Evaluation of the Effects of the Application of Dehydrated Pig Slurry on Wheat Production and on the Soil

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In Northeast Spain the expansion of the pig sector in the last thirty years has brought as a result the production of great amounts of pig slurry that exceeds field crops fertilization needs, therefore livestock effluents could significantly contribute to the polluting load and the progressive environmental deterioration of the region. Under such circumstances, it is necessary to treat pig slurry in order to reduce its polluting potential and/or facilitate the logistics of transporting the manure from the pig producer to the field. In the last years the implantation of six cogeneration treatment plants in our region that make full use of the energy, exceeding 90% of primary energy usage, and that treat 100,000 m^3 of pig manure per year each (46,000 pigs for plant) has facilitated a sound manure management. Although in our region some field experiments have been conducted to evaluate the fertilizer value and environmental impact of pig slurry as a fertilizer (Berenguer *et al.* 2008), little is known about the fertilizer value and eventual adverse environmental effects of dehydrated pig slurry produced in such plants. The aim of the present research was to evaluate the effects of a single autumn application of dehydrated pig slurry on wheat yield and soil nitrogen dynamics when applied to cover phosphorus and potassium crop fertilization needs.

Methodology

Field experiments were conducted in the river Ebro valley at Almacelles on a calcixerept soil (at 0-30 cm, pH 8.1, soil texture: 171, 388 and 441 g kg^{-1} of sand, silt and clay, respectively, and 21.4, 35 and 225 g kg-1 of organic matter, P(Olsen) and K(NH_4Ac), respectively) irrigated by a center-pivot. The crop received 250 mm of irrigation plus 207 mm of rainfall mostly in April when crop growth stage 43 (Zadoks et al 1974). Experimental units were 10 m x 10 m plots. Dehydrated pig slurry (DPS) application rates of 2000 and 6000 kg ha^{-1} (DPS2 and DPS6, respectively) were compared with a standard mineral treatment (M) and control plots (C) in a completely randomized experiment with tree replicates. DPS analysis showed that it contained 64.7 % organic matter, 4% N, 5% P_2O_5 and 7% K_2O, and 225 and 1791 mg kg^{-1} of Cu and Zn, respectively. Mineral treatment consisted of 67, 217 plus 233 kg ha^{-1} of urea, DAP and KCl, respectively, also in a single application. Wheat (cultivar Dollar) was seemed on November 29 2006 at 200 kg ha^{-1} (inter-row spacing was 0.15 cm) and harvested on July 12, 2007). Plants were harvested by hand, grain yield was estimated selecting ten random 2 m crop rows lengh, and yield components were estimated selecting two random 2 m rows length. Plant nitrogen uptake was calculated by multiplying grain and straw biomass by its Kjeldahl N relative content determined following standard methodology (Tan, 1996). Soil cores were collected each four weeks, 3 cores per plot at 0-30 and one at 30-60 cm depths from November 2006 to July 2007 using a soil-sampling tube (Veihmeyer,1928). Soil nitrates were extracted using $CaCl_2$ 0.01 M (Kmecl, 2005). Soil NH_4^+ -N was not measured, since its content was negligible, as confirmed also by other authors (Villar-Mir *et al.* 2002). Total Cu and Zn determinations were performed following the standard method (AOAC, 2003). Analysis of variance and Student-Newman-Keuls multiple comparisons were performed using SAS package (SAS, 1991).

Results

Analysis of yield showed that there were no significant differences in yield between treatments, being the average yield of 6170 kg ha^{-1}. However the analysis of yield components showed that the number of ears m^{-1} was lower in the control plots (623 ears m^{-2} *versus* 777 ears m^{-2}). There were no significant differences in the number of grains per ear (32.2 grains) and on 1000 grain weight (36 g). Plant analysis showed that there were not significant differences between treatments in the grain relative nitrogen content (24 10^3 mg N kg^{-1}), however straw N relative content of DPS2 (11.1 10^3 mg kg^{-1}) was significantly higher than that of the other treatments (8.9 10^3 mg N kg^{-1}). The results of soil core analysis showed that from December to March NO_3^--N content at 0- 30 cm depth was significantly higher in M treatment. There were no significant differences between C plots and DPS treatments. After harvest residual NO_3^--N content was negligible in all treatments. At the beginning of the experiment at 30 – 60 cm depth the NO_3^--N content was insignificant, it increases in January and then decreases so that after harvest its content is negligible in all treatments.

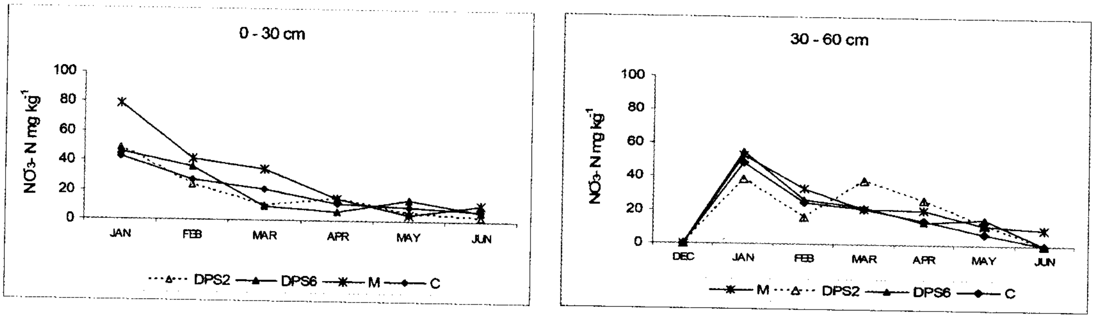

Figure 1. Dynamics of N-NO_3 from December to June at 0-30 cm and at 30-60 cm depth. M: mineral fertilizer treatment, DPS2 and DPS6: dehydrated pig slurry at 2000 and 6000 kg ha-1, respectively, C: control.

At 0-30 cm N-Kjeldahl content kept steady at about 3300 mg kg^{-1}, there were no significant differences between treatments. However at 30 – 60 cm N-Kjeldahl content increases from 1800 a 3200 mg kg^{-1}, since there are no differences between treatments that increase can not be attributed to DPS treatments. At 0 – 30 cm Cu and Zn total content were of 17.5 and 47 mg kg-1, respectively and at 30-60 cm depth 13.6 and 32.81 mg kg, respectively. No significant differences were appreciated.

Conclusions

These preliminary results seen to show that under irrigation dehydrated pig slurry could be promising fertilizer in autumn applications for cereals. In north east Spain dehydrated pig Slurry could be an alternative to mineral phosphate and potassium application in autumn. At 2000 and 6000 kg ha^{-1} rates crop performance and soil nitrogen dynamics are not significantly different from not fertilized plots.

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