Title: Methods of Soil Acidification in Blueberries

Progress Report

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Final Report

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Objectives: To demonstrate the effectiveness of applying acidifying agents to the soil in blueberry plantings via trickle irrigation versus traditional techniques to the surface of the soil or mulch.

Justification: Growth and fruiting of blueberry is optimal in soils having a pH of 4.8 to 5.2. Although soils in most areas of the Southeast are acidic, their normal pH levels are well above this desired range. Pre-plant pH adjustment and post-plant amendment of pH levels are crucial to the successful establishment and maintenance of blueberry plantings.

Following planting, routine soil testing is suggested to ascertain that soil pH levels remain in the desired range. In the event that the pH is elevated, recommended steps to reestablish the desired soil acidity level includes utilizing an acid-forming nitrogen source such as ammonium sulfate. If additional pH adjustment is needed, ferrous sulfate is suggested to further acidify the soil.

In some soils, maintaining soil pH in the desired range of 4.8 to 5.2 can be very difficult. Soil pH levels can rise very quickly and testing may not be frequent enough to achieve and maintain the desired response. In addition, the use of mulches, which are strongly recommended in many areas, can interfere with amending soil pH.

Since low volume irrigation (trickle) is utilized in most blueberry plantings, the possibility exists that irrigation water could be acidified and delivered to the root zone of the blueberry plant in a much more efficient manner than can be achieved through surface application of materials. Through close monitoring of the soil in the root zone of plants, frequent, minute adjustments could be made to keep the soil pH in the optimum range throughout the growing season.

This proposal involved investigating the use of acid injection via trickle irrigation systems versus traditional surface application of these materials on plant growth and fruiting.

Methodologies: This research was carried out over a three year period in two phases.

Phase one. The first year involved a mature blueberry planting on the Plateau Research and Education Center in Crossville, TN which was the site of a cultivar/mulching trial. The phase one plot was plot A, with Tifblue as the primary rabbiteye cultivar and Bluecrop as the primary highbush cultivar. Sulfuric acid (battery acid, at 33 percent sulfuric acid) was used to adjust the irrigation water to a pH of approximately 5.0 at the emitter. The acid was injected each time the crop was irrigated and the pH was generally checked the following day using a hand-held Oakton pH meter. All treatments received sulfuric acid injected into the irrigation water. Prior to the beginning of the research the plot had already been treated and exhibited a pH near 5.5

Phase Two. Phases two is a result of a continuation of the first year in order to provide greater validity to the research. The second and third years involved plot B, adjacent to plot A, but in which the pH varied from 6.1 to 7.1. It was planted in 2005 and consisted of 10 rows. There were two border rows, and two replications of four rows of three varieties of Southern Highbush per replication. Each row contained six plants of three varieties for a total of 18 plants per row. Each row was on a raised bed covered with black landscape fabric and equipped with irrigation (two .5 l/hr drippers per plant). This plot contained two treatments.

Treatment 1: To the five even numbered rows sulfur was added at a rate of 2 lbs/1000 sq ft for each 0.1 unit of pH above 5.5. The row length was 111 ft and the width was 3 ft. The application rate equated to 10 lbs per row. The elemental sulfur was mixed with warm water at a rate of 10 lbs per 30 gallons of water, which was then dispensed from a water tank until the entire contents was applied to each row. Additional water was applied to wash the sulfur through the permeable ground cloth which covered each row.

Treatment 2: Literature indicated that injection of sulfuric acid to be the preferred option for accomplishing pH reduction through the irrigation system where pH was higher than desired. For the five odd numbered rows the treatment consisted of adding battery acid (33 percent sulfuric acid) to pond water. Approximately 140 ml of battery acid was added to 5 gallons of filtered pond water (pH approximately 6.1). The solution was injected into the irrigation system. Approximately 500 gallons of water was applied to the 5 odd numbered rows over a period that varied from 2 hours to 2 hours and 45 minutes. The target pH at the emitter was 5.0. For the five even numbered rows acid was injected into the irrigation water. The pH was measured for each row from a composite of five core samples taken at random throughout each row immediately after the acid injection was complete. The pH was determined by mixing 10 grams of each sample with 10 ml of pond water and measured with a hand-held Oakton pH meter.

Results: The results will be discussed for each phase.

Phase 1: In plot A the first injection of sulfuric acid into the irrigation water occurred on July 2, 2008. When the pH was tested on July 7 the pH of all except one of ten rows had dropped (figure 1). A heavy rain occurred after the first pH soil test and all rows experienced an increase in pH by the second injection.

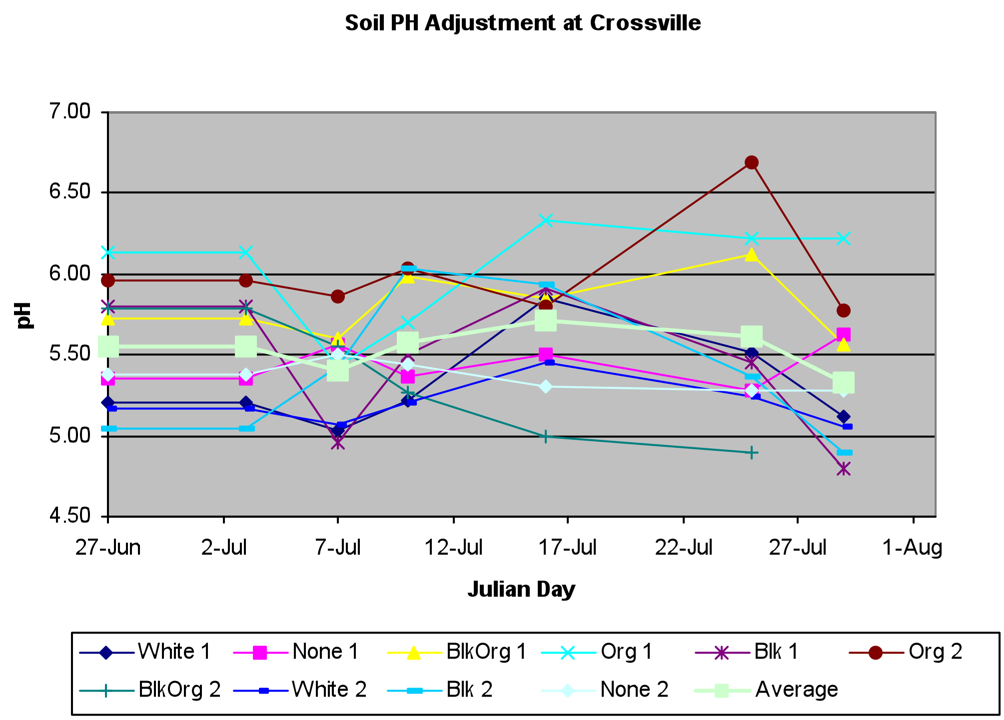


Figure 1. Results of pH adjustments at Crossville Research and Education Center in 2008.

A possible explanation is that the acidified irrigation water was flushed through the soil profile by the heavy rain thus causing the pH to increase. By the third injection on July 16, seven out of ten rows exhibited a downward trend in soil pH. On July 25 the sawdust was replenished on the Organic, and Black Organic treatments, which could explain the jump in pH at that time. After the last injection on July 26 eight out of ten rows exhibited a pH lower than when the test began a month earlier with a downward trend clearly established. If all ten rows are averaged together the ending pH is 0.2 points lower than the beginning pH.

Phase 2:

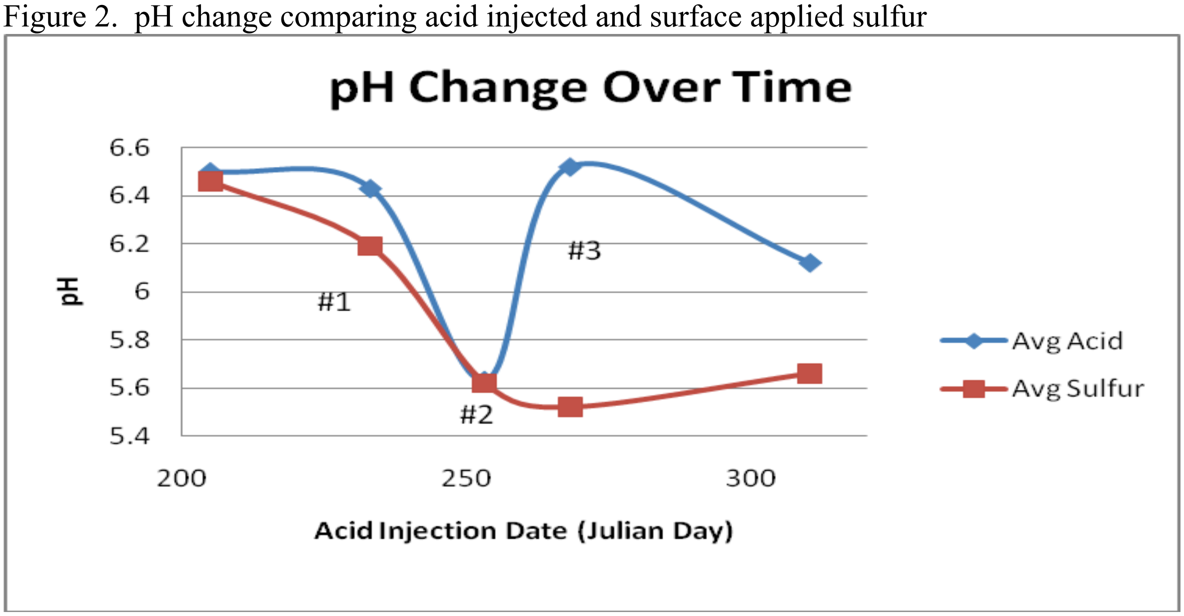
Table 1 lists the average actual pH values for each of the two treatments for the three injection events. The average pH value was obtained by averaging the pH measured for all five rows in each treatment. Included for July 24 are the pH values before any treatments were applied.

Table 1. pH comparison from acid injected and surface applied sulfur.

Injection #	Date of pH Determination	Julian Day	Injected Acid (treatment 1)	Surface AppliedSulfur (Treatment 2)
	Jul 24, 2009 (control)	205	6.5	6.46
1	Aug 21, 2009	233	6.43	6.19
2	Sept 10, 2009	253	5.63	5.62
3	Sept 25, 2009	268	6.52	5.52
No injection	Nov 6, 2009	310	6.12	5.66

Figure 2 graphically depicts the change in pH for the two treatments (acid injected and surface applied elemental sulfur) for four consecutive sample dates during phase 2.

Figure 2. pH change comparing acid injected and surface applied sulfur



For all four dates the pH was checked, the average pH for the surface applied sulfur is equal to or below the average pH for the injected sulfur. After the third injection the average injected pH jumped to an average value of 6.5 while the average measured surface applied pH remained low at a pH of 5.5. However, two days after the injection, 2.74 inches of rain was received. No acid was injected between the third injection and the final pH reading. During this forty one day period the pH for the injected treatment began to decrease toward the lower values of the elemental sulfur. Although 9.17 inches of rain were received the occurrences were more spread out that for the period between the second and third injections. It would be interesting to see how the pH for both treatments changed for an even longer period of time. It seems that the pH resulting from the acid injected sulfur is much more influenced by precipitation, especially if heavy, than the pH resulting from the surface applied sulfur.

In 2010, acid injection was used five times in the Phase 2 planting using the techniques outlined above. Soil samples were checked for pH levels the day following acid application. In all cases, the pH change obtained by acid injection was minor and not always consistent. In all cases, the plots receiving the acid injection exhibited pH levels considerably higher than those in the elemental sulfur plots.

Conclusions

With the variable and frequently heavy rainfall experienced at the Plateau Research and Education Center, acid injection has not proven to be a satisfactory method of attaining and maintaining the desired soil pH for blueberries. The acid application is not stable. Although it was possible to drop the soil pH with acid injection, values would rise quickly with rainfall or irrigation.

Soils at the Plateau Research and Education Center are Lily loam. This soil type is well drained and is sandstone derived. The topsoil is characterized as being slightly acidic. The difficulty experienced in obtaining and holding the soil pH at levels desirable for blueberries would make the acid injection technique undesirable for most growers. The surface application of elemental sulfur provided a greater and longer lasting pH change.

Impact Statement: The ability to precisely set soil pH levels and maintain them should result in superior growth and fruiting with blueberries. Most soils in the Southeast are acidic, but not to the point required for blueberries. The extra expense and the poor, inconsistent results obtained when using acid injection acid injection would be make this method of obtaining and holding soil pH at desirable levels unacceptable to growers. The use of elemental sulfur to establish and maintain soil pH in conjunction with the use of acid-forming fertilizers appears to be a much more reliable, effective strategy.