EFFECT OF NITRIFICATION INHIBITORS ON ELECTRICAL CONDUCTIVITY OF DASA® 26/13 AND ENSIN® FERTILIZERS

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Abstract. The aim of the paper was to compare the electrical conductivity of two very similar fertilizers delivered by the same manufacturer, DUSLO, Inc.,) Šala, Slovakia. Granulated nitrogen fertilizers DASA® 26/13 and ENSIN® were used with addition of nitrification inhibitors, dicyandiamide DCD and 1,2,4-triazole – TZ. Measurement of electrical conductivity was conducted by laboratory conductivity meter WTW Inolab, model Cond 720. The fertilizers were dissolved in distilled water. 5 g of fertilizer samples and 50 ml of distilled water were used as a dispersion agent. 6 replications of measurements were conducted. Solutions of distilled water and fertilizer were monitored for 120 hours. Time intervals of the measurement for the first 24 hours of the experiment were conducted in 1 hour interval and the next 96 hours a four hour time interval was used. The temperature during experiments ranged from 20.2 to 20.6 ºC. The effect of the nitrification inhibitors on the electrical conductivity of the DASA® 26/13 and ENSIN® fertilizers was found. The electrical conductivity of the solutions was increasing for all the time of the experiment (120 hours) from 0.652 to 15.109 $S \cdot m^{-1}$ and from 1.570 to 15.317 $S \cdot m^{-1}$ for ENSIN® and DASA® 26/13 fertilizers, respectively.

Keywords: fertilizer, fertilizer solution, electrical conductivity, nitrification inhibitors.

Introduction

Fertilization is an important factor that affects the crop yields [1; 2]. Nitrogen is an essential element for plant growth, which has fostered an extensive anthropogenic alternation of the natural nitrogen cycle by the application of fertilizer to optimize the crop yields in agriculture and forestry [3]. Using of the nitrification inhibitors in fertilizer composition affects solubility of fertilizers into the soil. Based on the electrical conductivity of fertilizer dissolved in distilled water it is possible to predict the determined rate of granule decomposition of the fertilizer in soil and therefore the nutrient availability. Measurement of the solution electrical conductivity of the fertilizer in distilled water may indicate the behaviour of the fertilizer in the soil [4-6]. The addition of nitrification inhibitors cause differences in the granulometric composition and in the airflow properties of the DASA® 26/13 and ENSIN® fertilizers [7] what cause irregularity during application of fertilizers. These irregularities lead to the local overdosing of fertilizers and cause increase of the range emissions released from the soil into the atmosphere [8-11]. Electrical conductivity is among the techniques commonly used for indirect detection methods of soil nutrients [12-15]. Dense measurements of soil conductivity are relatively rapid and inexpensive [16], however the precise definition of differences due to decomposition of fertilizers is not clear. In addition, the relationship between electrical conductivity and soil properties is likely to vary depending on the prevailing soil and climatic conditions. For example, in arid regions in salt-affected soils, a large portion of the electrical conductivity variation can be explained by concentrations of soluble salts [17; 18]. In humid climates, the soil texture, moisture, and cation exchange capacity are among the soil properties with the greatest influence on the electrical conductivity [19-22]. Therefore, the definition of the electrical conductivity differences during the decomposition of fertilizers remains to be identified in laboratory conditions and as a solution with distilled water to allow acquiring the most precise results. The scientific experiments were based on the main hypothesis discussed above. It is anticipated that the fertiliser enriched by inhibitors is characterised by higher values of electrical conductivity and slower release of nutrients which was the aim of our study.

The aim of the paper was to investigate the solution electrical conductivity of the nitrogen fertilizer and distilled water on two similar nitrate fertilizers from the same manufacturer. Granulated nitrogen fertilizer with sulphur content DASA® 26/13 and nitrogen fertilizer ENSIN® containing sulphur and nitrification inhibitors dicyandiamide DCD and 1,2,4-triazole – TZ were used.

Materials and methods

The experimental measurements were conducted in the laboratory of the Department of Agricultural Machines, Faculty of Engineering of the Czech University of Life Sciences in Prague, Czech Republic. During the experiments there were used two very similar fertilizers from the same manufacturer DUSLO, Inc. Granulated nitrogen fertilizer with sulphur content DASA® 26/13 was used. Nitrogen is in the ammonium and nitrate form and sulphur is in the water-soluble sulphate form. The granulate has a pink to brown colour and the surface is treated by a coating agent. As a second fertilizer a granular nitrogen fertilizer ENSIN® was used containing sulphur and nitrification inhibitors dicyandiamide DCD and 1,2,4-triazole – TZ. The granulate is treated by a coating agent and has green colour. The nitrification inhibitors ensure transformation of ammonium nitrate to nitrogen nitrate in the soil. The advantages of ENSIN® usage compared to DASA® 26/13 are that the fertilizer is applied in 1 dose and re-application of the fertilizer is not necessary. It allows farmers to save the time and money, increase the crop yields and allows for better quality of crops, the fertilizer is specially environment friendly, reduces nitrate leaching and reduces emissions of nitrous oxide to the atmosphere.

The chemical composition of the DASA® 26/13 and ENSIN® fertilizers is presented in Table 1, respectively. The grain-size distribution of the DASA® 26/13 and ENSIN® fertilizers is shown in Table 3.

Table 1

Chemical composition of DASA® 26/13 and ENSIN® fertilizers

Fertilizer	**DASA® 26/13**	**ENSIN®**
Technical specification	Content, %	Content, %
total nitrogen content (N)	26	26
ammonium nitrogen content	18.5	18.5
nitrate nitrogen content	7.5	7.5
sulphur (S) soluble in water	13	13
dicyandiamide DCD and 1,2,4-triazole content	-	0.37-0.74
DCD:TZ ratio	-	10:1

Table 2

Grain-size distribution of DASA® 26/13 and ENSIN® fertilizers

Dimension, mm	**Content of particles, %**	
	DASA® 26/13	**ENSIN®**
<1	max. 1	max. 1
2–5	min. 90	min. 90
>10	0	0

The measurement of the electrical conductivity was performed by a laboratory conductivity meter WTW Inolab, model Cond 720. The fertilizers were dissolved in distilled water. There were used 5 g of fertilizer samples and 50 ml of distilled water as a dispersion agent. 6 replications of measurements were conducted. The solutions of distilled water and fertilizer were monitored for 120 hours. Time intervals of the measurement for the first 24 hours of the experiment were conducted in 1 hour interval and the next 96 hours a four hour time interval was used. The temperature during experiments ranged from 20.2 to 20.6 ºC.

Results and discussion

The average values (six replication $n = 6$) of the obtained data for DASA® 26/13 and ENSIN® fertilizers during the experiment time interval are shown in Figure 1. The dependence of the electrical conductivity of DASA® 26/13 and ENSIN® fertilizers on the time interval was very similar as it could be seen on the polynomial equations (Fig. 1). The polynomial function was found as superior to describe the trend of the fertilizer decomposition and therefore for description of its dependence with high R^2 factor ($R^2 = 0.997$ and $R^2 = 0.994$ for DASA® 26/13 and ENSIN®, respectively).

During the comparison in the selected time intervals the effect of nitrification inhibitors on the electrical conductivity was found. The results revealed the majority of differences between the fertilizers at the beginning - start of the measurements. The electrical conductivity of the solutions was increasing for all the time of the experiment (120 hours) from 0.652 to 15.109 $S \cdot m^{-1}$ and from 1.570 to

15.317 S·m^{-1} for ENSIN® and DASA® 26/13 fertilizers, respectively. One, four and twelve hours after the start of the experiment the electrical conductivity of the solution with DASA® 26/13 fertilizer (without nitrification inhibitors) in comparison with the ENSIN® fertilizer (with nitrification inhibitors) was significantly higher about 140, 38 and 13 %, respectively. During the time, this difference decreased. After 24, 72 and 120 hours the difference between the DASA® and ENSIN® fertilizers in the solutions was 2.9, 2.5 and 1.4 %, respectively. The results showed that the nitrification inhibitors affect the electrical conductivity of the fertilizer solutions during the first hours of the experiment in higher rate than during the rest time periods.

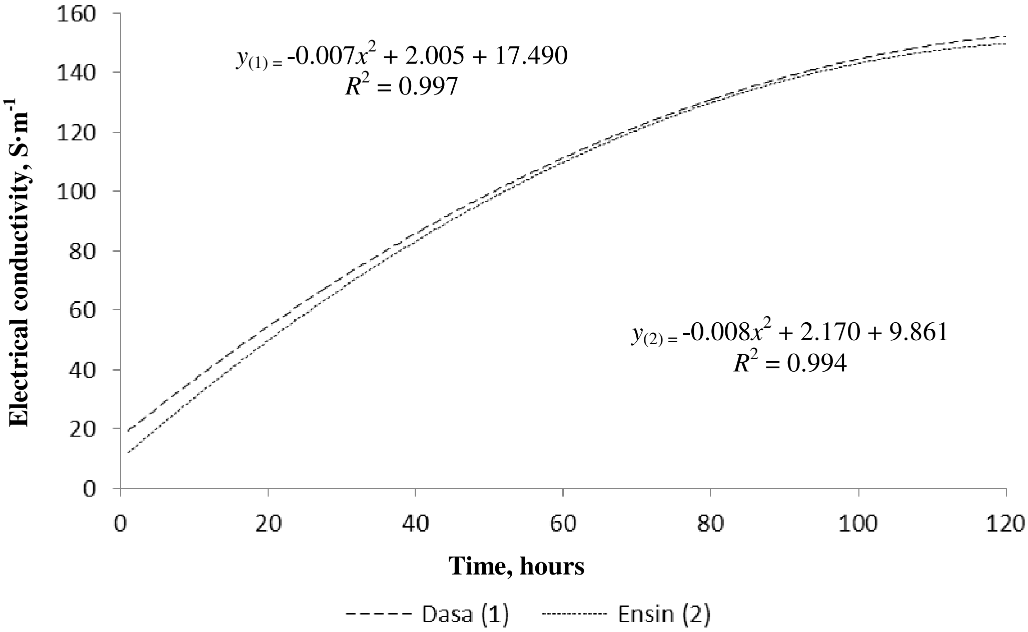

Fig. 1. **Dependence of electrical conductivity of DASA and ENSIN fertilizers on the time interval**

It is anticipated that the lower decomposition time rate of the fertilizer with additional inhibitors in distilled water solution will be reflected in the same or close time rate in soils after its application in comparison with the fertilizer without additional inhibitors. This effect, however, still remains to be seen and should be observed in field conditions which will be the aim of our future study.

Conclusion

The aim of the paper was to compare the electrical conductivity of two very similar fertilizers DASA® 26/13 and ENSIN®. The dependence of the electrical conductivity of the DASA® 26/13 and ENSIN® fertilizers on the time interval was very similar. During the comparison in the selected time intervals the effect of nitrification inhibitors on the electrical conductivity was found. The results revealed the majority of differences between the fertilizers at the beginning - start of the measurements. The electrical conductivity of the solutions was increasing for all the time of the experiment for both fertilizers. The results showed that the nitrification inhibitors affect the electrical conductivity of the fertilizer solutions during the first hours of the experiment in higher rate than during the rest time periods.

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