AGRICULTURE VICTORIA

Nitrogen application in pear orchards

Nitrogen is an essential element for plant growth. Nitrogen deficiencies in pear orchards result in poor tree vigour and yield while high levels of nitrogen lead to excessive vegetative growth and can adversely affect fruit quality. Accurate calculation of nitrogen requirements will help avoid excessive applications that can result in leaching of nitrates and subsequent environmental damage.

Nitrogen (N) is the nutrient most commonly applied to pear orchards and is applied in greater amounts than any other nutrient. Despite this, recommendations regarding application rates vary greatly, particularly for young pear trees. Orchardists can take a number of steps to improve nitrogen use efficiency so that trees and fruit do not suffer from deficient or excessive levels of nitrogen and nitrogen leaching into the environment is avoided.

Assessing nitrogen status

Plant symptoms can indicate deficient and excessive tree nitrogen status. Unfortunately, by the time leaf or fruit symptoms appear it may be too late to rectify the problem in the current season. Plant symptoms should not be relied on to plan fertiliser applications but being familiar with symptoms can be useful to identify areas within a block where nutrient uptake may be compromised (e.g. by waterlogging or soil properties).

Nitrogen status	Symptoms
Deficient	Symptoms first seen in older leaves
	Leaves are pale green to yellow
	Poor shoot growth
Excessive	Excessive vegetative growth
	Fruit storage problems

Soil tests are not good predictors of nutrient status of trees but soil tests prior to planting are useful to determine lime or gypsum requirements and may reveal potential nutrient availability problems.

Orchardists may request a service provider to take soil samples and interpret test results for them. Alternatively, a number of laboratories provide guidelines on sample collection and preparation. Many laboratories offer interpretation of test results. Assistance in interpreting results may be required as availability of a nutrient for uptake is affected by concentrations of other nutrients in the soil and soil pH.

Leaf tests are the most direct and accurate method of determining nutrient status. As for soil testing, a service provider may collect and interpret samples or orchardists can deal directly with reputable laboratories.

Leaf samples are taken from a number of trees and ‘bulked’ together for testing. Bulked samples should include only leaf material from the same block or management unit. Do not mix leaves from trees of different varieties, rootstock or age, or blocks that have different current or past management of fertilisers or irrigation or different soil types. Leaf samples are taken from mid-shoot positions from the current season’s extension growth.

Leaf samples should be collected in late-January or early-February as the standards cannot be used to reliably evaluate samples taken at other times. Alternatively, if trees are showing symptoms of a possible deficiency or toxicity, samples can be taken separately from healthy trees and compared to analysis of samples taken from symptomatic trees.

	Deficient	Low	Normal	High	Excess
% N	< 1.8	1.8 – 2.2	2.3 – 2.7	2.8 – 3.5	> 3.5

Annual testing of leaf nutrient status is desirable but may not be realistic for each individual block. Blocks that are underperforming in yield or fruit quality should be prioritised for leaf testing. Likewise, if soil testing has been undertaken, blocks known to have low nutrient reserves or low or high pH should have leaf tests. If a problem is identified, leaf testing in the following seasons will help evaluate the effectiveness of your management strategy. Results should be considered

in the context of past fertiliser management, crop loads and general tree health.

Orchardists should ensure that laboratories used are accredited by the Australasian Soil and Plant Analysis Council and/or National Association of Testing Authorities (NATA).

Calculating nitrogen requirement

Calculations of nitrogen requirements need to account for nitrogen used to establish tree structure (including annual trunk and root growth), nitrogen removed by fruit (and prunings), and nitrogen use efficiency (i.e. the proportion of fertiliser taken up by trees).

Young pear trees have been shown to accumulate as little as 2 to 3 g N/tree in the first season after planting, increasing to 10 to 15 g N/tree in the third season. At moderate planting densities this equates to a seasonal nitrogen requirement of 5 kg N/ha in the first season, increasing to approximately 25 kg N/ha in the third season. However, nitrogen use efficiency of young trees is low due to small root systems. Consequently, application rates of 50 to 80 kg N/ha are recommended. A low rate is adequate if trees are fertigated frequently throughout the season.

Mature pear trees have modest nitrogen requirements. Nitrogen is partitioned to fruit at a rate of 0.75 kg N/t, so a 60 t/ha crop will remove 45 kg N/ha from an orchard. Structural growth and one-year old wood utilise another 15 kg N/ha, with some of this recycled if prunings are mulched. Soil reserves will contribute to meeting nitrogen requirements. Supply of 50 to 100 kg N/ha will meet pear nitrogen requirements in most instances, with the higher rates being used when crop loads are high and nitrogen use efficiency and soil reserves are low.

Fertiliser options

Nitrogen can be applied in a number of forms (urea, ammonium, nitrate or combinations of these). There are implications in terms of availability for uptake, potential for leaching or volatilization losses, and soil conditions associated with each option; these need to be considered along with application methods when calculating fertiliser requirements and evaluating fertiliser cost.

Most nitrogen is taken up by plants in the form of nitrate. Other forms are less able (ammonium) or unable (urea) to be taken up by plants and need to be transformed to nitrate before becoming available. Losses are incurred during transformation processes, which may take days or weeks.

Mobile forms (urea and nitrate) are more prone to leaching, than less mobile forms (ammonium) that bind to clay particles. Careful irrigation management and timing of applications will minimise these losses. The use of ammonium or urea (urea transforms first to ammonium then to nitrate) will gradually build soil reserves of nitrogen.

Nitrate based fertilisers (calcium nitrate and potassium nitrate) tend to increase soil pH. Urea and ammonium based fertilisers (ammonium sulfate, diammonium phosphate, monoammonium phosphate) tend to decrease soil pH.

Additional nutrients can be supplied, as needed, by using fertilisers such as NPK, calcium or potassium nitrate, ammonium phosphates (MAP or DAP) or organic fertilisers (animal manure). Organic fertilisers may contain excessive or insufficient levels of certain elements and users should be aware that levels can vary widely from reported 'book' values. Responses to organic fertilisers can take multiple seasons to manifest as the organic material gradually breaks down.

High grade soluble fertiliser is required for use in fertigation systems. Pre-mixed liquid fertilisers are popular as they eliminate time spent dissolving solid fertilizer.

Foliar sprays of urea can be beneficial for pears but care must be taken to avoid leaf or bud damage. Low biuret, foliar grade urea should be used to minimise potential damage.

Timing and method of applications

Timing of nitrogen application should take into consideration nitrogen uptake and allocation patterns.

Nitrogen uptake early in the season is low as trees initially remobilise stored reserves. Remobilised nitrogen is important for cell division and fruit size. Nitrogen applied to the soil will have little uptake during this period and will therefore be more subject to loss from the system. Following this period, uptake of nitrogen by young trees peaks and is 'more or less constant' until leaf fall. In mature trees, nitrogen taken up during the first two to three months post bloom tends to be allocated to fruit and leaves, while later nitrogen uptake does not increase fruit nitrogen content but does contribute to nitrogen storage. High nitrogen content in fruit increases susceptibility to fruit storage problems.

Nitrogen application is generally not recommended for young and mature trees during the month following bud break. Foliar sprays of urea can be applied during bloom to improve pear fruit size by increasing cell division and decreasing crop load. In some instances, thinning caused by these sprays has had a significant adverse effect on yield.

Post-bloom, steady applications can be applied to young trees throughout the season until late April. Avoid or minimize nitrogen applications to mature trees up until the month prior to harvest, particularly if nitrogen status is high and applications would compromise fruit quality or encourage excessive vegetative growth. Increase applications in the month prior to harvest to rebuild nitrogen reserves.

Post-harvest applications are recommended if tree nitrogen status is low and should be applied as early as possible to allow uptake and storage for remobilisation the following season. Post-harvest foliar sprays have been shown to be effective in supplying nitrogen for remobilisation to fruit and leaves the following season.

The form of nitrogen (nitrate, ammonium or urea) should be considered when scheduling applications — less available forms of nitrogen need to be applied before nitrogen is needed by the trees. Foliar sprays of urea have been shown to be absorbed within two days of application but only provide low amounts of nitrogen.

Fertigation allows small, frequent (e.g. weekly) doses to be applied to the wetted rootzone and is suitable for both sprinkler and drip irrigation systems. Fertigation offers advantages in terms of labour, fuel and equipment savings while allowing fast supply of nutrients directly to the active rootzone in a schedule tailored to meet plant demand. Irrigation schedules need to allow time for both application of fertiliser (towards the end of the irrigation event) and flushing of lines (to avoid blockages). Not all fertilisers are suitable for use in fertigation systems. Information regarding fertigation system design and management can be found at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/378564/Fertigation-delivering-fertiliser.pdf

Tree-line applications of nitrogen should be split as much as practical to increase uptake efficiency and decrease losses from leaching. Ideally, apply fertiliser soon after an irrigation or rainfall event (when the soil is moist) and water in with a small irrigation.

Recommendations for nitrogen application:

- Assess tree nutrient status. Leaf testing provides the most accurate and direct measure of tree nutrient status.
- Calculate nitrogen requirement based on tree demand with adjustments for nitrogen use efficiency and considering tree nitrogen status.
- Choose fertiliser appropriate for your application method that is economical and meets other nutrition requirements where possible.
- Apply small amounts of fertiliser regularly to provide doses throughout the season to young trees and tailor supply to older trees to support adequate vegetative growth and provide stored nitrogen for next season's growth.

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