

JUNE 09 FUTURE ORCHARD 2012 WALK

ORCHARD NUTRITION



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Poor orchard nutrition can severely inhibit canopy development, reduce yields and fruit quality. It is not an exact science, but rather about pushing levels in the right direction. There are often several options and opinions on how to address each issue.

The law of minimum is an important concept. It states that crop yield will be limited by any essential component of plant growth which is insufficiently present.

How does the soil hold nutrients?

When we add fertilisers to the soil, they dissolve and divide into charged particles; cations, which are positively charged, and anions, which are negatively charged. Soil particles are negatively charged, so attract the cations (just as a magnet attracts metal), while the anions tend to stay in solution. Because the soil has the ability to hold onto these cations you can build up your soil fertility.

The main cations and anions in the soil solution

Cations		Anions	
Ca ²⁺	Calcium	NO ³⁻	Nitrate
Mg ²⁺	Magnesium	SO ⁴⁻	Sulphate
K ⁺	Potassium	PO ₄ ³⁻	Phosphate
H ⁺	Hydrogen	Cl ⁻	Chloride
NH ⁴⁺	Ammonium	CO ³⁻	Carbonate
Na ⁺	Sodium		
Metallic microelements		Nonmetallic microelements	

Cation Exchange Capacity (CEC) is measured in your soil test and provides an indication of the quantity of nutrient cations that a soil can hold. Light sandy soils will tend to have a low CEC, and so less ability to retain applied fertiliser. When applying fertilisers in these soil types, the "little and often" principle is often the way to go. Heavier soils and soils with high levels of organic matter will have higher CECs and a greater ability to hold on to cations.

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Soil Texture	Usual CEC Range
Sandy Loams	8 - 20
Silt Loams	15 - 30
Clay Loams	20 - 40
Peats	50 - 100

The % base saturation is the proportion of the CEC that each of the main nutrient cations (calcium, magnesium, potassium and sodium) occupy. Because these nutrients all compete with one another for plant uptake it is important to keep these levels in the right proportions to avoid excessive levels of one inhibiting the uptake of another.

Recommended Base saturation levels for Apples and Kiwifruit

	Apples	Kiwifruit
Calcium	70 – 80 %	55 – 70 %
Magnesium	8 – 10 %	6 – 10 %
Potassium	3 – 4 %	4 – 5 %

Excessive use of potassium will inhibit the uptake of calcium and magnesium, which has implications for post-harvest storage.

The table below illustrates how increasing Potassium in the soil has affected Calcium and Magnesium levels in the leaves.

Note that with increasing K (Potassium) soil saturation the leaf content of both Calcium and Magnesium reduces.

K soil saturation	Composition of Leaves		
	% K	% Ca	% Mg
0	0.4	1.4	1.5
0.5	0.5	1.2	1.1
1.0	0.8	1.1	0.7
2.0	1.0	0.3	0.6
4.0	2.1	0.7	0.4
8.0	2.1	0.6	0.3
12.0	2.2	0.6	0.4
16.0	2.2	0.4	0.4
20.0	3.1	0.3	0.4



The Calcium Issue

Low fruit calcium leads to a range of fruit quality issues. Water core, soft fruit, bitter pit, blotch pit, scald are all issues that can be linked to low fruit calcium. Bit pit prone varieties illustrate the impact of low calcium significantly but adequate calcium is critical for all apple varieties.

The calcium cation has a positive charge and so competes with potassium and magnesium (also both cations) both in the soil and in the fruit.

Calcium Movement into the Fruit

*Calcium is transported in the water conducting tissues – Xylem
It is largely immobile in the phloem*

- After bloom, calcium uptake is aided by transpiration, calcium is transported into fruit via the xylem. As fruit grows it develops a waxy cuticle and the surface to volume ratio decreases resulting in a decrease in water movement into the fruit via the xylem.
- About 6 weeks post bloom (when cell enlargement begins) the phloem takes over supplying the fruit interrupting the CA supply. Because calcium is largely supplied via the xylem in the transpiration stream
- As fruit size increases the calcium concentration decreases.

There are a number of management practices that can be implemented in the orchard to maximize the uptake of calcium.

- Attain adequate soil calcium levels and appropriate soil pH.
- Avoid excessive potassium and magnesium. These are antagonistic to calcium if levels are too high.
- Avoid moisture stress. The soil needs moisture for trees to be able to take up soil calcium.
- Ensure a good crop load balance. Large fruit on light cropping trees will have lower Calcium.
- Good pollination and fruit set. More seeds in fruit results in more calcium in fruit.
- Avoid practices that promote excessive vigour. In excessively vigorous trees Calcium is drawn towards new growth in the transpiration stream and away from developing fruit.
- Ensure adequate plant boron. Boron enhances within tree Calcium mobility.
- Implement season long calcium spray programme.
- Pre harvest fruit calcium test to check fruit calcium levels and assist with fruit storage risk assessment.

Vigour and Fruit Set

Inadequate nitrogen over bloom limits flower development and can increase biennial bearing tendencies. By focusing on this period we can use N to improve blossom quality and fruit set and minimize its impact on tree vigour.

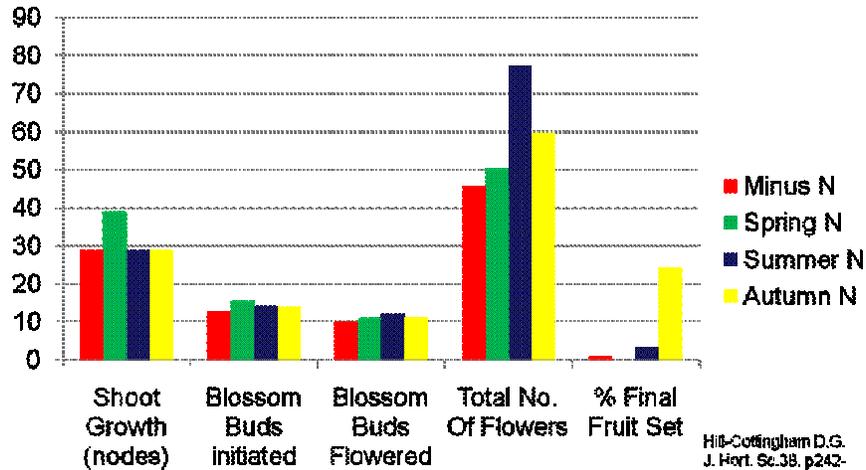


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Having sufficient nitrogen present during the bloom period increases ovule longevity.

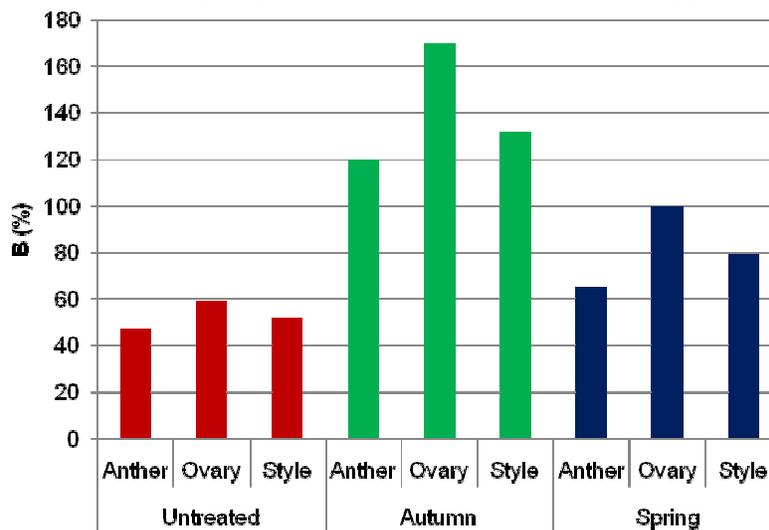
Effect of Timing of Nitrogen Application on Growth and Fruit Set.



Applying excess nitrogen, especially in spring, increases growth and does not reach the floral parts quickly enough. Autumn nitrogen applications build up the tree reserves for the following spring with minimal effect on vegetative growth. Converse to this, if the grower is after increased tree vigour as is often the case in the first 1-2 years of a new blocks development, regular spring and early summer nitrogen applications can be warranted to promote shoot growth. The key with Nitrogen rate and timing is to be aware of the result you are trying to achieve.

Boron lab studies show that when boron levels are low the addition of boron improves both pollen germination and pollen tube growth in apples and pears. Autumn foliar applications of boron are the most effective way of increasing boron levels during the bloom period.

Effect of Autumn/Spring sprays on B content (ppm) of apple flowers.



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By ensuring adequate supplies of nitrogen and boron over the blossom period you can increase your effective pollination period.

Zinc has no direct effect on pollination and fruitset, but a zinc deficiency can have an indirect effect on calcium levels. With low levels of zinc, bourse leaves never become fully expanded. This results in less carbohydrate for blossoms and developing fruit. Research has shown that increased bourse and spur leaf area is related to increased levels of fruit calcium.

Assessing Nutrient Needs

Soil tests – valuable test of the nutrient status of the soil. Particularly soil pH and macro nutrient levels. Also provides some information about the physical properties of the soil.

Basic soil test measures.

- Soil pH
- Available P
- Levels of available cations Ca, K, Mg, Na.
- Soil CEC → the ability of the soil to be fertile
- Bulk Density

Soil tests should be carried out initially on an annual basis particularly if fertilizer additions have been made. Thereafter biannually is usually sufficient.

Leaf tests – These are not an alternative to a soil test, but a valuable addition to them. They show what a plant has been able to utilize. Nutrient interactions mean they do not always agree with the corresponding soil test. They are a useful diagnostic aid and can be very useful to check on the plants level of micronutrients.

Basic test measures

Macronutrients

- N, P, K, Ca, Mg, S

Micronutrients

- B, Fe, Mn, Zn and Cu

Sample the youngest fully expanded leaves on current season's growth.

Historically samples have been taken in February, but this is too late to impact the current season's crop. With the development of season long leaf nutrient curves in other pipfruit growing regions, leaf tests can now be carried out earlier in the season.

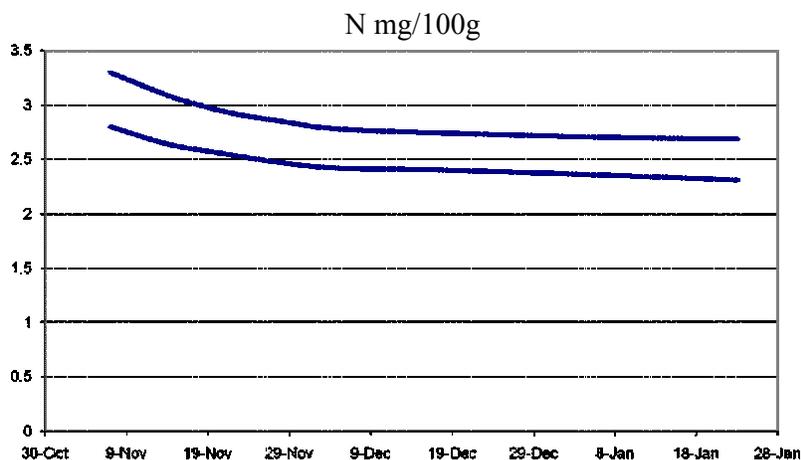
The South Tyrolean industry has developed seasonal leaf test levels of all major nutrients. This allows the grower to check leaf levels 2-3 weeks post bloom and make adjustments to the fertilizer program to correct issues in the current season. Often a “check test” is then taken in the traditional Feb period to confirm whether the season's strategies have worked. Here we present the curve derived for nitrogen but other nutrients are discussed in the powerpoint which is available on the APAL web site.



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Leaf Nitrogen – South Tyrol reference curve (corrected for Southern Hemisphere)
 Graph shows the season long changes in leaf nitrogen content. The lines represent the 25th and 75th percentiles of orchard survey data.



Aicher, M and Stimpfl, E.
 Acta Hort. 594, ISHS 2002.

Making Recommendations

Soil Test – use these to correct soil pH and base levels of macro nutrients.

Leaf Tests – Use these to check micro nutrients, seasonal issues and the result of any nutrient interactions. Can now be carried out pre Christmas.

Fruit Tests – assess fruit nutrient levels and storage risk profiles.

Crop records – use these to calculate the quantity of various nutrients that have been removed from the orchard.

Apple crop nutrient removal (kg/ha)

Tce/ha	750	1500	2000	2700	3500	4500	5500
T/ha	13.5	27	36	49	63	80	100
N	11	23	31	42	54	68	85
P	1.4	2.8	3.8	5.1	6.6	7.1	10.5
K	17	34	45	61	75	100	125
Ca	.7	1.35	1.8	2.5	3.2	4	5

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