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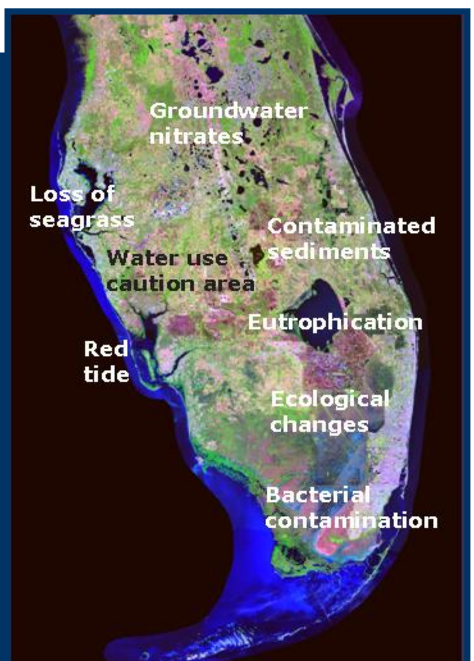
NUTRIENT MANAGEMENT EDUCATION CORE GROUP



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UNIVERSITY OF FLORIDA
IFAS EXTENSION

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Nutrient Management Education Core Group Background

Federal, state and regional agencies are working towards formulating regulations for agricultural operations to reduce nonpoint nutrient source pollution for water quality protection. Several of our IFAS faculty are currently involved with these agencies for developing Interim BMPs for various commodities. In all cases these efforts are interdisciplinary requiring frequent interaction among the UF/IFAS faculty statewide. Several of us feel the need for a stronger coordination among IFAS faculty in responding to these needs. The creation and successful functioning of the proposed Nutrient Management Core Group will enhance the credibility of UF/IFAS faculty and educational resources and create a nodal point for liaison with all the agencies and public that are interested in the issue. Several land grant institutions have formed similar core groups or self-directed teams and have developed educational material. We will interact with these institutions to benefit from their expertise and experience.

In February of 2001, this group coordinated the FDEP319 Prioritization meeting in Gainesville. This meeting was attended by state agencies and water management districts, growers, many commodity organizations and IFAS faculty and administration. All comments from this meeting were compiled in an electronic newsletter and distributed to all participants throughout the state.

Best Management Practices for the Green Industries – Research and Outreach

L.E. Trenholm, Environmental Horticulture

Outreach

The Green Industries Best Management Practices (BMP) manual was developed in 2002. This work was developed collaboratively by UF-IFAS, the Florida Department of Environmental Protection (DEP), Water Management Districts, and representatives from many facets of the lawn care and fertilizer industry. The primary goal of the manual is to provide the commercial lawn and landscape industry with guidelines to reduce non-point source pollution. Preservation of both water quality and quantity are the main objectives.

The outreach program to teach the industry how to use the manual is entering into its third year. To get the educational message of the manual out to all segments of the industry, the BMP Educational Program was developed. In 2003, over 1,000 workers were trained in training sessions held throughout the state. In 2004, we have trained just over 1200. Training materials include copies of the manual, a summary guide, and CDs with PowerPoint presentations and other references. Survey and quiz responses to these sessions include:

- 97% of respondents felt that the program met their expectations
- 99% knew more about the topics than they previously did
- 98% felt that the training materials would be used in training programs
- Average post-test scores increased 15% over pre-test scores

A number of training sessions are scheduled for 2005 throughout the state. To look at the schedule or to register for a session, go to http://turf.ufl.edu. There is a link to the BMP Education Program on the home page.

Lysimeter to be used for DEP turfgrass nutrient leaching research. Lysimeters are buried to a depth of 3'. Sampling will be conducted twice a week.

New Research

At this time, there are no plans to make these BMPs rule. This may change as a result of increased municipal ordinances regarding lawn and landscape use and maintenance. In anticipation of this, DEP has awarded a 5-year research grant to verify the BMPs for lawn grasses. Research will be conducted in Gainesville, Jay, and Ft. Lauderdale to evaluate nutrient leaching on various home lawn turfgrass species. Treatments include nitrogen source, rates, application timing, and irrigation. Lysimeters are being installed and sampling will be conducted throughout the season for nitrates and phosphates. Future work in this project includes evaluating specific turfgrass P requirements and determining phosphate leaching from varying rates of P, effects of winter fertilization on leaching, and nitrogen source and timing effects on nutrient leaching. Drs. Bryan Unruh, John Cisar, Jerry Sartain, and Laurie Trenholm are collaborating on this state-wide project.

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BMPs for the Green Industries – Research and Outreach (cont.)

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Previous Research

In previous turfgrass leaching research, St. Augustinegrass received different rates of quick-release nitrogen over the growing season. Rates of either 1, 4, or 7 lbs of N per 1,000 ft^{-2} were applied in three equal applications throughout the year. Lysimeters were placed to a depth of 18" under the soil line and leachate was collected every 3-5 days following treatment application. Leachate was analyzed for nitrate concentration from all sampling dates. Data were inconsistent in 2002 due to problems with leachate collection.

In 2003, the effect of nitrogen rate on leaching became apparent following fertilizer applications. Following the second and third treatment application, there was more nitrate in the 7 lb N rate leachate than from the other two N rates at all sampling dates except 4 DAT. There were no differences in nitrate levels between the 1 and 4 lb N rates at any sampling date. Clearly, turf serves as a protective filter for nitrates unless excess nitrogen is applied at one time.

"Clearly, turf serves as a protective filter for nitrates unless excess nitrogen is applied at one time."

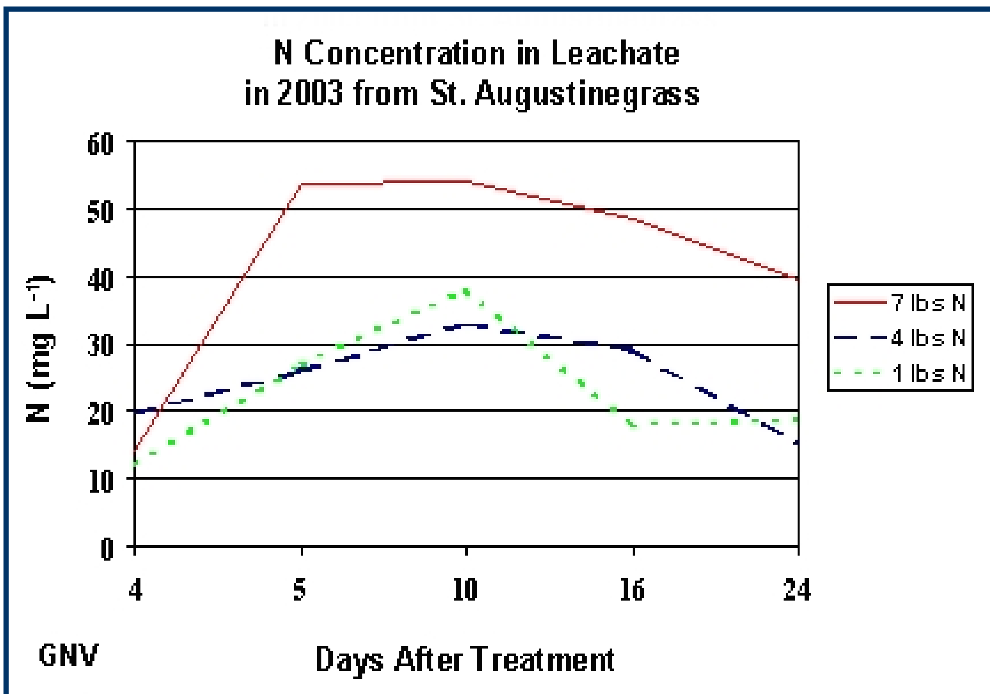

Figure 1. Container-grown foliage plants produced in shaded greenhouse.

A Second Look at Fertilization Requirements for Perennial Forage Hay Systems

C.L. Mackowiak, Soil & Water Science, A.R. Blount, and P. Mislevy, Agronomy

Figure 1. Bermudagrass plots (30 plots at 3 m x 6 m) in Ona,

Bahiagrass (*Paspalum notatum* Fluggé), bermudagrass (*Cynodon dactylon* L.) (Figure 1), and perennial peanut (*Arachis glabrata* Benth.) are common forages grown in Florida pastures and hay fields. Potassium deficiency in bermudagrass has been associated with a greater risk of leaf-spot diseases i.e., *Helminthosporium* spp. which may result in yield reductions and stand losses. It is suspected that dollar spot fungus in bahiagrass and perhaps even peanut stunt virus in perennial peanut may be aggravated by low soil fertility. Besides effects on plant vigor, the release of new, higher yielding cultivars of bahiagrass and bermudagrass are expected to increase nutrient demand and therefore current fertilizer recommendations may need to be adjusted.

Low pH and cation exchange capacity characterize a large portion of Florida soils. High annual rainfall adds to the potential leaching of nutrients, particularly N, K, and S from the topsoil. Unlike many annual row and vegetable crops, the perennial forages under study are deeply rooted and can pull nutrients, such as K, from several feet in the soil profile, thereby minimizing nutrient leaching losses. Characterizing and monitoring the soil fertility with soil depth over time will provide the needed data to help optimize fertilizer recommendations while minimizing fertilizer losses to the environment.

In the spring of 2004, experimental plots (3 x 6 m) were laid out in established, non-irrigated hay fields of bahiagrass, bermudagrass and perennial peanut located at the Range Cattle Research and Education Center (RCREC), Ona (no perennial peanut), the North Florida Research and Education Center (NFREC), Live Oak and NFREC, Marianna, to test K fertility practices with and without supplemental sulfate of potash magnesia. In contrast, with the University of Florida IFAS forage recommendations of applying a set amount of additional N and K following each clipping (haying) these plots received fertilizer based on the estimated yield from each harvest in an effort to better tailor fertilizer application to seasonal plant demand. For example, in Ona, bermudagrass growth does not accelerate appreciably until late spring (mid June), and it continues until late summer (Figure 2).

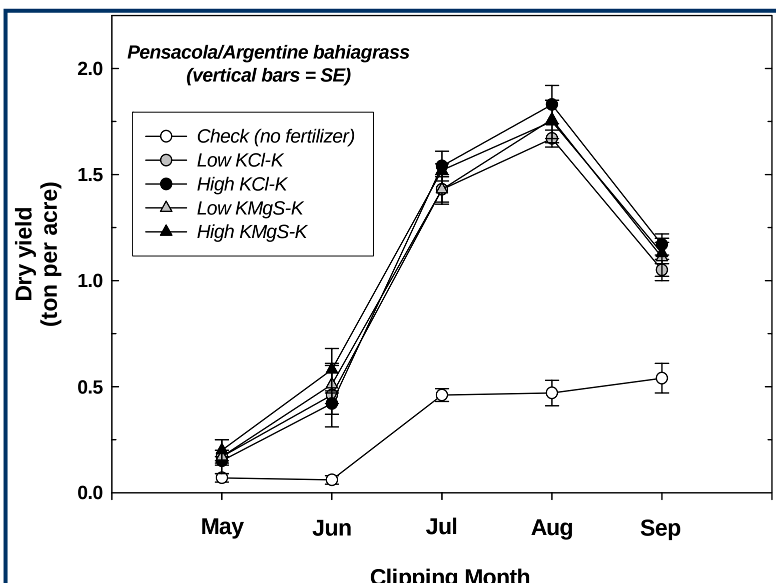

Figure 2. Bahiagrass growth in Ona during 2004.

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A Second Look at Fertilization Requirements for Perennial Forage Hay Systems (Cont.)

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There were small yield differences among bermudagrass and bahiagrass plots receiving low versus high K fertilization and no yield differences in perennial peanut plots. However, by midsummer, the bermudagrass at Ona was moderately chlorotic in plots not receiving the sulfate of potash magnesia amendment (Figure 3). It is suspected that plants in these plots were S limited but the plant tissue awaits analysis to verify the visual assessment. The IFAS recommendations do not address forage grass Mg or S fertilization requirements but may in the future based, in part, on results from this study. The biggest benefit from K, Mg, or S fertilization in Florida soils likely will be associated with plant vigor (resistance to disease and stand persistence) and improved forage quality. It may take several years to discern appreciable trends in stand persistence. Unlike some temperate forages (i.e., alfalfa), there is not a forage quality pricing scheme in place for southern forage hay. While a forage grading system is being developed, we will gather data that will help the grower determine if improved fertility returns a premium forage hay price and thereby respond accordingly with the appropriate fertility program.

Although it was not part of this study, N applications greatly increased hay yields (Figure 2) when comparing the check (no fertilizer) with all other treatments (N fertilization). Nonirrigated bermudagrass hay yields were over 7 ton per acre (12 ton per acre for Ona) in 2004, whereas bahiagrass and perennial peanut yields reached over 5 ton per acre, at some locations. Following IFAS recommendations, the Ona bermudagrass plots would have received 560 lb N per acre during 2004, whereas our method required the application of 700 lb N per acre. However, half of that 880 lbs N was applied in an 8 week period (July through August) when plant growth was greatest and the plants likely could utilize the additional fertilizer. In the case of bahiagrass, we applied 550 lb N per acre with half the total applied in July through August. The IFAS recommendations for the high yield option would have translated to 560 lb N per acre split equally, following each cutting, thereby applying much of the fertilizer in early spring when growth is minimal.

Figure 3. Two adjacent bermudagrass plots with the darker green sulfate of potash magnesia amended plot on the left.

Additionally, the IFAS N fertilization recommendations are the same for the higher yielding bermudagrass and bahiagrass and therefore bermudagrass hay production may not reach its potential under these recommendations. We will look more closely at perennial forage N demand, fertility and N-BMP development in future studies.

On-Farm Demonstration of Soil Water Movement in Vegetables Grown with Plasticulture

Eric Simonne, David Studstill, Bob Hochmuth and Justin Jones, Horticultural Sciences Dept.

Acknowledgment. The authors sincerely thank the cooperating growers for their time, efforts, and resources invested in this project. This project was supported in part by the Florida Agricultural Experiment Station and the Southern-SARE on-farm research program.

Irrigation management is directly linked not only to yield and economical value of vegetable crops, but also to the long-term sustainability and environmental impact of vegetable production. Precise knowledge of where irrigation water goes has direct implications on irrigation management, fumigant application and fertilizer leaching. The recommendations of UF/IFAS for irrigation management for vegetable crops include using a combination of target irrigation volume, a measure of soil moisture to adjust this volume based on crop age and weather conditions, a knowledge of how much water the root zone can hold, and an assessment of how rainfall contributes to replenishing soil moisture. Improving irrigation management in vegetable crops has been limited by the fact that water movement in soil is a process that cannot be easily seen because it occurs under ground.

Visualization of water movement in a musk-melon field using soluble dye on May 14, 2004 on an Orangeburg fine sandy loam. Note the dye accumulated above the impermeable layer.

A direct knowledge of how much water can be stored in the root zone can be gained by visualizing water movement in the soil using soluble dye. A blue dye and controlled irrigation conditions were used to visualize the wetting pattern of drip irrigation using different drip tapes on sandy soils representative of vegetable producing areas of Florida. As research tools, these dye tests were used to describe the shape of the wetted zone for several water volumes applied by drip irrigation, determine height, width and depth of the wetted zone, and determine if soluble fertilizer and the water front represented by the dye move together in the soil. As educational tools, these dye tests have been used to show growers how deep water moves into several soils and how drip tape flow rate and emitter spacing affects wetted zones. While novel in their approach, these dye tests have used single irrigation events and were done without an actively growing vegetable crop.

Past educational efforts and fertilization recommendations have generally attempted to reduce environmental impact by reducing fertilizer application rates. While this approach may be valid, it is not practical since fertilizer costs only represent 10% to 15% of the overall pre-harvest production costs. Fertilizer are often applied at rates above the crop nutritional requirement as a means to decrease the risk of reduced yields due to shortage of fertilizer, especially close to harvest. We believe that it is possible to follow a different approach for improving fertilizer management. As water is the vehicle for soluble nutrient movement in the soil, it may be possible to improve nutrient management by improving irrigation management. If irrigation water stays in the root zone, smaller amount of fertilizer are likely to be leached. If growers are shown how

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On-Farm Demonstration of Soil Water Movement in Vegetables Grown with Plasticulture

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their current irrigation schedules affect water movement in their fields, they are more likely to understand how water and nutrients are linked. With this integrated approach, sustainability becomes compatible with economical profitability.

The goals of this project were to demonstrate to cooperating growers how irrigation and fertilizer management are linked together and how management may prevent water movement below the root zone. More specifically, the objectives of this project were to (1) establish a partnership with three key growers and discuss fertilizer and irrigation management, (2) determine the position of the water front throughout the growing season, (3) diagnose crop nutritional status, and (4) determine nitrate distribution in the soil profile at the end of the growing season. From a producer's stand point, this information will be used to increase sustainability by reducing water used and environmental impact of vegetable production. From a regulatory stand point, this information will contribute to demonstrate the efficacy of possible nutrient/water Best Management Practices and set practical management expectations.

"As water is the vehicle for soluble nutrient movement in the soil, it may be possible to improve nutrient management by improving irrigation management. If irrigation water stays in the root zone, smaller amount of fertilizer are likely to be leached."

Manufacturer	Flow rate		Emitter Spacing (inch)
	Nominal (gal/100ft/hr)	Relative to grower (%)	
Site 1-Cantaloupe			
Roberts	24	100	12
Aquatraxx	20	83	12
Eurodrip	16	67	12
Site 2-Watermelon			
Roberts	24	100	12
Aquatraxx	20	83	12
Eurodrip	16	67	12
Site 3-Cantaloupe			
Eurodrip-grower	34	100	12
Eurodrip	25	74	12
Aquatraxx	20	59	12

Table 1. Drip tapes used during three on-farm dye tests in the Spring of 2004 in North Florida.

The project was conducted in North Florida in the Spring of 2004 on three commercial vegetable fields (referred to as 'site 1-cantaloupe', 'site 2-watermelon, and 'site 3-cantaloupe') with three cooperating growers who had participated in previous UF/IFAS irrigation management projects (Simonne et al., 2001). These growers are recognized as leaders in water and nutrient management. The approach was similar at the three sites. Growers prepared the field with raised bed, drip tape and plastic mulch. Sections of beds were replaced with drip tapes with three different flow rates (Table 1). Other cultural practices were conducted by the cooperating grower throughout the growing season (Table 2). Soluble blue dye (Terramark SPI High Concentrate, ProSource One, Memphis, TN) was injected three times at each site and was traced through three or four digs (Table 3). Petiole NO_3-N and K concentrations were also determined throughout the crop (Table 3) and compared to published sufficiency ranges (Maynard et al., 2003). Soil samples were taken in

Cultural practice	Site 1-Cantaloupe	Site 2-Watermelon	Site 3-Cantaloupe
Location	North Florida	North Florida	North Florida
Soil type	Blanton Fine Sand	Plummer Fine Sand	
Crop	Muskmelon	Triploid watermelon	Muskmelon
Variety	Athena (transplanted)	Sugar Heart with 790 pollenizer (both transplanted)	Athena (seeded)
Crop stage of growth			
Planting date	March 25	March 23	April 1
April 6 (dye injection 1)	2 leaves	6-inch long vines	Few plants visible
April 28 (dye injection 2)	2-ft long vines; 1-inch fruit	2-ft wide vines; begin bloom	6-inch long vines
May 14 (dye injection 3)	Closed rows; 5-inch fruits	Closed rows; full-size fruits	1-to-2-ft long vines; early bloom
June 2	Harvest	Harvest	
June 30			Harvest
Irrigation schedule			
Early season	1-4 WAT[z]: 50 min/day	1-3 WAT : 45 min/day	1-3 WAS - 3 x 30 min/day
Mid-season	5-6 WAT : 1 hr/day	4 WAT : 1 hr/day	as needed
Late season	7 WAT : 1.5 hr/day	5-6 WAT : 2 x 1hr/day	as needed
	8 WAT to harvest : as needed	7 WAT to harvest : 3 x1 hr/day	as needed
Preplant soil test	yes	yes	yes
Fertilizer schedule	Some preplant; weekly injection throughout the crop	Some preplant; injection start after fruit set	Some preplant; weekly injections throughout the crop

Table 2. Cultural practices used during three on-farm dye tests in 2004 in North Florida.

Event	Site 1-Cantaloupe	Site 2-Watermelon	Site 3-Cantaloupe
Petiole Sampling and Sap Testing			
Petiole 1	April 28	April 28	April 28
Petiole 2	May 14	May 14	May 14
Petiole 3	June 2	June 2	June 2
Dye Injection			
Dye 1	April 6	April 6	April 6
Dye 2	April 28	April 28	April 28
Dye 3	May 14	May 14	May 14
Digging			
Dig 1	April 28	April 28	April 28
Dig 2	May 14	May 14	May 14
Dig 3	June 2	June 2	June 2
Dig 4	June 30	June 30	June 30
Soil Sampling			
Soil Sample 1	July 1	June 30	June 30

Table 3. Schedule for petiole sampling, dye injection, digging, and soil sampling during three on-farm dye tests in 2004 in North Florida

"These growers are recognized as leaders in water and nutrient management ... Their respective fertilizer and irrigation schedules were considered to be sophisticated as they took full advantage of the flexibility of drip irrigation to split fertilizer applications and to change irrigation schedules based on plant growth."

On-Farm Demonstration of Soil Water Movement (Cont.)

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one-foot increments up to the 6 foot depth at each location after final harvest. Soil samples were dried, sieved to pass a 2-mm screen and sent to the University if Florida Analytical Research laboratory for NO_3-N and NH_4-N analysis using methods US EPA 352.3 and 350.1. Spring 2004 was warm and dry in North Florida; rainfall marginally contributed to replenishing soil moisture and did not interfere with the irrigation schedules. Cooperating growers were eager to participate in this project and showed continuous interest and support. Their respective fertilizer and irrigation schedules were considered to be sophisticated as they took full advantage of the flexibility of drip irrigation to split fertilizer applications and to change irrigation schedules based on plant growth. Yet, each grower had his own approach to fertilizer management, as the ratio of preplant:injected and the starting date of injection varied widely. These different approaches were consistent with current UF/IFAS fertilizer recommendations. Nitrate-nitrogen and

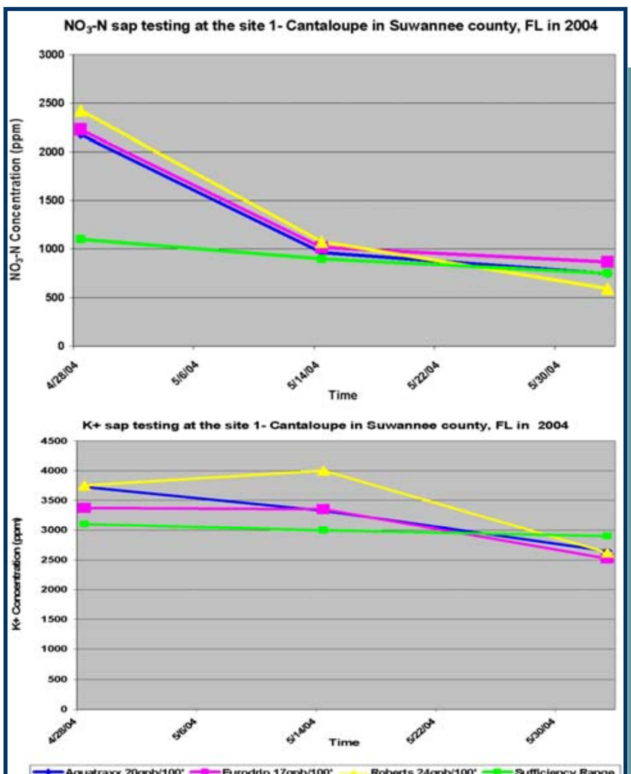

Figure 1. Nitrate and potassium concentrations (mg/L) in petiole sap of cantaloupe (site 1)

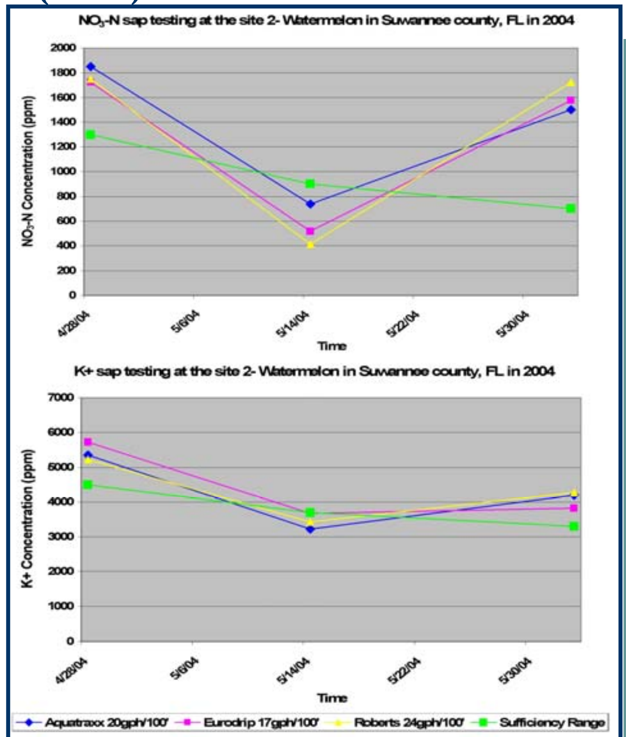

Figure 2. Nitrate and potassium concentrations (mg/L) in petiole sap of watermelon (site 2)

K concentrations in petioles were all at or above the sufficiency ranges (Figures. 1, 2, 3). Drip-tape flow rate had no practical influence on crop nutritional status. As drip irrigation flow rates ranged from 59% to 100% of all cooperating growers' rates, this suggests that crop nutritional status could be maintain while reducing fertigation inputs.

Soil types were different at the three sites. Soils were sandy at the 1-cantaloupe and 2-watermelon sites, and was relatively heavier (loamy) at the site 3-cantaloupe. Hence, the positions of the water front as represented by the dye were also different and are discussed separately (Table 4). At the 1-cantaloupe site, the depth of the first dye ring ranged between 30 and 38 inches and averaged 34 inches on April 28. From transplanting to that date, irrigation applied was for transplant establishment and was only 50 min/day (Table 2). Yet, 34 inches is well below the root zone. On the next dig two weeks later (May 14), the dye injected on April 6 (1st dye) had moved only an average of 5 inches deeper. On

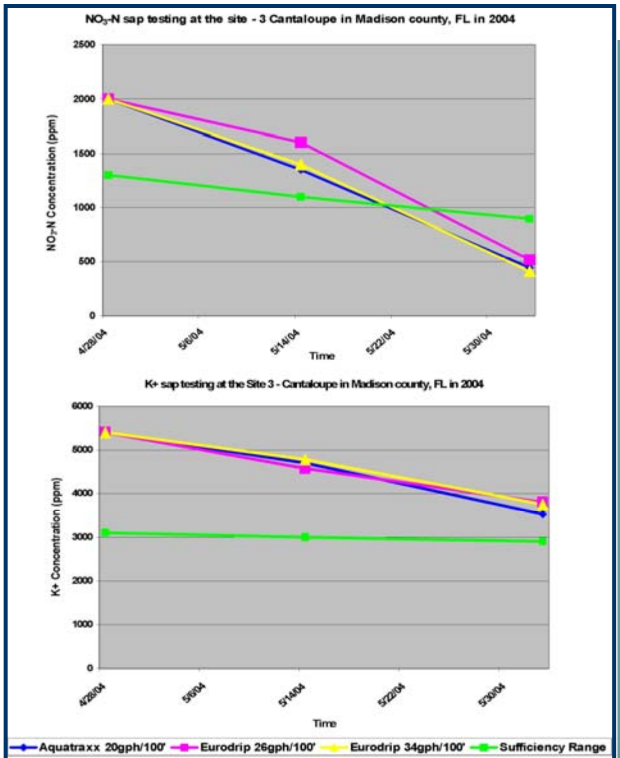

Figure 3. Nitrate and potassium concentrations (mg/L) in petiole sap of cantaloupe (site 3)

May 14, the dye injected on April 28 (2nd dye) had a depth ranging between 16 and 23 inches, with a 19 inches average. The second dye had moved less than the first dye. This is most likely due to differences in cantaloupe water use. Small plants (between April 6 and 14) used less water than larger plants (between April 28 and May 14). This example confirms the prediction that irrigation water needed early in the season for plant establishment may push the water front well below the root zone. Changing the existing irrigation schedule from 1 x 50 min/day to 2 x 30 min/day may not be currently practical as it take approximately 15 minutes to charge the drip irrigation system. If this 2 x 30 min/day schedule were adopted with the current irrigation system, a large (approximately 50%) portion of the irrigation cycle would be used for system charge, which is likely to decrease uniformity of application. A costly possibility to reduce the charging time would be to modify the drip irrigation system to keep it continuously pressurized. If this were not economically feasible, two alternative practices may be used to reduce the risk of nutrient leaching. First, it would be possible to modify the fertilizer program to include a smaller amount of preplant nitrogen and increase proportionally that injected after plant establishment. While this approach is theoretically valid, the feasibility of a 100% injected fertilizer program needs to be demonstrated first before growers are likely to adopt it. The second alternative is to change water distribution in the bed by using two drip tapes, each with lower nominal flow rates. For example, if the existing 24 gal/100ft/hr drip tape is replaced by two, 16 gal/100ft/hr drip tapes the same amount of water may be applied by reducing irrigation time by 25%. Using two drip tapes would reduce by approximately half the vertical movement of water, but would slightly increase production cost. However, the cost of the additional drip tape could be covered through cost-sharing.

On June 2, the position of the third dye (injected

Trt. No.	Drip tape manufacturer (Flow rate relative to grower's rate)	Digging date: April 28	May 14		June 2		
		Dye 1	**Dye 2**	**Dye 1**	**Dye 3**	**Dye 2**	**Dye 1**
	Site 1 - Cantaloupe						
1	Roberts (100%)	32	17	35	28	>50	>50
2	Aquatraxx (83%)	38	23	55	24	>50	>50
3	Eurodrip (67%)	33	16	30	14	>50	>50
	Average	**34**	**19**	**40**	**22**		
	Site 2 - Watermelon						
1	Roberts (100%)	24	>45	>45	16	>45	>45
2	Aquatraxx (83%)	21	>45	>45	19	>45	>45
3	Eurodrip (67%)	12	>45	>45	11	>45	>45
	Average	**20**	**>45**	**>45**	**15**	**>45**	**>45**
	Site 3 - Cantaloupe						
1	Eurodrip-G (100%)	--	22	>40	20	>30	>30
2	Aquatraxx (74%)	18	30	>40	17	>30	>30
3	Eurodrip-UF (59%)	--	38	>40	17	>30	>30
	Average	**18**	**30**	**>40**	**18**	**>30**	**>30**

Table 4. Depth of the blue dye (inch) representing the wetted zone on three commercial fields in North Florida in the Spring of 2004.

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On-Farm Demonstration of Soil Water Movement (Cont.)

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on May 14) ranged between 14 and 28 inches, and averaged 22 inches. Although irrigation was at that time several hours daily, large cantaloupe plants that were setting fruits used a large amount of water. The effect of drip tape flow rate was detectable only between digs 2 and 3. Reducing drip tape flow rate by 33% (from 24 to 16 gal/100ft/hr), reduced the position of the water front on the date of dig 3 by approximately 50% (28 vs. 14 inches). Cantaloupe roots were found mainly in the plough zone (top 12 inches), but several actively growing roots were found in the top 42 inches. These results suggests that reducing irrigation amount by 25% (by using a drip tape with reduced flow rate) may be instrumental in keeping the wetted zone within the root zone. Therefore, these findings and observations together suggest that it may be possible to keep the wetted zone within the root zone of cantaloupes on this sandy soils by using two drip tapes and reducing current grower's schedule by 25%.

At the 2-watermelon site, the depth of the first dye ring (injected on April 6 and dug on April 28) ranged between 12 and 24 inches, and averaged 20 inches. At this site, the depth of the dye ring tended to decrease as drip tape flow rate decreased. These results suggest that water used for watermelon establishment may be reduced by approximately 20%. A valve malfunction shortly after April 28 resulted in a non-scheduled 6-hour irrigation event which pushed the water front below the 45-inch depth on May 14. The depth of the third dye ring (injected on May 2) and dug on June 2 ranged between 11 and 19 inches, and averaged 15 inches. These results show that the grower's schedule during fruit set and enlargement was adequate and did not result in a dye front moving deep below the root zone. Lessons from the 2-watermelon site are similar to those from the 1-cantaloupe site. In the absence of rain, the risk of the water front moving below the root zone is greatest during crop establishment and when plants are small (1 to 5 WAT).

At the 3-cantaloupe site, the depth of the first dye ring (injected on April 6, dug on April 28) ranged between 16 and 18 inches. While roots may be found at the 18-inch depth when cantaloupe plants are fully grown, this depth was below the root depth when the plants were at the 6-inch long vines. On May 14, the dye injected on April 6 could not be found, and the depth of that injected on April 28 ranged between 22 and 38 inches, and averaged 30 inches. On June 2, the depth of the dye injected on May 14 ranged between 17 and 20 inches, and averaged 18 inches. On June 30, the depth of the dye injected on May 14 was similar to that found on June 2: it ranged between 17 and 20 inches, and averaged 18 inches. Because of the heavier soil texture, water tended to move less at this site than at the two other sites. However, it was also observed at this site that the greatest dye movement occurred when the plants were small. Grower's schedules when the plants were fully grown seemed adequate.

Depth (in)	Nitrate (mg/kg)	Ammonium(mg/kg)
	Site 1 - Cantaloupe	
0-12	0.95 a	5.54 a
12-24	1.07 a	5.17 a
24-36	1.04 a	4.24 a
36-48	1.05 a	5.20 a
48-60	0.74 b	5.37 a
R^2	*0.91*	*0.44*
p-value	*0.02*	*0.89*
CV (%)	*17*	*27*
	Site 2 - Watermelon	
0-12	1.47 b	5.09 a
12-24	2.89 b	2.92 b
24-36	4.78 a	1.91 b
36-48	2.05 b	1.83 b
48-60	3.25 ab	1.26 b
$R2$	*0.66*	*0.74*
p-value	*0.01*	*0.01*
CV (%)	*48*	*51*
	Site 3 - Cantaloupe	
0-12	0.90 b	5.31 a
12-24	0.72 b	1.30 b
24-36	0.97 b	1.32 b
36-48	3.27 a	1.37 b
48-60	--	--
$R2$	*0.90*	*0.88*
p-value	*0.01*	*0.01*
CV (%)	*38*	*42*

Table 5. Soil nitrate (NO_3-N) and ammonium (NH_4-H) concentrations in soils (mg/kg) in three commercial vegetable fields between the 0 and 60-inch depths.

Nitrate and ammonium concentrations in the soil significantly varied by depth (Table 5). At the 1-cantaloupe site, all NO_3-N concentrations were below 1 mg/kg, and were significantly lower at the 48-60 inch depth. Ammonium concentration was not affected by depth and averaged 5.10 mg/kg NH_4-N between the 0 and 60-inch depth (Fig. 4). At the 2- watermelon site, NO_3-N concentration was significantly greater at the 24-26 inch depth, while NH_4-N concentration was significantly greater in the 0-12 inch zone. The hard pan at the 3-cantaloupe site limited the depth of soil sampling to 48 inches. Nitrate-nitrogen concentration was significantly higher in the 12 inches above the hard pan (36-48 inch depth) than in the 0-36-inch section, while NH_4-N concentration was higher in the 0-12 inch depth. These results show that distribution of nitrate and ammonium are different in soils. In a deep sandy soil, NO_3-N may move vertically rapidly, while it may accumulate above an impermeable layer, and possibly move laterally thereafter. The effect of drip tape flow rate on the distribution of NO_3-N and NH_4-N in the soil profile was not significant at all three sites.

In conclusion, the irrigation and fertilizer schedules used by cooperating growers well followed UF/IFAS splitting and scheduling recommendations and well represented proposed nutrient BMPs. It was not possible to observe the three dye rings simultaneously at the end of the experiment, showing that these near-optimal fertigation schedules did not keep the water front within the root zone for the entire season. At the three sites, greatest water movement was observed at the beginning of the growing season between 1 and 5 WAT. This period should be the focus of educational efforts. Cooperating growers' irrigation schedule were overall adequate for the remainder of the season, but could be reduced by 20%. Using tapes with flow rates ranging from 59% to 100% did not practically affect crop nutritional status, and water movement. Cooperating growers' fertigation schedule maintain crop nutritional status within the recommended range.
As observed in previous dye tests, the uniformity of water distribution in the soil profile decreased with depth, as water found paths of preferential flow. Hence, leaching may not be uniform in a field even when the uniformity of the drip system exceeds 90%. Consequently, no consistent practical benefit was found in reducing irrigation rates as an attempt to reduce leaching. However, theoretically, reducing irrigation rates should

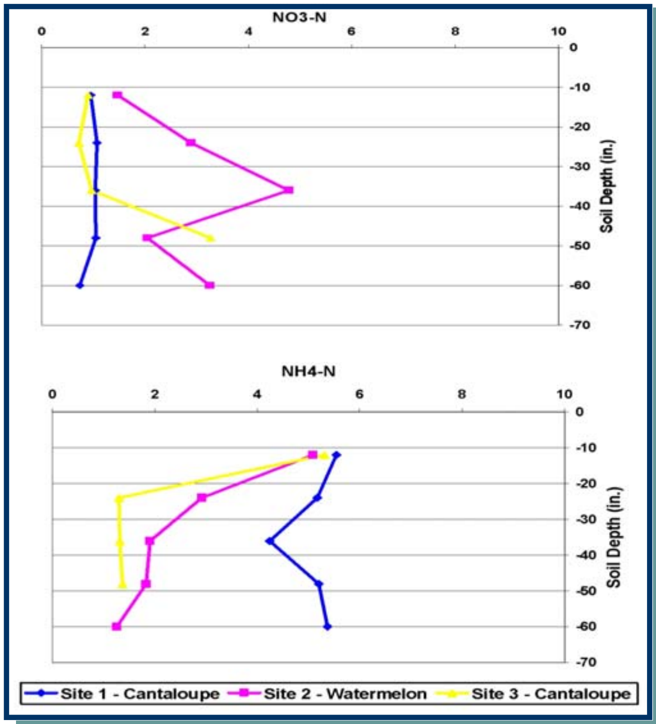

Figure 4. Soil nitrate (NO_3-N) and ammonium (NH4-H) concentrations in soils (mg/kg) in three commercial vegetable fields after harvest between the 0 and 60-inch depths.

reduce leaching. Another consequence of field heterogeneity is that growers tend to irrigate based on the 'dry spots'. This often results in increasing irrigation on the other parts of the field.

This project has demonstrated again the importance of soil texture in water movement. Water moved vertically faster on sandy soils than on the loamy soil. Lateral water movement was also less on the sandy soil than on the loamy soil. This project is a good illustration of the fact that the demonstration and implementation of BMPs are possible when vegetable growers are actively involved in it.

Improving Water and Nutrient Management Practices for Foliage Plant Production

Jianjun Chen, Mid-Florida Research and Education Center (MREC), Apopka

Florida leads the nation in foliage plant production. According to the USDA National Agricultural Statistical Service, the national wholesale value of foliage plants was $622.7 million in 2003, of which Florida accounted for $400 million. Florida's dynamic foliage plant industry is characterized by its intensive agriculture as up to 300,000 containerized plants may be produced per acre to which 50 to 100 acre-inches fresh water and 1,000 to 2,000 lb of nitrogen (N) are applied annually. Excessive fertilization and irrigation to container media that have limited nutrient and water holding capacities can lead to leaching and/or runoff of up to 50% of applied fertilizer, primarily N. The combination of these factors with Florida's sandy soils and frequent summer showers could result in N movement into aquifers, causing groundwater contamination.

As a member of the IFAS extension team on water and nutrient management, we have been developing best management practices (BMPs) for foliage plant production. We believe that a holistic evaluation of plant species, fertilizer application rates, container media, and irrigation methods is necessary to learn how to efficiently and effectively use nitrogen and to prevent leaching/runoff during plant production. In order to minimize groundwater contamination, we must understand N requirements of and apply N according to each plant's needs, improve media to retain water and nutrients, use controlled-release fertilizers, and subirrigate and/or recycle irrigation water.

Our demonstrations at the MREC and at local nurseries have shown that optimal N rates for Anthurium, Dieffenbachia, Epipremnum, Philodendron, and Spathiphyllum are at least 20% less than traditionally used rates. In addition, amending commercial potting media with selected zeolites can reduce nutrient leaching, including N and phosphorus (P), while the use of controlled-release fertilizers significantly reduces N and P

Figure 1. Container-grown foliage plants produced in shaded greenhouse.

> ***"Excessive fertilization and irrigation to container media that have limited nutrient and water holding capacities can lead to leaching and/or runoff of up to 50% of applied fertilizer, primarily N."***

Figure 2. A retention pond capturing irrigation runoff from a production bed and rain water from a greenhouse roof. Water from the retention pond was used to irrigate foliage plants for an entire production cycle.

leaching compared to the use of water-soluble fertilizers. An evaluation of subirrigation practices, such as ebb-and-flow and flood irrigation, showed that quality plants could be grown with zero runoff of nutrients while using 40% or less water. We also evaluated captured irrigation runoff and rain water for foliage plant production. Based on the results of 30 foliage and bedding plant species evaluated over a two-year period, it was concluded that the captured water can be used as an alternative irrigation source for marketable plant production. Each of these production options can significantly reduce nutrient leaching or runoff, and combining the options essentially eliminates nutrient leaching and/or runoff and greatly reduces the amount of fresh water used during foliage plant production.

Additionally, we sampled root-zone solutions derived from different fertilization practices and found that N concentrations in the solutions were positively correlated with electrical conductivities (EC). Based on the correlation, we have introduced "Chen's 1, 2, 3 Rules" for determining the nutrient status of container media when root-zone solutions are extracted using the pour-through method: if the EC reading is 1 dS/m, the plant will show nutrient deficiency if no fertilizer is provided; if the EC reading is 2 dS/m, nutrient levels are adequate; and if the reading is 3 dS/m or above, the rate or frequency of fertilizer application should be reduced. As EC measurements can be made by growers during foliage plant production, the simplified "rules" provide growers a convenient way of monitoring the nutrient status of container media during all production phases.

"We believe that a holistic evaluation of plant species, fertilizer application rates, container media, and irrigation methods is necessary to learn how to efficiently and effectively use nitrogen and to prevent leaching/runoff during plant production."

Other nutrient related work has shown that silicon application during foliage and orchid production can increase plant resistance to environmental and cultural stresses. Application of a silicon fertilizer in bromeliads and orchid nurseries has significantly reduced Erwinia incidence and saved one nursery more than a million dollars by reducing plant losses.

Beneficial Uses of Composts in Florida Vegetable Crops

Monica Ozores-Hampton. SWFREC/IFAS, Immokalee

Introduction. Florida is a major vegetable-producing state, with 418,000 acres under cultivation each year. Sandy soils used to grow Florida vegetables have low native fertility, so they require relatively high fertilizer inputs. Minimizing fertilizer leaching or runoff has become important due to potential negative environmental impacts. If water and fertilizer conservation could be increased, grower input costs and negative environmental effects could potentially decrease.

In recent years, composts produced from a wide range of waste materials have become available in Florida on a large scale. While environmental regulators are mainly interested in compost trace metal concentrations, growers have different interests once compost has passed regulatory health and safety standards. From a commercial vegetable grower=s point of view, compost quality is judged based on moisture and nutrient concentration, pH, soluble salts, organic matter concentration, C:N ratio, water-holding capacity, bulk density, cation exchange capacity, particle size, presence of weed seeds, and odor.

When compost is incorporated into soil, observed benefits to crop production have been attributed to improved soil physical properties due to increased organic matter concentration rather than increased nutrient availability. Optimum chemical and physical parameters for composts that might be used in vegetable crop production are listed in Table 1. Compost is not considered fertilizer, however, significant quantities of nutrients (particularly N, P, and micronutrients) become bio-available with time as compost decomposes in the soil. Amending soil with compost provides a slow-release source of nutrients, whereas mineral fertilizer is usually water-soluble and is immediately available to plants. Compost usually contains large quantities of plant-available micronutrients.

Physical Properties	Optimal range	Effect
Moisture (%)	35 – 55	Higher moisture, increased handling and transportation costs
Organic matter (%)	50 or more	Higher organic matter lowers application rate
PH	5.0 - 8.0	In acidic soil, alkaline compost will raise pH
Water holding capacity (WHC) (%)	20 – 60	Higher WHC leads to lower irrigation frequency
Soluble salts ($dS\square m^{-1}$)	less than 6.0	Higher than 6.0 means potential toxicity
Bulk density (lb/cu yd fresh weight)	500 – 1000	Higher moisture content means a greater bulk density
Particle size	Passes 1 inch screen	Increase soil porosity
C:N ratio	15 - 25:1	Higher C:N ratio causes "N-immobilization"
Maturity (G.I.[y])	Over 60	GI lower than 60 indicates phytotoxicity
Compost stability	Stable	Instability can cause "N-immobilization"
Weed seeds	None	Uncomposted materials disseminate weeds

[z] FDACS, 1995.
[y] G.I = (% seed germination x root length growth in % of control) /100 (Zucconi et al., 1981a).

Table 1. Physical properties of compost used in vegetable production[z].

(Continued from page 16)

Crop injury has been linked to use of poor-quality compost, such as that from early stages of the composting process. The type and degree of plant injury is directly related to compost **maturity** or **stability**. **Maturity** is the degree to which it is free of phytotoxic substances that can cause delayed seed germination, or seedling and plant death; **stability** is the degree to which compost consumes N and O_2 in significant quantities to support biological activity, and generates heat, carbon dioxide (CO_2), and water vapor that can cause plant stunting and yellowing of leaves. Plant stunting has often been attributed to high C:N ratio of the organic material before humification, and plant injury from exposure to phytotoxic compounds such as volatile fatty acids and ammonia. Phytotoxin identification in compost extracts from fresh and 5-month-old municipal solid waste (MSW) material showed that fresh compost contained acetic, propionic, isobutyric, butyric, and isovaleric acids in the largest concentrations. Acetic acid at 300 ppm concentration inhibited growth of cress seed.

In Florida, soil application of unstable compost consistently resulted in "N-immobilization," where available forms of inorganic N were converted to unavailable organic N followed by growth inhibition of vegetable crops such as beans, corn, peppers, tomatoes, and squash. When immature compost is applied and a crop is planted immediately, growth inhibition and stunting may be visible for 40 to 60 days (Figure 1). When using compost with C:N ratios higher than 25 or 30, N fertilizer should be applied, or planting delayed for 6 to 10 weeks to allow the compost to stabilize in the soil. Research on vegetable compost utilization in Florida had been established several potential application: soil amendments, soilborne disease suppression, biological weed control, alternative to polyethylene mulch, and as a transplant media.

Compost as a soil amendment.
Amending Florida soil with composted materials such as biosolids, MSW, and yard trimmings (YT) has been reported to increase crop yields of bean, blackeyed pea, okra, tomato, squash, eggplant and bean, watermelon and tomato, corn, and bell pepper. In calcareous soil, application rates of biosolids compost as low as 3 to 6 tons/acre resulted in crop yield increases for tomatoes, squash, and beans. In sandy (Figure 2) and calcareous soil, MSW compost application rates of 40 tons/acre resulted in crop yield increases for bean and watermelon. Contradictory crop response results were found

Figure 1. When immature compost is applied and a crop is planted immediately, growth inhibition and stunting may be visible for 40 to 60 days

Figure 2. In sandy and calcareous soil, MSW compost application rates of 40 tons/acre resulted in crop yield Increases.

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Beneficial Uses of Composts in Florida Vegetable Crops (Cont.)

(Continued from page 17)

"If all of Florida's solid waste was converted to compost, it could easily be assimilated by the Florida vegetable industry. If only 20 tons/acre of compost (fresh weight) were applied to each of the 418,000 acres of vegetables annually grown in Florida, 8.4 million tons of compost could be recycled each year."

when compost was compared to a traditional fertilizer program. However, combining compost and inorganic fertilizer has generally been more effective in producing a positive plant response than separate application of either material alone.

One concern of using biosolids or MSW-based composts is the possible presence of unwanted elements in the compost and their uptake by crops. Compost that does not meet EPA 503 standards for metals concentration in biosolids should not be applied to agricultural land. Research in Florida on tomatoes and squash grown on calcareous soil where biosolids, MSW, and co-composted biosolids-MSW that met the 503 standards were applied showed no trace metal accumulation in the edible plant parts.

If all of Florida's solid waste was converted to compost, it could easily be assimilated by the Florida vegetable industry. If only 20 tons/acre of compost (fresh weight) were applied to each of the 418,000 acres of vegetables annually grown in Florida, 8.4 million tons of compost could be recycled each year. The actual rate and frequency of compost use should be determined by compost properties such as nutrient concentration or N mineralization rate, and soil physical and chemical properties.

Soilborne disease suppression.
The colonization of compost by beneficial microorganisms during the latter stages of composting appears to be responsible for inducing disease suppression. Compost does not kill the pathogens that cause disease as fungicides do. Instead, compost controls the pathogens by keeping the beneficial microorganisms active and growing. Therefore, pathogenic agents will either not germinate or will remain inactive.

In Florida there have been few experiments in vegetable crop production under field conditions that demonstrate the use of compost in controlling soilborne pathogens. Municipal solid waste (MSW) was incorporated into calcareous soil in Dade County at 36 and 72 tons/acre and compared to an untreated control. A two-crop rotation of bush beans and southern peas were

Figure 3. Ashy stem blight of bean was almost completely eliminated where MSW compost had been applied.

seeded. Bean emergence and yield were improved by 25% in the compost treatment compared to the untreated control. Ashy stem blight of bean caused by *Macrophomima phasolina* was severe in areas with no compost application, but was almost completely eliminated where MSW compost had been applied (Figure 3). MSW compost reduced the damage by *Rhizoctonia* root rot in southern pea considerably compared with the untreated control. In the areas with no compost application, severe infections caused plant stunting and premature death, with significant yield reduction.

Biological weed control.
Weed growth suppression is an important attribute of surface-applied mulch. An organic mulch suppresses weeds by its physical presence as a surface cover, or by the action of phytotoxic compounds that it contains. Weed seed germination inhibition by burial under mulch is due to the lack of growth-promoting factors such as light, temperature, or moisture. Chemical effects of phytotoxic compounds (volatile fatty acids and/or ammonia) in compost can decrease weed seed germination. In Florida, a water extract of 3-week-old YT and immature MSW compost decreased germination of several perennial and annual weeds in petri dishes. Under field conditions application of immature 4-week-old MSW compost at 3 inches (45 ton/acre) or greater thickness completely inhibited weed germination and growth for 240 days after treatment (DAT) in vegetable crop row middles (Figure 4). Inhibition of germination or subsequent weed growth may be attributed to both the physical effect of the mulch and the presence of phytotoxic compounds (fatty acids) in the immature compost. Similar weed reduction was obtained with mature MSW compost (100 tons/acre) in row-middles of bell pepper compared with an untreated control, but herbicide provided improved weed control over mature compost.

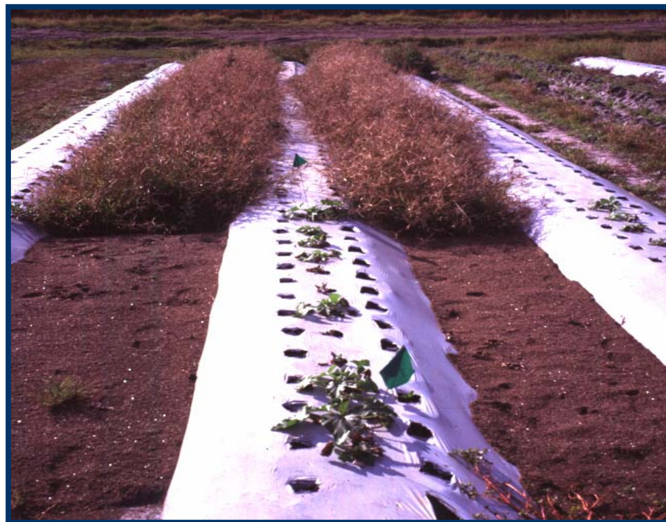

Figure 4. Application of immature 4 week-old MSW compost at 3 inches or greater thickness completely inhibited weed germination and growth for 240 days .

Alternative to polyethylene mulch.
Polyethylene mulch regulates soil temperature and moisture, reduces weed seed germination and leaching of inorganic fertilizer, and is a barrier for soil fumigants. Removal and disposal of polyethylene mulch has been a major production cost to Florida growers. Therefore, utilization of composted waste materials in combination with living mulches in a bell pepper production system was investigated. Traditional raised beds were covered with polyethylene mulch, MSW (Figure 5), wood chips, or biosolids-YT compost (100 tons/acre), and bed sides were either planted with a St.

Figure 5. Traditional raised beds were covered with polyethylene mulch, MSW, wood chips, or biosolids-YT compost (100 tons/acre).

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Beneficial Uses of Composts in Florida Vegetable Crops (Cont.)

(Continued from page 19)
Augustine grass living mulch or not planted. Bell pepper yields were higher on compost mulch plots than on unmulched plots but lower than on polyethylene-mulched beds.

Compost as a transplant medium.
The vegetable transplant industry relies on peat moss as a major ingredient in soilless media. Peat is an expensive, non-renewable resource. In Florida, alternative soilless media has been investigated to grow tomato (Figure 6), watermelon, lettuce, and citrus seedlings. Seed emergence and seedling growth was similar to traditional peat:vermiculite media when peat was partially replaced with compost. Negative growth effects were reported when the medium was 100% compost, especially when immature, unstable compost was used.

Figure 6. In Florida, alternative soilless media has been investigated to grow tomato, watermelon, lettuce, and citrus seedlings.

Checklist for compost utilization on vegetable crops:

1. Use of immature compost can cause detrimental effects on plant growth. We recommend assaying compost for the presence of phytotoxic compounds using a cress seed germination test. In this test, a compost sample is saturated with water, and the extract is squeezed from the sample. A portion of the extract is used to moisten filter paper in a petri dish, on which cress seeds are placed and allowed to stand for 24 hours. The germination index (GI) is measured as GI = [(% cress seed germination x root length in % of the control)/100]. If GI is less than 60, allow about 90 days between the time of compost application and planting of the crop. For example, if cress germination and root length on compost was 40% and 2 inches, and the control 80% and 1 inch, respectively, therefore we obtained a 50% cress seed germination and 50 % root length as % of the control. Thus, the GI = 25, indicating immature compost. An alternative measure is to continue composting the material to maturity before it is applied.

2.Most vegetable crops are sensitive to high soluble salts, especially when they are direct-seeded. We recommend measuring the soluble salts concentration of a saturation extract. If the electrical conductivity (EC) is below 6.0 dS/m, no salt toxicity should occur. If the EC is above 6.0 dS/m, the amended soil should be leached with water before planting seeds (only a few crops can tolerate this salt level).

3. High C:N compost can result in N immobilization. Have the compost analyzed for C:N ratio. If it is above 25:1 to 30:1, some N fertilizer applied to the crop may be immobilized due to N immobilization, possibly causing plant N deficiency.

4. Lack of equipment to spread compost in vegetable fields is a concern. We encourage compost facilities to play an active role in developing spreading equipment.

A Multi-Disciplinary Approach to Water Quality Education in Florida

Thomas Obreza, Soil & Water Science

Florida's population is 16 million, and 700 new residents arrive each day. The conversion of rural to urban land is projected to be 52,000 hectares per year during the next 20 years. At the same time, Florida's diverse and competitive agriculture is expected to remain strong. Florida's sandy soils, high water tables, nutrient and agrichemical use, sensitive ecosystems, finite groundwater aquifers, and limited rainfall storage capacity present unique challenges to the county agents. Watershed issues go beyond specialties and political boundaries. Changes at the urban and agricultural interface present new challenges to water resource management and water quality protection. Each land use has its own characteristic effect on surface and groundwater quality. County agents need training in watershed science to better serve clientele.

The UF-IFAS interdisciplinary "Watershed Education Team" was formed by five extension specialists with expertise in Soil and Water Science, Agricultural and Biological Engineering, and Fisheries and Aquatic Sciences to address new water resource management and water quality protection challenges presented by urban development encroachment into agricultural areas. The team includes Tom Obreza (Nutrient Management), Mark Clark (Wetlands and Aquatic Systems), Chuck Jacoby (Coastal Ecosystems), Sanjay Shukla (Water Resources), and Chris Wilson (Environmental Toxicology). This team has conducted annual workshops the last 3 years: "Managing Water Quality at the Agriculture-Urban Interface" (2002), "Watershed Management: Reducing Non-Point Source Pollution" (2003), and "TMDLs in a Watershed Context" (2004). The team trained a wide variety of agents (agriculture, urban, natural resources, Sea Grant) who were taught in the classroom, took part in demonstrations, and went to the field to see water quality problems and solutions first-hand.

The team evaluated knowledge gain about point and non-point source pollution, Total Maximum Daily Loads, BMPs, wetland function, and estuaries. Pre and post test comparison measured

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A Multi-Disciplinary Approach to Water Quality Education (Cont.)

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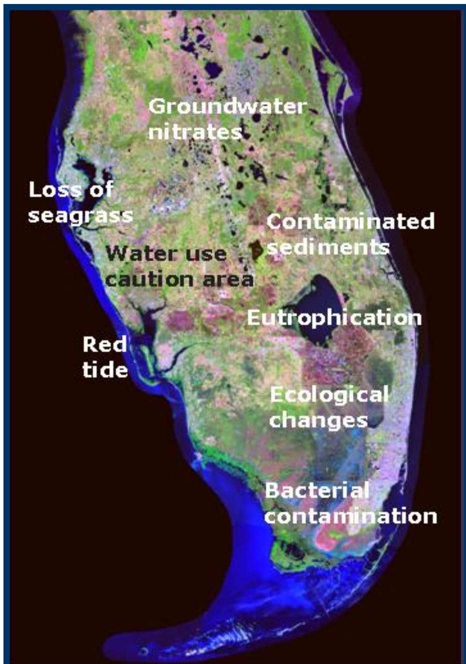
an average knowledge gain of 30%, and attendees used their new knowledge to augment their own educational programs and to aid client decision-making.



The impact of this training will be to:

- Increase understanding of water quality, runoff effects on surface water quality, non-point source pollution, and nitrogen and phosphorus loads
- Explain Best Management Practices, the value of aquatic plants in nutrient removal, and pond management
- Establish lake management plans
- Enhance citizen stewardship
- Increase volunteer monitoring at the county level
- Encourage residents to sample neighborhood stormwater ponds
- Present workshops on water quality and Total Maximum Daily Loads
- Train citizens interested in water quality protection

This newsletter was created to disseminate information on current projects in the Nutrient Management area. If you would like to submit an article for inclusion in a future newsletter please contact:

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