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Research Article

Investigation of Foliar Fertilization in Maize Production

Péter Jakab*, Gábor Zoltán, Dávid Festő, Levente Komarek

University of Szeged, Faculty of Agriculture Andrassy str. 15. Hódmezővásárhely, Hungary

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Abstract

The experiment was designed to study the effect of foliar fertilisation on the yield and some generative factors of maize in 2016. It was set on the territory of SZTE Tangazdaság Ltd in Hódmezővásárhely meadow chernozem soil. Three different foliar fertilizer products were applied in three replication randomised small plot experiment. The products were sprayed out individually and combined with each other as well, so there were six treatments and the control. In 2016 the amount of precipitation in the vegetation period of maize was higher than the average by 23.7 mm. Therefore this year was favourable for maize production. The data obtained during the experiment were processed by single factor variant analysis. Owing to the favourable dispersion of rainfall in the vegetative period of maize, the yields were relatively high. The average yield harvested from the control plots was 11.37 t/ha, and that of the treated parcels ranged from 11.61 and 12.86 t/ha. The foliar fertilizer products and their combinations increased the yield of maize, but this growing was not significant. By the using of foliar fertilization the generative factors of maize did not change significantly.

Keywords: maize, foliar fertilization, grain yield, thousand seed weight, grain moisture content

Introduction

Maize is one of the plants grown on the largest areas in the world and in Hungary as well. Its production is vital since it is a kind of grain that can be used in many ways. The genetic productivity of the newest maize hybrids is continuously growing. In order that the potential of hybrids productive capacity can be utilized as much as possible, the harmony of the agro-technical factors is necessary [1].

The low average yield in maize production can be due to the fall-back of chemical fertilization; this is why the use of fertilizers must be increased in order to reach higher and more consistent amounts of crop [2, 3, 4, 5, 6].

Most arable crops obtain the necessary macro and micro elements from the soil. Foliar fertilization is getting more and more widespread,

however it still requires comprehensive experimental research. Precise, repeated small plot trials must be carried out to clarify the factors influencing the effectiveness of foliar fertilizers and recommendations must be developed for producers [7].

The recent results of the soil tests show that due to the intensive maize production in Hungary the zinc content of soils fell back sharply. The soil might have a relative zinc deficiency even if there is a good supply of zinc. It is caused by the antagonism of phosphorus and zinc uptake in those areas where the phosphorus content of the soil is very high [8, 9, 10, 11].

The foliar fertilization improved the amount of the yield, but the growth was not significant. The yield components of maize did not change statistically justified due to the application of foliar fertilization [12, 13].

Foliar fertilizers are unanimously considered stimulating and corrective products for mineral nutrition. They exhibit a secondary fertilizing role, that determines a significant increase of the productive consumption for soil elements and soil-applied elements without substituting root

* Corresponding author: Péter Jakab,
jakabpeter@mgk.u-szeged.hu

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fertilization methods (through the soil), where foliar fertilizers are supplementary in balancing and optimizing the fertilization system applied to agricultural and horticultural plants [14, 15, 16, 17].

Nowadays besides the fertilizers even more farmers use different bacterium preparations in nutrient supply of arable crops. This product contains different bacteriums which can improve the nutrient supply of plant. With the application of these products we can reduce the amount of fertilizers, which enables the environmentally friendly and economical production. They improve

the physical properties and chemical properties of the soil, and maintain the soil fertility [18, 19, 20, 21, 22].

Material and Methods

The experiment was carried out on the territory of Tangazdaság Ltd. in Hódmezővásárhely on nearly neutral meadow chernozem soil (pH_{KCL} 7.17). Before setting the experiment soil analysis was done, and the obtained data showed that the soil had good nitrogen, and very good phosphorus and potassium contents (Table 1).

Table 1

The main properties of the experimental field area

pH (KCL)	P ₂ O ₅ (mg/kg)	K ₂ O (mg/kg)	Humus (%)	Soil plasticity value (K _A)
7.17	336	620	3.39	48

The year 2016 was favourable for maize production. In 2016 precipitation in the vegetative period of maize was higher by 23.7 mm than the 50 year average. In June and July fell more precipitation (+60 mm) compared the 50 years average. This amount of precipitation affected the generative development phases, the flowering and fertilization, just as the grain filling of maize populations favourable. In September there was an average amount of precipitation, which promoted the drying processes of maize crops and also the harvest works (Table 2).

The applied agro-technology

The small-scale experiment was carried out in three replications, in random blocks. The size of parcels was 7.6 m². The previous crop was winter wheat. Tillage (deep ploughing at 30 cm depth) was done in autumn. The sowing date was on 14

th. of April. The examined hybrid was Limanova (FAO 370). The plant density was 70.000 plant/hectare. Foliar fertilization treatments were applied at 6-7 leaves stage. The foliar fertilizer products were applied with a dose suggested by manufacturers. The applied products were the following: 1) Algafix (microbiological bio-stimulator, that contains live algae which produce cytokinin, a plant hormone to help the shoot-growth of the plant), 2) Amalgerol (a product containing plant oils, herb extracts, trace elements and essence) and 3) Fitohorm Turbo Zn solution (containing Zn, the most important microelement for maize). The products were sprayed out individually and combined with each other as well, so in total there were six treatments and the control. Apart from foliar fertilization the parcels received the same agrotechnology.

Table 2

The amount of precipitation in the vegetative period of maize in 2016

Month	Rainfall (mm)	Average rainfall (mm)	Difference (mm)
April	19.4	39.9	-20.5
May	38.8	58	-19.2
June	86.0	75.3	10.7
July	106	58.7	47.3
August	47.6	48.7	-1.1
September	47.2	40.7	6.5
Total amount of rainfall (mm)	345.0	321.3	23.7

The plots were harvested by hand, then the yield of the parcels, grain humidity, cob: grain yield rates and thousand-grain weight were measured, out of which the shelled grain yield in May was calculated.

In order to perform the analysis, one-way analysis of variance (ANOVA) and Tukey test were applied. ANOVA was used to clarify whether the means of the different treatments (groups) differ significantly. If ANOVA, based on the F-test, detects significant difference among these means, another test is then applied to determine exactly which means differ significantly from the others. Significant differences between the means of different treatments may highlight the impact of the individual treatments on the analyzed parameter.

There are several versions available for comparing means calculated from subsamples of

a sample. A relatively simple but effective way is to use the Tukey test [23, 24, 25].

Results and Discussions

Without foliar fertilization the yield of the hybrid in our experiment was relatively high, 11.37 t/ha. It shows, that this hybrid has good nutrient exploration and utilization capacity. The newer maize hybrids are improved both in the natural nutrient exploration and utilisation capacity and in their reaction of fertilizers.

With the foliar fertilization products the yield ranged between 11.61-12.86 t/ha. The treatments results 0.24-1.49 t/ha yield increasing compared the control plots. When foliar fertilization was applied, the yield was higher, but this growth was not significant on P 5% level compared to control. We obtained the highest yield in Amalgerol (12.86 t/ha) and Algafix+Amalgerol (12.34 t/ha) treatments (Figure 1).

Fig. 1. The maize hybrid yields in control and foliar fertilization treatments

The effect of foliar fertilization was studied on the yield components of maize (thousand grain weight, cob:grain yield rates, grain moisture content at harvest). The yield components are highly dependent on the genetically background of maize hybrid. However, the environmental and cultivation practices are able to influence these values. Among the cultivation practices, the nutrient supply had the highest effect on these

properties. The thousand grain weight was 423.33 g in control treatment. Under the influence of foliar fertilizers, the thousand grain weight ranged between 403.33 and 430.00 g. The highest values of thousand grain weight (430.00 g) we measured in Fitohorm Turbo Zn and Algafix+Fitohorm Turbo Zn treatments (Figure 2.) The change of thousand grain value compared the control was not significant on P=5% level.

Fig. 2. The effect of foliar fertilization on the thousand seed weight of maize

The average yield of maize is influenced by the cob:grain yield ratio. The larger the weight of grain, compared to the weight of the cob, the higher the yield is. One important objective for breeding is to increase the proportion of the grain. The cob: grain yield rates of the new hybrids are more than 80%, sometimes approach 90%. The cob: grain yield rates of hybrids are greatly influenced by the genetic traits of the hybrids, which can be altered only to a slight extent by different agrotechnical elements. It is also proved by our experiment results, as the value of the

control treatment did not change significantly the different treatments. The cob: grain yield rates of the maize hybrid increased most by Algafix (89.99%) as well as Algafix+Amalgerol (89.91%) and the Amalgerol+Fitohorm Turbo Zn (89.81%) treatments. The incensement compared the control (89.62%) was slight (Figure 3). The different treatments did not increase this parameter significantly on $P=5\%$ level, because it is highly dependent on the genetical characteristics of hybrid.

Fig. 3. The effect of foliar fertilization on the cob: grain yield rates

The grain moisture content at harvest is an essential measure of maize value. It is important that the hybrids should have low grain moistures at harvest, then the cost of drying can be reduced and also the profitability of maize production can be increased. The grain moisture content of control plots were 16.35%. In treated parcels we

measured 15.83-16.52%. The difference was not significant between control and treated results. The Amalgerol+Fitohorm Turbo Zn (15.83%) and the Algafix+Amalgerol (15.89%) treatments results the lowest grain moisture content at harvest (Figure 4).

Fig. 4. The influence of foliar fertilization on the seed moisture content at harvest

Conclusions

The year 2016 was favourable for maize production. Therefore the control yield of maize was relatively high, 11.37 t/ha. The different foliar fertilizer products increased the maize yield with 0.24-1.49 t/ha, but it was not statistically justified on P=5% level.

The generative factors did not change significantly either when using foliar fertilizer products. Our results proved that the foliar fertilization can increase the yield of maize in the case of favourable weather conditions; therefore it has an importance in maize production. The results of the experiment provide information only in case of the given test area; no general conclusions can be drawn. To make adequate statements, several-years experiment is necessary. Therefore we would like to continue our experiment.

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