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Analysis of the Influence of the Application of Effective Microorganisms on the Dynamics of Spring Wheat Emergence

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Abstract: Deterioration of the natural environment as a result of violation of its natural structures and self-regulatory mechanisms causes an urgent need to replace chemicals with effective and multidirectional biopreparations. Reduction of the amount of chemicals used in agriculture becomes possible through the use of Effective Microorganisms. This will reduce the burden on the environment. Agriculture that uses EM technology can count on help with germination rates; emergence uniformity; and crop yields, for example. EM formulations contain a mixture of different coexisting microorganisms. The following paper presents the results of own research on the use of Effective Microorganisms in seed dressing of spring wheat. It was shown that the microbial preparation EM Naturally Active affects the increase of wheat seed germination dynamics.

Keywords: Effective Microorganisms, wheat

1. Introduction

Recently, the state of the natural environment has attracted much attention. This is due to the unconscious disruption of biological homeostasis through human activities (Szymanek et al. 2020). Significant amounts of pesticides used in agriculture that persist in the soil can have long-term effects on the survival and functioning of Rhizobia (Ahemad & Khan 2012). Reducing the amount of chemicals used, according to Janas (2009), is possible through the use of a microbial preparation that is becoming increasingly popular in Poland and the world (Western Europe, Japan, USA, Brazil) Effective Microorganisms (Kosicka et al. 2015).

Effective Microorganisms are formed by selected and properly chosen smallest organisms on Earth. A composition of more than 80 different strains of aerobic and anaerobic microorganisms such as photosynthetic bacteria, lactic fermentation bacteria, *Actinobacteria*, yeast and fungi. The Effective Microorganisms technology was developed by Professor of Horticulture Teruo Higa of the Ryukyus University Agricultural Academy in Okinawa, Japan (Armand et al. 2021, Kolasa-Więcek 2010, Schulz et al. 2013).

The last several years has shown an increasing tendency towards the use of biopreparations with substances of natural origin. The aim of this action is to improve the health of plants, to allow them to better uptake nutrients and, as a result, to obtain an increased yield (Jilani et al. 2010, Kumar & Kumar 2019, Gao et al. 2020).

An important group of EMs are lactic acid bacteria that produce various metabolites, mainly in the form of bacteriocins, which have inhibitory effects on microbial growth (Chmielowski et al. 2020). Yeast produces many biologically active substances such as amino acids and polysaccharides that nourish other microorganisms. Phototrophic bacteria play a major role in the nitrogen cycle and carbon cycle. The use of EM in the soil or plant ecosystem can improve soil quality and health. It also stimulates plant growth, increasing yields and thus improving crop quality (SI 2016).

Effective Microorganisms technology is based on inoculating the soil with a mixture of beneficial microorganisms to create a favorable environment for plant growth and development (Olle & Williams 2015). When injected into the soil, they exert beneficial effects on plants by increasing the assimilation of nutrients that are difficult for plants to access on their own, reducing decay processes, improving humus-forming capacity, eliminating pathogens, and affecting growth and crop quality (Kosicka, et al. 2015).

The range of action of EM preparations is wide due to the fact that they have the ability to increase the biological activity of soils thus as a result, decay processes will be stopped. They can contribute to improving soil structure and fertility by dissolving certain compounds that are not available in non-dissolved form to plants. Their effect can also be seen by improving the physical and chemical properties of soils (Piskier 2007). EMs have the ability to break down organic matter and synthesize nutrient substances needed for plant growth (Devi & Manimaran 2012).

Seed quality is among the key factors that determine plant development and yield. Pre-sowing treatment of seeds is aimed at improving their germination capacity as well as seedling vigor. With this treatment, young plants will gain greater resistance to environmental stress and thus faster development and greater plant vigor will be noticed (Rhodes & McCarl 2020, Seran & Suthamathy 2013). Seed treatment before sowing affects germination rate and seedling growth, which in turn determines higher yield (Dziwulska-Hunek et al. 2020, Siyami et al. (2018).

The mechanism of action of Effective Microorganisms is a mapping of natural processes occurring in nature. Microorganisms are able to function in vast range of conditions such as a slurry tank, in sewage sludge remaining after wastewater treatment, in water and in soil. Those numerous microorganisms possess various enzymes that give them the ability to break down non-organic matter. They also have the ability to produce substances that prevent the functioning of fungal pathogens. Particular groups of microorganisms form certain compounds that constitute food for the others. In this way, the necessary food for continued growth is provided. Effective Microorganisms, while having constant access to food, are secreting vitamins, antioxidants and organic acids, contributing to changes in soil morphology, inhibiting the development of pathogenic processes (Janas 2009).

A composition of EM cultures has found its way into plant and animal production and into the regeneration of soils where their natural biological barrier has been breached. Agriculture using Effective Microorganisms can count on support in as the intensity of germination and yield. These preparations can improve the assimilability of nutrients in the deeper soil layers and influence the intensity of photosynthesis (Faltyn & Miszkieło 2008).

Since composing a mixture of Effective Microorganisms and their practical application, the importance of EM in various areas of the economy has increased rapidly. They have found their use in agriculture, horticulture, animal husbandry, medicine, industry, construction, food processing and environmental protection. Despite the advancing technology, there is still a conviction about the undiscovered possibilities of these organisms (Paśmionka & Kotarba 2015).

2. Materials and methods

The research was conducted in the Department of Technology in Environmental Engineering, Bialystok University of Technology in 2020. The aim of the research was to obtain information on the use of Effective Microorganisms and to present the effectiveness of EM Naturally Active preparation in the cultivation of spring wheat. The research was also aimed at determining the effect of the Naturally Active EM dose on the seed germination dynamics and the impact of seed treatment time on their ability to germinate depending on the applied EM concentration.

The research was conducted on sterile Petri dishes in two repetitions. Grains of spring wheat cultivar FEELING intended for analysis were sieved on strainers with diameter of 2.5-2.8 mm. The EM Naturally Active preparation used for the research contains a rich complex of alive, active microorganisms, including lactic acid bacteria, phototrophic bacteria, actinomycetes, yeasts and fungi, as well as nitrobacteria. This preparation comes from the company Greenland Technologia EM Sp. z o.o., which since 2008 has been producing and selling products based on the original Japanese technology of Effective Microorganisms, which are widely used in agriculture and horticulture and in biological environmental purification. EM Naturally Active has been registered as an organic fertilizer by the decision of the Minister of Agriculture and Rural Development No. 281/11 of March 31, 2011.

In the first test, appropriate dilutions of EM Naturally Active were prepared: 0.1%, 1%, 5%, and then the grain was soaked in them for 30 min, 1 h, and 3 h. Blotting paper was placed on sterile Petri dishes as a substrate. Then 20 grains were placed on each Petri dish, 5 grains per each quadrant. The grains on the plates were watered with water according to their requirement.

In the second test, appropriate dilutions of EM Naturally Active preparation of 0.5%, 1%, 5%, 15%, 30%, 50% were prepared and the grains were soaked in them for about 30 minutes. Blotting paper was placed on sterile Petri dishes as a substrate. Then 20 grains were placed on each of the Petri dishes, 5 grains for each quarter. The grain on the plates in the control trial was watered with water. In the test trials, the grains were watered with six different concentrations of EM Naturally Active solution according to their requirement.

Both dish experiments were conducted at 20°C and no light until the third day, and then the access to light for 12/12h day/night was provided. The dynamics of wheat emergence started being recorded from the third day after experiment commencement until the end of germination (Faltyn & Miszkieło 2008).

Experimental setup:

Object 1: grain not treated with EM solution;
Object 2: grain was treated for 30 minutes with 0.1% EM solution,
Object 3: grain was treated for 30 minutes with 1% EM solution,
Object 4: grain was treated for 30 minutes with 5% EM solution,
Object 5: grain was treated for 1 hour with 0.1% EM solution,
Object 6: grain was treated for 1 hour with 1% EM solution,
Object 7: grain was treated for 1 hour with a 5% EM solution,
Object 8: grain was treated for 3 hours with 0.1% EM solution,
Object 9: grain was treated for 3 hours with 1% EM solution,
Object 10: grain was treated for 3 hours with 5% EM solution,
Object 11: grain watered only with water,
Object 12: grain was watered with 0.5% EM solution,
Object 13: grain was watered with 1% EM solution,
Object 14: grain was watered with 5% EM solution,
Object 15: grain was watered with 15% EM solution,
Object 16: grain was watered with 30% EM solution,
Object 17: grain was watered with 50% EM solution.

3. Results and disscusion

Observations of wheat emergence dynamics are placed on individual graphs. The experiment was conducted for seven days. At that time the end of wheat germination was observed.

Treating grains with 0.1% EM solution for 3 hours resulted in 85% of grain emergence as early as day 3 of the dish test, and this contributed to the fastest germination of wheat compared to the control and 30 minutes, 1 hour grain treatment (Fig. 1).

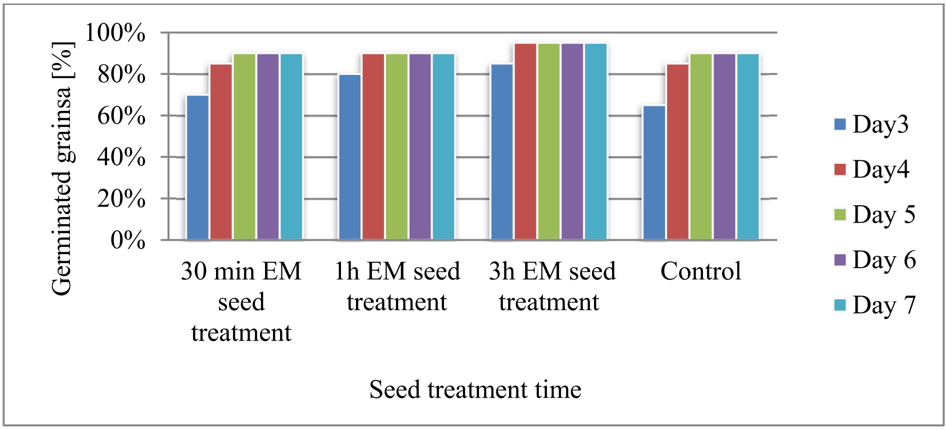

Fig. 1. A graph containing percentage comparison of germination strength results for grain dressed with 0.1% EM Natural Active solution

Treating grains with 1% EM solution in 3 hours time resulted in 85% of germinated grains as early as on the 3rd day from the day of the dish test, and this contributed to the fastest germination of wheat in comparison to the control and 30 minutes, 1 hour dressing of grains (Fig. 2).

In the case of 0.1% and, 1% concentration of EM preparation, the 30 minutes grain treatment time on the third day of observation is manifested by fewer germinated kernels than after 3 hours of treatment. On the third day of observation, grains treated with 0.1% and, 1% EM solution during 1 hour germinated fewer grains than after 3 hours of seed treatment.

Treating grain with 5% EM solution during 1 hour resulted in 75% of grain emergence already on the 3rd day after the plate test, and this contributed to the fastest germination of wheat compared to the control and 30 minutes, 3 hours grain treatment (Fig. 3).

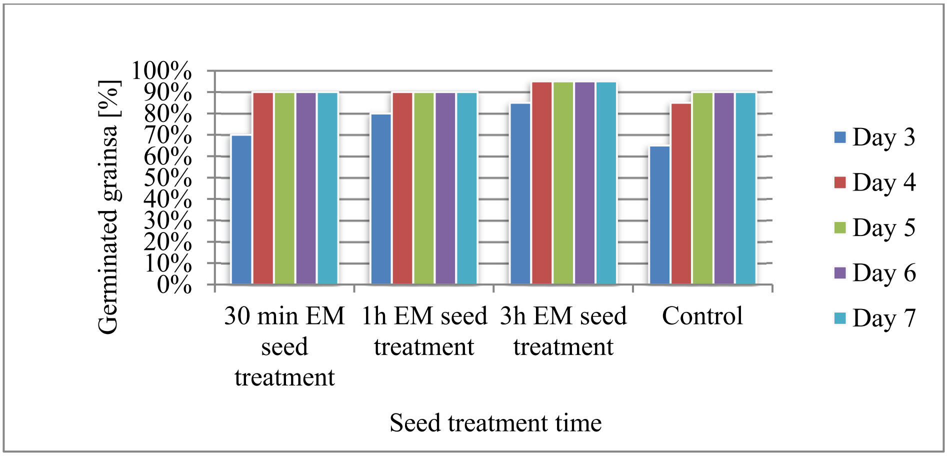

Fig. 2. A graph containing percentage comparison of germination strength results for grain dressed with 1% EM Natural Active solution

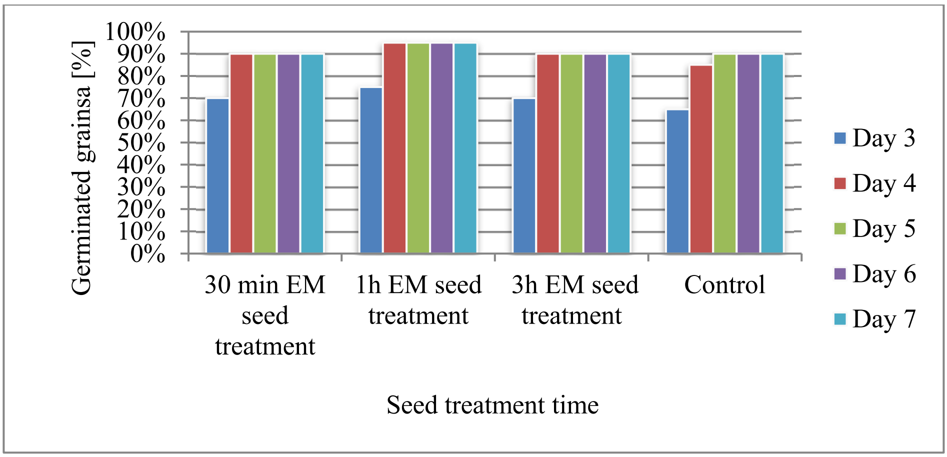

Fig. 3. A graph containing percentage comparison of germination strength results for grain dressed with 5% EM Natural Active solution

On the third day of observation, the seeds treated with 5% EM solution germinated in greater number in 1 hour than after 30 minutes and 3 hours of treatment

On the third day of observation, seed treatment with 0.1%, 1% and 5% concentrations accelerated kernel germination compared to the control. In the lower concentrations of 0.1%, 1% of EM preparation, a longer time of seed treatment is needed, while at the concentration of 5% the most seeds germinated after treatment in 1 hour.

On the seventh day, 95% wheat emergence was observed after seed treatment with 0.1%, 1% EM solution for 3 hours and 5% EM solution for 1 hour.

On the seventh day of observation the control germinated 90% which indicates that treating seeds with 0.1%, 1% EM solution at 3 hours and with 5% EM solution at 1 hour accelerates the increase in germination intensity and increases the number of germinated kernels.

Siqueira (1993) showed significant differences in germination percentage of EM treated pea, beet, bell pepper, tomato, cucumber, maize, carrot, bean and burdock grains. The application of EM increased the germination capacity of the seeds and accelerated their growth.

Faltyn and Miszkieło (2008) observed that the best emergence dynamics was after application of a standard dose of EM. Increasing the concentration of this mixture from 1.5 l to 3 l caused a decrease in the percentage of germinated kernels both in the initial and final germination period. Comparing the control treatment with water alone to the standard dose of EM-A, the percentage of germinated kernels was 10 percentage points lower.

Watering the kernels with 0.5% and 1% solutions of EM Naturally Active will result in a higher number of germinated kernels compared to the control. Watering with a 5% solution of EM Naturally Active will result in the same number of germinated kernels as the control. Watering with a 15% and 30% solution of EM Naturally Active reduced the number of germinated kernels compared to the control, while a 50% solution of EM Naturally Active inhibited the germination and development of the kernels.

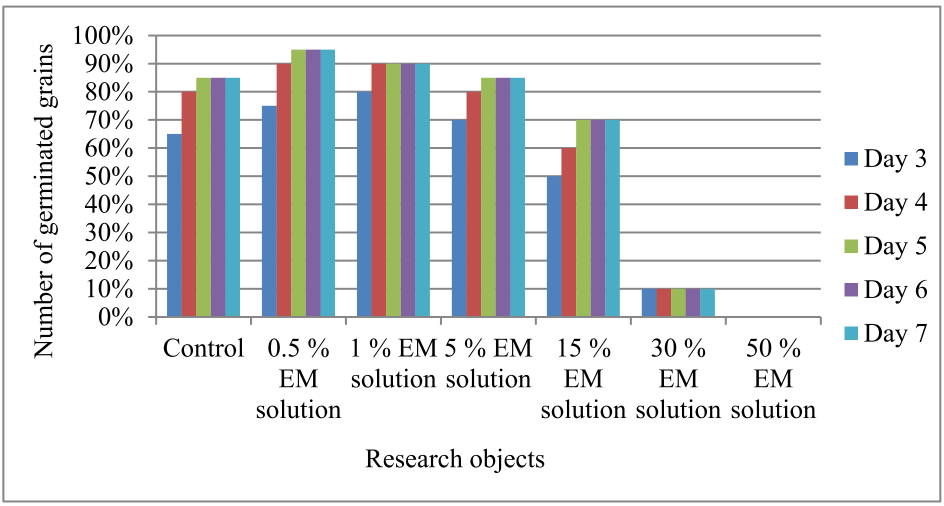

Fig. 4. Graph showing summary of spring wheat emergence dynamics measurements

On the third day of the experiment, 80% of the kernels irrigated with a 1% solution of EM Naturally Active germinating the fastest, while a slightly lower number of kernel emergence was observed in test sample 12 in which 75% of the kernels irrigated with a 0.5% solution of EM Naturally Active germinated.

On the seventh day of observation, the highest intensity of wheat emergence was 95%, which was watered with EM 0.5% solution, in relation to the control in which 85% of kernels germinated.

On the seventh day of observation the test sample 13 in which the grains were watered with 1% solution of EM Naturally Active showed a higher number of germinated grains than the control with 90% of germinated grains. On the seventh day of observation, the lowest intensity of wheat emergence was 0.1%, which was watered with 30% EM solution, and complete absence of kernel emergence was observed when watered with 50% EM Natural Active solution. The application of 50% EM Naturally Active solution concentration for watering was found to be too high, causing lack of germinated grains.

On the seventh day of the experiment, watering the kernels with a 0.5% EM solution will result in the sprouting of 95% of the kernels and the identical effects can be obtained by dressing the grains for 3 hours with 0.1% and 1% EM solutions. Treatment of seeds with 0.1% and 1% EM for 3 hours will cause faster germination already on the 3rd day of the experiment, at the level of 85%, while by watering with a 0.5% EM solution on the 3rd day of the experiment, the emergence is lower and amounts to 75% of the germinated seeds. Dressing the grain with 5% EM solution for 1 hour will result in 95% of germinated grains on the seventh day of observation, and watering with a 5% EM solution will result in 10% less sprouted grains on the seventh day of observation.

A study, which was conducted by Wolnej-Maruwki et al. (2010), says that the application of EM reduces the amount of mold fungi in the substrate, thus affecting the growth of healthy seedlings. According to Szydłowska and Małuszyńska (2011), seed treatment with a preparation containing Effective Microorganisms reduced the number of dead seeds and the number of abnormal seedlings formed as a result of pathogen infection.

Nowakowska (2005) found that seed dressing of sugar beet with Effective Microorganisms effectively reduces the death of seedlings. The research conducted by Janas and Grzesik (2006) indicates that the presowing treatment of seeds with Effective Microorganisms increased the number of germinated seeds of species with low germination capacity, such as marjoram, sage, dill, echinacea, coriander.

4. Conclusions

1. Presented results of dish experiments clearly show that the application of the EM preparation for seed dressing at an appropriate concentration of the preparation and time of dressing causes an acceleration of germination and increases the number of germinated kernels.
2. Watering the seeds with 0.5% and 1% solutions of EM Naturally Active increased the dynamics of seed germination as compared to the control, while too high concentration of the preparation caused lack of seed germination.
3. The conducted research indicates that the addition of Effective Microorganisms to soil is advisable and worth recommending.

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