Influence of Artificial Zeolite and Hydrated Lime Amendments on the Erodibility of an Acid Soil

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1. Introduction

The extremely acidic properties of the material, which restrict the plant growth, make the acid soil to be susceptible to erosion by water during rainy season (Menzies, 2003). Usually liming has been the standard practice used to improve productivity in acid soils primarily as a chemical ameliorant of acidity (Menzies, 2003). Another soil amendment that has been recently receiving increasing attention with regard to the improvement in soil physical and chemical properties is fly-ash (recycling material) and the industrially modified form of it, artificial zeolite. However, before zeolite can be recommended for wider use there is a need for comparative information on hydrated lime vs. zeolite, particularly with regard to sediment generation from acid soils.

2. Materials and methods

The soil used in this study was an acid clay loam taken from Yamaguchi prefecture. A Ca type artificial zeolite and hydrated lime of 70 % alkalinity were used as amendments to rectify acidity-induced impact on soil physical factors that control sediment generation. The amendments were mixed with dry soil at 10 % in the case of zeolite, and 0.5 % in the case of lime.

Air-dried soil material (≤ 2 mm) was packed in small soil plot trays; 30 cm by 50 cm by 5 cm. Before it was used for investigations, two pre-treatments were given; (a) the treated dry soil was left incubating for two weeks and (b) the treated soil was left for five months under irrigation with tape water (EC, 0.13 dS m^{-1}) at two-day intervals and at an air temperature of 25 °C. These two pre-treatments are referred to "no irrigated" and "irrigated", respectively in the subsequent text. Five months of irrigation was selected in this study since the growth cycle of field crops is generally no longer than five months. The soil tray was subjected to rainfall intensity of 30 and 60 mm h^{-1} for 2-hours and 1-hour, respectively

3. Results and discussion

The aggregate size fraction obtained after fast-wetting in tap water of aggregate size larger than 106 μm was affected by the amendment treatments and the pre-treatment. This aggregate size fraction is usually shown in **Fig. 1** considered as appropriate to assess ability of soils to withstand rain impact energy-induced sediment generation as it is responsible for decreasing water infiltration. There were significant differences ($P < 0.01$) among treatments in case of pre-treatment for five months with irrigation. The percentage increase in the stability of the aforementioned fraction after amendment was 8 % for lime and 14 for zeolite. Thus zeolite was more effective in stabilizing larger size fractions than lime, suggesting that sediment generation after zeolite amendment would be less than that after amendment with lime.

The cumulative soil loss through runoff as affected by amendment and pre-treatment is shown

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in **Fig. 2**. The soil loss decreased with amendment application and it was found that the pre-treatment affected it significantly ($P < 0.05$). Comparing between the two pre-treatments, the percentage decrease in soil loss from the soil subjected to 30 and 60 mm h^{-1} rainfall intensity was respectively 21 and 29 % for control, 27 and 40 % for lime, and 36 and 44 % for zeolite. This result implies that zeolite amendment was more effective than lime in reducing soil loss. Therefore, this decrease in soil loss with amendment application was consistent with the fast wetting aggregate stability results. In fact, the decrease in soil loss as a result of the five months of irrigation pre-treatment may be partly associated with an increase in the soil organic carbon (SOC) compared to the two weeks incubation.

4. Conclusion

The restriction of soil acidity on plant growth increases the risk of acid soil erosion during rainy season. The incorporation of artificial zeolite and hydrated lime decreased soil losses and the magnitude of reduction become higher when another pre-treatment with irrigation for five months was applied before subjecting the samples to simulated rainfall. Our results make us to conclude that the reduction in soil loss is associated with an increase in the aggregate stability of the aggregate size fraction > 160 μm, and artificial zeolite was more effective than hydrated lime in this regards.

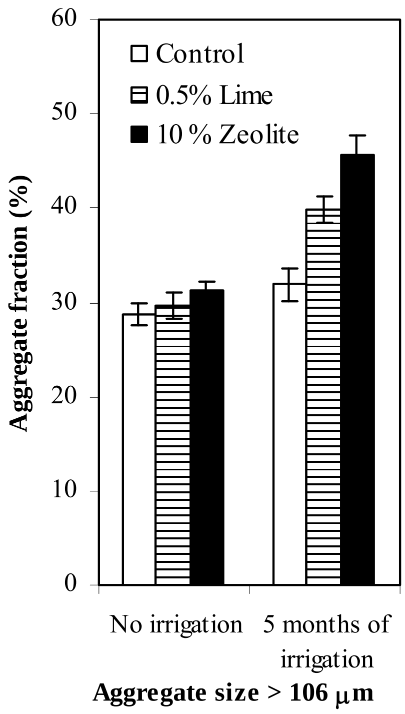

Fig 1. Soil aggregate stability. as effect of the pre-treatment.

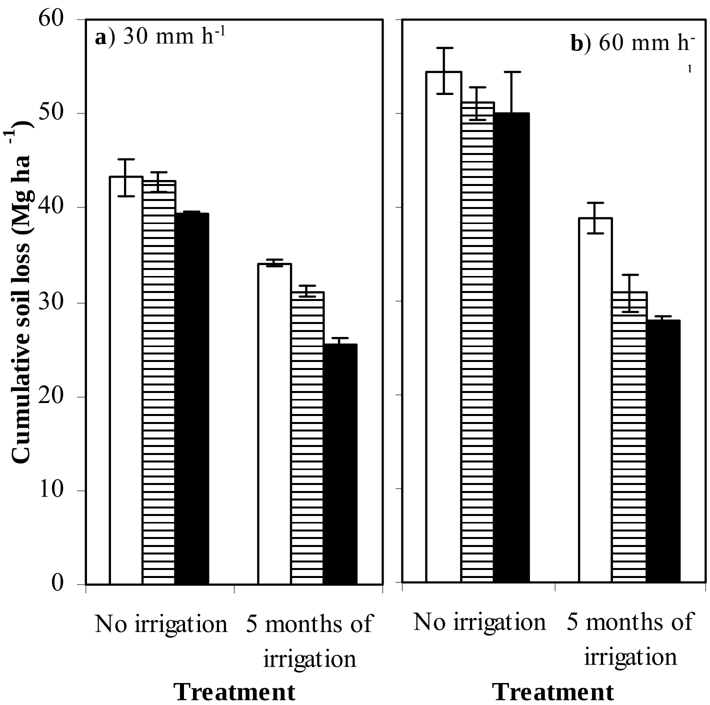

Fig 2. Cumulative soil loss as affected by the pre-treatment subjected to 30 and 60 mm h^{-1} rainfall intensity.

Reference

Menzies, N.W. (2003): Toxic elements in acid soils: Chemistry and measurement. In *Handbook of Soil Acidity*, ed. Z. Rengel, 267-298. Marcel Dekker, Inc., New York, Basel, USA.