

Vegetable BMP Research - 2006-2007 Season: Introduction

Seventy percent of the Florida tomatoes production is grown in South Florida counties of Collier, Manatee and Palm Beach with approximately 41,200 acres in 2006 (NASS, 2006). Tomatoes are grown primarily in sandy soils. These crops are mostly grown in South Florida in the fall, winter or spring growing seasons under intensive irrigation and fertilizer management. Nitrogen (N) fertilizer management has become an issue of environmental concern for Florida vegetable growers following the [adoption by the State of Florida](#) of vegetable BMPs (Best Management Practices).

BMPs emphasize the need to better manage fertilizer, increase fertilizer efficiency, and reduce N loss to the environment. The optimum fertilization management and application section of the manual incorporates University of Florida (UF/IFAS) N rate recommendations.

The most common method for producing tomato in South Florida is to use seepage-irrigation together with fumigated raised beds with polyethylene mulch. Therefore, nutrient management is tied to this unique irrigation system. Because the plastic mulch covers the soil surface, all fertilizers (N, P, K, and micronutrients) are applied pre-plant. Typically, fertilizer is applied as a “bottom mix” (or “cold mix”) and a “top mix” (or “hot mix”). All the P and micronutrients, and 20% to 30% of the N and K are applied broadcast and incorporated in the bed as the bottom mix. The remaining N and K are applied in 1 or 2 grooves made on the top of the bed. Fertilizer in the “top mix” is slowly solubilized as the water moves up by capillarity (Olson et al., 2006a and b). While this system is simple and well established, growers often use N fertilizer rates above the UF/IFAS recommended rate because N may be lost by leaching or denitrification (Cockx and Simonne, 2003), but mostly as an inexpensive insurance if the market conditions remain favorable resulting in a longer-than-expected harvest season. When soluble fertilizers are leached by excessive rainfall (a leaching rainfall is defined as 3 inches of rain in 3 days or 4 inches in 7 days), UF-IFAS recommendations (Olson et al., 2006a and b) and vegetable BMPs (BMP 33I, p.96 of the BMP manual for vegetable and agronomic crops) allow for a supplemental application (per planted acre basis) of 30 lbs of N and 20 lbs of K₂O. Supplemental fertilizer applications should be made after a leaching rain, not before, preventively. While drip irrigation allows for easy in-season fertilizer application, crops grown with plastic mulch and seepage irrigation require a down-the-row application of fertilizer, done either manually or using a fertilizer wheel increasing the production cost.

BMP education is a slow process that requires the reconciliation of the rigor of science with the reality of vegetable production today (Simonne and Ozores-Hampton, 2006; Cantliffe et al., 2006). However, when BMP education is based on trust and a mutual commitment in the success of the project, a win-win situation develops where productivity, profitability, and environmental impact are integrated. Since, the first 3 x 100-ft long bed demonstrations conducted in the 2003-2004 season by G. McAvoy and E. Simonne, a lot of trust has been developed between UF-IFAS, DACS, and South Florida growers on nutrient management issues. This is best shown by the number and size of trials conducted in 2006-2007 (multiple rate trials, randomization and replication of the treatments, and 3-acre plots; Ozores-Hampton et al., 2006).

Vegetable BMP Research - 2006-2007 Season: Objectives

A 3-year project was initiated in southwest Florida in 2004-05 to:

1. establish partnerships with selected tomato growers to evaluate the effects of N fertilization in commercial fields;
2. evaluate the effect of N fertilizer rate on plant growth, nutritional status, yield, disease and pest incidences, and crop market value;
3. determine the optimum N rate for tomato production; and
4. evaluate the cost effectiveness of selected N application rates. This paper reports the results of the 2nd year of this project and focuses on objectives (1) and (2).

Vegetable BMP Research - 2006-2007 Season: Field Trial

We conducted thirteen trials at [five commercial farms](#) in multiple locations and seasons (fall, winter and spring) during the 2006-2007 seasons ([Table 1](#)). Together the cooperating farms represented 16,000 acres (80%) of staked tomato production in southern and eastern Florida.

Soils in the area have a sandy surface layer that is prone to leaching, mostly comprised of Immokalee and EauGallie fine sand).

Growing seasons are defined as fall with planting dates from August to 15 Oct., winter from 15 Oct. to 15 Dec. and spring from 15 Dec. to 1 Feb. These seasons differ in rainfall patterns, temperatures and day length. For example, fall may bring hurricanes, leaching rains, and wide-ranging temperatures; winter brings cool temperatures and unpredictable freezes accompanying cold fronts; spring is typically dry with temperatures cool at the start and warm or hot at the end. Typical growing season lengths are 18, 20, and 16 weeks for fall winter and spring, respectively.

Therefore eight trials were done with seepage, two with drip and three a combination seepage/drip irrigation. One trial was conducted in the fall 2006, nine in the winter (2006-07) and four in the spring 2007. Treatments consisted of N fertilizer rates ranging from 200 to 330 lb/acre N applied to seepage-irrigated tomatoes in a ([Table 1](#)), except the multiple N rate study with eight N rates from 20 to 420 lb/acre at 60 lb/acre increment in a completely randomized block experimental design with four replications ([Table 2](#)). In [drip-irrigated fields](#), there were two individual zones representing IFAS and growers N rates. At the [seepage-irrigated fields](#), the UF-IFAS rates were achieved by changing the rate or composition of the hot mix and by applying custom-made blends to keep P, K micronutrients rates constant. Hot-mix N and K fertilizer sources were water soluble nutrients, except trials 7 and 8 with a 25% slow release fertilizer. The trials represented diverse growing conditions found in Southwest and East Florida, and also included different varieties (mostly Florida 47 and Sebring), plant densities (in-row spacing of 18 to 26 inches between plants; 5 or 6 ft bed centers), soil types (described above), and farm sizes (700 to 5,000 acres). Cooperators prepared beds, [fumigated the soil](#), applied [bottom](#) and [hot mixes](#) and [installed polyethylene mulch](#), [transplanted](#), pruned, [staked](#), irrigated and provided pest and disease control.

Data collection:

The [water table depth](#) was recorded bi-weekly throughout the growing season. Beginning at first flower buds and continuing until third harvest, fresh petiole sap NO₃-N and K concentrations were measured bi-weekly using [ion-specific meters](#) (Cardi, Spectrum Technologies, Inc., Plainfield, IL) (Olson et al., 2005). Harvested plots were 15 to 22-ft long row segments of 10 plants. They were clearly marked to prevent unscheduled harvest by commercial crews. Marketable green and color tomatoes were [graded in the field](#) according to USDA specifications of number and weight of extra-large (5x6), large (6x6), and medium (6x7) fruit (USDA, 1997) of green and color. Yield data were subjected to analysis of variance (ANOVA) mean separation using Duncans Multiple Range Test at the 5% level of significance as well as non-parametric analysis tests like binomial distribution and probability

Vegetable BMP Research - 2006-2007 Season: Results

Weather conditions and supplemental fertilizer applications

Overall, South Florida was hot and dry throughout the fall, and cool and dry during the winter and spring of 2006-2007. Rainfall recorded by growers during the 2005-2006 season showed accumulations of 5, 0.5 to 13 and 10 inches for fall, winter and spring, respectively ([Table 3](#)). The IFAS tomato fertilizer recommendation allows supplemental N and K fertilizer applications in specific situations (Maynard et al., 2003), as does the BMP manual (Simonne and Hochmuth, 2003). Under this recommendation, 30 lb/acre of N can be added for each leaching rain event. Therefore, using fall/winter/spring 2006-07 as an example, a supplemental application of 30 lbs/acre of N fertilizer was permissible in two trials (7 and 8) in Palm Beach and four trials (10,11, 12 and 13) in Manatee due to three leaching rains. No fertilizer addition due to leaching rain was justified in the rest of the trials, so N fertilizer application consisted of the base 200 lbs/acre rate only (Olson et al., 2005). These results suggest that analysis and prediction of leaching rain frequency and timing would be valuable for Florida's vegetable growing areas.

Irrigation management

The BMP trial acreage was irrigated 80% by seepage and 20% by drip systems. The water table in the [seepage-irrigated](#) trials fluctuated between about 16 to 20 inches deep and tensiometer readings were between 4 and 8 kPa. In the [drip-irrigated](#) fields, water was applied daily at a volume estimated from the Weather Service Class A Pan evaporation combined with a crop coefficient. In trial 6, there was a higher late blight incidence in the IFAS than grower's rate, probably due to a higher water tables or higher soil moisture and not to N rate.

Plant nutritional status

Petiole sap NO₃-N concentrations were above the UF-IFAS sufficiency threshold throughout the season in all thirteen locations and under all N treatments, except for the lower N rates in the multiple N rate trials ([Figure 1](#)). After seven, nine, ten, eleven, thirteen, fifteen and sixteen week after transplants (WAT) the 20, 60, 120, 180, 240, 300, 360 and 420 lb/acre treatment were lower

than sufficiency range to the end of the season. In general, the higher N rates produced tomato sap NO₃-N concentrations that were greater compared to the lower rates. Petiole sap K concentrations tended to be above the UF-IFAS sufficiency threshold during the all season ([Figure 2](#)). The sap data suggest a weak N and K relationship in a dry year.

Yield response to N rates

In this dry season, IFAS and higher N rate produced significant higher yield in first harvest of extra-large tomatoes (80% of the total harvest) and total yields in 1 and 2 out of 13 trials [[Figure 3](#) (P<0.05)] respectively. In general, during the season when soluble fertilizer was used there were between 90 to 300 boxes/acre more in total yields with higher N rates, although the differences were not significant [[Figure 3](#) (P<0.05)]. At the highest prices during the season of \$23/box growers revenues will be \$2,070 for 90 boxes/acre and \$6,900 for 300 boxes/acre to offset \$20 to \$45 in cost of extra fertilizer. Regression analysis of first and total harvest extra-large yields and total yields indicated a quadratic response to the multiple N rates in trial 10 ([Figure 3](#)). The trend indicated an increase in total yield and first harvest extra-large and total extra-large fruit from 20 to 240 lb/acre N, but a plateau with higher rates of N. There was no response to N treatment by other tomato size categories at first, second and third harvest or all harvest combined. These results show that it may be possible to reduce N rates especially when the risk of rainfall is low (winter, spring and dry year), or when only two harvests are expected (late spring).

Grower participation in the project

We would like to thank the growers participating in the project for their in-kind contribution and valuable inputs. The BMP trials are a popular on-farm research project where growers and IFAS cooperators work as a team. Together the cooperating farms represented 16,000 acres (80%) of staked tomato production in southern and eastern Florida and 310 acres under BMP experiments.

Vegetable BMP Research - 2006-2007 Season: Conclusion

Summary for the 2006-2007 seasons:

1. On farm trials continue to be a growers preferred research for N BMP studies. Extensive one-on-one grower contact was an effective means to engage growers in the implementation and outcome of this research and demonstration project.
2. Petiole sap NO₃-N and K concentrations throughout the season tended to be above the UF-IFAS sufficiency threshold for all N treatments and seasons.
3. In this dry season, IFAS and grower rates produced significant higher yield in first harvest of extra-large tomatoes and total yields in 1 and 2 out of 13 trials [Table 4 (P<0.05)] respectively. The trend indicated an increase in total yield and first harvest extra-large and total extra-large fruit from 20 to 240 lb/acre N, but a plateau with higher rates of N. These results show that it

may be possible to reduce N rates especially when the risk of rainfall is low (winter, spring and dry year), or when only two harvests are expected (late spring).

4. A cooperators grower's survey during 2007 indicated that they would like to continue two more years with N-BMP studies with a total of five year study. The main areas of interests are: testing grower vs. IFAS N rates under dry, moderate rainfall and a wet years; testing N rates in different crops: cherry, grape, plum, peppers, etc.; testing P, K and minor with N; continue with the economics of N; fall, winter and spring studies with multiple N rates in different farms; more drip and N; and finally more data is need in the early fall with high rainfall.