YIELD GAINED IN WHEAT CROP DUE TO THE USE OF NITROGEN-FIXING BACTERIA

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REVIEW

Abstract

Organic farming has numerous benefits for both the environment and human health. Here are some of these benefits: No pesticides and chemical fertilizers. Organic farming uses natural methods to control pests and improve soil fertility by eliminating or minimizing the use of pesticides and synthetic chemical fertilizers. Maintaining biodiversity: Through the diversified use of crops and agricultural practices, organic farming encourages biodiversity in the soil and agricultural ecosystems, helping to maintain ecological balance. At the same time, it also has a positive impact on wildlife and biodiversity, which are affected by the excessive use of chemical fertilizers and pesticides. Azotobacter can convert nitrogen gas from the atmosphere into a form that plants can use. This reduces reliance on chemical nitrogen fertilisers, saving costs for farmers and having a reduced impact on the environment. Nitrogen is an essential element for protein synthesis and other vital processes for plant growth. By providing an additional source of nitrogen, Azotobacter contributes to a more vigorous growth of plants, thus improving crop yield. Therefore, the wheat plants that were treated with Azotobacter chroococcum developed better and faster, of course, registering higher and higher quality yields per hectare. For this study, a product with a concentration of Azotobacter Chroococcum of over 1 x 109 CFU/cm³ was used, applied in stages. It is also worth noting that this experiment was carried out on the type of soil belonging to the luvosoil class. The works prior to the sowing period were carried out according to the crop to be sown and tested. In this study we conclude the major impact that Azotobacter chroococcum has on wheat yields in the organic wheat crop, where chemical fertilizers were not used, results were seen both in terms of plant growth and development, but also a resistance that Azotobacter Chroococcum offers to plants to stress factors, but also to pests.

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INTRODUCTION

Bacteria have a significant impact on agriculture, being involved in various processes that contribute to soil health and plant growth. Here are some ways bacteria are essential in the agricultural context:

Nitrogen fixation: Nitrogen-fixing bacteria, such as Rhizobium, are able to convert nitrogen gas into a usable form for plants. These bacteria establish symbiosis with the roots of leguminous plants, providing them with nitrogen and improving soil fertility.

Promoting plant growth: Certain beneficial bacteria, such as Azotobacter and Bacillus, can secrete growth substances and hormones that stimulate plant development and give them.

Biofertilization: Beneficial bacteria can be used in the production of biofertilizers, which contain beneficial microorganisms to improve nutrient uptake by plants.

Biological pest control: Beneficial bacteria, such as Bacillus thuringiensis (Bt), produce substances that are toxic to certain pests, providing an environmentally friendly way to control them.

Bioremediation: Some bacteria have the ability to degrade chemicals or absorb heavy metals from the soil, contributing to the bioremediation process and cleaning up contaminated soils.

Fermentation: Bacteria are involved in the fermentation process, which can be used in the production of organic fertilizers and other agricultural products.

Nutrient preservation: Bacteria participate in nutrient cycling in the soil, helping to release and transform nutrients for plants.

Disease resistance: Beneficial bacteria can boost plants' immune systems, giving them increased resistance to various diseases and infections.

The conscious and sustainable use of bacteria in agriculture can help improve productivity, reduce dependence on chemical fertilizers and pesticides, as well as promote sustainable agricultural practices. (Tállai et al, 2023)

Nitrogen-fixing bacteria are microorganisms that have the ability to convert atmospheric nitrogen (N_2) into a usable form for plants and other organisms. This ability is essential for the nitrogen cycle and for maintaining soil fertility. Here is some important information about nitrogen-fixing bacteria (Yingying et al, 2022):

Types of bacteria: There are several genera of nitrogen-fixing bacteria, and the best known are Rhizobium, Azotobacter, Clostridium and Frankia. Each of these genera has specific adaptations to different environments and can form symbioses with different types of plants.

Rhizobium: These bacteria establish a symbiotic relationship with the roots of leguminous plants (such as beans, peas, clover). By forming nodules on plant roots, Rhizobium fixes atmospheric nitrogen and converts it into the form of ammonium, which is usable by plants.

Azotobacter: These bacteria are present in the soil and can fix atmospheric nitrogen independently, without having a symbiotic association with specific plants. Azotobacter contributes to improving soil fertility and promoting plant growth.

Clostridium: Certain species of clostridia are nitrogen fixers, but they are typically involved in the processes of putrefaction and decomposition of organic matter. However, under anaerobic conditions, some clostridia can fix nitrogen.

Frankia: These nitrogen-fixing bacteria are involved in symbiosis with certain plants known as actinized plants (e.g., shrubs of the Elaeagnaceae and Myricaceae family). These plants form root nodules where *Frankia* fixes nitrogen.

Plant benefits: Nitrogen-fixing bacteria provide the plant with an additional source of nitrogen, an essential element for protein synthesis and overall plant growth. Through this symbiotic association or by fixing nitrogen in the soil, bacteria contribute to maintaining soil fertility.

Sustainable farming practices: Farmers can benefit from nitrogen-fixing bacteria by adopting sustainable farming practices, such as crop rotation with leguminous plants or by using bacterial inoculants in the soil to stimulate nitrogen fixation.

Nitrogen-fixing bacteria are therefore essential for soil health and supporting plant growth, helping to reduce the need for synthetic nitrogen fertilisers in agriculture.

Wheat cultivation worldwide is one of the most important and widespread cereal crops. Here are some key aspects regarding the wheat crop:

Wheat is one of the most produced cereals worldwide, and among the countries that produce the most significant quantities are the United States, Brazil, Argentina, China, etc. This plant, so widespread, has a very wide range of uses. It can be used in livestock farms for animal feed, but also for human consumption.

Another characteristic of wheat is its ability to be grown over a very large area, in different climatic conditions and on different types of soil. Of course, productions can be affected by the characteristics of each area. It is a plant that adapts easily, hence its worldwide spread.

The economic importance of wheat should not be neglected. Cereal cultivation contributes to the food security of many countries and also generates significant profits for farmers. In recent decades, several varieties of wheat have been discovered, and productions have increased worldwide.

The increase in the price of fertilizers and fuels used in agriculture has led farmers to find alternatives to these problems they face more and more often.

Such an alternative is represented by the use of fertilizers and organic stimulators, which intensify or have the ability to eliminate even completely the use of classic fertilizers, which in addition to destroying the humus layer so important for the development of plants by their excessive use, are also harmful to environmental factors, and can lead to the pollution of the groundwater.

Azotobacter Chroococcum can be a solution to this problem that affects thousands of farmers. Biological fertilizers do not only refer to materials from animal manure and plant residues, but also include all products obtained through the activity of microorganisms and them.

Azotobacter chroococcum It is an aerobic rhizobacterium that can fix atmospheric nitrogen in nitrogen-based compounds such as nitrogen dioxide (Karthikeyan & Sakthivel, 2011).

These bacteria are capable of fixing atmospheric nitrogen by an average of 20 kg per hectare. They are oval or spherical and pleomorphic, form thick-walled cysts and can produce a large amount of mucus.

These bacteria can produce antifungal antibiotics that can inhibit the growth of several pathogenic fungi (Nazmun Ara et al, 2009).

It is a good alternative to increase nitrogen reserves and crop production capacity (Baral & Adhikari, 2014; Kumar et al., 2015). Here are some aspects of the impact of this bacterium on wheat cultivation:

Nitrogen fixation: Azotobacter chroococcum is known for its ability to fix atmospheric nitrogen in the soil in the form of nitrogen compounds. It provides an additional source of nitrogen, an essential nutrient for plant growth, including wheat.

Increased productivity: By fixing nitrogen and releasing it into the soil, Azotobacter chroococcum can help improve soil fertility. Nitrogen is essential for protein synthesis and other plant metabolic processes, thus influencing the yield and quality of maize production.

Stimulation of seed germination: Applying Azotobacter chroococcum to seeds can stimulate their germination. This effect can contribute to a faster and more uniform emergence of maize plants, positively influencing the early stages of development.

Disease control: Azotobacter chroococcum can secrete chemicals with antimicrobial potential, helping to control some pathogens that can affect corn crops. This can lead to better plant health and reduced disease risk.

Savings in the use of nitrogen fertilizers: By fixing atmospheric nitrogen, Azotobacter chroococcum can reduce dependence on chemical nitrogen fertilizers. It can bring savings for farmers and contribute to more sustainable farming practices.

Interaction with other organisms: Through the production of substances such as phytohormones, Azotobacter chroococcum can influence the interactions between plants and other organisms in the soil, including insects and other microorganisms (Yingying et al, 2022).

This can contribute to the ecological balance of the agricultural system.

It is important to note that the exact impact of *Azotobacter chroococcum* may vary depending on specific soil conditions, agricultural practices, and other local factors. Specific farm-level experiments and observations can provide more detailed information about how this bacterium may benefit or influence the wheat crop.

Biofertilizers mainly include nitrogen-fixing microorganisms, phosphate solubilizers, and microorganisms that promote plant growth. Biofertilizers beneficial for crop production include Azotobacter, Azospirillum, blue-green algae, Azolla, phosphate-solubilizing microorganisms, mycorrhizae, and synorhizobe. (Hardika & Sarvjeet, 2020)

Organic fertilizers help improve the natural mechanisms of nutrient storage in the soil, both physically and biologically, and thus help manage the risk of overfertilization.

Organic fertilizers were the main focus for wheat production and were added to the soil in the form of biofertilizer, improved for nitrogen fixation, and compost to determine the best application of organic fertilizers for a higher harvest and better growth. (Peng et al., 2013)

Despite the high potential of microbial inoculants, their effective use is very low, estimated at about 2 % of their potential. The low adoption among farmers is largely attributed to their unpredictable response, low quality in terms of the total number of viable cells at the time of use, short storage time, and temperature sensitivity (Yadav & Chandra, 2014).

To ensure high viability of bacteria-based products, it is recommended to store them at a controlled temperature, away from the sun's rays and frost. It is important to avoid exposure to extreme temperatures, as this can affect the quality and efficacy of microbial inoculants.

Storage in optimal conditions, with a constant temperature and without large fluctuations, contributes to maintaining a high concentration of viable cells in the product.

MATERIAL AND METHOD

The experiment took place in region of Crisana, Bihor County Romania in a village called Sacadat 22 km from Oradea. The soil where the experiment was carried out belongs to the category of luvosoils.

Preparatory work before the sowing period we spread a natural fertilizer containing 8 tons of chicken manure per hectar. After that, as soon as possible not to waste in the atmosphere the NH_3, we plough to a depth of 25 cm and after we closed the ploughing with a cultivator that worked the first 12-15 cm.

Sowing was carried out at the optimal date in 03.10.2023. The dose of Azotobacter was determined according to the sowing norm, the distance between the rows and the number of plants per square meter. The wheat seeds we used was Apilco and we sowed a number of 400 g/square meter. The experiment was conducted over an area of 6 hectares, divided into two types: 3 control hectares and 3 test hectares. On the 3 control hectares, only chicken manure was applied, at a rate of 8 tons per hectare.

On the 3 test hectares, in addition to the 8 tons of chicken manure, applications of the product Azotohelp were made in different quantities and stages:

1. 2.5 liters of Azotohelp was applied to the soil, incorporated before sowing.

2. The wheat seeds were treated with 1.5 liters of Azotohelp per ton of seeds. Since 210 kg of seeds were used per hectare, 0.32 liters of Azotohelp was applied for seed treatment.

3. 2 liters of Azotohelp were applied to the soil before sowing, and 0.5 liters of Azotohelp were applied to the vegetation at the appearance of the tiller.

RESULTS AND DISCUSSIONS

Based on the tests conducted, we were able to draw some clear conclusions regarding the experiment we performed. Even in the early stages of wheat development, we noticed significant differences in the root structure between the wheat from the control fields and that from the test fields. In Figure 1, the differences between the roots of the control wheat and those treated with Azotohelp (*Azotobacter Chroococcum*) can be observed.

The roots of the wheat plants treated with *Azotobacter Chroococcum* are more vigorous and retain more soil around them, indicating the activity of microorganisms in the soil. In the control plots, the roots are less developed and retain less organic matter around them.

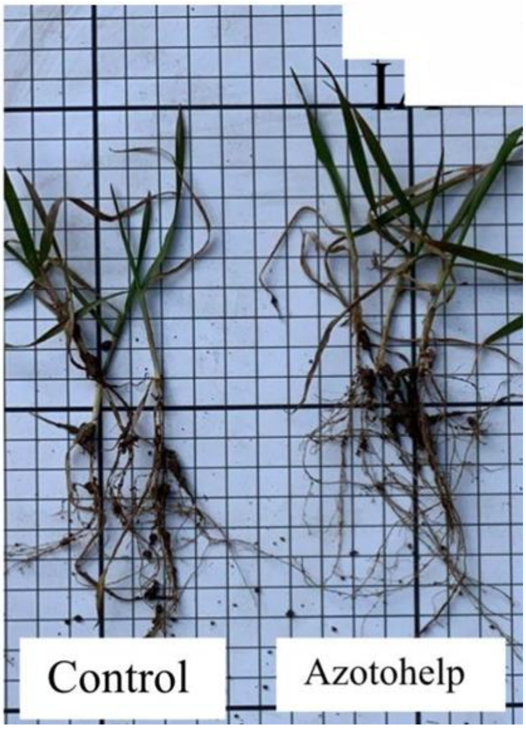

Figure 1. Difference in roots system

Visible differences in the color of wheat leaves in the test and control plots can be seen in Figure 2. On the right side of the image, where the wheat appears darker, denser and healthier, *Azotobacter Chroococcum* was used both before sowing and during the vegetation phase. On the left side of the image is the test area where only natural chicken manure was used.

Figure 2. Field picture between control and trial

In Figure 3, we observe the differences in wheat yield following the application of nitrogen-fixing bacteria at different stages of crop development and in varying amounts. While the differences between applying Azotohelp before sowing, post-emergence of the crop, and as a seed treatment are not very large—only a 20 kg difference between the two application rates—there is still a considerable yield difference when Azotohelp is applied both before sowing, sprayed on the soil, and during the vegetation phase (see Application rate 3).

Figure 3. Results after using *Azotobacter Chroococcum* in different concentrations

CONCLUSIONS

Following the tests carried out, we conclude with data from the field the percentage impact of *Azotobacter Chroococcum* in our wheat crop, the sustainability of its use and the yield it has given to our crop.

The differences in production obtained from the crosses made, we have benn a clear picture, given by figures and expressed in percentages in terms of yield obtained from the use of the Azotobacter bacterium in the wheat crop in its own soil conditions, using nothing else but live bacterias and natural manure for fertilization.

With our test we wanted to show that good yields can be obtained with only the use of natural imputs without pooring into the soil huge amounts of chemical fertilizers. Of course, using live bacterias is not an easy task, because of their needs for temperature and good soil conditions.

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