Plant sap analyses are putting crops on a precise diet

New method leads to new insights

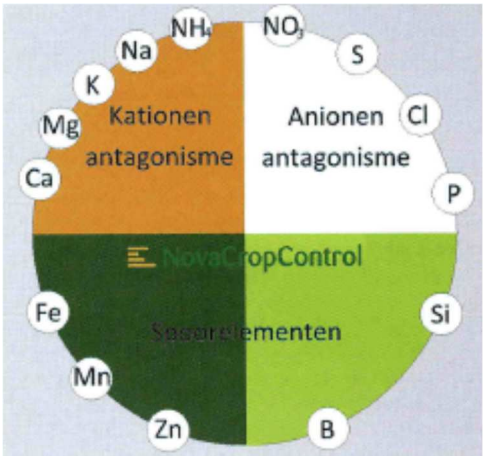
Plant sap analyses were found to be unreliable in the 90's. But by using another sampling protocol, the method of the Hortinova consultancy bureau is providing consistent and reliable data about the nutrient uptake by plants. Because the tests are not time-consuming, adjustments on fertilization strategies can be done quickly. This helps to avoid nutrient deficiencies or excesses in plants. By plant sap analyses, fertilization is more and more becoming a tool to manage crops.

By comparing the nutrient composition of young and old leaves with the concentrations in irrigation, drain, and substrate waters on a weekly base, the insight in relations between fertilization and cultivation problems increases quickly.

Picture by: Roel Dijkstra Fotografie

Text: Gerard Boonekamp, images: Hortinova

Growers can measure many different parameters of the greenhouse climate and plants, including photosynthesis. But the uptake of minerals is still being defined through an indirect calculation. It is assumed that the difference between the nutrient concentrations in the irrigation and the drain water is the actual uptake of minerals by the plant. For more information about the plant's nutrient reserves, additional dry matter analyses are often used. This is why fertilization program adjustments are often done only when problems occur. Besides, in fertilization consultancy, the antagonistic uptake of minerals is often not taken into account when a new fertilization strategy is being achieved (see image).



Antagonistic schedule: each quarter of the circle contains the elements that compete in nutrient uptake

Sjoerd Smits and Bart Vromans thought different on this topic. They founded NovaCropControl 5 years ago and fine-tuned a method of analysing old and young plant leaves separately, this in addition to the current irrigation, substrate and drain water analyses. ''Within 24 hours growers are being provided with the information about the mineral composition of their crops'', says Sjoerd Smits, Hortinova consultant in Udenhout, The Netherlands. He started with plant sap analyses in strawberries and open field cultivated vegetables. After pioneering during the first 3 years, the method is undergoing advances rapidly, especially in tomato and sweet pepper crops. The NovaCropControl laboratory already processes tens of thousands of samples each year. Growers are following courses to learn about plant fertilization and interpreting results of plant sap analyses. ''Fertilization, when applied correctly, can be used as a tool to manage plant balance, natural resistance, product quality and lowering disease pressure'', says Smits.

High potassium applications in vegetable crops

By working in collaboration with several groups of growers and consultants, the

High uptake of:	Suppresses the uptake of:
Potassium	Calcium, Magnesium
Sodium	Calcium, Magnesium, Potassium
Calcium	Phosphate, Magnesium, Iron
Phosphate	Nitrate, Zinc, Iron, Copper
Nitrate	Chloride

Macronutrients that can compete in mineral uptake

insight in the relations between fertilization and problems in cultivations is increasing rapidly. ''In a lot of vegetable crops, the application of potassium is too high, as a result of the current sampling methods'', states Smits. ''The excess is being caused by the fact that the actual nutrient reserves in plants, of potassium or phosphorus for example, are not taken into account''. The reserves of mobile elements (N,P,K,Mg) in the old leaves are still available for the young, developing plant parts. Current analysis methods do not take these reserves into account when defining the total available nutrients for plant growth. ''Not a grower dares to lower potassium concentrations to zero in drain and substrate water samples, but when your plate is empty after dinner, does it mean you are still hungry?''. In some cases it is possible to not apply potassium for a while. This can be useful to stimulate calcium uptake or to make the crop more generative.

Smits says that, for example, sweet pepper has difficulty with taking up calcium naturally and some tomato varieties are very susceptible for blossom end rot. ''Applying more calcium is making no sense when high potassium concentrations are blocking the uptake of calcium. In trials with sweet pepper we saw that the uptake of calcium only increased when the application of potassium decreased to 1 millimole per litre. A compromise of the calcium and potassium concentrations in the irrigation water should be made. In strawberry crops we saved varieties from being discarded, simply by adjusting the potassium application.

Major change in cultivation strategies

Susceptibility for blossom end rot can be traced back to a varietal, genetic disorder in the uptake of calcium, simply because of high, and easy potassium uptake. ''An example is the Roma Prunus tomato, which is world champion in potassium uptake'', Smits says. The Dutch tomato growing company Prominent, which is growing these Prunus tomatoes, greatly reduced the percentage of tomatoes infected by blossom end rot, confirms Marco van Noord, production manager

Fungi on tomato a tomato calyx is often related to an excess of manganese

at Prominent, who is working with Hortinova for the 3rd year now. ''During weather changes from clouded to sunny conditions we decreased the potassium applications, or we did not apply potassium at all. Because you are monitoring your crops on a weekly base, you notice that plants still have enough potassium reserves, then you are convinced to do this.'' He is very pleased with the method that Hortinova is providing. ''This is the biggest change that we ever achieved in the cultivation of Roma Prunus tomatoes. Each season your insight in plant growth and mineral uptake improves. This is how fertilizers are becoming a tool to manage our crops.'' The fertilization has become less intensive. ''We are adjusting our fertilization strategy a lot, but with small steps.'' Not only the potassium application has been adjusted. ''We also started to apply less phosphorus because this is blocking the uptake of micronutrients such as iron and zinc.''

Jules Klessens, crop specialist at a Dutch producer of snack tomatoes named Greenco, is conducting plant sap analyses for the 3rd season now. ''The major eye-opener was the antagonistic effect of different elements. In the past we thought we had to apply more fertilizers when a plant was deficient on an element. Now we first check if another element is blocking the uptake of a specific element. We are learning more and more about the interdependence of the elements and their influence on plant growth.'' When comparing last season's fertilizer usage to the 2008 season, we are saving between 10 and 15% on nitrate and phosphate fertilizers. The reduction of phosphate applications led to an improved uptake of micronutrients.

''This year we do not see plant part yellowing by increased uptake of iron. By sending in samples regularly, interpreting data and looking at the crop, we fine-tuned our fertilization strategy.

But we are only at the beginning of a major change. We assume that by reducing nitrogen applications, we can increase the sugar concentrations in our tomato fruits. We think that this method also contributes to our way of growing natural resistant plants, because the uptake of micronutrients improves.''

Becoming smarter

Ferry Klap, crop consultant at Horti Advies, is actively working with the Hortinova plant sap analyses method for two years now, last year this became more intensive. ''At this moment, 50% of all my clients is already using plant sap analyses. We collected a lot of data to compare different growing strategies with each other. Every 4 weeks, groups of growers meet to compare data and discuss about the observations in their crops. Hereby we became smarter regarding plant fertilization. As a grower, you should take time to analyse the data and interpret them correct.'' Klap is still wary with the plant sap analyses. ''We do not know all yet. There are differences between varieties and rootstocks.'' He did not notice yield improvements yet, but he expects that growers can save on fertilizer costs. Especially on iron, phosphate and potassium, which are becoming more and more expensive. ''Optimal fertilization will increase the plant's natural resistance, but to realize this, more fine-tuning is needed.''

'Never found calcium deficiency in case of leaf tip necrosis'

Leaf necrosis in tomato crops scientifically is related to calcium deficiency, after a recent literature study of Wageningen UR Glastuinbouw. ''But in all our plant sap analyses we never found a calcium deficiency'', explains Hortinova consultant Sjoerd Smits. Even when only damaged leaf tissue was tested, never a calcium deficiency showed up. In the end of December 2011 he found potassium deficiency to be the cause in a tomato crop with 5 fully developed trusses.

Calcium accumulation in substrates is suppressing boron uptake in autumn, which can cause (variety dependant) yellow calyxes.

''Despite the potassium enrichment of the fertilization schedule, the crop only had the availability of half of the needed potassium. The cause was the fact that the crop was irrigated only 3 times a day.''

Ferry Klap, consultant at Horti Advies, came to the same conclusion based on volume calculations of the potassium application and the crop's potassium requirement. ''Four years ago we already started to adjust the fertilization schedules. But by using plant sap analyses we can push to the limits more precisely and we made major progress in bounding leaf necrosis.'' Not only potassium deficiency leads to leaf necrosis. In illuminated cultivations of the tomato variety Komeett, Smits concluded last spring that also zinc deficiency causes leaf necrosis. ''Phosphate is being taken up easily in new cultivations and can block zinc'', is his explanation. Because the symptoms of leaf necrosis (see pictures next page) can have a different cause, plant sap analysis can be a helpful tool. When basing leaf necrosis on the scientific approach and the potassium application would be decreased to increase calcium uptake, there is a risk that only more leaf necrosis will occur.

Leaf necrosis in illuminated cultivations are often the result of potassium deficiency, despite the potassium rich irrigation water. The amount of irrigating then is insufficient for heavy crops

Last spring, zinc deficiency was the cause of leaf necrosis in illuminated cultivations of the variety Komeett

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