DOVE ASSOCIATES
Horticultural Consultants
Weggs Farm
Common Road
Dickleburgh, DISS
Norfolk IP21 4PJ
Tel: 01379 741200
Fax: 01379 741800
Email: info@dovebugs.co.uk
www.dovebugs.co.uk

Information

Acidifying Water Supplies

Most of our water in the south and southeast contain appreciable amounts of calcium giving it its characteristic 'hardness'. The calcium can result in several problems all of which can be alleviated by acidifying your water.

Although pH 7 is considered "neutral" (not acidic or alkaline), 7 is not the optimum pH for irrigation waters or substrate solutions for nutrient availability and growth in container production. This is due to the substrate components typically used in nursery and greenhouse production.

The recommended range of irrigation water pH and substrate solution pH for production depends on the crop being grown. In general, pH should range from 5.2 to 6.8 for irrigation water and 5.4 to 6.3 for substrate solution. If the pH and alkalinity are high, your water may need acid treatment prior to use on crops.

A pH reading is a measurement of the hydrogen ion concentration of a solution (how acidic or basic a solution is), and readings range from 0 (most acidic) to 14 (most basic). Availability of micronutrients such as iron, manganese, zinc, copper, and boron and future plant growth can be reduced severely by high substrate and irrigation water pH (Figure 1). High pH water can cause salts to precipitate out of fertilizer stock tanks. High pH water can also reduce the efficacy of pesticidesas as many pesticides are active longer in low pH solutions than in high pH ones.

This calcium is largely in the form of calcium bicarbonate, which precipitates out as the familiar white deposit of calcium carbonate. The continual use of hard water for irrigation can lead to an accumulation of calcium in composts, unless heavy nitrogenous feeding leaches it out. It is a particular problem with long-season protected crops grown in pots when irrigation eventually leads to an undesirably high pH. Many species of nursery stock are sensitive to lime and the build-up pH in the compost of container-grown nursery stock can be harmful. Mist propagation of nursery stock can cause the development of a white scale on leaf surfaces, reducing photosynthesis.

Blocked nozzles especially mist nozzles and stiffened capillary matting are a result of deposits building up from the use of hard water.

Alkalinity

Alkalinity is a measure of water's capacity to neutralize acids. It is the concentration of soluble alkalis in a solution. Dissolved bicarbonates such as calcium bicarbonate ($Ca(HCO_3)_2$), sodium bicarbonate ($NaHCO_3$), and magnesium bicarbonate ($Mg(HCO_3)_2$); and carbonates such as calcium carbonate ($CaCO_3$) are the major contributors to alkalinity in irrigation water. Dissolved hydroxides are a minor contributor in most cases. Ammonia, borates, organic bases, phosphates, and silicates can also be minor contributors to alkalinity.

Total carbonates

Since bicarbonates and carbonates are the major components of water alkalinity, most laboratories assume that Total Carbonates (TC = carbonates + bicarbonates) equals alkalinity. In most cases, this is a safe assumption. For most waters in the Southeast, bicarbonates account for more than 90% of all alkalinity present.

The term "alkalinity" should not be confused with the term "alkaline," which describes situations where pH levels exceed 7.0. Laboratory test results generally express alkalinity as milligrams per liter (or parts per million) of calcium carbonate (mg/L or ppm $CaCO_3$) or as milliequivalents per liter of calcium carbonate (meq/L $CaCO_3$). You can convert between these two units using the following values: 1.0 meq/L $CaCO_3$ = 50.04 mg/L $CaCO_3$. The term "total carbonates" (TC) may also be used by some testing laboratories to refer to alkalinity of a solution. Some laboratories assume that all alkalinity is derived solely from bicarbonates (HCO_3^-) and will report alkalinity as bicarbonates using ppm (mg/L) or meq/L. To convert between these two units, use the following values: 1 meq/L HCO3- = 61 mg/L HCO_3^-.

Alkalinity establishes the buffering capacity of water and affects how much acid is required to change the pH. The following example may help explain the importance of alkalinity when trying to acidify water): Grower A has water with a pH of 9.3 and an alkalinity of 71 mg/L $CaCO_3$ (TC = 1.42 meq/L). To reduce the pH of this water to 5.8, it takes 121ml of 35% (w : w) sulfuric acid per 1,000 litres of water. In contrast, Grower B has water with a pH of 8.3 and an alkalinity of 310 mg/L $CaCO_3$ (TC = 6.20 meq/L). To reduce this water to a pH of 5.8, it takes 539ml. of 35% sulphuric acid per 1,000 litres of water. Even though Grower B's water is one pH unit lower than Grower A's, it takes more than four times more acid to lower the pH to 5.8 due to the differences in alkalinity. Both alkalinity and pH are must be considered when adjusting the pH of water.

Water Softening

There are various methods used to soften water. The safest and also the most expensive involve the use of ion-exchange resins, which completely remove the calcium and bicarbonate. Household water softening treatments involve the addition of sodium and are unsuitable for use on nurseries. For horticultural use the calcium bicarbonate can be neutralised by the addition of small quantities of concentrated acid to the water supply.

Acidification of Water

By adding the correct amount of acid the pH of water supply can be reduced to 5.8 – 6.0 which is suitable for most purposes.

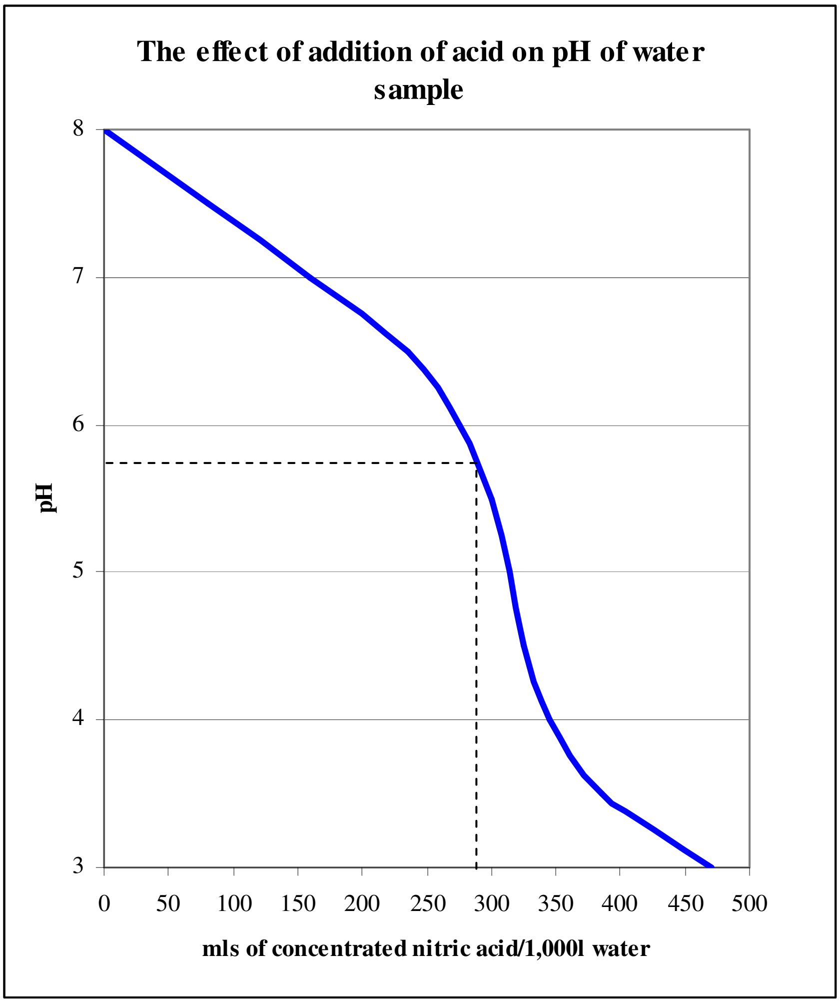
Concentrated nitric acid (60% w/w) is usually preferred as it also provides some nitrogen feed helping to offset the cost of applying the acid. For each 100ml of concentrated nitric acid added to 1,000 litres of water you are supplying 22mg/litre (ppm) of nitrogen.

From a number of hard water samples tested the amount of acid required was found to vary from between 140 and 200ml of concentrated nitric acid per 1,000 litres of water supply. If the water is from a borehole or other source it may be considerably less.

It is essential to assess accurately the amount of acid required for your particular water supply. If a small quantity of acid is added in excess of that required the water supply will become very acid as can be seen from the graph.

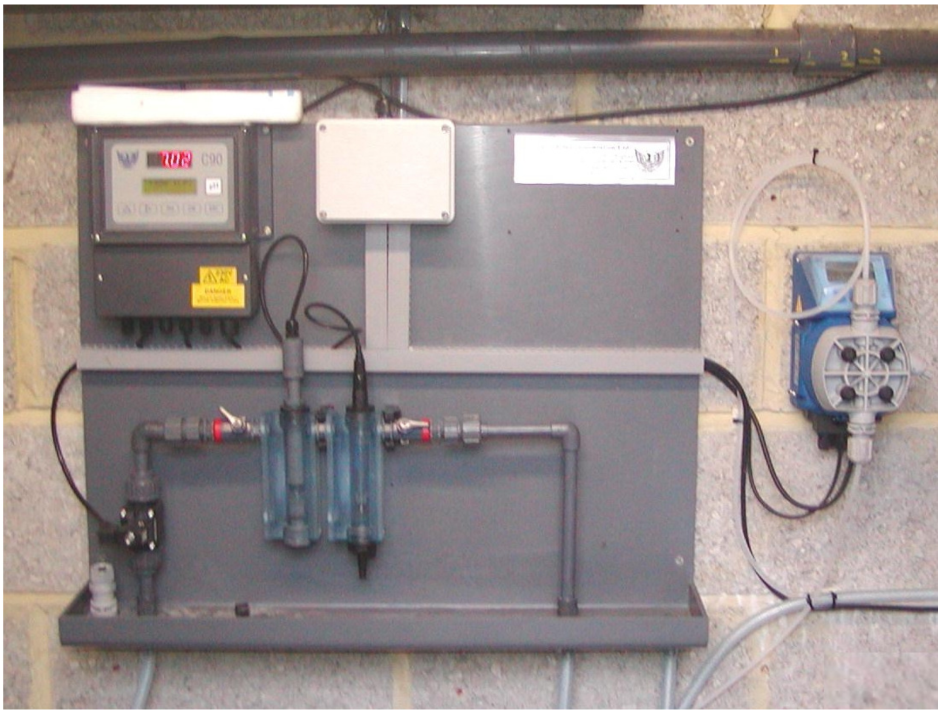
The quantity of acid required is assessed by plotting a graph of the effect of additions of acid on the pH of the water sample.

A typical graph is shown below, from a water sample containing 100mg/l of calcium. Here 275ml of concentrated acid are required to bring the pH to 5.9. This will also provide 60mg/l of nitrogen.



<u>NOTE:</u> This graph is an example only. Your water sample should be assessed individually.

Remember concentrated acids are dangerous chemicals and must be handled with care. Always add acid to water not water to acid. Acidified water is corrosive and may eat away the metallic components of your irrigation system. Ask for a full information sheet on the safe handling of acids.



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Nutrients from acids

With the exception of citric acid, acids used for water acidification also supply a plant nutrient in conjunction with supplying H+. The nutrient supplied can be beneficial to plant growth (if not supplied in excess), but it can also react with fertilizer salts in concentrated stock solutions or with pesticides if mixed into spray solutions.

Growers who acidify their water should adjust their fertilization program for the nutrient supplied by the acid (Table 1). For example, if using phosphoric acid, make sure to reduce your P accordingly to account for the P supplied from the acid. When attempting to acidify waters very high in alkalinity, phosphoric acid may not be feasible. For example, if your water supply contains 6.0 meq/L of alkalinity and you used phosphoric acid to neutralize the alkalinity, over 126 mg/l P (280 mg/l P_2O_5) are supplied at each irrigation. This is an extremely high level of P considering a maximum of 55 mg/l P (125 mg/l P_2O_5) is recommended. Use another acid if more than this amount of P is being injected with phosphoric acid. If using nitric acid, account for the additional N supplied from the acid. Using 67% nitric acid to acidify water containing 6.0 meq/L of alkalinity would supply 67 mg/l N at each irrigation, a significant quantity of nitrogen. Sulphuric acid treatment for 6.0 meq of alkalinity would supply 75 mg/l S, more than sufficient sulphur for plant production (20 to 30 mg/l S is suggested for most ornamental crops).

Acid recommendations

Citric acid is ideal as an acidifier for nutrient stock solutions and pesticide solutions, as it is much less likely to react with fertilizer salts or pesticides than the other three acids. However, the cost of citric acid makes it less desirable as an acidifier for large volumes of water used for irrigation and fertilization.

Literature cited

North Carolina State University Water Conference.