3 ways to avoid common fertil izer problems

By Shannen Ferry and Karen Kackley

Understand formulation numbers and calculations, select the right fertilizer and deal with the results from fertilizer use.

Water quality is the primary consideration when choosing a fertilizer. It may even determine which crops can be grown with relative ease at a production facility.

It is imperative that you know the alkalinity of your irrigation water and its effect on growing medium pH plus the other mineral components of the water's soluble salts. Only then will you be able to make the best fertilizer choice to meet your plants' needs.

Your water source may change seasonally or yearly whether it is from a well, surface water or municipal water supply. Therefore, you should have a complete water analysis done seasonally by a horticultural testing laboratory until you understand how or if your water quality fluctuates. Thereafter, yearly testing may suffice.

A growing medium's levels of calcium, magnesium and pH can change dramatically within the first couple of weeks after it is initially irrigated.

Common fertilizer concerns

The most common fertilizer questions or problems can be divided into three categories:

1. **Proper fertilizer selection.**
2. **Fertilizer numbers and calculations.**
3. **Dealing with results.**

Proper fertilizer selection

PROBLEM: Lemming syndrome: Following the crowd may leave you standing alone.

RESOLUTION: Blindly following the recommendations of a manufacturer's representative, respected grower or industry researcher without knowing your irrigation water quality can lead to problems. Not all growers benefit from using the same fertilizers. This is one reason so many different fertilizers are available. Growers must balance crop needs, water quality, fertilizer quality and cost-in-use.

PROBLEM: One-size-fits-all or wanting to use one fertilizer regime for all crops.

RESOLUTION: Crops have very different nutritional needs. Select and use fertilizers based on these needs and on testing results. Major concerns include:

- Many vegetatively propagated young plants grown for spring color require low phosphorus levels.
- Zonal geraniums and African marigolds need a higher medium pH to prevent iron and manganese toxicity.
- Pentas prefer a medium pH of 7 for best growth.
- Poinsettias are damaged by a high boron level and require a high calcium level (greater than 75 parts per million constant liquid feed).
- Bedding plants often require higher boron levels; their growing medium pH requirements vary.

PROBLEM: Failure to maintain adequate levels of calcium and magnesium. Improper calcium:magnesium ratio.

RESOLUTION: Not all water sources supply adequate levels of calcium or magnesium. Some irrigation water contains relatively high amounts of sodium (greater than 50 ppm is a concern). Therefore, it is necessary to supplement calcium and magnesium by adding dolomitic lime to the growing medium or by using soluble calcium and magnesium. In general:

- Calcium requirements vary by crop. Most plants need 40 ppm or more on a constant basis.
- The amount of calcium should equal or exceed the level of sodium in the water plus fertilizer solution.
- Maintain a calcium:magnesium ratio of 2 or 3 parts calcium:1 part magnesium for proper balance.

PROBLEM: Choosing intermittent feed over constant liquid feed.

RESOLUTION: Constant fertilization at lower levels maintains a consistent supply of nutrients for a crop as compared to intermittent feed with clear watering irrigation in between. Constant liquid feed helps to maintain a more constant medium pH and prevents poor growth due to lack of nutrient supply during environmental conditions that favor growth.

PROBLEM: Not understanding water alkalinity.

RESOLUTION: Alkalinity in greenhouse water is primarily composed of carbonates and bicarbonates.

Alkalinity "controls" pH. It is a measure of the water's ability to neutralize acid. It is reported in ppm, milligrams per liter (mg/l), the same number used as ppm, or milliequivalents per liter (meq/l).

Since pH affects nutrient availability, and alkalinity affects pH, it is necessary to know and understand the alkalinity of your water.

High water alkalinity can cause the medium pH to rise over time. Alkalinity's effect is greater in small pots because they are watered more frequently than larger pots.

PROBLEM: High sodium and chloride levels.

RESOLUTION: A high sodium level competes with potassium, calcium and magnesium. Therefore, if the sodium level is higher than potassium, calcium and magnesium levels in the water, growing medium or fertilizer, you may encounter problems with the latter nutrients even though they may be present in normal amounts. Check fertilizer sources for sodium.

Chlorides compete with nitrates. Excessive chloride salts compete with nitrate-nitrogen for plant root uptake. Water supply, fertilizer sources containing chlorides and lack of leaching during irrigation contribute to chloride buildup in the medium. Minimize chloride inputs and irrigate to leaching to avoid nitrate competition.

PROBLEM: High boron levels in water.

RESOLUTION: A high boron level in water is of particular concern during poinsettia season, especially if boron levels exceed 0.25 ppm. Normal water levels can be as high as 0.5 ppm. Water with higher boron levels may require the use of "no boron" fertilizer formulations. Marginal chlorosis of older leaves, quickly followed by necrosis, is a symptom of boron toxicity.

Boron is absolutely essential for plant growth. Know the individual crop require-

Recommended water quality guidelines for most crops

Units of measure are in parts per million unless noted	Acceptable range	Low	High
Alkalinity (ppm calcium carbonate)	60-180	<40	>200
Soluble salts (electrical conductivity, mmhos/cm)	0.3-1.0	<0.2	>1.3
Nitrogen as nitrate			>10
Nitrogen as ammonium			>10
Phosphorus			>10
Potassium			>10
Calcium	40-75	<25	>100
Magnesium	30-50	<15	>50
Iron			>2.0
Manganese			>1.5
Copper			>0.2
Zinc			>0.4
Boron			>0.50
Aluminum			>1.0
Sodium	<50		>50
Chlorides	<70		>70
Fluorides			>1.0

ments and remember to figure total inputs of water plus fertilizer.

Fertilizer numbers and calculations

PROBLEM: Figuring calculations.
RESOLUTION: Fertilizer bags have directions on their labels. You may avoid some confusion by remembering that:

• When a recommendation is stated as "ounces (pounds, grams, etc.) per 100 gallons" that is the dilute strength of the fertilizer delivered to the plants. You must use this figure when determining how to mix a concentrate to use with your injector. The easiest way to do this is to set your injector ratio at 1:100 and dissolve the quantity stated "per hundred gallons" in each gallon of water for your concentrate. Each gallon will then be diluted into 100 gallons of water.

• The proportioning ratios of Hozon-type proportioners fluctuate depending on the water pressure and flow. The ratios vary between 1:12 and 1:16. Most manufacturers' calculations assume an average ratio of 1:15 for these proportioners.

• Fertilizer company technical representatives and university extension personnel can help you fine-tune the calculations.

PROBLEM: Misunderstanding the injector or "My injector is set at 100 ppm."
RESOLUTION: Your injector does not deliver a fixed ppm of nitrogen. You must determine the amount of fertilizer to dissolve per gallon of water to make the appropriate concentrate for a specific injector setting.

PROBLEM: Not properly measuring fertilizer and water amounts.
RESOLUTION: You need to weigh the fertilizer. Carefully mark your fertilizer concentrate tank in graduated increments (1 gallon, 2 gallons, etc.) so that you don't waste fertilizer or deprive your plants of nutrients. Volumetric measurements are problematic. Not all coffee cans or 4-inch pots contain the same volume. To measure an accurate volume of fertilizer, check the amount by weighing out that volume periodically on scales. Use a soluble salts meter for checking amount of fertilizer delivered. Solution color is not a reliable gauge for fertilizer strength.

PROBLEM: How much water is needed to dissolve one bag of fertilizer?
RESOLUTION: One 25-pound bag of fertilizer contains 400 ounces (25 pounds x 16 ounces). If you know the amount of fertilizer you need per gallon of concentrate, divide 400 by that number to give you the number of gallons of water needed to make the concentrate with one bag of fertilizer.

Example: To apply 100 ppm nitrogen using any 15 percent nitrogen fertilizer, dissolve 9 ounces of fertilizer per gallon of water and set your injector ratio to 1:100.

400 ÷ 9 = 44.5 gallons of water to dissolve one bag of fertilizer to apply 100 ppm nitrogen at an injector setting of 1:100.

PROBLEM: When adding two fertilizers together, what is the resulting analysis?
RESOLUTION: One of the easiest ways to figure this out is to line up the analyses like an old-fashioned math problem, making sure to line up the numbers for nitrogen, phosphorus and potassium.

21-5-20
15-5-15

If they are added together in equal weights, then add the numbers in each column

36-10-35

and divide each number by 2 to determine the combined fertilizer analysis of 18-5-17.5.

If the fertilizers are added together in different weights, you must then multiply each number per analysis by the corresponding weight, add the columns together and then divide by the total weight of fertilizer used.

Example: You are using 2 pounds of 21-5-20 and 3 pounds of 15-5-15. Multiply the fertilizer numbers by the weight:

2 x (21-5-20) = 42-10-40
3 x (15-5-15) = 45-15-45

Add the two groups of numbers together: 87-25-85 and divide by the total number of pounds (5) to get a fertilizer analysis of 17.4–5–17.

PROBLEM: Percent injection vs. ratio designation (markings on the injector).
RESOLUTION: Most injectors have either a fixed injector ratio or some means of changing those ratio settings. Many have dual markings in percent and ratio. A 1 percent setting is the same as a 1:100 (read as one to one hundred) ratio. A 2 percent setting is the same as a 1:50 ratio. A 0.5 percent setting is the same as a 1:200 ratio. There may be more possibilities depending on the injector manufacturer.

PROBLEM: Not checking injector settings and function.
RESOLUTION: If you set your injector at a ratio of 1:100, it should take up 6.4 ounces of concentrate for every 5 gallons of fertilized water coming out of the hose. Confirm this by placing the uptake tube in a quart jar full of water. Mark the beginning level of water. Turn on the hose and fill up a 5 gallon bucket. Measure the ounces of water taken up from the quart jar. It should measure about 6.4 fluid ounces.

Do the maintenance tasks recommended by the injector manufacturer. Simply replacing gaskets and O-rings on a regular basis makes a difference in injector efficiency.

PROBLEM: How to check ppm nitrogen using electrical conductivity.
RESOLUTION: Fertilizer manufacturers should provide information on the soluble salts or electrical conductivity readings that correspond to ppm nitrogen levels. Use a good electrical conductivity meter that reads in millimhos per centimeter (mmhos/cm) or deci-Siemens per meter (dS/m). These two units of measurement represent the same number.

Add the electrical conductivity of your raw water to the number expected from your fertilizer to determine your target electrical conductivity.

If you add two fertilizers together, add their corresponding electrical conductivities to the water electrical conductivity and use that number as your target.

Example: Electrical conductivity of 100 ppm nitrogen solution from 21-5-20 is 0.58 mmhos/cm. Electrical conductivity of 100 ppm nitrogen from 15-5-15 is 0.66 mmhos/cm. Raw water electrical conductivity is 0.56. Total electrical conductivity expected is 0.58 + 0.66 + 0.56 = 1.8 mmhos/cm.

PROBLEM: Meters that measure in "funny looking little µ-mhos/cm."
RESOLUTION: These meters measure micromhos per centimeter. That little "µ" symbol stands for "micro." One milli is 1,000 micros. Therefore, the readings on this meter will be 1,000 times larger. The expected reading in the above example would be 1,800 mmhos/cm.

PROBLEM: When should a mineral acid be used with irrigation water?
RESOLUTION: If your water alkalinity is too high and your growing medium pH is climbing out of normal range for your crop.

If you fertilize primarily with nitrates or basic fertilizers and your medium pH is climbing out of normal range for your crop.

Using acids should not be determined based on a single medium sample. You need to know the pH trend over time.

PROBLEM: What about Epsom salts: electrical conductivity and ppm magnesium?
RESOLUTION: Epsom salts are magnesium sulfate and usually contain 10 percent magnesium. One ounce of Epsom salts per 100 gallons of water contributes 7.5 ppm magnesium. Each ounce of Epsom salts per 100 gallons of water contributes 0.056 mmhos/cm to the electrical conductivity.

Example: 30 ppm magnesium needs to be injected on a constant liquid feed basis. Add 4 ounces of Epsom salts per gallon of concentrate at a 1:100 injector ratio and increase the target electrical conductivity by a total of 0.224 mmhos/cm.

PROBLEM: Problems with dissolving fertilizers.
RESOLUTION: Manufacturers usually print the maximum solubility of each fertilizer on the package. Attaining maximum solubility is difficult and most growers do not attempt this. Fertilizers dissolve best in hot water. More fertilizer can be dissolved in warm water compared to cold water. As soon as fertilizer is added to water, it lowers the temperature (an endothermic reaction).

Most fertilizers, if they are completely soluble to begin with, will go into solution within a reasonable period of time. Small batches of stock solution may only take 10 minutes with constant agitation. Large volumes requiring several bags of fertilizer may take hours to completely dissolve depending on water quality, initial temperature and agitation speed.

Make sure you are not mixing incompatible fertilizers and expecting them to go into solution, too.

PROBLEM: Compatibilities.
RESOLUTION: Do not mix concentrates of fertilizers containing calcium e.g., calcium nitrate) with sulfates (e.g., Epsom salts, which is magnesium sulfate). This combination will quickly result in a precipitate in the solution, gypsum (calcium sulfate), and it can be a mess.

Do not make concentrates combining standard phosphate-containing fertilizers with calcium sources. The result will be insoluble calcium phosphate. Exceptions to this rule include fertilizers with urea phosphate or citric acid to create a low-pH stock solution. Check with fertilizer manufacturers for compatibility because citric acid is not always indicated as an ingredient on package labels.

Dealing with results

PROBLEM: Excess alkalinity in water resulting in high growing medium pH.
RESOLUTION: Higher water alkalinity (greater than 180 ppm for a 6-inch pot) can cause the pH of the growing medium to rise to an undesirable level. Periodic media analysis will assist you in tracking medium pH. You may also conduct in-house tests to monitor it more closely. Don't wait for plants to show micronutrient deficiencies due to high pH. Proper fertilizer selection will aid in maintaining desired pH.

PROBLEM: Active vs. Potential Acidity/Basicity.
RESOLUTION: Potential acidity/basicity ratings should be listed for each bag of fertilizer. The rating is a calculated value which indicates the relative potential that a fertilizer has to change the medium pH. The numbers used for these potentials refer to the pounds of limestone (calcium carbonate) that it takes to either neutralize (potential acidity) or be equivalent in reaction to (potential basicity) one ton of that fertilizer. The larger the number, the greater likelihood that the medium pH will be affected.

In theory, if you alternate (or combine) fertilizers having opposite potentials with the same number, you should be able to stabilize your medium pH. In reality, you should carefully monitor medium pH since the medium is a dynamic system and so many other things (fungicide drenches, root exudates, etc.) may affect its pH.

The active acidity or basicity of a fertilizer is how the fertilizer reacts in water. In general, most fertilizers do not significantly change the water pH. Exceptions include fertilizers containing urea phosphate or citric acid.

PROBLEM: Not wetting out the medium with an acidic fertilizer.
RESOLUTION: The growing medium should be first irrigated with an acidic fertilizer to activate additives like lime. Lime is added to raise pH, and both calcium and magnesium are added with dolomitic lime. The levels of calcium, magnesium and pH can change dramatically within the first couple of weeks after proper wet-out.

PROBLEM: Yellow leaves do not always mean iron deficiency.
RESOLUTION: Chlorosis on younger tissue may result from excessive soluble salts, low calcium, high temperatures, medium pH problems, improper chemical application or a general micronutrient deficiency. Applying iron sulfate or an acidic fertilizer to "cure" the chlorosis is not advised unless appropriate water, medium and tissue analyses indicate a need.

PROBLEM: Focusing on pH independently of soluble salts.
RESOLUTION: Fertilizers contribute soluble salts to the growing medium. Poor medium-fertilizer input control results in poor pH management. Low soluble salts levels generally result in high medium pH levels while high soluble salts can produce lower than normal pH levels. Calibrate equipment and frequently conduct on-site monitoring to track medium pH and electrical conductivity or soluble salts. Match fertilizers to water quality and plant needs. Optimum fertilizer use is a key factor in medium pH management.

PROBLEM: Not knowing/monitoring fertilizer effects in the medium.
RESOLUTION: Perform water, fertilizer solution and growing media tests regularly to know if your injector is working properly and if your medium's nutrient and pH levels are optimum. Do not base major changes on one test. Use graphical tracking for your crops to determine the best picture.

Suggested alkalinity guidelines for greenhouse crops*

Container size	Optimum range (ppm calcium carbonate)	Level of concern
Plugs	60-100	< 40, >120
Small pots/shallow flats	80-120	< 40, >140
4- to 5-inch pots/deep flats	100-140	< 40, >160
6-inch or larger pots/ long-term crops	120-180	< 60, >200

* The highest alkalinity level that a grower can manage depends on the plants produced, type of growing medium, potential acidity of the feed program and watering practices. Container size and irrigation frequency impact the effect of alkalinity. Levels listed are guidelines only.

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