# Steering plant balance by adjusting Nitrate supply

Fertilisation plays a greater role in vegetative or generative steering than most growers realise. Especially the Nitrate supply has a strong influence on maintaining a stable plant balance.

By **Peter Visser**

Vegetative and generative steering are an inseparable part of fruit production. Vegetative corrections mainly focus on investing in the development of leaves, stems and roots. In the generative phase, the emphasis shifts to the allocation of energy and sugars towards flower formation, fruit set and fruit development. Measures such as temperature control, leaf pruning and crop load management are well-known tools to influence this balance.

Fertilisation also affects generative and vegetative balance, but according to most fruit vegetable growers, its impact is limited. As a result, it often receives little attention in practice.

*With an extremely low nitrogen supply, more sugars are directed towards the fruits. This is visible in a thinner head compared to a standard fertilisation programme (photo to the right).*

*Crop with standard fertilisation programme.*

## Nitrate accumulation in the plant

NovaCropControl has conducted research on steering growth balance through adjusted nitrate treatments in tomato. At a standard treatment of 16 mmol/l nitrate, $NO_3$ values in the plant sap of young leaves fluctuated around the upper side of known safe target values. Older leaves contained considerably more than required. With a low nitrate supply (10 to 11 mmol/l), $NO_3$ levels in the plant sap of young leaves remained well within the safe target range. Later in the crop cycle, levels in older leaves rose slightly above this range. The reduction caused no yield loss. Only the extremely low nitrate treatment of 6 mmol/l caused the plant sap values to measure slightly below the safe lower threshold during the early growth phase. Analysis of sugar content showed that higher nitrate levels increased water uptake and caused sugar dilution. With lower nitrate supply, sugar percentages were higher. Bink concludes: "This makes sugar analysis a valuable indicator of plant balance."

Growers tend to estimate the contribution of fertilisation to plant balance at no more than about 5%. At NovaCropControl in Oisterwijk, however, they take on a different view. They estimate that fertilisation accounts for roughly a quarter of the influence on the generative or vegetative development of the crop, mainly due to the major role of nitrogen. Researchers and advisors at NovaCropControl observe that an increasing number of the growers they consult are becoming convinced of this as well.

### EC as a steering tool

Lowering or raising the EC can help regulate plant balance. A low EC facilitates water uptake, results in high turgor, and allows plant cells to expand more easily. This is considered a vegetative steering measure.

As the opposite, generative action, growers generally increase the EC. The higher salt concentration around the roots indeed restricts water uptake. However, a high EC also increases plant stress, which negatively affects plant resilience. In addition, this stress costs the plant energy that could otherwise be directed towards more productive processes. Unnecessarily high EC values can also complicate the continued recirculation of drain water.

*From the tomato fertilisation trial, it appeared that lowering the nitrate level had no adverse effect on production. Photos: NovaCropControl*

Nevertheless, growers often find an EC reduction rather risky, notes horticultural advisor Tessa Bink of NovaCropControl. They have a target value in mind and believe they need that higher EC to remain sufficiently generative. Yet by lowering the EC, it becomes easier to reduce the absolute amount of nitrate without ending up with excessive levels of other 'ballast' elements such as chloride. And nitrate is one of the largest contributors to total EC in a fertilisation programme.

"If you feed a plant according to its actual needs, you don't have to bully it. You can steer calmly and in a balanced way. Just as it is much easier for a person to maintain a desired body weight by eating in moderation and making small adjustments when needed, than by overeating first and then having to work very hard to lose weight afterwards."

Moreover, due to recent global issues, mineral fertilisers have become about three times more expensive over time. So any reduction of fertilizer use directly lowers production costs for the grower.

## Nitrate as a corrective tool

Nitrogen supply plays an important role in crop plant balance, even when no concessions are made to customary EC levels. High nitrogen levels in the nutrient solution have a vegetative effect. They promote cell elongation, leaf development and leaf area, stem elongation and stem thickness. Sugars are diluted due to increased water uptake, and the sugars produced are mainly used for vegetative growth. The  more luxuriant growing crop may require increased leaf removal at the head, which in turn further increases nitrogen demand.

## Plant resilience

Plant balance also influences plant resilience. Vegetative growth results in cell elongation, making it easier for pest insects to penetrate cell walls with their mouthparts. In situations where high nitrogen levels contribute to vegetative growth, nitrogen also serves as a primary food source for aphids, making the crop more attractive to this pest. In a more generative growth balance, sugars are less diluted due to reduced water uptake.

Higher osmotic pressure within the cells makes insect penetration more difficult. If penetration does occur, sugars function as a defence mechanism, acting as signalling molecules that activate beneficial defence responses within the plant. In addition, high sugar concentrations in plant sap represent a metabolic burden for pests such as aphids, as they cannot efficiently utilise these sugars. Much of it is excreted as waste via honeydew.

Low nitrogen levels, on the other hand, promote generativity, resulting in a more compact and firmer crop that directs more sugars towards the fruits. A thinner crop absorbs nitrogen more efficiently, allowing nitrogen levels in the plant sap to sufficiently rise towards target values. "We want to encourage a more restricted nitrogen supply, as it benefits both plant balance and plant resilience."
Nitrogen deficiency should be avoided, as it can lead to chlorosis, reduced growth, and ultimately lower fruit set and yield. Many tomato growers therefore play it safe to ensure adequate growth, often aiming for a total nitrogen value of around 2.000 ppm. Bink explains: "But you can safely take more risk. Based on plant sap analysis results, maintaining a total nitrogen level of 1.000 ppm is still sufficient to ensure adequate nitrogen uptake without yield loss. From around 600 to 700 ppm it could become critical. We want to encourage a more restricted supply, because it benefits plant balance and plant resilience." For growers who do not have access to interpretation of plant sap analyses, a slightly higher lower limit of 1.400 ppm nitrogen is recommended, as each variety and substrate responds somewhat differently and additional factors may influence nutrient uptake.

With a lower nitrogen supply, growers need to intervene less frequently and less aggressively through climate control or other cultivation measures to steer generatively. This benefits the consistency of plant balance and, consequently, production. Among growers who have experienced this easier steering, NovaCropControl has not seen anyone revert back to the standard fertilisation strategy they used previously.

Whereas 20 to 25 mmol nitrate per litre was once a common target, 15 to 17 mmol/l has now become the standard, and this could be reduced even further. Research shows that the higher Nitrate treatment of around 20 mmol/l do not result in a meaningful additional accumulation of nitrate in the plant.

As confidence in lower nitrate supply grows through experience, growers often dare to fine-tune fertilisation even further to better match crop demand. Plant sap analyses safeguard this process and demonstrate that everything remains on track, even when hardly any nutrients are detectable in the drain water. After all, less unused nutrient surpluses are staying behind.

## Substituting Nitrate

To keep anions balanced while reducing the nitrogen input, nitrate in the nutrient solution can be replaced by sulphate or chloride. Sulphur is generally preferred, as it is less stressful for the plant. This makes it easier to adjust the balance between different nutrients. Sulphur also supports the conversion of nitrate into proteins.

Sulphur promotes a more generative balance. It reduces vegetative leaf elongation, increases dry matter content in leaves and fruits, improves sugar use efficiency and distribution, and promotes firmer fruits. Some growers deliberately use nitrate substitution with sulphur to enhance tomato flavour by increasing sugar availability under moderate nitrogen supply.

Chloride has minimal physiological functions in the plant and is mainly used to suppress nitrate levels in fertilisation recipes. Chloride exerts its generative effect through more compact growth (less cell elongation) and firmer leaves by influencing turgor. Reduced vegetative growth leaves more sugars available for fruit development. However, care must be taken to avoid excessive chloride levels, as this increases the risk of leaf edge burn, drooping leaves, and competition with nitrogen, sulphur and possibly phosphorus uptake.