

Effect of crop systems and nitrogen application upon soil acidification

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Important advances were obtained in the understanding of soil acidification due to agriculture/husbandry in the last years. The work of some scientists, mainly after 1980's, deserves special consideration, taking into account their contributions to the comprehension of the main factors and processes involved in soil acidification (Helyar and Porter, 1989). However, much is still lacking in getting a holistic view about soil acidification when all factors of environment are present and, most important, in what we can do for diminish soil acidification and make sustainable the land exploitation. The main challenge is to understand exactly how and why it happens in order to manage soil in such a way to minimize the rates of soil acidification, devising strategies to reduce rates of acidification other than by applying lime. As important as to refine the current knowledge is to diffuse this knowledge to people that deal with soil acidification. In agriculture systems, the C and N cycles are the main factors of soil acidification. In the C cycle, as plants develop and uptake nutrients - mostly as cation forms - the root system exudates protons in order to maintain the electrical neutrality of its cells, leading to the transient generation of acidity in the soil and, concomitantly, the plant material becomes potentially alkaline. In a closed system, when there is no input or output of material, the alkalinity present in the plant material is equal to the soil acidity and there is neutralization after plant death. However, when part of the alkaline material is removed from the system as grains, hay, silage, or as animal products, there is not enough alkalinity to neutralize all acidity generated in the soil, resulting in net soil acidification. In the N cycle, legume species and mineral N can contribute with soil acidification mainly due to increase in nitrate leaching and by increasing the exportation of alkaline plant material. In addition, each mineral N fertilizer has different reaction in the soil and, depending on what source is applied, mineral N can promote soil acidification even when no N is lost due to nitrate leaching. In this context, vegetation can affect soil acidification through variations in N fixation capacity, in the ability to absorb and recycle nutrients from and in the soil profile, in its ability to minimize nutrient leaching through effects on water use and nutrient 'stripping' from the leached water, in concentrations of anions – amount of alkali lost in removal of plant material, build-up in organic matter, and its effect on erosion of fertile topsoil. In a long-term no-till experiment without liming, Vieira (2007) found higher rates of soil acidification in legume-based than in grass-based crop systems, and soil acidification was exacerbated by N-urea application. The interesting fact is that, in both cases, the increase in soil acidification was mainly due to the N effect on the increase in grain yield, and not due to increases in nitrate leaching. The main strategies to diminish soil acidification by management are to improve the balance between N supply and plant requirement/uptake; choose mineral N fertilizers that have more alkaline reaction;

keep live plants cycling and absorbing nutrients; in grazing pastures, cultivate grass species together with legume species, choosing preferentially species with deep and abundant root system; develop strategies to conciliate low soil pH and adequate plant development; search for Al-tolerant genotypes; insert Al-tolerance characteristics in other genotypes; improve soil organic matter contents in order to maximize Al complexation.

References

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