Field Crops Newsletter

Granville and Person County
Mikayla Berryhill

Managing Alkalinity in Tobacco Float Beds with Acidifying Agents

By: Drs. Matthew Vann, Brian Whipker, Kristin Hicks, and Mrs. Maggie James

Successful tobacco seedling production is heavily dependent upon sound production practices. One of the first greenhouse production considerations pertains to water quality and, more specifically, focuses on the management of float water alkalinity. Alkalinity is a measurement of the water's ability to neutralize acid and buffer water pH. It is frequently measured as the total sum of carbonates (CO_3^{2-}), bicarbonates (HCO^{3-}), and hydroxide (OH^-) concentration in solution. Moreover, in North Carolina, alkalinity and water pH are often positively correlated (Figure 1). For example, water solutions with a high pH often test high in alkalinity, as the carbonates and bicarbonates have neutralized a significant amount of hydrogen ions (H^+) which lowers water pH. The opposite can also be true, as low pH water solutions are likely to have low carbonate and bicarbonate concentrations. The relationship between alkalinity and pH in water is indirect because pH may vary significantly with small changes in water temperature and chemistry, while alkalinity remains stable under these conditions. Consequently, alkalinity is the preferred measure of acid-neutralizing ability than pH.

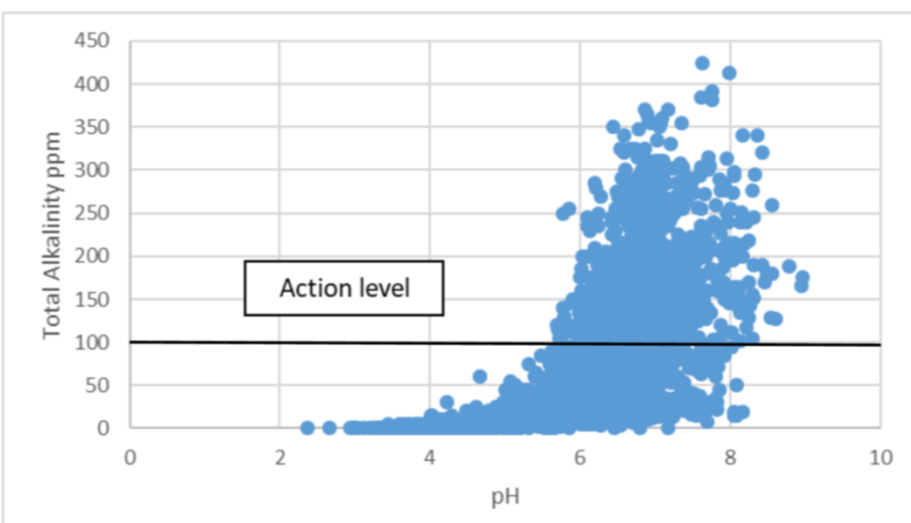

Figure 1. Total alkalinity and corresponding pH of tobacco float bed source water samples submitted to NCDA&CS from 2010-2023. n=2318.

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INSIDE

This newsletter is designed to give you up to date information on crops from NC State University and other sources. For more information:

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Tobacco Greenhouse Reminders (continued…)

**NOTE – THE NCDA&CS SOLUTION LAB WILL BE CLOSED 2/14-2/25 SO IF YOU WILL NEED WATER RESULTS DURING THAT TIME, A PRIVATE LAB SAMPLE MAY BE NECESSARY. CONTACT MIKAYLA BERRYHILL (336-599-1195 or 919-603-1350) FOR MORE INFORMATION. **

Water quality can vary due to location, well depth, season and over time. Each individual well should be tested annually. Quick, reliable, and low cost testing can be done by NCDA&CS. See https://www.ncagr.gov/divisions/agronomic-services/solution-analysis for more information.

For tobacco float bed source water and nutrient solutions, total alkalinity (TA) is reported as the sum of carbonates and bicarbonates and is expressed in parts per million (ppm) of calcium carbonate ($CaCO_3$). Individual measurements of carbonate (CO_3^{2-}) or bicarbonate (HCO_3) are usually reported in milliequivalents per liter (meq/L).

In tobacco float systems, bicarbonates are generally the largest contributor to total alkalinity, and excessive levels of bicarbonate (>100 ppm or 2 meq/L) may have a negative effect on tobacco seedling growth and development (Coggins, 1993). Generally, seedlings produced in water solutions with high bicarbonate concentrations may be stunted, yellow, have a brown colored root system, and exhibit variable growth rates across an entire greenhouse. In addition, high alkalinity increases greenhouse substrate pH which reduces micronutrient availability. Iron availability is the sensitive element to elevated substrate pH, but sometimes boron can also be affected.

Applications of acidifying chemicals are recommended in order to neutralize bicarbonate concentration to ≤100 ppm or ≤2 meq/L. The amount of acid needed will depend on the type and concentration of the acid used. When total alkalinity is >100 ppm, NCDA&CS provides a recommendation for an Acid Requirement (AR) which will neutralize 80% of the alkalinity. The AR assumes the use of 35% sulfuric acid. Where acid other than sulfuric acid is used, the volume of acid to apply must be carefully determined.

Growers must exercise caution when applying acidify chemicals and should not over-acidify float water solutions in order to retain a nominal amount of buffering capacity in the bed. If bicarbonates and/or other sources of alkalinity are completely neutralized, then the pH of the float water solution will read pH 4.4 and substrate pH will decline rapidly.

Historically, applications of sulfuric acid (H_2SO_4, also referred to as battery acid) have been recommended to neutralize float water bicarbonates. Sulfuric acid is highly effective, affordable, readily available, and once applied will supply additional sulfate for seedling uptake and assimilation. For these reasons, sulfuric acid has been the standard chemical used by commercial seedling producers for bicarbonate management. Moreover, alternative options are generally quite limited when the commercial supply of sulfuric acid is limited. Alternatives to sulfuric acid include nitric acid, phosphoric acid, citric acid, acetic acid (vinegar), and thiosulfate. Application rates, nutrient contribution, and specific considerations for these products are included in Table 1. When calculating acid application rates, one must only neutralize bicarbonates in excess of 2 meq/L or total alkalinity in excess of 100 ppm. For example, if the total alkalinity is 325 ppm, only 225 ppm should be included in the acid application rate calculations. Using another example, if the bicarbonate concentration is 3.3 meq/L, only 1.3 meq should be included in the acid application rate calculation. By leaving a reserve of alkalinity in the tobacco float water, it offers buffering capacity, which prevents dropping the pH too low.

An alternative to manually calculating the amount of acid to add is to use AlkCalc, an online tool developed by NC State University for commercial greenhouse growers. https://e-gro.org/alkcalc/dist/index.html

When sulfuric acid is not available, factors to consider when choosing an alternative acid are cost, availability, handling hazard, and corresponding nutrient being injected (e.g. N, P, or S).

- Citric acid ($C_6H_8O_7$) is available in granular and liquid form, is relatively safe to handle, and is compatible with fertilizers. However, it is comparatively expensive, a weak acid (poor acidifying agent), and does not supply additional plant nutrients like nitric, phosphoric, or sulfuric acid.
- Nitric acid (HNO_3) is a very effective acidifying agent (achieves 100% H dissociation) that is compatible with fertilizers and which supplies an appreciable amount of N, but is very caustic and dangerous to handle.
- Phosphoric acid (H_3PO_4) is not as caustic as nitric, is safer to handle, and is compatible with fertilizers, but is not as effective an acidifier as nitric or sulfuric acid. Avoid utilizing high amounts of phosphoric acid, as the extra phosphorus can lead to excessive plant stretch (“leggy” seedlings).
- Acetic acid (CH_3COOH), aka vinegar, is readily available, particularly at food grade concentrations (4-6%) and is much safer than sulfuric, nitric, and phosphoric acid, but is a weak acidifying agent.

Producers are strongly encouraged to consult with their local Extension Agent before treating tobacco float beds with these alternative products in order to fully know the differences in how these products may react once in solution and to ensure the appropriate calculations are used when determining acid application rates.

Caution: Use extreme care when mixing acid and water. The chemical reaction can cause acid to splash into the eyes or onto skin and clothing. ALWAYS ADD THE ACID TO THE WATER, AND NOT THE REVERSE. Add the acid slowly in very small portions and mix thoroughly before adding more. The reaction generates heat. WEAR SAFETY GOGGLES AND PROTECTIVE CLOTHING. Have a large supply of clean water readily available to flush any area of the body contacted by the acid. Remove clothing if necessary. Do not work alone; have an assistant nearby who can summon medical assistance if necessary.

Table 1. Sources of acid that may be used to neutralize tobacco float water alkalinity.

Acid Source (and concentration)	Amount that will neutralize 1 meq of alkalinity	Special comments
Nitric acid (67%)	0.68 fl. oz/100 gallons	Will provide 0.164 ppm N/fl. oz applied/100 gallons of water
Phosphoric acid (75%)	0.73 fl. oz/100 gallons	Will provide 0.288 ppm P/fl. oz applied/100 gallons of water
Sulfuric acid (35%)	1.1 fl. oz/100 gallons	Will provide 0.11 ppm S/fl. oz applied/100 gallons of water
Acetic acid (5%)	66 fl. oz/100 gallons	Similar concentration to food grade vinegar
Acetic acid (30%)	11 fl. oz/100 gallons	More highly concentrated than food grade vinegar
Citric acid (99.5%)	0.91 oz/100 gallons	Can be purchased as a dry or liquid material

Acidic fertilizers can also be used to neutralize small amounts of alkalinity. Listed on a fertilizer bag is a “Potential Acidity” or “Potential Basicity” value, expressed in pounds of calcium carbonate equivalent per ton. Only fertilizers with “Potential Acidity” can neutralize alkalinity in the irrigation system. Table 2. lists the calculated neutralizing potential (removal) of alkalinity in meq of acidic commercial fertilizers at various ppm of nitrogen. As one increases the fertilizer rate, the amount of alkalinity being neutralized increases. Please keep in mind that most acidic fertilizers contain higher amounts of ammoniacal nitrogen which promotes leaf expansion and higher amounts of phosphorus which promotes stem elongation. Therefore, it is recommended that for high concentrations of alkalinity that acid injection is used first to avoid the potential of lush tobacco transplant growth.

Table 2. Calculated neutralizing potential (removal) of alkalinity in meq of acidic commercial fertilizers at various ppm of nitrogen.

Fertilizer[1]	Potential Acidity	% of Total N Provided by NH_4-N[2]	Total % of P_20_5 Provided	Calculated meq alkalinity neutralized by fertilizer at various ppm N[3,4]					
				50	100	150	200	250	300
20-10-20	400	40%	10	0.82	1.64	2.46	3.28	4.10	4.92
16-5-16	285	37%	5	0.78	1.56	2.34	3.12	3.90	4.68

[1] Manufacturers vary in their formulations when blending fertilizers, so values may vary.

[2] Includes both ammoniacal and urea forms of nitrogen.

[3] Based on a mathematical method by C.L. Bethke. 1996. Fertilizer Practices for High Alkaline Water. Georgia Floriculture 6(4):38. Adapted from: Whipker, B. et al. 2001. Plant Root Zone Management, page 12.

[4] Conversion factors: 1 meq of alkalinity = 50 ppm calcium carbonate equivalent or 61 ppm bicarbonate.

Upcoming Events:

Tobacco Associates Export Promotion Referendum

February 26th

- Voting location at the Granville and Person County N.C. Cooperative Extension Centers (304 S. Morgan St., Roxboro, NC AND 125 Oxford Outer Loop, Oxford, NC)
- This vote is for the continuation of the Tobacco Associates Export Promotion Programs for 2025, 2026 and 2027. This will continue an assessment not to exceed 1/5 of one cent per pound.

Are There Any Options for Managing Deer in Soybean Fields? - WEBINAR

February 25th @ 9:00AM

- VIA ZOOM
- Given by Dr. Cory Heaton, an Extension Assistant Professor and State Wildlife Specialist with Clemson University
- You MUST register at: https://ncsu.zoom.us/meeting/register/2ZPNkRcvRUKSeOOGxoW08w

NC SOYBEAN PRODUCERS ASSOCIATION

Impact of EPA's ESA Strategies on NC Farms - WEBINAR

February 26th @ 1:00PM

- VIA ZOOM
- Speakers include Dr. Charlie Cahoon from NC State University and Leah Duzy from Compliance Services International
- Register at: https://go.ncsu.edu/soybeanesawebinar

Organic Commodities & Livestock Conference

March 3rd @ 8:30AM

- NC A&T State University Farm & Pavilion (3020 McConnell Rd., Greensboro, NC)
- Breakfast and lunch will be provided
- Register at:
- carolinafarmstewards.org/organic-commodities-and-livestock-conference

Pesticide Exam Session

March 13th @ 1:00PM In-Person exam session allowing you to become a pesticide applicator OR add a category (i.e. Commodity Fumigation)

- Person County Office Building (304 S. Morgan Street, Roxboro, NC)
- You MUST Register to sit for an exam! Registration is currently still being set up, so please contact me if you are interested at (mikayla_berryhill@ncsu.edu) and I will get the information to you!

ABOUT N.C. COOPERATIVE EXTENSION

North Carolina Cooperative Extension is a strategic partnership of NC State Extension, The Cooperative Extension Program at N.C. A&T State University, USDA-NIFA, and 101 local governments statewide. Extension professionals in all 100 counties and the Eastern Band of Cherokee translate research-based education from our state's land-grant universities, NC State and N.C. A&T, into everyday solutions. Extension specializes in agriculture, youth, communities, food, health and the environment by responding to local needs. In compliance with the Americans with Disabilities Act, N.C. Cooperative Extension or NC State University will honor requests for reasonable accommodations made by individuals with disabilities. Please direct accommodation requests to Mikayla Berryhill, Mikayla_berryhill@ncsu.edu, 919-603-1350 or 336-599-1195. Requests can be served more effectively if notice is provided at least 10 days before the event.