



Foliar Fertilisers for Pasture and Cropping

A Practical Guide for Farmers

Kangaroo Island Landscape Board | 2025

Foliar fertilisers are a precision tool to quickly correct nutrient deficiencies identified through sap or tissue testing. They work best as a complement to a sound soil nutrition program, not as a replacement for it.

Prepared for the KILB Foliar Fertiliser Workshop, 2025



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Use this guide as a practical reference for planning foliar fertiliser decisions, interpreting sap and soil test results, and mixing nutrient brews safely.

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1. What Are Foliar Fertilisers?

Foliar fertilisers are liquid nutrient solutions applied directly to plant leaves. Nutrients enter the plant through the leaf surface and stomata, bypassing the soil altogether. This makes them fast-acting and highly efficient for correcting specific deficiencies.

Why Use Foliar Fertilisers?

- **Fast response:** nutrients reach the plant within hours to days, compared to weeks via soil pathways
- **Bypass soil constraints:** alkaline subsoils, sodicity, and high pH can lock up trace elements in soil; foliar application goes around this problem
- **Precision delivery:** target specific nutrients that sap or tissue tests show are deficient
- **Environmental benefit:** reduced nutrient runoff and leaching; lower risk of over-application
- **Cost-effective:** home-mixed brews can be significantly cheaper than commercial alternatives
- **Complement soil nutrition:** works with, not instead of, good soil management

TIP: Foliar feeding is not a replacement for soil nutrition. It is a precision tool to fill gaps quickly, especially where soil constraints prevent normal root uptake.

2. The Science Behind Foliar Nutrition

Understanding why foliar fertilisers work helps you make better decisions about when and what to apply.

How Nutrients Enter Through Leaves

Nutrients enter leaves via two main pathways:

- **Stomata (leaf pores):** stomata open in the morning and evening, making these the ideal spray times
- **Cuticular absorption:** nutrients can slowly penetrate the waxy leaf surface, especially when chelated or applied with a wetting agent

The Role of Chelation

Trace elements on their own (e.g. copper sulphate dissolved in water) can precipitate out of solution or bind with other elements, reducing effectiveness. Chelation is the process of wrapping a nutrient in an organic molecule to keep it soluble and available.

- **Citric acid:** the most common chelating agent used in home brews. Dissolve trace elements in citric acid before adding to the main tank
- **Fulvic acid:** a natural humic substance that acts as a chelator and bio-stimulant. Improves nutrient uptake and supports plant energy
- **Humates:** similar to fulvic, support soil life and plant nutrition when included in the mix
- **Molasses:** provides a carbon energy source for beneficial microbes and helps nutrients stick to leaf surfaces

KEY SCIENCE: Magnesium (Mg) is the central atom in chlorophyll and is essential for photosynthesis. Sulfur (S) is a key building block for proteins. Together, Mg and S are critical for nitrogen use efficiency (NUE). If these are low, adding more nitrogen will not improve yields or grain protein.

Nutrient Interactions: Balance Is Everything

Nutrients do not work in isolation. Adjusting one element affects others. Key relationships to understand:

- **Nitrogen (N) and Mg + S:** without adequate Mg and S, plants cannot efficiently convert nitrate into protein and growth
- **Copper (Cu) and Zinc (Zn):** both are low in alkaline/sodic subsoils and critical for enzyme function, grain fill, and disease resistance
- **Molybdenum (Mo):** essential for N metabolism in legumes; even very small deficiencies limit pasture legume performance
- **Boron (B):** supports cell division and pollination; however, excess B is toxic and can already be high in some soils (e.g. Bellavista soil profile showed high subsoil B)
- **Calcium (Ca):** strengthens cell walls, improves plant structure, supports uptake of other nutrients

- **Cobalt (Co) and Selenium (Se):** primarily important for livestock nutrition via plant uptake; low levels in pasture cause deficiencies in grazing animals

3. Reading the Evidence: Bellavista 2025 Demo

The Bellavista foliar fertiliser demonstration (2025, Kangaroo Island) provides a real local example of how soil testing, sap testing, and foliar fertilisation work together. Here is what the data showed.

Soil Core Findings (June 2025)

A deep soil core revealed significant constraints at depth that directly affect foliar fertiliser decisions:

Constraint	What Was Found	Why It Matters for Foliar
High alkaline pH below 20 cm (pH 8.15-8.41)	Zn, Cu, Mn, Fe availability drops sharply	Foliar trace elements bypass the alkaline subsoil limitation
High sodicity (ESP 32-34% subsoil)	Reduced root function and water infiltration	Plant deficiencies often reflect uptake limitation, not simply low soil supply
High salinity/chloride load at depth	Cl 1500-1650 mg/kg; EC 2.34-2.58 dS/m subsoil	Osmotic stress reduces nutrient conversion efficiency and amplifies trace limitations
Trace element cliff below 20 cm	DTPA Zn <0.5, Cu 0.2-0.3, Mn 1.6 mg/kg subsoil	As crops rely on deeper moisture, trace supply drops sharply. Foliar application is a key response tool

Wheat Sap Analysis (September 2025, GS 30-39)

Sap testing at early stem extension (Zadoks GS 30-39) revealed the following key findings across the Control and Urea-applied (UAE) strips:

Nutrient	Control Status	Urea Status	What it means for foliar decisions
Sulfur (S)	LOW	LOW	Critical for protein synthesis and N use efficiency. Priority for foliar application
Magnesium (Mg)	LOW	LOW	Central to photosynthesis and N metabolism. Low Mg limits how effectively plants use N
Copper (Cu)	LOW	LOW	Enzyme function, grain fill, disease resistance. Low across all treatments
Zinc (Zn)	LOW	LOW	Enzyme function and protein production. Low across all treatments
Iron (Fe)	LOW	OK	Borderline; Control strip Low. Improves slightly with UAE
Boron (B)	LOW	OK	Cell division and pollination. Important to note subsoil B is high - dose carefully
Chloride (Cl)	HIGH	HIGH	Reflects subsoil salt load and background stress in the plant

Nutrient	Control Status	Urea Status	What it means for foliar decisions
			system
Nitrate (NO ₃)	OK	OK	Within desirable range. N was NOT the primary limiting factor at this stage

KEY FINDING: The 2025 Bellavista sap data showed that nitrogen was NOT the main limiting factor. The consistent constraints were Mg, S, Cu, Zn and Fe. Adding more N (via UAE) lifted nitrate in sap but did not address the cofactors needed to convert that N into protein and yield.

4. When to Apply Foliar Fertilisers

Timing Principles

- **Spray during cool parts of the day:** early morning or late evening when stomata are open and evaporation is low
- **Avoid spraying in hot, dry, windy conditions:** solution evaporates before being absorbed, risk of leaf burn
- Avoid rain within 2-4 hours of application
- **Growth stage matters:** apply when the plant is actively growing and can use the nutrients delivered

Cropping - Key Windows

- **Tillering (GS 20-29):** nutrient applications influence tiller number and head production
- **Stem extension / early booting (GS 30-39):** a key window to support N use efficiency, apply Mg, S, Cu, Zn if low in sap
- **Pre-flowering / late tillering:** mix of kelp, soluble calcium, and potassium supports cell division, stem density, and plant strength
- **Grain fill:** foliar applications can improve grain quality, test weight, and protein content

Pasture - Key Windows

- **Autumn and winter:** optimal timing especially when grazing lush pasture
- Periods of rapid growth with potential nitrate accumulation: foliar Ca and Mg helps maintain rumen pH and supports rumen microbial activity
- **Base pasture trace element applications on sap testing:** KI pastures are commonly low in Cu, Mo, Mn, Zn
- Co and Se are primarily important for livestock health via plant uptake: include in pasture mixes

IMPORTANT FOR LIVESTOCK FARMERS: Excess nitrate in pasture disrupts rumen microbes, reduces fibre digestion, and can cause scours. A foliar application of soluble Ca and Mg during periods of lush growth helps manage rumen health in grazing stock.

5. The Recipes

The following recipes were developed for use at the Bellavista foliar fertiliser demo and KILB workshop, 2025. All recipes are based on a 1000 L IBC brew. Always base your rates on sap or tissue test results and adjust for your situation.

Recipe 1: Pasture Foliar Mix (Jenny Stanton's Recipe)

Developed by Jenny Stanton (Regional Agronomist, Kangaroo Island) for KI pasture, primarily clover-based. Based on pre-foliar sap testing that showed low Mo, Zn, Fe, Cu and a salt signal. Recipe confirmed September 2025.

Pasture Recipe: 1000 L IBC Brew (Jenny Stanton, confirmed Sep 2025)

Ingredient	Rate (per 1000 L)	Role / Notes
Citric Acid	Add first	STEP 1: Add citric acid first to chelate and condition the water before any other elements are added. This prevents precipitation throughout the mix.
Copper Sulphate (CuSO ₄)	10 kg	Pre-dissolve at 20% (1:5 ratio with water) in a separate bucket before adding. Low in KI pastures; essential for enzyme function, N metabolism, livestock health.
Manganese Sulphate (MnSO ₄)	75 kg	Photosynthesis and enzyme activation; often limited under alkaline soil conditions.
Magnesium Sulphate (MgSO ₄)	100 kg	Photosynthesis and plant resilience. Mg supports chlorophyll; S in MgSO ₄ supports protein synthesis.
Zinc Sulphate	25 kg	Enzyme function and protein production; low in alkaline soils and consistently limiting on KI.
Boron (soluble)	10 kg	Cell division and pollination. CAUTION: subsoil B at Bellavista is already high. Always verify with sap test before applying B.
Kelp	5 kg	Biostimulant; natural source of growth regulators, trace elements, and amino acids.
XCal (liquid calcium)	375 L	Calcium base; supports cell wall strength, plant structure, and rumen pH stability in grazing livestock.
Selenium (Se)	300 g	Pre-dissolve at 50% before adding. Handle carefully - avoid selenium dust. Primarily for livestock: low Se in pasture causes white muscle disease in lambs and calves.
Cobalt (Co)	500 g	Pre-dissolve at 25% before adding. Livestock nutrition: Co is required for Vitamin B12 synthesis in ruminants.
Molybdenum (Mo)	500 g	Pre-dissolve at 20% (1:5 with water) before adding. N metabolism in legumes; very low in pre-foliar pasture sap. Critical for clover performance on KI.
Iron Sulphate	Pending sap test	Add if follow-up sap test confirms Fe deficiency. Pre-dissolve separately before adding to tank. Rate to be confirmed once sap results available.

Recipe 2: Wheat Crop Foliar Mix (Tom Robinson's Mix)

Applied October 2025 at Bellavista to the wheat paddock (majority area). Designed to address Mg, S, Cu, Zn, and B limitations identified in the sap baseline.

Wheat Crop Recipe: 1000 L IBC Brew

Ingredient	Rate (per 1000 L)	Role / Notes
Citric Acid	25 kg	Chelating agent; add first to condition water and prevent trace element precipitation
Fulvic Acid	25 kg	Bio-stimulant and chelator; improves nutrient uptake and plant energy. Add after citric acid
Boron (soluble)	25 kg	Cell division, pollen viability, grain set; was low in Control strip sap. Monitor carefully
Cobalt (Co)	2 kg	Enzyme function; also supports livestock mineral nutrition via plant uptake
Molybdenum (Mo)	2 kg	N metabolism efficiency; important even in wheat for N use efficiency
Magnesium Sulphate (MgSO ₄)	200 kg (8 x 25 kg bags)	Critical - Mg was low in both Control and Urea strips. Central to photosynthesis and N conversion
Copper (CuSO ₄)	Dose to sap	Was consistently low across all strips; pre-dissolve at 20% (1:5 with water) before adding to tank

NOTE: Tom's crop recipe did not include explicit zinc sulphate in the recorded rates, however Zn was consistently low in sap. Consider adding Zn to future applications based on updated sap results. Always check current sap data before finalising rates.

6. Step-by-Step Mixing Guide

Follow these steps in order every time you mix a brew. Sequence matters: adding elements in the wrong order causes precipitation and reduces effectiveness.

Equipment Checklist

- 1000 L IBC (Intermediate Bulk Container) or similar large mixing vessel
- Accurate scales or measuring jugs for solids and liquids
- Stirring paddle or recirculation pump
- Spray tank or backpack sprayer
- Individual buckets for pre-dissolving elements
- Gloves, goggles, and apron (mandatory)
- pH meter or test strips
- Record sheet

Mixing Steps

Step	Action	Detail
1	Safety check	Gloves, goggles, apron on. Work in a well-ventilated area. Keep children and pets away. Have water nearby for rinsing.

Step	Action	Detail
2	Fill IBC with water	Use clean water. Pasture recipe: no heating needed. Crop recipe: can heat to 30-35 degrees C to help dissolve solids. Do not boil.
3	Add chelating agents first	Add citric acid (and fulvic acid if using) and stir well. This conditions the water and prepares it to receive trace elements without precipitation.
4	Add molasses (if using)	Rate: 1-3 L per 1000 L. Stir gently. Provides energy for microbes, improves sticking to leaf surfaces. Note: pasture recipe at the workshop did not include molasses.
5	Add calcium and magnesium	Add liquid calcium (XCal) first, then MgSO ₄ . Rates based on sap test results. Stir well between additions.
6	Pre-dissolve trace elements	In separate buckets, dissolve each trace element individually before adding to the main tank: Copper: 20% solution (1 part CuSO ₄ : 5 parts water). Selenium: 50% solution. Cobalt: 25% solution. Molybdenum: 20% solution. This prevents precipitation in the main tank.
7	Add trace elements slowly	Add pre-dissolved Cu, Zn, Mn, Co, B, Fe, Mo one at a time, stirring between each addition. Watch for any colour changes or precipitation.
8	Mix and observe	Stir gently but thoroughly. Check for: precipitates (clumping), colour changes, unusual smell. Record observations.
9	Test pH	Ideal spray pH: 5.5-6.5. Adjust if needed: add citric acid to lower pH, or potassium bicarbonate to raise pH. Correct pH improves nutrient stability and uptake.
10	Spray and record	Fill sprayer from IBC. Spray during cool parts of the day (morning or evening). Record: date, crop/pasture type, growth stage, weather, batch recipe, observations.

7. Troubleshooting

Common Problems and Fixes

Problem	Likely Cause	Fix
Leaf burn	Solution too concentrated; sprayed in hot conditions; pH incorrect	Increase water volume; spray early morning or evening; check and adjust pH

Problem	Likely Cause	Fix
		to 5.5-6.5
Precipitation in tank	Elements added in wrong order; not pre-dissolved; incompatible combinations	Pre-dissolve each element separately; add citric acid first; add elements one at a time
Uneven coverage	Nozzle blockage; poor agitation; wrong spray volume	Check nozzles; use agitation; target 50-100 L water/ha minimum for good coverage
Nutrient lock-up	pH too high or low; antagonistic nutrient interactions	Correct pH; avoid mixing highly incompatible elements (e.g. Ca and phosphate)
Pest attack after N application	N push attracts aphids and RLEM; soft new growth is susceptible	Balance N with cofactors; include trace elements to support plant immune function
Boron toxicity	Over-application; not checking soil/sap status before applying	Always sap-test before applying B; KI subsoils can already have high B levels

8. Using Sap Testing to Guide Your Program

Sap testing is the most powerful tool for making foliar fertiliser decisions. Unlike soil tests, which tell you what is in the soil, sap tests tell you what is actually inside the plant at that moment.

How to Use Sap Results

- Collect samples from the same plant part, same time of day, same growth stage each time for reliable comparisons
- Sample the youngest fully emerged leaf for most nutrients
- Compare results against desirable range guidelines for your crop type and growth stage (Agvita or equivalent)
- Prioritise nutrients that are clearly below the desirable range
- **Do not just treat one element in isolation:** consider interactions and balance
- Take a follow-up sample 7-14 days after application to check response

Decision Framework: N vs NUE

A common grower concern is whether to add more nitrogen. The 2025 Bellavista data suggests a better question to ask first:

PRACTICAL RULE: If nitrate (NO₃) in sap is adequate or high but Mg, S, Cu, and Zn are low, prioritise fixing the cofactors and energy pathways BEFORE adding more N. More N without adequate cofactors does not improve protein or yield and may attract pests.

On-Farm Observations to Combine with Tests

- **Plant health and growth:** visual symptoms, colour, vigour
- **Livestock health:** condition, worm counts, offspring health
- **Pasture measurements:** dry matter, hay quality tests
- **Soil biology:** cotton strip test, infiltration, worm counts
- **Compaction and structure:** visual soil assessment, penetrometer

9. Safety

Working with trace element concentrates and chemical additives requires care. Follow these rules every time.

- Always wear gloves, goggles, and an apron when mixing

- Work in a well-ventilated area
- Keep children and pets away from the mixing area
- Always add chemicals slowly to water, never water to concentrated chemicals
- **Selenium requires special care:** handle in well-ventilated conditions, wear a mask when handling dry selenium
- Store concentrated chemicals separately and securely
- Label all prepared solutions clearly with contents, concentration, and date
- **In case of skin or eye contact:** flush immediately with water for 15 minutes and seek medical advice if needed
- **Keep a log sheet of all batches mixed:** date, recipe, observations

10. Foliar Fertilisers, Soil Health, and Carbon

Foliar fertilisers are not just about plant nutrition. Used alongside good soil management, they support the broader farming system.

- Healthy soils retain nutrients more efficiently and support the full value of foliar applications
- Precision foliar nutrition reduces over-application risk and the associated nutrient runoff and leaching
- Supporting plant health through balanced nutrition builds more biomass and root mass, which drives carbon return to the soil
- Molasses and fulvic acid additions support beneficial soil microbiology when they return to the soil via run-off or root exudates
- Foliar programs complement, but do not replace, longer-term soil amelioration work (e.g. gypsum, compost applications for sodic or compacted soils)

LONG GAME: The Bellavista site demonstrates that subsoil constraints (sodicity, salinity, alkalinity) limit what roots can access. Foliar nutrition is a practical tool for the short to medium term, but addressing subsoil constraints through gypsum, organic matter, and biological activity is needed for long-term productivity gains.

11. Quick Reference: Nutrient Functions at a Glance

Nutrient	Key Role in Plant	Common Form Used	KI Notes
Magnesium (Mg)	Central to chlorophyll; photosynthesis; N use efficiency	MgSO ₄ (Epsom salts)	Low in Bellavista wheat sap across all treatments. High priority
Sulfur (S)	Protein and amino acid synthesis; N metabolism	MgSO ₄ provides S; also ammonium sulphate	Low in Bellavista wheat sap across all treatments. High priority
Copper (Cu)	Enzyme function, grain fill, disease resistance	CuSO ₄ (pre-dissolved 20%)	Consistently low in KI pastures and Bellavista wheat sap
Zinc (Zn)	Enzyme function, protein production, growth hormones	ZnSO ₄	Very low in subsoil at Bellavista; low in all wheat sap treatments
Iron (Fe)	Chlorophyll production, electron transport	FeSO ₄ (pending sap test)	Borderline in wheat sap; can be limited by high pH
Manganese (Mn)	Photosynthesis, enzyme activation	MnSO ₄	Can be limited in alkaline soils; included in pasture recipe
Boron (B)	Cell division, pollination, grain set	Soluble boron/boric acid	CAUTION: subsoil B at Bellavista is high. Dose strictly to sap results
Molybdenum (Mo)	N metabolism; legume N fixation	Sodium/ammonium molybdate	Very low in pasture sap; critical for clover performance on KI

Nutrient	Key Role in Plant	Common Form Used	KI Notes
Cobalt (Co)	Livestock Vitamin B12 via plant uptake	Cobalt sulphate/chloride	Important for animal health; include in pasture mixes
Selenium (Se)	Livestock health (white muscle disease prevention)	Sodium selenate	Deficient in many KI pastures; handle carefully
Calcium (Ca)	Cell wall strength, structure, nutrient uptake	Liquid calcium (XCal)	Supports plant structure and rumen health in livestock
Citric Acid	Chelating agent; keeps trace elements soluble	Food grade citric acid	Add first to every brew; critical for preventing precipitation
Fulvic Acid	Bio-stimulant; chelator; improves uptake	Commercial fulvic product	Included in Tom's crop recipe; supports plant energy
Kelp	Growth regulators, amino acids, trace minerals	Liquid kelp product	Included in pasture recipe; natural bio-stimulant
Molasses	Carbon source for microbes; leaf adhesion	Blackstrap molasses	1-3 L per 1000 L; improves microbial activity and spray coverage

12. Is It Worth It? Return on Investment

A common question is whether foliar fertilisers stack up economically. Jenny Stanton (Regional Agronomist, KI) shared the following example after the 2025 workshop.

JENNY'S EXAMPLE - Pasture spray during lush clover/capeweed growth: Cost: ~\$20/ha spray + \$15/ha application = \$35/ha total Benefit: Reducing scouring in lambs by correcting excess nitrate effects via soluble Ca and Mg can deliver an extra 100-200g/head weight gain for 1 month. At \$10/kg liveweight, that is \$30-60 per lamb extra return. At 7 lambs/ha, that is \$210-420/ha return on a \$35/ha spend. Return on investment: \$6-12 for every \$1 spent. Bonus: Animals can be turned off faster, leaving behind feed for other stock.

Jenny also noted that a dung score assessment before and after application is a simple way to track and demonstrate the response on your own farm. This calculation does not include the longer-term benefits of improved animal health, reduced veterinary costs, or retained pasture value.

Broader Economic Principles

- In agriculture, it is not just about cost. It is about value and return for each dollar spent.
- Foliar fertilisers are most cost-effective when applied at the right time to address a specific deficiency identified through sap or tissue testing.
- Guessing at nutrient needs without testing increases the risk of wasted spend and unbalanced nutrition.
- Home-mixed brews using raw materials (CuSO₄, MnSO₄, MgSO₄) are significantly cheaper than commercial pre-mixed products.
- Small broadcast water rates (50-100 L/ha) keep application costs low while achieving good leaf coverage.

13. Contact and Further Information

For assistance with foliar fertiliser programs, sap testing, or soil health on your property, contact the Kangaroo Island Landscape Board: Cassandra Douglas-Hill LSA Soil Extension Officer Email: cassandra.douglas-hill@sa.gov.au Phone: 0402 107 167 Kangaroo Island Landscape Board: (08) 8553 2476 Website: landscape.sa.gov.au/ki

This document was prepared for the KILB Foliar Fertiliser Workshop, 2025. All recipes and recommendations should be verified against current sap and soil test data before application on your property. This guide is for general information purposes only.