Evaluation of Various Soluble and Controlled Release Fertilizer Sources and Delivery Methods in Watermelon for Yield, Fruit Number, Average Fruit Weight, and Nitrogen and Potassium Levels in Leaf Tissue

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Background

For the past several years, faculty at the NFREC-SV have conducted research on using conventional and controlled release fertilizers (CRF) to grow watermelons, field corn, snap bean, potato, and carrot to determine how CRF may fit into the BMP nutrient toolbox. Past trials funded by Florida Watermelon Association, Florida Department of Agriculture and Consumer Services (FDACS) Office of Ag Water Policy, Suwannee River Water Management District, other agencies, and industry supporters have been focused on comparing CRF with conventional fertilizer.

Controlled Release Fertilizer (CRF) releases small amounts of fertilizer components over time when the plant needs them. These polymer-coated fertilizers are designed to release nutrients at a predetermined rate over a specific time. The release rate is aligned with the plant growth curve for specific crops and the release is guided by temperature and is based for the region and season where the CRF will be used. This can result in "decreased nutrient losses and enhanced nutrient-use efficiency" (IFAS Publication HS1255). In addition, an alternative fertilizer program where small amounts of nitrogen are applied via drip irrigation delivery routinely (example weekly or twice per week) for the entire season could also minimize leaching losses.

Research at NFREC-SV and on-farm trials has shown that a crop can be produced with CRF with similar yields and leaching can be reduced when compared to traditional uncoated fertilizers commonly used in the region to grow these crops. The high risk of leaching with traditional fertilizer is especially high in the early part of the season when the plant root system is small. CRF can greatly reduce these early season losses due to over-irrigation or leaching rain events because the fertilizer granules are protected within a polymer coating. It is likely to anticipate some reduction in the amount of nitrogen needed during a season, but the biggest benefits from CRF or an “all-liquid” fertigated program may be helping the plants to use fertilizer more efficiently and reducing leaching in the early part of season.

Objectives:

This trial will compare nitrogen and potassium management programs and sources including controlled release fertilizer, all liquid sources, and a traditional commercial program (a portion in the bed and the remainder fertigated) in a plastic mulch and drip irrigation production system for watermelon grown in deep sandy soils in North Florida.

Materials and Methods

This trial was conducted at the North Florida Research and Education Center- Suwannee Valley (NFREC-SV) during the spring of 2023. The research trial area was prepared by power-tilling the soil and pressing the beds using a Kennco Manufacturing Inc. (Ruskin, Fl) bed press. Rows were pressed and spaced eight feet apart and 150 feet long. Each plot was 70 feet long with a 5-foot buffer between plots in the same row. The formed beds were 24-inches wide and 6-inches high. Preplant conventional and controlled release fertilizers were incorporated into the soil where the beds were to be formed. Any additional nitrogen and potassium needed toward the middle and end of the end of the season was applied vis fertigation through the drip tape. After mulches were applied, the herbicide combination of Sinbar and Sandea was applied to the row middles.

There were four fertilizer treatments in this trial. All treatments received the same total season nitrogen (150 lbs/A and potash (200 lbs/A) rates. The potash applications included 50 lbs per acre pre-plant applied to all plots from the application of 0-8-13 (N- P_2O_5-K_2O) and the remainder applied to each treatment as described in the treatments. Plots were arranged in a randomized complete block design with 4 replications. All nutrients other than nitrogen and potassium were applied uniformly to the experimental area before beds were formed. Conventional granular and CRF fertilizer treatments were applied to the soil (flat ground) in a 24-inch swath where the beds would be formed and later covered with mulch. After fertilizers were applied to the soil, the soil was rototilled to a 6-inch depth and beds were formed with a set of hilling discs. Mulch was applied to the pressed beds on March 24, 2023, with a “Kennco Speed Layer.” Drip irrigation tape was applied as the mulch was laid with the same machine. Drip tape was applied to the bed center and slightly buried in a shallow one-inch groove. Three of the treatments (those other than Full Season CRF) required liquid fertigations of N and K and were set to be fertigated once or twice a week when fertigations were required. The fertigation events were implemented using a 4-head Masterflex peristaltic roller-type pumping system. For fertigations, the 4 plots per treatment were plumbed together independent of the other treatments. On any fertigation event, those treatments not needing N and K were injected with water only so to maintain all plots with equal irrigation events all season. The N and K_2O fertigation schedules were set for the season based on watermelon crop needs each week. The Full Season CRF treatment received no additional N or K via fertigations. The All Liquid, Partial Season CRF, and Conventional treatments all received fertigations of an 8-0-8 (N-P_2O_5-K_2O) solution with no additional macro or micronutrients according to the rates set in Table 1. The Conventional and Partial Season CRF treatments were both set to provide 45 lbs/A of N and K_2O in the pre-bed granular fertilizer applications and the remaining 105 lbs/A of N and K_2O via the

liquid fertigation events. During the first 5 weeks of fertigation events, fertigations were made once per week, but after week 5, fertigation events were done twice per week with half of the weekly requirement applied to each of the two weekly fertigations.
Each treatment had one soil moisture sensor installed in one of the 4 reps. These Sentek soil moisture sensors supplied through BMP Logic were used to assure each plot was receiving similar and adequate irrigation. The irrigation events were automated using a simple battery-operated timer and master solenoid. Length and number of irrigation events each day varied as plant needs increased during the season. Irrigation events started out with 20-minute events every other day and incrementally increased to 2 events daily for 60 minutes each, as needed, to provide for crop needs but avoid leaching in the sandy soil at the site.

Fertilizer treatments were as follows:

1. "Conventional" - Traditional conventional granular fertilizer (uncoated) with 45 lbs/A of N and K_2O in the bed prior to laying plastic mulch and the remainder (105 lbs/A) of N and K_2O via fertigations into drip irrigation system.
2. "Full Season CRF" - Polymer coated fertilizer applied to the soil prior to laying plastic mulch for season long supply of nitrogen and potassium (150 lbs/A of N and K_2O).
3. "Partial Season CRF" - Polymer coated nitrogen and potassium fertilizer with 45 lbs/A of N and K_2O applied to the soil prior to laying plastic mulch and the remainder (105 lbs/A) of N and K_2O applied via fertigations into drip irrigation system.
4. "All Liquid" – Soluble sources of nitrogen and potassium (8-0-8 N-P_2O_5-K_2O) solution were supplied from the very beginning of the season, fertigated via drip irrigation (150.5 lbs/A of N and K_2O.

Five-week-old seedless watermelon transplants (Fascination) and superpollinizer (SP-7) transplants were established in the field on March 29, 2023. Seedless plants were transplanted on a 36-inch spacing in the row and superpollinizer plants were transplanted on the opposite side of the drip tape positioned between every third and fourth seedless plants. Holes for the seedless plants were punched with a Kennco "water wheel" metal drum with spokes every 36 inches and holes for the superpollinizer plants were punched by hand with a wooden hole-punch. The crop was managed with commonly used fungicide and insecticide applications weekly. The experimental area was more heavily infested than expected with nutsedge. Early in the season nutsedge was managed by hand weeding but the population was too high to manage by hand, resulting in the decision to apply halsulfuron as a broadcast spray over the crop to save the experiment.
Data collection included three sampling dates for leaf tissue analysis for nitrogen and potassium. A sample of 15-20 most recently matured leaves (blade and petiole) were collected from each plot and sent to Waters Agricultural Lab in Camilla, GA. Mature fruit were harvested on three dates and each fruit was weighed and the weights recorded.

Results and Discussion

As expected, the crop progression was temporarily slowed after the halsulfuron application. The crop recovered well yet did have a delay in the first harvest.

Leaf tissue N levels were maintained in all treatments on all three sampling dates within or above the recommended range (Plant Tissue Analysis and Interpretation for Vegetable Crops in Florida, G. J. Hochmuth and E. Hanlon, (https://edis.ifas.ufl.edu/publication/EP081)). Leaf tissue N was significantly different for treatments at the first sampling date (May 5, 2023, at first flower, 37 days after transplanting) (Table 1). Highest leaf N was found in Partial Season CRF and Conventional fertilizer programs. Lowest N levels at first sampling date were found in Full Season CRF and All Liquid fertilizer programs. The All-Liquid N levels were not significantly different from either Full Season CRF or Conventional fertilizer programs. On the second sampling date (May 18, 2023, 50 days after transplanting), there were no significant differences found in leaf tissue N levels between treatments. On the third sampling date (May 30, 2023, 62 days after transplanting), all leaf tissue N levels were high, but the highest levels were found in All Liquid, Conventional and Partial Season CRF fertilizer treatments. Overall, each fertilizer treatment maintained an adequate or high level of leaf tissue N during the entire season.

Leaf tissue K levels were typically maintained within or slightly below the recommended range at the three sampling dates (Hochmuth and Hanlon). At the first sampling date, leaf tissue K levels were highest in Partial Season CRF, Conventional and All Liquid fertilizer treatments (Table 1). At the second and third sampling dates, there were no significant differences found among treatments. Overall, minor differences in leaf tissue K were found early in the season, but during the remainder of the season, leaf tissue K was not affected by fertilizer treatments.

Early season yields (first harvest) were statistically similar among fertilizer treatments (Table 2). Average fruit weight at the first harvest was significantly different among fertilizer treatments. The highest average fruit weight was highest in All Liquid (15.9 lbs/a) and Partial Season CRF (15.1 lbs/A) fertilizer treatments. There was no significant difference in the number of fruits harvested per acre at the first harvest.

Total yields in this trial ranged from 68,265 to 73,865 lbs/A for three harvests summed together and there were no significant differences in total season yields among any of the fertilizer treatments (Table 2). Total season average fruit weights ranged from 12.6 to 13.0 lbs per fruit with no significant differences among treatments. Likewise, there were no significant differences among treatments for the number of fruits per acre for the total season. Overall, the harvest data showed that all fertilizer programs evaluated in this trial performed in a very similar manner for early season yield and number of fruits, and total season yield, average fruit weight and number of fruits. All fertilizer treatments provided the same total amount of N and K for the season, and treatments only varied with sources, timing, and methods of application. One of the main purposes of the trial was to determine if an "all liquid" program starting from the very beginning of the season could produce similar yield and quality to the more proven traditional conventional programs of some granular N and K fertilizer in the bed, followed by liquid fertigations during the season. In addition, we included two recently tested scenarios of CRF N and K, one as a partial season CRF in the bed, followed by liquid fertigations (as in conventional program) and the second CRF was a full season CRF N and K program. The data confirmed that any of these programs can adequately meet the crop N and K needs and provide similar yields and fruit size.

Table 1. Nitrogen and Potassium Weekly Fertigation Schedule for Treatments Requiring Fertigation Events During the Watermelon Season

Fertigation (weeks)	Fertigation Rates for All Liquid treatment (Lbs of N and K_2O /A/day)	Fertigation Rates for Conventional and Partial Season CRF treatments (Lbs of N and K_2O /A/day)
March 21 = Week 1	1.5	0
2	1.5	0
3	1.5	0
4	2.0	0
5	2.0	2.0
6	2.5	2.5
7	2.5	2.5
8	2.5	2.5
9	1.5	1.5
10	1.5	1.5
11	1.5	1.5
12	1.0	1.0
Season Total	150.5	105

Note: The 8-0-8 solution used in this trial weighed 9.89 lbs per gallon.

Table 2: Leaf Tissue Nitrogen and Potassium Percentages

	Leaf Tissue N%			Leaf Tissue K%		
Fertilizer Treatments	Date 1	Date 2	Date 3	Date 1	Date 2	Date 3
All Liquid Program	4.80 bc	3.54 a	5.00 a	2.75 ab	2.25 a	1.93 a
Partial Season CRF	5.23 a	3.56 a	4.85 ab	2.93 a	2.20 a	1.93 a
Conventional Program	5.08 ab	4.13 a	4.90 ab	2.89 a	2.48 a	1.89 a
Full Season CRF	4.62 c	3.40 a	4.69 b	2.51 b	2.32 a	1.86 a
Significance at .05 level	*	NS	*	*	NS	NS

Note: NS= not significant at .05 level
*= significant at .05 level

Table 3: Yield Data in Pounds per Acre for the First Harvest and Total Harvest

	First Harvest			Total Harvest		
Fertilizer Treatment	Yield(lbs/A)	Avg. Fruit Wt.(lbs)	Number of Fruit per Acre	Yield(lbs/A)	Avg. Fruit Wt.(lbs)	Number of Fruit per Acre
All Liquid Program	36,637 a	15.9 a	2,318 a	73,865 a	12.8 a	5,523 a
Partial Season CRF	39,367 a	15.1 ab	2,606 a	72,489 a	12.9 a	5,391 a
Conventional Program	35,393 a	14.8 b	2,396 a	72,442 a	13.0 a	5,484 a
Full Season CRF	33,471 a	14.5 b	2,318 a	68,265 a	12.6 a	5,289 a
Significance at .05 level	NS	*	NS	NS	NS	NS

Note: NS= not significant at .05 level
*= significant at .05 level

Photo 1: Watermelon plants emerging after seeding on February 16, 2023.

Photo 2: Watermelon plants awaiting being transplanted.

Photo 3: March 21, 2023. Fertilizer being applied in preparation for bedding and plastic application.

Photo 4: March 24, 2023. Ground bedded up and treatments marked in preparation for plastic mulch application.

Photo 5: Measuring out the fertilizer for a fertigation event.

Photo 6: Setup being utilized for fertigation event on Week 8, May 9, 2023.

Photo 7: Mid-season view of trial. The left row is the CRF Full Season Treatment row, and the right row is the Conventional Treatment.

Photo 8: Left row is the All-Liquid Treatment row, and the right row is the CRF Partial Season Treatment.