Chapter 22

FRUIT NITRATE MANAGEMENT

Version 1, 1 Feb 2006

Why do we need to manage nitrates?

High nitrate fruit are a problem at the Golden Circle Ltd cannery. Pineapple is packed in tin-plated cans because this stops oxidation of the fruit to an off-putting brown colour. The nitrate ion is a strong oxidizing agent, and it can strip the tin from the can. Pineapple fruit with a nitrate level in excess of 8 ppm can remove enough tin to approach the legal limit of this contaminant in the product. Even higher levels can strip off enough tin to expose the acid fruit to bare steel.

Processing high nitrate fruit is costly because it causes downgrading of products, unplanned changes to production schedules, stoppages in the plant and customer complaints.

How are nitrates formed?

Nitrogen (N) can be present in the soil in several forms, as proteins and amino acids in organic matter, and as the inorganic nitrate and ammonium ions. All forms of N (organic and inorganic) that reach the soil are ultimately converted first to ammonium, then to nitrites and finally to nitrates by micro-organisms (mainly bacteria) in the soil. N is taken up by plants mostly in the nitrate form and to a lesser extent the ammonium form.

In plants, the N pattern is reversed. Nitrates taken up from the soil are converted to nitrites using enzymes then ammonium before assimilation to amino acids and proteins. Plants cannot produce nitrate-N. **Any nitrate in a plant has therefore come directly from an outside source.** When the plant's requirement for N is exceeded, the extra N remains in the nitrate form. Plants cannot store ammonium-N except as amino acids or proteins.

Most of the N available to plants in soils comes as grower-applied fertilizer. Any quantity of N (in any form) in excess of the plants' requirements for protein production can show up as stored nitrates in fruit. Therefore, high nitrate in fruit represents N that has not been used by the plant for growth and development. It is a waste of resources and reduces the quality of the fruit for canning.

Hence, if application of N to the soil is minimised, nitrate formation in the soil will also be minimised.

Avoiding high nitrate fruit

1. During drought the quantity of N fertiliser applied must be reduced because the plant can't absorb and use as much as normal and it will only accumulate in the soil and in the plant. When rainfall comes the accumulated nitrates in the soil enter the soil solution and are taken up by the plant in excessive amounts.

2. The use of foliar fertiliser applications are recommended over side-dressings because with foliar applications rates per treatment are light, thus allowing greater flexibility for altering applications in response to changing conditions.

3. Total soil N should be determined by soil analysis prior to planting. This amount forms part of the N-budget and is essential for determining the amount and timing of grower-applied N.

4. No more than 600 kg N/ha should be used in the plant crop cycle, and this includes N present in the soil before planting and the N applied as part of the flower induction program.

5. Healthy first ratoons require less N for optimum production than plant crops. No more than 400 kg/ha should be applied, and in many cases less than this amount is needed for optimum production.

6. N should not be applied after flower induction or during fruit development.

7. Irrigation during dry periods can help the crop to take up and assimilate nitrates more evenly.

Note: Leaf tissue analysis for N is not recommended as a way of monitoring N because unfortunately it is not a reliable indicator. Also, although both juice and leaf nitrate levels increase in response to increased N applications, leaf nitrate levels are not consistent or well correlated enough with juice levels to be used for monitoring.

Factors that can aggravate fruit nitrate build up

Since the conversion of nitrates in the plant into other products such as proteins depends on photosynthesis, **any factor that slows the rate of photosynthesis will reduce the rate at which nitrates in the plant are assimilated into other products**. Thus, whilst nitrate uptake by the roots may continue, the rate of use in the plant slows and therefore the level of nitrates in the plant builds up.

Drought
Drought slows plant growth which reduces the need for nutrients including N. Any attempt to improve crop growth rate during drought conditions by increasing N application must be avoided as this will simply accelerate the build up of nitrates in the plant.

Drought can also delay induction due to poor growth but no additional N should be applied simply because the growing season is longer.

During drought, boom spraying of reduced fertiliser rates in high water volumes is beneficial.

Reduced solar radiation
Light is required for photosynthesis so low light conditions e.g. from prolonged cloudy weather or shading, can result in a build up of nitrates.

Damaged leaves
When leaves are damaged (e.g. by pests, diseases, hail, frost, windburn, fertiliser burn, mechanical breakage etc) photosynthesis is reduced so the plant's use of nitrates will also be reduced causing nitrates to accumulate in the plant.

Unbalanced nutrition
For all processes in the plant, including photosynthesis and the metabolism of nitrates into proteins, a large number of different nutrients other than N (*refer to the chapter on essential plant nutrients*) need to be present and available in approximately the right balance. Therefore plant and soil nutrient analysis needs to be carried out regularly and the results used to guide the amounts and timing of applications of these essential mineral elements. The soil pH should also be maintained within the optimum range. Despite reports from overseas that molybdenum can reduce the nitrate level in fruit juice, research in Queensland has failed to demonstrate this.

Summary

Any conditions that slow plant growth have the potential to raise nitrate levels in the fruit. Do not exceed recommended rates of N during normal growing conditions and when growth is constrained reduce N applications proportionately.

References and further reading

Scott, Col (1994). Update of nitrate trials. *Australian annual pineapple industry field day notes*.

Scott, Col (2000). The effect of molybdenum applications on the juice nitrate concentration of pineapples. *Australian annual pineapple industry field day notes*.