

**Trial No: BGT18101-SR-US01-FL01**

**Bacstone Maximum 12-0-0**

**Citrus fertility and growth response**

**2018**

#### **Abstract**

Bacstone Maximum was evaluated as a drip irrigation injection fertilizer during fall flush of grapefruit compared with the grower standard nitrogen drip irrigation application and as an additive to the grower standard program. Treated trees were evaluated for canopy volume, foliar flush, vigor, foliar tissue nitrogen content and citrus canker incidence.

Application problems were encountered due to emitter clogging by a precipitate in the Bacstone Maximum formulation during the first two of three applications. Use rates for the first two applications were determined from material balance calculations based on material remaining in the injection tank following application.

Bacstone Maximum and Bacstone Maximum plus the grower standard were comparable to the grower standard in canopy volume, foliar flush, vigor and foliar tissue nitrogen levels indicating potential for Bacstone Maximum use as a nitrogen fertilizer for citrus.

Bacstone Maximum provided reduction in citrus canker incidence compared to the grower standard fertilizer program even though both treatments had standard foliar spray copper bactericide treatments in addition to the fertilizer treatments.

#### **Introduction**

Bacstone Maximum is a simple mineral fertilizer containing 12% ammoniacal nitrogen, 1% copper and 5% zinc. The product is formulated in a unique manner intended to enhance availability of the nutrients contained to provide nitrogen and prevent or solve copper and zinc deficiency. Bacstone Maximum is registered in many countries for foliar application and as an irrigation injection application.

#### **Objective**

The objective of this trial was to evaluate the use of Bacstone Maximum for use on citrus during the fall flush as a substitute for the grower standard nitrogen fertilizer application and as a supplemental nitrogen application to the standard application. It was also an objective to determine if the use of Bacstone Maximum on citrus as a fertilizer during fall flush had any effect on disease susceptibility of citrus to Asiatic canker, *Xanthomonas citri*.

## Materials and Methods

The trial was conducted by Florida Pesticide Research, Inc. on a 28 acre two-year-old grove of Ray Ruby grapefruit on sour orange root stock in Seminole county Florida. Irrigation was supplied by a drip irrigation system with a line running down the tree row adjacent to the tree trunk. The grove was arranged with 10-foot tree spacing in rows 23 feet apart with 189 trees per acre. The plot area was comprised of three treatments replicated six times on plots of three trees each or 12,420 square feet, or 0.29 acres in a randomized complete block design in the center of the 28-acre grove. Soil texture in the grove was typical of this production region in Florida, classified as sand and comprised of 96% sand, 7.1% silt and 1% clay with 1.5% organic matter, a pH of 7.1 and cation exchange capacity of 4.8.

Table 1 lists maintenance pesticide applications that were made to all trees in the grove in the summer and fall of 2018. During this time, applications of copper were made to the trees on July 14 and September 5th and Actigard 50WG was applied on August 23 as standard treatments for citrus canker disease.

**Table 1. Grove maintenance treatments summer and fall 2018.**

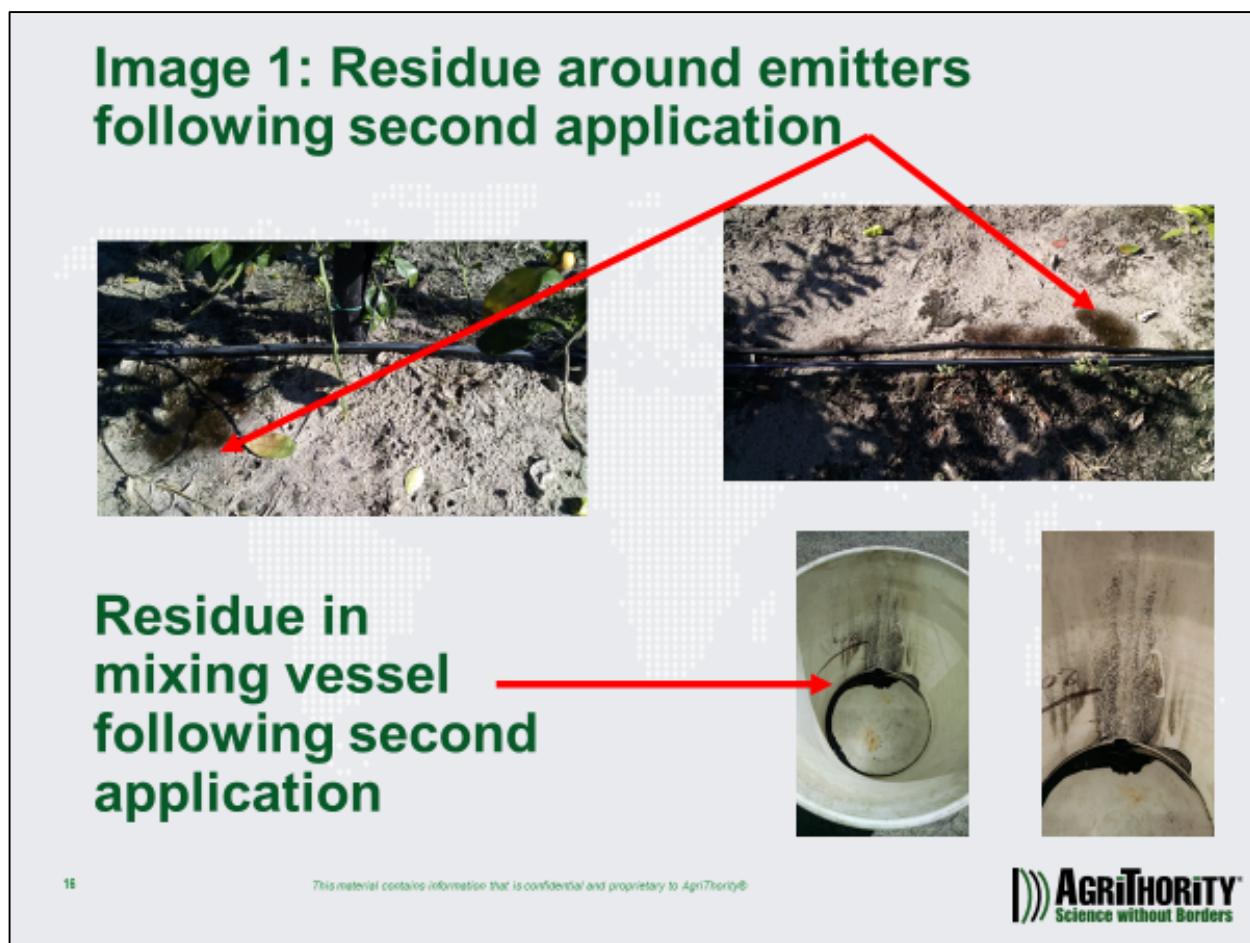
DATE	TYPE	PRODUCT	Rate
Jul-14-2018	FUNG	EF-L Copper	80 FL OZ/A
Jul-14-2018	INSE	Actara	35 FL OZ/150 gal
Jul-30-2018	INSE	Micromite 80WGS	6.5 OZ /A
Aug-23-2018	FUNG	Actigard 50 WG	1 OZ /A
Aug-23-2018	INSE	Admire Pro	0.5 Gal/55gal
Aug-24-2018	HERB	Glyphosate	1 GAL/A
Aug-24-2018	HERB	Solcam DF	5 LB/A
Sep-5-2018	FUNG	ET-F Algicide/Bactericide	100 FL OZ/150 gal
Sep-5-2018	INSE	Agri-Mek 0.15 EC	40 FL OZ/150 gal
Sep-17-2018	HERB	Paraquat	1.25 qt./55gal
Sep-17-2018	HERB	Karmex DF	4 pt./55gal

**EF-Copper, Actigard 50WP and ET-F Algicide/Bactericide were applications for prevention or control of citrus canker.**

Experimental treatment drip applications were made using a John Deere 5400 tractor equipped with a 55-gallon three-point hitch tank and pressurized by a 12-volt electric pump capable of

delivering 5 gallons per minute (gpm). The discharge line from the pump was connected to 30' of TORO-Aqua Trax medium flow drip tape. Sprayer pressure was 30 PSI. The drip tape was

calibrated prior to application to deliver 1 gallon per tree total volume or 189 gallons per acre. During application 1 and 2, It was confirmed that the test substance was plugging the drip emitters. At Application 3 the drip tape was replaced with poly tubing and three microjets. This solved the plugging problem, but commercially, the plugging will be a problem on drip applications. The particulate causing the plugging shown in image 1, was identified and reported to the Study Director.



University of Florida citrus production recommendations for nitrogen application to two-year-old trees through drip irrigation systems is .03 to .06 lbs. nitrogen/tree/application for 10 applications/year. The target application rate for Bacstone Maximum was 5.8 fl. oz. per tree or 8.56 gal./acre for each of three applications on August 10, September 7 and October 16. The rate of 5.8 fl. oz. Bacstone Maximum/tree should deliver 0.05 lbs. N/tree. Based on material remaining in the application system after treatment it is estimated the Bacstone Max was

applied at 66% of the target rate for application 1, 75% of the target rate for application 2 and 100% of the target application rate for application 3.

The actual application rates for Bacstone Maximum were therefore calculated to be 0.033, 0.0375 and 0.05 lbs. nitrogen per tree or 5.65, 6.426 and 8.56 gallons of Bacstone Maximum per acre on August 10, September 7 and October 16 respectively. (Table 2)

**Table 2. Treatment details of Bacstone Maximum irrigation injection application to grapefruit during fall flush 2018.**

	Treatment	N content	Rate/acre	Rate/tree	Application*	Application method	Total volume
1	Bacstone Maximum	12 %	8.56 GAL	5.8 FL OZ	ABC	Irrigation injection	189 GAL/AC
2	Calcium Nitrate	15.5 %	73 LB	0.06 OZ	C	Irrigation injection	189 GAL/AC
3	Bacstone Maximum	12 %	8.56 GAL	5.8 FL OZ	ABC	Irrigation injection	189 GAL/AC
	plus Calcium Nitrate	15.5 %	73 LB	0.06 OZ	C	Irrigation injection	189 GAL/AC
*Application A applied 10 Aug., Application B applied 7 Sep, application C applied 16 Oct.							

**Due to clogging of the drip tape, application A was made at approximately 66% of target rate and application B was made at approximately 75% of target application rate.**

At each evaluation date, each of the three trees per plot were assessed for growth parameters and disease symptoms. On August 10 and November 11, tree width, length in-row and height were taken, and tree canopy was calculated (width X length in-row X height). On these same dates, new terminal growth (flush) was measured and subjective vigor ratings made on a scale of 0-10 (0 = no flush and 10 = perfect tree) were taken from all plots. Leaf samples were collected and analyzed for total nitrogen on November 15 and citrus canker disease ratings on a 0-10 scale (0 = no disease and 10 = lesions on all foliage) were recorded for each plot August 31 and October 16. Data was statistically analyzed with ARM software from Gylling's Data Management using standard analysis of variance and means were separated using the least significant difference (lsd) test at P=.05.

## Results

### Canopy Volume and Canopy Volume Increase

Table 3 depicts results of canopy volume calculations Aug. 10, the day of the first Bacstone application and Nov 15 approximately one month after the third and final Bacstone application and the grower standard of a single high rate nitrogen fertilizer application. Column 3 depicts results of canopy volume increase after the different fertilizer application schedules. There were no statistically significant differences in canopy volume or volume increase during the test. Numerical comparisons of canopy volume increase in the test show that the Bacstone and Bacstone + standard treatments both started out on Aug 10 with lower canopy volumes than the standard treatment but at the end of the trial these treatments had greater increases in canopy volume than the standard treatment.

**Table 3. Canopy volume and volume increase of grapefruit following Bacstone Maximum irrigation injection application during fall flush 2018.**

Fertilizer Injection Treatments*	Canopy Volume, Cubic ft.**		
	8/10/2018	11/15/2018	Increase
1. Bacstone Maximum 5.8 fl. oz./tree	90.25 a	138.89 a	48.64 a
2. Calcium Nitrate 0.06 lbs./tree	116.24 a	150.53 a	34.29 a
3. Bacstone Maximum 5.8 fl oz. + Calcium Nitrate 0.06 lbs./tree	109.56 a	148.70 a	39.15 a
*Treatments 1 and 3 applied Aug 10, Sep 7 and Oct 16. Calcium Nitrate applied Oct 16.			
**Means in a column followed by the same letter do not significantly differ (P=.05, lsd).			

Canopy volume was determined by measuring the canopy width between rows, canopy length in the row and the tree height.

Width X length in the row X height = canopy volume.

Increase in canopy volume was calculated by subtracting the initial volume on Oct 10 from the Nov 15 volume.



### Fall Flush and Fall Flush Increase

Table 4 depicts results of new terminal growth (fall flush) on the date of the first applications and at the end of the trial as well as the increase in flush that occurred during the trial. There were no statistically significant differences between treatments in the amount of flush or increase in flush during the trial. Three applications of Bacstone Maximum were equal to the grower standard in amount of fall flush that occurred during the trial.

**Table 4. Fall flush and increase in flush of grapefruit following Bacstone Maximum irrigation injection application during fall flush 2018.**

Fertilizer Injection Treatments*	Flush, Inches**		
	8/10/2018	11/15/2018	Increase
1. Bacstone Maximum 5.8 fl. oz./tree	9.17 a	14.61 a	5.44 a
2. Calcium Nitrate 0.06 lbs./tree	8.50 a	13.94 a	5.44 a
3. Bacstone Maximum 5.8 fl oz. + Calcium Nitrate 0.06 lbs./tree	7.67 a	10.94 a	3.28 a
*Treatments 1 and 3 applied Aug 10, Sep 7 and Oct 16. Calcium Nitrate applied Oct 16.			
**Means in a column followed by the same letter do not significantly differ (P=.05, lsd).			

Flush was determined by measuring new growth of stem tips in the early and late stages of fall flush.

Increase in flush was calculated by subtracting the length of new growth on Oct 10 from new growth measured on Nov 15.

## Vigor Ratings

Table 5 depicts results of subjective vigor ratings at the beginning of the trial and approximately one month after the third and final irrigation injection application of the treatments. There were no statistically significant differences in vigor between Bacstone Maximum treatments and the grower standard treatment or the grower standard plus Bacstone Maximum.

**Table 5. Vigor ratings of grapefruit following Bacstone Maximum irrigation injection application during fall flush 2018.**

Fertilizer Injection Treatments*	Vigor, 0-10 Scale**	
	8/10/2018	11/15/2018
1. Bacstone Maximum 5.8 fl. oz./tree	6.06 a	5.50 a
2. Calcium Nitrate 0.06 lbs./tree	5.78 a	4.94 a
3. Bacstone Maximum 5.8 fl oz. + Calcium Nitrate 0.06 lbs./tree	5.78 a	4.89 a
*Treatments 1 and 3 applied Aug 10, Sep 7 and Oct 16. Calcium Nitrate applied Oct 16.		
**Means in a column followed by the same letter do not significantly differ (P=.05, lsd).		

Vigor was rated in the early and late stages of fall flush on a 0 to 10 scale.  
A zero rating signifies no flush and a 10 rating signifies a perfect tree.

## Canker Ratings

Citrus canker was present in the trees in this trial, so canker ratings were taken 21 days after the first application of Bacstone Maximum and 46 days after the second application of Bacstone Maximum and the single application of the grower standard, calcium nitrate. There were no statistically significant differences in canker ratings between treatments at the first evaluation date. On the second evaluation date, plots treated with Bacstone Maximum and Bacstone Maximum + calcium nitrate had lower canker ratings than plots receiving only calcium nitrate. The canker rating reduction in the Bacstone Maximum treatment compared to the grower standard calcium nitrate was statistically significant. The canker ratings in both treatments that included Bacstone Maximum declined from the beginning of the trial to the end of the trial while ratings in the standard calcium nitrate treatment increased during the trial.

**Table 6. Canker ratings of grapefruit following Bacstone Maximum irrigation injection application during fall flush 2018.**

Fertilizer Injection Treatments*	Canker Rating, 0-10 Scale**	
	8/31/2018	10/16/2018
1. Bacstone Maximum 5.8 fl. oz./tree	1.78 a	1.53 b
2. Calcium Nitrate 0.06 lbs./tree	2.00 a	3.00 a
3. Bacstone Maximum 5.8 fl oz. + Calcium Nitrate 0.06 lbs./tree	2.39 a	2.17 ab
*Treatments 1 and 3 applied Aug 10, Sep 7 and Oct 16. Calcium Nitrate applied Oct 16.		
**Means in a column followed by the same letter do not significantly differ (P=.05, lsd).		

Canker was rated on a 0-10 scale where 0 = no canker lesions present and 10 = a serious infestation with 100 % of foliage and fruit damaged.

All plots received a standard spray program of copper bactericides during the flush period.



### Foliar Tissue Nitrogen Levels

Foliar samples collected from the trial area before the first applications of fertilizer showed the mean tissue nitrogen level to be 2.04%. This is considered low to deficient for citrus. Table 7 depicts results of analysis of foliar samples collected on Nov 15 from the trail area. Tissue samples collected on Nov 15 were analyzed for total nitrogen. There were no statistically significant differences between treatments in foliar tissue nitrogen levels at the end of the trial. All treatments had higher nitrogen levels than the pretreatment baseline samples. All treatments provided mean tissue nitrogen levels in the low to sufficient range.

**Table 7. Foliar tissue nitrogen levels in grapefruit following Bacstone Maximum irrigation injection application during fall flush 2018.**

Fertilizer Injection Treatments*	% Tissue N
	11/15/2018
1. Bacstone Maximum 5.8 fl. oz./tree	2.41 a
2. Calcium Nitrate 0.06 lbs./tree	2.40 a
3. Bacstone Maximum 5.8 fl oz. + Calcium Nitrate 0.06 lbs./tree	2.35 a
*Treatments 1 and 3 applied Aug 10, Sep 7 and Oct 16. Calcium Nitrate applied Oct 16.	
**Means in a column followed by the same letter do not significantly differ (P=.05, lsd).	

Baseline samples prior to the first irrigation injection application showed the mean tissue nitrogen level in the trial area was 2.04 % which is considered low to deficient for citrus.

Percent Nitrogen was determined by collecting leaf tissue from all trees in each plot and submitting them to a commercial lab for total nitrogen determination.

### Discussion and Conclusions

Results from canopy volume calculations, foliar flush measurements, vigor ratings and leaf tissue nitrogen analysis did not detect statistically significant differences between irrigation injection treatments of Bacstone Maximum applied at 4 to 5-week intervals alone and in combination with the grower standard applied once compared with the grower standard applied once.

Three applications of Bacstone Maximum applied in place of the grower standard resulted in a statistically significant reduction in the incidence of citrus canker disease compared to the grower standard. Three applications of Bacstone Maximum applied in combination with the grower standard program provided a numerical reduction in citrus canker disease, but the reduction was not statistically significant.

The statistically significant reduction in citrus canker ratings indicates Bacstone Maximum applied as a nitrogen fertilizer during fall flush by irrigation injection in addition to foliar copper fungicide/bactericide applications will provide citrus canker suppression.

Citrus canker is normally treated with foliar applications of copper earlier in the growing season. Canker control with irrigation injection of products is not common. The impact of canker incidence reduction during fall flush is not known but on non-bearing trees it should provide an advantage in tree development toward future yield potential.

### Recommendations

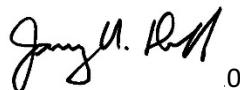
Future trials with irrigation injection of Bacstone Maximum should look at season-long use as a nitrogen source. Ten applications at the rate used in this trial should be evaluated. Foliar tissue analysis should determine zinc and copper levels as well as nitrogen. Trials should be evaluated in the following flush to determine if the added suppression of citrus canker reduces canker incidence in the following year. Work on bearing trees should also be considered to look at yield impact.

Formulation development work is needed to determine if the residue clogging emitters in this trial can be eliminated.

### References

Obreza, Thomas A. and Kelly T. Morgan, Editors. 2017. Nutrition of Florida Citrus Trees, 2<sup>nd</sup> Edition. University of Florida, IFAS. 98 pp.

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