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Soil, liming policy and common scab in potatoes

During 2018, NIAB CUF undertook a review for AHDB on the effect of liming and pH on the risk of common scab in potatoes. The review examined the historic basis of current advice for liming, and gathered experimental studies to summarise current understanding in the area, highlighting knowledge gaps where future research is needed to enable clear, accurate, advice for liming.

Current practice

The use of lime as a soil conditioner, particularly the liming of acidic soils to increase pH, has been found to improve the yields of many crops in the UK. This can be through improved water and nutrient availability and uptake, development of improved root systems, enhancement of soil organic matter breakdown, and improved soil texture (such as through increased friability). The relationship between yield and soil pH differs between crops and is influenced by soil type and texture. The British Survey of Fertiliser Practice suggests that there has been a decline in liming. On average, of fields surveyed over the 11 years from 2007-2017 (Defra, 2007-2017), around 1% of potato fields, 9% of arable (tillage) fields and 24% of sugar beet fields were limed immediately ahead of the respective crop.

The Nutrient Management Guide (RB209) – Section 5 (Potatoes), and current advice from AHDB for managing the risk of common scab, advises that liming immediately before potatoes should be avoided, unless the soil pH is very low, owing to the risk of common scab at higher pH. Following several interviews, this is also a commonly held view amongst growers, agronomists and fertiliser sales, distribution and application companies.

The disease

Common scab in the UK is mainly caused by *Streptomyces scabiei*. It is an unsightly blemish disease that can affect any crop where tubers experience a dry surface during the critical stage in the six weeks following tuber initiation (Figure 1). *S. scabiei* is widely distributed and is therefore a threat in almost all soils. Variety resistance can effectively limit development of the disease, but in the driest years infection can occur even in highly resistant varieties. The use of irrigation during the period of tuber initiation has provided an effective control measure where properly applied.

Although common scab on potato was first described more than 100 years ago, the factors underlying the disease are still largely not understood. This is partly due to lack of understanding in terms of the pathogen itself (variation in genetics, pathogenicity, strain aggressiveness), in terms of the basis of potato variety resistance, and the complexity of environmental factors.

At least two species of scab-causing *Streptomyces* species actually occur in the UK including *S. scabiei*, which is thought to be the most predominant in causing common scab, and *S. acidiscabiei* which can cause scab in acid soils. The species have different, but overlapping, pH tolerance ranges, with common scab prevalent in neutral soils (pH 5.0-7.5) and

Figure 1. Common scab

acid scab occurring in more acid soils (pH 4.0-5.2).

In the 19th century, studies noted that the application of calcareous material to soils growing potatoes resulted in symptoms of common scab and discouraged the use of such materials in production. Studies in the 1950s to 1970s also noted that increased soil calcium resulted in increased tuber calcium which was positively correlated with scab severity.

When calcium (in the form of lime) is added to the soil, the pH rises (a variable amount depending on soil type and texture); the link between the addition of calcium and increasing pH was made in most of these papers, but was not separated out. This correlation is thought to be the background to current advice and common practice. More recent literature tends to identify high pH as the predominant factor in increasing the risk of common scab, rather than the calcium itself. The complexity of other factors which can affect the incidence of common scab (such as water availability, temperature, variety, soil nutrient levels etc.) means that results between seasons, cultivars and locations, can be inconsistent or contradictory.

With increased restrictions on water use, alternative approaches to the control of common scab would be beneficial, but have not yet proven successful or consistent.

Assuming pH is a key factor for the occurrence or expression of scab symptoms, increasing soil pH to beyond the tolerance maximum of the scab-causing organism could contribute towards an effective control of the pathogen. This would mean above pH 5.2 for *S. acidiscabiei*, and above pH 7.5 for *S. scabiei*. The central range between pH 4.0 and 7.5 includes all of the scab-causing species found in the UK. If soil pH was not raised substantially above 7.5, increasing the alkalinity from a low pH could potentially move pH into the risk zone. Identification of the starting pH and scab organism present would impact the target pH and whether this could feasibly (and economically) be achieved through the application of lime.

Field experiments undertaken at NIAB CUF, and by British Sugar, suggest that the application of lime and other calcium products such as gypsum, can give reductions in scab and improvements in marketable yield, but the picture is complex. It is suggested that lime application can increase pH above the upper tolerance for pathogenic *Streptomyces* (pH 7.5). NIAB CUF field trials showed reductions in scab with liming, but only on one site was pH increased beyond 7.5. In a site with a low pH (5.2), liming only increased pH to 6.6, but reductions in the incidence of scab were still found.

Results from field experiments undertaken by British Sugar using LimeX, a calcium by-product of sugar manufacture (Cogman, 2018), found reductions in the percentage of yield affected by common scab where LimeX was applied. These experiments were mostly on soils of pH 6.6 to 8 where application increased pH beyond 7.5. On black fen soil where the starting pH was 5.4, LimeX at the highest rate only increased pH to 5.7 and had no significant effect on scab.

The review also reports evidence for a non-pH induced change in scab susceptibility from gypsum application. Despite having a neutral or slight acidifying effect on soil pH, reductions in scab were observed by adding gypsum that could not be explained by calcium since other calcium products had no effect on scab. Gypsum is a well-known improvement agent for low organic matter clay soils, and this could have increased easily available water-holding capacity in the soil surrounding tubers, thereby aiding control of common scab using irrigation.

Figure 2. Lime spreading

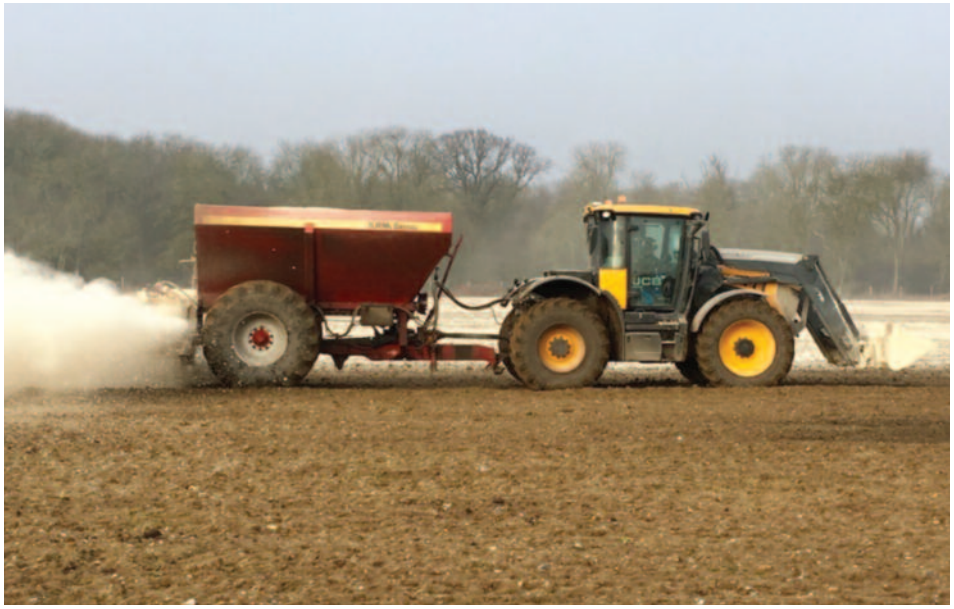

Photo: Keith Mount Liming

The impact of liming on other crops

Liming has consequences for other crops in the rotation, particularly on diseases and nutrient availability. Lime may be applied to ameliorate problems in other crops such as to correct soil pH to maximise yield and sugar content of sugar beet. Brassicas may suffer from infection by the clubroot pathogen, *Plasmodiophora brassicae*. Clubroot severity is linked to soil pH and boron and calcium content, and crops in acidic soils are more at risk of severe symptom development. For cavity spot disease in carrot (*Pythium violae* and *P. sulcatum* in the UK), experiments have suggested that lime may be used to raise the pH of soils, and reduce incidence.

Next steps

The review identified several areas where knowledge gaps exist and where future research could increase resolution of advice for crop performance and quality. These include the question of whether the current recommendation for avoiding liming ahead of potatoes is correct when pH is not increased above 7.5. Does the advice need to be modified for high pH soils? And confirmation of the upper and lower limits of pH tolerance for the pathogenic species present in the UK.