DIFFERENT WAYS OF FERTILIZER APPLICATION TOGETHER WITHBIO-EFFECTORS FOR MAIZE BIOTOPE

L. Chládek[1], Z. Holečková[2], P. Vaculík[1]

[1]Department of Technological Equipment of Buildings, Faculty of Engineering, Czech University of Life Sciences Prague, Czech Republic
[2]Department of Agro-Environmental Chemistry and Plant Nutrition, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Czech Republic

Abstract
This project is focused on different effect of applications of so-called bio-effectors on hectare yield and dry matter in maize plants. The difference between local and broad applications was monitored in field conditions on two sites. Local application was performed using machine GFI 3A and broad application was performed manually by tap. The results show that difference between local and broad application of bio-effectors does not have a statistically significant effect on yield per hectare or on a percentage of dry matter.

Key words: fertilizer, application, bio-effector, maize.

INTRODUCTION

The aim of this study was to evaluate the influence of different fertilizer application together with so-called bio-effectors in field conditions on percentage of dry matter and yield of maize. Today's society is dependent on inorganic compounds of nutrients (fertilizers, feed or food additives) and largely exploits limited world natural resources of minerals this way, which are important for fertilizer production. For these reasons, there is a common need for development of more sustainable mechanisms that would maintain availability of nutrients for crops and livestock, with a smaller amount of supplied mineral fertilizer which will also lead to improvement of soil functions. Creation of new strategy requires better public awareness about consequences of farming approaches on the environment, better understanding of the dynamics of nutrients in the soil-plant relationship, the creation of new innovative technologies in order to reduce dependance of world population on mined minerals and increase efficiency of fertilization. Development of new strategies is expected to have significant economical and environmental impact WITHERS (2014). Due to growing world population it is expected that demand for food and feed will be continuously increasing and limited availability of productive agricultural land and increasing dependance on mineral fertilizers will be among main issues for society to cope with. It is necessary to develop alternative strategies for plant nutrition NEUMANN (2012) and HOGENHOUT (2009). This project deals with different effects of applications so-called bio-effectors on hectare yield and dry matter in maize plants. These compounds containing microorganisms (bacteria, fungi) and active natural substances, such as extracts from soil or compost, microbial residues, plant extracts or products of biological processes. These products are developed for a wide variety of crops (e.g. maize, wheat, tomatoes, rape, spinach, grass, ornamentals). Their efficiency causes mobilization of nutrients from less accessible forms in soil NEUMANN (2012) and SMALLA (2012), they further support root growth GALLETTI (2015) and FERRIGO (2014) and mycorrhiza development YUSRAN (2009). Examined the difference between local applications, which was performed using machine GFI 3A (Maschinen und Antriebstechnik GmbH Güstrow, Germany) and broad application, which was performed manually by tap.

Principle of local application

Mineral fertilizers are the most expensive and most important annual volume input into agriculture ŠANTRŮČEK (2007). For this reason was especially in Germany, intensively studied and gradually applied in agricultural practice a new system of plant nutrition using local applications, which should increase the use of nutrients from applied fertilizer or other substances applied BALÍK (2007). Local application is based on earlier discoveries of Mr. Prof. Karl Sommer from Bonn University and current research in small plot trials in the Czech Republic. One of the new liquid fertilizer application technologies, pesticides or different nutrient solutions is so-called injectable dosage. MAŠEK (2005) and JUREN (2006) report that so-called injection dosage of liquid fertilizer or other nutritive substances is agro technical act "in reserve", where plant can uptake amount of nutrients, which it needs from the depot in soil. The machine consists of tank, pumps and application frame, which can reach up to 18 meters width (picture 1 and 2A/B). On the frame there are small spaced wheels, which are circumferentially positioned apexes, which deliver nutrient solution to the soil. The wheels roll over the soil surface and apex which just enters soil and applies nutrient solution. In the application site there is high concentration of nutrients, which are toxic for roots and organisms, but around this stock is formed so-called diffusion zone. From this zone a plant can uptake nutrients via roots depending on the growth stage. The solution is injected under pressure of 150-600 kPa.

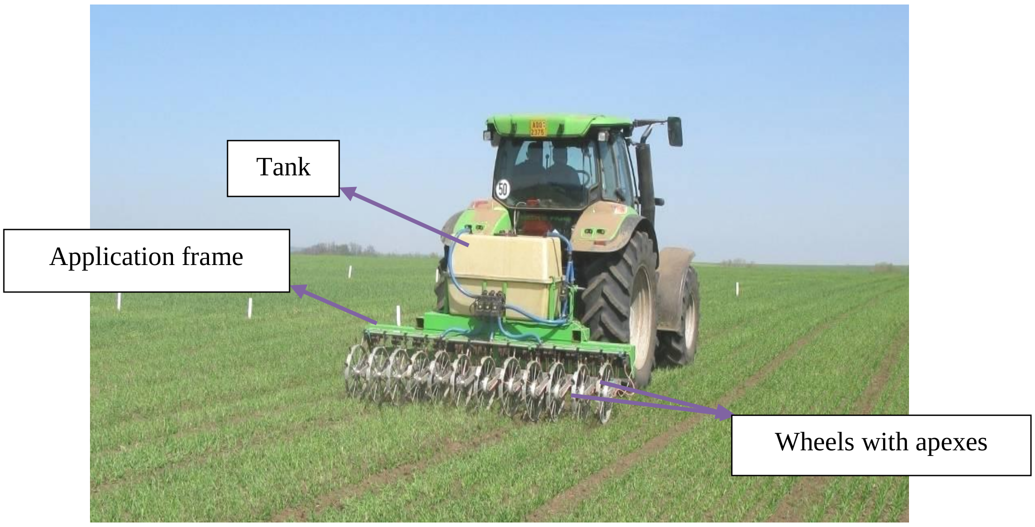

Fig. 1. – Injecting applicator

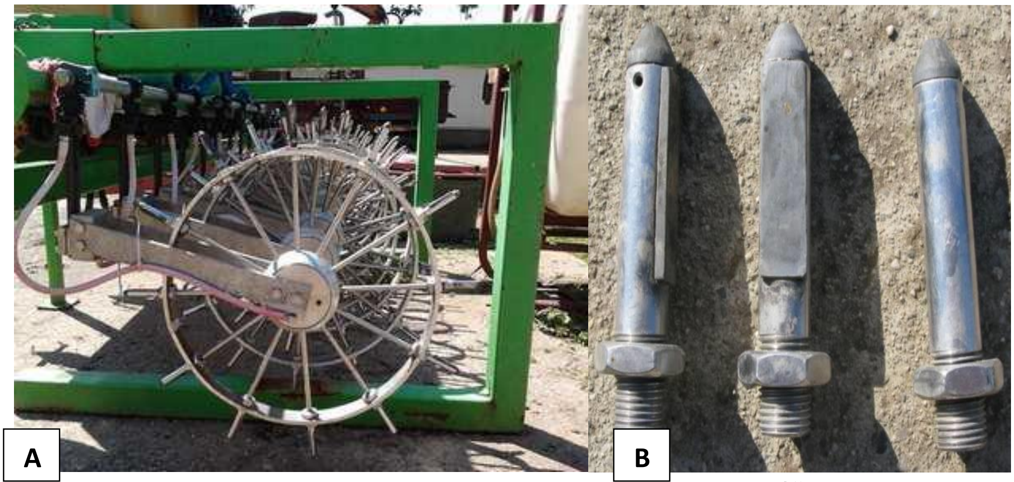

Fig. 2. – Wheels with apexes GFI 3A (A) and application apexes (B) (A – SEDLÁŘ (2013) and B – KOZLOVSKÝ (2011))

MATERIALS AND METHODS

Field experiments

Field experiments were established on 23rd April 2014 at Humpolec site and on 25rd April 2014 at Lukavec site. Test plants was maize (variety Colisee) and machine, seeding rate was 90,000 seeds per hectare. During the field experiment in plots with an area of 31.5 square meters two bio-effectors (Proradix and RhizoVital) were applied in combination with rock phosphate (RP) and triple superphosphate (TSP), which were applied at the same dose of P (2 kg P/ha). Experiments were uniformly fertilized with nitrogen, which was delivered in the form of calcium ammonium nitrate with limestone (CAN) and potassium (Patentkali), which were applied at the same dose of N (120 kg N/ha) and K (50 kg/ha). Each treatment was carried out in ten repetitions. Bio-effectors used in the field experiment were following, with active substance (in parentheses):

i) BE0: Control (water only)
ii) BE1: Proradix (*Pseudomonas sp*.)
iii) BE2: RhizoVital (*Bacillus amyloliquefaciens*, strain FZB42).

Bio-effectors (22.7 kg/ha of Proradix and 2 l/ha of RhizoVital) for the broad application were applied in the form of solution diluted with tap water to the final volume 9 litters per plot (l/plot). For the local application, injection application to the depot was conducted using the machine GFI 3A (Maschinen und Antriebstechnik GmbH Güstrow, Germany). The dose of the Proradix was 10 times lower compared to broad application and the dose of RhizoVital was 1.5 l/ha. Both bio-effectors were applied diluted with tap water (solution dose of 2 l/plot). The same dose of water was also applied (9 l/plot) in control treatment. Experiment was harvested on 18th September 2014 at Humpolec site and on 24th September 2014 at Lukavec site.

Tab. 1. – Design of field experiment (Humpolec and Lukavec site)

No.	Treatment	Fertilizer	BE application
1	0	0	0
2	BE0 (water)	0	broad
3	BE0 (water)	RP	broad
4	BE0 (water)	TSP	broad
5	BE1	0	broad
6	BE2	0	broad
7	BE1	RP	broad
8	BE1	TSP	broad
9	BE2	RP	broad
10	BE2	TSP	broad
11	BE1	RP	local
12	BE1	TSP	local
13	BE2	RP	local
14	BE2	TSP	local

RESULTS AND DISCUSSION

Results of measuremets are described in Tab. 1, 2 and 3. Results were processed in the software Statistica, concretely one-way ANOVA. The introduced results in the Tab. 2 are an average arithmetic values from 14 measurements.

Tab. 2. – Characteristics of experimental fields

Site	Humpolec	Lukavec
Latitude	49°33'15" N	49°33'36" N
Longitude	15°21'02" E	15°58'22" E
Altitude (m above sea level)	525	610
Mean yearly temperature (°C)	7.0	8.2
Mean yearly rainfall (mm)	665	573
Soil type	cambisol	cambisol
Soil sort	sandy loam	sandy loam
pH[1)]	5.1	5.4
P (mg/kg)[2)]	77 (±10) B[3)]	120 (±10) B[3)]

1) Estimated in air dried soil, 0.01 mol/l $CaCl_2$, 1:10 w/v
2) Average basic data estimated using Mehlich 3 method
3) Cathegory B – low content

Tab. 3. – Percentage of dry matter (%) and yield per hectare (t/ha) field experiments in 2014 at Humpolec and Lukavec sites

	Humpolec		Lukavec	
No.	dry matter (%)	yield (t/ha)	dry matter (%)	yield (t/ha)
1	19.4[a]	34.4[a]	25.2[a]	30.2[a]
2	20.6[a]	35.4[a]	25.5[a]	32.3[a]
3	21.1[a]	38.1[a]	24.1[a]	34.9[a]
4	21.4[a]	34.7[a]	24.6[a]	32.8[a]
5	20.3[a]	33.0[a]	24.5[a]	26.9[a]
6	18.8[a]	35.8[a]	24.7[a]	31.4[a]
7	19.2[a]	36.3[a]	24.3[a]	30.6[a]
8	18.4[a]	31.4[a]	25.1[a]	30.1[a]
9	18.9[a]	33.9[a]	23.9[a]	32.5[a]
10	18.7[a]	31.6[a]	26.8[a]	30.4[a]
11	21.4[a]	35.4[a]	23.9[a]	33.1[a]
12	22.4[a]	33.6[a]	23.9[a]	32.8[a]
13	20.5[a]	34.6[a]	24.1[a]	30.3[a]
14	21.2[a]	34.2[a]	28[a]	32[a]
F-test	1.03	1.21	1.00	0.68
p≤*	n.s.**	n.s.**	n.s.**	n.s.**

* p – significance level
** n.s. – no significant

Tab. 3 presents average percentage of dry matter and yield for conducted field experiments. In 2014 had the lowest dry matter percentage variants 8 and 10. On the contrary, the highest percentage of dry matter had treatments 11 and 12, which were treatments of local bio-effector application. The highest average yield per hectare had treatment 3, which was conducted within broad application without bio-effector, only the same volume of water and 7, which was treatment of broad bio-effector application. The lowest yield showed treatment 8 and 10 both at Humpolec site. At Lukavec site had the lowest dry matter percentage treatments 9, 11 and 12. The highest percentage of dry matter had treatment 10, where was conducted broad application of bio-effectors and 14, where was conducted local application. The highest average yield per hectare had treatment 3 where was conducted broad application without bio-effector, only the same volume of water and 11 with local application. On the contrary, the lowest hectare yield had treatments 5 and 8, where broad applications were conducted.

The results show that difference between local and broad application of bio-effectors did not have statistically significant positive effect on yield per hectare or on percentage of dry matter at either of experiment sites in 2014.

Several experiments were realized with bio-effectors in field conditions with various test plants, and there were evaluated the effect of application bio-effectors on plant growth and a many different parameters. And so we cannot confirm results, which were reported by FRÖHLICH ET AL. (2012). They reported positive effects of this preparate in barley cultivation in field conditions. When Proradix was used in field conditions, it increased grain yield (up to 20%) and also increased weight and mass of straw. In our field conditions there was not statistically positive effect of bio-effector application on dry matter or yield.

CONCLUSIONS

Due to growing world population it is expected that demand for food and feed will be increasing and limited availability of productive agricultural land and increasing dependance on mineral fertilizers will ever more come into a question. It is therefore necessary to develop alternative strategies for plant nutrition. This project was focused on different effects of applications so-called bio-effectors on hectare yield and dry matter volume in maize plants. The difference between local applications, which was performed using machine GFI 3A and broad application, which was performed manually by tap was observed. Test plants was maize (variety Colisee) and field experiments were realized at Humpolec and Lukavec site. The results show, that different way of bio-effectors application did not have statistically significant effect on yield per hectare or on a percentage of dry matter at either of experiment sites in 2014. Due to limited number of experiments in the year 2014 only is necessary to continue in this research to obtain the objective results under impact of different climatic condition in following periods.

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Corresponding author:

doc. Ing. Ladislav Chládek, CSc., Department of Technological Equipment of Buildings,Faculty of Engineering, Czech University of Life Sciences Prague, Kamýcká 129, Praha 6, Prague, 16521, Czech Republic, phone: +420 22438 3250, e-mail: chladekl@tf.czu.cz