DEMONSTRATION OF PHOSPHORUS FERTILIZER MANAGEMENT FOR POTATO GROWN IN A CALCAREOUS SOIL

YUNCONG LI AND STEVE O’HAIR
University of Florida, IFAS
Tropical Research and Education Center
Homestead, FL 33031

RAO MYLAVARAPU
University of Florida, IFAS
Department of Soil and Water Science
Gainesville, FL 32611

TERESA OLCZYK AND MARY LAMBERTS
University of Florida, IFAS
Miami-Dade County Cooperative Extension Services
Homestead, FL 33030

Abstract. Recent studies have shown no yield responses of potato to phosphorus fertilizer application in the Miami-Dade County area. The objective of this trial was to evaluate the effects of reduced phosphorus fertilizer rates on potato yield and quality. The trial was conducted in a commercial potato field with a Biscayne marl soil with 3 rates of P fertilizer (0, 50 and 100% of grower rates). Phosphorus fertilizer application neither significantly increased AB-DTPA extractable P in the soil, nor affected the concentration of leaf P, yield and quality of potato.

Potato (Solanum tuberosum) is a major cash vegetable crop grown in Miami-Dade County on about 4,600 acres and with sales of about $23.8 million in 1996 (Degner et al., 1996). Potato is grown on calcareous marl soils which are characterized by an alkaline pH 7.4-8.4, low water holding capacity and rapid permeability. In addition, marl soils have shallow depths (normally less than 20 inches) and the water tables are within 10 inches of the surface for several months each year. These marl soils have very low holding capacities for nitrogen (N) and other water soluble nutrients. Frequent applications of fertilizer are necessary to ensure high yields. Balanced fertilizers [Sol-U-Gro (12-48-8) and Nutri-leaf (20-20-20)] and other water soluble nutrients. Frequent applications of fertilizer are necessary to ensure high yields. Balanced fertilizers [Sol-U-Gro (12-48-8) and Nutri-leaf (20-20-20)] are commonly used in this area. Recent studies showed no or little response of potato yield and quality to phosphorus fertilizer application in this area (Lamberts et al., 1997).

The objective of this study was to demonstrate and evaluate the effects of reduced phosphorus fertilizer rates on potato yield and quality in south Florida.

Materials and Methods

A commercial potato field on a typical Biscayne marl soil (Loamy, carbonatic, hyperthermic, shallow Typic Fluvaquents) was chosen for this experiment. Dry fertilizer was applied at planting with three rates of P (0, 50 or 100% of the grower rate), equivalent to 0, 108, 216 lb P2O5/ac of 6N-12P2O5, 10K2O, 6N-6P2O5-10K2O, or 6N-0P2O5-10K2O fertilizers. The experiment consisted of 3 replications. Each plot was about 1 acre. ‘LaRouge’ potato tuber pieces were planted 6 inches apart and 38 inches between rows on November 9, 1999. Foliar fertilizers [Sol-U-Gro (12-48-8) and Nutri-leaf (20-20-20)] were applied on all plots during the season which amounted to about 20 lb P2O5/ac.

Soil samples were taken one day prior to fertilizer application (November 8, 1999) and on January 6, 2000 about 2 months after fertilizer application. Soil samples were air dried, ground and sieved with a 2-mm sieve. Ten grams of each soil sample was extracted with 20 ml of AB-DTPA solution. The extracted solution was analyzed using an inductively coupled plasma emission spectroscopy instrument (ICPES). (Hanlon et al., 1996). Soil samples were also extracted with 2 M KCl for NH4-N and NO3-N analyses. A composite sample collected prior to planting was analyzed for pH, organic and inorganic carbon, and particle distribution (sand, silt and clay) based on methods described by Zhou et al. (2000). The percent of sand, silt and clay in the soil were determined only on particle size, but not on mineralogy.

Leaf samples were collected on January 6, 2000. Leaves samples were washed sequentially with tap water, 1% detergent, and 1% HCl and deionized water. Samples were dried at 70°C for 48 hours, ground using a Wiley mill, and dry-ashed in a muffle furnace at 550°C for 6 hr for leaf and 8 hr for root samples, respectively. The ash was cooled and dissolved in diluted HCl. Concentrations of nutrients were measured with ICPES.

Plant biomass (fresh and dry weight) was also measured from 10 ft of each plot on January 6, 2000. Potatoes were harvested from 60 feet in each plot on March 7, 2000. Total weight and size of tubers from each plot were recorded. The grower also harvested, graded and weighed tubers from the experimental site on March 16, 2000.

Table 1. Soil properties of the experimental site

<table>
<thead>
<tr>
<th>pH</th>
<th>Organic carbon</th>
<th>Inorganic Carbon</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2</td>
<td>2.0</td>
<td>88.9</td>
<td>3.5</td>
<td>84.9</td>
<td>11.6</td>
</tr>
</tbody>
</table>

This project was supported in part by a grant from the Center of Natural Resources, University of Florida. We thank Dale Williams and Dwayne Williams, Williams Farm for their support.
Data were analyzed by analysis of variance and means were compared using Duncan’s Multiple Range Test, 5% level.

Results and Discussion

Approximately 89% of the soil in the experimental site is inorganic carbon, dominantly calcium carbonate (Table 1). Soil organic carbon is only 2%, and is lower than in typical marl soils in this region (Noble et al., 1996). The land had been farmed for more than 40 years and long-term farming may contribute to decomposition of soil organics. Increasing soil organic carbon using cover crops or organic soil amendments such as compost will help to improve soil fertility (Li et al., 1999; 2000).

Soil pH and electrical conductivity were not significantly affected by fertilizer treatments (Table 2). All treatments received the same amounts of N, K, Mg and micronutrient fertilizers. As expected, there were no differences between these nutrients in soils from three fertilizer treatments. Relative low values of EC and readily water soluble nutrients such as nitrate and K indicated loss of nutrients during 2 months after fertilizer application through rainfall, irrigation or high ground water fluctuation. Ground water table in the field was about 1-2 ft below the soil surface during potato growing season.

Concentrations AB-DTPA extractable P ranged from 56.8 to 57.7 mg/kg for soils from no P fertilizer treatment and 100% grower fertilizer treatment, respectively (Table 2). The soil P concentration for potato crop production proposed as sufficient by IFAS/University of Florida is 10 mg P/kg for calcareous soils in Florida. AB-DTPA extractable P was increased only slightly as P fertilizer application rates increased, but there was no statistically significant difference among treatments at 0.05 probability level. Soil testing also indicated large variation among replications because large plots (about 1 acre per plot) were used and plots were not completely randomized within the field.

Concentrations of leaf nutrients were not significantly different among treatments (Table 3). All nutrients were in the sufficient range for potato. Phosphorous fertilizer rates did not affect P concentrations of leaves. Plant fresh and dry weights two months after planting were also not affected by fertilizer treatments (Table 4).

The tubers were harvested within 60 feet from each plot. Phosphorus fertilizer application neither significantly increased tuber yield, nor improved fruit quality (Table 5). Nine days after we had harvested each subplot from each treatment, the grower harvested the remaining tubers from each treatment in the experimental site and recorded the yield (Table 6). The highest yield came from 100% grower fertilizer rate. Also potato sales were calculated based on the market price, and these calculations indicated the grower might gain $14 or lose $32 by applying P fertilizer. No statistical analysis was performed on the grower’s data because he did not separate yield by replications.

In conclusion, the application of P fertilizer to a calcareous soil with relatively high levels of AB-DTPA extractable P did not appear to increase the level of available P and to affect leaf P level, fruit yield or quality. The preliminary results from this demonstration trial indicate that it is possible to reduce...
the P fertilizer application rate for potato grown on calcareous soils with high AB-DTPA extractable P without substantial reductions in tuber yield and quality. However an assessment of contribution of soil P by estimating the release from soil on a yearly basis should be made.

### Table 6. Yield and quality of potato harvested by the grower in 1999-2000 season. The grower harvested potato by treatment without separating replicates. The harvest by the grower occurred 9 days after the harvest in the authors' experiment.

<table>
<thead>
<tr>
<th>P Fertilizer as % of grower rate</th>
<th>Yield</th>
<th>0</th>
<th>50</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 A</td>
<td>190</td>
<td>225</td>
<td>214</td>
<td></td>
</tr>
<tr>
<td>#1 B</td>
<td>119</td>
<td>83</td>
<td>109</td>
<td></td>
</tr>
<tr>
<td>Creamers</td>
<td>19</td>
<td>22</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>#2 A</td>
<td>114</td>
<td>114</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>#2 B</td>
<td>30</td>
<td>42</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total marketable (mkt.)</td>
<td>487</td>
<td>496</td>
<td>505</td>
<td></td>
</tr>
<tr>
<td>Sales ($)</td>
<td>3,770</td>
<td>3,738</td>
<td>3,784</td>
<td></td>
</tr>
</tbody>
</table>

1 bag = 50 lb.

\[ \text{Sale prices calculated based on 1 bag #1A = $7.91, 1 bag #2A = $11.14, 1 bag Creamers = $20.08, 1 bag #2A = $2.72, and 1 bag #2B = $6.64.} \]

USEFULNESS OF TENSIOMETERS FOR SCHEDULING IRRIGATION FOR TOMATOES GROWN ON ROCKY, CALCAREOUS SOILS IN SOUTHERN FLORIDA

**TERESA OLCZYK AND RUBEN REGALADO**
University of Florida, IFAS
Miami-Dade County Extension Service
18710 SW 288 Street
Homestead, FL 33030

**YUNCONG LI**
University of Florida, IFAS
Tropical Research and Education Center
18905 SW 280 Street
Homestead, FL 33031

**RALPH JORDAN**
Circle M Farms, Inc.
14540 SW 136 Street
Miami, FL 33186

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**Abstract.** In southern Florida, irrigation is a critical factor for winter vegetables grown on calcareous soils, characterized by very low nutrient and water holding capacity. Traditional approaches to irrigation are based on stage of the growth or on visual estimation of soil moisture. This often leads to under- or over-irrigation of the crop. Under-irrigation may reduce yield and quality, while over-irrigation may lead to the leaching of the nutrients from the root zone, contributing to ground water pollution. A demonstration with using tensiometers to schedule irrigation was conducted in a commercial field in Homestead area. The objective was to demonstrate the usefulness of tensiometers in such applications. The frequency of irrigation events and amount of applied water based on tensiometer readings were compared with the grower's irrigation schedule. Data collected included total number, weight and quality of fruit. The results showed that reduction of irrigation water did not decrease total and marketable yield and tensiometers with proper calibration; installation and maintenance can be successfully used for scheduling irrigation.

Miami-Dade County is a major producer of winter vegetables in the U.S. Production of tomato (*Lycopersicon esculentum*) plays an important role in economy of the county. Tomatoes are grown on about 3,300 acres, about 1,800 acres less than in 1991-92 season. (Florida Agricultural Statistics, Veg. Summary 1996-97). This acreage reduction is the result of many

**Literature Cited**


