THE EFFECT OF BACTERIAL BIOPREPARATIONS ON THE PRODUCTIVITY OF PEPPER CULTIVATION IN THE PEDO-CLIMATE CONDITIONS OF THE RESEARCH-DEVELOPMENT STATION FOR VEGETABLES BUZĂU

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The present article has the role of presenting the results obtained within the pepper culture, on the SCDL Buzău lots. During the resort, an experiment was performed in which two types of biological fertilizers were tested simultaneously, in parallel with a chemical fertilizer, on an area of approx. 3 ha. Based on the experiments, certain parameters were established in order to highlight the effects of organic fertilizers on the culture of bell peppers and their contribution on the productivity and well-being of the aforementioned culture. After analyzing and interpreting the data (both standard-Excel program and statistical-program Anova) it was concluded that the activity of live bacterial cultures in the content of the two biological fertilizers led to a substantial increase in both secondary parameters and a increase in the most important parameter, namely agricultural productivity.

Keywords: increasing agricultural productivity, biological fertilization, live bacterial cultures.

INTRODUCTION

The use of fertilizer products in agricultural crops is a beneficial source of supplementing the nutrients needed for the growth and development of both plants and an increase in agricultural production. However, often the fertilizer doses applied per hectare to agricultural crops are not respected (Khalid *et al.*, 2009). Failure to comply with the applied fertilizer doses will lead to the occurrence of negative phenomena for soil, environment and agricultural crops, implicitly for human and animal health. Increasing the fertilizer doses per hectare and not respecting them will lead to the occurrence of soil acidification (Malusá și Vassilev, 2014). An acidic soil will lead to a deterioration of the active processes of the soil as well as of the beneficial fauna from its structure. Deterioration of soil fauna will lead to

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a decrease in bacterial colonies beneficial to the soil. This aspect will be a negative factor for the germination of seed material, for the growth and development of agricultural crops but especially for obtaining quantitative agricultural productions (Tejera *et al.*, 2005).

The decrease of the bacterial colonies in the soil will bring with it a decrease of the humification processes, of the decomposition and solubilization processes of the complex compounds in the soil as well as favoring the leaching and appearance of the complex compounds in the soil (in large quantities) (Ravikumar *et al.*, 2007). The increase of complex compounds in the soil will lead to a decrease in pH (below pH 7), which will lead to an increase in soil acidity. On acidic soil, crops will not reach their maximum potential in productivity (Ininbergs *et al.*, 2011).

In order to restore the beneficial flora of the soil, the processes carried out in the soil and to restore the amount of organic matter in the soil, agricultural specialists have proposed a number of emerging technologies for the negative effects that excess fertilization has brought with it. Specialists have proposed a new fertilization technology, namely the use of live biological fertilizers (live bacterial cultures or bacterial biopreparations) (Yang și Hoffman, 1984). These fertilizers are biodegradable so they are not a polluting factor for agricultural ecosystems. Bacterial culture combinations can be diverse.

They can be used both as fertilizers and as biological insecticides, insecticides or herbicides. Research in crops has shown that the use of bacteria as fertilizers and PPPs activates various mechanisms such as nutrient synthesis and the production of phytohormones that feed and support plants in the growth, development and productivity phases of the crop (Glick *et al.*, 2007). Another important process favored by the activity of bacterial cultures is the mobilization of soil compounds. This process involves an action of bacteria on insoluble compounds in the soil and their solubilization so as to ensure a balance of basic nutrients for plant food and support the basic processes of plants: photosynthesis and chemosynthesis (Fu *et al.*, 2010).

The use of bacterial biopreparation technologies in agricultural crops plays an important role in plant protection. Some bacterial cultures give plants a protection against pedo-climatic stress, a resistance to the attack of diseases and pests as well as conferring a protection on environmental factors (drought, heavy rainfall, cold, etc.). The use of these bacterial products as fertilizers as well as plant protection products has been shown to have great potential in growing, developing, maximizing agricultural production, in restoring and greening the soil and its beneficial flora, the role of these biological fertilizers being to address a green, sustainable, sustainable agriculture and achieving high, healthy, nutrient-rich productivity, beneficial to human and animal health (Revillas *et al.*, 2000).

The use of microorganisms as fertilizer and plant protection products in agricultural crops in Romania, has led to an increase in agricultural productivity of farmers, productions that represent a substantial profit for them. The mechanisms of action of microorganisms (PGPR mechanisms) are described in the following figure (Dweipayan *et al.*, 2016) (Figure 1):

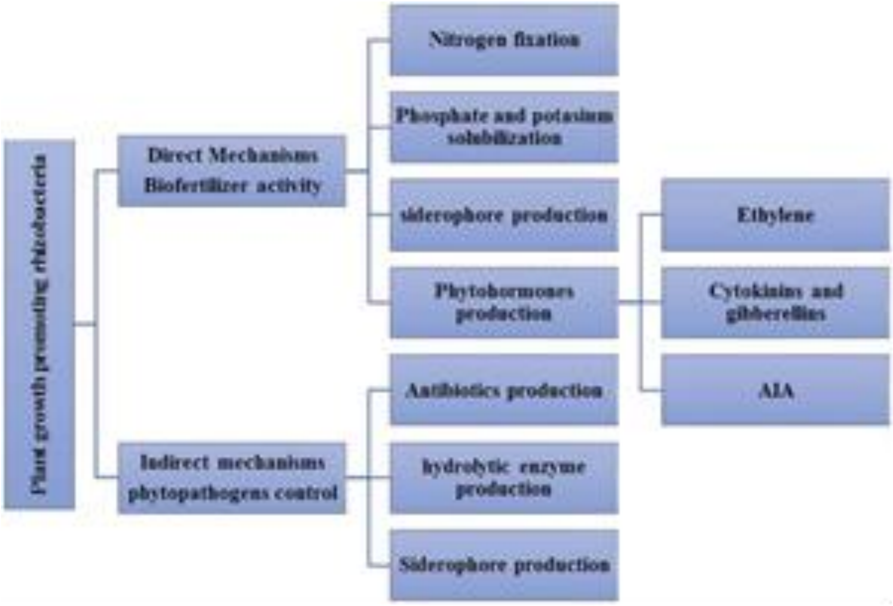

Figure 1. PGPR mechanisms of plants (Sansinenea, 2019)

Nitrogen is the basis of plant processes. The nitrogen cycle in plants is the essence in the processes of photosynthesis and chemosynthesis, this element being necessary in the formation of amino acids, proteins in order to grow and develop plants. The bacterial species used in biological fertilization products (bacterial biopreparations) contain atmospheric nitrogen-fixing microorganisms, the most representative species like *Azospirillum spp.*, *Azotobacter spp*. and *Bacillus spp*. (symbiotic bacteria associated with cereals and legumes), Frankia (actinorizale plants) (Ravikumar *et al.*, 2007; Ininbergs *et al.*, 2011).

MATERIAL AND METHODS

The research was carried out at Buzău Research-Development Station for Vegetable. At the research center, for the cultivation of peppers, the superior yellow variety, three lots were established:

V1- biologically fertilized lot 1-product fertilization Rom-Agrobiofertil NP (equal mix of live bacterial cultures of *Azotobacter chrooccum*, *Azospirillium lipoferum* and *Bacillus megaterium*),

V2- biologically fertilized lot 2- Azoter product (equal mix of live bacterial cultures of *Azotobacter chroococcum*, *Azospirillum brasilense*, *Bacillus megaterium* bacteria).

V3- chemically fertilized lot- product Complex NPK 16:16:16 (250kg / ha).

The experiment was performed in the period 2019–2020. The data obtained within the three batches were collected, statistically processed and, based on the results obtained from their modeling, the effectiveness of each product could be proven. The two biological fertilizer products, the chemical fertilizer product and the batches where these products were tested were used as working materials. Methods of observation, data collection, analysis, interpretation of data and methods of their dissemination were used as working methods.

RESULTS AND DISCUSSIONS

Following the pepper culture experiment, certain parameters were established to differentiate between the fertilizer products tested. Data interpretation was performed both by the Excel program (Table 1) and by the Anova statistical calculation program (Table 2), as follows:

Between the three lots there are differences between the established parameters, differences highlighted both between the two biologically fertilized lots and between the biologically fertilized lots and the chemically fertilized one. The most important parameter is crop productivity. Production showed a substantial increase of approx. 9.63% (V1 vs V2), 66.67% (V1 vs V3) and 52.03% (V2 vs V3). Based on these data, it was demonstrated that the effectiveness of bacterial cultures in the composition of biological fertilizers led to a substantial increase in pepper plants in the two biological groups.

Table 1

Results data parameters pepper culture (Excel program)

Objectives	Parameters			Differences			
	V1-Rom-Agro	V2-Azoter	V3-NPK	V1 vs V3	V1 vs V2	V2 vs V3	V2 vs V1
Plant height (cm)	46.33	49.33	45.22	2.45	-6.08	9.09	6.48
Plant diameter (cm)	44.89	42.67	39.89	12.53	5.20	6.97	-4.95
Number of leaves	142	120.11	108.11	31.35	18.22	11.10	-15.42
Leaf length (cm)	17.68	17.48	16.58	6.63	1.14	5.43	-1.13
Leaf width (cm)	6.88	7.08	6.89	-0.15	-2.82	2.76	2.91
Number buds	25.56	19.22	18.56	37.72	32.99	3.56	-24.80
Number of fruits	6.89	5.44	6.56	5.03	26.65	-17.07	-21.04
Number of flowers	7.78	5.44	6.33	22.91	43.01	-14.06	-30.08
Stem diameter (cm)	1.11	1.11	1.16	-4.31	0.00	-4.31	0.00
Total production (t / ha)	20.5	18.7	12.3	66.67	9.63	52.03	-8.78
		Azoter parameters> Rom-Agrobiofertil NP parameters					
		Rom-Agrobiofertil NP parameters> Azoter parameters					

Fig. 2. Differences between pepper plants, the upper yellow variety.
a. Rom-Agrofertil NP, b. Azoter, and c. NPK chemical fertilized plant.

Fig. 3. Superior yellow bell pepper plant (organic fertilized lot produced Rom-Agrobiofertil NP).

From the two figures we can see that the effect of bacterial cultures in the composition of the two biological fertilizers was much more beneficial than the effect of chemical fertilizer. This effect was visible both on the number of inflorescences on the plant but especially on the effect of bacterial cultures on agricultural production. At the same time, the experiments performed on the seed material (with the two biological fertilizers) showed that the bacteria in their content have the ability to produce enzymes and antioxidants (catalase, peroxidase, etc.) that have important roles in plant phenophases and plant protection. stress, acid rain, reactive oxygen (superoxide, hydrogen peroxide etc).

At the same time, in order to support the previous arguments, the statistical data from Excel were modeled with the help of a statistical program, namely Anova. Following the modeling of the data, it was proved that the effect of bacterial cultures was beneficial on agricultural productivity as well as on the amount of soil elements. After modeling the data through the Anova program, the following values were obtained:

Table 2

Results data parameters pepper culture (Anova program)

Anova: Two-Factor Without Replication						
SUMMARY	***Count***	***Sum***	***Average***	***Variance***		
Plant height (cm)	3	140.88	46.96	4.52		
Plant diameter (cm)	3	126.45	42.15	9.20		
Number of leaves	3	370.22	123.41	295.28		
Leaf lenght (cm)	3	51.74	17.25	0.34		
Leaf width (cm)	3	20.85	6.95	0.01		
Number buds	3	63.34	21.11	14.94		
Number of fruits	3	18.89	6.30	0.58		
Number of flowers	3	19.55	6.52	1.40		
Stem diameter (cm)	3	3.38	1.13	0.00		
Total production (t/ha)	3	51.5	17.17	18.57		
V1- Biologically fertilized lot 1 (Rom-Agrobiofertil NP fertilization product)	10	319.62	31.96	1739.18		
V2- Biologically fertilized lot 2 (Nitrogen fertilizer product)	10	286.58	28.66	1289.22		
Chemical fertilized lot (control lot - Complex 16:16:16 x 250 kg / ha)	10	260.6	26.06	1039.60		
ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Rows	36097.27	9	4010.81	140.27	8.3128	2.456281
Columns	175.00	2	87.50	3.06	0.071788	3.554557
Error	514.70	18	28.59			
Total	36786.97	29				

After the end of the harvesting campaign, as a result of the increase of the productivity of the pepper crop on the biologically fertilized lots, a series of soil samples were taken in order to carry out an agrochemical mapping. Due to the lack of funds, it was decided to take samples from the control group (chemical fertilizer) and biologically fertilized lot 1 with the fertilizer product Rom-Agrobiofertil NP. Following pedological analyzes in a reference laboratory, the following changes in soil structure were identified:

Table 3

Soil sampling mapping results (biologically fertilized lot 1 vs chemically fertilized lot)

Samples	**pH**	**Humus**	**Nt**	**P_{AL}**	**P_{AL}^1**	**K_{AL}**
Sample 1- control lot (chemical fertilization product Complex NPK 16:16:16)	8.04	2.59	0.191	562	275	460
Sample 1- biologically fertilized lot 2 (biological fertilization product Rom-Agrobiofertil NP)	8.01	2.59	0.185	570	287	404
Biological vs chemical differences	**-0.37**	**0.00%**	**-3.14%**	**1.42%**	**4.36%**	**-12.17%**
Sample 2- control lot (chemical fertilization product Complex NPK 16:16:16)	8.09	2.53	0.186	590	275	484
Sample 2- biologically fertilized lot 2 (biological fertilization product Rom-Agrobiofertil NP)	8.14	2.53	0.182	611	270	424
Biological vs chemical differences	**0.62%**	**0.00%**	**-2.15%**	**3.56%**	**-1.82%**	**-12.40%**
Sample 3- control lot (chemical fertilization product Complex NPK 16:16:16)	6.61	2.53	0.365	317	302	569
Sample 3- biologically fertilized lot 2 (biological fertilization product Rom-Agrobiofertil NP)	6.54	2.47	0.359	310	297	563
Biological vs chemical differences	**-1.06%**	**-2.37%**	**-1.64%**	**-2.21%**	**-1.66%**	**-1.05%**

CONCLUSIONS

The use of excess chemical fertilizers in agricultural crops has led to a deterioration of the soil flora and a decrease in crop yields. The replacement of chemical fertilizers with biological fertilizers, which identify live bacterial cultures, had the effect of restoring the flora damaged by the action of chemical fertilizers, increasing the parameters of agricultural crops, especially their productivity and the amount of mineral elements in the soil. The use of these biological fertilization products in Romanian agricultural crops was an important step for Romanian agriculture. At first, farmers were reluctant to use these products because they were and still depend on chemical fertilization. The application of these products in agricultural crops has allowed farmers to open a new horizon, a horizon that has led to their transition from a conventional agriculture to a sustainable, ecological, environmentally sustainable agriculture.

Replacing chemical fertilizers with organic fertilizers was a great advantage for farmers in Romania and beyond. The beneficial bacteria from the content of biological fertilizers ensured the restoration of the soil (following its degradation), its recolonization with beneficial bacteria as well as an increase and maximization of agricultural production and obtaining healthy crops with a much better quality. At the same time, these bacterial biopreparations have the effect of lowering the pH of the soil through various pH regulation mechanisms. The decrease of the soil pH is an important aspect because the lands affected by this phenomenon can be reintroduced in the crop production circuit, which for farmers will represent a larger area, which will bring a substantial profit for them.

Bacterial cultures also have the effect of greening the groundwater and breaking down complex compounds into soluble compounds, easily assimilated by plants. Bacterial cultures in the composition of organic fertilizer products increase the amount of protein elements in plants and, implicitly, in agricultural production. Thus, farmers will get a higher production, much richer in beneficial elements for human and animal health. The use of microorganisms in agricultural crops has led to a balance of soil electrolyte balance, balancing soil processes and the very fast and beneficial mediation of energy exchange between soil, environment and agricultural ecosystems. Another important aspect in the use of microorganisms in agriculture is their use as a treatment for seed material. Inoculation of the seed material in the three bacterial cultures from the Rom-Agrobiofertil NP product led to a much faster germination of the seed material, protection of the seeds from some pests in the soil and fixation of the planting material in the soil, a much better rooting and much better plant development in the soil.

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