Biogas Residues in substitution for Chemical Fertilizers: Mitigation of agricultural nitrogen pollution

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Abstract

To provide food and feed, farming systems hinge on chemical fertilizers causing nitrogen pollution of the ecosystems. The multipurpose process of biomethanation has the potential to facilitate the transition towards circular agriculture. We compared the agricultural performance of biogas residues (BRs) and chemical fertilizers (CFs) while monitoring nitrate accumulation under repeated application on a grassland in Belgium during 2013-2018. BRs demonstrated the potential to mitigate nitrate leaching while achieving similar yield and N uptake compared to CFs. The agricultural and environmental benefits of BRs advocate for their suitability as biofertilizers and substitutes for CFs in similar grassland systems.

Keywords: anaerobic digestion, nitrate leaching, nutrient recycling

1. Introduction

Coupling the environmentally sound multipurpose process of biomethanation to sustainable agriculture could alleviate agricultural nitrogen pollution and cease the dependancy of farming systems on chemical fertilizers while contributing towards climate change mitigation.

The main goal of this study was to compare the agricultural performance of BRs and CFs while monitoring the residual nitrate accumulation in the soil under repeated application (Tsachidou *et al.*, 2019; 2019).

2. Materials and Methods

Eleven fertilization treatments and two nitrogen doses were tested on a grassland in the Walloon Region following repeated application during 2013-2018. Total N in aboveground plant biomass, yield of harvested forage and residual soil nitrate were assessed for each fertilization treatment. The N rates tested were 230 and 350 kg N ha^{-1} yr^{-1}, in accordance with the maximum admissible doses in the Walloon Region.

3. Results

BRs did not cause nitrate accumulation in the soil, and were N rate independent, while CFs indicated a cumulative effect under repeated application and high N dose, posing a nitrate leaching risk. Similar nitrogen uptake and forage yield were obsereved for most treatments with the maximum nitrogen rate suggesting a plateau for both BRs and CFs. Finally, the partial substitution of CFs by BRs reduced nitrate in the soil without having a negative impact on the yield and N uptake.

Fig. 1: Total N uptake, dry mass yield and residual soil nitrate assessed for each treatment: CONTROL: No treatment; RD 230:Raw Digestate; LD 230:Liquid Phase; SD 230:Solid Phase; DD 230:Dried Digestate; AN 230:$(NH_4)(NO_3)$; RD + AS 350: Raw Digestate + $(NH_4)_2SO_4$; RD + PN 350:Raw Digestate + KNO_3; RD 350:Raw Digestate; AS 350:$(NH_4)_2SO_4$; PN 350:KNO_3; AN 350:$(NH_4)(NO_3)$.

4. Conclusions

The agricultural and environmental benefits of BRs underline their suitability as biofertilizers and substitutes for CFs in similar agricultural systems.

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