Potassium problem ... What problem ?

By Mark Measures of the Organic Advisory Service, England

No one would dispute the importance of potassium in soil health, plant growth and animal nutrition. Its primary function in the plant is its role in the maintenance of osmotic pressure and cell size, thereby influencing photosynthesis and energy production as well as stomatal opening and carbon dioxide supply, plant turgor and translocation of nutrients. As such, the element is required in relatively large proportions by the growing plant.

Observation and analysis

The consequences of low potassium levels are apparent in a variety of symptoms - restricted growth, reduced flowering, lower yields and lower quality produce. The latter is of significance in straw strength and protein levels for example. In the soil, potassium also plays a key role in the optimum functioning of microorganisms, most notably the nitrogen fixing rhizobium.

The potential problem of potassium supply in organic husbandry is brought to our attention by soil analysis and by nutrient budgeting. The problem is distorted by applying a conventional soil scientist's interpretation. Soil analysis of water soluble potassium as carried out by both an organic farming center in England: Elm Farm Research Center and ADAS (Agricultural Development Advisory Service) type methods does indicate low levels on many soils. Levels at which deficiency are apparent and levels at which a yield response to potash fertilizer is found in conventionally managed crops.

Low levels are then often looked at in the context of crops and crop rotation where the net removal of potassium is considerably greater than the input, even where all manures are returned. Hence, with a mentality that is restricted to the view that ``what you do not put in, you do not get out'', there are serious implications on the horizon for organic producers.

However, the reality is somewhat different. In my experience, through contact with organic farmers and growers throughout the country, and in my work interpreting soil analysis results at Elm Farm, there is clearly not a problem on the scale one might expect. Some deficiency symptoms are occasionally apparent, the consequences vary from severe loss of red clover plants on potassium deficient chalk soils to mild, temporary symptoms of little consequence on brassicas in loams. Frequently, we find crops thriving under conditions of low analyzed levels. In contrast, we do very occasionally find symptoms showing under medium levels. Elm Farm Research Center's long term monitoring of fixed point sites are at an early stage, but are not showing depletion of available potassium in good organic rotations. Interestingly, regular analysis of some organic farms in Germany is showing an increase of potassium, even in situations where there is no applied mineral or imported manure.

Explanation

So, what is happening? First we must realize that one limitation of our current understanding is that the analytical techniques used, are unable to measure fixed and reserve potassium levels in ways that identify all necessary aspects. There are 4 identifiable fractions of potassium in the soil:

1. Potassium as a component of soil minerals

2. Fixed potassium

3. Exchangeable potassium

4. Water soluble potassium

The water soluble potassium is available immediately to the plant and is susceptible to leaching. Exchangeable potassium is also available to the plant and is the usual form of potassium analyzed, together with the water soluble potassium. The fixed potassium and mineral potassium are present in the soil in very much greater proportions and may provide a potentially in exhaustible supply to fractions 3 and 4. However, fixed potassium is normally only released in low exchangeable potassium conditions, and mineral potassium is only released after weathering, which may be a very slow process.

The various fractions and the movement between the different fractions is dependent on the sand and clay components, and on clay types; availability is also influenced by moisture. The vermiculite, illite and smectite clays have very high natural levels of fixed and exchangeable potassium which is available to maintain water soluble potassium. The sands and organic soils have much lower reserves of potassium and in these situations any analyzed potassium is likely to be water soluble potassium and is very susceptible to leaching. The silt component of soils has conventionally been thought to be a poor reservoir of potassium. However, German work is demonstrating far greater supplies than previously thought.

Organic Techniques

Within an organic system the potential for utilizing natural soil potassium and not developing deficiency symptoms of depletion in the future, may be considered. Firstly, the development of a "living"soil is crucial. There is a considerable effect on natural weathering of minerals and mobilization by root acids, on the action of soil micro-organisms such as fungi and bacteria and also on the churning action of that vital creature, the earthworm. Secondly, organically managed crops are reputed to have deeper and more intricate root systems which will allow the plant to have access to soils from which potassium would not otherwise be available. Thirdly, a sound rotation involving certain crops, such as beans (faba), which have a greater capacity for making potassium available. The objective within an organic system is therefore improved availability of the vast reserves of potassium, not short term mining. The optimum utilization of that potassium is then another matter. It involves close attention to proper manure management, return of crop residues and appropriate crop rotations. This is all very well, but for the farmer with deficiency symptoms, the farmer with exceptionally sandy soils, or someone who is about to convert from conventional management, some other action may be essential. Conventionally of course, muriate of potash (potassium chloride) is used, resulting in high water soluble levels, at risk from leaching, causing damage to germinating seedlings inhibited uptake of other minerals and reducing the quality of the crop. Unfortunately, no-one has yet come up with the equivalent of rock phosphate - a slow release potassium mineral fertilizer.

Andularian shale (Highland rock potash) is used by some farmers but at present there is no indication that any of the potassium is available to the plant except over an exceptionally long weathering process - perhaps involving centuries. Imported manures may play a role in improving or maintaining levels on some farms, particularly for the intensive grower. The greatest wasted resource of our time is, of course, sewage and while that has vast potential it largely remains unacceptable in organic situations because the water authorities are unable to control the heavy metal content, due to industrial pollution.

One further option remains in the Soil Association standards (U.K.) and that is the restricted use of potassium sulfate. It should be remembered however, that even though natural sources are available, it is a highly soluble source of potash with all the problems which we are trying to avoid in organic husbandry. If, under exceptional circumstances, it does have to be used, very careful attention needs to be paid to quantities, timing and to the crop type.

The potassium problem is not as great as might be expected on a superficial view; soil analysis of rechargeable and water soluble levels alone, may be of limited value, but there is great potential to tap soil reserves. However, much valuable information can be obtained from the soil type, the clay types in particular and a knowledge of the biological activity of the soil. While an effective source of rock potash would be very useful, the principal means of managing the situation lies in growing crops appropriate to the soil type, in a good rotation and with careful attention to full recycling of potassium by returning crop residues and storing and applying manure thoroughly.

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