Scientific Papers. Series A. Agronomy, Vol. LXV, No. 2, 2022
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

RESEARCH ON THE BEHAVIOR OF CORN CULTURE ON THE ACTION OF DIFFERENT TYPES OF FERTILIZERS (CHEMICAL VS. BIOLOGICAL)

George TOADER[1], Cătălin-Ioan ENEA[2], Daniela TRIFAN[3], Leonard ILIE[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania
[2]Agricultural Research and Development Station Suceava, 15 1 Mai Blvd, Suceava, Romania
[3]Agricultural Research and Development Station Brăila, Road Vizirului km 9, Brăila, Romania

Corresponding author email: toadergeorge92@gmail.com

Abstract

The processes of interaction between the plant and the active soil microbiome are the determining factors of plant welfare and health, crop productivity and soil fertility. The new technologies applied in the agricultural field have as role the promotion of the growth and development of the plants, the sustainability of the agricultural crops, the maximization and the yield of the agricultural crops. The bacteria used in the composition of fertilization or plant protection products are selected bacteria, bacteria accredited by international gene banks, these bacteria being determinants and plant health. The associativity of bacterial cultures has the role of developing and supporting the growth of plants and their protection from certain diseases or pests, through various mechanisms.

The use of live bacterial cultures in agriculture has different characteristics. The most important characteristics that these biopreparations have are represented by: the biological fixation of atmospheric nitrogen in the soil, the solubilization of phosphates, the acceleration of the ACC deaminase process, the production of siderophores and phytohormones, the growth and development of plants. The present paper aims to present the role on which the combinations of bacterial cultures that are used in agricultural ecosystems, bacterial cultures that can replace chemical fertilizers as well as some plant protection products. This article presents, in addition to the biology of each bacterium - the role, action and benefit that these bacterial cultures have in the activity of the soil microecosystem. The positive impact of biofertilizer "BioWais" on plant growth and development, enhancement of resistance of bacterized plants to hypothermia and pathogenic infection, increase of carotid content were demonstrated at the stations where we done the experiments.

Key words: *biofertilizers, live bacterial cultures, nitrogen fixation.*

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. 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 (Jugenheimer, 1976). 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). 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. 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 sustainable agriculture and achieving high, healthy, nutrient-rich productivity, beneficial to human and animal health (Hallauer et al., 1988). Soil is the basis of agriculture. The soil is a mediator of processes mediated by microorganisms, both at the surface of the soil and at the root system of plants (Mureşan, 1973). The rhizosphere is the area of maximum activity of microorganisms. At this level, the activity of bacterial cultures is carried out in optimal parameters, the rhizosphere being the part of the soil that includes the surface of the root to the top of the absorbent hairs. The rhizosphere is an appropriate environment for the growth, development and interactions of microorganisms with soil, plants and the environment (Figure 1A) (Stammen, 2005). At the rhizosphere, plants through the roots, more precisely at the pylorus (calytra) release a range of phytohormones that are involved in the process of fusion with soil microorganisms (beneficial soil microorganisms communicate with plants based on phytohormone emission, transmission, recovery, decoding and response from both parties involved - plants and microorganisms) (Vary et al., 2007). The role of soil bacteria is to recolonize the bacterial fauna of the soil, to increase plant growth, increase agricultural production and ensure protection against diseases, pests, abiotic stress and fluctuations in soil and climate conditions. The mechanisms of action of bacterial cultures involve processes of availability of nutrients derived from genetic processes in plants (photosynthesis and chemosynthesis) and other related processes such as biological nitrogen fixation, solubilization of insoluble compounds in soluble compounds, production of siderophores (Ardelean, et al., 2007). Root processes are symbiotic, endophytic and associative processes (Figure 1B) that have the role of colonizing the roots (by bacteria), which creates a favorable environment for development, growth, agricultural productivity and soil greening (Alves et al., 2004; Adesemoye et al., 2009; Hungary et al., 2010).

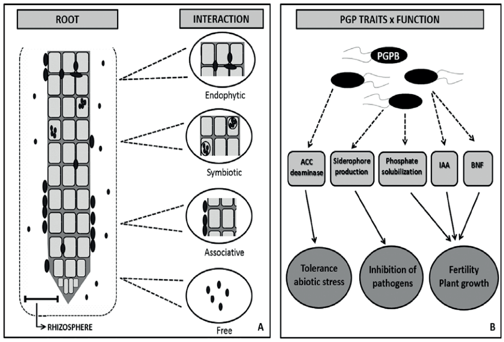

Figure 1A. The interaction between the rhizosphere and soil bacteria
Figure 1B. Colonization and association of bacteria with plant roots

The use of new fertilization technologies in Corn crops as well as an appropriate treatment of Corn seed will bring with it a number of benefits both for the soil and, implicitly, for the plants. The use of innovative fertilizers for Romanian agriculture (fertilization products based on live bacterial cultures) as well as combinations of bacterial cultures have the role of growing and developing the plant mass of the plants and, implicitly, supporting the harmonious growth and development of cobs so as to a maximized yield of agricultural Corn production on a given area is obtained.
At Suceava Research and Development Station for Agriculture, a series of experiments were carried out on the cultivation of corn with different types of fertilizers in order to prove the effectiveness of each of them.

MATERIALS AND METHODS

At SCDA Suceava, a series of experiments on plant fertilization were carried out on the *Millenium* corn crop, as follows (Table 1):
V1 - unfertilized control lot;
V2 - chemically fertilized lot (Complex Azomures NPK 20-20-0, 300 kg/ha - in autumn) + 100 kg nitrocalcar in spring;
V3 - biological fertilized lot produced Rom-Agrobiofertil NP (30 liters/ha).
In each lot, a series of biometric determinations were made to present the differences between the types of fertilizers used in the tests (colour, number of leaves, number of absorbent hairs, plant height, productivity per hectare, etc.).

Table 1. Variants of the experiment

Fertilization type	Experimental variants		
	V1	V2	V3
	The unfertilized lot (control lot)	Chemically fertilized lot (Complex Azomures NPK 20-20-0, 330 kg/ha- in autumn) + 100 kg nitrocalcar in spring	Biological fertilized lot produced Rom-Agrobiofertil NP (30 liters/ha) 01.05.2020 - first treatment, 20.05.2020 - second treatment

As materials used in the research carried out, we can mention the following: Complex Azomures NPK 20-20-0 300 kg, Nitrocalcar and the biological fertilizer product, based on live bacterial cultures Rom-Agrobiofertil NP.

Methods of crop observation, determinations of established parameters, statistical methods and methods of quantitative and qualitative analysis were used as methods.

The technology of cultivation and tillage of the corn crop (of the experimental lots) within SCDA Suceava was carried out with the help of mechanized equipment (tractor, seed drill, disc, MET).

RESULTS AND DISCUSSIONS

Following the application of the previously mentioned technologies, the following results were obtained for the corn crop at SCDA Suceava (Table 2).

Table 2. Production sheet

Parameters	**Experimental variants**			**Differences**			
	V1 - The unfertilized lot (control lot)	V2 - Chemically fertilized lot (Complex Azomures NPK 20-20-0, 330 kg/ha - in autumn) + 100 kg nitrocalcar in spring	V3 - biological fertilized lot produced Rom-Agrobiofertil NP (30 liters/ha)	V2 *vs* V1	V3 *vs* V1	V3 *vs* V2	V2 *vs* V3
No. grains/row	31	36	43	16.129	38.710	19.444	-16.279
TGW, g	251	274	303	9.163	20.717	10.584	-9.571
Grain yield %	81.7	89	98.9	8.935	21.053	11.124	-10.010
HM, kg	72.7	78.7	80.4	8.253	10.591	2.160	-2.114
Production, kg/ha	4587	6478	8753	41.225	90.822	35.119	-25.991
Humidity, %	16.6	16.4	16.6	-1.205	0.000	1.220	-1.205

It can be seen that there are a number of major differences between each even batch. In particular, we can observe that the batch fertilized with the biological product recorded the highest production. Although a good part of the corn crop was affected by hail, the action of the bacteria in the fertilization product led to the support of agricultural productivity and the restoration of both the root system of the plants and their leaf surface.

Due to the bacterial activity in the biological fertilizer, a good part of the complex compounds in the soil structure were decomposed, which led to an increase in the macroelements necessary for the growth and development of plants and agricultural productivity: nitrogen, phosphorus and potassium. At the same time, a significant amount of microelements also resulted from the decomposition.

Increasing the amount of micro and macro elements in the soil and stimulating the nutrition of corn plants with the help of bacteria led to their growth and development.

A significant increase and a much better development of the plants brought with it a high productivity per plant and, implicitly, per hectare.

The development of plants brought with them growth and stimulation of fruiting. As such, the yield (number of grains per cob) of the plants was much higher in the biologically fertilized lot compared to the chemically fertilized lot or the unfertilized control.

Also, at harvest, compared to the chemically fertilized batch and the non-fertilized control, the grain moisture was much better in the biologically fertilized batch.

From the culture sheet we can see that the biologically fertilized batch led to the acceleration of seed germination, better rooting of the plants. Also, a reduction in plant fall before vegetation can be observed, but the most important aspect is the number of plants fallen during harvesting: 0 (Table 3).

Table 3. Observation sheet

Experimental variants	Corn crop sowing date	Corn crop emergence date	The date of the appearance of the third leaf	No. days between sowing and sunrise	Flowering date	Date of appearance of silk	Physiological maturity date	Plant height (cm)	Fallen plants during the vegetation period (%)	Fallen plants at harvest (%)
V1	31.04	07.05	12.05	8	09.07	11.07	10.08	175	7	4
V2	31.04	07.05	10.05	8	06.07	08.07	15.08	220	3	1
V3	31.04	07.05	08.05	6	02.07	04.07	10.08	237	1	-

Compared to the non-fertilized and chemically fertilized control, it is observed that the plant size increased significantly in the biologically fertilized lot, followed by the chemically fertilized lot, the treatment with the organic fertilizer Rom-Agrobiofertil NP contributing much more to the thickening of the package and the increase of leaf mass (Table 4).

Also, the action of the phytohormones produced by the bacteria in the biological fertilizer had a positive effect on plant growth, seed germination, flowering date, silk emergence date, plant maturity date, their height, as well as on the fall of plants in vegetation and harvesting. These aspects were identified in the batch fertilized with the product based on microorganisms, in parallel with the two batches.

Thus, we can affirm the fact that the microorganisms contained in the biological fertilizer acted as a support for the corn culture, and through the biological processes, along with the stimulation of the physico-chemical processes of the plants and the soil, a production surplus was created as seen in Table 3.

From the Anova analysis (Table 4) we can see that the biological fertilizer stimulated the physico-chemical and biological processes and allowed a link between soil, environment and plants. Through this "mediation", the increase in production in the biologically fertilized batch was much higher than the other two batches (chemically fertilized and unfertilized control).

We can affirm the fact that the bacteria contained in organic fertilizers have the role of stimulating the growth and development of plants.

This growth is beneficial for the soil and plants because, based on it, an increase in production can be obtained with a minimal investment, an increase in production which, for the farmer, represents a profit.

Figures 2-7 present different aspects from the experimental variants.

Table 4. Production sheet - Anova: Two-Factor without replication

Anova: Two-Factor Without Replication						
SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
No. grains/row	3	110	36.67	36.33		
TGW, g	3	828	276.00	679.00		
Grain yield, %	3	269.6	89.87	74.52		
HM, kg	3	231.8	77.27	16.36		
Production, kg/ha	3	19818	6606.00	4351177.00		
Humidity, %	3	49.6	16.53	0.01		
V1 - The unfertilized lot (control lot)	6	5040	840.00	3376633.35		
V2 - Chemically fertilized lot (Complex Azomures NPK 20-20-0, 330 kg/ha - in autumn) + 100 kg nitrocalcar in spring	6	6972.1	1162.02	6790708.65		
V3 - biological fertilized lot produced Rom-Agrobiofertil NP (30 liters/ha)	6	9294.9	1549.15	12465198.72		
ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Rows	105971658.5	5	21194331.69	29.47	0.000011	3.326
Columns	1512921.348	2	756460.67	1.05	0.384923	4.103
Error	7191045.119	10	719104.51			
Total	114675624.9	17				

Figure 2. Corn crop - V3 organic fertilizer lot Rom-Agrobiofertil NP (15 liters/ha x 2 applications)

Figure 3. Corn crop - V3 biologically fertilized lot produced Rom-Agrobiofertil NP

Figure 4. Corn crop - fertilizer complex fertilizer (control lot) NPK 20-20-0 (300 kg/ha autumn) + 100 kg nitrocalcar in spring

Figure 5. Corn crop - fertilizer complex fertilizer (control lot)

Figure 6. Corn crop - V3 biologically fertilized lot produced Rom-Agrobiofertil NP - after hail

Figure 7. Corn crop - fertilizer complex fertilizer (control lot) NPK 20-20-0 (300 kg/ha autumn) + 100 kg nitrocalcar in spring - after hail

CONCLUSIONS

The agricultural year 2018-2019 was a very difficult one from a climatic point of view, with large rainfall deficits for spring crops and pedological drought recorded in the periods April-May and July-August, which caused delays in plant growth and development.

There were also two hail showers, which affected plant development in June 2019, and weeding was also very high, affecting crop plants in the second half of the growing season.

The experimental results showed that both the treatment with the organic fertilizer Rom-Agrobiofertil NP, in Corn cultivation positively influenced the growth and development of plants, both in Corn with very significant positive results in terms of quantity and quality of agricultural products, despite the fact that the crop was affected by hail.

Treatment with organic fertilizer Rom-Agrobiofertil NP has a positive influence on the growth of leaf area and maintaining the turgidity of plant tissues, prolonging the vegetation period, which contributes to the accumulation of reserve substances in large quantities, compared to untreated foliar control.

Production increases were on average 2.275 tons compared to the chemically treated Corn variant.

Complex beneficial association with soil microbiomes is necessary for plant growth, nutrition, stress tolerance and antagonizes their pathogens.

The ability of plants to synthesize substances with bactericidal and fungicidal effects in order to control diseases and pests in agricultural crops is very important for farmers.

Bacteria give plants a tolerance and a resistance of plants to unfavorable environmental factors (heavy metal pollution of the soil, soil salinization and drought).

Also, bacteria give a biocontrol and remediation system for the main functions of the plant, it present a intensification of the process of photosynthesis and chemosynthesis of plants and -increasing agricultural production.

However, the beneficial effects of the bacteria mentioned above lead to growth of the plant mass, height, number of fruits per plant, growing shoots on the plant, increasing the number of flowers per plant, increasing the number of fruits and also increasing agricultural productivity per hectare (for biologically fertilized lots).

Decomposition of complex compounds in the soil and release of mineral elements necessary for plant growth and development is a significant increase in agricultural productivity which will also lead to a large increase in seed material and increasing the root system of the plant will lead to a better absorption of mineral elements from the soil.

The activity of bacteria on the soil has a positive effect on the decomposition of complex compounds in the soil as well as on better elasticity of the plant (wind resistance, better grip of the plant in the soil (increase of its root system).

ACKNOWLEDGEMENTS

This research work was carried out with the support of Suceava Agricultural Research and Development Station.

REFERENCES

Adesemoye, A. O., Torbert, H. A. and Kloepper, J. W. (2009). Plant growth-promoting rhizobacteria allow reduced application rates of chemical fertilizers. *Microb. Ecol.,* 58:921-929.

Alves, B. J. R., Boddey, R. M. and Urquiaga, S. (2004). The success of BNF in soybean in Brazil. *Plant Soil,* 252:1-9.

Ardelean, M., Sestraş, R. (2007). *Tehnică experimentală horticolă*. Ed. AcademicPres, Cluj-Napoca.

Hallauer, A. R., Miranda, J. B. (1988). Quantitative Genetics în Corn Breeding. Iowa State Univ. Press, Ames, Iowa, 224-238.

Hungary, M., Campo, R. J., Souza, E. M. and Pedrosa, F. O. (2010). Inoculation with selected strains of *Azospirillum brasilense* and *A. lipoferum* improves yields of corn and wheat in Brazil. *Plant Soil,* 331:413-425.

Jugenheimer, R. W. (1976). Corn improvement seed production and uses. John Wiley & Sons Inc., 278-345.

Mureşan, T. (1973). *Cultura porumbului*. Ed. Ceres, Bucureşti.

Stammen, S. (2005). Optimierung der Proteinsekretion in *Bacillus megaterium.* In Institute for Microbiology Braunschweig: Technical University of Braunschweig.

Vary, P. S., Biedendieck, R., Fuerch, T., Meinhardt, F., Rohde, M. (2005). *Bacillus megaterium*-from simple soil bacterium to industrial protein production host. *Applied Microbiology and Biotechnology*, Vol. 76, No. 5, 957-967.