

THE INFLUENCE OF THE TUBER SIZE ON YIELD AND OTHER PRODUCTIVITY FEATURES OF POTATOS

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INTRODUCTION

Potato is a leading agricultural culture in Montenegro. According to planted areas and the level of realized returns, the northern part of Montenegro, Niksic region in particular, is one of the most important production regions of this important agricultural crop.

However, despite favorable agro-ecological conditions, average potato yields are still low (around 15 t / ha). The main reasons for this low yield are certainly extensive cultivation systems, the use of inadequate planting material, improper selection and poor implementation of agricultural measures (production without irrigation), adverse impact of agro-ecological factors (high summer temperatures and rainfall deficit), periodic epi-phytotic attacks of late blight, as well as other reasons (Jovovic et al., 2008, Milosevic et al., 2004).

The size of planted tuber and density of planting potatoes, which means the optimum number of primary shoots per unit ground area, is a very important element of the technological process of potatoes production to which special attention has to be given, in order to achieve high yields.

The yield of potatoes, number of primary stems and their height, size of assimilation surface and total organic production depends significantly on the size of planted tuber. Size of potato tuber, especially share of fraction in the total yield depends not only on the fraction of seeds planted, but also on the variety, level of applied agro-technology, agro-ecological conditions of production and so on. (Ilin and Sabados, 1995, Ilin et al., 2000).

The aim of this paper was to examine the effect of the size of planting materials and planting density on yield of potatoes and some other parameters of productivity in the agro-ecological conditions of Northern Montenegro.

MATERIAL AND METHODS

Studying the impact of the size of seedlings and planting density on yield and other parameters of potatoes productivity were done during 2008 and 2009 in Zupa (around Niksic), on acid brown soil (Table 1), at altitude of about 800 m. The experiment was performed in a completely randomized block design, in 4 replications. The surface of an elementary plot was 21 m². The main processing, preparation before planting and fertilization of soil was carried out as standard for seed potatoes. Protection of crops from weeds and pests causing illness was performed in a timely manner.

Table 1. Chemical characteristics of acid-brown soil on experiment field

Depth (cm)	pH		Ca CO ₃	Humus	Soluble mg/100 g	
	H ₂ O	nKCl	%	%	P ₂ O ₅	K ₂ O
0-40	5,68	4,68	0,23	4,59	8,6	32,74

Kennebec variety was tested with 4 different sizes of planting materials: 28-35 mm (F1), 35-45 mm (F2), 45-55 mm (F3) and > 55 mm (F4). Due to different size of seedlings, the number of primary stems per m² (ps/m²) was taken as a basis for planning of planting density. Most authors consider that the optimal number of primary shoots per m² of mercantile production is 15-20, so in our case, we decided for 18 ps/m² (Table 2).

Determining the number of primary stems and their height was carried out under a full flowering of potatoes.

A few days before extraction of the potatoes, sampling was carried out, by taking 10 boxes of potatoes by repetition, after that a complete biometric analysis of the number, size and weight of Tuber was made.

Table 2. Plant density in the experiment

Fraction	Row distance (cm)	Distance in a row (cm)	Size of the vegetation area (m ²)	Number of plants / ha	Planned stem number / tuber	Planned primary stem number / ha
28-35 mm	70	20	0.14	71429	2.5	178500
35-45 mm	70	28	0.20	51020	3.5	178500
45-55 mm	70	32	0.22	44643	4	178500
>55 mm	70	40	0.28	35714	5	178500

Extraction of potato was carried out after full maturation of vegetation mass, and then the total yield per hectare was calculated, according to theoretical categories of the density of crops.

All the data were statistically processed. Meteorological data during the experiments are shown in Table 3.

Table 3. Meteorological conditions during the experiment

Year	Month				Average
	May	June	July	August	
Air temperature(°C)					
2008	14.9	19.6	22.0	23.0	19.9
2009	17.0	18.2	21.8	22.3	19.8
Amount of rainfall (mm)					
2008	81	86	18	40	225
2009	73	158	81	51	363

RESULTS AND DISCUSSIONS

Tuber size and density of planting of potatoes, which means the optimum number of primary stems per unit ground area (ps/m²), is a very important characteristic (Georgiakakis et al., 1997; Karafyllidis et al., 1997) and is a very interesting problem for further research. To achieve high yields it is necessary to provide enough lush ground mass and its activity in the long run, thus the protection of crops from diseases and pests in that sense is of utmost importance. On the other hand, too much growth of the ground mass is at the expense of the tuber growth. In the two-year average, the highest number of ground stems (Table 4) were obtained by the potato plants in the variant when tuber fraction bigger than 55 mm - 5.2 ps/plant were planted, while the least primary stems - 3.1 were found in the variant which was planted with the

potato fraction 28-35 mm. The difference in the number of primary stems between these treatments was evaluated as statistically very significant.

Potato growth and development primarily depends on sorts, agro-ecological conditions during the vegetation period, as well as on agricultural measures carried out. Stem height varies in sorts of different vegetation length: late maturing and medium maturing sorts are characterized by increased stem height and a larger number of ankles in comparison with early maturing sorts. Complex of conditions in the mountainous region has a refraining impact on some characteristics of potato. At higher altitudes, under conditions of relatively lower temperature for growth and development of ground mass, all varieties of potatoes generally have lower primary stems (Momirovic et al., 2000).

Table 4. Number of primary stems and their height depending on applied variant in the experiment

Parameter	Year	Size of planted tuber			
		28-35 mm	35-45 mm	45-55 mm	> 55 mm
Number of primary stems per plant	2008	2.8	3.8	4.8	5.5
	2009	3.4	3.7	4.6	4.9
	Aver.	3.1	3.8	4.7	5.2
Stem height (cm)	2008	38	40	38	44
	2009	47	51	55	63
	Aver.	42.5	45.5	46.5	53.5

	2008		2009		2008-09	
	LSD _{0.05}	LSD _{0.01}	LSD _{0.05}	LSD _{0.01}	LSD _{0.05}	LSD _{0.01}
Number of primary stems	2.334	3.228	0.904	1.250	0.707	0.977
Primary Stem height	-	-	7.196	9.952	5.074	7.017

Analysis of variance of the average height of the primary stem showed statistically significant difference between treatments with the application of largest fraction (53.5 cm) and variations on which Tuber size 28-35 and 35-45 mm (42.5 and 45.5 cm) were planted. The results of studying the impact of the size of tubers and planting density on yield of potatoes and other productivity parameters are shown in Table 5. During the two-year study, the highest average number of tuber per plant was obtained

under the influence of the largest fraction - 7.2, slightly smaller by planting tuber size 45-55 mm - 6.6, while the least tubers were found on the plot where the smallest tuber (28-35 mm) - 3.5 was planted. Differences in the average number of tubers among all studied fractions and 28-35 mm fractions are indicated as very important. The differences between the average number of tuber between F4 and all other fractions are marked as very important.

Table 5. Potato yield depending on applied variant of the experiment

Year	Variant of the experiment	Average tuber number per plant	Tuber mass (g)	Yield (t/ha)
2008	F1 28-35 mm	3.4	95	19.1
	F2 35-45 mm	5.7	73	24.5
	F3 45-55 mm	6.4	74	27.7
	F4 > 55 mm	6.6	74	29
2009	F1 28-35 mm	3.5	139	28.5
	F2 35-45 mm	5.4	130	33.3
	F3 45-55 mm	6.8	124	34.2
	F4 > 55 mm	7.8	121	36.1
2008-2009	F1 28-35 mm	3.5	117	23.8
	F2 35-45 mm	5.6	102	28.9
	F3 45-55 mm	6.6	99	31
	F4 > 55 mm	7.2	98	32.6

	2008		2009		2008-09	
	LSD0.05	LSD0.01	LSD0.05	LSD0.01	LSD0.05	LSD0.01
Average tuber number	0.337	0.466	0.782	1.081	0.398	0.551
Average tuber mass	5.519	7.633	8.428	11.655	6.086	8.417
Yield	1.924	2.661	4.477	6.192	2.280	3.153

The average number of tubers significantly depends on the number of primary sprouts that are formed per one potato plant, which affects the average tuber production per plant and total yield per unit area. The total number of tuber grows when planting large fractions (45-55 and more than 55 mm), which confirmed the results of our research. By planting bigger fractions of planting material on larger row distance, bigger number of big tuber is obtained (Brocic et al., 2000).

From the measurement results it can be seen that the tuber with the highest average weight were obtained in the variant where the smallest fraction - 117 g was planted, while all other variants in this regard were very unified: F2 - 102, F3 - 99 and F4 - 98 g. Analysis of tuber average weight showed statistically highly significant differences between F1 and all other variants of the studied variants.

Size of tubers, as well as their number, depends on the number of sprouts that are formed by a plant, and if the number of primary sprouts is higher the number of formed tubers is higher, but not their masses and vice versa (Bugarcic, 2000,

Butorac and Bolf, 2000, Jovovic, 2002). The results are in favor of this statement.

The highest overall tuber yield was measured on the variant F4 - 32.6 t/ha, and the variants F3 and F2 - 31 and 28.9 t/ha. The lowest tuber yield was found in the variant F1 - 23.8 t/ha. The differences in yield between variants F4, F3 and F2 and variant F1 are indicated as statistically very important. Statistically highly significant deviations in yields were obtained by comparing variants F4 and F2.

The highest stem, the average tuber weight and the overall yield were measured in the year 2009, which is explained by the fact that the year was wetter, and by the fact that it also had a more favorable distribution of rainfall. Hence, in the year 2009, 363 mm fell during the vegetation period of potato, while in the same period in the year 2008, 225 mm of water deposits were registered. Bearing in mind that the year 2008 was very hot and dry

(Table 3) and that the experiment was carried out in conditions of dry farming, the results are quite expected.

Water consumption is low in the early stages of potato development, later the need for water increases, so that the lack of water in the critical stages of growth and development significantly reduces the yield. In both years studied, the potato plants had relatively favorable conditions in the phase of emergence and tuberization which can be seen in the number of initiated tubers (Kennebec variant forms a relatively small number of tubers). In later stages (intensive growth and soaking of tuber), in the year 2009, weather conditions were much better thus soaking of initiated tubers, and the overall yields were significantly better. According to Vos & Groenwold (1988) reduction of the yield of potatoes during the dry period is 117 kg / ha for each mm of rainfall deficit, which was confirmed in these researches.

CONCLUSIONS

Based on the results of two-year study of the impact of the size of planting material on yield and other components of potatoes yield in mountainous conditions of Montenegro, in conditions of dry farming, the following can be concluded:

1. The largest number of above ground stem was obtained by planting tuber fraction larger than 55 mm - 5.2 ps /plant.
2. The greatest average height of the primary stem was obtained by planting largest fraction - 53.5 cm, while the minimum was obtained by planting small tubers - 42.5 cm.
3. The largest number of tubers per plant - 7.2, was determined on the variation on which tubers greater than 55 mm were planted.
4. Tubers with the largest average weight were obtained on an experimental variant where the smallest tubers - 117 g were planted.
5. The highest tuber yield was measured on the variation with the application of fractions larger than 55 mm - 32.6 t/ha, while the smallest yield was obtained on the variant with the fraction 28-35 mm - 23.8 t/ha.

ABSTRACT

This paper presents the results of the two-year study of the impact of the size of the planting material on yield and other productive features of the potato around Niksic (Zupa).

The highest yield was obtained in experiments by planting potatoes' large fraction (> 55 mm) - 32,6 t / ha, while the smallest was measured in plots where a small fraction was planted (28-35 mm) - 23.8 t / ha.

All tested fractions of plant material, compared to the fraction 28-35 mm, gave significantly higher yields of tuber.

28-35 mm fraction potatoes gave the largest average tuber (117 g) and differences established in comparison with other variants are marked very important. Number of primary potato shoots, as well as their height grew as size of tuber planted increased.

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