

FBG Spray Water Quality SnapShot



2025

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Executive summary

Key Findings

It's probably not a surprise to many growers familiar with managing milky-muddy dams in the Jerramungup region that many water sources had clarity levels well above recommended ranges for sensitive chemicals. While some sources showed high hardness levels, many growers mentioned addressing this with Ammonium sulphate (AMS). pH levels were variable across samples, with most falling in the slightly to highly alkaline range. Some water sources had salinity levels above suggested limits.

We encourage you to read the full document for detailed insights, but if you're short on time, we've distilled the key take-home messages for you here.

- 1. Test your water regularly**, especially if you use sources other than rainwater or store it in concrete tanks for extended periods. Scheme water is generally consistent in quality, but pH and alkalinity can vary due to residual chlorination, and interactions with older or cement-based piping over long distances. Testing may still be needed if water is stored, blended with other sources, or used for sensitive spray applications.
- 2. Plan your spray program** around water quality; use the most sensitive chemicals with your best water sources.
- 3. Check before treating or adding adjuvants.** Some products are already formulated with the necessary components and may self-adjust.
- 4. Always read the product label.** It is recommended to read the herbicide label to ensure the minimum water quality level is achieved, however, in many cases the herbicide labels do not state the minimum water quality threshold; in which case you should consult with your agronomist or use clean water only.

Water Clarity (Turbidity)

- 32 samples had high turbidity, which may interfere with soil-binding herbicides like paraquat and glyphosate.
- Use rainwater or clean water whenever possible.
- If muddy water must be used, plan your spray program carefully to avoid sensitive chemicals.
- Pay particular attention to herbicides with Koc values greater than 800 mL/g, as they have a higher potential to adsorb onto suspended organic matter and fine clay particles in turbid water. This adsorption can reduce herbicide availability and efficacy, especially for foliar-applied and contact herbicides. Using clean water is recommended to minimise this risk.

Hardness

- 14 samples hardness > 300 mg/l
- Water hardness >200–250 mg/L can reduce chemical effectiveness, especially at 300 mg/L.
- Bicarbonate levels (75–175 mg/L) can impact product performance request bicarbonate levels in water tests if you

pH

- Regularly monitor pH of both the water source, point of mixing and with different tank mixes. Some chemicals contain built-in adjuvants and buffers, so additional pH adjustment may not be needed. Settling treatment like alum can change pH.
- Use immediately after mixing. If pre-mixing is necessary, check the label for the half-life of the active ingredient at the mix's pH and temperature to understand how quickly it may degrade.
- Very acidic water (pH < 5) can cause mixing issues with salt-based formulations (e.g. 2,4-D amine may gel or precipitate).
- Weak-acid herbicides (e.g. glyphosate, glufosinate, clethodim, 2,4-D) perform better in slightly acidic spray water (pH 5–6).

- Sulfonylurea Herbicides (e.g. Metsulfuron-methyl, Chlorsulfuron) improved with slightly alkaline water (~pH 8)
- Not all chemicals are sensitive to pH.

Table 1. NSW DPI 'Weed control in winter cropping 2025 (Heuston and Macpherson, 2025) (pp24)

Product (herbicide)	Water quality				
	Muddy	Saline	Hard	Alkaline (pH >8)	Acidic (pH <5)
2,4-D or MCPA amine	✓	✓	X	NR	–
2,4-D or MCPA ester	✓	Test	Test	✓	✓
2,4-DB	–	–	X	NR	–
Affinity® Force (carfentrazone-ethyl)	✓	✓	✓	X	NR
Associate® (metsulfuron-methyl 600)	✓	✓	✓	Marginal	X
Brodal® Options (diflufenican 500)	–	✓	✓	X	–
Chlorsulfuron	✓	✓	✓	Marginal	X
Dicamba	✓	✓	NR	NR	–
Diuron	✓	Test	✓	✓	–
Diuron + 2,4-D amine	✓	Test	X	NR	–
Fusilade® Forte (fluazifop-p-ethyl 128)	✓	✓	✓	NR	X
Glyphosate	X	✓	X	–	✓
Gramoxone® 360 Pro (paraquat 360)	X	✓	✓	✓	✓
Haloxyfop	✓	✓	✓	NR	✓
Legacy® MA (diflufenican + MCPA)	✓	X	X	NR	–
Lontrel® Advanced (clopyralid)	✓	✓	X	X	–
Simazine	✓	X	✓	NR	–
Trifluralin	–	✓	✓	✓	✓
Valor® (flumioxazin)	✓	✓	–	X	✓

Key

✓ okay to use, X do not use, – no data.

NR = not recommended, but if there is no other option, do not allow the chemical mixture to sit in the tank for any period. Spray out immediately.

Test = mix herbicides and water in proportion before use; if any instability is observed, do not use.

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Introduction

This document is intended to support grower group staff and grower members in understanding how water quality affects herbicide efficacy. It presents regional results from a snapshot water quality monitoring program for the Fitzgerald Biosphere Group (FBG). It breaks down key water quality parameters, clarifying common sources of confusion around units and terminology. The goal is to facilitate a practical understanding, drawing from a range of existing resources referenced throughout. We acknowledge and appreciate the contributions of those resources and the experts who developed them. While this document draws extensively from industry reports and anecdotal evidence, it's important to note that many guidelines referenced are not linked to peer-reviewed scientific literature. Therefore, we encourage you to seek independent advice or consult an agronomist when making decisions based on this information.

Many factors, including environmental conditions, plant stress levels, weed growth rates, nozzle setup, and tank cleanliness, influence herbicide performance. The compatibility of tank mixes and the condition of the equipment also play a role.

Here, we focus on water as the carrier for chemical application. Water can make up more than 95% of a typical spray solution, and its quality can significantly influence the effectiveness of chemical applications. It is an often-overlooked factor in performance, and its impacts can sometimes be mistaken for herbicide resistance.

We present data from a snapshot water sampling campaign conducted for Fitzgerald Biosphere Group (FBG), considering what constitutes good water quality and the potential issues that may arise if water quality is poor.

On 13 and 14 May 2025, 70 water samples were collected from various farm sources and analysed for key parameters known to affect spray chemical efficacy. The goal of this sampling was to provide growers with a baseline understanding of the water quality they use during knock-down, pre-emergent and early post-emergence herbicide applications.



Photos: FBG and UWA teams collecting water samples in May 2025

Water quality can vary significantly depending on its source (rainwater, farm dams, or groundwater), the material in which water is stored, and may fluctuate throughout the year, particularly following periods of heavy rainfall or drought conditions.

Before diving into this document, it's important to understand that **the impact of water quality on spray effectiveness is product specific**. Some chemicals are very sensitive to factors such as hardness or turbidity (water clarity), while others are not. **Always refer to the product label for specific guidance**. While many helpful general resources are available, which have been synthesised here and listed at the end of the document, more research is needed to understand these interactions fully. Therefore, the **information in this report is general and intended to raise awareness and enhance understanding**. Before making any changes to your spray program, it's recommended to consult with an expert.

Data collection

Water samples were collected directly from the source that growers indicated they used in their spray program to ensure an accurate representation of the water quality at the point of use. Parameters like pH, which change rapidly, were measured directly from the source at collection using a multiparameter handheld meter (*YSI PRODSS or TPS Ranger*). Turbidity was also recorded in the field using a portable Turbidimeter (*2100Q Hach*) or the ProDSS meter. For all other parameters, samples were kept <4 °C and sent to a NATA-accredited laboratory for analysis. Parameters assessed in the laboratory included alkalinity, conductivity, total dissolved solids (TDS), total suspended solids (TSS), chloride, dissolved major cations, dissolved metals via ICP-MS, and total metals.



Photo: YSI ProDSS Multiparameter Handheld Meter – portable water quality instrument

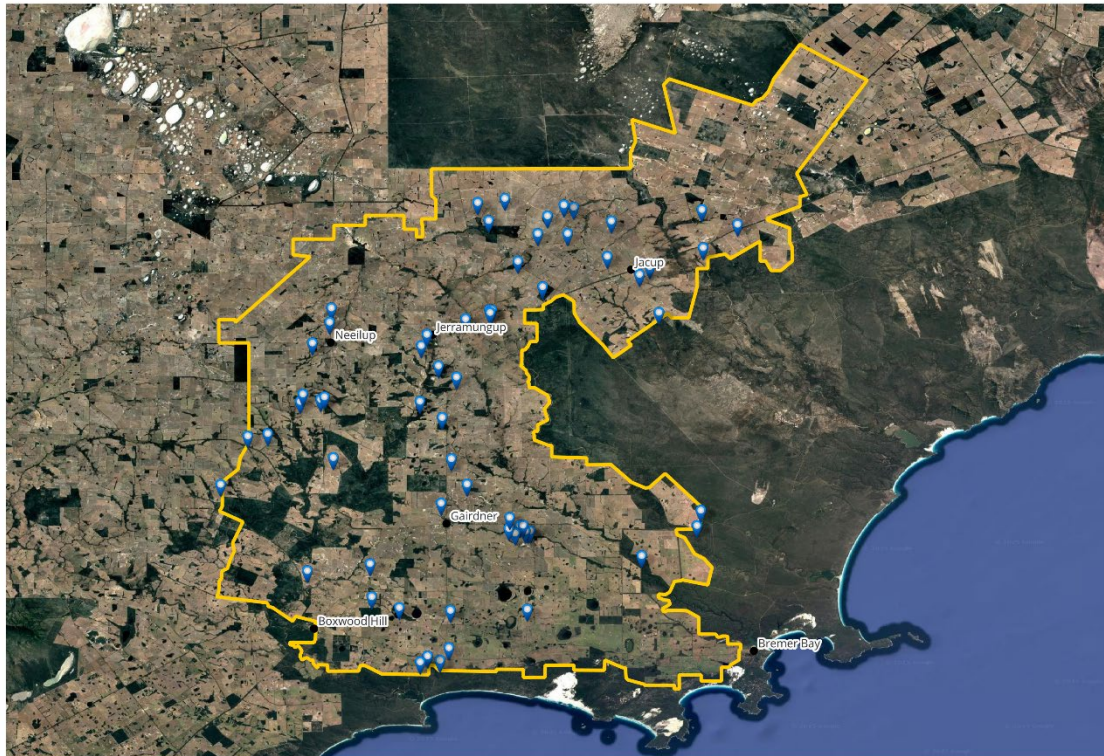


Figure 1: Approximate location of sampling across the FBG region.

Snapshot Data Interpretation: Notes and Caveats

- The data presented here is from a grab sample from a single point in time. Please note that water quality can change seasonally.
- Three teams collected samples. All water quality probes were calibrated and cross-checked against each other to ensure confidence; however, repeat measurements should confirm any outliers.
- Every effort was made to determine the water source during sampling. When the grower was present, the source was confirmed directly. In cases where water was sampled directly from the source (e.g., bore or dam), the origin is clear. However, in instances where water is collected from a tank and the source is not confirmed, the classification may be uncertain. We recommend that growers review the grouping and source information provided and verify its accuracy.
- Materials of the tank and storage time of water may impact quality, such as concrete tanks. Therefore, the issues may originate from the raw source or storage.

- The data presented here is to raise awareness. We recommend repeating sampling and monitoring the quality of your water sources across time to plan your spray program.

Data Interpretation

Water quality data is presented as a box and whisker plot to show the spread and distribution of values.

- The line in the middle of the box is the median value. Half the data points lie above and below this line.
- The top and bottom edges of the box show where most of the middle values lie. The top edge marks the 75th percentile (meaning 75% of the data is below this point), and the bottom edge marks the 25th percentile.
- The “whiskers” are the lines that stretch out from the top and bottom of the box. These whiskers show the spread of most of the data.
- The dots represent data points that are outlier values that fall significantly above or below the rest of the data.

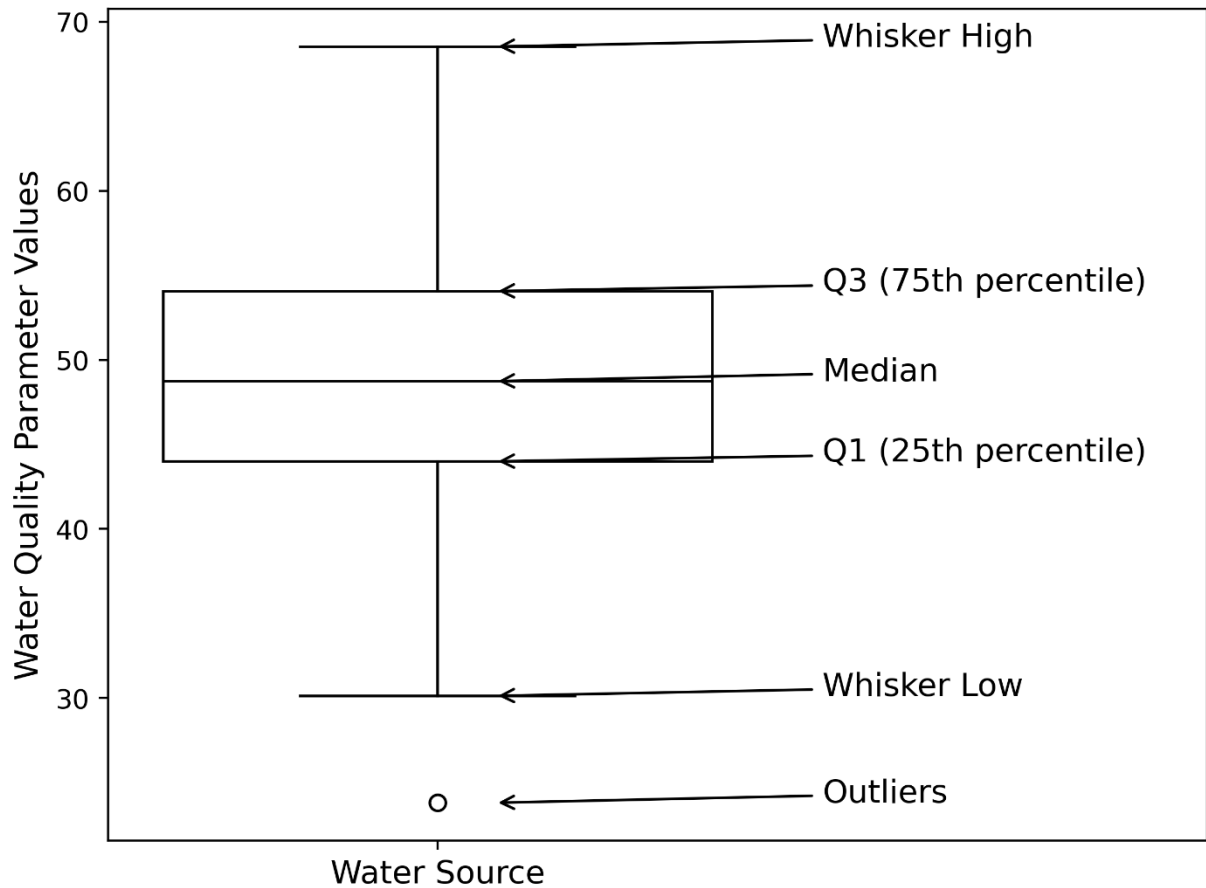


Figure 2: Example Box and Whisker Plot

pH

The pH of water indicates if it is acidic, neutral or alkaline and is measured on a scale from 1 to 14. The pH scale is logarithmic, which means that for each unit of pH change, there is a 10-fold increase in acidity or alkalinity. pH is a measure of the relative amount of free hydrogen (H⁺) and hydroxide ion (OH⁻) in the water.

pH < 7: Water is acidic due to more hydrogen ions (H⁺) (e.g. Vinegar)

pH 7: Water is neutral due to balanced amounts of hydrogen (H⁺) and hydroxide ion (OH⁻). (e.g. pure water)

pH > 7 Water is alkaline (basic) due to more hydroxide ions (OH⁻) (e.g. Soapy water)

Freshwater typically has a pH between 6.5 and 8. Many farm water sources, especially those from bores or dams, can be alkaline, often with a pH of 8 or even 9.

Hydrolysis

Why is the amount of Hydrogen (H⁺) and hydroxide ion (OH⁻) important when adding a chemical to a tank of water?

The amount of Hydrogen (H⁺) and hydroxide ion (OH⁻) is important, as at high levels they can break down the active ingredients. H⁺, as a positive charge, will seek out and take electrons from your product in a process called **acid hydrolysis**. In alkaline conditions, the OH⁻, as a negatively charged ion, will donate electrons to the product in a process known as **alkaline hydrolysis**. Hydrolysis causes the breakdown of the product, which makes the active ingredient less effective.

Why does pH matter?

pH > 8 Alkaline Water:

- Alkaline hydrolysis will break down the active ingredients in your pesticides. The higher the pH and the warmer the water, the faster the breakdown will occur. An ingredient breakdown will reduce absorption into the plant and ultimately decrease effectiveness.
- Can cause deposits in pipes and blockages in equipment.

pH < 6.5 Acid Water

- Acidic water can cause corrosion of metal pipes and fittings and may also affect the stability of some chemicals through acid hydrolysis (described above).
- Acid hydrolysis is generally less of an issue than alkaline hydrolysis, but some chemicals are sensitive to pH <5 (e.g. Sulfonylurea herbicides like Metsulfuron-methyl, Chlorsulfuron).

Mixing times and half-life

Water pH and hydrolysis are key reasons why many products should be mixed just before use. At certain pH levels, some chemicals can break down rapidly, reducing their

effectiveness. If spray program logistics require pre-mixing, check the product label to ensure it doesn't advise against it. You could also look for information on the product's half-life at the pH of the mix to understand how long the active ingredient will remain effective after mixing.

	Product Half-Life		
	pH 9	pH 7	pH 5
Brand X Herbicide	10 minutes	17 hours	16 days
Brand X Fungicide	2 minutes	3 hours	10 hours
Brand X Insecticide	24 hours	10 days	stable

Figure 3. An example from Purdue University 'The Impact of Water Quality on Pesticide Performance publication (pg36) of how pH can impact some chemical break down (Whitford, 2009).

What is the optimum pH range for spray water?

The pH of mixing water plays a critical role in determining the effectiveness of chemicals. However, the optimum pH range varies depending on the specific product. Some pesticide labels include information on critical pH thresholds, beyond which the chemical may degrade or become less effective (Figure 4).

Restraints (apply to all use patterns):

DO NOT apply by aircraft.

DO NOT apply by a vertical sprayer.

DO NOT apply by misting machines.

DO NOT treat weeds under poor growing or dormant conditions (such as occur in drought, waterlogging, disease, insect damage or following frosts) as reduced control may result. Weeds should be actively growing at time of treatment.

DO NOT apply in high pH water (pH >7).

DO NOT allow the spray mix to stand overnight.

DO NOT irrigate up to the point of run-off for at least 3 days after application.

Figure 4. Example of a pH recommendation from Titan FLUMIOXAZIN 500 WG label.

Some general guides on pH ranges:

- Weak-Acid Herbicides (e.g. glyphosate, glufosinate, clethodim 2,4-D) improved with slightly acidic spray water (pH 5–6) (Daramola et al., 2022).
- Very acidic water (pH < 5) can cause physical mixing issues, especially with salt-based formulations. For example, 2,4-D amine, a salt-based formulation, may gel or precipitate when mixed in very acidic water. This issue is exacerbated

when combined with other salt-based products, resulting in clogged nozzles and/or uneven spray distribution. (Congreve and Cameron, 2023; GRDC, 2019).

- Sulfonylurea Herbicides (e.g. Metsulfuron-methyl, Chlorsulfuron) improved with slightly alkaline water (Congreve and Cameron, 2023)
- Not all chemicals are sensitive to pH, for example, Bipyridyl herbicides (e.g paraquat) (Congreve and Cameron, 2023)
- Note that its good idea to test scheme water pH for sensitive chemical as treatments like chlorination can shift pH levels into the alkaline range.

FBG pH Results

The pH of water sources sampled for FBG ranged from 4.3 to 9.4, with a median value of 7.8. The pH varied by source, with dam water exhibiting both the lowest and highest pH values.

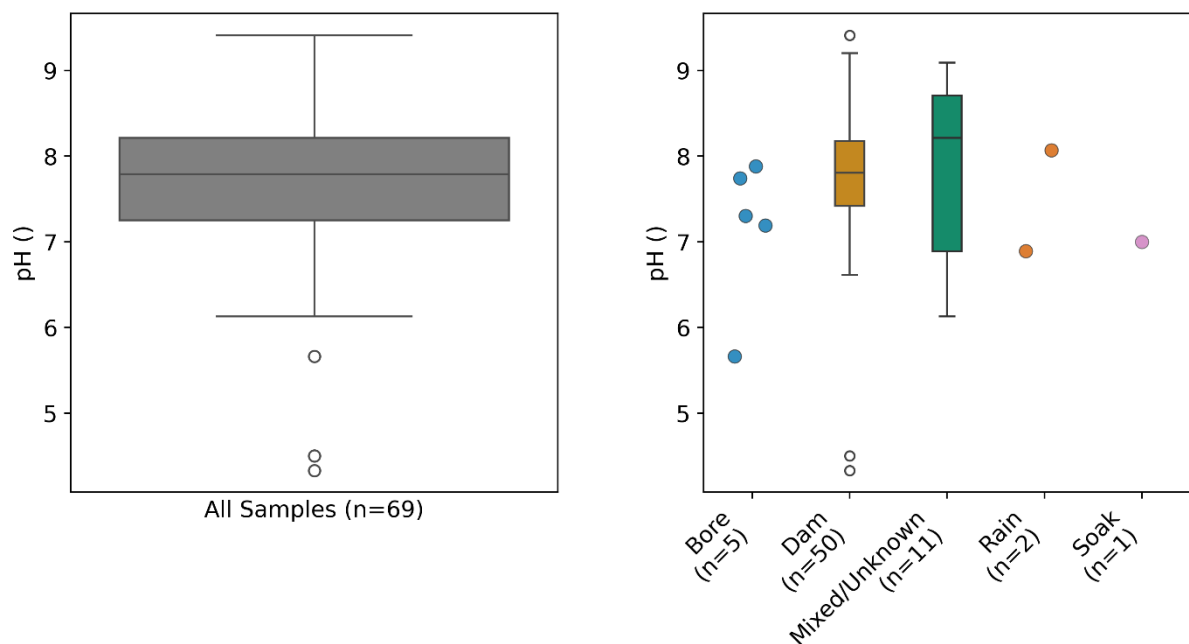


Figure 5. Boxplots showing the pH of all water samples (left) and grouped by farm water source (right). The "Mixed/Unknown" category includes samples that were either blended or collected from tanks where the original water source was unknown.

Two of the samples with low pH values (4.3 and 4.5) came from dams with treatment notes, and one specifically mentioned the use of alum. Turbidity treatment using alum likely contributed to the low pH (see Water Treatment). It's essential to

monitor pH both before and after treatment to assess the suitability of the water for the herbicide being used. For example, caution would be necessary when using low pH water with sulfonyleurea herbicides, such as metsulfuron-methyl, as a low pH can reduce their effectiveness. Similarly, for the 25 water samples with pH>8, consider the implications of alkaline hydrolysis on chemicals like Valour (flumioxazin) and mixing times, as most products mixed in alkaline water should be sprayed immediately.

Hardness

Hardness refers to water with a high concentration of dissolved minerals, mainly calcium and magnesium, but can also include other elements such as sodium, iron, aluminium, and zinc. Groundwater often has higher hardness as it dissolves these minerals from the surrounding rocks.

Hard water can be an issue for certain herbicides, especially weak acid herbicides (e.g., glyphosate), as the positively charged minerals can bind to the negatively charged herbicide molecules. The binding creates herbicide-salt compounds that are less soluble or inactive, which means they are harder to absorb or move within the target weed, reducing effectiveness. Hard water can also cause chemicals to precipitate out of solution and hinder surfactants (McDougall, 2012).

Water hardness is commonly measured in milligrams per litre (mg/L) and is typically expressed as calcium carbonate (CaCO₃) equivalents. According to Australian drinking water guidelines, good quality water falls within the range of 60–200 mg/L CaCO₃, with scaling risks increasing above 200 mg/L (NHMRC and NRMCC, 2011). For spray applications, **water hardness exceeding 200–250 mg/L** can reduce the effectiveness of chemicals, with 300 mg/L considered the upper recommended limit (GRDC, 2019). Some spray resource suggests a hardness level of 150 mg/L will begin to impact spray applications. (Whitford, 2009)

Note: mg/L is equivalent to parts per million (ppm) 200 mg/l is 200ppm if you are more familiar with working in ppm.

FBG Hardness Results

The hardness of water sources sampled for FBG ranged from 1 to 877 mg/L, with a median value of 146 mg/L. Hardness varied by source, with 14 samples having hardness levels greater than 300 mg/L.

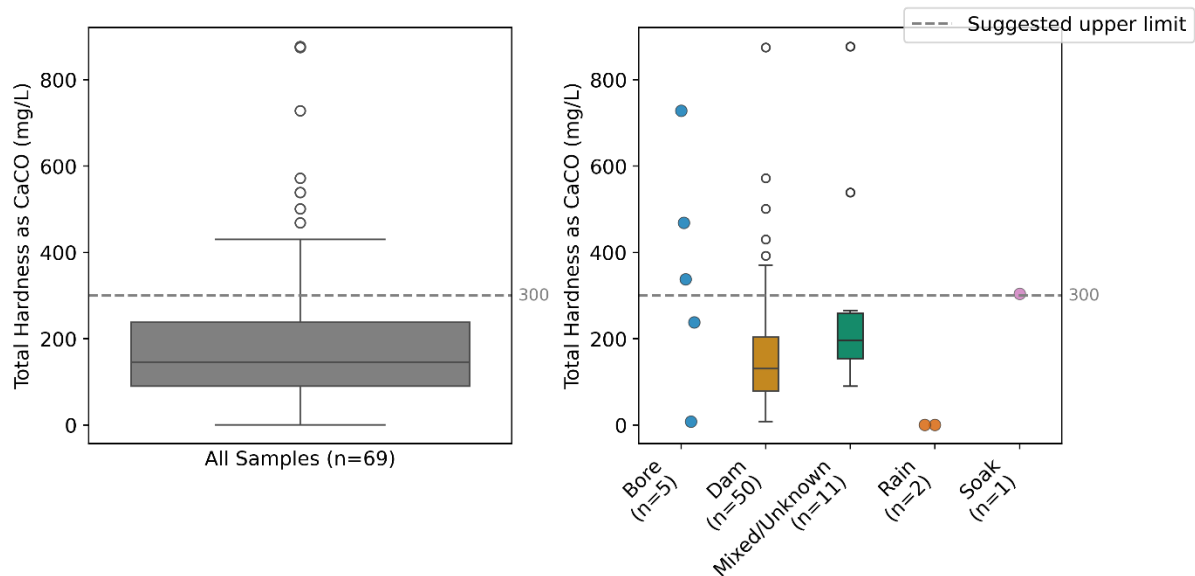


Figure 6: Boxplots showing the Total Hardness of all water samples (left) and grouped by farm water source (right).

The "Mixed/Unknown" category includes samples that were either blended or collected from tanks where the original water source was unknown.

Alkalinity and Bicarbonate

The term given to water's ability to maintain a stable pH by neutralising acids (H^+ ions). Alkalinity is often referred to as the buffering capacity of water and dictates how easily the pH can be changed. It measures the concentration of alkaline substances, mainly bicarbonates, carbonates, and hydroxides.

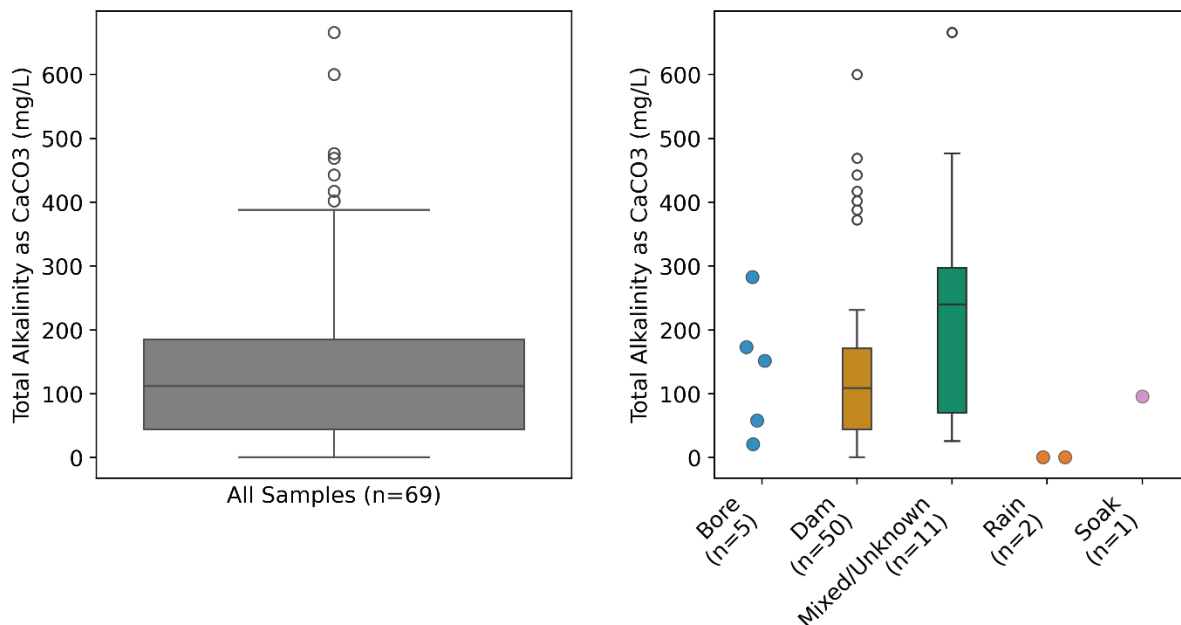


Figure 7: Boxplots showing the Alkalinity of all water samples (left) and grouped by farm water source (right). The "Mixed/Unknown" category includes samples that were either blended or collected from tanks where the original water source was unknown.

Alkalinity and hardness are often confused while the presence of positively charged ions (calcium, magnesium) defines water hardness, these are balanced by negatively charged ions, most commonly bicarbonates (HCO_3^-) (Figure 8). Bicarbonate can react with both acids and bases, which drives the water's ability to buffer pH changes alkalinity.

There is evidence that in GRDC and WeedSmart resources that Bicarbonate levels as low as 75-175 mg/L have been reported to reduce the efficacy of certain herbicides, including Group A (1) herbicides and 2,4-D amine (GRDC, 2019).

"A bicarbonate level of 75 ppm and above will lead to reductions in the efficacy of 2,4-D amine and Group A formulations," he says. "Ammonium sulfate can be used to reduce the effect of bicarbonates on Group A (1) herbicides, but will produce little improvement on 2,4-D amine formulations." Craig Day of Spray Safe and Save- WeedSmart Blog- (Cindy Benjamin, 2017)

Because of this, it's recommended to request bicarbonate levels as a separate

measurement when conducting a water quality test if you have any concerns with herbicide effectiveness.

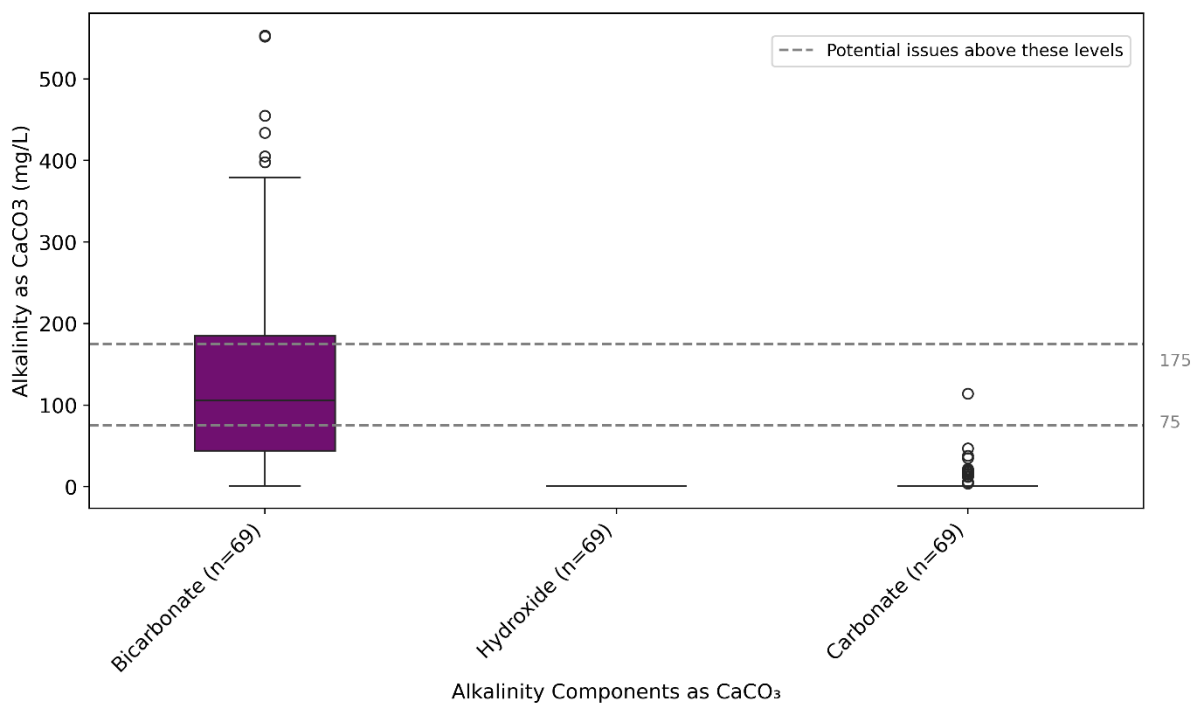


Figure 8: Boxplots showing the Alkalinity Components of all water samples (left). There is evidence that in GRDC and WeedSmart resources that Bicarbonate levels as low as 75-175 mg/L have been reported to reduce the efficacy of certain herbicides.

Salinity

Salinity refers to the concentration of all soluble salts in water. It is typically measured by its electrical conductivity (EC, a field measurement) or total dissolved solids (TDS, a laboratory measurement). The more dissolved salts (ions) in the water, the higher the EC. When salts dissolve in water, they become positively charged (cations) or negatively charged ions (anions).

Both hardness and salinity involve dissolved salts, but they refer to different aspects of water chemistry. Hardness is mainly caused by the presence of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions (see Hardness above). In contrast, salinity includes all dissolved ions, such as sodium (Na^+), chloride (Cl^-). Importantly, water can have a high electrical conductivity (EC) without being classified as hard. For example, water high in sodium chloride (NaCl) may have high salinity but low hardness.

There are no clear guidelines for EC level for use in spray water. However, elevated salinity levels, typically exceeding EC values above 500 $\mu\text{S}/\text{cm}$, can cause some chemicals to precipitate out of the solution or become inactive (GRDC, 2019). It is best to avoid water sources with high EC values for spraying or mix them with freshwater sources to lower EC levels. However, if you are running low on high-quality spray water, consider that some herbicides are less sensitive to salinity, so plan your spray program accordingly.

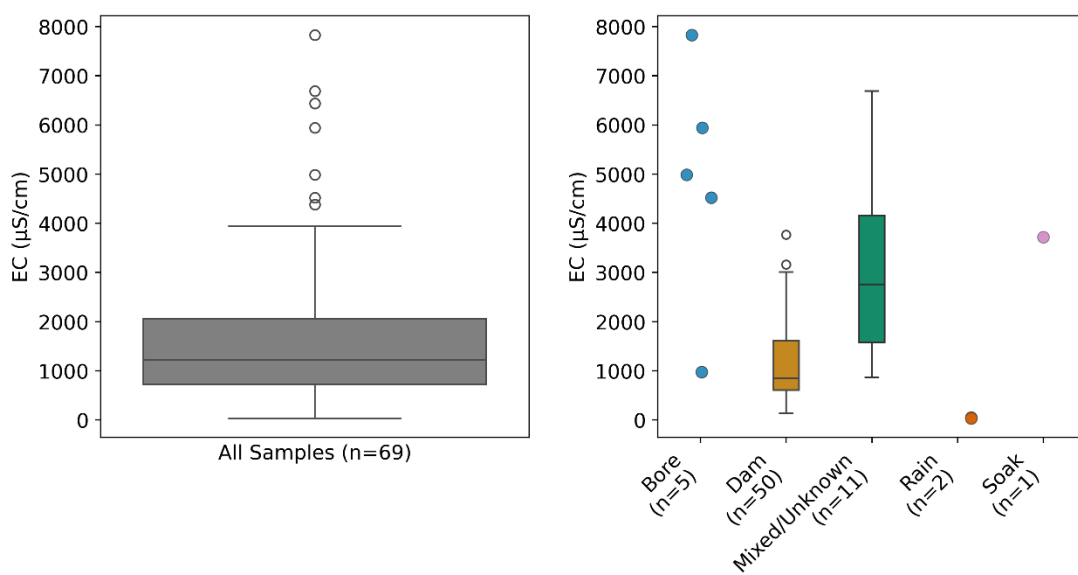


Figure 9: Boxplots showing the electrical conductivity (EC) of all water samples (left) and grouped by farm water source (right). The "Mixed/Unknown" category includes samples that were either blended or collected from tanks where the original water source was unknown.

Why are there so many units for salinity?

A common frustration for growers, extension staff, and scientists is the lack of a standard units for water salinity. Handheld field meters and lab reports use different formats, which can make it hard to compare results quickly.

Salinity is typically measured in the field using electrical conductivity (EC). EC is a measure of how well water conducts electricity and is commonly reported in units such as $\mu\text{S}/\text{cm}$, mS/cm , or dS/m .

Lab tests often report Total Dissolved Solids (TDS) which measures all dissolved salts in water in milligrams per litre (mg/L) or parts per million (ppm). Many field meters often estimate TDS by converting electrical conductivity (EC) readings using a standard formula.

Water Salinity tool on Salt Land Genie

The Water Salinity tool on Salt Land Genie is handy for converting between units and it also places your measurement against livestock drinking guidelines (works best on tablet or computer)



(<https://www.saltlandgenie.com/#/watersalinity>)

Water Clarity (Turbidity)

Turbidity is a measurement of water clarity by recording light penetration through a liquid. Some sources of turbidity can be from suspended particles of clay, silt, and fine organic matter. Dissolved organic compounds, such as tannins, can also discolour water and lead to a higher turbidity reading.

Turbidity is typically recorded in Nephelometric Turbidity Units (NTU) or Formazin Nephelometric Units (FNU). Water with turbidity <1 NTU appears “crystal clear”, while at 5 NTU it looks slightly muddy or milky in a glass, and at levels above 60 NTU you won’t see through the water (NHMRC, 2011).

Muddy water can significantly reduce spray effectiveness, as some herbicide active ingredients bind tightly to soil particles, making them less available for plant uptake and reducing overall efficacy. For example, turbidity is linked with reduced efficacy of paraquat, diquat, glyphosate, clethodim, sethoxydim and diflufenican (Daramola et al., 2022).

The GRDC recommends a simple rule of thumb: if you can’t see a 10-cent coin at the bottom of a bucket, the water is too dirty for use with products sensitive to dirty water. (GRDC, 2019).

If you’d like to estimate your NTU range based on visibility, Loughborough University’s Technical Notes on Drinking-Water (Reed et al., 2013) provide a simple guideline using a 2.5 cm dull copper coin placed at the bottom of a bucket. If the coin is no longer visible at a depth of:

- <32 cm visibility = likely >20 NTU (high turbidity)
- 32–50 cm visibility = likely 10–20 NTU
- >50 cm visibility = likely <10 NTU (clearer water)

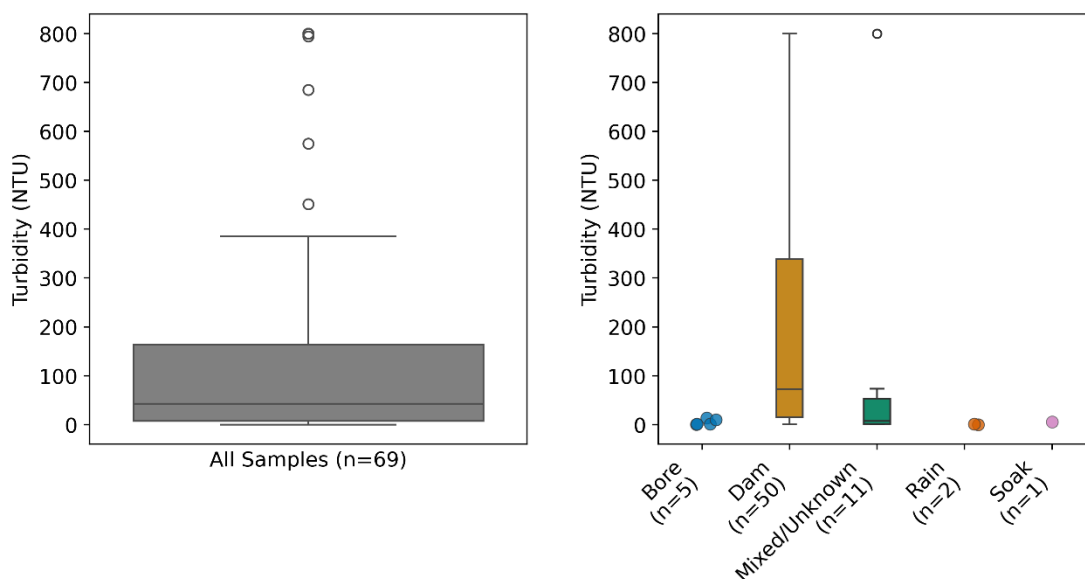


Figure 10. Boxplots showing the Turbidity (NTU) of all water samples (left) and grouped by farm water source (right). The "Mixed/Unknown" category includes samples that were either blended or collected from tanks where the original water source was unknown. Note there were 8 samples with values >800 that were set to 800 as this upper range of the field meter calibration.

The turbidity of water sources sampled for FBG ranged from 0.2 to 800 NTU, with a median value of 42 NTU, 38 samples had NTU >20 and 29 exceeded 60 NTU.

Whenever possible use your cleanest available water for spraying. Water from sources with high turbidity should not be used with chemicals like Glyphosate or Paraquat. If you're trying to assess whether a chemical is particularly sensitive to water clarity, you often find the clean water requirement on the label.

Reduced results may occur if water containing soil is used, eg. water from ponds and unlined ditches; or if hard water containing calcium salts is used. (Glyphosate 450)

Mix this product with clean water only. Water should be clean and free from clay, silt and algae. Providing it meets this requirement, saline water, water collected from roofs, bore water, dam water and water from creeks may be used. - Genfarm Paraquat 250 Herbicide Label

If label guidance isn't available, you can search for the active ingredient e.g., for Roundup®, search for glyphosate on the University of Hertfordshire Pesticide Properties Database (<https://sitem.herts.ac.uk/aeru/ppdb/>). Look for the Koc value,

which stands for the soil organic carbon sorption coefficient. This indicates how strongly a chemical binds to organic matter in soil or suspended particles in water. Purdue University recommends making sure you use clear water when the Koc value is > 800 (Whitford, 2009).



Metals

As part of the sampling process, we also collected data on total and dissolved metals, including aluminium, copper, manganese, zinc, and iron (Figure 11).

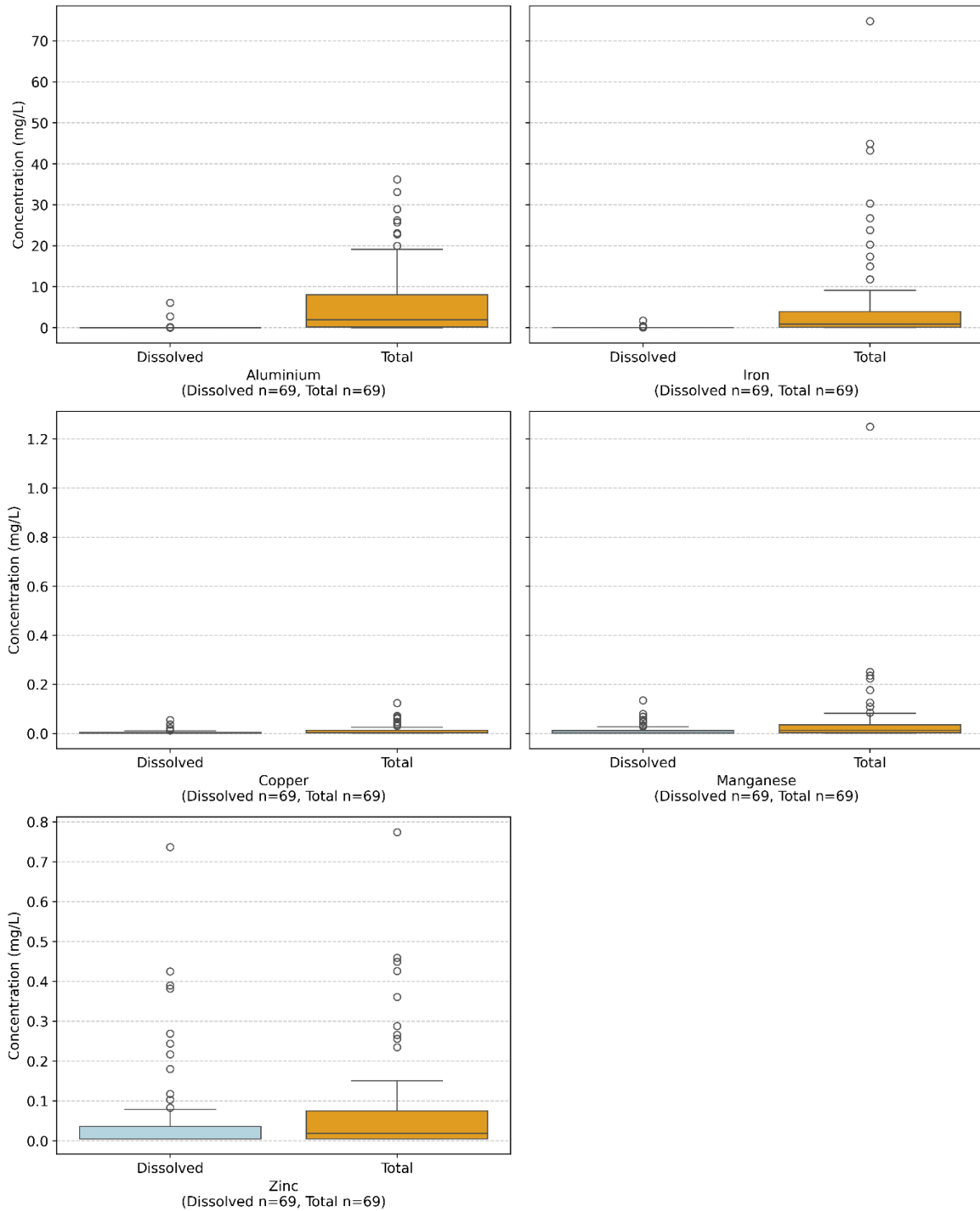


Figure 11. Boxplots showing the dissolved and total metals for all water sources sampled

There is limited published information or guidelines for the level of metals in spray water. Some of the advice in published spray water resources includes;

- Water conditioners are advised when Iron levels exceed 25 ppm and hardness plus iron exceed 400 when herbicides are used (Whitford, 2009).
- Iron-loving bacteria thrive in water containing 0.3 to 1.5 mg/L (or ppm) of iron, which can lead to potential blockages in equipment. Iron concentrations > 1.5 mg/L deposits can form in pipes and equipment (McDougall, 2012).

In lieu of spray water guidelines Table 2 provides reference values from irrigation, drinking water, ecosystem health, and livestock guidelines to help understand the results.

Table 2. Guidelines values for metals in water.

Metal	Irrigation Short-term guideline value (mg/L)	Drinking Water Guideline (mg/L)	Livestock Drinking Guideline (mg/L)
Aluminium	20	No health-based guideline.	<5
Copper	5	2	<0.5 (sheep) <1 (cattle) <5 (pigs/poultry)
Iron	10	Aesthetic limit 0.3	Low risk; no guideline
Manganese	10	Health-based limit: 0.1	<10
Zinc	5	Aesthetic limit: <3	<20
https://guidelines.nhmrc.gov.au/australian-drinking-waterguidelines/part-5/physical-chemical-characteristics https://www.waterquality.gov.au/sites/default/files/documents/irrigation-guidelines-draft-4.2.pdf https://www.waterquality.gov.au/sites/default/files/documents/livestock-drinking-water-guidelines-draft.pdf			

Water Temperature

Water Temperature speeds up or slows down chemical reactions. For example, high water temperatures can accelerate the process of hydrolysis. Very cold water can cause gelling, particularly with oil additives (DPIRD, 2024)

Testing your Water

- Drop by the FBG office at 10 Tobruk Road, Jerramungup, WA 6337 for support and access to testing tools.
- FBG can currently test pH, Turbidity and EC quickly and accurately on farm in around 10 mins per site.
- If there is interest in annual sampling rounds, FBG could offer area sampling across the Shire through a grouped fee-for-service model
- pH should be measured within 6 hours of sample collection for accurate results.
- Testing options quick overview:
 - Test strips-cheapest and least accurate; like pool testing kits.
 - Handheld meters- A Range of options and cost, but at a minimum, they should cover EC and pH. For all units, regardless of the amount spent, they are only reliable if they are calibrated or checked against standards regularly. The FBG team can also support you with this.
 - Lab testing is best for detailed analysis; use handheld meters for regular field testing of parameters like pH and as an initial to guide in determining if you should send away for testing.

Water Treatment

When treating water, it's essential to consider the impact on all water quality parameters and avoid assessing each one in isolation. Conducting a jar test can help you evaluate treatment effects. The information provided here is general in nature and intended to raise awareness and support understanding. Before making any changes to your spray program, it's strongly recommended that you consult with a qualified expert.

pH

Should you adjust the pH before mixing?

- Adjusting the pH of spray water is generally only necessary when the water is highly alkaline (typically pH > 8) or when using herbicides that are very sensitive to pH. Acidifying adjuvants or buffering agents can be added to adjust pH.
- Note that many high-quality herbicide formulations already include buffering components or adjuvants that help stabilise the pH of the spray solution and may not require further adjustment.

Hardness

Ammonium sulphate (AMS) is widely used to treat hard water. Of the growers we spoke to as part of the FBG sampling, a common response was to use an AMS rate of 1%.

When AMS ($(\text{NH}_4)_2\text{SO}_4$) dissolves in water, it separates into ammonium (NH_4^+) and sulphate (SO_4^{2-}). The sulphate ion binds with hard water cations (Mg^{2+} , Ca^{2+}) to form insoluble sulphates, which precipitate out of solution, preventing the cations from binding with the herbicide (Figure 13).

In addition to treating hard water AMS is also often used as it may improve the uptake of negatively charged herbicides through the leaf cuticle. The positively charged ammonium ions (NH_4^+) can neutralise the herbicide's negative charge, aiding its movement into the leaf (Johnson et al., 2019).

1) Adding Glyphosate to untreated hard water.

2) Adding Glyphosate to hard water treated with well mixed AMS.

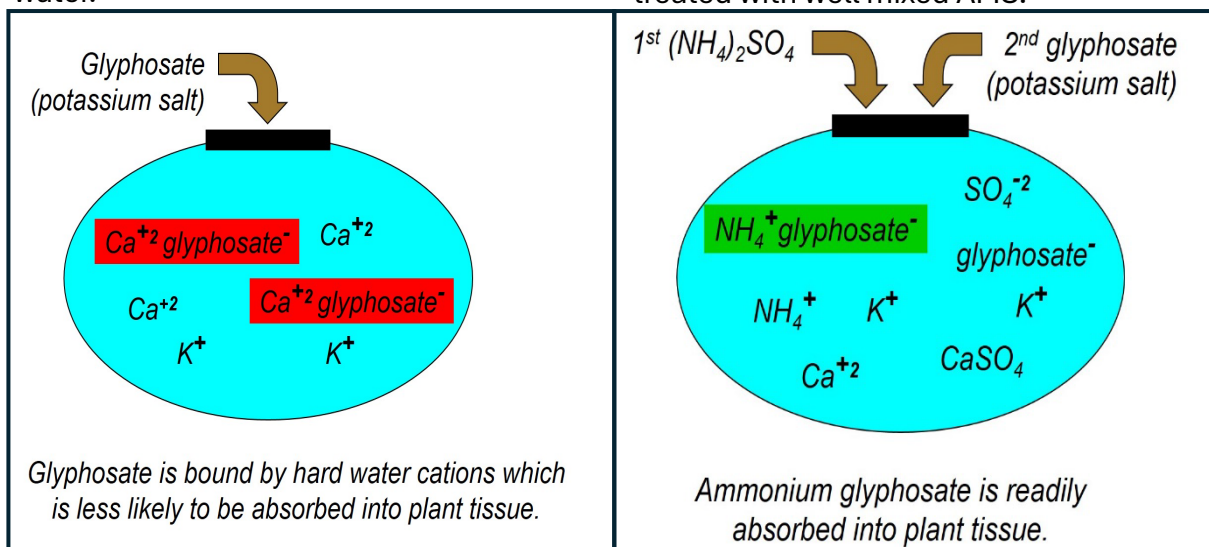


Figure 13. A diagram from Purdue University showing the chemistry of treating hard water with Ammonium sulphate (AMS) (Johnson et al., 2019).

AMS is available in both liquid and crystalline forms. Ensure AMS is fully dissolved and mixed before adding spray chemicals, especially when using 2,4-D. As it may bind with your active instead of the hard cation you are trying to treat.

As a starting point use the label rate of AMS. The GRDC offers valuable resources and advice on using crystalline ammonium sulphate (CAMS) (GRDC, 2025) [here](#) , which can be summarised as follows:

- CAMS cools water upon dissolving; therefore, begin with warmer water and a higher initial tank volume (60-80%) to prevent excessive cooling, especially during winter, ensuring proper mixing.
- Allow 10 minutes after adding CAMS for complete dissolution before introducing other products.
- CAMS product quality can vary; always verify dissolution and regularly check filters.

Liquid AMS products, although more expensive, are a good option when time is limited or when having issues dissolving CAM products completely.

If you've had your water tested as part of this project and are using Crystalline Ammonium Sulphate (CAMS), you can follow the GRDC-recommended formulation below. (GRDC, 2025)

$$\text{Kg CAMS / 100L water} = (0.001 \times \text{Ca (ppm)}) + (0.0006 \times \text{Na}) + (0.0002 \times \text{K}) + (0.0017 \times \text{Mg}) + (0.005 \times \text{Fe})$$

Here we result from one of the FBG water samples to demonstrate

Table 3. Example of water quality result for on of the FBG water sources

Total hardness (mg/L)	572
Calcium (Ca)	135
Sodium (Na)	461
Potassium (K)	33
Magnesium (Mg)	57
Iron (Fe)	1.8
Kg CAMS/100L water $= (0.001 \times 135) + (0.0006 \times 461) + (0.0002 \times 33) + (0.0017 \times 57) + (0.005 \times 1.8)$ $= 0.52 \text{ kg /100kg}$ which would be 0.5% for this water source	

Muddy Water

Settling: Transfer the water to a settling tank, where heavier particles will naturally sink to the bottom. Carefully draw water from the top of the tank to avoid disturbing the settled material.

Filtration: Use a physical filter to remove larger particles from the water.

Flocculants- Dealing with Fine Sediment

Fine particles often remain suspended and don't settle easily. In this case it is common to use flocculants like alum (aluminium sulphate) or Gypsum (calcium sulphate).

See the DPIRD factsheet- "Clearing cloudy or coloured water on farms in Western Australia" (DPIRD, 2025) which step through the best process and considerations with using common settling agents

Alum

Aluminium sulphate ($\text{Al}_2(\text{SO}_4)_3$), commonly known as Alum, reacts with water to form aluminium hydroxide floc, which traps fine particles and helps them settle.

When alum reacts with water, it produces sulfuric acid (H_2SO_4), which can lower the pH of the treated water. **Always test the water after the application of Alum.**

The formation and stability of the aluminium hydroxide floc are pH-dependent. It has minimum solubility in neutral to slightly alkaline pH (~6-7.5) where it will form the best floc.

Alum use is generally not recommended if the water pH is <5 as aluminium becomes more soluble, leading to poor floc formation and increasing the concentration of dissolved aluminium in the water, which can lead to toxicity issues

It is not recommend to use water treated with Alum to spray amine formulation chemicals.(McDougall, 2012)

Gypsum

Calcium sulphate dihydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), commonly known as gypsum, is another widely used flocculant in Western Australia.

When gypsum dissolves, it releases calcium and sulphate ions into the water. Unlike Alum, it doesn't change the water pH, but it is generally less effective at removing fine particles.

Spray Water Quality Resources

NSW Department of Primary Industries

Water quality for chemical spraying. Available at:

https://www.dpi.nsw.gov.au/_data/assets/pdf_file/0008/433691/Water-quality-for-chemical-spraying.pdf

Purdue University

The Impact of Water Quality on Pesticide Performance. Available at:

<https://www.extension.purdue.edu/extmedia/ppp/ppp-86.pdf>

GRDC and WeedSmart

Water quality for spraying operations. Available at: <https://grdc.com.au/resources-and-publications/all-publications/publications/2019/spray-water-quality>

GrowNotes Herbicide Use. This publication provides a water quality section under each mode of action). Available at:

<https://www.weedsmart.org.au/app/uploads/2020/10/GRDC-GrowNotes-Herbicides.pdf>

WeedSmart Don't start mixing until the water quality is right. Available at:

<https://www.weedsmart.org.au/content/dont-start-mixing-until-the-water-quality-is-right/>

Department of Primary Industries and Regional Development

Factors affecting herbicide performance. Factsheet DPIRD-39 Available at:

https://library.dpird.wa.gov.au/fc_factsheets/50/

Clearing cloudy or coloured water on farms in Western Australia Clearing cloudy or coloured water on farms in Western Australia. Available at:

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