

A STUDY OF THE EFFECT OF ORGANIC AND CONVENTIONAL CULTIVATION ON THE POTATO YIELD

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ABSTRACT:

Potato is one of the most expanded vegetable crops, and it is one of the most important agri-food products in the world and our country, too. Because of its high reproductive potential and ability to achieve high yield, the potato has taken a very high position among vegetable crops. The goal of this study was to show differences in the rates of crop performance, comparing six potato varieties organically and conventionally cultivated. The potato varieties are Adora, Jaerla, Agria, Desiree, Kennebec and Triplo. Depending on the regime of cultivation, more specifically on the treatments unique to the cultivated regime, different varieties have achieved different yields, and with a precise weighing mass, values for each variety have been determined. Different measurements have been carried out on the visually smallest tubers, visually biggest tubers, and total potato yield for each variety.

KEYWORDS: potato, yield, organic growing, conventional growing

INTRODUCTION

The potato (lat. *Solanum tuberosum*) is the most widespread tuberous crop in the world and the fourth largest vegetable crop in terms of fresh products, after rice, wheat and corn [1]. The potato belongs to the nightshade family, *Solanaceae*. It is an annual, dicotyledonous plant in terms of its vegetative and flowering habits, but can be considered perennial in terms of its ability to be reproduced by tubers [2]. The potato has a significant capacity for adaptation. Potato production systems show differences in different countries and regions within the same country, depending on climatic and soil conditions and socio-economic structure [3]. Potato is an intensive crop that requires a large investment of labour, which is of special interest for economically underdeveloped areas because by focusing on this production, significant surpluses of living human labour can be absorbed. Nothing less important is the large consumption of material necessary for the production of potatoes, and especially large amounts of mineral and organic fertilizers and seed planting material [4]. To achieve a high yield of potatoes, a large amount of nutrients is needed [5-7]. The presence of nitrogen up to 180 kg / ha has a positive effect on potato yield, but also market-sized tubers [8]. However, the use of nitrogen in large quantities is not acceptable from an agronomic, ecological or economic point of view [9]. Potato is a plant that removes large amounts of

minerals from the soil and therefore has significantly higher requirements in terms of fertilization (compared to other field crops). The highest yield is achieved by a combination of organic and mineral fertilizers. The most important organic fertilizers are manure, slurry and green manure, which provide higher yields and improve the structure and physico-chemical properties of the soil and enhance microbiological activity in the soil. Manure fertilization is performed in autumn before autumn-winter tillage in the amount of 30 to 35 t/ha. Mineral nutrients are crucial for the growth and development of potato plants [10]. Although tuber growth is influenced by many elements, mineral fertilization is based on the intake of three basic macro elements: N, P and K. Each variety, but also the technological purpose of potatoes (early to late harvest), has special requirements in terms of fertilization [11].

MATERIALS AND METHODS

The experiment was conducted at the fields of "Milo Selo" farm in Lukavac, in 2018.

Using the farm's resources, production was organized in two separate regimes, as follows:

- Organic (plot 1) and
- Conventional (plot 2).

Two separate cultivation regimes are marked with the numbers "1" – organic cultivation and "2" – conventional cultivation. The experimental part of this

work was performed on the mentioned plots, and the subject of cultivation was six different varieties of potatoes. The cultivated varieties of potatoes are Adora, Jaerla, Agria, Desiree, Kennebec and Triplo. The plots on which potatoes were grown had similar exposures, soil structure and fertility as well as soil pH. The subjects of monitoring were two rows, both of them ten meters long, for each variety in both cultivation regimes.

Seed potatoes

Seed potatoes were bought in March and April of 2018. Tubers of the varieties Desiree, Agria, Adora, Triplo and Kennebec were cut in two in the period from 13th to 15th of March and left in a dark place at a temperature of 15 °C for germination until planting, and tubers of the variety Jaerla were cut the same day as they were planted.

Organic and mineral fertilizers

The following organic fertilizers were used on plot 1: stallatico (pelleted organic fertilizer), amixol (L-amino acids of plant origin in liquid form), slavol (liquid microbiological fertilizer), and diamond-grow (liquid fertilizer from *Ascoum* seaweed species).

The following synthetic fertilizers were used on plot 2: N: P: K - 15:15:15 (complex mineral fertilizer) and KAN (nitrogen mineral fertilizer). Mature sheep manure (pre-sowing soil preparation) was applied to both plots.

Organic and mineral fertilizers for plant protection

The following organic agents were used on plot 1: ozoneem (organic liquid insecticide - contains active substances from tropical neem tree seeds), kraken (biological insecticide containing *Bacillus thuringiensis*). The following synthetic agents were used on plot 2: cadillac (preventive contact fungicide from the Dithiocarbamate group), calypso (systemic insecticide), mospilan (systemic insecticide).

Soil and plants treatments during cultivation

On plot 1, the application of mature sheep manure in the amount of approximately 20 t was performed in March 2018, after which tillage and milling of the plot were performed as pre-sowing preparations. Planting of potatoes in mechanically open rows was done at the beginning of the second decade of April 2018, when the application of pelleted fertilizer in the amount of 115 kg was also done. The weather conditions at the time of planting were extremely favourable, and the air temperature measured at the time of planting was

18 °C. Potatoes were planted manually, with a distance of 40 cm in a row to a depth of 5 cm. The plot has an area of 0.2 ha.

On plot 2, the application of mature sheep manure in the amount of approximately 24 t was performed in March 2018, after which tillage and milling of the plot were performed as pre-sowing preparations. The potatoes were planted at the same time as on plot 1 under the same weather conditions, and the mineral fertilizer N: P: K - 15:15:15 was applied in the amount of 225 kg. Potatoes were planted manually, with a distance of 40 cm in a row to a depth of 5 cm. The plot has an area of 0.25 ha.

During cultivation, we applied organic means and fertilizers for protection and fertilization on plot 1, while on plot 2 we applied synthetic means and fertilizers for protection and fertilization, according to the manufacturer's instructions.

Tuber weight measurement

Measurement of the mass of extracted tubers was performed with a digital scale CAS XE 1 500, and the total yield for each variety was measured with a digital scale Straus - 350 kg. Ten visually smallest tubers and ten visually largest tubers were measured for each variety in both cultivation regimes, and the total yield height for each variety was measured. We entered the results in the table, after which the yield height was compared, depending on the type of cultivation regime.

RESULTS AND DISCUSSION

Table 1 shows the average values of weights (g) of the visually smallest tubers of all cultivars obtained by measuring ten samples for each variety in organic (1) and conventional (2) cultivation.

Table 1. Average values of masses (g) of visually smallest tubers

Variety	Tubers' mass (g) 1	Tubers' mass (g) 2
Adora	2.24	2.84
Jaerla	2.21	9.85
Agria	4.31	3.06
Desiree	2.25	2.76
Kennebec	2.82	2.75
Triplo	3.95	2.98

Statistical data processing was performed using ANOVA Test and the processing results are shown in the following tables:

Table 2. Statistical data processing

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3.477633333	1	3.477633	0.772984	0.399929	4.964603
Within Groups	44.98973333	10	4.498973			
Total	48.46736667	11				

Table 3. Statistical data processing

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	17.71836667	5	3.543673	0.691471	0.648743	4.387374
Within Groups	30.749	6	5.124833			
Total	48.46736667	11				

Since $p \gg 0.05$ there is no statistically significant difference between the observed parameters, from that there is no relationship between the masses of the visually smallest potato tubers.

The average weight of the smallest samples of tubers for the Adora variety in the organic regime was 2.24 g, while the average weight of the smallest samples of tubers for the same variety in the conventional regime was 2.84 g. The Adora variety cultivated in the conventional regime had an average of 26.78% higher mass of visually smallest tubers compared to the organic regime.

The average weight of the smallest samples of tubers for the Jaerla variety in the organic regime was 2.21 g, while the average weight of the smallest samples of tubers for the same variety in the conventional regime was 9.85 g. The Jaerla variety cultivated in the conventional regime had an average of 345.7% higher mass of visually smallest tubers compared to the organic regime.

The average weight of the smallest samples of tubers for the Agria variety in the organic regime was 4.31 g, while the average weight of the smallest samples of tubers for the same variety in the conventional regime was 3.06 g. The Agria variety cultivated in the conventional regime had an average of 29% less mass of visually smallest tubers compared to the organic regime.

The average weight of the smallest tuber samples for the Desiree variety in the organic regime was 2.25 g, while the average weight of the smallest tuber samples for the same variety in the conventional regime was 2.76 g. The Desiree variety cultivated in the conventional regime had an average of 22.66%

higher mass of visually smallest tubers compared to the organic regime.

The average weight of the smallest tuber samples for the Kennebec variety in the organic regime was 2.82 g, while the average weight of the smallest tuber samples for the same variety in the conventional regime was 2.75 g. The Kennebec variety cultivated in the conventional regime had an average of 2.48% less mass of visually smallest tubers compared to the organic regime.

The average weight of the smallest samples of tubers for the variety Triplo in the organic regime was 3.95 g, while the average weight of the smallest samples of tubers for the same variety in the conventional regime was 2.98 g. The variety Triplo cultivated in the conventional regime had an average of 24.55% less mass of visually smallest tubers compared to the organic regime.

Table 4 shows the average values of the masses (g) of the visually largest tubers of all cultivars obtained by measuring ten samples for each cultivar in organic (1) and conventional (2) cultivation.

Table 4. Average values of masses (g) of visually largest tubers

Variety	Tubers' mass (g) 1	Tubers' mass (g) 2
Adora	298.77	329.14
Jaerla	316.00	320.75
Agria	404.86	397.49
Desiree	336.50	449.67
Kennebec	225.15	454.40
Triplo	560.48	398.58

Statistical data processing was performed using ANOVA Test and the processing results are shown in the following tables:

Table 5. Statistical data processing

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	461,1685	5	8043,837	1,042693	0,470836	4,387374
Within Groups	11,28125	6	7714,486			
Total	86506,10589	11				

Table 6. Statistical data processing

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3614,699408	1	3614,699	0,436076	0,523941	4,964603
Within Groups	82891,40648	10	8289,141			
Total	86506,10589	11				

Since $p \gg 0.05$ in both cases there is no statistically significant difference between the observed parameters, from that there is no relationship between the masses of the visually largest potato tubers.

The average weight of the largest samples of tubers for the Adora variety in the organic regime was 298.77 g, while the average weight of the largest samples of tubers for the same variety in the conventional regime was 329.14 g. The Adora variety cultivated in the conventional regime had an average of 10.16% higher mass of visually largest tubers compared to the organic regime.

The average weight of the largest samples of tubers for the Jaerla variety in the organic regime was 316 g, while the average weight of the largest samples of tubers for the same variety in the conventional regime was 320.75 g. The Jaerla variety cultivated in the conventional regime had an average of 1.5% higher mass of visually largest tubers compared to the organic regime.

The average weight of the largest samples of tubers for Agria variety in the organic regime was 404.86 g, while the average weight of the largest tuber samples for the same variety in the conventional regime was 397.49 g. The Agria variety cultivated in the conventional regime had an average of 1.82% less mass of visually largest tubers compared to the organic regime.

The average weight of the largest samples of tubers for the variety Desiree in the organic regime was 336.5 g, while the average weight of the largest samples of tubers for the same variety in the conventional regime was 449.67 g. The variety Desiree cultivated in the conventional regime had an average of 33.63% higher mass of visually largest tubers compared to the organic regime.

The average weight of the largest samples of tubers for the Kennebec variety in the organic regime was 225.15 g, while the average weight of the largest samples of tubers for the same variety in the conventional regime was 454.4 g. The Kennebec variety cultivated in the conventional regime had an average of 101.82% higher mass of visually largest tubers compared to the organic regime.

The average weight of the largest samples of tubers for the variety Triplo in the organic regime was 560.48 g, while the average weight of the largest samples of tubers for the same variety in the conventional regime was 398.58 g, 28.88% less mass of visually largest tubers compared to the organic regime.

Table 7 shows the total yields of extracted tubers for all cultivated varieties in organic (1) and conventional (2) cultivation regime.

Table 7. Total yield of extracted tubers (kg)

Variety	Total yield (kg) 1	Total yield (kg) 2
Adora	15.15	32.6
Jaerla	31.4	29
Agria	15.14	32
Desiree	24.5	28.7
Kennebec	11.23	27.3
Triplo	18.2	24

Based on the measurement results, it was concluded that all varieties except the Jaerla variety achieved higher yields in the conventional cultivation regime compared to the organic cultivation regime.

The Adora variety grown in the conventional regime had a 115.18% higher yield compared to the yield in the organic cultivation regime. The cultivar Agria cultivated in the conventional regime had a 111.36% higher yield compared to the yield in the organic cultivation regime.

The variety Desiree grown in the conventional regime had a 17.14% higher yield compared to the yield in the organic cultivation regime. The variety Triplo cultivated in the conventional regime had a 31.86% higher yield compared to the yield in the organic cultivation regime. The Kennebec variety grown in the conventional regime had a 143.09% higher yield compared to the yield in the organic cultivation regime. The Jaerla variety cultivated in the conventional regime had a 7.64% lower yield compared to the yield in the organic cultivation regime.

In a study conducted by Hamouz et al. (2005), the yield of six different potato varieties in the conventional regime was 60.173% higher than in the organic regime in the amount of 37 t / ha, while in the organic regime it was 23.1 t/ha [12]. Jarvan et al. in a study in 2007 state that the yield of Laura potatoes in the conventional regime was 188.728% higher than in the organic cultivation regime and amounted to 29.97 t / ha, while in the organic regime (organic I) it was 10.38 t/ha [13].

To sum up, in this experiment, the Jaerla variety proved to be the most favourable for cultivation in the organic cultivation regime, while the Kennebec variety found the largest difference in yield in two different cultivation regimes, 143.09% in favour of the conventional regime.

CONCLUSION

The use of synthetic fertilizers and pesticides in potato cultivation, in addition to harmful effects in

relation to organic cultivation, has its advantages which can be seen in the results of this experiment, the yield depending on agro ecological conditions, agrotechnics and potato varieties. The yield of the same varieties cultivated in different regimes and measured in this experiment, varied greatly depending on the treatments. So, it can be concluded that the Kennebec variety had the largest percentage difference in the amount of yield in favour of conventional cultivation. All cultivated varieties except Jaerla achieved higher yields in conventional cultivation. The only exception is the Jaerla variety, which achieved a higher yield in organic cultivation, 7.64% higher than the conventional one.

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