Nutrient sweet spot for optimal potato yields

To increase potato yield and quality, nutrients need to be carefully managed, taking into account what the plant requires and how applied elements interact with each other. **Charles le Roux** of Diagnosis and Recommendation Integrated System spoke to **Lindi Botha** about optimising nutrition for maximum synergy.

Traditional soil analysis entails surveying what nutrients are available, knowing what the crop requires for optimal growth, and topping up elements as required.

But this method fails to take into account whether elements are plant-available or how they interact, often leading to increased nutrient applications that have little effect on the crop.

It's a lose-lose situation in which farmers spend money on inputs that bring no value, and nutrient run-off creates further problems.

This is where the Diagnosis and Recommendation Integrated System (DRIS), used to interpret plant tissue analysis data and assess plants' nutritional status, can be of great value.

The benefit of DRIS over traditional plant analysis is that it helps identify imbalances, deficiencies, and excesses of plant nutrients by analysing the ratios between different nutrients, not just their individual concentrations.

BELOW: A trial planted using Diagnosis and Recommendation Integrated System technology yielded potatoes that were more evenly sized, reducing the percentage of outliers like overly big or small potatoes. PHOTOS: LINDI BOTHA

While the system is not new, having been developed in 1973 by Dr ER Beaufils, formerly from the Department of Soil Science and Agrometeorology at the University of KwaZulu-Natal in Pietermaritzburg, it is now gaining renewed interest globally.

FULLY INTEGRATED, PRACTICAL METHOD

Ronald Schroder, agronomist at DRIS and one of Beaufils's former students, was involved in much of the original research and has continued refining and expanding the system into what it is today. DRIS now combines soil, tissue, and sap analysis into a fully integrated, practical method that delivers real-time recommendations using modern fertilisers and foliar applications.

"It is the only system that presents both sap and tissue data in a single, easy-to-read graph, giving farmers a clear, visual understanding of both nutrient storage and immediate uptake at the same time," says Charles le Roux, director of commercial and business development at DRIS.

"One of the reasons why potato farmers aren't getting the marketable yields they should is because of nutrient deficiencies and imbalances. A common issue with current fertiliser practices is that farmers are often using generic programmes based on old norms developed for cultivars that we don't even plant anymore.

"The yield potential of the new varieties is much higher, and so we are seeing a trend where farmers are increasing the fertiliser without taking into account how the different elements applied react to each other, or if there is an oversupply of one element that is causing suppression of another," he explains.

DRIS helps farmers determine whether the nutrients are balanced in relation to one other and identify any limiting factors.

"Some elements will only be fully absorbed by the plant if another nutrient is also available, and in the right quantity. Then there are nutrients that suppress others if their levels are too high," adds Le Roux. "For example, traditional soil analysis could

show that there is a potassium deficiency, but not how much potassium is needed, or what caused the deficiency. DRIS calculates if there really is a potassium shortage, or if there is just a limiting or suppressing factor preventing available potassium from being absorbed.

"Then, if more potassium needs to be applied, the system will also indicate if a potassium increase will cause unintended consequences that create limiting factors for other elements.

"Ultimately, the program allows us to create fully balanced fertilisation that works to increase yield, without wasting inputs."

DRIS HELPS FARMERS DETERMINE WHETHER THE NUTRIENTS ARE BALANCED IN RELATION TO ONE OTHER

Cost savings follow, since elements aren't being overapplied. With input costs rising rapidly over the past few years, farmers could be tempted to cut fertiliser costs. But Le Roux notes that a certain percentage blanket reduction is not the answer.

Instead, there should be a methodical approach to optimise the elements that are being applied to prevent overapplication or waste. "This is why balancing the nutrients is so important," he says.

While potato farmers would generally do a soil analysis prior to planting, and a leaf analysis in season to determine nutrient applications, Le Roux's process does additional tissue and sap analysis to monitor nutrition throughout the season, enabling farmers to make real-time adjustments. "Crop monitoring is done every two weeks to ensure the plant has everything it needs. A follow-up sample is then taken to ensure that the plant has reacted the way it should to give the farmer peace of mind," he explains.

USEFUL NITROGEN

When looking at data collected over the years, Le Roux has identified a common issue affecting quality and limiting marketable yields for many potato farmers – too much nitrogen (N).

High levels of N, especially early in the season, can be very suppressive, negating the effect of other nutrients. This is especially the case with calcium (Ca), which then results in suboptimal plant development early in the season. High N levels also promote vegetative growth, not root development or reproductive growth.

"Farmers are understandably afraid of losing yield, so if they have the budget, they ramp up nutrient levels without looking at the cause and effect of lifting the levels.

"Instead, if the plants' energy levels are properly managed, you can drive yields higher without increasing inputs," says Le Roux.

He notes that fertiliser programmes for potatoes are generally nitrate (NO_3) driven, but that it is important to distinguish between the different forms of N: nitrate (NO_3), nitrite (NO_2), ammonia (NH_4), and organic or total N. This is where sap analysis is useful, since it makes this distinction.

"Any N applied must be converted to amino acids and proteins so that it can be used by the plant. This requires the presence of micro-elements, and energy within the plant to do the conversion."

Le Roux says a telltale sign that soils are compacted and that the applied N has not been converted by the plant is high NO_2 levels in the sap analysis. DRIS helps farmers manage the N conversion of the plant by balancing the elements responsible for the conversion, and the energy required. A good example of such a micro-element crucial for N conversion is molybdenum.

"At the right dose, molybdenum can make the world of difference to the crop and the input costs. It's a simple adjustment, but one that is easy to overlook if you are not taking nutrient balances into account," he says.

ABOVE: Charles le Roux (left), commercial manager at DRIS, and Ronald Schroder, agronomist at DRIS.

INCREASING QUALITY

N has a suppressing effect on another crucial element for success: Ca.

Optimal Ca levels result in high-quality potatoes. This was an insight Le Roux gleaned after analysing potato tubers to compare the nutrient levels between good-quality potatoes, and those with internal issues like browning.

"In most cases, calcium is the limiting factor that brings quality down. A lot of work has been done to find ways to increase calcium levels in tubers. Results show that simply increasing calcium applications does not work.

"But when we started looking at the balance of elements, we saw that nitrates were suppressing Ca. As soon as this was addressed, Ca levels in the plant could be corrected, which translated to higher levels in the tubers, and better quality of the end result," he explains.

The correct form and quality of Ca is important; it's available as calcium carbonate, calcium sulphate or gypsum ($CaSO_4$), and calcium nitrate [$Ca(NO_3)_2$], and the forms are not interchangeable.

Traditionally, farmers use lime (calcium carbonate) to adjust soil pH, gypsum to supply Ca and sulphur and to leach salts, and calcium nitrate to feed the plant. However, many crop

FAST FACTS

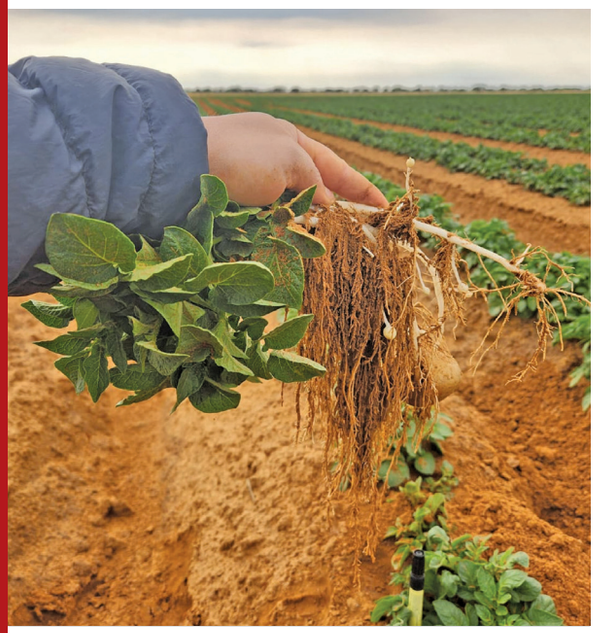
The Diagnosis and Recommendation Integrated System is used to interpret plant tissue analysis data and assess plants' nutritional status.

When the levels of some nutrients are high, they can suppress the uptake of others.

Small adjustments to balance fertiliser programmes can make a big difference in yield.

challenges – including poor nutrient uptake, limited root development, and suppressed energy metabolism – are rooted in soil compaction and poor aeration. DRIS looks at available Ca to address these issues head-on.

"We recommend finely micronised lime and gypsum not only to correct calcium levels, but specifically to flocculate compacted soils, restore oxygen flow, and rebuild soil structure. Aeration is the foundation of nutrient availability and biological activity – without it, even the best fertiliser won't reach its potential. DRIS calculates the exact amount of micronised calcium carbonate needed to 'open' the soil and then applies calcium sulphate to enhance leaching and support sulphur nutrition," Le Roux explains.



ABOVE: A sign of balanced nutrition and good soil aeration is substantial root development, with plants establishing deep, healthy roots that enable efficient nutrient uptake.

He adds that, in contrast, calcium nitrate, while plant-available, often adds to the excessive nitrate load, further suppressing Ca uptake and failing to deliver the full structural and energy benefits that Ca should provide.

"Many farmers are understandably cautious about reducing N or trying alternative calcium forms. That's why continuous crop monitoring and real-time adjustments are so valuable. DRIS gives farmers the data they need to manage the root cause – not just the symptoms – and grow stronger, more resilient crops from the ground up."

Continuous monitoring of the crop's nutrient levels throughout the season means that the energy levels of the plant can be managed to ensure that it is always functioning optimally, absorbing and converting nutrients, and producing the maximum potato yield.

Consistent energy availability also results in a more uniform size of individual potatoes across the season.

SOIL RECTIFICATION

In a case study where the DRIS Crop Monitoring Protocol was utilised, the farmer achieved higher volumes of marketable potatoes due to tailored fertiliser and foliar applications.

Soil rectification was done, which included the application of available Ca and micronised Ca to reduce soil compaction. The process started with soil analysis and correction before planting. Then, as the crop progressed through its growth stages – emergence, vegetative, tuber initiation, tuber filling, and maturity – leaf analysis was conducted to continuously monitor how well the plant responded to the adjustments made and environmental stressors.

Le Roux says this ongoing monitoring helps ensure that nutrient availability is balanced and optimised for reproductive growth. The planting fertiliser mix was tailored to align with the balance in the soil and the needs of the plant at each specific growth stage.

"One of the early signs of success was the uniformity of germination and emergence across the entire field. The even establishment of plants allowed for consistent growth, reducing variability and ensuring that the plants were all at a similar stage of development," he explains.

STRONG ROOT SYSTEM

Le Roux notes that initially, vegetative growth was more controlled, allowing the plants to focus their energy on building a strong root system.

"The result was substantial root development, with plants establishing deep and healthy roots that enabled efficient nutrient uptake. This is a sign of balanced nutrition and good soil aeration. The strong foundation allowed the plants to withstand environmental stress and prepare for optimal tuber development."

The tailored nutrient programme, which included precise foliar applications, resulted in earlier tuber initiation, and short, strong stolons with no tuber weaning. This uniformity was key in ensuring that the plants developed tubers of consistent size and quality.

"During the bulking phase, the plants had enough energy to support uniform tuber growth. Proper soil aeration as a result of the micronised calcium promoted healthy tuber bulking, and also helped the plants recover quickly from environmental stress, including an early frost. The tailored foliar applications ensured that nutrient deficiencies were corrected in real time, allowing the plants to thrive throughout the growing season.

"The shift from an N-based programme to a Ca-driven nutrient strategy also reduced pest pressure and led to a more resilient crop," explains Le Roux.

While the results of the study showed no significant increase in total yield, the marketable yield increased, with around 1 000 10kg bags per hectare. "The internal and external quality of the potatoes improved, resulting in a longer shelf life. The crop exhibited greater uniformity in tuber size and higher nutrient density."

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