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RESEARCH ON THE INFLUENCE OF PROCAINE TREATMENT ON POTATO PRODUCTION AND QUALITY

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Abstract

The response of agricultural crops to the application of biostimulators depends on the climatic conditions, the type of soil and cultivated variety. While knowing the role of biostimulators on the growth and development of crops, as well as on quantitative and qualitative increases in the scientific field, the aim of this research is to follow the influence of procaine treatments on the level of production and quality of two potato varieties (Armonia and Gared), depending on planting density (55 X 10^3 and 70 X 10^3 tubers/ha). The tubers were treated with procaine by immersion, for two hours, prior to planting, in a 10 mg/l solution. The research was carried out in the period 2019-2022, in the pedoclimatic conditions of the Almaj Depression, on a semi carbonate eutric alluvial type soil, located in the meadow area, with loamy-sandy texture, slightly alkaline soil reaction, pH 7.67, and a medium humus content (2.72%). The researched area has a moderate continental temperate climate, with Mediterranean and oceanic influences, which give a special nuance to the depression, with multiannual average of atmospheric precipitation varying between 670-750 mm. Fertilization of the crop was achieved by incorporating under ploughing 25 t/ha of manure and 600 kg/ha of 15:15:15 complex fertilizers. The results obtained highlight the positive effect of the treatment with procaine on the tubers before planting, on average on the two tested varieties and the two densities, expressed in production increases of 7%.

Key words*: procaine, potato variety, crop planting density.*

INTRODUCTION

Due to its nutritious properties and tastiness, potatoes are used as a basic food in the diet of many peoples (Bende, 1991).

To meet the increasing demand for food products due to the rapid growth of the population, there is a need for sustainable, ecologically safe agricultural systems that can only be achieved through the application of innovative technological solutions (Marshall, 2015; Clark & Tilman, 2017; Jones, 2018; Gonçalves, 2021).

Among these innovative solutions, a common practice is the use of biostimulants, in order to stimulate physiological processes, the absorption of nutritional elements and increase resistance to water stress (Gu et al., 2014; du Jardin, 2015; Craggs, 2017).

The studies carried out so far present the beneficial effects of stimulating the tubers before planting depending on the climatic conditions, the type of soil, the cultivated variety (Cachita and Ardelean, 1996; Berindei 1995; 1996; 1998). Procaine treatments were initiated based on the favorable effect reported by Cachita and Ardelean (1996).

Thus, in the experiments carried out by Cachita and her team by treating the tubers for two hours (by immersion) prior to planting with procaine 10 mg/l, a 13% yield increase was obtained. The same authors mention that in Tisem, Satu Mare County, by treating the tubers with procaine 10 mg/l, the plants grew in height by approx. 12 cm, and the production increased by 10.7% when unsprouted potatoes were used for planting and by 31.3% when sprouted tubers were used for planting.

In Brașov, by bathing the tubers with 10 mg/l, bathing for two hours, they determined a stimulation of plant growth, namely the number of stems and their height increased by 14%, the surface of the leaves increased by 4%, and the number of large tubers was increased by 8.46%.

MATERIALS AND METHODS

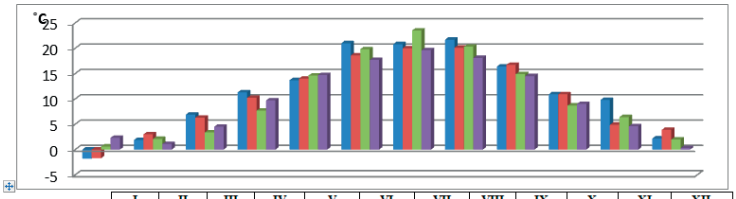
The research was carried out in the period 2019-2022, in the pedoclimatic conditions of the Almaj Depression, on a semicarbonate eutric alluvial soil, located in the meadow area, with loamy-sandy texture, slightly alkaline soil reaction, pH 7.67, and the humus content is medium (2.72%).

The researched area, according to the data recorded at the Bozovici Meteorological Station, belongs to the temperate continental climate, with Mediterranean and oceanic influences, which give a special nuance to the depression, the multiannual average of atmospheric precipitation varying between 670-750 mm (Figures 1 and 2).

In order to follow the effect of the treatment with procaine, a trifactorial experiment was organized, according to the method of subdivided plots with three repetitions, with the following gradations of the factors:

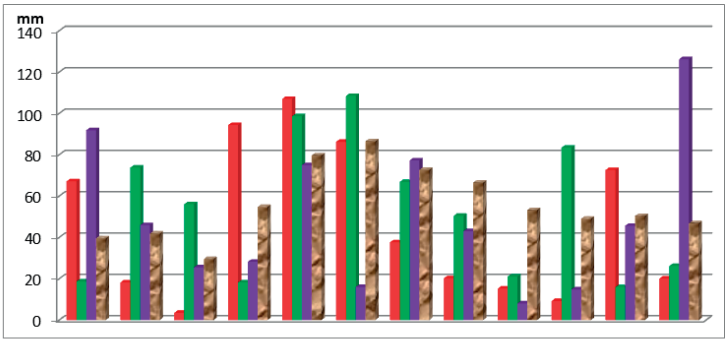
- factor A - the cultivated variety, with two grades: of1 - Harmony; of2 - Garage;
- factor B - treatment of tubers with procaine: b1 - untreated; b2 - treaty;
- factor C - plant density: c1 - 55000 tubers/ha; c2 - 70000 tubers/ha.

The biological material used in the experiment was the varieties Armonia and Gared from the group of late varieties.



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2019	-1,8	1,9	6,9	11,3	13,7	21,0	20,8	21,7	16,4	10,9	9,8	2,2
2020	-1,7	3,0	6,3	10,2	14,0	18,6	20,0	20,1	16,7	10,9	4,9	3,9
2021	0,6	2,1	3,4	7,7	14,6	19,8	23,5	20,3	14,9	8,7	6,4	2,0
Temperaturi multianuale	2,3	1,1	4,5	9,7	14,7	17,7	19,6	18,1	14,5	9,0	4,6	0,3

Figure 1. Monthly average temperatures recorded at Bozovici meteorological station in the period 2019-2021, compared with multiannual values



	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*	*XII*
2019	*67,1*	*18,2*	*3,5*	*94,4*	*107,0*	*86,2*	*37,6*	*20,2*	*15,2*	*9,2*	*72,6*	*20,1*
2020	*18,6*	*73,7*	*56,0*	*18,2*	*98,6*	*108,4*	*66,8*	*50,4*	*21,0*	*83,4*	*15,9*	*26,1*
2021	*91,8*	*45,9*	*25,5*	*28,2*	*75,0*	*16,0*	*77,2*	*43,0*	*8,0*	*14,8*	*45,6*	*126,2*
Temperaturi multianuale	*39,5*	*41,8*	*29,5*	*54,7*	*79,6*	*86,5*	*72,7*	*66,5*	*53,2*	*49,0*	*50,3*	*46,8*

Figure 2. Monthly precipitation recorded at Bozovici meteorological station in the period 2019-2021, compared with multiannual values

Soil work consisted of autumn plowing at a depth of 28-30 cm. Land preparation in the spring consisted of a disc harrow work and a combine work before planting. Planting was done in the last decade of March. The tubers were treated with procaine by immersion, for two hours, prior to planting, in a 10 mg/l solution. Fertilization of the crop was achieved by incorporating under the basic plowing 25 t/ha of manure and 600 kg/ha of complex fertilizers of the 15:15:15 type.

Herbicide was carried out with Dual Gold 960 EC 1 (S-metolaclor 960 g/l) l/ha + Sencor 600 SC (Metribuzin 600 g/l), 1 l/ha. The vegetation was treated against diseases and pests. Harvesting was done at the time the tubers matured, when the pods were dry, the tubers were easily detached from the stolons, and the peel was suberified.

RESULTS AND DISCUSSIONS

Table 1. shows the harvests obtained in the 2019-2022 experimental cycle.

It is found that on the set of factors b and c, respectively the treatment of the tubers and the planting density of the GARED variety, an 11% higher yield was obtained than the yield recorded with the ARMONIA variety. The yield difference of 4,465 kg/ha was statistically assured as distinctly significant.

The treatment with procaine applied to the tubers, on average for the two varieties and the two densities, increased the yield by 7%. The yield difference of 2,705 kg/ha was statistically assured as very significant.

The increase in yield in the variants treated with procaine is lower than that reported in other research carried out in different experiences in the country. The explanation can be found in the fact that they worked with other varieties and in other pedoclimatic conditions, compared to those in which carried out the respective research, which entitles us to the conclusion that the varieties react differently to this treatment.

By increasing the density from 55,000 to 70,000 tubers per hectare, an average increase of 3% was obtained, respectively a distinctly significant difference in yield of 1367 kg/ha.

In the Armonia variety, at both planting densities (55,000 and respectively 70,000 tubers/ha), the treatment with procaine determined yield increases around 3000 kg/ha.

In the GARED variety, at a density of 55,000 tubers/ha in the version treated with procaine, yield increased by over 3,000 kg/ha, whereas at a density of 70,000 tubers/ha, the increase in yield in the treated version was only 1,000 kg/ha.

Table 2 shows the starch content. On average for the experimental factors, in the Gared variety the starch content was higher than the content recorded in the Armonia variety by 1.1%.

Table 1. Summary of production results

Factor A Variety	Factor B Treatment of tubers	Factor C – Planting density		Average factor A (varieties)			
		55000	70000	Crop (t/ha)	%	Difference (kg/ha)	Significance
Harmony	B1- Untreated	35621	40253	39560	100		
	B2 - Treated	39176	43191				
Garage	B1- Untreated	43162	42721	44025	111	4465	20th
	B2 - Treatedt	46479	43741				

DL 5% = 723 kg/ha; DL 1% = 1685 kg/ha; DL 0.1% = 4953 kg/ha

Average factor B Average factor C

Specification	50000	70000
Crop (kg/ha)	41109	42476
%	100	103
Difference (kg/ha)		1367
Significance		20th

Specification	B1- Untreated	B2 - Treated
Crop (kg/ha)	40439	43146
%	100	107
Difference (kg/ha)		2705
Significance		XXX

DL 5% = 575 kg/ha; DL 1% = 10210 kg/ha; DL 0.1% = 1723 kg/ha. DL 5% = 452 kg/ha; DL 1% = 763 kg/ha; DL 0.1% = 1121 kg/ha

Table 2. Starch content

Variety	Tubers not treated with procaine		Tubers treated with procaine		Average varieties
	55000	70000	55000	70000	
Harmony	15.2	15.3	14.7	14.9	15.02
Garage	16.45	16.4	16.05	15.95	16.01
Average of planting treatments and densities	15.82	15.85	15.37	15.42	
Influence of procaine treatment	15.83		15.39		

Increasing the density from 50,000 to 70,000 tubers per hectare did not differentiate the variants in terms of starch content.

Treating tubers with procaine led to a slight decrease in starch content, on average over the two experimental years, the two varieties and the two densities, by 0.44%.

In both varieties, starch production was higher in the variants with a density of 70,000 tubers/ha, compared to 55,000 plants/ha, a more obvious fact in the Armonia variety where the difference was 321 kg/ha, compared to the Gared variety, where the difference was only 101 kg/ha.

In the variants treated with procaine, starch production was 253 kg/ha higher, compared to the variant in which the tubers were not treated, before planting.

In conclusion, the highest amounts of starch per hectare are obtained in the Gared variety, when tubers treated with procaine are used for planting. The increase in density from 55,000 to 70,000 tubers/ha favorably influenced starch production, more evident in the Armonia variety, as a result of the increase in tuber production.

Table 3 shows starch production according to the factors studied. The production of starch in the Gared variety was superior to the production recorded in the Armonia variety by 1,182 kg/ha. This fact is explained both by the higher tuber production and by the higher starch content in the Gared variety. In both varieties, starch production was higher in the variants with a density of 70,000 tubers/ha, compared to 55,000 plants/ha, a more obvious fact in the Armonia variety where the difference was 321 kg/ha, compared to the Gared variety, where the difference was only 101 kg/ha.

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Table 4 shows the protein content of the two studied varieties (Armonia and Gared), depending on the planting density and Armonia, the protein content was higher than that determined in the Gared variety by 0.28%.

The density did not influence the protein content in the Armonia variety, but it was slightly higher at the density of 55,000, compared to the one of 70,000, in the Gared variety. Treating the tubers with procaine before planting favorably influenced the protein content by 0.2%.

Table 3. Starch production depending on variety, density and treatment with procaine

Variety	not treated with procaine		Tubers treated with procaine		Average varieties
	55000 tubers per hectare	70000 tubers per hectare	55000 tubers per hectare	70000 tubers per hectare	
Harmony	5258	5999	5609	6283	5787
Garage	6932	6834	7294	6816	6969
of planting treatments and densities	6095	6416	6451	6553	
Influence of procaine treatment	6255		6508		

Table 4. Protein content (%)

Variety	not treated with procaine		Tubers treated with procaine		Average varieties
	55000 tubers per hectare	70000 tubers per hectare	55000 tubers per hectare	70000 tubers per hectare	
Harmony	2.2	2.1	2.45	2.25	2.25
Garage	1.85	1.9	2.15	2.0	1.97
of planting treatments and densities	2.02	2.0	2,3	2.12	
Influence of procaine treatment	2.01		2.21		

The protein production is presented in Table 5. It is found that protein production was influenced by both protein content and tuber production.

Among the varieties, Armonia stands out, with protein production of 857 kg/ha, compared to 839 kg/ha recorded for the Gared variety.

By increasing the density from 55,000 to 70,000 tubers per hectare, protein production increased in tubers not treated with procaine from 769 kg/ha to 807 kg/ha. In the tubers treated with procaine before planting, the amount of protein was higher in the variants with the density of 55,000 tubers/ha. On average over the experimental cycle, the two varieties and the two planting densities, the amount of protein per hectare was higher in the variants in which the tubers used for planting were treated with procaine, by 120 kg/ha.

In conclusion, it can be found that the protein percentage and protein production was influenced by the variety, the annual climatic conditions and the procaine treatment performed on the tuber.

Table 5. Protein production by density and procaine tratment

Variety	not treated with procaine		Tubers treated with procaine		Average varieties
	55000 tubers per hectare	70000 tubers per hectare	55000 tubers per hectare	70000 tubers per hectare	
Harmony	759	823	934	915	857
Garage	779	792	931	854	839
of planting treatments and densities	769	807	932	884	
Influence of procaine treatment	788		908		

CONCLUSIONS

The research carried out in the 2019-2022 experimental cycle in the Bozovici Depression basin regarding the influence of planting density and procaine treatments carried out on the tubers on the harvest and its quality, in the Armonia and Gared potato varieties, revealed important conclusions from the point of view scientific and practical.

1. On the set of experimental factors, the production recorded in the Gared variety was higher by 11%, i.e. by over 4,000 kg/ha, compared to the one recorded in the Armonia variety.

2. Treating the tubers with procaine before planting increased the yield by 7% on average for the two varieties and two planting densities, returning a yield difference of over 2,700 kg/ha.

3. Increasing the density from 55,000 to 70,000 tubers/ha increased the yield of the Armonia variety by 11%.

In the Gared variety, by increasing the density from 55,000 to 70,000 tubers/ha, production decreased by 4%.

4. The starch content was higher in the Gared variety (16.21%), compared to the Armonia variety (15.02%).

5. Increasing the planting density from 55,000 to 70,000 tubers/ha did not obviously influence the starch content.
6. Treating tubers with procaine led to a slight decrease in starch content, on average over the two experimental years, the two densities and the two varieties by 0.44%,
7. The amount of starch per hectare was influenced by both the starch content and the tuber harvest. The highest amounts of starch/ha were obtained in the Gared variety, when tubers treated with procaine were used for planting. Increasing the density from 55,000 to 70,000 tubers/ha favorably influenced the production of starch in the more obvious variety Armonia as a result of the increase in the production of tubers.
8. The protein content was higher in the Armonia variety than that determined in the Gared variety, by 0.28%.
9. Treating the tubers with procaine, before planting, favorably influenced the protein content by 0.2%.
10. Protein production was influenced by both protein content and protein production.
11. Among the varieties, the Armonia variety stood out, with a protein production of 857 kg/ha, compared to 839 kg/ha for the Gared variety.
12. On average over the experimental cycle, the two varieties and the two planting densities, the amount of protein/ha was higher by 120 kg/ha in the variants in which the tubers used for planting were treated with procaine.

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