HOW TO USE FOLIAR FERTILISERS TO BOOST GROWTH,

IMPROVE FARM YIELDS AND REDUCE RISK OF CROP FAILURE

A whitepaper by Advanced Nutrients

ABSTRACT

Some experts have long doubted the efficacy of foliar application of fertilisers.

However, research suggests that successful use of foliar fertiliser is highly dependent on the timing of application & nutrient source. This paper examines the scientific evidence evaluating the use of foliar fertilisers, and how growers can best use them to improve yields, boost growth and reduce the risk of crop failure.

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EXECUTIVE SUMMARY

Some experts have long doubted the efficacy of foliar application of fertilisers.

However, here is a large body of research that suggests that foliar fertilisers do work is highly dependent on the timing of application. This paper examines the scientific evidence evaluating the useful foliar fertilisers, and how growers can best use them to improve yields, boost growth and reduce the risk of crop failure.

Some key findings about foliar fertilisers in this whitepaper:

- Foliar fertilisers work through pushing photosynthesis to greater efficiency.
- Research shows they also promote root growth and increase nutrient uptake efficiency from the soil.
- Michigan State University analysis showed that it foliar fertilisers can be eight to 10 times more effective than soil-applied types.
- Other research indicates that it could be up to 100 times as effective, depending on the crop type.
- Misapplication is the key cause of foliar fertiliser failure.
- Spray foliar fertilisers during periods of maximum nutrient demand in the crop and ideally in the early-morning in cool weather.
- Growers can use foliar fertilisers to reduce risk by using less soil-applied fertiliser even before seed is sown.

The mystery of foliar fertilisers

Growers have been using foliar fertilisers to improve crop yields since the 1950s. However, many ‘experts’ maintain that liquid fertilisers are a waste of time and money.

Some insist foliar fertilisers do not contain a sufficient concentration of macro or micronutrients to have any effect. Others say crops simply do not absorb nutrients through their leaves.

They point to the inability of some growers to obtain the desired results.

However, some suggest that foliar fertiliser is all a grower truly needs. Yet others advocate using foliar fertilisers in conjunction with soil-applied (granular) fertilisers.

But what does the science show?

What are foliar fertilisers?

Foliar fertilisation is any fertilising substance applied in a liquid form.

At its most basic, this could be the simple water-extractions of animal manure and seaweed that home gardeners often use. This can be time consuming — a great deal of effort to procure a small amount of liquid plant nutrient.

By contrast, modern foliar fertilisers are concentrated, high-grade solutions of essential nutrients, in which nitrogen, phosphorus and potassium are combined to specific growth-optimising ratios in a controlled and repeatable fashion.

These essential elements are generally divided into two groups:

1. **Macronutrients:** those required in relatively large quantities. This includes carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur.
2. **Micronutrients:** those required in smaller quantities. This includes iron, chlorine, manganese, boron, zinc, copper and molybdenum.

Chelated trace elements (chelation prevents them from being tied-up in insoluble forms) are also often added, along with seaweed, humic acid, growth hormones and vitamins depending on crop requirements.

How foliar fertilisers work

In short, foliar fertilisers push photosynthesis — the engine room of plant growth — to greater efficiency.

Somewhat surprisingly, photosynthesis is actually a relatively inefficient process.

Only about 1% to 2% of the solar energy falling on a field of corn over a growing season is converted to chemical energy the crop can use. The photosynthetic efficiency of uncultivated plant life is as little as 0.2%. Even in sugar cane — one of the world’s most efficient plants — only 8% of the light absorbed by the plant is converted to usable chemical energy that will fuel growth.

The implication is obvious: small improvements to the photosynthetic efficiency of a crop might deliver significant increases in yield.

This is precisely what Washington State University accomplished when it genetically engineered a new rice variety containing a corn gene to induce a higher rate of photosynthesis. This modified variety produced 35% more rice per hectare.

The use of genetic engineering is not the point here, it’s the result — increased photosynthesis indisputably raises crop yield.

Foliar fertiliser uses the same principle.

Within as little as four hours of the application of foliar fertiliser, cellular-based chlorophyll synthesis and photosynthesis in the leaves ramps up. Rapid leaf growth spurts require far more water than the plant normally stores within its tissues, and the plant begins to draw additional water up from the roots and soil.

In turn, this increased water uptake by the plant’s vascular system also increases the uptake of nutrients from the soil.

The ultimate result is faster, stronger growth.

Does it really work? What is the evidence?

We can actually see this increase in chlorophyll, cellular activity and respiration. It’s one of the first signs you will see in a crop after the application of foliar fertiliser — the leaves turn a darker green.

This increased efficiency can reduce the need for soil applied fertiliser, which reduces leaching and run off of fertilising nutrients.

However, this does not mean that the application of foliar fertiliser replaces the soil applied fertiliser. Instead it increases their uptake.

In 1953, Michigan State University (MSU) examined foliar absorption of fertiliser nutrients, using radio-isotopes to trace the precise movement of those nutrients within the plant. The hope was that isotopes would offer a way to analyse fertiliser-use efficiency — how much the plant absorbed, and how much was lost to the environment.

The project revealed that all foliar-applied nutrients are absorbed by the leaves. They were even absorbed through the woody tissue (bark) of trees.

In fact, the Michigan State University analysis showed that it was eight to 10 times more effective to foliar feed a plant as far as the amount of nutrients required and the speed with which those nutrients were used.

Some of the latest research indicates a small amount of potash or phosphate when a crop needs it in high quantities can increase yield significantly. This can drive uptake of nitrogen uptake and actually providing a better return on investment than soil-applied fertiliser.

Foliar fertilisers versus soil-applied fertilisers

Research also shows that foliar fertiliser performs very favourably compared to soil-applied types.

Where MSU's radio-isotope analysis showed foliar application of nutrients was eight to 10 times more effective, the other researchers (see Table 1) have found foliar application to be between 12 and 100 times more effective.

Fact is, leaves are extraordinarily efficient as organs for absorption nutrients.

That means that growers can potentially apply only a fraction of the nutrients they would normally add to the soil and still achieve the same sort of crop quality and yield.

The soluble nutrients in foliars fuel growth more easily. They are directly available to the crop because they do not have to be dissolved by moisture before going into soil solution — a situation where they can be easily transformed into insolubalised by carbonates, bicarbonates and hydroxides.

However, it is important to note that the most favourable returns for foliar fertilisers only occur under conditions of extreme soil fixation.

Table 1: Comparative efficiency of foliar and soil applications of fertiliser

Nutrient	Crop type	Foliar ratio	Soil ratio	Source
Zinc (ZnSO4)	Annual crops	1	12	Lingle & Holmberg (1956)
Phosphorus (H3PO4)	beans, tomatoes	1	20	Wittwer, et al. (1957)
Iron (FeSO4)	Grain, sorghum	1	25	Withee & Carlson (1959)
Magnesium (MgSO4)	Grain, sorghum	1	100	Krantz (1962)
Magnesium (MgSO4)	Celery	1	50-100	Johnson, et al. (1957, 1961)

Approximate ratios of amounts required for comparable crop response.

The mere presence of a particular chemical in the soil will not necessarily promote crop growth. Certain soil conditions, such as pH, excess moisture, or cool temperatures, may render soil-applied granular fertilisers unavailable to the root system.

Foliar fertilisers circumvent this issue because they are directly applied to the crop. Plus foliar-applied fertilisers can be tailored to meet a plant's specific needs for one or more micro and macro nutrients — especially trace minerals.

And they often deliver immediate improvement (within hours) in plant health and growth.

An efficient way to correct late-season nutrient deficiency

This can enable growers to strengthen weak or damaged crops, speed growth — and correct nutrient deficiencies.

In fact, Arkansas researchers discovered in 2002 that spraying potassium on cotton foliage can correct late-season deficiencies quickly and efficiently of this important nutrient. Cotton appears to be more sensitive to low potassium availability than most other major field crops. It often shows signs of potassium deficiency on soils not considered deficient and this becomes crucial during cotton boll development.

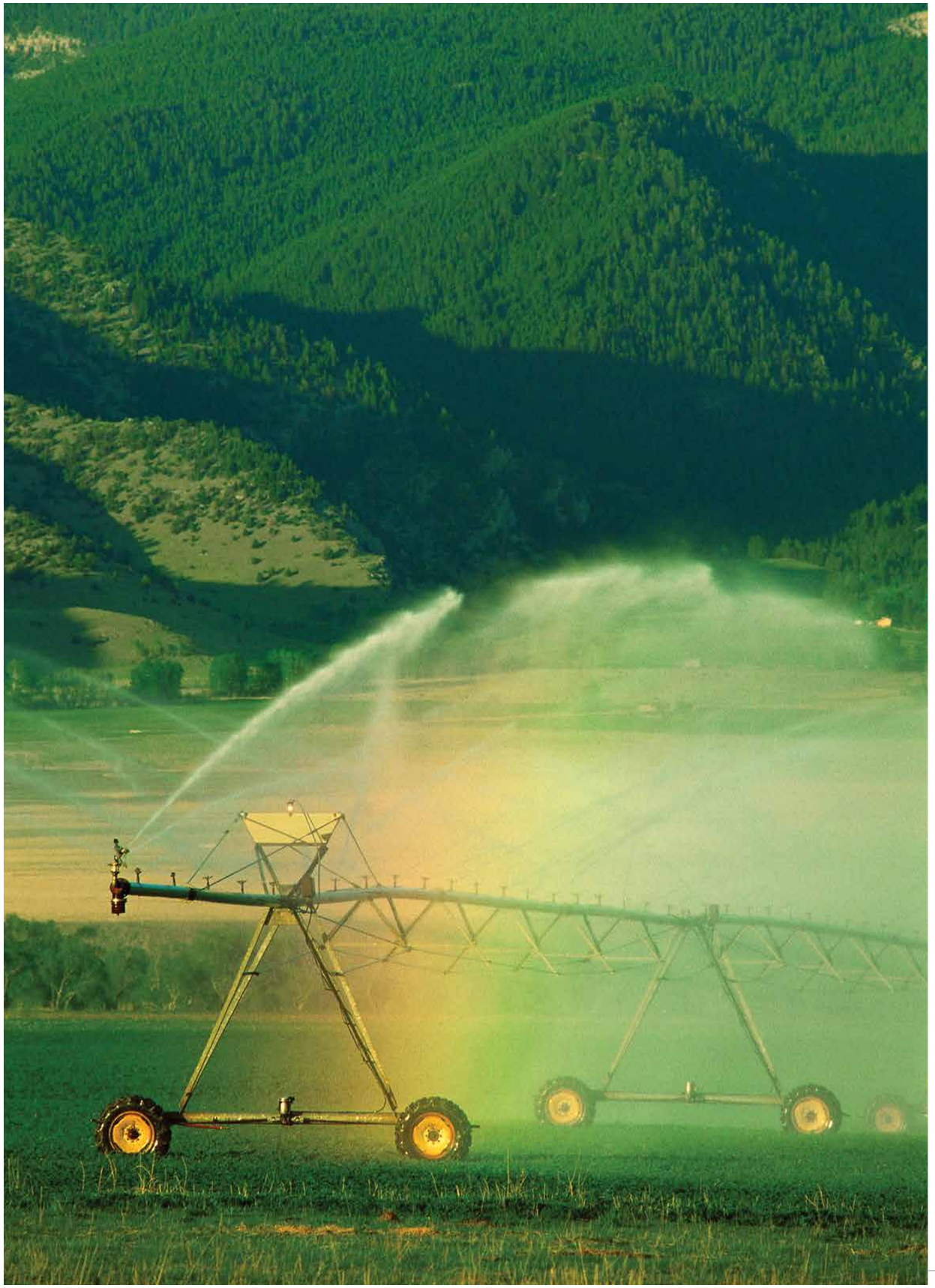
However, late season soil application of potassium is less likely to be effective. The researchers indicated that properly timed foliar applications of potassium during cotton boll development can correct inadequate potassium, and significantly increase the ultimate cotton yield.

A feedback mechanism that drives nutrient uptake

More recently researchers have established that foliar fertilisation also stimulates the plant roots themselves to become more efficient in the uptake of all nutrient requirements. That is, foliar fertilisers actually have the potential to deliver substantial efficiencies because they stimulate growth of the entire 'pumping' system of the leaf cells and plant. Thus a small amount of foliar fertiliser can actually increase the total nutrient uptake several times more than the amount of initially sprayed on the crop. Some researchers suggest a 6:1 return.

Here's how:

1. **Root mass growth.** The need for more water and greater gaseous exchange stimulates additional root mass to provide it.
2. **Microbial action.** Increased sugar synthesis (the result of more chlorophyll) creates an excess of carbohydrates. The root hairs excrete these and this energy source stimulates microbial colonies to grow on the root surface.
3. **Root stimulant generation.** In turn, these colonies create auxins and other compounds that stimulate root growth.
4. **Additional root growth.** Additional root tissue and hair growth boosts the plant's ability to absorb even more water and soluble nutrients, providing more nutrition to the growing tips of the plant.
5. **Feedback loop.** Smart growers can set-up a chain reaction if the right nutrients are applied at the right time.



How to ensure success with foliar fertilisers

As outlined, crops absorb nutrients (as well as other chemicals such as herbicides) through their foliage. This makes foliar fertilisation particularly fruitful, as long as you understand the principles that drive it.

However, the most common reason that plant-growth regulators, micronutrients, and foliar sprays fail is that growers simply do not apply the material at the most critical time.

1. **Time application for periods when high levels of nutrients are needed.** Often foliar fertiliser is applied too late in the growing season and proves largely ineffective. Instead, use them during periods of great growth activity or when crops change from a vegetative to a reproductive state and require significant levels of nutrients.
2. **Use chelated fertilisers.** Chelation prevents nutrient "tie-up" into insoluble forms within the spray tank. If the nutrients in your foliar fertiliser convert to insoluble forms, the crop cannot absorb them, and your investment is wasted.
3. **Avoid periods of heat and water stress.** Foliars should be applied during cooler weather and when the plant is not in water stress (unless the foliar fertiliser is intended to combat or prevent water stress). The optimum spraying temperature is about 22°. If the temperature is 26° or above, the fertiliser will be much less effective.
4. **Include nitrogen and phosphorous.** Nitrogen acts as an electrolyte to carry nutrients and a small amount of phosphorous assists internal circulation within the leaves.
5. **Apply when the leaf stomata are open.** Spray foliar fertilisers between 7am and 10am, or after 5pm, when the stomata are open. This maximises absorption.

Spraying techniques to maximise foliar nutrient absorption

Generally, nutrients are only absorbed while still wet on the leaf. Thus the best way to prolong the absorption window is to spray early in the morning, while it's still cool, the humidity is higher, and leaves are wet with dew.

Always mix the spray thoroughly and apply in as fine a mist as possible.

A quality wetting agent will reduce droplet formation (these will focus sunlight and burn the leaf below) and maximise the amount that sticks to the leaves. Low volume sprayers may not be as effective.

Try to coat the upper and lower leaf surfaces when practical. Spray not only remains damp on the underside of the leaf for longer, it's also where many crops have more stomata. Take care to avoid leaf burning when spraying in direct sunlight.

Using foliar fertilisers to reduce risk

Foliars are an exceptional tool for growers to reduce the risk of crop failure (or low yield).

Primarily, they enable growers to hedge, and adjust their rate of soil-applied fertiliser on the fly. This provides options to increase nutrient availability, or vary and enhance the nutrient mix to take into account the growth stage and growing conditions.

A prime example of the elevated risk of pure soil-applied fertiliser is a situation where it is pre-sown into the soil. This situation invests heavily up-front, even before seed is planted, let alone before the grower knows for certain what rainfall will occur.

Crops also require different nutrients during different stages of growth. If these are pre-sown, there is more risk of leaching, environmental run-off and nutrient tie-up. In all cases a substantial amount of the investment is wasted.

Instead, foliar application allows growers to reduce the amount of soil-applied fertilisers (especially early on) and apply the correct nutrient as it is needed — and leaf absorption eliminates the tie-up problem.

CONTACT US TO TRIAL ADVANCED NUTRIENT FOLIAR FERTILISERS

We hope you've found this whitepaper both interesting and useful.

If you'd like to learn even more about our using foliar fertilisers, or explore the potential for a trial on your crops, so you can see for yourself how they measure up, then contact us at **service@advancednutrients.com.au** or call **1800 244 009**.

References

Advanced Nutrients. How Foliar's Can Improve Your Farm's Production And Reduce Your Risk.

Gary Grigg (2005). Fertilization with foliar absorbed nutrients.

Fred Miller (2002). Potassium spray corrects deficiency.

About Advanced Nutrients

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