

assistance with plot installation; Mr. S. R. Brinton for sample collection and preparation; Mr. A.L. Wilkerson for assistance with plot upkeep; the UF/IFAS Extension Soil Testing and Analytical Research laboratories for analyses; and Mr. W. G. Pothier for C:N ratio analyses.

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Proc. Fla. State Hort. Soc. 109:156-159. 1996.

REDUCING NUTRIENT APPLICATIONS FOR VEGETABLE PRODUCTION IN THE LAKE APOPKA BASIN

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Additional index words. Fertilizer, Histosols, phosphorus, water quality.

Abstract. The Lake Apopka Hydrologic Unit Area Project was initiated in 1991 to encourage the adoption of water and nutrient management practices that reduce P loading into Lake Apopka. Strategies used to implement practice changes included soil and tissue testing services, field trials, educational seminars, newsletters and other publications, and frequent consul-

tations with growers. An annual survey was conducted to document fertilizer application rates on approximately 12,000 acres of muck (Histosols) and bordering sand soils (Entisols) used for vegetable production. P application rates have been reduced by nearly 50% for a net reduction averaging 370,700 lb per year. Net K applications were concurrently reduced by 1 million lb per year. In addition to reducing the potential risks of excessive nutrients in the environment, fertilizer costs were reduced with no loss in crop yields or quality.

Lake Apopka is the fourth largest lake in Florida and is the headwater for the Oklawaha Chain-of-Lakes that empty into the St. Johns River (Conrow et al., 1993). It is located at latitude 28°37'N and longitude 81°38'W. The drainage basin includes 119,773 acres, 34,084 acres of which is covered by surface water. Approximately 53,437 acres are used for agriculture, of which 20,000 acres are Histosols presently or formerly farmed for vegetable and sod production. Citrus groves, nurseries, timber, and pasture occupy the remainder of the agricultural land. The remaining acres are comprised of wetlands, forestland, rangeland, barren land, and urban development.

Lake Apopka was identified by the Florida legislature in the Surface Water Improvement and Management Act of 1987 as a priority water body in need of restoration and preservation. Controlling agricultural discharges was a key component of the restoration plan (Conrow et al., 1993). It was estimated that 20 billion gal of water were discharged annually from farming operations. The quality of discharge water was poor due to high concentrations of nutrients. P was the nutrient of primary concern. P loading of the discharge water is a function of many factors, some of which can be controlled

Florida Agricultural Experiment Station Journal Series No. N-01333. This work was supported by the Extension Service, U.S. Department of Agriculture, under special project number 91-EHUA-1-0046.

by the growers using this productive land (Anderson et al., 1994).

The Lake Apopka Hydrologic Unit Area (LAHUA) Project was initiated in 1991 as a cooperative project between the Florida Cooperative Extension Service, Natural Resources Conservation Service (NRCS) and USDA Consolidated Farm Services Agency. The objectives were to improve nutrient and water management practices for vegetable production within the Lake Apopka drainage basin, resulting in reduced nutrient loading. Recommended practices including water table control, land leveling, calibrated soil testing, installation of water control structures, and others were encouraged through educational and technical assistance to growers. Similar best management practices for Histosols in the Everglades Agricultural Area have been published by Bottcher et al. (1993), Anderson and Howell (1993), and Anderson and Flaig (1995).

Materials and Methods

Baseline data for the 1990-91 season were collected by an interview survey with each of the ten vegetable farms within the drainage basin. The initial survey addressed management decisions and attitudes, as well as specific water- and nutrient-management practices. Fertilizer application data for the five leading muck crops and the top five sand crops were collected. In 1993, 94, 95, and 96, specific fertilizer application data were collected from the same farms for the previous year.

A number of educational strategies were implemented encouraging growers to adopt recommended changes in nutrient and water management. These methods included personal consultations, group meetings, newsletters, and other publications. Each grower received a specially-prepared 3-ring notebook containing the most current University of Florida Institute of Food and Agricultural Sciences (UF-IFAS) and NRCS publications pertaining to crop production, fertilizer use, water control, and pest management.

In an effort to promote the use of calibrated soil testing, Extension personnel provided free soil testing with a one-week turnaround time for farms in the LAHUA. Samples were analyzed for P, K, Mg, Ca, Zn, Mn, Cu, and pH in this program. The analyses were conducted and recommendations made by the UF-IFAS Extension Soil Testing Laboratory (ESTL) using the Mehlich 1 extraction technique (Hanlon et al., 1990).

During 1991-95, ten replicated field trials were conducted to improve our database on crop nutrient requirements for the major vegetable crops and soils in the LAHUA. A summary of five of these trials was previously published (Crnko et al., 1993). In none of the replicated field trials was there a response to P fertilization, even in the one field in which initial soil-test levels were very low. P in the irrigation water was apparently sufficient to meet the crop nutrient requirement. These trials also served as demonstrations for the landowner to observe his normal P rate against a rate based on soil test recommendations (usually zero).

Tissue testing was made available to growers on a rapid turnaround basis. Sap testing for N and K was introduced to growers as a potential method for gathering information on crop nutrient concentration, however, these tests had not been calibrated for use on the majority of crops in the drainage basin (Hochmuth et al., 1991).

NRCS prepared conservation plans on 12,750 acres within the drainage basin. The plans included management practices such as land leveling, water table control, irrigation water management, and nutrient and pesticide management.

Results and Discussion

In 1990-91, only 20% of the growers were considering UF-IFAS recommendations when deciding how much fertilizer to apply, whereas 60% used advice from the fertilizer dealer. Forty percent fertilized a particular crop the same way year after year. At the present time, 90 to 100% of the farms are considering UF-IFAS recommendations, along with other factors, when making fertilizer decisions.

ESTL has analyzed more than 1,700 soil samples for this project since 1991, 87% of which were organic or organic-mineral soils and 13% of which were mineral soils. Eighty-nine percent of the soil samples tested high or very high in P (Fig. 1) and thus no P fertilizer was recommended for crop production (Hanlon et al., 1990). Average P use, however, was 23.5 lb/acre at the beginning of the project.

The average P application rate was reduced by 50% to 12 lb/acre for 1993-96. The net amount of P applied for vegetable production within the drainage basin was reduced by an average of 370,700 lbs per year, a 62% reduction for the 1995-96 growing season (Fig. 2a). This percentage is a reflection of both reduced P rates per acre and a reduction in crop acreage produced (Fig. 3).

The average amount of P applied to each of the major muck crops in the 1990-91 growing season compared with 1992-96 is shown in Figs. 4 and 5. P fertilization rates were reduced by an average of 60% for carrot and 50% for sweet corn, crops which account for well over half of the crop acreage each year (Fig. 3). The 95-96 average application rates of 17 lb/acre P for sweet corn and 10 lb/acre P for carrot still exceed the UF-IFAS recommendation of zero P for soils testing high or very high. However, they are less than the recommended rates of 35 lb/acre P for sweet corn or 44 lb/acre P for carrot grown on soils with medium P levels as determined by the Mehlich 1 procedure (Hanlon et al., 1991; Hochmuth

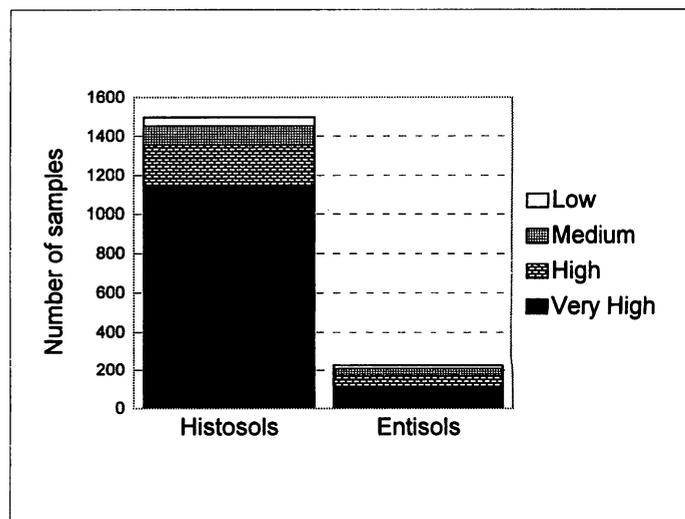


Figure 1. Distribution of soil samples testing low, medium, high, and very high by the Mehlich 1 extraction method.

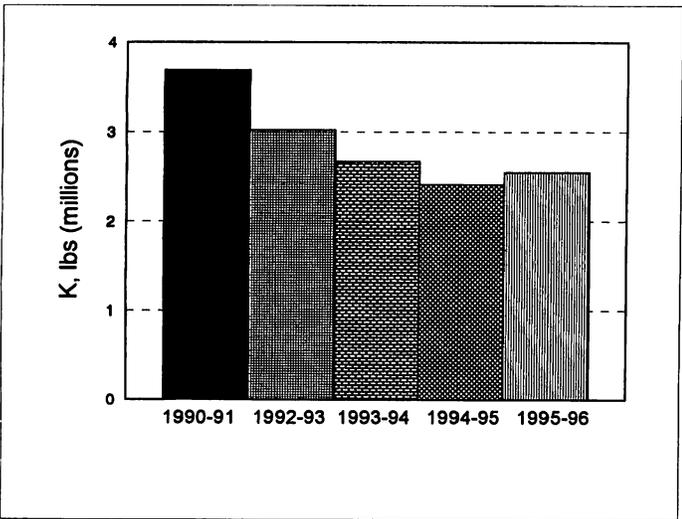
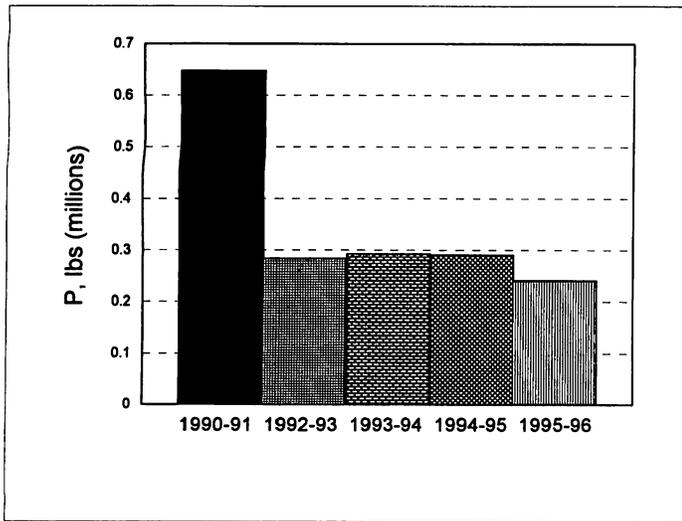


Figure 2. Net annual application of P (Figure 2a) and K (Figure 2b) for vegetable production in the Lake Apopka basin 1990-91 and 1992-96.

et al., 1996). Only 9% of the soil samples analyzed for sweet corn or carrot fell into the medium or low range.

Other crops such as celery and leaf crops, with only two to three farms producing these crops, had less consistent results and more variability among farms. Celery P application rates dropped 20% in the final year; however, P rates on leaf crops (endive, escarole, romaine, leaf lettuce) were higher in 1994-96 than in the baseline year. This is not a point of major concern, however, since baseline rates for leaf crops were already low, relative to corn, carrot, and celery. The average P rate of 25 lb/acre for celery or 14 lb/acre for leaf crops are well below the IFAS recommendation for medium P level soils using the Mehlich I test (Hanlon et al., 1991). The P rate for leaf crops would be consistent with fertilizer levels based on relatively high levels of water extractable P (Hochmuth et al., 1996).

Radish, a very short-term crop, is typically not fertilized, relying upon residual fertilizer from previous corn or carrot crops, unless successive radish crops are being grown. Two growers who did fertilize radishes on a regular basis changed to fertilization based on UF-IFAS soil-test recommendations, hence the reduction in average rates for 1992-93 shown in

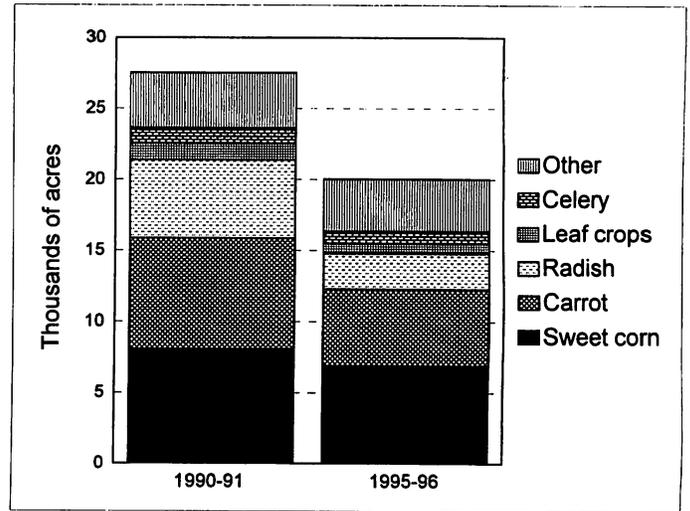


Figure 3. Acreage of vegetable crops produced in the Lake Apopka basin, 1990-91 and 1995-96 growing seasons. "Other" includes miscellaneous muck crops and all crops grown in the Lake Apopka basin on sand soils, i.e., cucumber, potatoes, squash, cabbage and cauliflower.

Fig. 5. The small increases for 1994-96 reflect soil test recommendations which called for P application following years of reduced crop fertility.

To avoid disclosure of confidential information, the fertilizer use data on crops grown only on two farms with sandy soils are not presented individually but are included in the totals for the drainage basin (Figs. 2a and 2b). Crops grown on sand accounted for only 12 to 18% of the annual crop acreage (Fig. 3).

Although not considered a factor in water quality issues, K rates in the baseline data were observed to be far in excess of maximum IFAS recommendations for sweet corn, celery, cucumber, cabbage, and cauliflower. Educational efforts addressed fertilizer management as a whole, realizing that resource conservation and potential cost savings could result from more appropriate management of K and other nutrients. Potassium applications have been reduced by an average of 21 lb/acre (data not shown) but are still higher than UF-

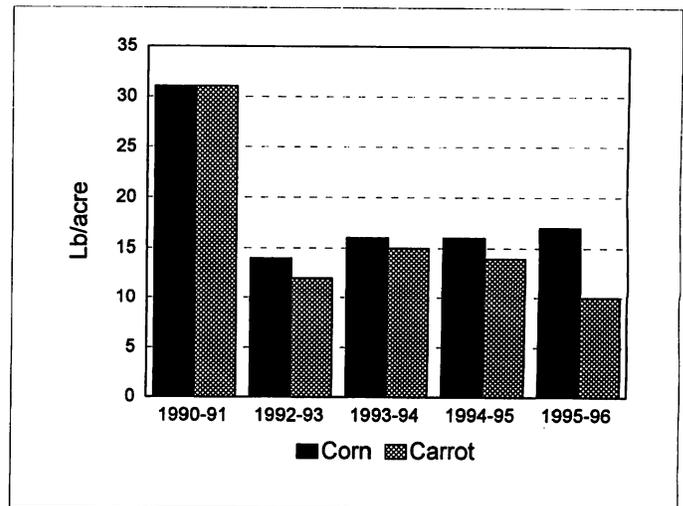


Figure 4. Average application rate of P (lb/acre) for sweet corn and carrot production.

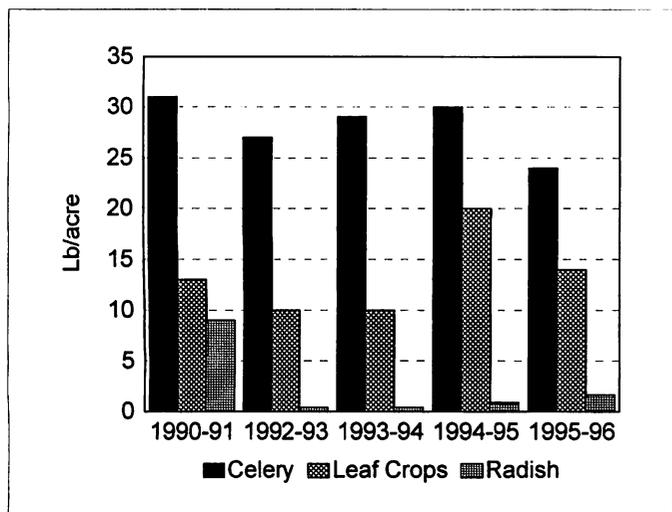


Figure 5. Average application rate of P (lb/acre) for celery, leaf crops, and radish production.

IFAS recommendations. Potassium was reduced in only two years out of four for sand crops; however, this was balanced by a consistent reduction averaging 22% on muck crops. Net reduction in the Lake Apopka basin totaled over 1 million lb of K per year, or 31% for 1995-96 compared to the baseline (Fig. 2b).

In addition to nutrient management, 164 water control structures and 14 internal pumps were installed, thousands of acres were laser-leveled, and improvements made in irrigation and drainage water management. One large farm constructed a tailwater recovery pond in 1992, allowing recycling and reuse of the water. Overall, the amount of farm water discharged annually to Lake Apopka has been reduced by 60% compared to historical averages, based on data from the farms and the St. Johns River Water Management District. The Zellwood Drainage Control District also installed an alum injection system that ties up and inactivates more than 76 percent of the available phosphorus in the water being dis-

charged to the lake (G. Van Duyne, Zellwood Drainage District, personal communication). P discharges into the lake from vegetable farms have declined from 13 lb/acre per year in 1991 to an average of 5 lb/acre per year in 1995, a 63% reduction. The St. Johns River Water Management District, however, mandated that P discharges be less than 0.8 lb/acre per year, and will require the farms to construct large storm-water retention facilities in order to continue operations. Currently, negotiations are underway to purchase the muck farms in order to stop farmwater discharge completely (State of Florida, 1996).

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