USE OF LIMESTONE FROM MUSSEL SHELLS IN ACID SOIL OF GALICIA (NW SPAIN)

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1 INTRODUCTION

Galicia (NW Spain) is currently the main mussel producer in Europe and the second producer in the world after China, the production in 2007 was 208186 tonnes. This production provides the raw material for the cannery industry and this activity generates a large volume of waste due to the mussel shell represents 31-33% of the total mussel weight (Macías, 2000). The existence of these residues is recognized by industry as a serious problem.

The shell is a composite biomaterial, of which the mineral portion, calcium carbonate, accounts for 95-99% by weight and the remaining 1-5% is the organic matrix (Marin and Luquet, 2004), and small amounts of other elements: nitrogen, sulfur, phosphorus, potassium and magnesium.

In Spain mussel shells have been used as an animal feed additive, for the production of mortars, a liming agent and constituent in fertilizers. In Galicia, several studies have been performed using mussel shells as a liming agent (Iglesias-Teixeira et al., 1997; Álvarez-Rodríguez et al., 2009), for the recovery and the formation of soils (Macias, 2000) and the recovery for mine tailings (Asensio-Fandiño et al., 2008).

In recent years, companies have emerged in Galicia dedicated to the treatment of mussel shells to achieve their recovery and facilitate recycling, transforming the mussel shells into by-products, revaluing this waste.

Acid soils are a common problem in Galicia, limiting crop growth. These soils are usually neutralized by the addition of calcium mineral. Therefore, the mussel shells could be used as a liming agent in acid soils and were traditionally used by farmers in areas near to cannery industries.

The aim of this work was study the effect of application on limestone from mussel shells, on chemical properties of soil.

2 MATERIALS AND METHODS

The experiment was carried out on an acid soil of sandy texture at the Organic Farm "A Laxe" localized in Palas de Rei (Lugo, Spain) during the 2009 growing season. Treatments were applied to subplots (each 50 m^2), in a randomized block design with three replicates. The following treatments were applied on 24 May: i) C=control, no application of limestone and ii) L=application of 3 tons/ha limestone from mussel shells. Subsequently, wheat was sown on 30 May at a seed rate of 350 seeds/m^2, and harvested on 22 September.

The operations carried out by the transformer industry to obtain limestone from mussel shells were washing, calcination and milling, producing a particle size of 2 mm and a minimum content of 89% calcium carbonate and a maximum content of 1.5% magnesium carbonate.

Soil was sampled at 20 cm depth, taking a representative sample in each subplot after harvest date of the crop (26 September). The sampler walked a zig-zag through the plots to take 6 subsamples from each subplot using a hollow cylindrical tube 7 cm in diameter. Soil samples were air dried, passed through a 2 mm mesh sieve and measured for pH, exchangeable calcium, magnesium and aluminium, and available phosphorous. The pH was determined in a 1:2.5 soil:water suspension (Guitián-Ojea and Carballas, 1976), the estimation of available phosphorus in soils by extraction with sodium bicarbonate ($NaHCO_3$ 0,5M) (Olsen and Dean, 1965) and exchangeable cations (Ca^{+2}, Mg^{+2} and Al^{+3}) by extraction with ammonium chloride (NH_4Cl 1N) (Peech et al., 1947).

All data were subjected to a one-way ANOVA and the means were compared by Fisher's Least Significant Difference procedure.

3 RESULTS AND DISCUSSION

Table 1 shows the effect of limestone application on chemical properties of soil, means of three replicates of parameters determined. The application of limestone produced a non-significant increase in pH and a significant decrease in exchangeable aluminium, which was related with higher soil exchangeable calcium content and availability of phosphorous, although not significantly. With regard to exchangeable magnesium, there was no significant differences between treatments.

TABLE 1 **Effect of application of limestone on chemical properties of soil: pH, exchangeable aluminium (Al), calcium (Ca) and magnesium (Mg), and available phosphorous (P). Mean values from 3 replicates.**

Treatments	pH	Al (cmol(+)/kg)	Ca (mg/kg)	Mg (mg/kg)	P (mg/kg)
C	5,00 a	1,34 a	280 a	44 a	22 a
L	5,14 a	1,25 b	294 a	47 a	23 a
p	ns	**	ns	ns	ns

Means within the same column which are followed by the same letter are not significantly different.

**: $p<0,01$; ns: not significant.

Iglesias-Teixeira et al., (1997), showed in a study on acid soil monitored over 17 months, that the higher dose of limestone from mussel shells (9 tons/ha) neutralization the acidity to a similar extent to the magnesian limestone commercial, but was effective over a longer term. Therefore, to obtain more conclusive results, it would be necessary to monitor for longer, because the effects of limestone accrue over a long period, and the dose used in this experiment, 3 tons/ha, was low. In consequence, further experiments should be conducted with higher doses and monitored for longer.

4 CONCLUSIONS

The application of limestone caused a non-significant increase of pH and a significant decrease in exchangeable aluminium, and also a non-significant increase in available phosphorous.

The results indicated a small positive effect on soil chemical properties, therefore, the use of limestone is recommend but with higher doses.

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