Use of digested and co-digested pig slurry in maize crop grown in a sandy loam soil

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Introduction

Intensive pig farm management has been leading to excessive production of slurries with related environmental disadvantages. Such materials must be treated, namely digested, in order to minimize environmental damage and then recycled to enhance the future crop production by improving soil quality and also as a source of plant nutrients processes.

However, pig production units (particularly farrow-to-finish systems), in Mediterranean climate countries, are often characterized by generating very dilute slurries, 1.5-2,5 % total solids (TS) with a total volatile solid (VS) content of 67%. This represents a barrier to establish economically feasible Anaerobic Digestion (AD). Therefore, in several full scale farm biogas plants it would be advantageous to introduce other substrates to co-digest with pig slurry, in order to raise biogas production (Ferreira, 2006). The remaining digested and co-digested materials can often provide interesting quantities of nitrogen to plants nutrition.

Anaerobic digestion of pig slurry has been referred to increase the amount of easily available nitrogen, through the mineralization of some amount of organic nitrogen. In fact, digested slurries may show a high efficiency in nitrogen (N) supply to crops in the first growing season after their application. However, such an increase of the short term availability of N may reduce residual N effects, thus reducing soil structure benefits, as less organic nitrogen is applied to the soil (Schröder, 2006).

The aim of the present work was to compare the short-term effect of the digested, co-digested and untreated pig slurry on the uptake of nitrogen by maize crop, and impact on nitrate leaching. Moreover, the increasing of co-digestion practice, makes it urgent to better understand the effects of these products for land application.

Materials methods

An experiment using Kick-Brauchmann pots was carried out under semi controlled environment conditions, using a Cambic Arenosol (FAO). Fresh (S75, S100, S125), digested (DS75, DS100, DS125) and co-digested (CDS75, CDS100, CDS125) pig slurries (table 1) were mixed to the soil as basal dressing, in amounts corresponding to applications of 75, 100 and 125 kg N ha^{-1}. Control treatments received the same amounts of N as mineral basal dressing (NH_4NO_3) (C75, C100, C125). An "only soil" control treatment was also performed (C). All the treatments were performed in triplicate. Other nutrients (except N) were applied as nutrient solution, according to soil analysis, and maize (*Zea mays.* L.) was sown. After one month growth, an amount corresponding to 100 kg N ha^{-1} was added to each pot, as top dressing. The three different slurries and urea were used respectively in slurry and control treatments. Pots were periodically weighted and watered to keep soil at 60 % WHC. Plants nitrogen content and uptake, nitrate leaching and soil N content were evaluated after crop harvest. Nitrogen determination was performed segmented flow spectrophotometry after a 2*M* KCl extraction (Mulvaney, 1996).

Results discussion

The application of slurries to the soil, enhanced maize growth, regardless of the treatment to which the slurry had been previously subjected (p<0.05), compared to control treatments with the same amount of nitrogen applied as basal dressing. This was probably due to the presence of small and variable amounts of micronutrients in the slurries.

Table 1. Some chemical characteristics of the pig slurries under study

	Fresh slurry (S)	Digested slurry (DS)	Co-digested slurry (CDS)
pH	8.4	8.1	8.0
Kj-N (g L^{-1})	3.12	3.46	2.14
N-NH4 (g L^{-1})	1.52	1.90	1.04

Moreover, the digested slurry led to an increased maize yield. The same effect of increased N use efficiency had been reported before by Schröder et al. (2006) to the use of digested cattle slurry. On the other hand, pH value of digested slurry was lower than that of fresh slurry, thus becoming closer to the optimum values for microorganisms activity, namely nitrifying bacteria (Silva and Vale, 2000).

Figure 1. Maize dry matter yield in all treatments performed (t/ha)

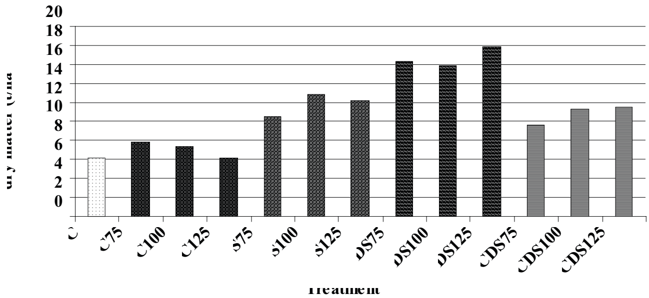
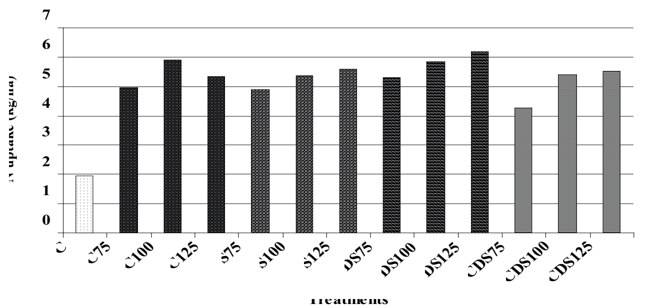


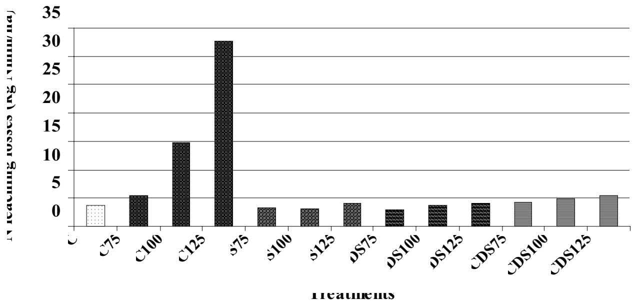
Figure 2. Nitrogen uptake by maize shoots (kg N/ha)



Although the presence of slurries enhanced maize growth, it did not lead to a higher N uptake by the plants during the period of the experiment (p<0.05). In fact, the amounts of N applied were the same in each treatment. A similar N uptake reveals that the nitrogen present in the slurries was as much available as that in the mineral fertilizer. The high availability of N in pig slurries had been reported before by Cordovil et al. (2006) in ryegrass grown in a soil of similar texture and in the presence of the solid phase from pig slurry.

As expected, nitrogen leaching losses increased with the increasing amounts of N applied to the soil, particularly in the control treatments. The losses were higher from the pots receiving only mineral fertilization, whereas in the treatments where only slurries were applied, the losses averaged 12 to 20 % of the total amount applied. Maize yield was lower in control treatments with mineral N application, when compared to the treatments where pig slurry was added. In fact, when mineral N was applied, the N losses ranged from 27 to 97 % of the total amount applied, thus significantly reducing the amount of N available for plant nutrition. This suggests that the application of treated pig slurries can be more environmentally friendly.

Figure 3. Total mineral nitrogen leaching losses (mg N/pot)



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