*Proc. Fla. State Hort. Soc.* 102:344-345. 1989.

# ACIDIFICATION OF AN EVERGLADES HISTOSOL USING SEVERAL FERTILIZER SOURCES

J. M. LOCKHART
*Hundley Farms/W. E. Schlechter and Sons Farm*
*Belle Glade, Florida 33430*

C. A. SANCHEZ
*University of Florida, IFAS*
*Everglades Research and Education Center*
*P.O. Box 8003*
*Belle Glade, Florida 33430*

*Additional index words.* ammonium nitrate, ammonium sulfate, phosphoric acid, urea ammonium nitrate, elemental S, pH.

*Abstract.* **A Histosol with an initial pH of 7.0 was acidified using 5 compounds which are often applied as fertilizer in the Everglades Agricultural Area. Soil acidifying materials compared in this study were ammonium nitrate, ammonium sulfate, urea-ammonium-nitrate solution, phosphoric acid, and elemental S. The N sources and the phosphoric acid treatment achieved their full potential to decrease soil pH by 21 days after treatment (DAT). Elemental S was the least effective treatment both in terms of rate and magnitude of soil acidification. Higher soil pH values for the ammonium sulfate and urea ammonium nitrate solution treatments left on the soil surface for 4 days prior to disking indicated that losses of $NH_4$-N may have occurred before incorporation. Other than a slight stand reduction with ammonium nitrate, the acid sources did not deleteriously affect the growth of radishes (*Raphanus sativus* L.) planted 6 days after treatment. However, there was a significant decrease in the incidence of bulb cracking with a decrease in soil pH.**

Organic soils in the Everglades agricultural area are becoming increasingly alkaline as a result of soil subsidence which is reducing the distance between the soil surface and the underlying limestone bedrock (8). In addition, some fields are fallow flooded with canal water containing significant amounts of basic cations. Elemental S has traditionally been the acid source selected to reduce the soil pH and improve micronutrient availability (4). However, the questionable cost effectiveness of S applications has led to the study of alternative acid sources (3).

At present, a number of compounds which have been shown to release acidity to the soil are applied as fertilizers in the Everglades. Ammonium nitrate, ammonium sulfate, and urea are all used as sources of N while phosphoric acid is applied to several vegetable crops as a source of P. Most are applied to the soil in narrow bands before and after planting. Band applied elemental S is currently recommended for south Florida sugarcane where the soil pH is 6.5 or greater (6). Beverly (2) applied several mixtures containing S to celery, and concluded that banding the materials at reduced rates could prove a cost-effective means of improving plant growth. The efficiency of other acid sources which are applied in bands to Everglades Histosols has not been thoroughly investigated. The objective of this study was to compare the relative effectiveness of commonly used acid-forming compounds with regard to rate and magnitude of soil acidification. In addition, the effect of applying high rates of these acid sources on the growth of radishes was evaluated.

Florida Agricultural Experiment Station Journal Series No. N-00159.

## Materials and Methods

The soil type selected for this experiment was Pahokee muck (euic hyperthermic Lithic Medisaprist) which had been in crop production for over 20 years. No fertilizer was applied based on the results of pre-plant soil tests that indicated the amounts of residual P and K were in excess of the levels required to sustain maximum radish growth (10). All 5 acid sources (Table 1) were applied at 2.24 $Mg \cdot ha^{-1}$ of material on 4 Dec. 1986. Dry materials were broadcast by hand to the soil surface while the urea-ammonium-nitrate solution and phosphoric acid solution were applied using a backpack sprayer. The experiment contained 2 ammonium sulfate and urea-ammonium-nitrate treatments. One treatment for each compound was incorporated immediately by disking the soil (incorporated) while the other was left on the soil surface for 4 days prior to incorporation (surface). All other treatments were incorporated at the time of application.

The experimental design was a randomized complete block with 3 replications. Plots were 9 m x 9 m in size. Soil samples were taken prior to treatment and at 26, 41, 80, and 120 days after treatment (DAT) and analyzed for water soluble P, acetic acid extractable K, and pH (10). Radishes (cv. Red Devil) were planted on 10 Dec. 1986. Three rows by 4.5 m were harvested from the center of each plot on 15 Jan. 1987. The bulbs were weighed, sized, and graded for defects such as cracks. Plant tissue analysis was performed on both the root and shoot portions of the plant. A second crop of radishes was planted on 3 Feb. 1987, and harvested on 3 Mar. 1987. Data were statistically analyzed by SAS (9).

## Results and Discussion

The acid sources reduced the soil pH relative to the untreated control on all sampling dates (Table 2). The N sources were significantly more effective than either elemental sulfur or phosphoric acid with regard to reducing soil pH at 26 and 41 DAT. By 120 DAT, the N compounds were still responsible for the 3 lowest mean soil pH values. Ammonium sulfate lowered pH more than any other treat-

Table 1. Sources used for soil acidification.

| Treatment | Abbreviation | Description |
|---|---|---|
| Urea Ammonium Nitrate | UAN | 32% N solution |
| Ammonium Nitrate | A/N | 34% N dry prill |
| Ammonium Sulfate | A/S | 21% N, 24% S crystal |
| Elemental Sulfur | S | 90% S water dispersible |
| Phosphoric Acid | P-Acid | 23.5% P commercial grade |

Table 2. Soil pH on four sampling dates following acid treatment.

| Treament | Days after treatment (DAT) | | | |
|---|---|---|---|---|
| | 26 | 41 | 80 | 120 |
| Control | 6.93 a[z] | 6.97 a | 6.70 a | 6.87 a |
| Sulfur | 6.63 b | 6.67 b | 6.47 bc | 6.50 b |
| P-Acid | 6.53 b | 6.50 c | 6.57 ab | 6.80 a |
| UAN | 6.17 c | 6.23 d | 6.23 de | 6.47 b |
| A/N | 6.17 c | 6.23 d | 6.33 cde | 6.43 b |
| A/S | 6.00 c | 5.97 e | 6.17 e | 6.30 b |

[z]Means followed by same letter are not significantly different at the 5% level.

ment at all sampling dates. Beverly (1) found that ammonium sulfate was more effective at reducing the pH of an Everglades Histosol than several elemental S sources.

Phosphoric acid was also superior to elemental S on the first 2 sampling dates. Although S was not the most effective acid source, the pH in the S treated plots was significantly lower than the pH in the control plots on all sampling dates. The soil which received S application attained a minimum mean pH of 6.5 on 80 DAT. Apparently, the oxidation of S in this soil did not proceed as rapidly or as completely as the nitrification of $NH_4$-N. It can be assumed that phosphoric acid has an almost immediate effect on soil pH since it immediately releases carbon dioxide when added to a medium containing free carbonate.

Gascho (5) reported a loss of 20% of the total N from urea-ammonium-nitrate solution which was applied to the surface of a sandy soil. Estimates of 36 to 45% loss of N from surface applied ammonium sulfate were obtained for a calcareous sandy soil in Texas (7). Nitrogen fertilizers are not always immediately incorporated when applied to organic soils in south Florida. Nitrogen volatilization would result in a reduced potential for soil acidification. The pH values for surface and incorporated ammonium sulfate were statistically different at 41 DAT. Although this was the only pair of readings where differences were significant, the pH values with the 'incorporated' treatments were always less than the corresponding 'surface' treatments for all sampling dates (Table 3). The data support the likelihood that some of the N from both sources was lost during the 4 days when they were left on the soil surface.

In contrast to previous findings (1), there were no significant increases in radish bulb weight for either of the 2 crops as a result of soil acidification (data not shown). There was, however, a relationship between soil pH and the amount of split bulbs for the first crop (Fig. 1). The degree of bulb cracking, expressed as a percentage by weight, was reduced by the acid treatments. There were

Table 3. Soil pH on four sampling dates for surface versus incorporated treatments.

| Source | Treatment | Days after treatment (DAT) | | | |
|---|---|---|---|---|---|
| | | 26 | 41 | 80 | 120 |
| UAN | Surface | 6.20 a[z] | 6.33 a | 6.40 a | 6.57 a |
| | Incorporated | 6.17 a | 6.23 a | 6.23 a | 6.47 ab |
| A/S | Surface | 6.17 a | 6.23 a | 6.37 ab | 6.50 ab |
| | Incorporated | 6.00 a | 5.97 b | 6.17 b | 6.30 b |

[z]Treatments within a column followed by the same letter are not significantly different at P = 0.05.

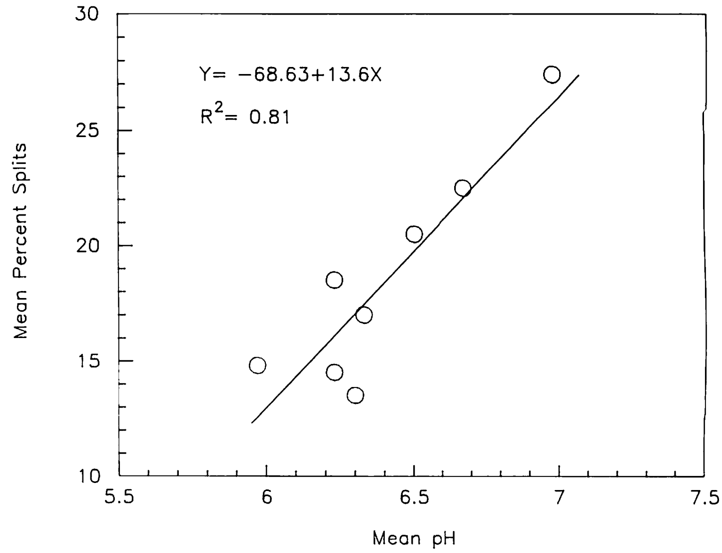


Fig. 1. Relationship between soil pH and bulb cracking of radishes produced on a high pH Histosol.

no significant differences in split bulbs which were much less severe in the second crop. Since grading costs are greatly increased when bulb cracking occurs, a cultural practice which could decrease the incidence of splits would be an important discovery for the Florida radish industry. Unfortunately, bulb cracking is related to a number of plant stresses and it is doubtful that pH adjustment will completely solve the problem.

In conclusion, all of the fertilizer sources evaluated caused greater soil pH reduction than elemental S. Similar behavior can be expected when these compounds are applied in concentrated fertilizer bands as commonly practiced for vegetables produced in the Everglades agricultural area. The acidifying properties of fertilizers should be considered when developing effective fertilizer and pH management programs for vegetables produced on high pH Histosols in Florida.

## Literature Cited

1. Beverly, R. B. 1986. Radish responses to foliar nutrient sprays and pH adjustment of an organic soil. J. Fert. Issues 3:75-79.
2. Beverly, R. B. 1987. Celery responses to foliar nutritional sprays and acidification of a Histosol. HortScience 22:1271-1273.
3. Beverly, R. B. and D. L. Anderson. 1987. Effects of acid source on soil pH. Soil Sci. 143:301-303.
4. Forsee, W. T. 1949. The effect of soil pH upon the growth of celery seedlings on the peat and muck soils of the Everglades. Proc. Fla. State Hort. Soc. 62:143-146.
5. Gascho, G. J. 1986. Improving the fertilizer efficiency of urea ammonium nitrate solutions by adding other nutrients. J. Fert. Issues 3:62-65.
6. Gascho, G. J. and G. Kidder. 1979. Responses to phosphorus and potassium and fertilizer recommendations for sugarcane in south Florida. Univ. Fla. Agr. Exp. Sta. Bull. 809.
7. Hargrove, W. L., D. E. Kissel, and L. B. Fenn. 1977. Field measurements of ammonia volatilization from surface applications of ammonium salts to a calcareous soil. Agron. J. 69:473-476.
8. Lucas, R. E. 1982. Organic soils (Histosols) formation, distribution, physical and chemical properties and management for crop production. Mich. Agr. Expt. Sta. Res. Rpt. 435.
9. SAS Institute, Inc. 1982. SAS User's guide:Statistics. SAS Institute. Inc. Cary, N.C.
10. Sanchez, C. A. 1989. Soil testing and fertilizer recommendations for crop production on organic soils in Florida. Univ. of Fla. Tech. Bull. 876.