The complicated world of cover crop nutrient release

"You have to build in how much nitrogen has probably been taken up by the cover crops, and how much water is left in the soil."

DR MARC ALLISON

From understanding how much nitrogen a cover crop might release to hearing how technology and research could improve potato growing, CUPGRA's annual conference delivered some valuable insights. *CPM* attended the event to understand more.

By Mike Abram

How much nitrogen can a cover crop realistically transfer to a following potato crop, and could it be used to reduce fertiliser inputs? Those seemingly straightforward questions are far from easy to answer accurately, stated Dr Marc Allison at the annual CUPGRA potato conference in Cambridge.

In a bid to find out more, Marc has co-authored a £4000 literature review for CUPGRA – Cambridge University Potato Growers Research Association – of which, the findings will feed into a separate ongoing review of fertiliser recommendations being undertaken by GB Potatoes.

"The more you go through this, the more complicated it gets," he told a workshop at the conference. This is because nitrogen uptake into cover crops is controlled by a mixture of factors including species type, how much nitrogen residue is in the soil, soil conditions – better structured soils allowing greater root growth take up more nitrogen – and weather, continued Marc.

Cover crop biomass, which research has shown is directly linked to ground cover and solar radiation, is also an important factor, alongside emergence date – more than drilling date – and termination and incorporation dates.

C:N RATIO

However, the carbon to nitrogen ratio (C:N) of the incorporated cover crop mix is a key factor in how much nitrogen will be available to the following potato crop, stated Marc. Cover crops, such as those containing lots of legumes with low C:N ratios are almost instantly mineralised, while mature cover crops with high C:N initially lock up nitrogen. But, that isn't the complete story, noted Marc.

"Eventually [high C:N material] will be processed [by microbes], build up soil organic matter and there'll be more nitrogen."

For this nitrogen release to be most beneficial, it has to coincide with when the potato crop requires it the most – typically up to 35-40 days after emergence, commented

Amalgamated research

Dr Marc Allison has co-authored a literature review for CUPGRA, looking at how much nitrogen a cover crop might release.

International learnings

Independent agronomist Martyn Cox has evaluated three systems other countries are using to measure cover crop performance and nitrogen release.

Marc. If the C:N ratio is too high, nitrogen release may be delayed past the time when the potato crop is actively taking up nitrogen.

For his contribution towards the review, independent agronomist Martyn Cox has evaluated three systems other countries are using to measure cover crop performance and nitrogen release.

He pointed out that perhaps the best of the three is MERCI (Méthode d'Estimation des Restitutions par les Cultures Intermediaries), developed by the Regional Chamber of Agriculture in Nouvelle-Aquitaine, INRA and other partners, which allows for an estimation of nitrogen and other nutrient release.

The method involves a measurement of cover crop biomass, ideally split by species, which is then used with an online platform to incorporate data from extensive experiments and simulation models to provide detailed N, P and K estimates – total amounts, what will be immediately available, or after 30, 60, 90 days or beyond.

"It's very educational," said Martyn, while sharing comparisons between the model and lab analysis of biomass weight within 2kg/ha for a two-species cover crop he'd looked at.

Another system he's reviewed is an American cover crop nitrogen calculation system (CC-NCALC), which Martyn highlighted only simulates nitrogen release. "This worked reasonably well, although you have to use a field location in the US."

For his work, Martyn used Washington State as closest to a comparable climate to the UK. "You use real data and it gives you a prediction for N release for your estimated following crop planting date."

Its prediction for radish was similar to MERCI, he said, but there were significant differences for some cereals, with MERCI predicting immobilisation while CC-NCALC suggesting nitrogen release.

Martyn stressed that a third system used by the Dutch was too complex and included the input of assumptions about cover crop N content, partly because its farmers were encouraged to put nitrogen on ahead of cover crops. Martyn said he thought that would affect the calculation's accuracy in the UK. "We wouldn't recommend you to use it currently," he urged.

RB209

Broadly, the review has unearthed some potential challenges regarding using AHDB's Nutrient Management Guide (RB209) field assessment method for calculating a following crop's fertiliser requirements, when growing cover crops.

"At the moment, how much nitrogen is taken up by the cover crop and the reduced amount of water flowing through the soil profile aren't taken into account properly by RB209," suggested Marc. "Using oilseed rape as a proxy for a cover crop, and comparing it to bare soil over winter, you can change the amount of water that's moving through the profile by a substantial amount depending on the size of a cover crop. ▶

"So if you start making recommendations simply based on excess winter rainfall [on bare soil] and the previous crop, you'll be wrong. You have to start building in how much nitrogen has probably been taken up by the cover crops, and how much water is left in the soil."

Conversely, in a dry winter where there was little nitrogen leaching, a study by Rothamsted Research suggests that growing a cover crop could be detrimental, as the released nitrogen from it might not coincide with when it's required by the potato crop.

"The problem is, of course, you don't know whether it'll be a dry or wet winter, so on average, you're probably better off having the cover crop. But just be aware of some of the problems," stressed Marc.

The literature review also highlighted research that showed some evidence that in cover cropping every year, perhaps by altering the amount of water going through the soil profile or by the slow build-up of nitrogen residues, that you might just be delaying nitrogen leaching to another point in the rotation rather than preventing it.

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SCENARIO PLANNING

Finishing the workshop, Martyn discussed different potential cover cropping scenarios to highlight how to consider potential nitrogen release. Variables to note include soil type, cover crop mix, rainfall in early autumn, drilling or emergence date, incorporation date, and the status of the cover crop when chopped.

For example, a mid-August-drilled radish mix on sand, incorporated when green in early February, would likely release nitrogen, he said. "Radishes are deep scavenging and effective at picking up nitrogen, so they'll absorb nitrogen when drilled early," he said.

But the same scenario drilled in early October with higher autumn rainfall would be too late for the cover crop to as effectively mop up nitrogen. "With rainfall before the cover crop emerges, leaching will have already happened.

"It's complicated, but RB209 would have assumed high N-leaching that the cover crop would have prevented in the first situation, but wouldn't have done in the second."

In a second example, he evaluated a mid-August drilled cover crop of black oats terminated in late March; rainfall had been low in autumn. "RB209 would assume on a sandy clay loam in a dry winter, not much nitrogen has been lost. But the cover crop would have taken up nitrogen, and as it's been chopped in late when it's woodier, it's going to take a little while to break down. The outcome will be that you won't get that 30kgN/ha from the cover crop."

Remember cover crops can be radically different in how much nitrogen they might release and when, he concluded.

Helping to reduce costs and improve quality on a Scottish farm

Technology is playing a crucial role in growing and storing potatoes at Lacesston Farm in Fife

Speaking at the CUPGRA conference, farmer John Weir shared that he grows 65ha of white potatoes for the pre-pack market, focusing on yield, baking quality and long-term storability. "The majority is on contract for Greenvale, and everything is lifted as clean as possible directly into boxes."

The farm has two stores with a combined capacity of 4200t, he said, with the newer building fitted with solar photovoltaic panels. He also had a small wind turbine on the farm, with both used to reduce the cost of storage with the help of energy optimisation software.

"It's probably the technology which has shown the clearest quantifiable gain," he pointed out.

Generally, unless it's very windy, the energy generated by the wind turbine powers only one of the two stores, explained John. "The software uses a priority system and will cool the warmest store first and then switch to cool the second store. If it stays windy, we'll over-cool when it's generating power with a view to turning it off when it goes calm. Effectively, we're using the potatoes as a big battery," he said.

Potato storage
John Weir's farm has two potato stores offering a combined capacity of 4200t, with the newer building fitted with solar photovoltaic panels. *Photo: John Weir.*

"That's saved a lot of money. I get a text every day telling me the temperatures in the stores, the amount of energy we've generated, the amount used and what we've exported. My aim is not to export any as that's the cheapest electricity we can use."

In field, GPS technology is used to implement variable rate planting, allowing him to adjust seed density based on the topography of the fields, particularly on land with significant hills.

"Variable rate planting isn't something that's widely used," he suggested. "But the main opportunity I see, is to plant at lower density at the top of hills, because frequently what we harvest from the top are far smaller than those at the bottom."

He's also reduced planting density in tramline beds and directly either side, as he's also found these areas tend to grow smaller potatoes than his baker quality target. "It's trying to even up the crop going into boxes so we don't have these small run boxes that cause a problem."

A lot of the technologies trialled on the farm originate from its involvement with the UK Agri-Tech Centre's farm network. "For example, we have a sound recorder that uses AI to identify which birds we have around the farm – that helps when we're doing a LEAF audit to evidence what wildlife we have."

But, not all of the technology trialled has shown a good return on investment, he countered. "Two years ago, we trialled Harvest Eye technology, which is an optical camera that takes a picture of potatoes going over the harvester, to give a size distribution and total yield.

"It worked well and I thought it might be a valuable tool where I could market exactly what we harvested. Fortunately, that year potatoes were good value, so it made no difference.

"Maybe in a year like this one [with lower prices] where bakers will become scarcer, it might be more beneficial if I could market smaller run potatoes earlier in the season."

Even so, given he knows to a large extent which boxes those potatoes are in already, albeit not down to the individual potato, he said he can't justify the overall cost. "Perhaps if we were grading into store and you set it up on the grader as well, you'd get more use from it by sizing accurately," concluded John.

Utilising technology
Speaking at CUPGRA, John Weir shared that GPS technology is used on his farm to implement variable rate planting in potatoes. *Photo: Beanstalk Global.*