THE CHALLENGE OF PHOSPHORUS IN BROADACRE ORGANIC SYSTEMS

Chris Penfold of the University of Adelaide, Roseworthy Campus, reports on how phosphorus nutrition can be improved on broadacre farms in Australia

Broadacre organic farming in Australia is a unique agricultural system. Practiced on a large scale with soils that are ancient, weathered and generally nutrient poor, farmers are growing crops using low inputs of fertilisers, while attempting to sustain or improve the quality of our soil resource. This is difficult, as crop production accounts for a substantial amount of nutrients which are exported in product from the farm.

To complicate the problem, Australia has adopted international certification standards which are based in Europe, and which have little regard for the very different biophysical and economic environment existing in Australia. This is very evident when dealing with soil nutrition. In Europe, plentiful supplies of animal manure or compost can be applied cheaply to intrinsically fertile soils for mineralisation during their warm, moist summer growing period. Over the large areas of less fertile soil on Australian broadacre farms, with cold winter growing conditions, these systems are unsuitable.

A dilemma in soil nutrition has now arisen amongst established broadacre organic farmers. Soil available phosphorous has declined to levels where yields are being compromised and the sustainability of the farming system is being questioned, despite the best efforts of farmers to address the issue using inputs allowed under the present certification standards.

The observed decline in available phosphorus is supported by scientific studies, which have found phosphorus nutrition to be limiting production by as much 60%. In organic / biodynamic systems which are deemed to be sustainable and producing product of the highest quality from nutritionally balanced soils, there are some significant questions that must be answered quickly to ensure the long term productivity and profitability of these farming systems.

In organic farming, it is preferable to close the nutrient cycle, whereby surplus nutrients in grains and forage that are fed to livestock are returned to the soil as organic manure. Alternatively, if the product is used off-farm, waste product from the next link in the consumption chain (eg manure from a dairy to which the organic farmer has sold their hay or grain) is returned and spread on the organic property. This system works well on many small European farms. By contrast, the Australian broadacre farmer generally does not have access to large amounts of readily composted manures to replace those nutrients which have been exported. The alternative is the use of fertilisers permitted under the organic standards, which are expensive per unit of nutrient, of poor performance or both.

With regards to soil nutrition, the management of phosphorus is the primary concern of organic farmers for the following reasons:

- Its natural abundance in most Australian soils is very low.
- It is a major element, and the one most limiting organic broadacre production systems in Australia.
- It is the driving force behind chemical fertility. Legumes will supply biologically fixed nitrogen to the soil in adequate quantities to support a well-managed organic cropping system, but they require an adequate supply of available P to function properly.

Despite the apparent difficulties, it is believed that some improvements can be made in nutritional management on many organic farms, by utilising known practices within a farming systems context. This paper is intended to provide some management practices that will assist in reducing phosphorus deficiencies, within the constraints of availability and cost of certified products.

REVIEW OUTCOMES

The provision of adequate phosphorus to plants using conventional practices is comparatively easy in Australia, so long as the cost is readily redeemed in the product sold. Water soluble phosphatic fertilisers have been used with considerable success in Australia for over 100 years, and they remain the standard by which others are judged in all farming regions. In some situations they can adversely affect plant growth, by inducing trace element deficiencies, or disrupting legume nodulation, but this is rare. More often however, inadequate phosphorus is likely to be limiting plant productivity.

In conventional farming systems, the efficiency of phosphorus fertilizer use is low, with only 10-20 % of that applied being used by the growing plant. This fact, coupled with historical applications of phosphorus beyond plant requirements, has led to a bank of soil phosphorus in many of our agricultural soils. In most situations this is only slowly released to become plant available, but in other regions it may mean that plants are no longer responsive to further fertiliser application. This is the preferred position for a person to begin farming organically, as it should be possible to maintain this level of soil phosphorus using certified phosphate rock products. On the other hand, using these same products, it would be a challenging and expensive proposition to raise plant available phosphorus to adequate levels in highly responsive soils. The plant growth response to the different phosphate rock fertilisers also varies considerably between plant species, soils and climatic regions.

There are however, numerous management options available to the farmer which will assist in phosphorus nutrition. These start with the location of the property, as having soils which are below pH 6 and in medium to high rainfall areas is an advantage. All seed sown

should be of the highest quality, as this will greatly assist the plants early growth pattern. This is an important issue given the impending requirement for all seed used to be organically grown. Where seed is derived from crops grown in a phosphorus limiting environment, plant early vigour is suppressed, the capacity to compete with weeds is reduced, and yields will be compromised. Access to varieties best suited to particular farms will also be restricted. This is an unacceptable and unnecessary impediment to the organic industry in Australia, and as a policy it needs to be addressed very soon.

Where possible, seeding should occur as early as permissible, using crop species known to perform well in a particular environment, which will probably mean a genotypic adaptation to the P status of soils in that area. Legume dominant pastures (annual or perennial) will cycle P, and if these are green manured prior to cropping, then phosphate rock should be broadcast before ploughing down. Organic matter is all important in general soil nutrition, and with phosphorus it is no exception. Enhancing the soil organic matter levels through the growth of healthy crops and pastures with a high legume component will ultimately enhance P nutrition.

When sourcing fertilisers, a ready source of compostable manure nearby is desirable, but this is rarely the case. Other possibilities must therefore be explored. The most reactive phosphate fertiliser available should be used.

Despite a lot of work investigating phosphate solubilising micro-organisms, there is uncertainty about their future role in Australian farming systems. However, the potential of humic acids should be explored further, particularly for the areas of alkaline soil where rock phosphates are of little apparent value.

Through using some or all of these practices, it is expected that phosphorus nutrition can be improved on broadacre farms in Australia. This review has also identified many research areas which require further investigation or validation for Australian conditions. Overcoming the problems of phosphorus availability in broadacre organic farming is of vital importance, as it is a major constraint to the further expansion of this burgeoning industry. As such, it is hoped that appropriate levels of funding will soon be directed to this field of investigation.

The complete paper, *Phosphorus Management in Broadacre Organic Farming Systems,* published in 2000, can be found on the RIRDC website http://cybershopper.com.au/rirdc/index.html