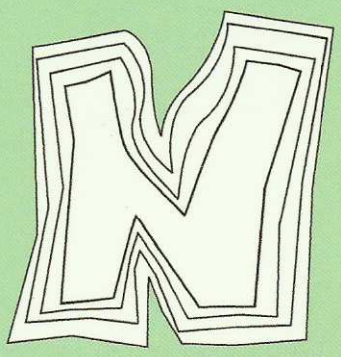

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MAXIMIZE THE PLANT NITROGEN USE EFFICIENCY OF ANIMAL SLURRY USING AN EFFICIENT TREATMENT PRIOR SOIL APPLICATION

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Animal slurry is widely used as organic fertilizer to supply plant nutrients, namely nitrogen (N) but it is well known that slurry application to soil can lead to strong losses of N by gaseous emissions (ammonia and nitrous oxide) and/or leaching (nitrate and organic nitrogen). These N losses have a negative impact on environment and significantly affect the plant N use efficiency of animal slurry.

Slurry injection has been proposed to minimize ammonia (NH3) emissions but this technique implies high financial investment and is not easily applied in some type of soils. Furthermore, a decrease of ammonia emissions may lead in some conditions to an increase of nitrous oxide (N2O) emissions or nitrate leaching.

On the other hand, several slurry treatments (prior to soil application) such as solid-liquid separation and acidification proved to be efficient to decrease NH3 and N2O emissions after soil application. An application of the liquid fraction or acidified slurry rather than untreated slurry using adapted conventional methods could therefore be as efficient as slurry injection. Indeed, the negative impact of slurry broadcasting by splash plate can be minimized if slurry is applied using a surface banding technique.

Thus the main question to be clarified in this study is:

'Is animal slurry injection in soil more efficient to reduce the associated environmental impacts and increase the plant N use efficiency than a combined approach of slurry treatment followed by surface banding application?'

To answer this question, the following objectives were established:

a. Estimate the leaching of nitrogen (nitrate and organic N) following untreated slurry injection or surface band application of pre-treated slurry;

b. Compare the nitrogen dynamics in soil as well as the plant production in soil amended by injection of untreated slurry or by surface banding application of pre-treated slurry;

c. Compare the N2O and NH3 emissions at soil surface in soil amended by injection of untreated slurry or by surface banding application of pre-treated slurry;

An overview of the main results obtained in this study will be shown and analysed in order to propose an efficient solution to maximize the plant N use efficiency of animal slurry.

Materials and Methods

Both laboratory and field experiments were performed to achieve our objectives. Two slurries were considered, cattle and pig slurry, and 6 treatments were established in 3 different soils (sandy and 2 sandy-loam soils):

i. untreated slurry injected at 10 cm (IWS),

ii. untreated slurry applied on soil surface followed by soil mobilization (WS);

iii. liquid fraction applied to the soil surface without mobilization (LF);

iv. acidified slurry applied to the soil surface without mobilization (AWS);

v. Acidified liquid fraction applied to the soil surface without mobilization (ALF).

vi. Control (no amended soil)

The liquid fraction (LF) was obtained by mechanical separation (screw press or centrifugation) and acidification to pH 5.5 was performed by addition of concentrated sulfuric acid.

Ammonia emissions were measured using a dynamic chamber method and nitrous oxide emissions were estimated using a closed chamber system.

Leaching was measured at field scale using ceramic suction cups and soil column experiments were conducted under controlled conditions.

The plant N use efficiency of animal slurry was evaluated considering two crops: oat and maize silage. Plant production was estimated in field and pot conditions.

Results and Discussion

Results obtained with soil column experiments showed that application of treated slurry by separation or acidification may lead to an increase of NO3 leaching relative to WS application but the differences relative to IWS were not so significant. Furthermore, as expected, slurry acidification may increase salts leaching.

At field scale, our results showed that slurry injection may be replaced by surface application of acidified slurry in order to minimize the NH3 emissions. However, high NH3 emissions were observed in LF treatment. Furthermore, in the case of sandy soil, surface application of acidified slurry followed by incorporation appears as a more efficient solution than injection of non-treated slurry to minimize NO3 losses.

Crops production and N use efficiency is higher in AWS treatment relative to WS but differences between IWS and AWS treatments were low.

Lower N2O emissions were observed in IWS relative to WS whereas AWS and WS led to similar emissions.

Conclusions

Our results indicate that surface application of acidified slurry is a good alternative to slurry injection to minimize environmental impacts and increase the the plant N use efficiency of animal slurry

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