The technology of obtaining mineral fertilizers with a controlled release rate (CRF) by the coating methods.

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Introduction

The project is carried out by a consortium of entrepreneurs - Grupa Azoty Zakłady Azotowe "Puławy" there are. (Leader) and Grupa Azoty Zakłady Chemiczne "Police" S.A. and a research institute of- Łukasiewicz Research Network - New Chemical Syntheses Institute in Puławy. The main goal of the project is to develop a biodegradable polymer coating for nitrogen fertilizers (urea) and compound fertilizers (NPK) in order to ensure a slow release of nutrients into the soil and thus increase the use of these nutrients by plants. The subject matter of the project is a response to the challenge of developing coated fertilizers that will degrade in the soil environment within a maximum of 48 months.

Project description

The main objective of the project "Environmentally friendly slow-release fertilizers" is to develop a biodegradable polymer coating for nitrogen fertilizers (urea) and multi-component fertilizers (NPK). It is planned to use large and oligomolecular materials, in particular of natural origin. All materials tested as coating/film-forming substances will be tested for effective biodegradability in soil conditions to meet the current and/or planned legal regulations in the field of environmental requirements and the production and use of mineral fertilizers. Coating of the fertilizer granules will be aimed at ensuring a slow release of fertilizing nutrients from the fertilizer to the soil, and thus increasing the use of these nutrients by plants, which will positively affect the yield and quality parameters of the fertilized plants.

Research methodology

An application of the material to be coated on the fertilizer granules was carried out with one of two methods:

- in a fluidized bed with the use of a Mini Glatt fluid granulator,
- or by spraying a batch/portion of fertilizer bed with a disc/pan granulator or a granulating drum.

The methods applied whereas the same for urea and for NPK fertilizers. The coating tests carried out in a batch disc/pan or granulation plate was performed at ambient temperature. Additives forming the fertilizer coating were applied stepwise, starting with the introduction of a modified vegetable oil layer, (mixing for approx. 2 minutes), followed by the addition of the powdered material (mixing for 2 minutes). Next, the fertilizer was poured into trays and dried at 80 °C for 1 - 2 h in order to harden the applied layer. The residence time was adjusted based on the observation of the drying surface. On all produced samples, a total of 1 to 7 layers were applied: first layer: oil - 1 wt.% for urea, 1.5 wt.% for NPK; 2-6 layers: 1% w/w oil + then 1% dust component. The oil layer was to prepare the surface of the granules, i.e. close the pores (especially for NPK fertilizers). Urea (regardless of the powdered material) absorbed about 12.5% of total coating by weight during the application of 7 layers, whereas NPK fertilizers, due to their surface and shape, absorbed 10 - 14%. The produced fertilizers with coatings were subjected to tests for macronutrient release over time (after 24 h and 28 days) and for clumping. The tested fertilizers did not show a tendency to cake due to the addition of oil. Graphs of the kinetics of macronutrient release from coated fertilizers produced based on Polifoska are presented below (Fig. 1-3).

Kinetics of the release of macronutrients from the Polifoska fertilizers.

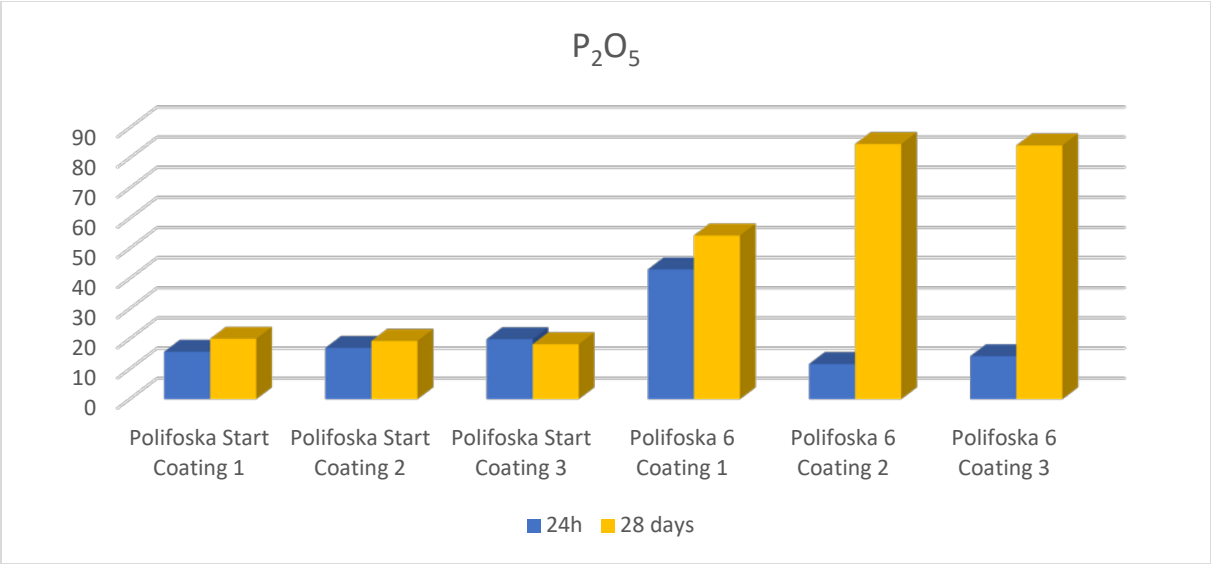

Fig. 1 P_2O_5 release rate from coated fertilizers after 24 hours and 28 days.

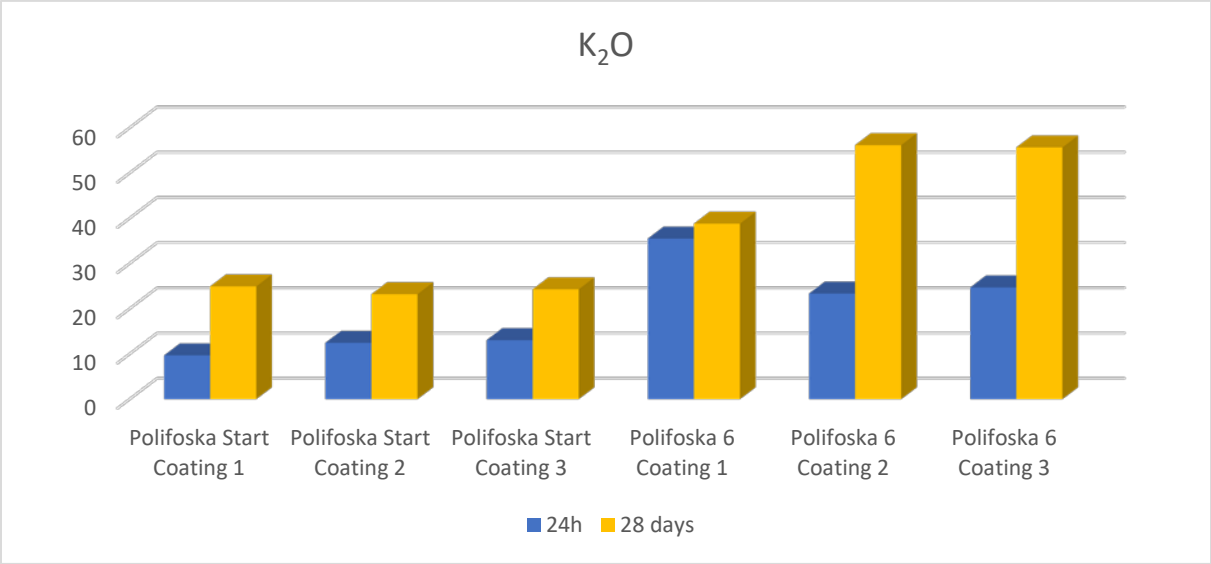

Fig. 2 K_2O release rate from coated fertilizers after 24 hours and 28 days.

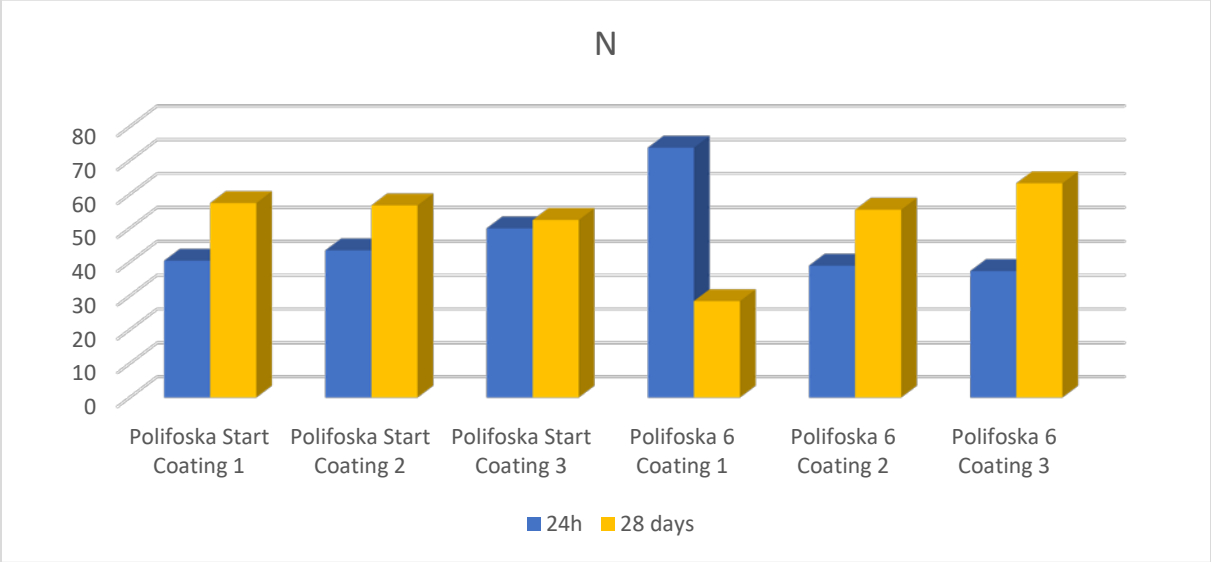

Fig. 3 The rate of N release from coated fertilizers after 24 hours and 28 days.

Conclusions

a) It was found that only double excess of modified vegetable oil made it possible to apply the desired layer using the fluidized method. Other tested coating materials caused a number of problems, (including those of a technical nature during application to fertilizer), which excludes them from the use of the fluidized bed method on a laboratory scale and therefore also on an industrial scale. In the opinion of SBŁ-INSCh, the properties of organic substances (flammability, toxicity, explosiveness) used to dissolve selected polymers exclude these preparations from use in the final technological process of coating fertilizers due to safety concerns, as well as the need to design a complex coating system containing a unit for the recovery and purification of the solvents used.

b) Coatings based on modified vegetable oil with the addition of derivatives meet the criteria for slow-release fertilizers.

c) Number of applied layers in the case of the above approach is too high (7 layers), one should strive to reduce the number of layers and the mass fraction of coatings.

d) Coatings obtained as a result of spraying caprolactone dissolved in chloroform cause the destruction of urea granules due to the penetration of residual solvent into the granules.

e) Assessment of toxicity and biodegradability will be performed at a later stage,

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