 \times day/ha$	
		per plant, cm^2	thousand m^2/ha			
A ₁	B ₁	35.7	6123	19.4	1163	23
	B ₂	40.8	5843	21.5	1278	23
	B ₃	47.6	5442	22.3	1351	23
	B ₄	57.1	4947	24.4	1483	22
	B ₅	71.4	4621	27.8	1691	20
	average for A ₁		5395	23.1	1393	22
A ₂	B ₁	35.7	6530	21.7	1265	26
	B ₂	40.8	6220	23.8	1391	24
	B ₃	47.6	5996	26.1	1521	23
	B ₄	57.1	5424	28.6	1663	22
	B ₅	71.4	4845	31.1	1844	20
	average for A ₂		5803	26.3	1537	23
A ₃	B ₁	35.7	6873	22.5	1344	26
	B ₂	40.8	6633	24.9	1518	24
	B ₃	47.6	6148	26.4	1627	22
	B ₄	57.1	5947	30.1	1858	20
	B ₅	71.4	5085	30.9	1970	19
	average for A ₃		6137	27.0	1663	22

The yield-best variants of small tuber plants formed a slightly smaller leaf surface area per plant equal to 5442 cm^2 than medium tubers - 6530 cm^2 , and large tubers - 6873 cm^2 . However, due to the denser planting of 47.6 thousand, the leaf surface area of 22.3 thousand m^2 was the same as in the medium tubers - 21.7 thousand m^2 , and large tubers - 22.5 thousand m^2 . The photosynthetic potential at the end of the growing season in small tubers was 1351 thousand $m^2 \times day/ha$, slightly higher than in the medium tubers - 1265 thousand $m^2 \times day/ha$, and large tubers - 1344 thousand $m^2 \times day/ha$. Net photosynthetic productivity of small tubers was 23 kg/1000 $m^2 \times day/ha$, which is lower than in medium and large seed tubers.

Summary

On average for three years, the goal of the research - the yield of 30 t/ha of Lugovskoi mid-season potato variety was achieved in small (30-50 g) tubers with a thickening of 47.6 thousand planting tubers, medium (50-80 g), and large (80-100 g) 35.7 thousand tubers. To achieve the goal, small tubers formed 137.7 thousand stems, medium tubers formed 146.5 thousand stems, and large tubers formed 181.1 thousand stems. The leaf surface area was practically the same - 21.7 thousand m^2 ; the photosynthetic potential at the end of the growing season in small tubers was 1351 thousand $m^2 \times day/ha$, slightly higher than in the medium tubers - 1265 thousand $m^2 \times day/ha$, and large tubers - 1344 thousand $m^2 \times day/ha$. Net photosynthetic productivity of small tubers was 23 kg/1000 $m^2 \times day/ha$, which is lower than in medium and large seed tubers.

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