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BIOTECHNOLOGICAL APPLICATIONS OF MYCORRHIZAL PRODUCTS IN INTENSIVE AGRICULTURE

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Abstract

The article analyzes the evolution of mycorrhizal fungi, which have occupied the function of symbiotic partners in association with plants, more precisely with their root system. The advantage brought by the existence of mycorrhizal symbioses for plant nutrition, highlighted the influence that this association has on the growth and development of plants. Mycorrhizae are present in mature ecosystems, ecosystems that show a cyclical and unitary evolution of the components between the biotic and abiotic unit, when mycorrhizal associations have the role of regulating the assimilation of food resources for the plants with which they are associated. In this association, hyphae play an important role in the nutrient cycle, having the function of stopping losses in the ecosystem.
The present study aims to highlight the benefits of associating fungi with plant roots on wheat production. Thus, it was cultivated on a small area of wheat on a land where a fungal suspension was inoculated. Cultivated in parallel the control variant, in order to highlight the benefits of mycorrhiza. The obtained productions, the abiotic factors and the evolution of the plants were analyzed.

Key words: *Mycorrhizae, fungi, symbiosis, nutrients.*

INTRODUCTION

Mycorrhiza is a form of symbiosis between fungi and plants, more precisely a fungus comes in contact with the roots of plants. After studying the fungus-plant relationship, especially the connection with the root system of the plant, it was observed a considerable capacity of them to deliver nutrients to the plant. Thus, it is believed that mycorrhiza can replace inorganic fertilizers in cereal cultivation technologies in an intensive system. The need for crop fertilization and the principles of rational fertilization are summarized in the fertilization plan which is the instrument of control and management of fertilizers. The fertilization plan is based on a foundation made up of the combination of the following parameters: crop rotation, the genetic production potential of the crop, the availability of the nutrient reserve in the soil, the water resource and the dose of fertilizer applied. The dose of fertilizer applied is the result obtained from the calculation of the system made up of three equations: the genetic production potential of the crop, the availability of the nutrient reserve in the soil and the water resource. Basic fertilization is carried out with organic fertilizers and / or complex chemical fertilizers that provide the plants with the necessary nutrients, which they need for the desaturation of the vegetative cycle with a satisfactory result. The role of the *Glomus intraradices* fungus is to form mycorrhiza, and improve plant nutrient absorption from the soil.
In mycorrhizal symbiosis, the main benefit for the host plant is the progressive assimilation of immobile nutrients, especially nitrogen and phosphorus. The vesicular-arbuscular type relationships increase the assimilation of nitrogen in the tissues of the host plant, as a result of the competition of hyphae for mineralized organic nitrogen. The most important role is to minimize chemical fertilizer inputs from the farm management system, optimizing nutrition cycles - with minimal negative environmental impact - by ensuring increased yields. Therefore, these fungi should be considered an important component in sustainable agricultural system.
The shrub was assumed to be a key unifying structure and is the only place where the mushroom acquires carbon. This certainly does

not rule out the role of carbon transfer regions of intercellular hyphae and intracellular loops. There are other difficulties: the definition states that all descriptions of vesicular-arbuscular fungal species must be accompanied by proof that these fungi can form shrubs, which is problematic because, in some symbioses, curly hyphae predominate; there are also fungi in which the development of spores and vegetative morphology are typical but atypical carbon transfer. Leaving aside these issues, the remaining characters used by Morton and Benny (1990) are based on spore characteristics that are qualitatively varied but stable and distinct in each species. Vegetative structures were not used due to the plasticity of their development and their variation in different host plants.

The choice of the host plant was made according to its genotype. The effectiveness of the same species of mycorrhizal fungus can vary greatly between different species of host plants, so some associations are much more effective than others. The effectiveness of symbiosis may vary within the same species depending on the soil conditions in which the species is located (e.g. pH variations). The physiological and anatomical characteristics of the host plant influence the way in which colonization takes place; therefore, plants dependent on a large amount of phosphorus are more susceptible to colonization with vesicular-arbuscular fungi than the less demanding ones. Depending on the amount of absorbent hairs that the plant possesses, colonization can be more or less efficient. Consequently, it was chosen as the host-wheat plant, meeting the primary conditions.

Another parameter that influences mycorrhiza is the soil - the structure of the soil influences the characteristics regarding the water regime, the biochemical processes, the carbon storage, the resistance to erosion. Soil organic matter plays a major role in the formation of soil aggregates, as a result of biological activity in the soil.

Mature ecosystems are characterized by a permanent and cyclical movement of the elements between the biotic and abiotic part of which they are composed. Mycorrhizae have the role of regulating the composition and functioning of plant communities by allocating food resources and influencing the growth of the plants with which they interact.

Fungi interact with nitrogen-fixing bacteria found in the soil. Colonization with vesicular-arbuscular fungi favorably affects the populations of nitrogen-fixing bacteria in the rhizosphere of the plant that colonizes it; and the growth and development of the plant colonized by both organisms is greatly stimulated. The hypothesis that mycorrhizae should be independent at all times from the physiological state of the host plant is difficult to accept. Following an experiment by Azcon et al. (1978), with hormones synthesized by different bacteria (*Azotobacter, Rhizobium, Pseudomonas*), it was found that the formation of mycorrhizal associations is positively influenced by treatments on host roots. Among the hormones used in the experimental stage, auxins are distinguished by the influence they have on the formation of roots and on the relaxation of cell walls; gibberellins act on the formation of leaves and roots, and cytokinins are involved in the basic processes of plant growth.

The aim of the study is to use the benefits of mycorrhizae in the productivity of wheat plants. The experiment of absorption of macronutrients from the soil was performed in relation to the wheat flats. The system designed to highlight the benefits of mycorrhizae was to sow wheat in a chemically unfertilized soil. The necessary food being provided by the connection made between the root system of the plant and the extraradical hyphae of the fungus.

MATERIALS AND METHODS

Experimental works were performed both in the field and the collaborating laboratories of Agricola Berceni SRL. The multiplication of the *Glomus intraradices* fungus was used, on a solid nutritious Bulion type culture medium. After Multiplication, they were stabilized in compliant solutions, later reaching the experimental field cultivated with the host-wheat plant. Two experimental plots of wheat were established in the experimental field. One plot was cultivated as a control, while the second plot was cultivated and treated with mycorrhizae. In order to establish the wheat crop, the technology according to this crop was executed, without compromising on any operation.

Two experimental fertilization variants were used:

Variant 1: Suspension based on fungi - *Glomus intraradices* - Mycorrhiza: with rooting effect it was used for fertilizing the crop. The fertilizer was added to the surface of the crop substrate when the wheat crop was in the needle phase. An average rate of 16 L/ha of dizziness was distributed on the mycorrhizal base. The fertilizer was added in one pass. The same treatment options were applied for the two plots eluted in the analysis. The Mycorrhiza-based compound used was added in order to determine the rapid development of the root system based on the formation of the mycorrhizal relationship optimizing the transformation of nutrients blocked from solin nutrients available to the plant, bringing the elements in a form assimilable by the root system. fortified.

Variant 2. Classical wheat cultivation technology. At sowing it was fertilized by incorporation with NPK complex (15-15-15 active substance). Straw cereals have specific average nutrient consumption (Cs = kg N, P_2O_5, K_2O/1 t production), but are extremely demanding to fertilization, given that they have a poorly developed root system and have low solubilization capacity. nutrients from soil reserves, especially wheat. Later in the winter, at the start of vegetation, in the spring was fertilized with 140 kg N active substance in the form of Urea, being film-coated with neem oil. The presence of neem oil, which is an inhibitor, allows the root system to gradually absorb nitrogen over a longer period, acting as a nitrification inhibitor, preventing leaching, and in the phenological phase of the bellows. applied foliar fertilizer highly concentrated in micronutrients, containing cationic micronutrients (iron, copper, manganese and zinc) that are completely chelated (EDTA).

Later, after the winter period, at the beginning of vegetation, in spring, the active substance in the form of urea was fertilized with 140 kg N, and in the phenological phase of grain formation the phase in which the formation of reproductive elements takes place (micro and macrospogenesis), microgametogenesis, growth of floral components, blades and elongation of the rachis segments. With the appearance of the ear, there is macrogametogenesis and finalization of the formation of all organs of inflorescence and flowers, and flowering occurs fertilization and formation of zygotes-applied foliar fertilizer highly concentrated in micro-nutrients, containing cationic micronutrients and zinc, which are fully chelated (EDTA).

RESULTS AND DISCUSSIONS

A well-developed root system means a good capacity for the absorption of nutrients from the soil followed by the sustained development of the aerial part of the plant, the increase of the vegetative mass and the final increase of the quality of the harvested vegetables. The addition of phytohormonal solutions can add to the growth of the plant.

The purpose of biological fertilization with mycorrhizal compound (*Glomus intraradices*) is to identify an increase in wheat yield. From the first year of cultivation the differences in productivity were observed. The control variant registered in the agricultural year 2019/2020 a production of 3500 kg/ha, while in the variant treated with Mycorrhiza a production of 4950 kg/ha was registered. The production growth trend for the variant treated with mycorrhiza was also maintained in the agricultural year 2020/2021, in pursuit of productivity in the agricultural year 2021/2022. But in addition to increasing productivity, the aspects of physical/ architectural development of the plant were also monitored.

In most types of mycorrhizae, the movement of carbohydrates, produced during photosynthesis, is done from the host plant (autotrophic partner) to the symbiotic fungus (heterotrophic partner). In the case of absorption of nutrients from the soil, the transfer has an inverse direction, from the fungus to the host plant (Jacobsen 1999). The contribution of vesicular-arbuscular fungi to the assimilation of nutrients is the absorption of nutrients (especially phosphorus) from the soil, with the help of extraradicular hyphae - especially from those parts of the soil to which the plant did not have access. The hyphae of the fungus act similarly to the absorbent hairs on the root of the plant; After comparing the diameter of the absorbent hairs (5-20 µm) with that of the mushroom hyphae (3-7 µm), the absorbent hairs would gain the cause, but comparing the length and density of the mushroom hyphae with that of the absorbent hairs - the fungus would be, because it exceeds the possibilities of expansion of the plant by 10 to 100 times more.

Glomus intraradices increased the concentration and content of macronutrients, especially nitrogen from the root in the plant, this being supported by the coloristic aspect of the foliar apparatus of the plant, taken in comparison with the control variant. It is known that a proper nutrition with nitrogen leads to a coloristic of the foliar apparatus of dark green wheat, while the lack of this element corresponds to a foliar apparatus of green-yellow color.

Concentrations and nitrogen content in the root were significantly higher when the hyphae had a rich water intake.

As can be seen in Figures 1 and 2, the control variant shows a weak development compared to the variant treated with mycorrhizae, both in terms of root system and foliar apparatus. The photo presented above is in the first decade of April.

The abiotic factors that impact mycorrhizae have been studied.

The light. The energy source of the symbiotic fungus is in the plant and depends directly on how it processes photosynthesis and its ability to translocate the products of photosynthesis to the root (Varma, 2008). The lack of light source causes a restriction for the development of the fungus, so its evolutionary process is slowed down, sporulation no longer takes place, and the spread of the mycelium in the soil and root is reduced.

Temperature. In terms of spore germination processes, root penetration by hyphae, and proliferation within cortical cells, temperature may be a limiting factor (Gavito et al., 2005).

Soil pH. The efficiency of the fungus-plant association is determined by the adaptability of the fungal partner to a certain pH level of the soil. The pH affects both the germination of spores and their development. The relationship between soil pH and the effects of mycorrhizae depends on the host species, soil type, phosphorus forms, and fungal species involved.

Salinity. In the case of high salinity, a decrease in the production of propagating structures (propagules) and in the colonization of vesicular-arbuscular fungi was observed (Pfeiffer & Bloss, 1988).

Figure 1. Variant comparison (left-mycorrhiza-treated variant, right control variant)

Figure 2. Variant comparison (left - control variant, right - mycorrhiza-treated variant)

CONCLUSIONS

The general conclusion of the research is to identify the intake of nutrients brought by mycorrhiza for wheat cultivation. The mycorrhizal relationship leads to the solubilization of minerals, the production of plant growth stimulants and the control of

pathogens. The cumulative benefit brought to the plant leads to a high production by substituting chemical fertilize.
It is concluded that it brings a major benefit in the transport of nutrients for plants.

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