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Effect of Polymer Coated Urea on Nutrient Efficiency and Nitrate Leaching Using Maize and Annual Ryegrass

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Abstract : The worldwide exponential growth of the population and the simultaneous increasing food production requires the strategic realization of sustainable and improved cultivation systems to ensure the fertility of arable land and to guarantee the food supply for the whole world. To fulfill this target, large quantities of fertilizers have to be applied to the field, but the long-term environmental impacts remain uncertain. Thus, a combined system would be necessary to increase the nutrient availability for plants while reducing nutrient losses (e.g. NO3- by leaching) to the environment. To enhance the nutrient efficiency, polymer coated fertilizer with a controlled release behavior have been developed. This kind of fertilizer ensures a delayed release of nutrients to synchronize the nutrient supply with the demand of different crops. In the last decades, research focused primarily on semi-permeable polyurethane coatings, which remain in the soil for a long period after the complete solvation of the fertilizer core. Within the implementation of the new European Regulation Directive the replacement of non-degradable synthetic polymers by degradable coatings is necessary. It was, therefore, the objective of this study to develop a total biodegradable polymer (to CO2 and H2O) coating according to ISO 17556 and to compare the retarding effect of the biodegradable coatings with commercially available non-degradable products. To investigate the effect of ten selected coated urea fertilizer on the yield of annual ryegrass and maize, the fresh and dry mass, the percentage of total nitrogen and main nutrients were analyzed in greenhouse experiments in sixfold replications using near-infrared spectroscopy. For the experiments, a homogenized and air-dried loamy sand (Cambic Luvisol) was equipped with a basic fertilization of P, K, Mg and S. To investigate the effect of nitrogen level increase, three levels (80%, 100%, 120%) were established, whereas the impact of CRF granules was determined using a N-level of 100%. Additionally, leaching of NO3- from pots planted with annual ryegrass was examined to evaluate the retention capacity of urea by the polymer coating. For this, leachate from Kick-Brauckmann-Pots was collected daily and analyzed for total nitrogen, NO3- and NH4+ in twofold repetition once a week using near-infrared spectroscopy. We summarize from the results that the coated fertilizer have a clear impact on the yield of annual ryegrass and maize. Compared to the control, an increase of fresh and dry mass could be recognized. Partially, the non-degradable coatings showed a retarding effect for a longer period, which was however reflected by a lower fresh and dry mass. It was ascertained that the percentage of leached-out nitrate could be reduced markedly. As a conclusion, it could be pointed out that the impact of coated fertilizer of all polymer types might contribute to a reduction of negative environmental impacts in addition to their fertilizing effect.

Keywords : biodegradable polymers, coating, enhanced efficiency fertilizers, nitrate leaching
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