EFFECTS OF SOIL BACTERIAL INOCULATION ON MAIZE AND SUNFLOWER ORGANIC MATTER AND CROP PRODUCT

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Abstract. *The aim of my dissertation is to dispel the doubts about bacterial treatment and to find out which preparation is worth to use under operating conditions, under given soil conditions, and whether they can actually have a measurable effect on plant productivity and, if so, to what extent. in addition to the specific operating technology. Area treated with Biofil Savanyú and Biofil Savanyú + Biofil S performed above control. Thus, considering the totality of chlorophyll measurements in the second place, Biofil Savanyú was performed, which produced high chlorophyll values in all measurements, so the nutrients were better in the area treated with this preparation compared to the control. The area treated with Biofil Savanyú + Biofil S produced significant chlorophyll fluctuations, from this it is concluded that certain components of the bacterial content of the two preparations are in competition with the plant population for water and nutrients as a function of improvement or deterioration of the water supply. For Bactofil A10 and Bactofil A10 + AlgaFix, chlorophyll values in the second half of the culture period were around or below the control plot values, Thus, chlorophyll accumulation was not significantly affected, and in some cases chlorophyll accumulation was even pushed back compared to the control plot, suggesting a less favorable rhizosphere and an adverse effect of nutrient competition. In the case of plots treated with Bactofil A10 alone, a small increase in the generative phase as a result of the improved water supply indicates that the bacteria after a suitable puppet or spore survived, they were reactivated and improved as a result of improved water supply and bacterial activity. The area treated with the combination of Biofil Savanyú + Biofil S formulations also produced a significant increase, although the same was true for the plot treated with Biofil S, Thus, knowing this, I declare that the response of the bacterial strains in Biofil S to soil dehydration and re-wetting is better, as for the strains in the Biofil Savanyú formulation. The area treated with Biofil Savanyú + Biofil S, which produced the smallest yield, produced the best 1000 seed weight. In summary, bacterial inoculation can increase the average yield by 500-600 kg / ha. Bacteria improve soil nutrient supply with favorable soil moisture, which improves the yield parameters of plants.*

Keywords: *soil bacteria, maize, sunflower, soil inoculation*

INTRODUCTION

The microbial life of the soil was almost completely unknown to researchers until the mid-1900s. In the 1950s and 60s, Soviet and non-Soviet researchers began to deal with the inoculation of soil bacteria into the soil. During this period, only vaccination with Rhizobium and Azotobacter strains was the focus of the research. This is due to natural attempts to reduce the use of N fertilizers. It reveals itself the different species of bacterial, fungal and radial fungal strains that have a major impact on soil nutrient management and organic matter accumulation.

In the 1960s, fungal-plant contact with free-living micorrhizal fungi was discovered. As early as the '70s and' 80s, they began to focus on the application of cellulose-degrading bacteria in an attempt to accelerate the breakdown of stem residues of increasing mass. Non-rotational cultivation, no-till, min-till, strip-till and other forms of cultivation that also supported the improvement of microbial life began to spread. And since the second half of the 2000s, there has been an increasing emphasis on vaccines containing various bacterial and fungal strains. However, some farmers to this day are skeptical of these formulations and have no high hopes for using the formulation.

ANTAL (2005), BIRKÁS (2001) found that the complex system of agricultural production is based on 3 subsystems, the third subsystem is the system of microorganisms, which converts organic waste and by-products from plant associations and animal husbandry into useful and operational humus, thus closing the carbon cycle.

According to FÜLEKI (1999), soil microorganisms can be divided into two groups:

1. Autotrophs: Organic matter is not required for their development. The materials needed to build up organic matter are sourced from the soil's nutrients and decompose carbon dioxide through solar radiation. Energy producers. FÜLEKY (1988) found that sulfur bacteria and nitrifying bacteria, which produce substances important for plant nutrition, also belong to this group.

2. Heterotrophs: They consume energy derived from the organic matter content of the soil in order to build both their vital functions and their body. According to FÜLEKY (1988), fungi, radial fungi and degrading bacteria also belong to this group.

NIZSALOVSZKY (1960) found that bacteria remain in the soil cycle even after they die because they are consumed by larger-bodied soil-dwelling animals. SZABÓ (1986) found that microorganisms living in our soils can play a significant role in the transformation processes of rocks and minerals. Therefore, in the 1980s, the soil was inoculated with silicate bacteria to make K bound in the soil available to plants.

According to FÜLEKY (1988), during the formation of soils, the biological weathering of rocks takes place under the influence of carbonic acid and other organic acids produced by microorganisms through chemical and physical processes. LOCH AND NOSTICZIUS (2004) found that organic nitrogen is organized into inorganic forms by soil microorganisms. According to FÜLEKY (1988), in the first step, N is oxidized to nitrite by Nitrosomonas bacteria, and then this nitrite is oxidized by Nitrobacteria to form nitrate, which is valuable for plants in the soil.

If N-containing substances predominate in the soil, N is mineralized, while if carbohydrate or other non-nitrogenous substances predominate, N is immobilized. (GYŐRI 1984, MENYHÉRT 1979). In corn crops, wich doesn't have water-deficient, the yield increases linearly up to the value of 5-5.5 LAI and to a declining extent then to the value of 6-7 LAI. There is also a correlation between the size of the leaf area of corn and the grain yield (FUTÓ 2003).

According to the research of SZABÓ (1986), a competitive situation can be observed between soil microbes and cultivated plants during the supply of microelements. However, since micronutrients are usually applied as foliar fertilizers, these relationships are still well known to this day, but LOCH AND NOSTICZIUS (2004) have shown that soil microorganisms play an important role in transporting micronutrients to the root. Maize can absorb water from a depth of 150-200 cm. Drought during the period of tassel vomiting can reduce yields by 53%, while drought at seed saturation can reduce yields by 30% (FUTÓ AND SÁRVÁRI 2015).

During plowing, aerobic bacteria are transferred to the lower part of the cultured layer by rotating the upper layer, as a result, the bacteria in this layer are placed in an anaerobic environment, thus, humification processes are intensified at the expense of the decomposition of the recycled organic matter According to FUTÓ (2019) the sunflower yields increased to growing nutrient supply. The highest yields were 3.67 t/ha in 2017. and 4.67 t/ha in 2018. (150 kg/ha N, 90 kg/ha P_2O_5 and 110 kg K_2O active substance. According to BIRKÁS (2006), operations without rotation create favorable biological conditions for the activity of microbes, as they provide them with an aerobic environment, but the machines are equipped with roller harrows, so the decomposition of humic substances is a controlled process, thus, the cementitious materials that give the structure to the soil crumbs decompose to a lesser extent.

MATERIAL AND METHOD

The experiment was set up on the near of Kétpó village on chernozem soil. Soil binding is AK 46, so we know that the dominant component in the soil is clay. The pH of the soil is 6.0 with a weakly acid-neutral pH. In terms of nutrient supply, the area is moderately equipped with N, P and K elements. The humus content of the soil is 2.5%, so it should be classified as medium.

In winter, rainfall was below the multi-year average, resulting in an inadequate water supply in the soil for the initial development of the plants even at the time of sowing. The initial favorable germination and stock development testing was ensured by the precipitation of the properly stored and well-preserved autumn-winter period. The average temperature of the 2019 production year was slightly cooler during the growing season given the conditions of recent years.

In the 2020 growing season, the distribution of precipitation was much more uneven than in 2019.. However, from the point of view of sunflower, the significant precipitation in June and July, as well as the root, which easily penetrated deep into the effect of loosening, were able to cover the plant's water needs in the second part of the growing season, in its critical generative phase, as well as in August and September, which created favorable conditions for crop production.

During the experiment, I designated an area of 1.5 hectares where it should be possible to use multiple bacterial treatment formulations under operating conditions. The area of the plots was 0.25 hectares, which was divided into 3 replicates. The treatments received the same agrotechnics, while avoiding the agrotechnical modifying factor. During the experiment, Biofil Savanyú and Biofil S formulations were prepared by two manufacturers, Biofil Microbiology, Gene Technology and Biochemistry Ltd., against AgroBio Kft Bactofil A10 and Bactofil B10, and their combined treatments with AlgaFix. During the experiment, the area was sown with a uniform crop and a uniform hybrid within that crop.

During the experiment, in the case of maize, up to 5 samples were formed from the sample, and sunflower was sampled three times during the growing season. In the case of maize, samples were taken every 3 weeks from 22 June 2019 to 26 August 2019. In the case of sunflower, sampling took place at each of the major phenological stages, in the star bud state, after flowering, and during the ripening of the lemon. During the sampling, 5 plants were excavated repeatedly, which means 15 plants in 1 treatment, while a total of 90 plants were reported separately during each sampling.

Washed root weight, leaf area index, stem weight and leaf weight were measured during sample processing, in the case of maize, in the generative phase, cob length and cob weight were measured in addition to these, while for sunflower, plate diameter and scythe weight were measured during the 2nd and 3rd sampling. In the case of maize, the samples were allowed to dry for 3 weeks, followed by processing. In the case of sunflower, on the other hand, the samples were processed the next day after sampling.

To measure the weight of the washed root, we were able to determine whether the root mass of the plants could be positively affected by bacterial vaccines and whether there were correlations between the root weight and the individual products of the plant.

By measuring the leaf area, she determined the size of the leaf width and length, and then determined the size of the leaf area using the Montgomery formula. The leaf area was measured to see if it was possible to detect a positive correlation between the plant assimilative surface and the vaccine used with the given treatment.

The measurement of leaf weight was aimed at the effect of the treatments on the amount of nutrients accumulated in the leaves between each treatment, thus, the increase in the nutrient capital of bacteria suggests the extent of their activity.

RESULTS AND DISCUSSIONS

Effect of bacterial inoculation on the relative chlorophyll content of maize

The favorable initial effect on the initial development of maize was exerted by Biofil Savanyú, thus, it can be concluded that it can have a positive effect on the intensity of the initial chlorophyll synthesis. Similarly high chlorophyll values (compared to the control) were given by plots treated with Biofil S. Initially, the combination of Biofil Savanyú and Biofil S resulted in a lower SPAD value compared to the control, which is likely to be the higher number of individuals present, which occurs due to competition for nutrients between the plant and the bacterial flora.

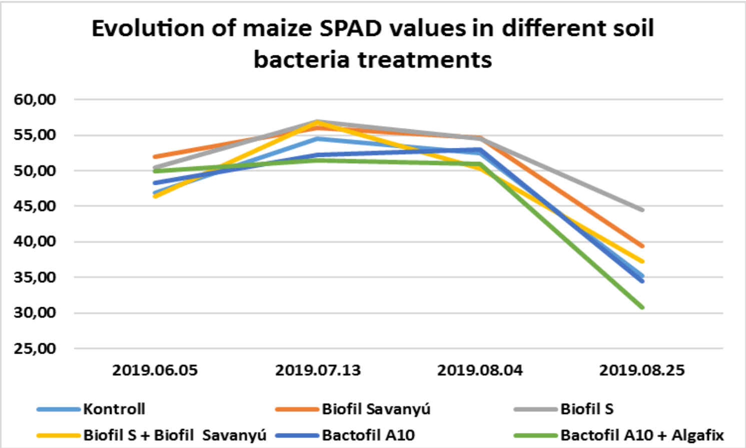

Figure 1: Development of SPAD values of maize during the growing season

Correlations between bacterial inoculation and maize leaf area

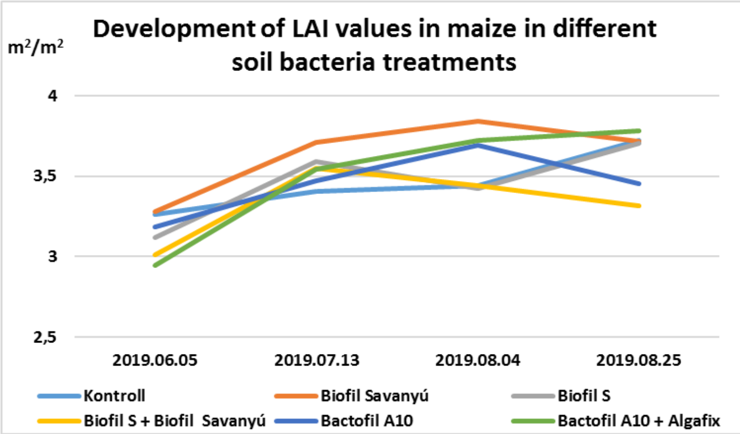

Figure 2: Results of the LAI value of maize during the growing season

During the wax maturation period, the leaf area values of the plots treated with Biofil Savanyú and Biofil S formulations dropped to the values of the control plot, however, then both Biofil Savanyú and Biofil S produced higher SPAD values, thus, by combining the two data, the foliage of both areas underwent a higher level of photosynthesis compared to the control, which thus resulted in better nutrient inflow into the cobs.

The combination of Biofil Savanyú + Biofil S formulations in this case resulted in lower leaf area values compared to the control. Although the SPAD values at that time were significantly higher than the control value, but still this higher chlorophyll content and the resulting more intense photosynthesis could not compensate for other differences resulting from smaller leaf area, it was practiced by plant crop formation. The best performing treatment was BactofilA10 + Bactofil AlgaFix treatment. Here, in returning the result, I came to the conclusion that the effect of the bacterial vaccine is smaller, yet the beneficial effect of algae is not reflected in the SPAD values, but in their effect on leaf area, as the SPAD values measured at this time were nothing below the control treatment for the combination.

In the case of the plot treated with Bactofil A10 only, I experienced an important decrease in leaf area, which can be traced back to the fact that the bacterial treatment alone can only have a positive effect on chlorophyll synthesis and thus on leaf life, however, not an increase in leaf area towards the end of the growing season.

Effect of bacterial inoculation on corn grain saturation

During milky maturation, bacteria stimulate plant development. The formulations were able to produce an average weight gain of 45-50 g as development progressed, versus an increase of 30 g in the control. I can trace this back to their effect on SPAD values, whereas the less favorable water supply allowed both the assimilates of the plant to flow through half of the pipes, in addition, it was associated with higher root mass during treatment with AlgaFix, which can all be attributed to the positive, stimulating effect of microbial life.

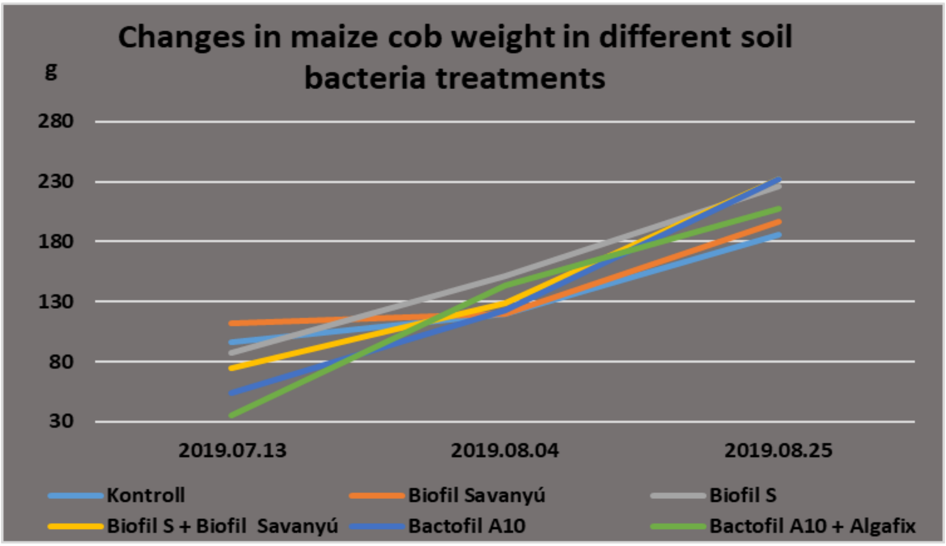

Figure 3: Changes in maize cob weight during the generative phase of the growing season

Effect of bacteria on maize grain yield

The plot treated with Bactofil A10 and the area treated with Biofil S produced the best values, producing more yields with a yield surplus of 1.5 t/ha *(Figure 4)*. For Biofil S, steadily increasing grain saturation, high chlorophyll content is easily caused by the treatment, large leaf area during milky ripening, which, together with the high chlorophyll content, increased the flow of large amounts of assimilates.

The aforementioned effective was coupled with the high stem weight after flowering, which referred to the highly advanced water-carrying tissues, then the "revitalization" of the stem after the subsequent reduction, which ensured the influx of nutrients into the crop even in the late times. In the case of Bactofil A10 the average of the sampling results, can be said in comparison with each other, that the effect of bacterial treatment is steadily developing resulted in a plant that responds evenly and with little fluctuation to various stress effects (drought, herbicide treatment), which conclusion I came to taking into account the increasing and decreasing tendencies of the data of stem, leaf, and root masses.

So the reason for this is the effect of bacteria in this treatment may be to eliminate the effects of stress, which we can deduce from the activity of bacteria in aiding plant nutrient uptake. In 3rd place was the area also treated with AlgaFix. The effect of Bactofil A10 varies in this area as in the area treated with pure Bactofil A10 alone. Here, the beneficial effects of algae are reflected in the initial SPAD values, which, with its initial high chlorophyll content, helped the plant to develop its rapid growth vigor.

The combination of Biofil Savanyú + Biofil S products produced the smallest yield increase (approximately 900 kg/ha). This is due to the fact that although it helped the development of the plants compared to the control, but in the first half of the growing season, the bacteria competed with each other at the expense of plant development, which I can attribute to the toxic substances produced as well as the antibiotics produced.

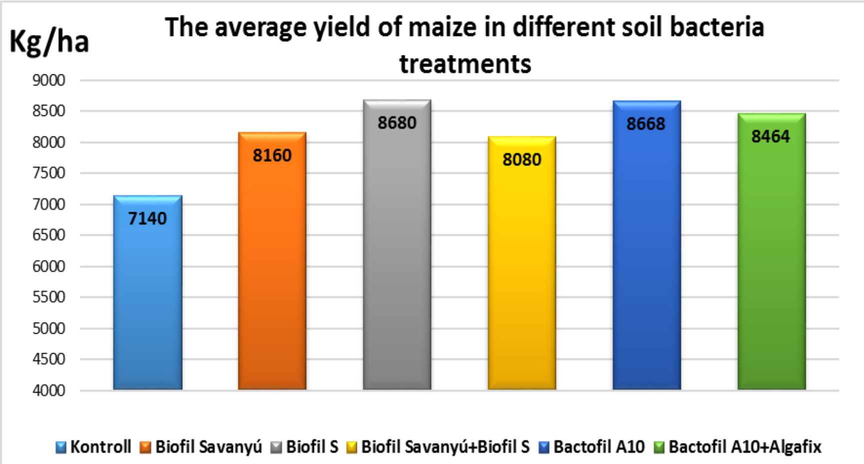

Figure 4: Yield results for each plot

Changes in sunflower root mass as a result of bacterial inoculation

In sunflower experiment the most significant difference in star bud condition was the change in root mass of Bactofil B10, Bactofil B10 + AlgaFix, and Biofil Savanyú. It can be clearly seen that the root mass of the area also treated with AlgaFix was twice as large as the control panel, which may have 2 factors in the background.

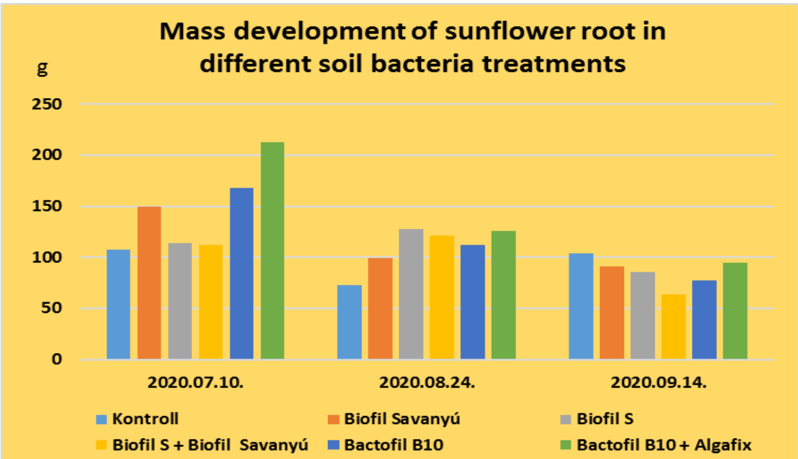

Figure 5: Changes in sunflower root mass as a result of treatments

First, algae had a stimulating effect on the vegetative mass of plants, as a result of which the root growth also had to keep pace with the above-ground vegetative organic growth, so that it can optimally supply the vegetative mass with water and nutrients. The second factor was that higher root mass was associated with higher bacterial activity around the root, which results in the amount of nutrients that can be used for the larger root, which stimulated root growth. Although the plots treated with Biofil S and Biofil Savanyú + Biofil S exceeded the values of the control plot, but the masses lagged significantly behind the other treatments, which I trace back to, that in the case of the plot treated with Biofil Savanyú + Biofil S preparations, the bacterial strains competed with each other differently stimulated them with root growth. However, in the case of a plot treated with Biofil S, the delayed action of slower-growing bacteria can be inferred from the step, which also resulted in slower rhizoplan layer formation (Figure 5).

Effect of bacterial inoculation on SPAD of sunflower leaves

In the phenophase of the lemon maturation, knowing that the decrease in value, the fall as a result of each treatment was different. The smallest decrease was observed in the plot treated with the combination of Biofil Savanyú + Biofil S formulations, which I can be aware of, that the bacterial flora had recovered by the last third of the growing season, competition was eliminated, which had a positive effect on chlorophyll content, whereas the larger bacterial flora was able to form a more varied composition of rhizoplanes at the root, resulting in a chlorophyll content producing smaller fluctuations.

The other treatments decreased by an average of 6 values, however, the AlgaFix-treated plot fell by only 5.4. In light of this, I can conclude, that although the intensity of bacterial life has decreased in re-drying soil, plots treated with algae were able to positively affect SPAD values *(Figure 6).*

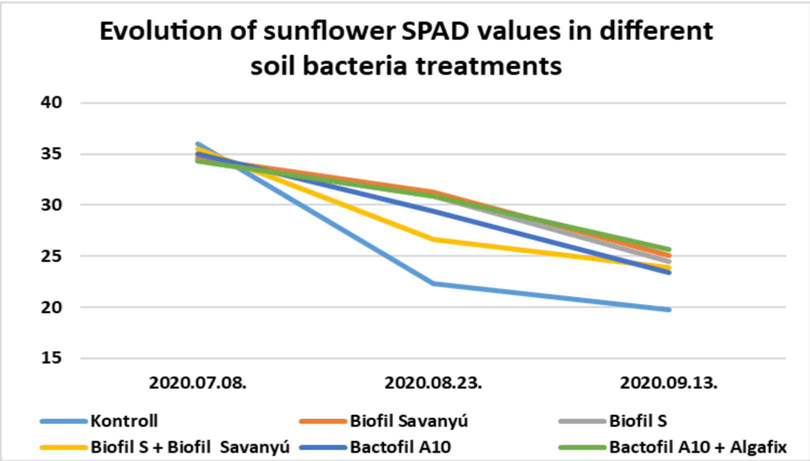

Figure 6: Development of SPAD values of sunflower as a result of treatments

Effect of sunflower yield on bacterial inoculations

The best results were produced by the plot treated with Bactofil B10 + AlgaFix, with a yield surplus of nearly 400 kg. The yield surplus can be clearly seen by comparing the yield results of the control, Bactofil B10 and Bactofil B10 + AlgaFix plots, that the algae had the best effect, however, it should be mentioned here, that algae mediate the effect of plant water release on the life of bacteria, they were able to create more favorable conditions, thus, they were better able to make their nutrient exploration work worthwhile, however, which lagged behind plots inoculated with Bactofil B10 alone.

The plot treated with the combination of Biofil Savanyú + Biofil S was below the control plot, which I can trace back to the fact that, as a result of the mixing, the bacterial strains began to compete with each other, resulting in the choice of substances and antibiotics. The plot treated with Biofil Savanyú was able to produce an extra 120 kg yield for the control, thus, the beneficial effect of bacteria was also present in this plot, however, here it is more during vegetative development (*Figure 7)*

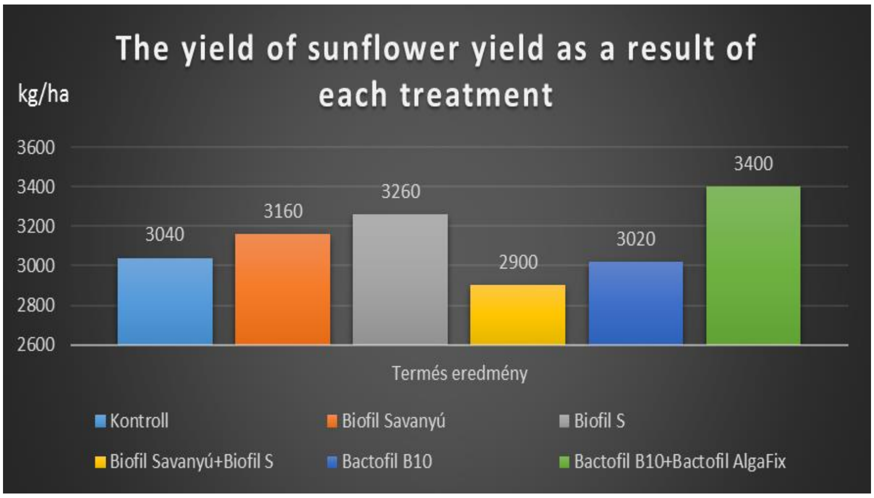

Figure 7: Effect of bacterial inoculation on yield

CONCLUSIONS

Algae were best able to affect plant mass as well as chlorophyll content, however, their effect was rather measurable in the long run by the fact that the tissues of plant levels began to age instead of slower, and they were better able to withstand the drought. This is all due to the fact that algae, when penetrating the tissues of plant levels, in conjunction with them, they improve the water supply by introducing the assimilates they produce into plant tissue, and stimulated the synthesis of chlorophyll, which had a positive effect on eye development later in the generative phase.

The effect of bacterial inoculation on yields was extraordinary. This is due to the effect that the rhizoplane layer formed by the bacteria on the roots, revealed nutrients, they could flow more intensively into the tissues of the plant, which in the area treated with bacteria were able to reach the place of fruit formation in the more advanced tracheal passages, thus optimally supplying the formed grains with water and nutrients even in the most unfavorable period.

In conclusion, I can say that there is a raison of bacterial inoculation, because in drought years up to 500-600 kg of crop surplus or even greater results can be achieved through activities as well as through the impact of plant development.

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