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MAIZE ORGANIC FERTILIZATION BY MEANS OF A MODULAR SLURRY SPREADER [1]

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SUMMARY

The slurry spreading represents a critical moment of the waste management strategy since it influences the nutrients' availability for the crops. The Italian Normative in force sets severe limits to the slurry application to land. These limits - and the necessity to optimise the slurry fertilising value - require to operate with the correct application rate and with a sufficient spreading uniformity. An innovative slurry spreader able to optimise the reuse of this by-product as an agronomic resource respecting the national normative has been tested in operative conditions. The agronomic trials showed that the organic fertilisation - realised with the innovative slurry spreader - gave no statistically different grain yield results from those obtained with the chemical fertilisation. The ammonia emissions recorded after the slurry injection were the 16% of those recorded after the band application.

INTRODUCTION

The agro-industrial system produces great amount of wastes by livestock activity which may have a high fertilising power if used in appropriate ways, but can be cause of environmental pollution when applied to land in an uncontrolled way and with inadequate devices. Moreover, ammonia volatilisation and offensive odours from surface applied slurry are major concerns (Meisinger and Jokela 2000, Pain et al., 1991,Rahman et al., 2001). The slurry spreading, in detail, represents a critical moment of the waste management strategy since it influences the nutrients availability for the crops. A survey on the main typologies of slurry spreader actually used in Italy showed that they often are inefficient and equipped with spreading device unable to apply the slurry with the required uniformity. Furthermore, the Italian Normative in force sets severe limits to the slurry application to land both as maximum nitrogen application rate and the distances from tolerance zones as watercourses, urban areas and wells on which the distribution is prohibited. These limits - and the necessity to optimise the slurry fertilising value - require to operate with the correct application rate and with a sufficient spreading uniformity. To try to solve these problems has been developed, by DEIAFA-University of Turin with the financial support of CNR, a modular spreading machine with an electronic device able to optimise the use of this by-product as an agronomic resource respecting law and the environment.

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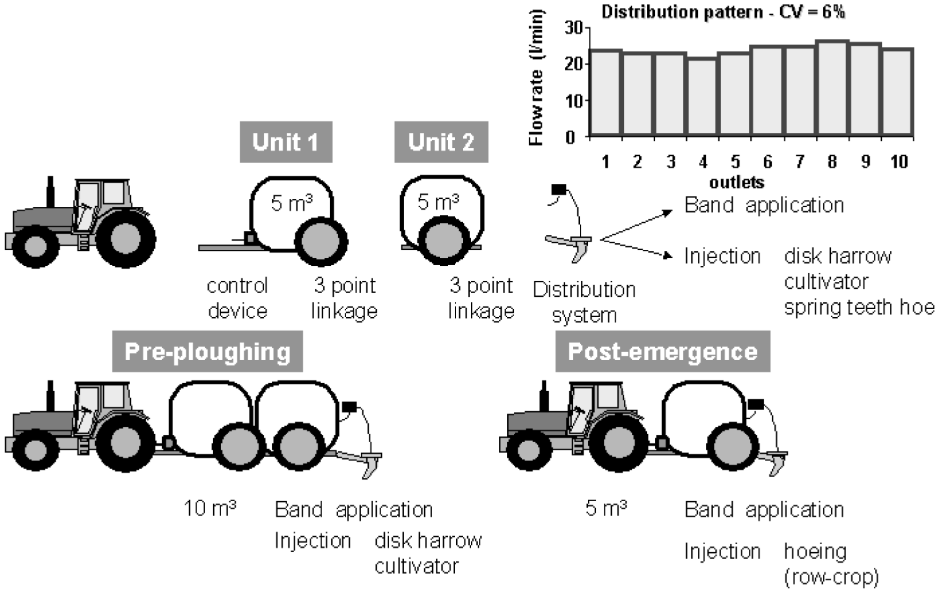
MATERIALS AND METHODS

The slurry spreader

The developed slurry spreader is a modular unit with a 10m^3 tank divided into two independent sections each with a 5 m^3 plastic tank. Each unit has a three points linkage at which can be linked the distribution devices: a disk-harrow for the slurry application in pre-ploughing, and a spring teeth hoe for the post-emergence distribution, allowing to operate, in any case with a CV of 6% (fig. 1).

The slurry spreader can operate in pre-ploughing, in the 10 m^3 tank arrangement and in post-emergence of maize, in the arrangement with 5m^3 tank. The machine has a dose control system electronically activated able to apply the product at controlled application rate independently by the machine's forward speed. The system for the application rate control consist in a forward speed sensor, a volumetric lobe-type pump - equipped with a rotation speed sensor - and a central control unit.

Figure 1 - The modular slurry spreader developed.



The trial

The modular slurry spreader developed was tested in the organic fertilisation of a 600 FAO class maize hybrid (fig. 2).

The trial was carried out in the western Po Valley on a sandy-loam soil (pH 6.0; 1.7% O.M.), in which six different fertilisation techniques were considered in a randomized block design with 3 replications:

1) chemical fertilisation;
2) slurry injection in post-emergence;
3) slurry band application in pre-ploughing and chemical fertilisation in post-emergence;
4) slurry band application in pre-ploughing and slurry injection in post-emergence;
5) slurry injection in pre-ploughing and chemical fertilisation in post-emergence;
6) slurry injection in pre-ploughing and slurry injection in post-emergence.

Figure 2 - The modular slurry spreader during the trial.

In pre-ploughing

In post-emergence

In each plot (about 400 m^2) the fertilisers were applied before ploughing and in maize post-emergence.
The slurry was taken from a pit below a slatted loose house for young stock. The chemical characteristics of slurry were determined the week before the application. The slurry had an average total solids content of 5.5% (range 5.4-5.6) a mean content of 4.3 (range 4.1-4.5) and 2.7 (range 2.3-2.8) of total and ammonium nitrogen respectively, a mean content 3.9 (range 3.7-4.1) of P_2O_5 and a mean content of 2.7 (range 2.5-2.8) of K_2O. The slurry was applied at a rate of about 80 m^3/ha (26 m^3/ha in pre-ploughing and the remaining in post-emergence) corresponding to an average application of about 300 kg/ha of total nitrogen, 270 kg/ha of P_2O_5 and 196 kg/ha of K_2O. With the chemical fertiliser were applied the corresponding rate on nitrogen in post-emergence, using urea applied by an hoe with a spreader attachment, and the corresponding rate of N, P2O5 and K2O in pre-ploughing with a linear distributor.
In each plot were determined the yield and grain DM content at harvest.

The ammonia emissions determination
The ammonia losses were determined - for the band application and the injection of the slurry - by means of a device consisting in a funnel (0.145 m2), a bottle containing a 1% boric acid solution, a vacuum pump powered by a 12V lead-acid battery, an interceptor trap and a flow meter. The device was arranged to suck the air below the funnel with a flow rate near 9 l/min. The ammonia present in the air was fixed by the boric acid solution and its amount was determined by titration using a sulphuric acid solution and an acid-base indicator (Balsari et Al., 1992).

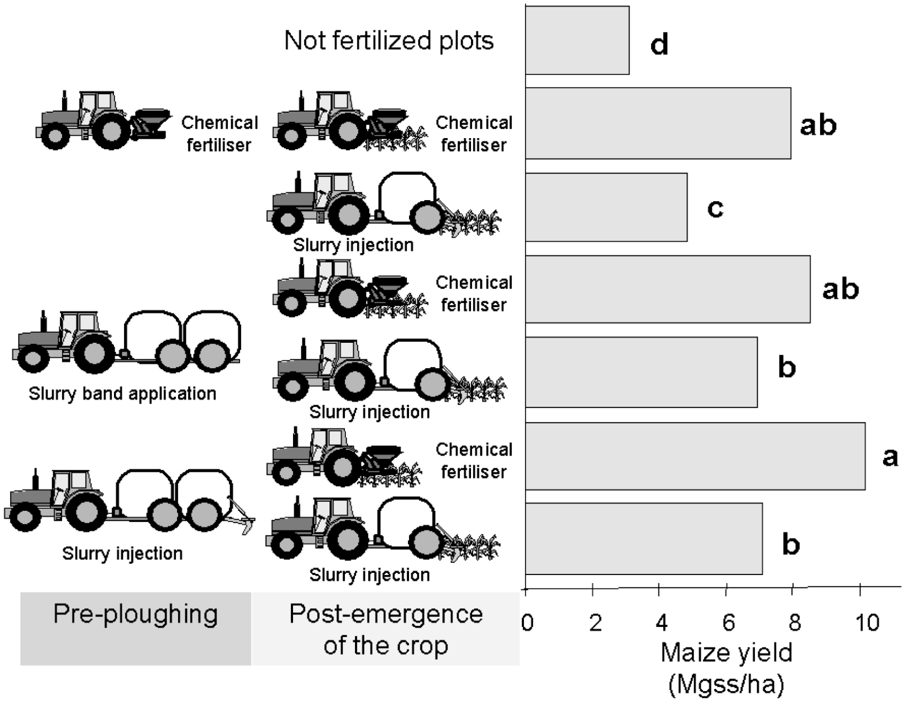
RESULTS AND DISCUSSION

Ammonia emissions
The trial pointed out that the 7,6% of the Ntot applied with the slurry was lost as ammonia with the band application while the 1,3 and 2,1% after the slurry injection into the soil respectively in pre-ploughing and in post-emergence. The low values of the ammonia emissions with pre-emergence band application are probably due to the low temperature recorded during the trial on average near 9 °C (range 7.4, 11.2 °C).

Maize yield
The best yield was obtained with injection of slurry in pre-ploughing and with the application of urea in post-emergence, with a production a little over 10 Mgss/ha.
A result not statistically different was obtained with the band application of the slurry in

pre-ploughing, always using urea in post-emergence intervention, and with chemical fertilisers applied both in pre-ploughing and in post-emergence of the crop. On the other hand, these results were not statistically different from that obtained with application of slurry both in pre-ploughing and post-emergence.
The whole application of slurry in post-emergence of the crop reduced significantly the yield (fig. 3).

Figure 3 - Maize yield in the different fertilisation techniques. Values with the same letter are not statistically different (Tukey Test, α=0.01).



CONCLUSION

The developed slurry spreader allowed a good control of the application rate both in pre-ploughing and in post-emergence of the crop. The machine is interesting above all for organic farming, in which allows an organic fertilisation in post emergence of the crop with slurry. In this way it is possible to increase the distribution period, without the requirement of a dedicated machine, increasing the yearly utilisation of the machine and reducing the cost of slurry application.

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