Fertilising potential of a mineral compound fertilizer based on struvite recovered from the liquid fraction of digestate

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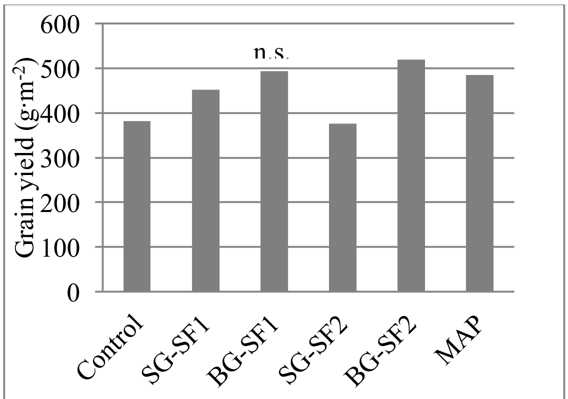
Precipitation of struvite (magnesium ammonium phosphate) has emerged as an effective route for recycling phosphorus from liquid waste streams, e.i. animal manure processing (Cerillo et al., 2015; Szymańska et al., 2019), municipal wastewater treatment (Hallas *et al*., 2019), chemical fertilizer industrial effluents (Rafie *et al*., 2013), dairy industry wastewater (Uysal and Kuru, 2015), urine (Liu *et al*. 2016; Ahmed *et al*., 2018), etc. The struvite is not readily water soluble as compared to conventional mineral phosphate fertilizers such as superphosphates and mono- or di- ammonium phosphates (Talboys et al., 2016). However, literature data (Ackerman *et al.,* 2013; Cerillo *et al*., 2015, Talboys *et al*., 2016) confirm that it is the effective fertilizer for a range of crops. The study conducted by Degryse et al. (2016) showed that the particle size of fertilizer granules affects the dissolution rate of struvite and hence its agronomic effectiveness. Moreover, it is useful to produce struvite products in a form which can be handled, stored and spread by farmers, using their current equipment, and fine powders may not be appropriate (Scope Newsletter 121, 2016).
For the production of the struvite-based fertilizers the following additional raw materials were used: ammonium sulfate from caprolactam production (Grupa Azoty, Poland) and potassium sulfate (SoluPotasse®, Tessenderlo Group, Belgium). The fertilizer granules were produced by the compaction technology in order to avoid dust during dispersion onto the ground and for better (reduced) solubility. The studied fertilizers were produced within the project "Cradle to cattle farming (CtoC farming)", ERA-NET Bioenergy 8th Joint Call "Innovative Bioenergy Concepts".

The objective of the study was to assess the fertilizing potential of a mineral compound fertilizer produced from struvite recovered from the remaining liquid fraction of anaerobically digested cattle slurry. The struvite originated from the struvite precipitation unit located at the Experimental Dairy Farm "de Marke" in Hengelo, the Netherlands (Szymańska *et al*., 2019). The fertilising values of new struvite-based fertilizers of two various particle sizes of granules were compared to monoammonium phosphate (MAP).

Field trials with small plots (one plot area of $1m^2$) were carried out at the Experimental Site of the Institute of Soil Science and Plant Cultivation – State Research Institute, Poland (51º24'N, 21º57'E) on Luvisols, grouped to the class IIIa and good wheat complex of valuation on agricultural suitability. The soil pH was neutral (pH_{KCl}=6.6). The content of mineral nitrogen was 85.9% (gravimetric method). The content of available phosphorus (P_2O_5) was 26.9 mg/100g (spectrophotometric method). The content of available potassium (K_2O) was 18.3 mg/100g (FAES). The content of available Mg was 7.4 mg/100g (FAAS) and the content of Ca was 921 $mg \cdot kg^{-1}$ (FAAS). The fertilising potential of the studied mineral fertilizers were evaluated through: (i) grain yield and selected yield components of spring wheat, (ii) nutrient uptake by wheat grain.

One – way ANOVA analysis was performed to identify differences between treatments.



n.s. - not significant at p<0.05

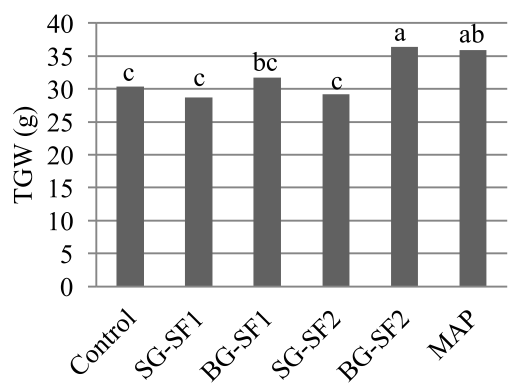


Figure 1. Grain yield and thousand grain weight (TGW) of spring wheat depending on the fertilizer type (2018).

Table 1. Yield components of spring wheat depending on the fertilizer type (2018).

Treatment	Plant number·m^{-2}	Spike number·m^{-2}	Grain weight per plant (g)	Grain number per plant (g)	Grain weight per spike (g)	Grain number per spike
Control	312	445	1.22	40	0.86b	28
SG-SF1	358	536	1.27	44	0.84b	29
BG-SF1	306	511	1.62	51	0.97ab	31
SG-SF2	324	433	1.16	40	0.87b	30
BG-SF2	324	455	1.61	44	1.14a	31
MAP	325	482	1.49	41	1.00ab	28

Conclusions

In 2018, the studied fertilization treatments did not have a statistically significant effect on the grain yield of spring wheat, however, they affected the thousand grain weight (TGW) and grain weight per spike (GWS). The highest TGW was found on the plot where big-size granules of struvite-based fertilizer (BG-SF2) and MAP were used as compared to the control and other fertilization treatments. The highest GWS was found on the plots where MAP and big-size granules of both struvite-based fertilizers were applied. To sum up, the particle size of struvite-based fertilizers affects the dissolution rate of struvite and hence its agronomic effectiveness. To confirm our results, the experimental spring wheat plots will be continued in 2019.

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