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Balancing soil nutrient availability on commercial organic farms

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Summary

Soils from two commercial farms were analysed for cation exchange capacities with the aim of improving the balance of available nutrients at soil level, and to support the basic organic principle of maintaining and improving the long-term fertility and microbiological activity of the soil.

Introduction

One of the main management tools for the maintenance of crop and animal health in conventional farming systems is the use of chemical inputs to address the effects of imbalances, or to treat symptoms. Organic systems promote a preventative approach for management of the natural system of soil, climate, crops and animals, to the benefit of long-term sustainability and health (SOPA, 2004). Health is inevitably linked to nutrition, and soils provide the baseline source of nutrients.

The analysis of soil nutrients has traditionally focused on soil pH and total soil concentrations of nitrogen, phosphorus and potassium, with the aim of defining the quantities of these nutrients to be applied to the benefit of the subsequent crop. In the current programme, soil analysis was the measurement of cation exchange capacities (CEC) of the soil, with recommendations for chemical amendments based on the Albrecht system (Albrecht, 1975). The system measures the percentage of different cations sited on the negatively charged colloids in the soil. The CEC of soils is a measure of the soil's ability to hold, absorb and exchange nutrients for plant uptake. The Albrecht soil analysis also provides information on pH, percentage organic matter and microbiological activity levels. This short paper describes a five-year programme of soil management on two commercial farms in Scotland, through conversion to organic status.

Materials and Methods

The two collaborating farms were a mixed livestock and cropping unit on grade 3 soils in East Scotland, and the other a dairy and grassland unit in southwest Scotland also on grade 3 soils. Each field on both farms was initially sampled with a screw auger to a depth of 15 cm, with 20 cores collected systematically following a 'W' pattern across the field. Samples were bulked and sent for analysis at two commercial laboratories: one for standard soil parameters of pH, and extractable phosphorus, potassium and magnesium, and the other for CEC and Albrecht recommendations. Both farms were presented with the results and recommendations. Soil pits were dug to confirm the presence of high level soil pans where indicated by high iron concentrations. A number, but not all of the recommendations were carried out on each farm. Both farms continued to apply farmyard manures and slurry conventionally. The sampling protocol was repeated on both farms after three and five years, during which time the farms had fully converted to organic status.

Results

A sample of the macronutrient status derived from the (?) CEC results is shown on Fig. 1, from farm 1. The change to using calcium limestone instead of magnesium limestone reduced the mean deficit in Ca across 16 fields in farm 1 from -1,170 kg ha^{-1} to -233 kg ha^{-1} in five years, whilst soil pH moved from a mean of 5.8 to 6.1. The mean magnesium surplus declined from 207 kg ha^{-1} to 26 kg ha^{-1}, whilst the small deficit of potassium stayed relatively unchanged. Fertiliser costs and whole farm profitability are reported elsewhere (Robertson *et al*., 2006). The conventional soil analysis provided recommendations for lime applications that did not differentiate between the use of calcium and magnesium limestone.

Discussion

The range of recommendations based on the Albrecht soil analyses was extensive, but was not applied fully by the commercial farms due to concerns about costs and lack of supporting information about the efficacy of the treatments. Both farms applied calcium limestone as a substitute for magnesium limestone and farm 1 applied trace element applications dependent on the following crop. Farm 2 purchased a heavy-duty aerator to provide aeration to a depth of 10–12 cm to break up the extensive high level pans on grazing fields. Farm 2 did not apply the recommended applications

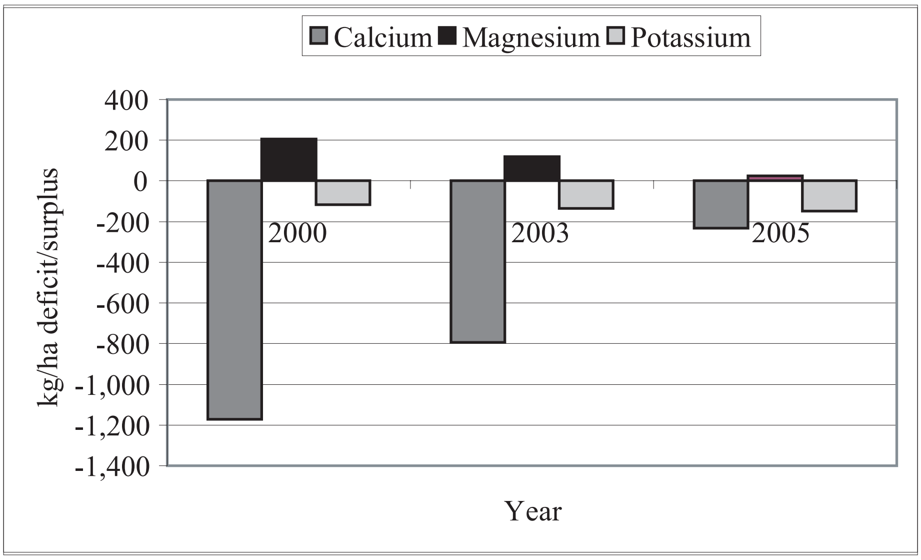

Fig. 1. Change in availability of soil Ca, Mg and K over 5 years with calcium limestone application (n=16 fields, Farm 1))

of trace elements due to difficulty in sourcing a contractor with the resources for applying low rates of 5 kg ha^{-1}.

The use of calcium limestone in place of magnesium limestone improved the calcium: magnesium cation ratio towards the recommended ratio of 64:12. The dairy cattle on farm 2 had previously required a routine supplementation of calcium prior to calving; blood sampling demonstrated that this was no longer necessary after two years, with milk yield dropping by less than 5% compared with pre-conversion levels. The clear presence of a high-level soil pan on the grazing fields was not fully dealt with by the purchase of a soil aerator. There is a requirement for timely use of the aerator, when the soil is neither too wet nor too dry, and the farm had difficulty in prioritising a new task into the existing routine of fieldwork. Improving the balance of available nutrients at soil level appears to be a logical management practice but commercial application is restricted by practical concerns about efficacy of the treatments. It would be useful to include as sentence on how you might go forward with these ideas/approaches.

Acknowledgments

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