RESULTS OF FOLIAR FERTILIZER TREATMENTS ON MAIZE YIELD IN DRY YEAR

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Abstract. *The aim of our study was to evaluate the effect of different foliar fertilizers on the yield and grain protein, oil and starch content of maize. The experiment was set up in 2021 at the Öthalom research station of the Hungarian University of Agriculture and Life Sciences in Szeged. The soil was deeply salt meadow chernozem. Its nitrogen content was medium, phosphorus and potassium content was good. The experiment was carried out in three replications, using random blocks design. The size of plots were 14 m^2. The produced maize hybrid was DKC 4555 (FAO 350). We sprayed three foliar fertilizers individually and combined with each other. We processed the obtained data by single factor variant analysis. 2021 was unfavourable year for maize. The amount of precipitation was lower by 113.58 mm than the average in the vegetative period of maize, therefore we got relatively low yields. The yield amount of control plot was 2.44 t ha^{-1}. As a result of lack of precipitation the foliar fertilizers resulted low yield increasing (0.04-0.7 t/ha) which was not significant. The highest yield (3.14 t ha^{-1}) we got in Amalgerol+Fitohorm Zn treatment. The foliar fertilizers resulted minimal and not significant changes in maize grain protein, starch and oil contents. We can conclude, that in unfavourable relatively dry year caused low effectiveness of foliar fertilizers in maize production.*

Keywords*: maize, foliar fertilizer, yield, grain protein content*

INTRODUCTION

Among the plants grown on a large area in the world, the area sown with maize (~196 million hectares) and the amount of maize produced (~1150 million tons) grew the fastest in the last two decades and this trend continues today. The reasons for this are complex, among which the particularly high productivity, the ever-expanding successes of breeding (e.g., improving abiotic stress tolerance), modern agrotechnology, the excellent plant reaction to agrotechnical elements (fertilization, irrigation, etc.) and its versatile usability should be highlighted (PEPÓ, 2022).

The nutritional requirements of maize are high. It requires a significant amount of nitrogen, which is necessary to create a large vegetative surface, and the need for potassium is also high. Phosphorus is also an important macro-element, which is important for the development of the root system and maize grain. Of the meso-elements, calcium and magnesium, and of the micro-elements, zinc is the most important for maize (LÁNG, 1976; BOCZ, 1976; PEPÓ and SÁRVÁRI, 1999; KRISTÓ, 2004; NAGY, 2007; PEPÓ and CSAJBÓK, 2013; MONOSTORI, 2014; DÓKA and SZABÓ, 2014; KINCSES and BALLÁNÉ, 2017; SÁRVÁRI, 2018; NAGY, 2021)

Bio-stimulants are natural or artificial substances that can be used in different ways (applied on the surface of the seed, on the vegetation or in the soil). These substances result in changes in the metabolic processes of plants, which increase resistance to abiotic stress effects, and also affect growth and the quantity and quality of the crop. Another advantage is that the usage of fertilizers can be reduced with their application (HOFFMANN et al., 2014; *Timac Agro Hungária*, 2020).

Plant nutrition through the leaves is a new technological possibility of modern plant cultivation, which has a direct effect on the physiological processes of the plant. The soil plays a mediating role in the absorption of nutrients, which is why the ability to absorb nutrients is greatly influenced by the physical and chemical properties of the soil. In a study, an algal biostimulator foliar fertilizer treatment was used in the 8-leaf development stage of maize. Based on the research results, it was found that the algae treatment increased the protein content of the grain crop by more than 0.6% and the amount of the crop by 10-11% (ILLÉS et al., 2020).

MACC-612 *Nostoc piscinale* cyanobacterium treatment of maize plants resulted in a higher yield than that of the control. Treatments increased cob length and thousand-grain weight and, in some cases, cob diameter as well (TAKÁCS et al., 2020).

As a result of the biostimulator foliar fertilization, the yield of maize increased, but this could not be verified statistically. Among the yield-forming elements, the treatments also increased the thousand-grain weight *(*JAKAB et al., 2016; JAKAB et al., 2017).

MATERIAL AND METHODS

Our experiment was carried out in 2021 at the Öthalmi Experimental Plant of the Hungarian University of Agriculture and Life Sciences, Institute of Plant Breeding Sciences, Plant Breeding and Agrotechnical Research Station in Szeged. The soil of the experiment was deep salty meadow chernozem. The soil was almost neutral, medium in nitrogen, and well supplied in phosphorus and potassium. The small-plot experiment in the field was set up in a random block arrangement in 3 repetitions. The size of the plots was 14 m^2. The forecrop was autumn barley. During the nutrient supply, 200 kg/ha of NPK fertilizer (15:15:15) was applied in the autumn of 2020. In the spring of 2021, 40 kg/ha of nitrogen fertilizer was applied as top dressing. Sowing took place on April 24, 2021, the test plant was the DKC 4555 (FAO 340) maize hybrid. Post-emergence weed control was carried out after sowing.

The foliar fertilizers were applied with a backpack sprayer in the dosage recommended by the manufacturers, in the 6-8-leaf stage of the maize.

The applied foliar fertilizers were the following:

Algafix, microbiological biostimulator, which contains Balaton algae producing cytokinin, thereby helping the growth of plant shoots.

Amalgerol, which is a complex preparation, containing plant extracts, plant essential oils and mineral oils.

Fitohorm Turbo Zn, which contains zinc, the most important trace element for maize.

The protein, starch and oil content of the maize kernel was measured with a Miniinfra 2000 T grain analyzer instrument.

The statistical tests were performed using one-factor analysis of variance, based on the method of SVÁB (1986).

In 2021, the rainfall during the maize growing season was 113.58 mm less than the long-term average, which was very unfavorable for the vegetative and generative development of maize and resulted in low crop averages *(Table 1).*

Table 1

Amount of precipitation during the growing season of maize
(Szeged-Öthalom, 2021)

Month	Precipitation (mm)	Long-term average precipitation (mm)	Deviation from average (mm)
April	30.4	37.15	-6.75
May	70.6	64.56	6.04
June	10.7	78.85	-67.15
July	40.3	61.30	-21.00
August	33.6	38.78	-5.18
September	30	49.55	-19.55
Total	**215.6**	**329.18**	**-113.58**

(Source: *Cereal Research Non Profit Company*, 2021)

RESULTS AND DISCUSSIONS

The yield measured in the control treatment was 2.44 t/ha. In comparison, we obtained higher yields on all plots treated with foliar fertilizers (2.48-3.14 t/ha) *(Figure 1).*

However, the deviation from the yield of the control plot could not be statistically verified in any of the treatments.

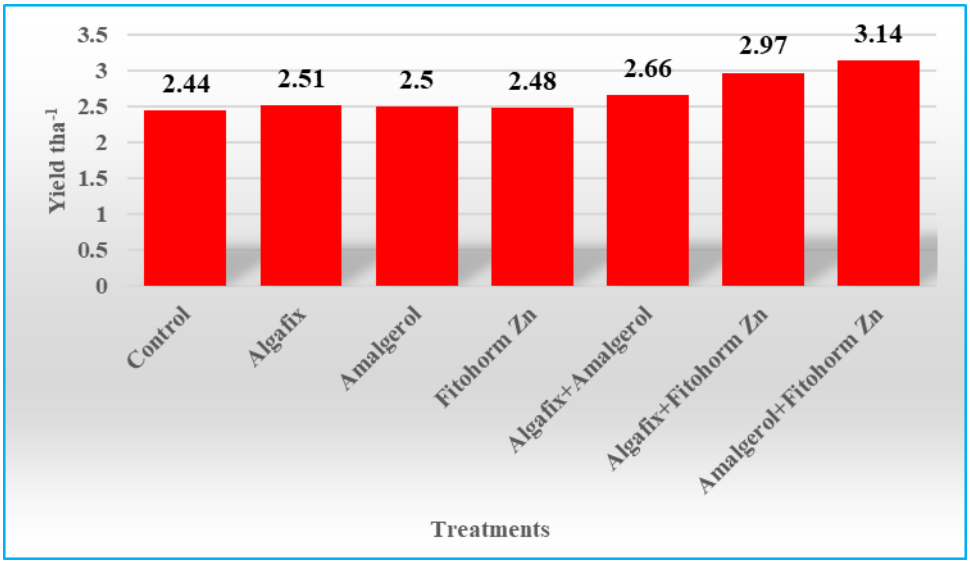

Figure 1. The effect of foliar fertilizers on maize yield (t/ha)
(Szeged-Öthalom, 2021)

When the foliar fertilizers were used alone, we measured a yield increase of 0.04-0.07 t/ha compared to the control treatment. The highest yield increase of 0.07 t/ha resulted from the treatment with Algafix.

When we used the foliar fertilizers in combination, we achieved a yield increase of 0.22-0.7 t/ha compared to the yield of the untreated plot. The Amalgerol + Fitohorm Zn treatment resulted in the greatest yield increase of 0.7 t/ha.

We investigated the effect of foliar fertilizers on the protein, starch and oil content of corn kernels. We measured 11.50% protein content in the untreated plot. The protein content of the corn kernel increased slightly (0.17-0.23%) when the foliar fertilizers were used alone. The highest value, 11.73%, was measured in the plot treated with Amalgerol and Fitohorm Zn preparations. When the foliar fertilizers were used in combination, the protein content of the corn kernel decreased compared to the control.

The starch content in the control treatment was 67.13%. As a result of the foliar fertilizers, the change in starch content was small (0.13-0.83%). Among the examined content values, the oil content of corn kernels changed the least (0-0.27%). Compared to the values measured in the control treatment, the magnitude of the change could not be statistically verified in any of the cases.

Table 2

The effect of foliar fertilizers on the protein, starch and oil content of maize kernels

Treatments	Protein content (%)	Starch content (%)	Oil content (%)
Control	11.50	67.13	3.60
Algafix	11.67	66.93	3.60
Amalgerol	11.73	67.00	3.50
Fitohorm Turbo Zn	11.73	67.17	3.67
Algafix+Amalgerol	11.00	67.97	3.50
Algafix+Fitohorm Turbo Zn	10.83	67.70	3.63
Amalgerol+Fitohorm Turbo Zn	11.37	66.93	3.33
$LSD_{0.05}$	**1.68**	**1.42**	**0.36**

CONCLUSIONS

The dry weather of 2021 had an unfavorable effect on the maize yield. The crop of the control treatment was only 2.44 t/ha. As a result of the foliar fertilizer treatments, this amount only increased by 0.04-0.7 t/ha. There was no statistically verifiable increase in the yield. The foliar fertilizer did not significantly affect the protein, oil and starch content of the corn kernel. Although the yield-increasing effect of the foliar fertilizers fell short of the 1-1.5 t/ha reported in the literature, the results still prove that the foliar fertilizers are able to increase the yield and improve crop safety even in a dry season. As a result, their use is justified even in the increasingly variable weather conditions in maize cultivation.

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