THE EFFECT OF GLYCEROL BY-PRODUCT ON THE DEVELOPMENT OF MAIZE AND ZINC UPTAKE

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Introduction

Glycerol that is produced as by-product of biodiesel production contains methanol, potassium hydroxide, macro and microelements valuable for plants. After different cleaning procedures it is utilized in agriculture as forage, in food and cosmetic industry. The purification procedure is long and expensive, however, due to the organic carbon content, and the significant amount of macro and micro elements of the by-product, it could be utilized to increase soil fertility.
Our objectives were to find out the effect of glycerol by-product on the Zn uptake of maize, and to examine if it has any effect on the different developmental stages of maize.

Materials and methods

The parameters of the glycerol by-product used for the experiments can be seen on ***Table 1.*** Maize seeds (Zea mays) were used for the experiments, which were put into solution containing 0.5% and 1% glycerol by-product, and glycerol. The seeds were taken out of the solution every hour in the first six hours of the experiment, then 12, 24, and 48 hours later, the seeds were taken out, wiped and measured. After this, the swollen seeds were put onto cotton wools, that were soaked with the previously mentioned solutions, and then the exact time of the turnout of the sprout was detected.

pH_{H2O}	pH_{KCl}	Dry matter %	LOI % (Loss on ignition)	C %	N %	Total P mg cm^{-3}	Total K mg cm^{-3}	Zn-EDTA µg cm^{-3}	Zn-H_2O µg cm^{-3}
10,7	9,6	36	92,6	53,7	0,04	0,92	14,81	28,35	1,4

Table 1. *Parameters of the applied glycerol by-product (on a dry matter basis)*

	pH_{KCl}	pH_{H2O}	LOI %	C : N	Total P mg kg^{-1}	Total K mg kg^{-1}	Zn_{EDTA} mg kg^{-1}	Zn_{H2O} mg kg^{-1}
Control	4,17	5,74	2,08	15	760	4429	1,56	0,15
Gly bp	4,83	5,68	2,57	18	900	5092	2,02	0,29
Zn	4,41	5,47	2,08	15	800	4400	136,8	2,94
Gly bp + Zn	4,73	5,53	2,54	15	960	5100	118,6	1,81

Table 2. *Parameters of the brown forest soil (Gödöllő-Szárítópuszta) used in the experiment*

In order to examine the further development stages of the plant, pot experiments were set on brown forest soil from Gödöllő-Szárítópuszta (***Table 2.***), which K_A value was 25.
The soils have been incubated on room temperature for three weeks with glycerol by-product (1%) /Gly bp/; Zn (100 mgZn kg^{-1} as $ZnSO_4$); and together with glycerol and Zn /Gly bp + Zn/. After this, 200-200g of soil and 8-8 pieces of maize seeds were put into pots. The soil moisture was set to field capacity. The parameters of the incubated soil are presented in ***Table 2***.
The emergence time and the increase of length until the 4 leaf-stage were determined. At this point, the plants were taken out of the soil, then dry matter, Zn concentration and Zn uptake of the shoots and roots were determined. The shoots and roots were hydrolysed by HCl at 105˚C temperature. The Zn content was determined by Perkin-Elmer AAS. The experiment was carried out in 3 replicates.

Results and discussion

The start of germination was considered when the rootlet appeared. Due to the glycerol treatments, the germination of maize seeds started later and was slower compared to the control (Figure 1.) . Regarding the emergence intensity of the seed, neither the glycerol, nor the Zn caused any significant difference compared to the control. However, the glycerol and the Zn together in the soil elongated the emergence time significantly (Figure 2.).
Zn treatment had positive effect on the shoot growth. The glycerol by-product had a growth inhibiting effect until the 2-3 leaf-stage, however, at this effect was not noticeable at 3-4 leaf-stage. The glycerol by-product and Zn together caused the decrease of the plants' height at both the 2-3, and 3-4 leaf-stage (Table 3.).

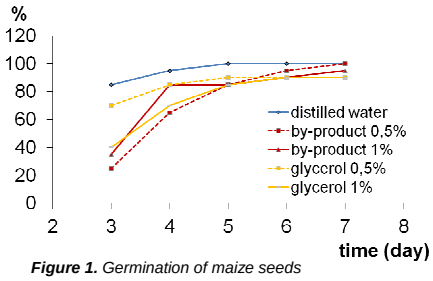

Figure 1. *Germination of maize seeds*

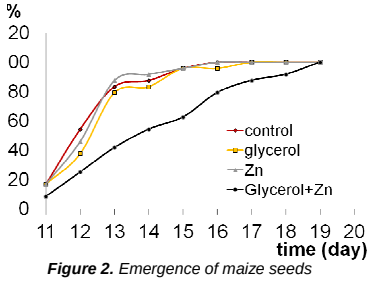

Figure 2. *Emergence of maize seeds*

Based on the results of the dry weight of roots and shoots, the Zn treatment had a positive effect on both the shoot and root yield. The root yield increased due to the glycerol by-product and the Zn treatment compared to the control. At the original Zn content of soil (control and glycerol treatment), the glycerol treatment did not have any effect on the Zn content of root and shoot.
However, soils that were treated with 100 mg kg^{-1} Zn, the Zn content of plants showed significant increase compared to the control, furthermore, the presence of glycerol beside Zn decreased the Zn content of plants. It can be stated regarding the Zn uptake, that the root took up more Zn from soil than the shoot, which is probably due to the higher dry matter weight of root.

	Height (2-3 leaves) cm	Height (3-4 leaves) cm	Dry weight (3-4 leaves) g		Zn concentration (3-4 leaves) mg kg^{-1}		Zn uptake (3-4 leaves) µg pot^{-1}	
			root	shoot	root	shoot	root	shoot
Control	5,15	12,83	0,65	0,31	46,4	55,7	30	17
Gly bp	3,83	11,58	0,81	0,35	46,4	57,2	25	20
Zn	5,60	14,60	0,85	0,43	299,8	253,7	255	109
Gly bp + Zn	2,83	10,94	0,72	0,28	196,4	121,9	142	34
$SD_{5\%}$	**0,76**	**1,35**	**0,14**	**0,08**	**28,6**	**28,4**	**42**	**16**

Table 3. *The effect of glycerol by-product on the parameters of the maize in different developmental stages*

Conclusions

Contaminated and uncontaminated glycerol in different concentrations does not have any effect on the swelling of maize seed after 48 hours. Inhibiting effect of glycerol by-product can be noticed after the physiological processes start within the seed (germination, emergence, growth), especially with Zn treatment, which effect decreases by the development of plants (3-4 leaf-stage).

Acknowledgements

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