Sewage Sludge Agricultural Use

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Abstract
Sewage sludge use in agriculture is promoted by the European Union since the normative of cleaning waters related to the compulsory use of depuration plants in all cities over 2000 inhabitants was finally implemented in 2005. The University of Santiago de Compostela (USC) has been conducted long-term experiment research about the application of different sewage sludge doses in silvopastoral systems. Main results shown that sewage sludge can be successfully used as fertilizer for both tree and pasture development, with reduced toxicity for animals when plant production is considered in both very acidic and acidic-neutral soils. This paper provides an overview of the main findings in acidic soils of the long-term results after application of sewage sludge in soils.
Keywords: fertilization, inorganic, lime, tree growth, silvopasture

1. Introduction

The use of any fertilizer coming from in-farm or out-farm organic resources has to take into account two aspects: quality of the fertilizer and soil fertility level and in the case of sewage sludge the level of pollutants that are added into the soil. The quality of the fertilizer is measured considering the main nutrients that are needed in the soils: N, P and K, while the main soil analysis should be focussed on the levels of P and K that are stored in the soils and easily available for crops when nutrients are needed. When we consider sewage sludge, the fertilizer quality should take into account the amount of heavy metals they have as they are regulated and potential harmful impact on biodiversity and for human beings can appear. However, it is also important to predict the impact of the fertilization with sewage sludge on crop/pasture production and quality in different soil conditions. This paper summarizes the impact of the use of sewage sludge on pasture production and quality considering production in different soil conditions.

2. Quality of the fertilizer

Inorganic and organic fertilizers add heavy metals into the soils. The main difference between inorganic and organic fertilizers is the amount of fertilizer that should be added into the soil to fulfil crop needs that is usually higher with organic fertilizers due to the lower nutrient content they have. Main aspects associated to an organic fertilizer deals with the humidity content, the concentration of nutrients and pollutants but also the degree of availability of those nutrients linked to the mineralization rate of the fertilizer. Humidity is related with the profitability of using organic fertilizers in a plot, as higher the humidity as higher the storage and transport costs are, which limits the potential use of sewage sludge based on the distance between where the organic fertilizer is produced and where it is needed. Main nutrients are associated to the initial composition of the waste material. Sewage sludge use to have a similar level of N and P but a lower level of K and a higher level of heavy metals than manure or agro-industrial wastes. Moreover, sewage sludge origin and stabilisation also determines the quality of sewage sludge as a source of nutrients for the crops. In an experiment where 45 Spanish sewage sludge plants were analysed (compost, anaerobic and pelletized sewage sludge) it was concluded that the level of nutrients and heavy metals in the composted sewage sludge was much lower than in anaerobic and pelletized sewage sludge. However, the potential of contamination with pollutants is higher in the case of compost compared with anaerobic or pelletized sewage sludge because the mineralization rate is higher in the anaerobic or pelletized sewage sludge (25%) than in the composted sewage sludge (usually composted with woody perennial residues with a low C/N relationship) which makes needed a higher input to reach the same available amount of N for crops.

3. Crop and tree production

The impact of the inorganic or organic fertilizer inputs in crop production depends on the type of soil. Inorganic fertilizers are usually associated to an acidification of the soil as it promotes the extraction of cations and if ammonia nitrogen compound is used acidification comes from the process of nitrification that

releases hydrogen protons. However, organic fertilizers are usually associated to the increase of soil pH due to the high level of cations it has but also due to the long term availability of the nutrients associated to a long term nutrient release which affects production and biodiversity.

Experiments conducted in Galicia in silvopasture systems showed the different behaviour of sewage sludge addition on productivity and biodiversity linked to the soil acidity. The experiments consist of applying sewage sludge in neutral (water pH close to 7) and very acidic (water pH of around 4.5) soils and compare them with the use of mineral fertilizers and no fertilization in silvopasture systems, as usually grasslands are fertilized but afforestation in former croplands/grasslands areas are not fertilized at all. In soils with water pH close to 7, mineral fertilization caused a significant increase of pasture production that was in detriment of tree growth. The opposite happened when no fertilization was added: the fertility of the soil was high enough to increase tree growth but the lack of nitrogen reduced the potential pasture growth. When sewage sludge was added, both tree and pasture were growing similarly to the no fertilization and mineral treatment, respectively. This may be explained by the fact that, initially the sewage sludge application increased pasture production, but during the summer drought that usually happens in Galicia, tree growth was enhanced due to the inputs of organic matter associated to the sewage sludge that allowed the tree to overcome the summer drought, the limiting factor for tree growth. The initial differences among tree growth of the different treatments were also detected 20 years after the experiment was established. When similar treatments were applied in very acidic soil, with a high level of heavy metals, we found that no fertilization treatments caused a low tree and pasture production due to the low fertility of the soil, while the fertilization with the mineral fertilizer caused an increase of tree growth but not of the pasture. This may be explained by the fact that the low soil pH prevents the pasture from taking advantage of the mineral fertilizer inputs that was subsequently. When sewage sludge was applied, it increased soil pH that make possible for the pasture to use the applied nutrients. Moreover, when liming was only applied in very acidic soils, tree growth was enhanced due to the release of nutrients that liming caused in very acidic soils with a high level of organic matter. These treatments also caused biodiversity modification in grasslands as those pastures were production was increased have a higher proportion of monocots or grasses than those where pasture production was low, which has a higher proportion of dicots. Heavy metals in soils were increased by sewage sludge application at short term due to the sewage sludge inputs and at long term due to the heavy metal tree uptake that is finally incorporated into the soil once tree leaves fall.

4. Conclusions

Sewage sludge is a good source of nutrient that can be usefully use as fertilizer, the dose and the timing depends on the crop requirements and tree growth. With small doses applied once in silvopastoral systems a long term response is found.

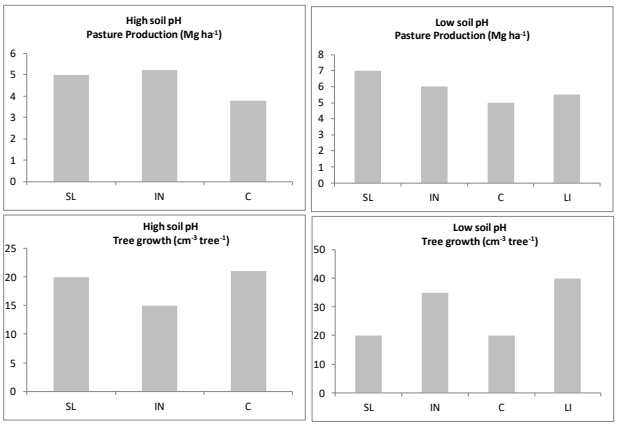

Figure 1. Pasture production and tree growth after sewage sludge (SL), inorganic fertilizer (IN), lime (LI) applications and control (C).

References

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