

PROGRESS REPORT: YEAR 3 of 3 (2004-05)

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**Performance of current N-BMPs for maximizing citrus profitability and
groundwater protection on the Florida ridge
(Project # 00005912)**

by

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INTRODUCTION

A Nitrogen Best Management Practices (N-BMPs) rule for Florida Ridge citrus was implemented in 2002, replacing the previous nitrate interim measure. This is a proactive, incentive-based program founded on fertilization and irrigation guidelines for citrus that were developed from citrus-specific research since the early 1990s. Some controversial aspects of citrus N-BMPs remain; one of these is the maximum annual rate of N permitted for optimal citrus production of mature bearing groves. This measure was introduced to prevent surficial groundwater contamination from surplus nitrate-N fertilizer not absorbed by the crop. For bearing mature round oranges this maximum was set at 240 lb N/ac/y, for a 4-year running average. An additional 30 lb N/ac/y is permitted with prior justification of high yields; a 3-year average yield of at least 700 boxes /ac/y for early and mid-season oranges, and 500 boxes /ac/y for 'Valencia'. There is some concern that these maximum N rates are still insufficient for optimal production of high-yielding citrus, while other concerns are that the maximum rates are too high for adequate protection of groundwater. Both concerns are best resolved with additional research evidence, which is why this project was developed to test current N-BMPs on highly productive Ridge citrus.

The main objectives of this experiment are to 1) test the effectiveness of current citrus N-BMPs to protect groundwater from nitrate contamination while maintaining or increasing profitable fruit production, 2) establish the yield - N responses and optimum N-rate for mature citrus under an optimized comprehensive BMPs program (BMPs) and also a more conventional management program ("non"-BMPs).

EXPERIMENT METHODS

A suitable high-yielding block of 'Hamlin' orange on Cleopatra mandarin rootstock was selected in mid-2002 at Gapway Grove's Fort Meade division. Commercial block average yields from these trees were:

Season	Yield (boxes/ac)
1997-1998	800
1998-1999	749
1999-2000	490 (topped that year)
2000-2001	808
2001-2002	720
2002-2003	550 (topped that year)
2003-2004	892
2004-2005	323 (impact of 3 hurricanes in 2004)
MEAN (last three years):	588

The block is 38.5 acres in extent, all on Candler sand soil, of which the northern ~20 acres were selected for experiment plots and fertilizer treatments were initiated in Fall 2002. Since the average yield for three consecutive years was often over 700 boxes/ac/y, the higher N-BMPs limit for round oranges of 270 lb N/ac/y can be applied. Five fertilizer rates chosen for this experiment were therefore designed to test the full range of allowed N, and beyond, in order to evaluate the protection of groundwater with maximum (BMPs) rates, and to establish whether there are additional economic yield increments beyond the maximum rate. These rates are: 140, 180, 220, 260, 300 lb N/ac/y. An additional 2-treatment factor (split plot design) was added to the experiment in order to contrast conventional "non-BMPs" 3 times per year fertilizer splitting with BMPs 4 times per year fertilizer splitting. Specifically, the maximum of 65 lb N/ac/application of dry granular fertilizer permitted by the N-BMPs was implemented for all BMPs-compliant annual rates (140-260 lb N/ac/y) by using four splits (treatments 1-4; Table 1). Treatment 5, with a total annual N rate of 300 lb N/ac/y does not comply with the N-BMPs on either the annual total or the split application, but is necessary to test the effects of such

deviation on both groundwater contamination and fruit yield. In treatments 1-5, we installed special “spoked+fill” 360-degree circular pattern nozzles to provide better coverage of water under the trees and prevent leaching. Treatments 6-10 are the basic non-BMPs comparative treatments; no special leachate conservation (standard “double-fan” nozzles) and no optimal splitting to limit amounts of N per application were included (Table 1). In all treatments, the applications are timed to avoid the main rainy season of June to September, as prescribed by the N-BMPs (Table 1).

The trees were planted in 1981 at 25 x 20 feet spacing, with single yellow nozzle /tree (20 gph) microsprinkler irrigation. Historically all fertilizer was applied in the dry granular form, and for this experiment was applied with a variable rate fertilizer spreader. The M&D split-chain 3-ton spreader we used is capable of independent left and right swathe rate control, and has been modified to deflect the fertilizer stream under the tree canopy. Fertilizer was applied according to a prescription map read by an on-board GPS-controlled computer, while real-time tree sensors were programmed to shut off the fertilizer at resets or missing trees (about 9% of the grove in 2003). Resets were individually fertilized at a lower rate by hand according to the BMPs. The gross plot size is 6 x 6 trees, with the middle 4 x 4 reserved for measuring and harvesting. The double row, double tree buffers should avoid any inter-plot treatment contamination, while the larger than normal net sampled plot size should also help improve the precision and accuracy of this experiment. There are four complete replications of the 2x5 split plot treatments, making 40 total split plots. All plots received K nutrients in the same fertilizer mixture at about a 1:1 N:K ratio to ensure sufficient K fertility. Variable rate fertilizer prescription and as-applied maps were generated for the entire test plot area.

We estimated nitrate leaching losses from the trees in each treatment with mini vacuum lysimeters, placed at 5 feet below the soil surface to intercept leachates escaping below the root zone. Samples were collected as leaching occurred and were analyzed for nitrate-N in the laboratory.

EXPERIMENT TREATMENTS:BMP treatments for N 1-5[§]

Application date	Allocation (%)	N1	N2	N3	N4	N5
		N rate (lb/ac)				
mid-Feb	25	35.0	45.0	55.0	65.0	75.0†
early-Apr	25	35.0	45.0	55.0	65.0	75.0†
end-May	25	35.0	45.0	55.0	65.0	75.0†
early-Oct	25	35.0	45.0	55.0	65.0	75.0†
<u>TOTAL p.a.</u>	<u>100</u>	<u>140</u>	<u>180</u>	<u>220</u>	<u>260</u>	<u>300</u>

non-BMP treatments for N 6-10[¶]

Application date	Allocation (%)	N6	N7	N8	N9	N10
		N rate (lb/ac)				
mid-Feb	33.33	46.7	60.0	73.3	86.7	100.0
end-May	33.33	46.7	60.0	73.3	86.7	100.0
early-Oct	33.33	46.7	60.0	73.3	86.7	100.0
<u>TOTAL p.a.</u>	<u>100</u>	<u>140</u>	<u>180</u>	<u>220</u>	<u>260</u>	<u>300</u>

§ Apply all current BMPs - max dose 65 lb/ac, optimized splitting and timing, using “spoked+fill” 360-degree circular pattern nozzles for irrigation

† Current BMP maximum N application dose (65 lb/ac) exceeded slightly for the highest rate of N only

¶ Use “conventional” grove practices for fertilizer splitting (3), dosing, timing, and irrigation nozzles

Note: The remainder of block 4, Fort Meade received 240 lb N/ac /y fertilizer, split into four applications as in treatments N1-N5 above.

PROGRESS TO DATE (2005)

The importance of correct N rate matching with tree crop demand, and the danger of excess irrigation which causes leaching were already demonstrated in this experiment (June 2003 report). We further demonstrated with the fruit yield of 2003-2004 that this highly productive grove can continue to produce high yields in excess of 900 boxes/ac while complying with the N-BMPs (Fig. 1). Soluble solids production per box of fruit peaked at about 230 lb N/ac/y (Fig. 2). The economic optimum granular fertilizer rate for total soluble solids production in this grove was 220-230 lb N/ac/y (Fig. 3), 40-50 lb N/ac/y less than the maximum 270 permitted by the N-BMPs. Growers are paid for the production of soluble solids in the fruit, so this criterion was the most important for determining the optimum fertilization rate (Fig. 3). The maximum N rate set by the ridge N-BMPs is 270 lb N/ac/y for early and mid-season varieties producing over 700 boxes/ac/y. However juice production and fruit yield continued to increase with additional N fertilizer up to the maximum 300 lb N/ac/y tested in this experiment. There was no evidence in the early years of this experiment that the management option of four fertilizer splits per year was better than three splits, despite the fact that only the two lowest N rates (140, 180 lb N/ac/y) complied with the N-BMPs (not more than 65 lb N/ac/application; Table 1). Leaf N concentrations during summer of 2003 were adequate for all fertilizer rates (Fig. 4), and were marginally excessive (> 3%) for the highest fertilizer rate of 300 lb N/ac/y. Yield results in 2004-2005 were low and non-significant among treatments, as a result of hurricane damage. There were major losses of green fruit dropping to the ground as early as August 2004 (Hurricane Charley; see damage in Fig. 5). As a result, we lost a year of production data from this experiment.

This experiment is particularly valuable because of the high yield potential, the large plot sizes (36 trees, or about 0.5 acre each), and the fact that the fertilizer was accurately applied with the latest variable rate technology, including deflectors to band the fertilizer granules under the trees, and tree sensors which automatically omit fertilizer from recent resets or missing trees. The data obtained in the first treatment year already showed significant growth responses which appeared accurate and reliable. This is one of the few experiments conducted during the past 15 years which has adequate double row plot buffers to prevent inter-plot fertilizer treatment contamination. Most fertilizer experiments conducted over the past decade had single-row plots with no buffer rows, and small harvested fractions (1-4 trees /plot). This experiment potentially has 16 trees /plot available for harvest and we used the best 8 /plot for assessing fruit yields. Due to the good early results so far, and due to the failed harvests of 2004-2005 as a result of the central Florida hurricanes, we are hoping to continue this experiment for at least another two years.

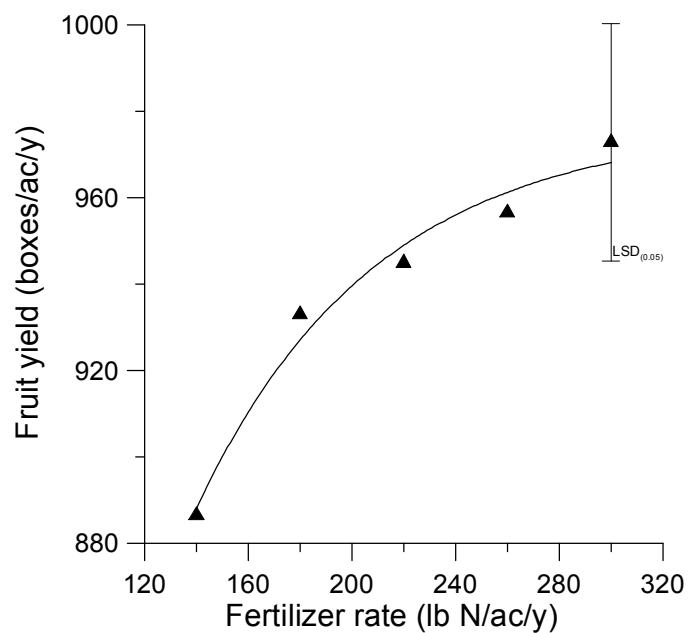


Figure 1. Fruit yield at different fertilizer rates in the 2003-2004 season

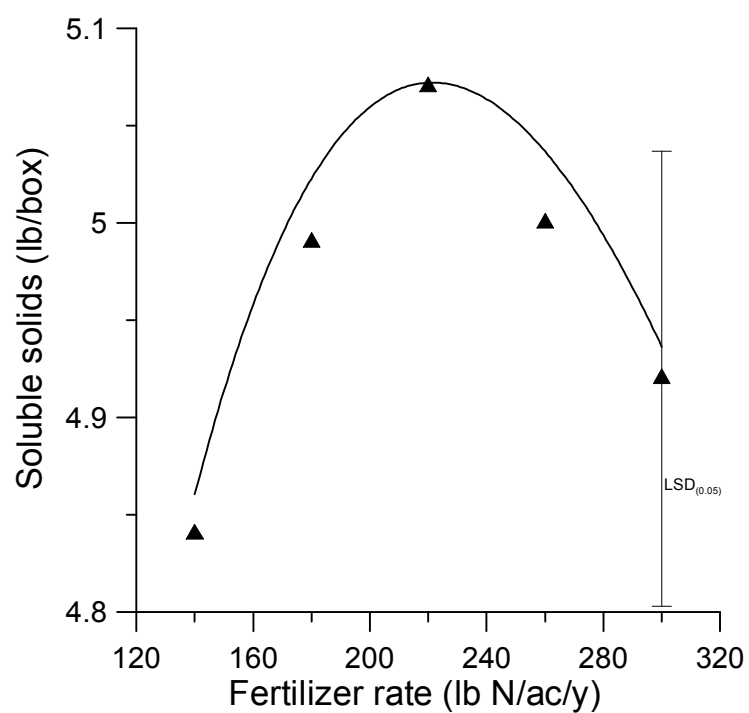


Figure 2. Soluble solids production per box of fruit at different fertilizer rates in the 2003-2004 season

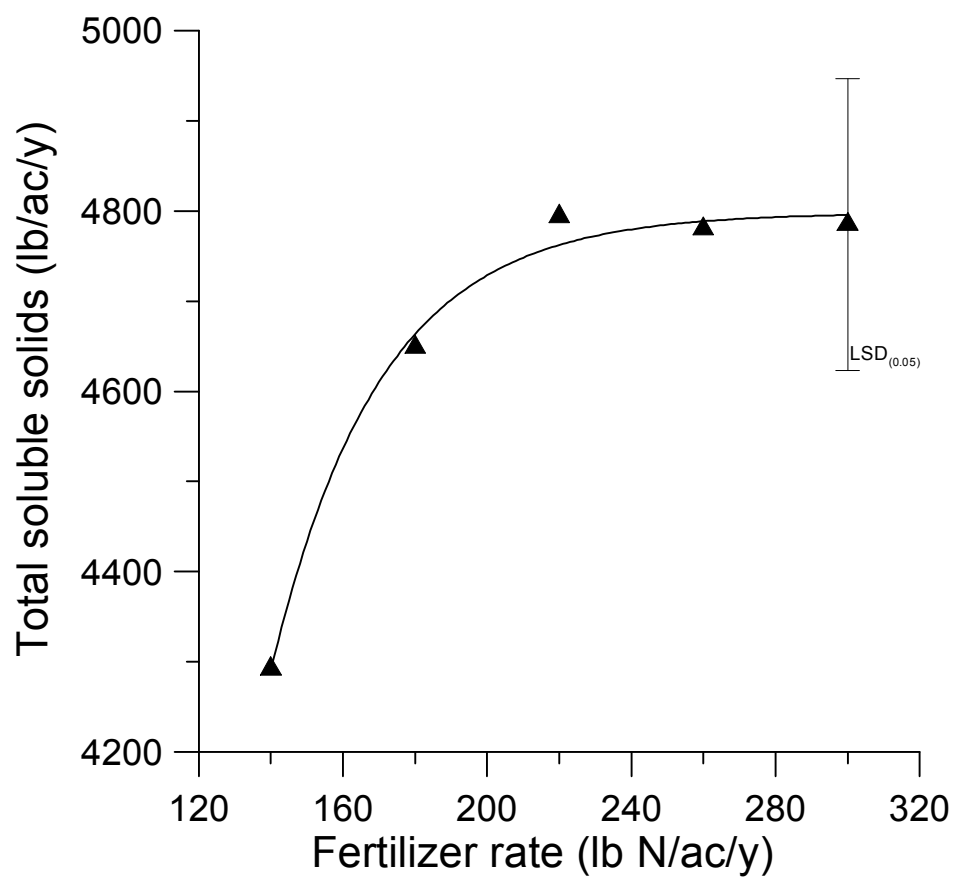


Figure 3. Total soluble solids yield at different fertilizer rates in the 2003-2004 season

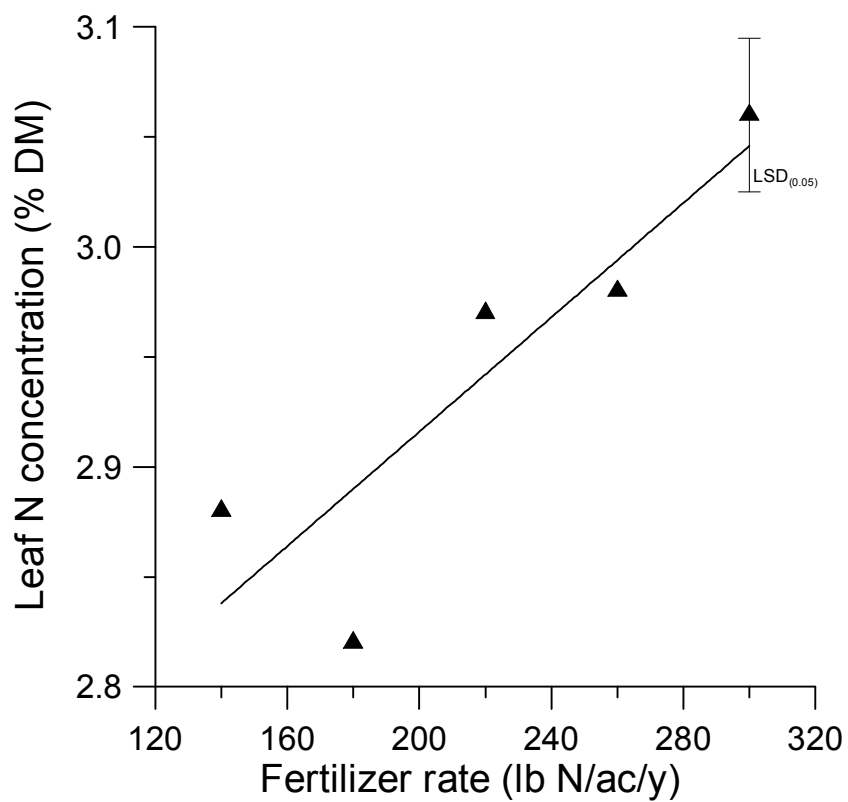


Figure 4. Leaf N concentrations at different fertilizer N rates during summer of 2003



Figure 5. Fruit drop caused by hurricane Charley in August 2004