CRDF Study on Preharvest Fruit Drop Prevention using PGRs, Year 2 - July 2024 Report

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Introduction: The Citrus Research and Development Foundation (CRDF) commissioned a series of field trials in June 2022 to investigate the effectiveness of exogenous applications of plant growth regulators (PGRs) to stop or reduce preharvest fruit drop in citrus. The project was developed by CRDF and conducted by John Curtis of Better Crops. At the conclusion of the first year CRDF leadership asked that the trials to be continued for a second year. The best performing treatments identified in year 1 were carried over into the second year of the project. Additional treatments were developed for year 2 that were focused on tank mixes which combined 2,4-D and Gibberellic acid.

In year 2, seven treatments were investigated at five trial sites. Two sites evaluated early maturing Hamlin orange. The three remaining sites evaluated late maturing Valencia orange. The Hamlin sites were in the southwest flatwoods near Immokalee and on the central Ridge near Lake Wales. The Valenica sites were on the East Coast near Ft. Pierce, in the southwest flatwoods near Immokalee, and a third site was on the central Ridge near Frostproof. The geographic distribution of these sites was intended to account for the environmental variability of the Florida citrus production ecoregions.

The PGR treatments evaluated in year 2 were developed from data analyses in year 1 and grower observations regarding PGR tank mixes. It is important to understand that the experimental treatments were mixed with no other agrochemicals beyond the PGR, an organosilicon surfactant or 435 spray oil, and water. Mixing the PGRs with foliar nutritional products or foliar applied pesticides could increase the potential for phytotoxicity. Consultation with the manufacturer any PGR you plan to use is encouraged.

Trial Evaluation: Each trial site evaluated 7 treatments in a side-by-side replicated trial. Each treatment consisted of five replicated plots with each replicate having seven trees (=35 trees per treatment). The center five trees of the seven-tree plot (25 trees) were used for evaluation. The plot design was constructed to eliminate over-spraying or cross contamination of adjacent plots. All spray applications were applied with a Rears PAK Blast sprayer at a volume of 200 gallons per acre.

For each trial site, the trees used for evaluation were of the same age, scion, and rootstock. To the best of the CC's ability, trees of similar health status were chosen. The same evaluations were performed at all sites. Evaluation consisted of Disease Index Ratings (DI rating = visible disease appearance), fruit drop counts, yield, and fruit quality. Using the values for fruit drop and yield, a calculation was made to determine the percentage of fruit drop by treatment. Yield was collected on a per tree basis. Yield values were reported as pounds of fruit per tree. A calculation of boxes per tree was performed by dividing the total weight of the fruit for one tree by 90 pounds (=1 box). The values presented in the tables for each site represent the average boxes per tree for each treatment. A single fruit quality sample was collected for each 5-tree treatment plot (n=35 fruit samples) at each trial site. The quality samples were processed at the CREC in the State House testing laboratory.

DI Rating Procedures and Scoring

Decline Index (DI) ratings were taken at the start of each trial and at the time of harvesting. DI ratings are a standardized visual rating of an individual tree's appearance. The tree canopy is divided into 4 segments (upper right, upper left, lower right, and lower left) and each section is given a rating. The same process is conducted on the opposite side of the tree. This method yields 8 sections to be rated (4 sections on each side of the tree).

The DI ratings scale ranges from 0 – 40 for the whole tree. An individual section of the tree gets a score between 0 and 5. The ratings from the 8 sections are totaled to give the final DI rating for the tree. A tree with no HLB symptoms would receive a rating of 0. A tree with moderate HLB decline would have a rating of 15 – 25. A tree with severe HLB decline would have a rating above 30.

DI ratings are subjective and prone to human influence. DI ratings between different evaluators can vary by 1-3 points per tree. It is important to use the same evaluators each time a DI rating is taken. DI ratings help to ensure consistency in visual tree health when selecting trees to be a part of a trial. DI ratings also provide insights into a treatment's effect on canopy health and appearance.

For this project, the same people conducted the DI ratings at the beginning and ending of the project.

Data Analysis

The data were analyzed by a CRDF-contracted statistician using the mixed model analysis procedure GLMMIX in SAS® software and the Tukey HSD multiple comparison procedure to test for significant differences among treatment means. Significant differences were judged at a p-value below 5%.

Treatments (see Appendix for additional treatment details by site).

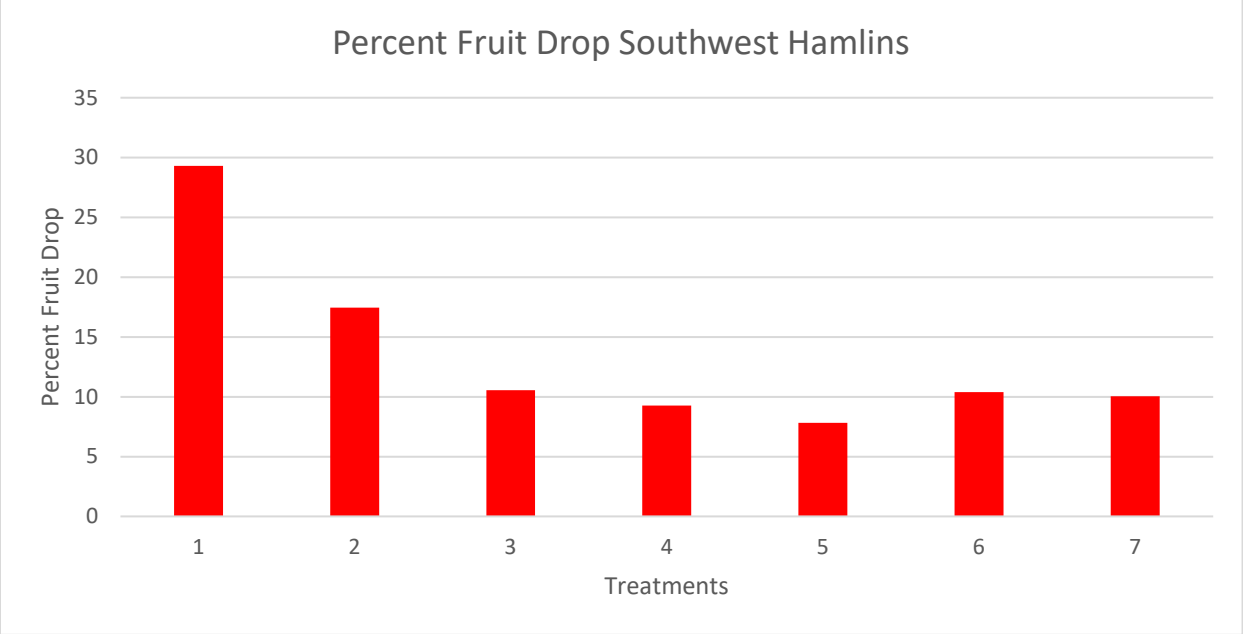
1. **Untreated Control**
2. **2,4-D at label rate and instructions**
    a. 1 application – 3.2 oz/A
    b. No surfactant or oil
        i. Hamlin – October application
        ii. Valencia – late December
3. **Split Rate of 2,4-D with 435 oil**
    a. 1.2 oz/A, 1 oz/A, 1 oz/A
        i. Hamlin – July, September, October applications
        ii. Valencia – August, October, December applications
4. **2 applications of 2,4-D at full rate with 435 oil**
    a. 3.2 oz/A with 435 oil
        i. Hamlin – August and October applications
        ii. Valencia – September and November applications
5. **Gibberellic acid tank mixed with 2,4-D with an Organosilicon surfactant**
    a. 20 oz/A Gibberellic acid
    b. 1.6 oz/A 2,4-D
    c. 2 applications
        i. color break
        ii. 2 months before anticipated color break
    d. Night spray
6. **Gibberellic acid mixed with 2,4-D with 435 oil**
    a. 20 oz/A Gibberellic acid
    b. 1.6 oz/A 2,4-D
    c. 2 applications
        i. color break
        ii. 2 months before anticipated color break
    d. Night spray
7. **Gibberellic acid mixed with 2,4-D with 435 oil**
    a. 10 oz/A Gibberellic acid
    b. 3.2 oz/A 2,4-D
    c. 1 application
        i. Hamlin – September
        ii. Valencia – late December
    d. Night spray

Trial Results

Hamlin Southwest

The Southwest Hamlin trial site is in Immokalee. The trees were planted in April 2007. They are grown on Swingle rootstock. The tree spacing is 22' x 12'. The planting density is 165 trees per acre. Harvesting of this trial was on November 16, 2023. Fruit Quality Samples were processed at the Citrus Research and Education Center in Lake Alfred, Fl on November 20, 2023.

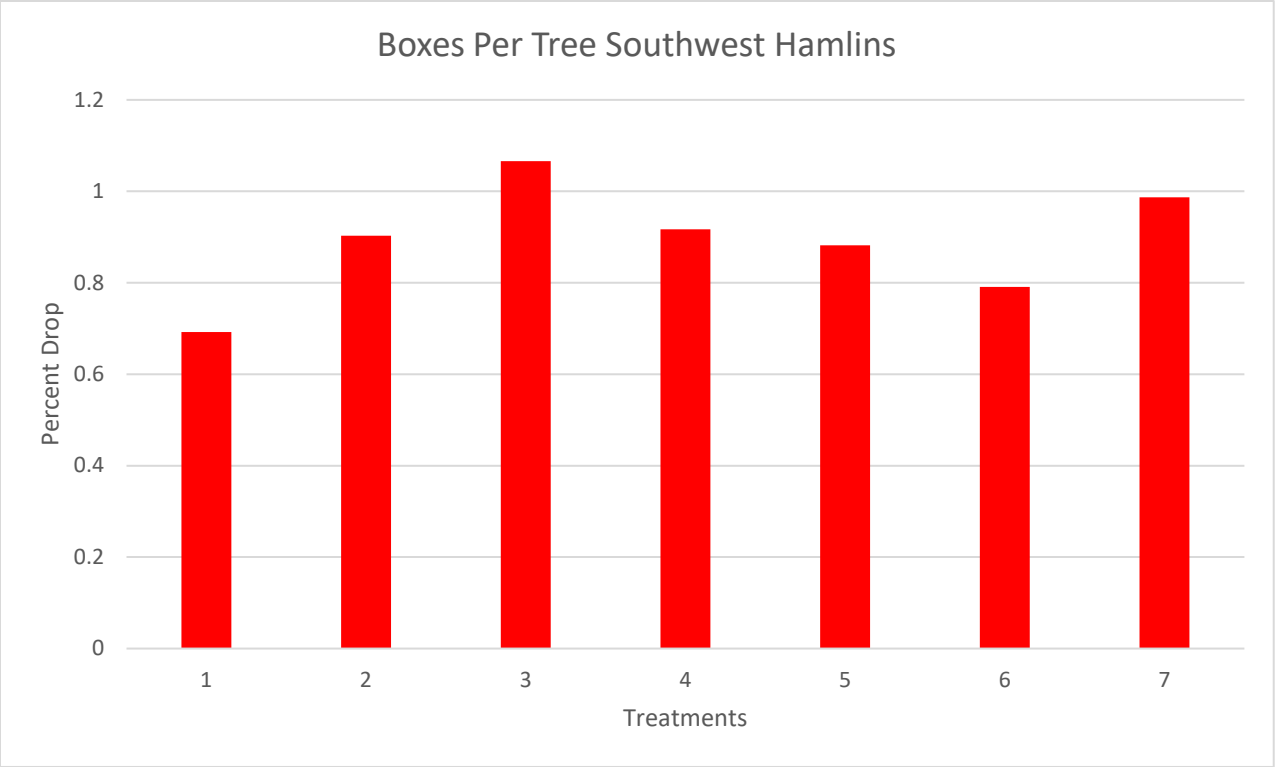
Table 1. Percent Fruit Drop for Hamlin Southwest



Treatments	Percent Fruit Drop	
1	29.29	A
2	17.45	B
3	10.56	BC
4	9.27	C
5	7.82	C
6	10.4	BC
7	10.05	BC
Model p>F	<0.0001	

The untreated control (Treatment 1) had the highest percentage of drop of all the treatments at 29.29%. All PGR treatments had significantly less drop than the untreated control. Treatment 5 (Gibberellic acid tank mixed with 2,4-D) produced the lowest percentage of fruit drop but was only significantly different from treatments 1 and 2.

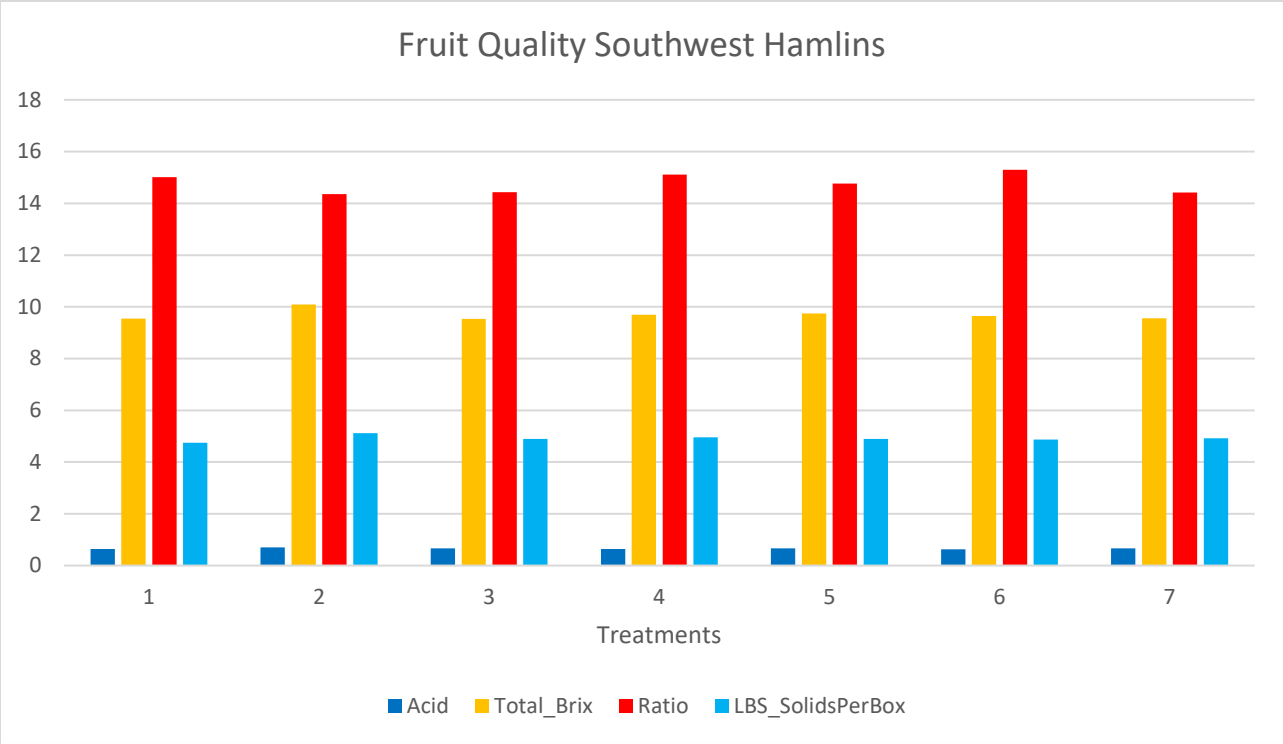
Table 2. Boxes Per Tree Hamlin Southwest



Treatments	Boxes Per Tree	
1	0.692	B
2	0.903	AB
3	1.066	A
4	0.917	AB
5	0.882	AB
6	0.791	AB
7	0.987	AB
Model p>F	0.0153	

The untreated control, Treatment 1, had the lowest per tree yield at 0.69 boxes per tree and lower than the 1 box per tree yield in Treatment 3 (Split Rate of 2,4-D with 435 oil). Treatment 1 was not significantly different from Treatments 2, 4, 5, 6, and 7.

Table 3. Fruit Quality Hamlin Southwest

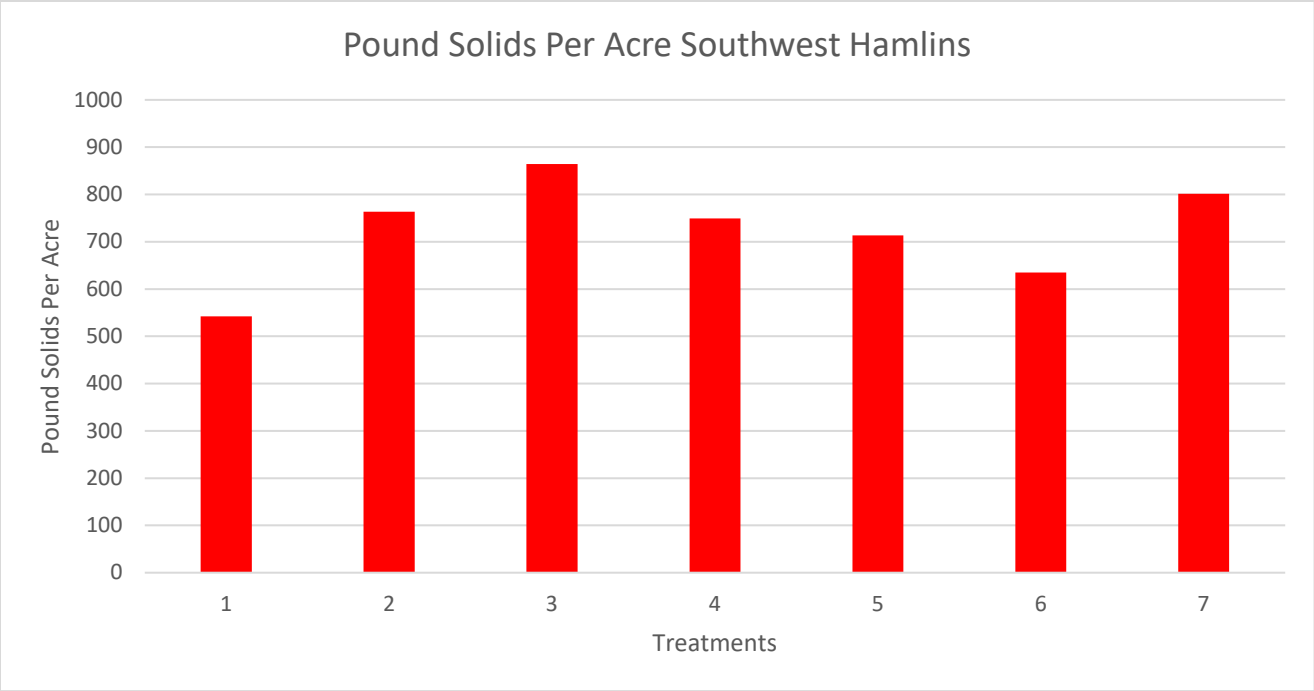


Treatments	Acid		Total Brix		Ratio		Pound Solids Per Box	
1	0.636	A	9.54	A	15.01	A	4.75	A
2	0.706	A	10.09	A	14.36	A	5.12	A
3	0.66	A	9.53	A	14.43	A	4.89	A
4	0.642	A	9.7	A	15.11	A	4.96	A
5	0.66	A	9.74	A	14.76	A	4.9	A
6	0.633	A	9.65	A	15.3	A	4.87	A
7	0.664	A	9.56	A	14.42	A	4.92	A
Model p>F	0.0663		0.6342		0.4638		0.5132	

The quality samples were processed at CREC in the State House testing laboratory on November 20, 2023. Although not significantly different, the analysis of Brix indicates Treatment 2 tended to have the highest Brix content at 10.09°. The lowest Brix value, 9.53°, was found in Treatment 3.

Titratable acid levels, Brix/acid ratios and Pound Solids Per Box values were not significantly different among treatments.

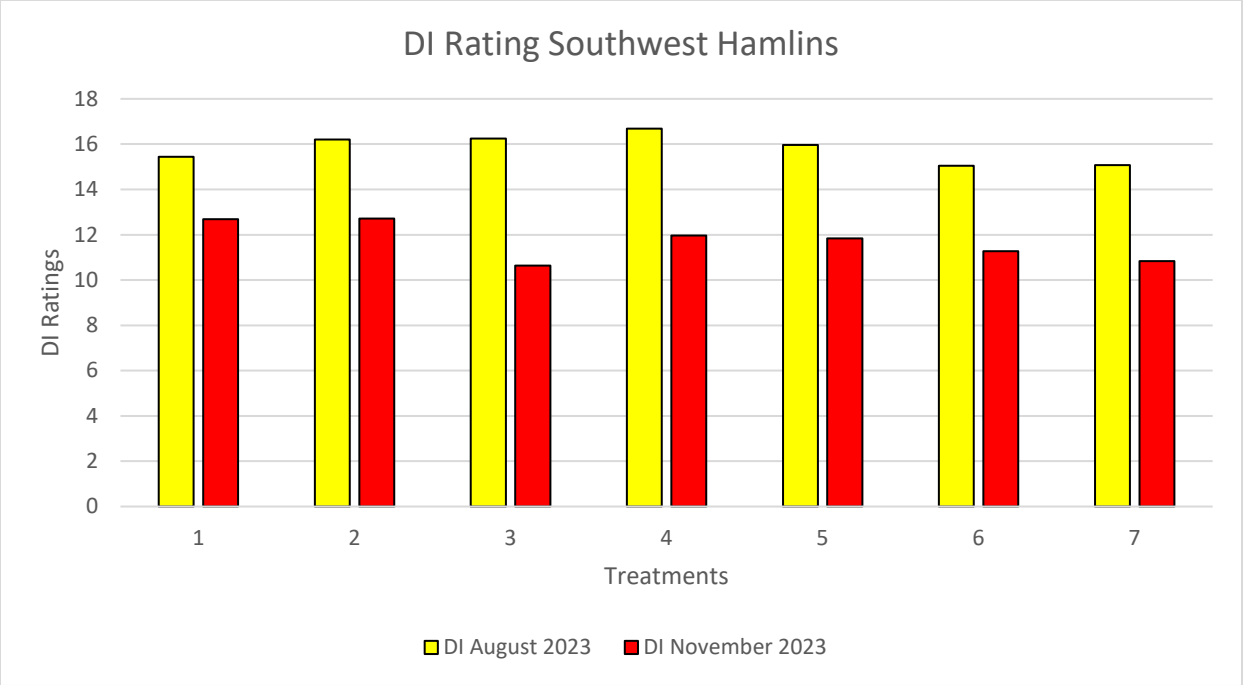
Table 4. Pound Solids per Acre Hamlin Southwest



Treatments	Pound Solids Per Acre	
1	541.89	B
2	763.71	AB
3	864.05	A
4	749.33	AB
5	713.4	AB
6	634.82	AB
7	801.63	AB
Model p>F	0.0163	

Pound Solids/Acre was calculated by combing the pound solids/box data with the calculation of boxes per acre. Treatment 3 (Split Rate of 2,4-D with 435 oil) had significantly higher Pound Solids Per Acre than the untreated control (T1). There were no significant differences between Treatments 2 through 7.

Table 5. DI Ratings Hamlin Southwest



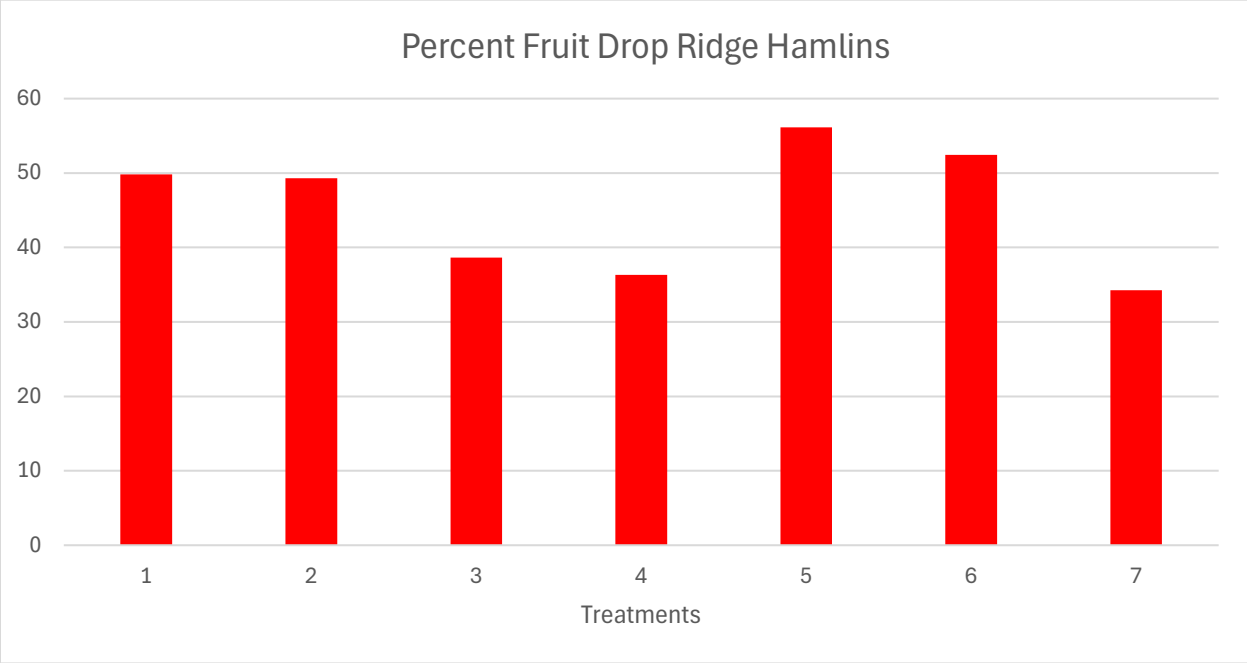
Treatments	DI August 2023		DI November 2023	
1	15.44	A	12.68	A
2	16.2	A	12.72	A
3	16.24	A	10.64	A
4	16.68	A	11.96	A
5	15.96	A	11.84	A
6	15.04	A	11.28	A
7	15.08	A	10.84	A
Model p>F	0.175		0.0767	

DI ratings for the Southwest Hamlin site were not significantly different in August or November 2023. Thus, there was no treatment effects on visual appearance in summer or fall. The average DI rating did decrease (better appearance) from August to November for all treatments.

Hamlin Ridge

The central Ridge Hamlin trial site is in Lake Wales, near Bok Tower. The trees were planted in October 2007. All trees are grown on Swingle rootstock. The tree spacing is 25' x 12'. The planting density is 145 trees per acre. Harvesting of this trial was on December 11, 2023. Fruit Quality Samples were processed at the Citrus Research and Education Center in Lake Alfred, Fl on December 12, 2023. This trial site was impacted by a hailstorm in April 2023. The hail damage was significant enough to necessitate a crop insurance claim. The damage to the fruit did cause significant fruit drop and evidence of the April hailstorm was seen on the fruit collected for quality analysis. This site did exhibit phytotoxicity symptoms on the fruit. The untreated control had no detectable phytotoxicity. The fruit appearance did suffer varying levels of phytotoxicity from the PGR treatments (data not shown).

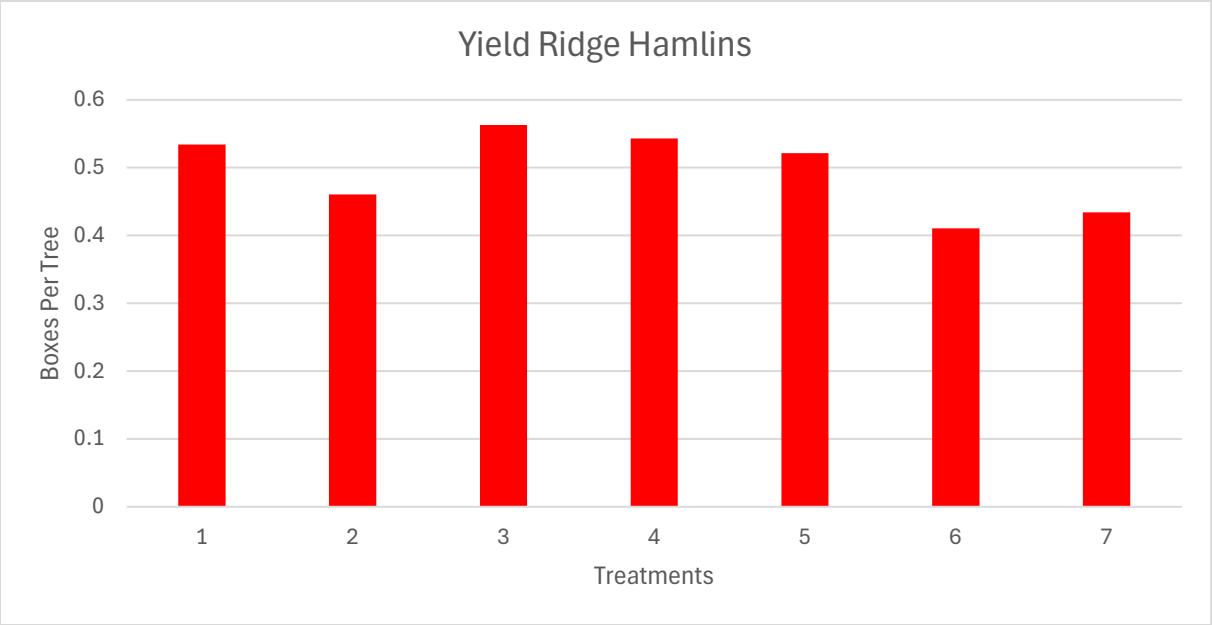
Table 6. Percent Drop Hamlin Ridge



Treatments	Percent Fruit Drop	
1	49.81101	A
2	49.2976	A
3	38.64096	A
4	36.31218	A
5	56.13122	A
6	52.44397	A
7	34.24491	A
Model p>F	0.1342	

There were no significant differences identified for percent fruit drop. The lowest percentage of fruit drop tended to be in treatment 7 at 34.2%. The highest fruit drop was seen in treatment 5 at 56.1%. All fruit drop values were high and reflect the damage caused by the April 2023 hailstorm.

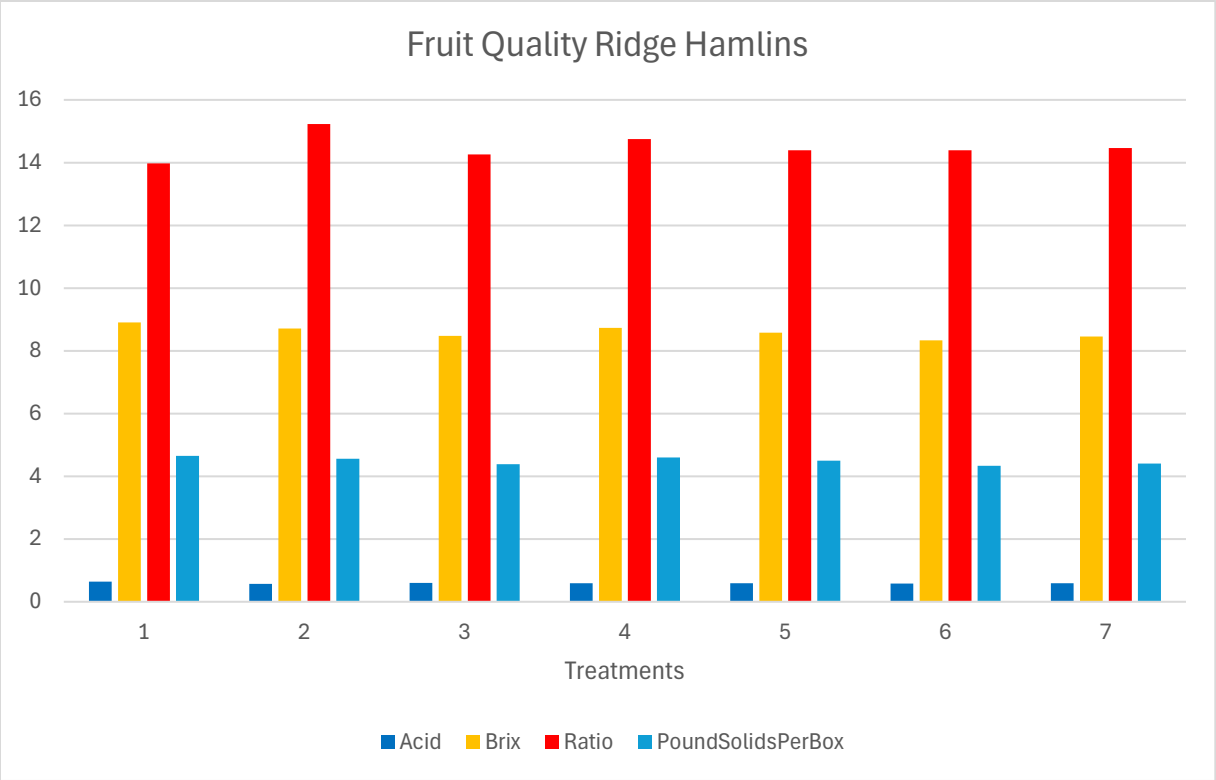
Table 7. Boxes Per Tree Hamlin Ridge



Treatments	Boxes Per Tree	
1	0.53413333	A
2	0.46053333	A
3	0.56297778	A
4	0.54302222	A
5	0.52155556	A
6	0.4104	A
7	0.43391111	A
Model p>F	0.9194	

There were no significant treatment differences for yield at the Ridge Hamlin site. Treatment 3 tended to have the highest yielding at 0.56 boxes per tree. Treatment 6 was the lowest yielding at 0.41 boxes per tree. Yield was impacted by the April 2023 hailstorm.

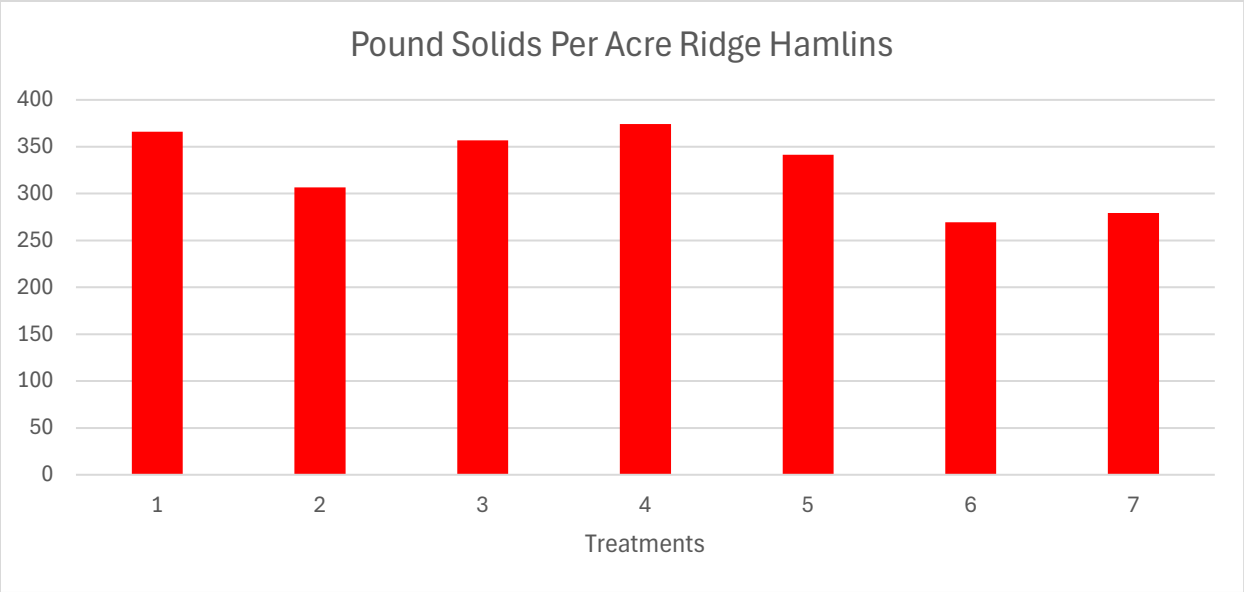
Table 8. Fruit Quality Hamlin Ridge



Treatments	Acid		Brix		Ratio		Pound Solids Per Box	
1	0.638	A	8.9	A	13.974	A	4.6487	A
2	0.574	A	8.71	A	15.226	A	4.56026	A
3	0.598	A	8.474	A	14.258	A	4.3887	A
4	0.592	A	8.728	A	14.754	A	4.60462	A
5	0.596	A	8.574	A	14.396	A	4.50044	A
6	0.58	A	8.338	A	14.398	A	4.337	A
7	0.586	A	8.46	A	14.468	A	4.4113	A
Model p>F	0.1779		0.6319		0.6581		0.6839	

There were no significant treatment effects for juice quality. The highest Brix content and pound solids per box was seen in Treatment 1 (Untreated control). Thus, all treatments tended to lower Pound Solids per Box than the control though not significantly so.

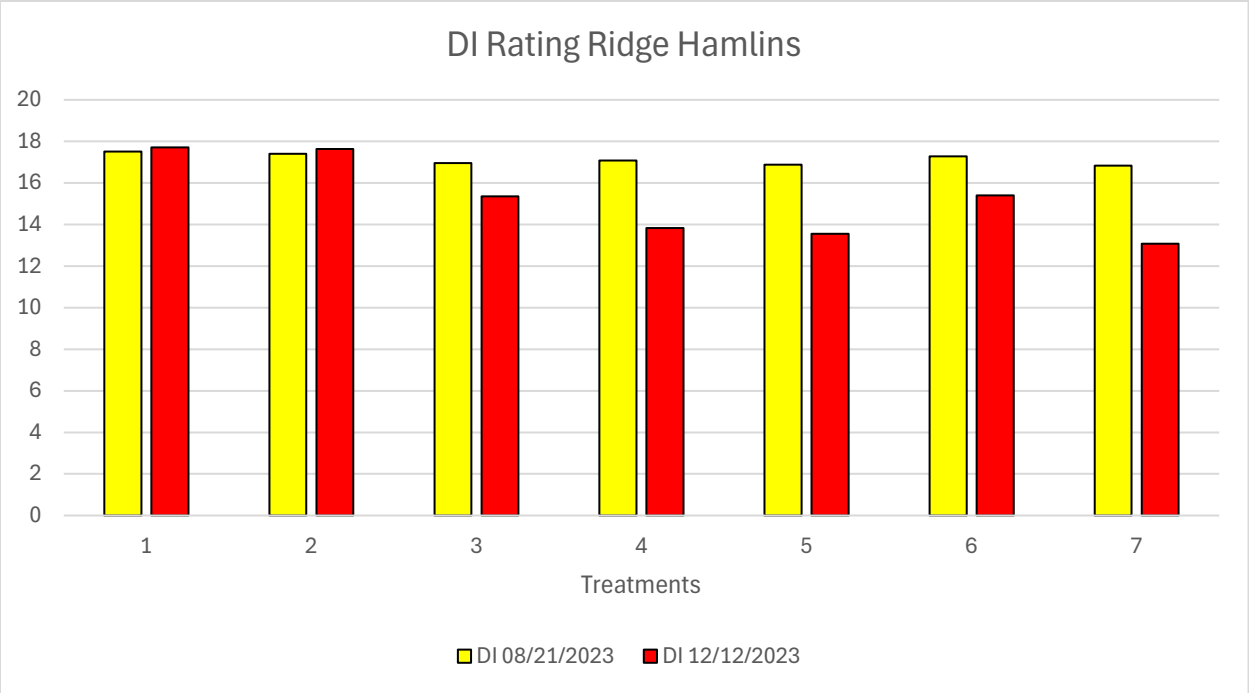
Table 9. Pound Solids Per Acre Hamlin Ridge



Treatments	Pound Solids Per Acre	
1	365.866212	A
2	306.564129	A
3	356.918181	A
4	374.194179	A
5	341.517843	A
6	269.261304	A
7	279.375584	A
Model p>F	0.9247	

There were no significant treatment differences in Pound Solids per Acre. The highest value was in Treatment 4 at 374.1. The lowest value was seen in Treatment 6 at 269.2.

Table 10. DI Ratings Hamlin Ridge



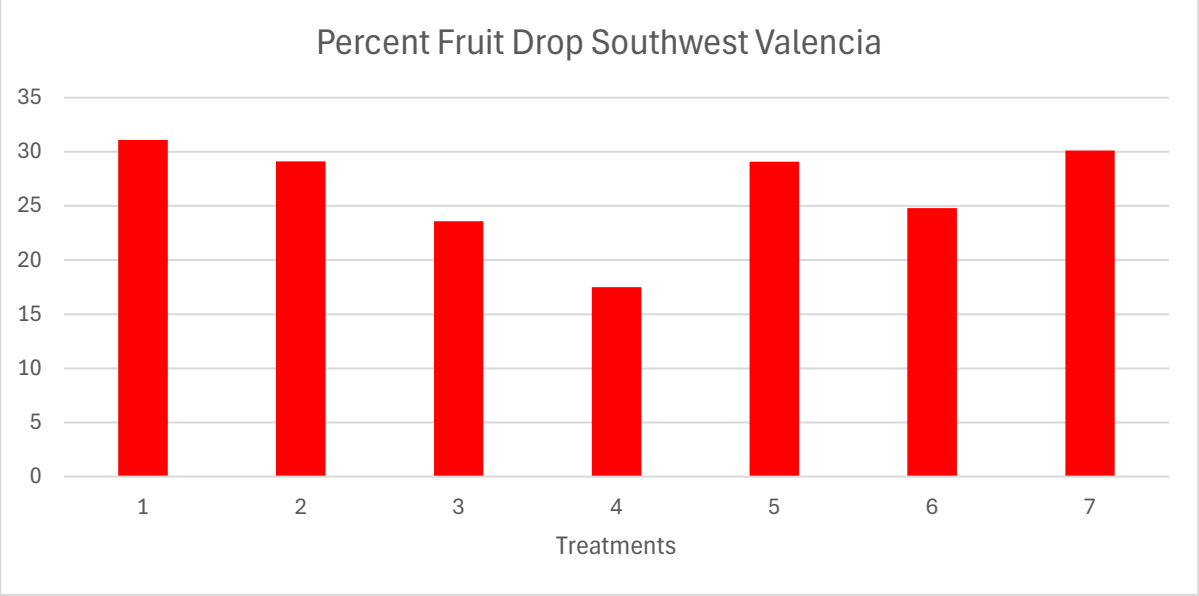
Treatments	DI August 2023		DI December 2023	
1	17.52	A	17.72	A
2	17.4	A	17.64	A
3	16.96	A	15.36	A
4	17.08	A	13.84	A
5	16.88	A	13.56	A
6	17.28	A	15.4	A
7	16.84	A	13.08	A
Model p>F	0.9908		0.0391	

DI ratings at the start of the second year of PGR treatment were nearly identical. The DI ratings in December improved by a few points for some of the treatments, but none of the values were significantly different.

Valencia Southwest

The Southwest Valencia trial site is in Immokalee. The trees used in this trial were planted in November 2000. All trees are grown on Swingle rootstock. The tree spacing is 22' x 12'. The planting density is 165 trees per acre. Harvesting of this trial was on February 7, 2024. Fruit Quality Samples were processed at the Citrus Research and Education Center in Lake Alfred, Fl on February 9, 2024.

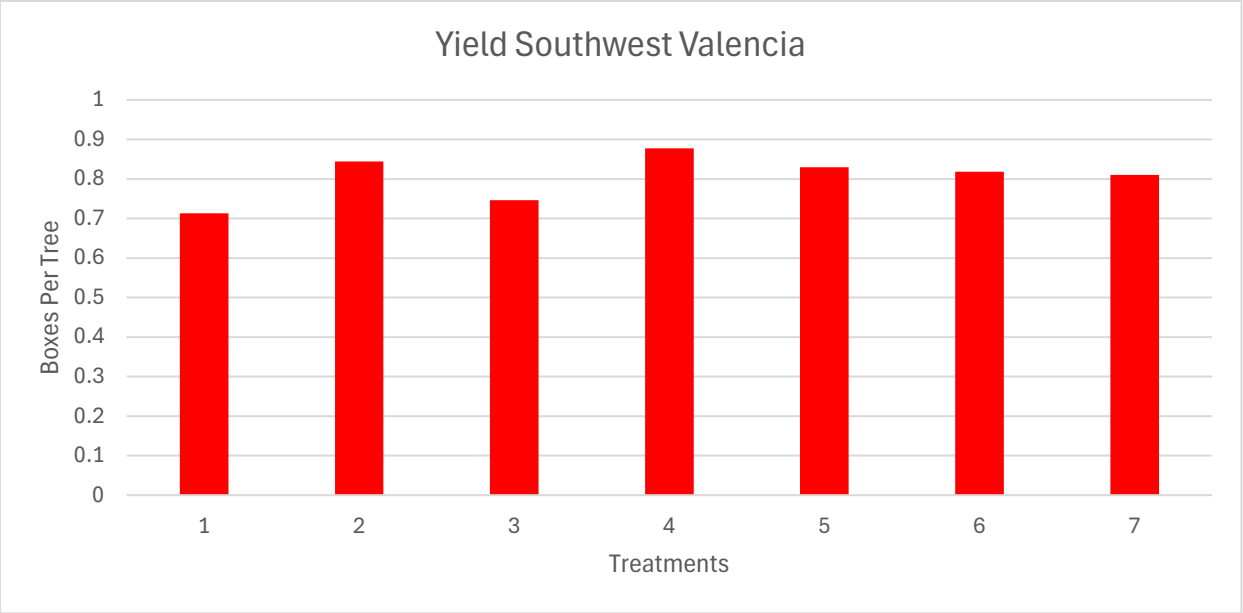
Table 11. Percent Drop Valencia Southwest



Treatment	Percent Fruit Drop	
1	31.09476	A
2	29.10934	A
3	23.58619	A
4	17.48857	A
5	29.10019	A
6	24.80017	A
7	30.13227	A
Model p>F	0.2892	

There were no significant differences for Percent Fruit Drop. The range in the percentage of fruit drop at this site was 13.6%. The treatment with the highest percentage of fruit drop was the untreated control, Treatment 1, with 31% drop.

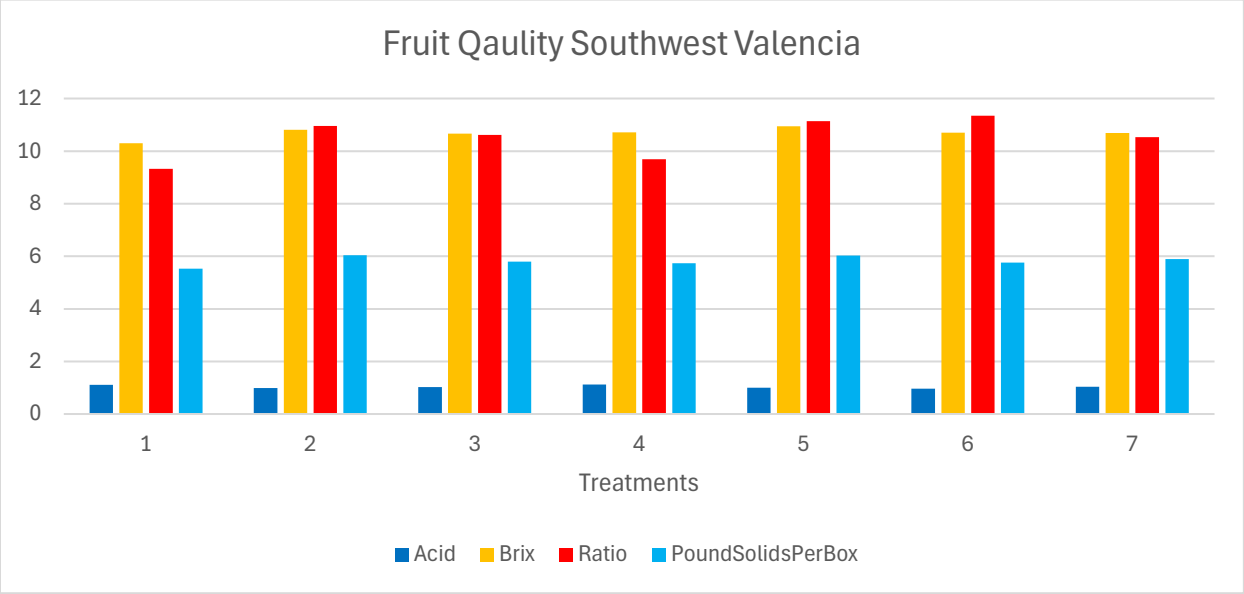
Table 12. Boxes Per Tree Valencia Southwest



Treatment	Boxes Per Tree	
1	0.71339253	A
2	0.8441256	A
3	0.74591467	A
4	0.87720569	A
5	0.82934507	A
6	0.81824382	A
7	0.80991173	A
Model p>F	0.687	

There were no significant differences in the per tree yield values. The highest yield was seen in Treatment 4 with 0.87 boxes per tree. The lowest yield was seen in Treatment 1 with 0.71 boxes per tree.

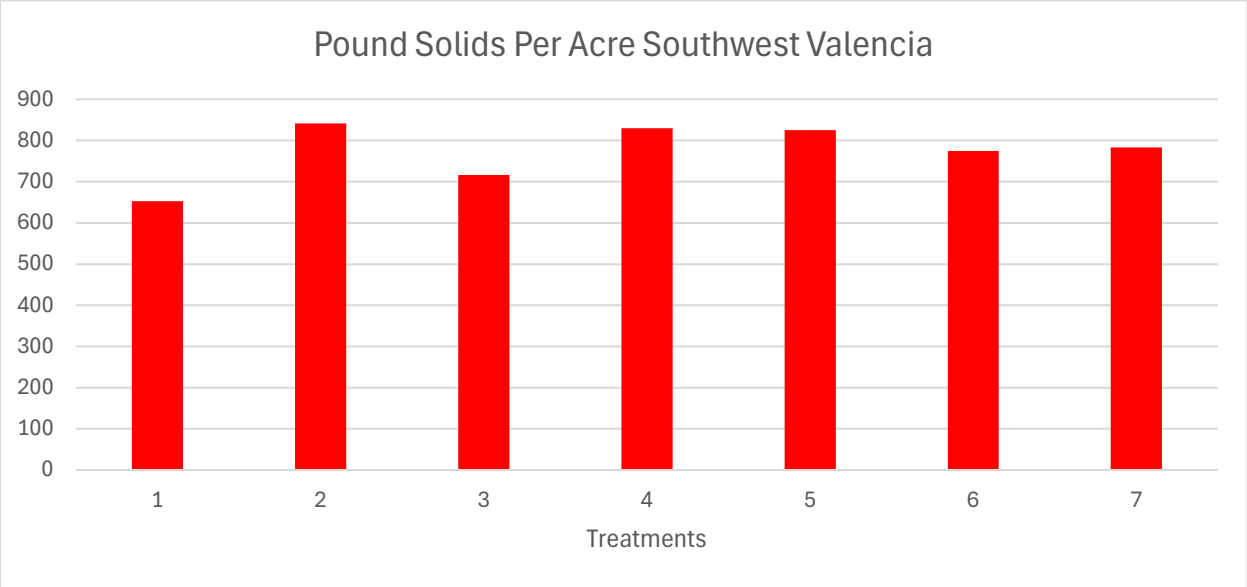
Table 13. Fruit Quality Valencia Southwest



Treatment	Acid		Brix		Ratio		Pound Solids Per Box	
1	1.112	A	10.304	A	9.322	A	5.5299	A
2	0.992	A	10.812	A	10.952	A	6.03662	A
3	1.028	A	10.666	A	10.614	A	5.79554	A
4	1.126	A	10.708	A	9.69	A	5.731	A
5	1.002	A	10.942	A	11.144	A	6.02844	A
6	0.96	A	10.696	A	11.34	A	5.7632	A
7	1.036	A	10.692	A	10.528	A	5.89178	A
Model p>F	0.4925		0.6008		0.3863		0.2203	

Fruit Quality analysis identified no significant differences for titratable acid, brix, ratio, or pound solids per box for this site. The lowest Pound Solids per Box value was in the untreated control, Treatment 1. The highest value was identified in Treatment 2 with 6.03-pound solids per box.

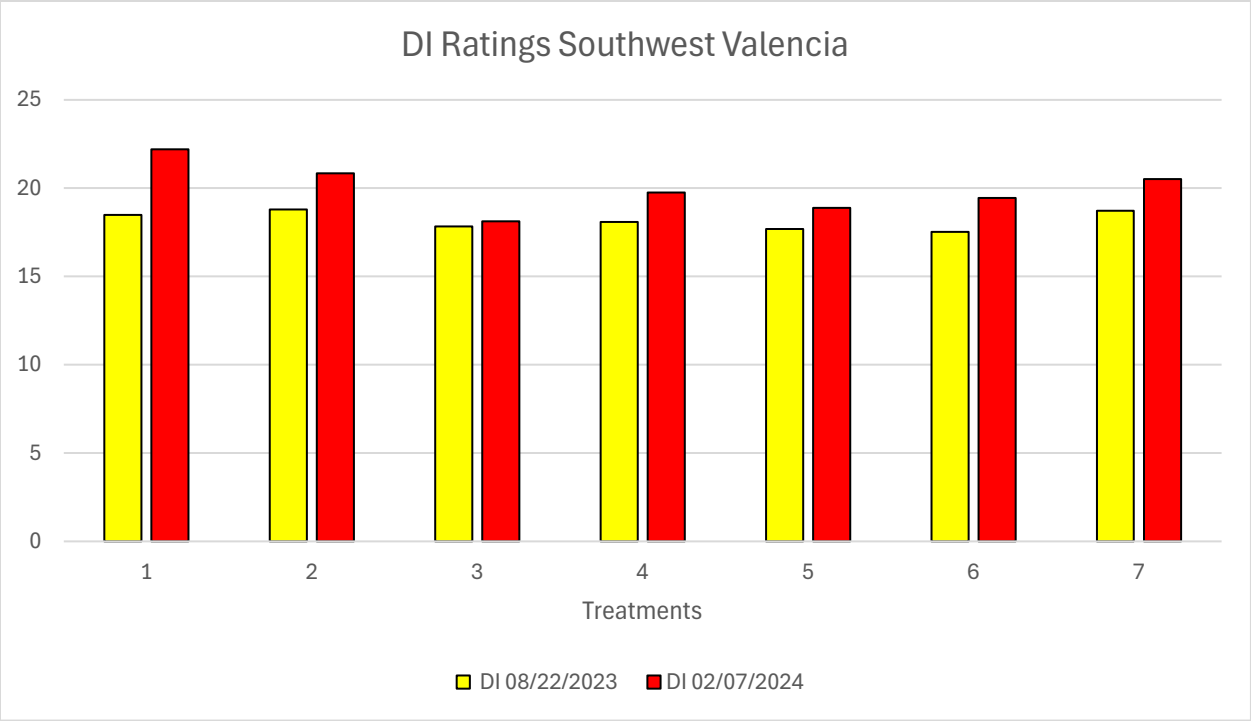
Table 14. Pound Solids Per Acre Valencia Southwest



Treatment	Pound Solids Per Acre	
1	652.569035	A
2	841.842487	A
3	716.147444	A
4	829.559081	A
5	824.871836	A
6	774.983735	A
7	782.85555	A
Model p>F	0.4519	

There were no significant differences found in the analysis of Pound Solids per Acre. The highest value was seen in Treatment 2, while the lowest value was in Treatment 1.

Table 15. DI Ratings Valencia Southwest



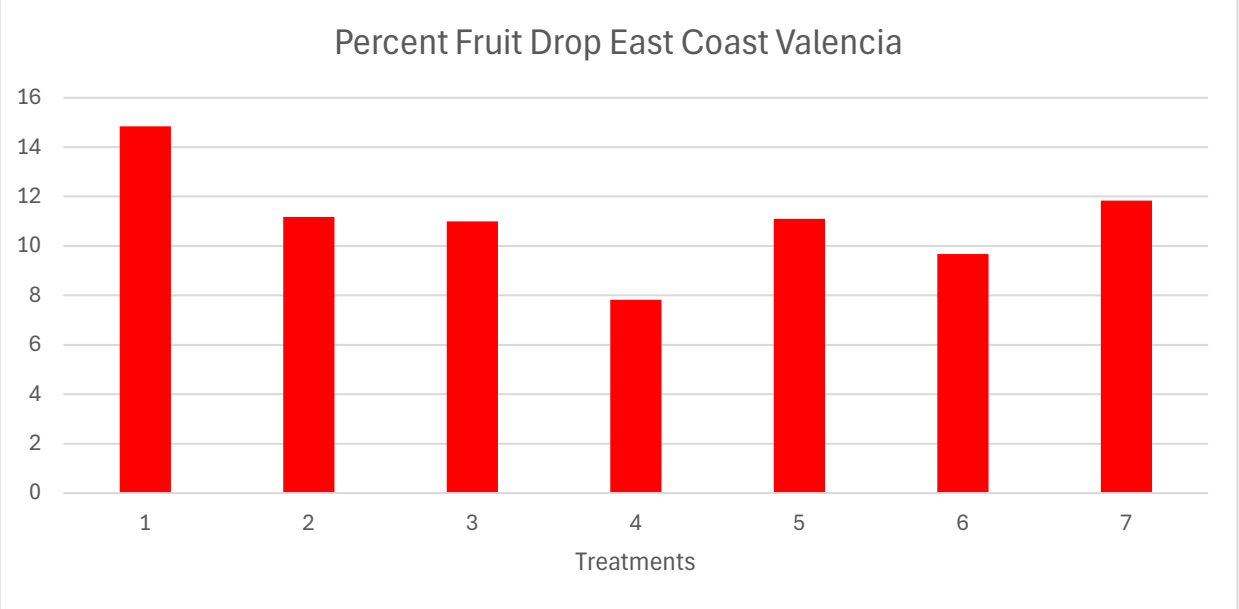
Treatment	DI August 2023		DI February 2024	
1	18.48	A	22.2	A
2	18.8	A	20.84	A
3	17.84	A	18.12	A
4	18.08	A	19.76	A
5	17.68	A	18.88	A
6	17.52	A	19.44	A
7	18.72	A	20.52	A
Model p>F	0.9594		0.6447	

There were no significant differences in DI ratings at Southwest Valenica site for August or February. On average, the DI ratings increased (more visible disease) by almost 2 units from August to February.

Valencia East Coast

The East Coast Valencia trial site is in Ft. Pierce. The trees used in this trial were planted in January 2019. All trees are grown on US 942 rootstock. The tree spacing is 19' x 8'. The planting density is 286 trees per acre. Harvesting of this trial was on January 31, 2024. Fruit Quality Samples were processed at the Citrus Research and Education Center in Lake Alfred, Fl on February 2, 2024.

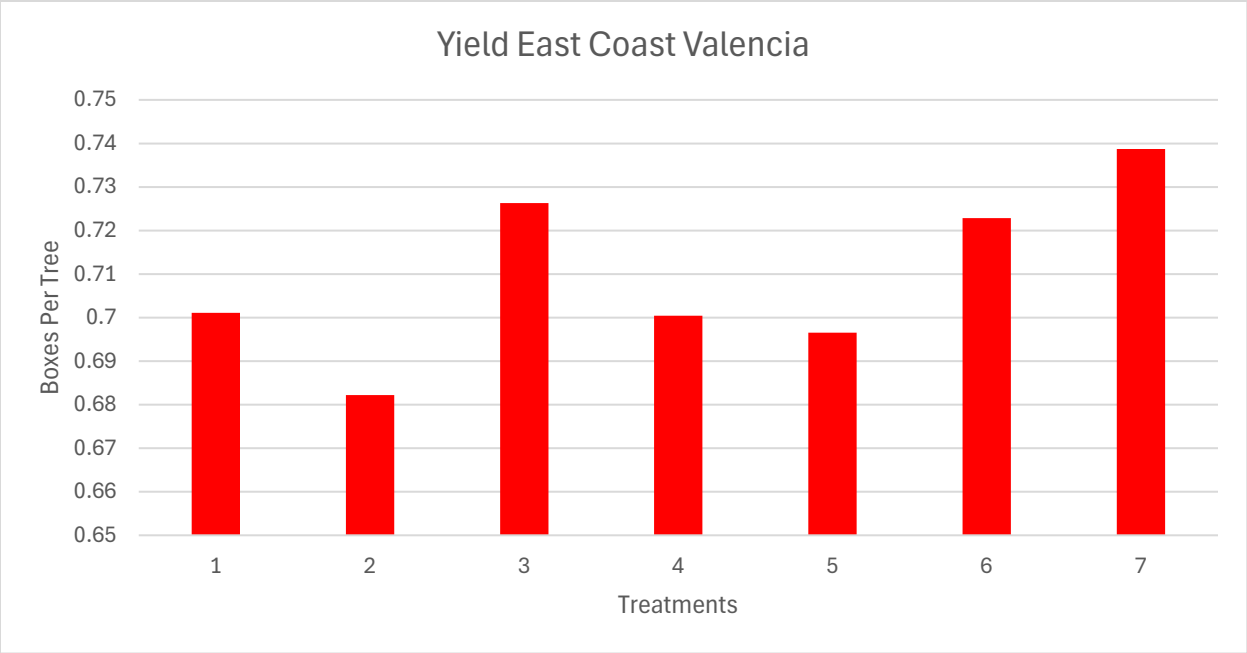
Table 16. Percent Drop Valencia East Coast



Treatment	Percent Fruit Drop	
1	14.84321	A
2	11.178432	A
3	10.993043	A
4	7.820991	A
5	11.098232	A
6	9.67487	A
7	11.836699	A
Model p>F	0.2822	

There were no significant differences found for the percent fruit drop values. Treatment 1, the untreated control, tended to have the highest amount of fruit drop of all the treatments with 14.8%. The lowest amount of fruit drop was found in Treatment 4 with only 7.8% drop.

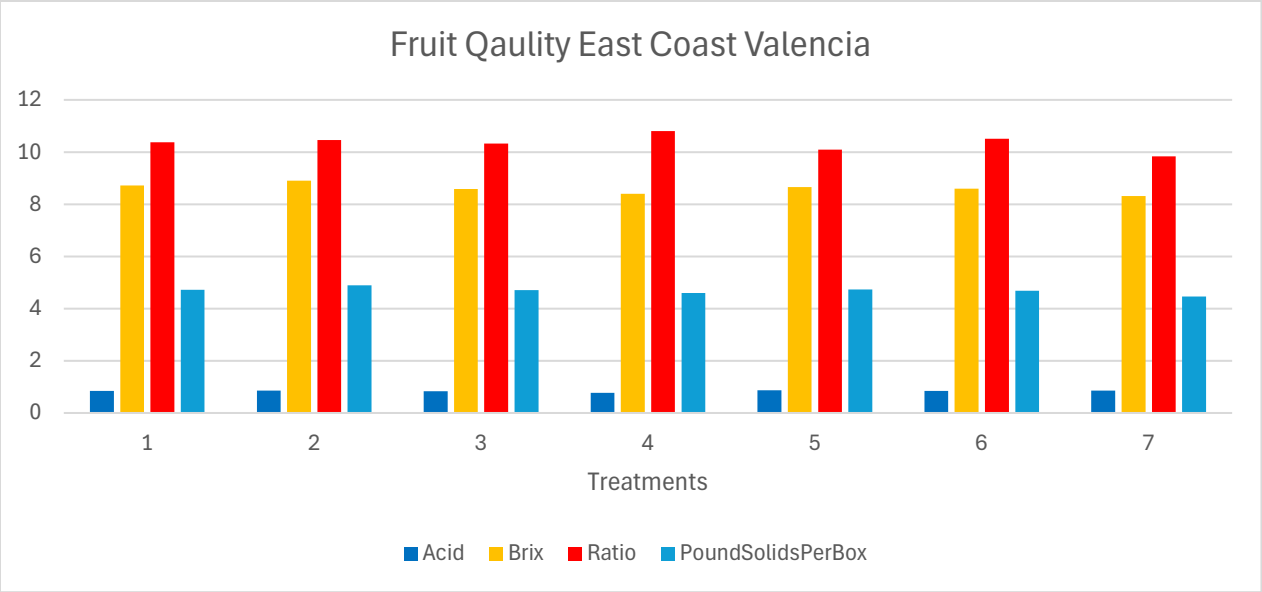
Table 17. Boxes Per Tree Valencia East Coast



Treatment	Boxes Per Tree	
1	0.70106667	A
2	0.68222222	A
3	0.72626667	A
4	0.70044444	A
5	0.69653333	A
6	0.72284444	A
7	0.73875556	A
Model p>F	0.9523	

No significant differences were found in fruit yield. Yield at this site increased by over a half-box per tree, regardless of treatment, compared to the prior year.

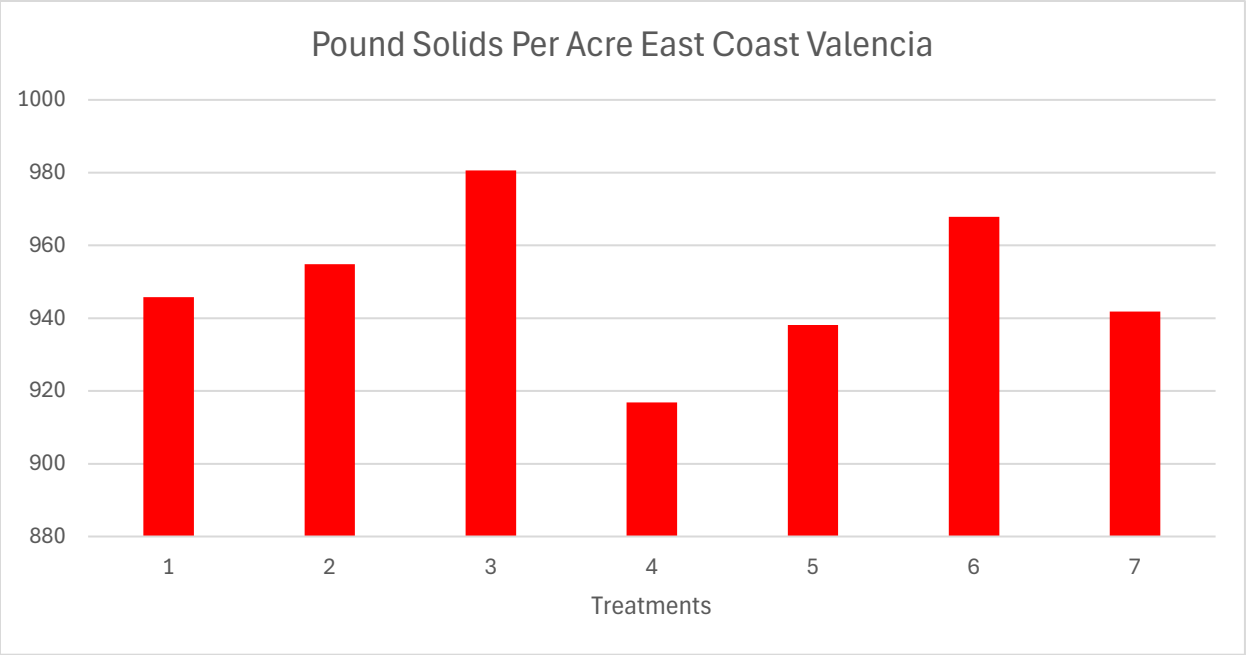
Table 18. Fruit Quality Valencia East Coast



Treatment	Acid		Brix		Ratio		Pound Solids Per Box	
1	0.84	A	8.718	A	10.372	A	4.72344	A
2	0.862	A	8.902	A	10.466	A	4.89726	A
3	0.836	A	8.58	A	10.332	A	4.71452	A
4	0.778	A	8.396	A	10.804	A	4.59844	A
5	0.87	A	8.658	A	10.088	A	4.73132	A
6	0.842	A	8.592	A	10.504	A	4.68354	A
7	0.858	A	8.318	A	9.834	A	4.46956	A
Model p>F	0.8796		0.6192		0.9277		0.3935	

No significant treatment differences were found in the juice quality analysis for titratable acid, brix, ratio, or pound solids per box.

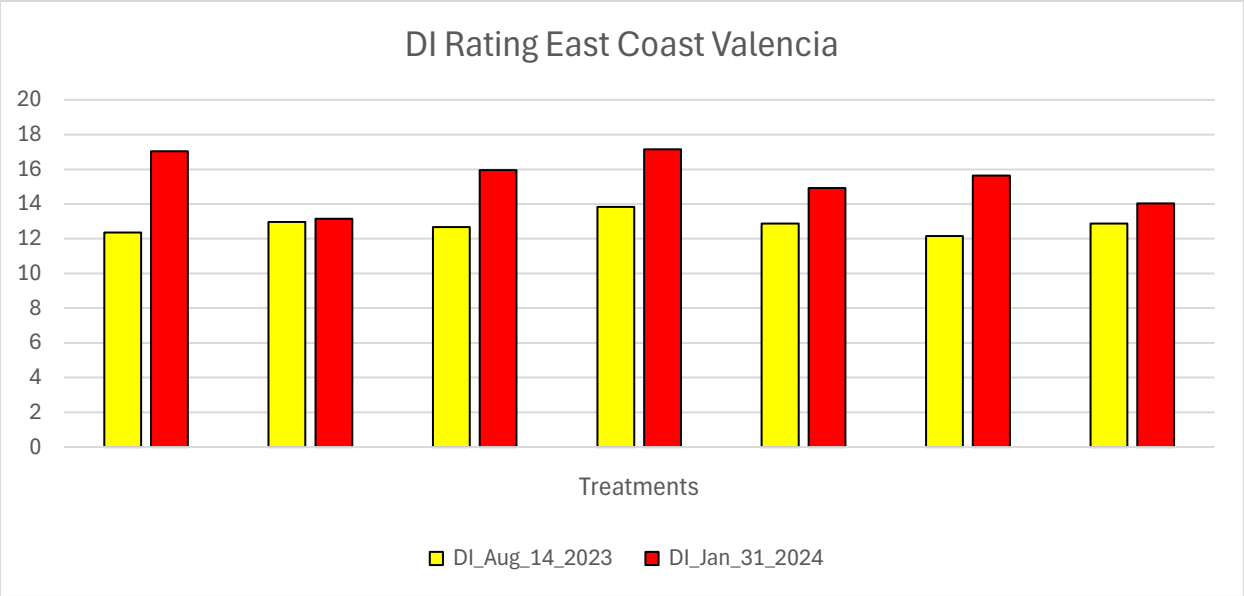
Table 19. Pound Solids Per Acre Valencia East Coast



Treatment	Pound Solids Per Acre	
1	945.803462	A
2	954.826056	A
3	980.564808	A
4	916.825268	A
5	938.134215	A
6	967.8292	A
7	941.824475	A
Model p>F	0.9824	

There were no significant treatment differences in the pound solids per acre. Pound Solids per Acre values ranged from 916.8 in Treatment 4 up to 980.5 in Treatment 3, but not significantly different from the untreated control.

Table 20. DI Ratings Valencia East Coast



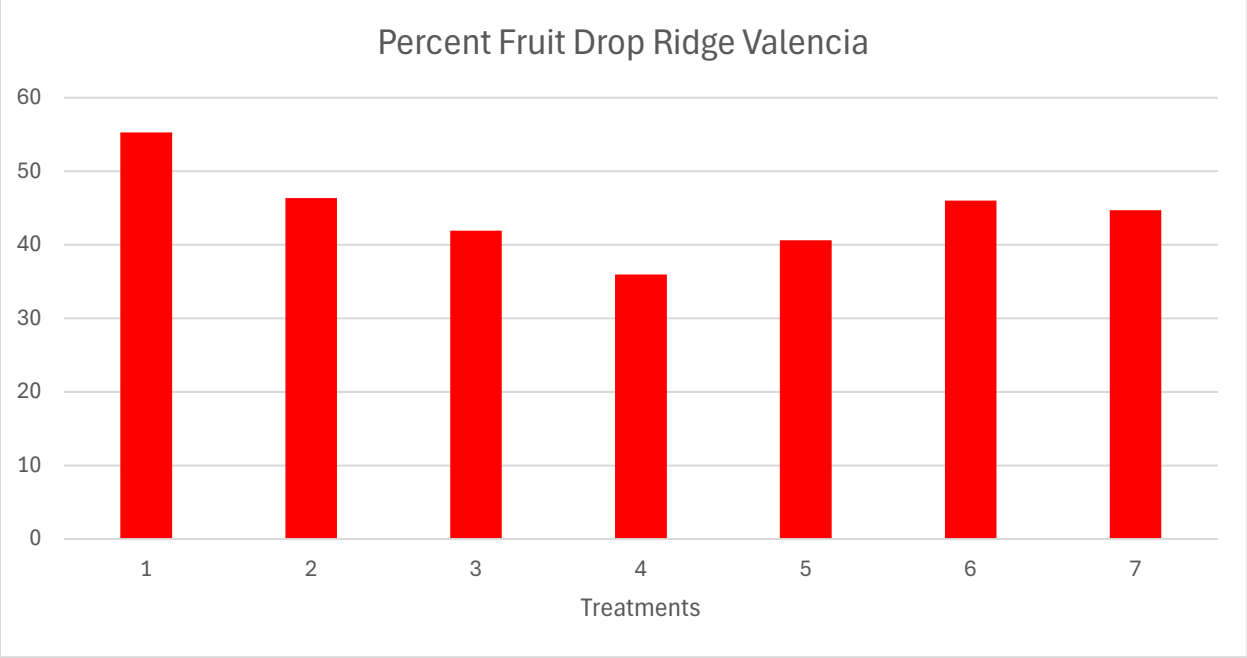
Treatment	DI August 2023		DI January 2024	
1	12.36	A	17.04	A
2	12.96	A	13.16	B
3	12.68	A	15.96	AB
4	13.84	A	17.16	A
5	12.88	A	14.92	AB
6	12.16	A	15.64	AB
7	12.88	A	14.04	AB
Model p>F	0.7095		0.0165	

There were no treatment differences in the DI ratings taken in August 2023. The January 2024 DI ratings did increase (more visible disease) for all treatments. In January, Treatment 2 was significantly lower (better appearing) than Treatments 1 and 4.

Valencia Ridge

The Ridge Valencia trial site is in Frostproof. The trees used in this trial were planted in 2007. All trees are grown on Swingle rootstock. The tree spacing is 25’ x 12’. The planting density is 145 trees per acre. Harvesting of this trial was on April 3, 2024. Fruit Quality Samples were processed at the Citrus Research and Education Center in Lake Alfred, Fl on April 18, 2024.

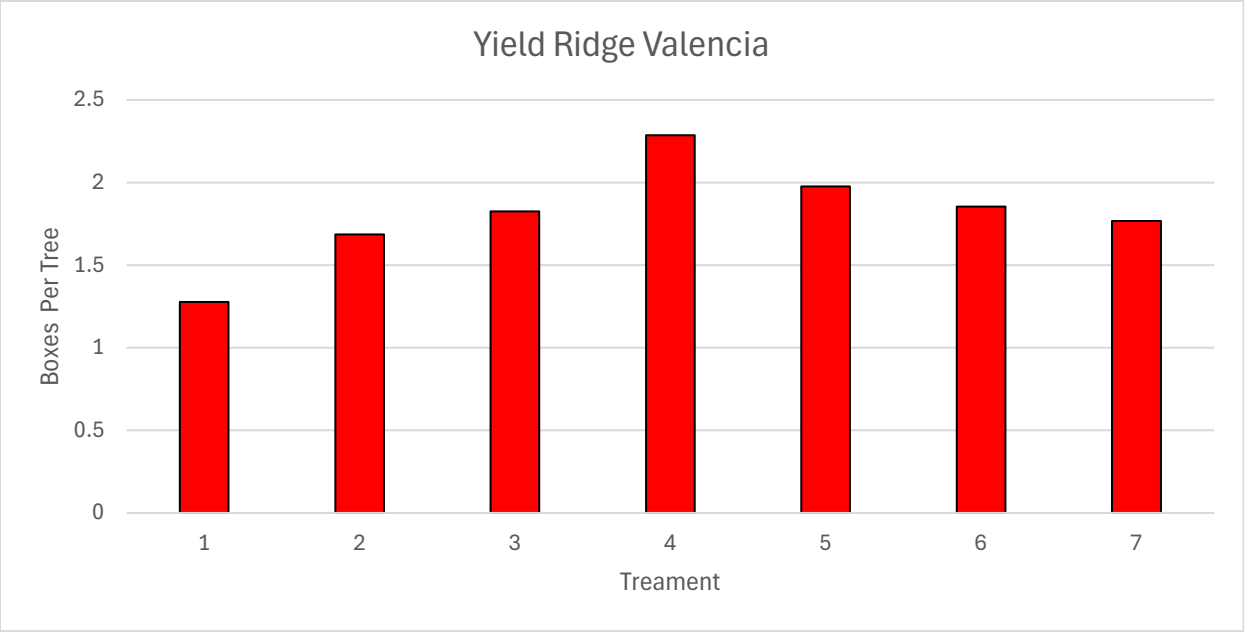
Table 21. Percent Drop Valencia Ridge



Treatment	Percent Fruit Drop	
1	55.29202	A
2	46.36954	AB
3	41.9142	B
4	35.94873	B
5	40.63027	B
6	46.00628	AB
7	44.72269	AB
Model p>F	0.0039	

Percent Fruit Drop was lowest in Treatments 3, 4 and 5, and highest in the untreated control, Treatment 1. Treatments 2 through 7 were not significantly different from each other.

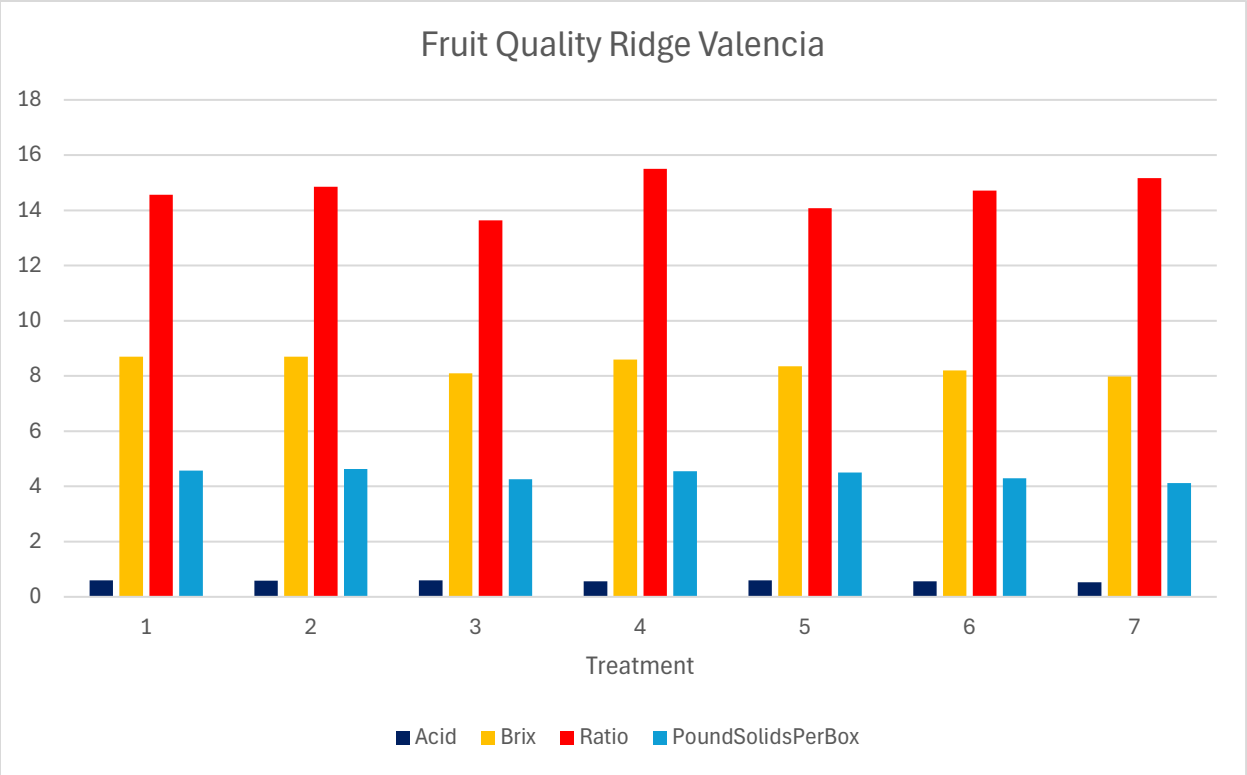
Table 22. Boxes Per Tree Valencia Ridge



Treatment	Boxes Per Tree	
1	1.2771556	B
2	1.6859111	AB
3	1.8241778	AB
4	2.2866311	A
5	1.9751556	AB
6	1.8533778	AB
7	1.7668	AB
Model p>F	0.0869	

Yield per tree was highest in Treatment 4 and lowest in the untreated control, Treatment 1. There was no significant difference in yield between Treatments 2 through 7.

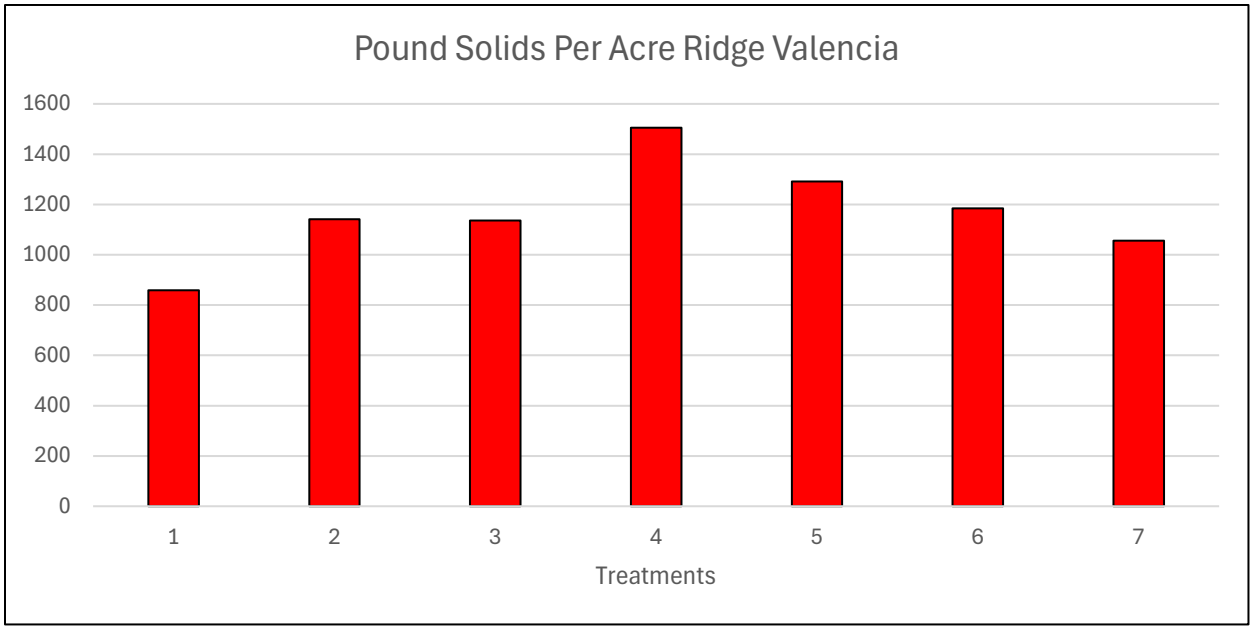
Table 23. Fruit Quality Valencia Ridge



Treatment	Acid		Brix		Ratio		Pound Solids Per Box	
1	0.602	A	8.704	A	14.568	A	4.56978	A
2	0.586	A	8.696	A	14.852	A	4.6271	A
3	0.594	A	8.092	A	13.636	A	4.26348	A
4	0.564	A	8.59	A	15.5	A	4.54582	A
5	0.598	A	8.354	A	14.08	A	4.49956	A
6	0.564	A	8.206	A	14.71	A	4.29738	A
7	0.528	A	7.976	A	15.162	A	4.11806	A
Model p>F	0.4044		0.1694		0.6003		0.3361	

There were no significant differences for Acid, Brix, Ratio, or Pound Solids per Box.

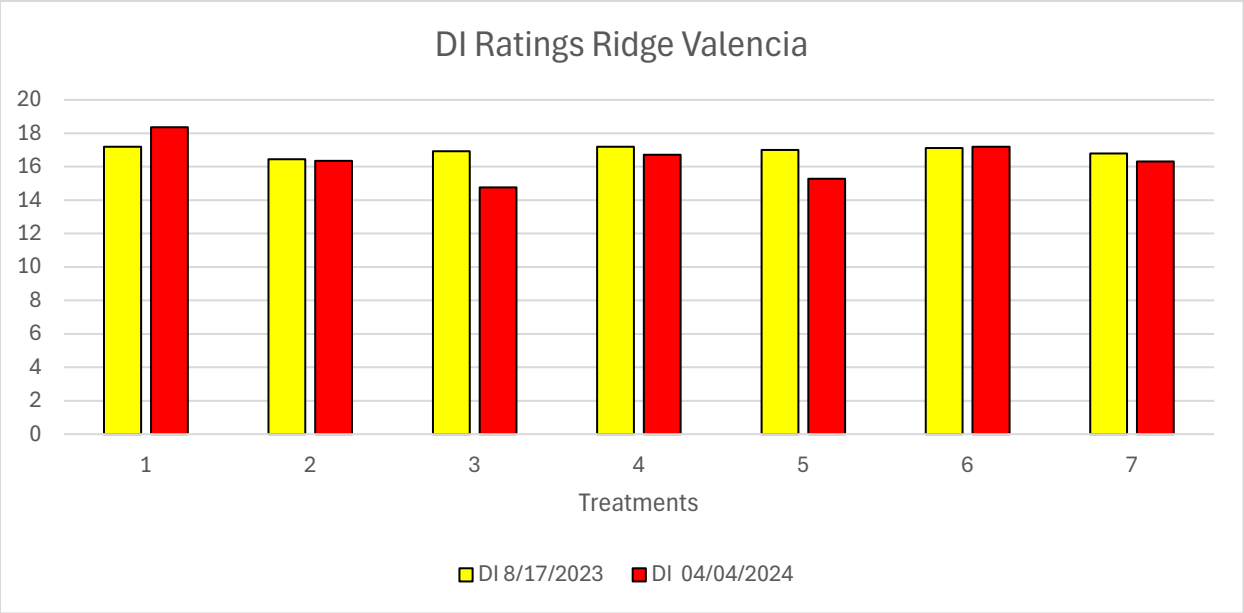
Table 24. Pound Solids Per Acre Valencia Ridge



Treatment	Pound Solids Per Acre	
1	858.8623	A
2	1141.08494	A
3	1136.68804	A
4	1505.55967	A
5	1291.9349	A
6	1184.67204	A
7	1056.28767	A
Model p>F	0.1639	

There were no significant differences in pound solids per acre for the Valencia Ridge site. Treatment 4 tended to have the highest solids per acre and Treatment 1 the lowest.

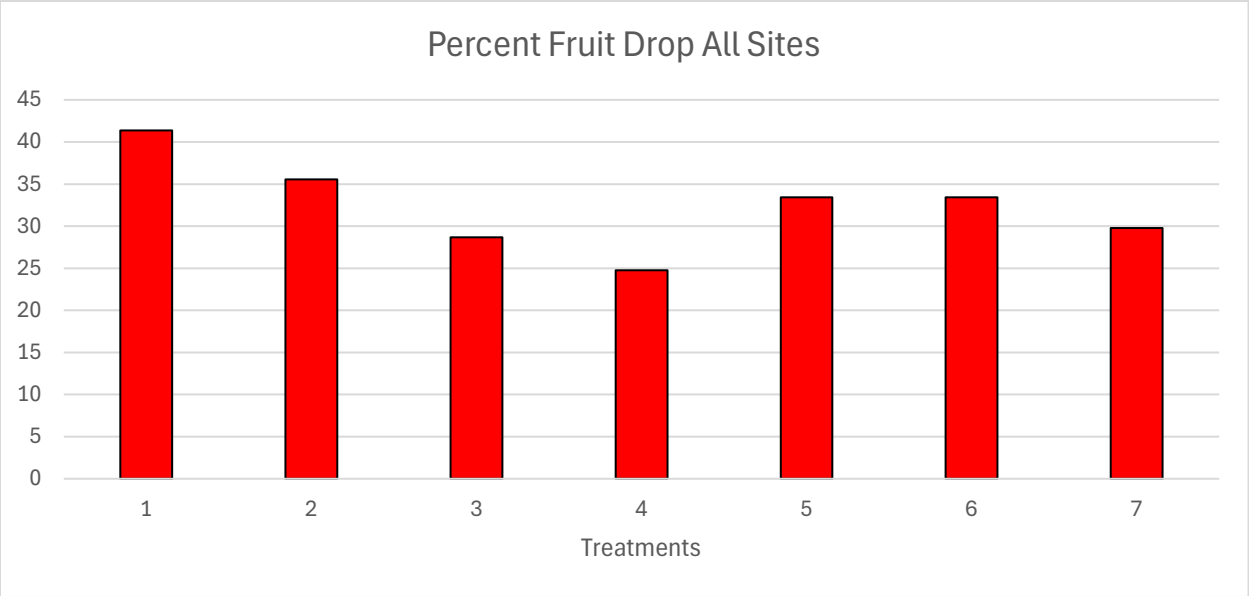
Table 25. DI Ratings Valencia Ridge



Treatment	DI August 2023		DI April 2024	
1	17.2	A	18.36	A
2	16.44	A	16.36	AB
3	16.92	A	14.76	B
4	17.2	A	16.72	AB
5	17	A	15.28	AB
6	17.12	A	17.2	AB
7	16.8	A	16.32	AB
Model p>F	0.8426		0.0365	

There were no significant differences for the August 2023 DI ratings. The DI ratings in April 2024 did not change much from the August ratings. In April, Treatment 3 was significantly lower (better appearance) than the untreated control, Treatment 1. No other significant differences were observed.

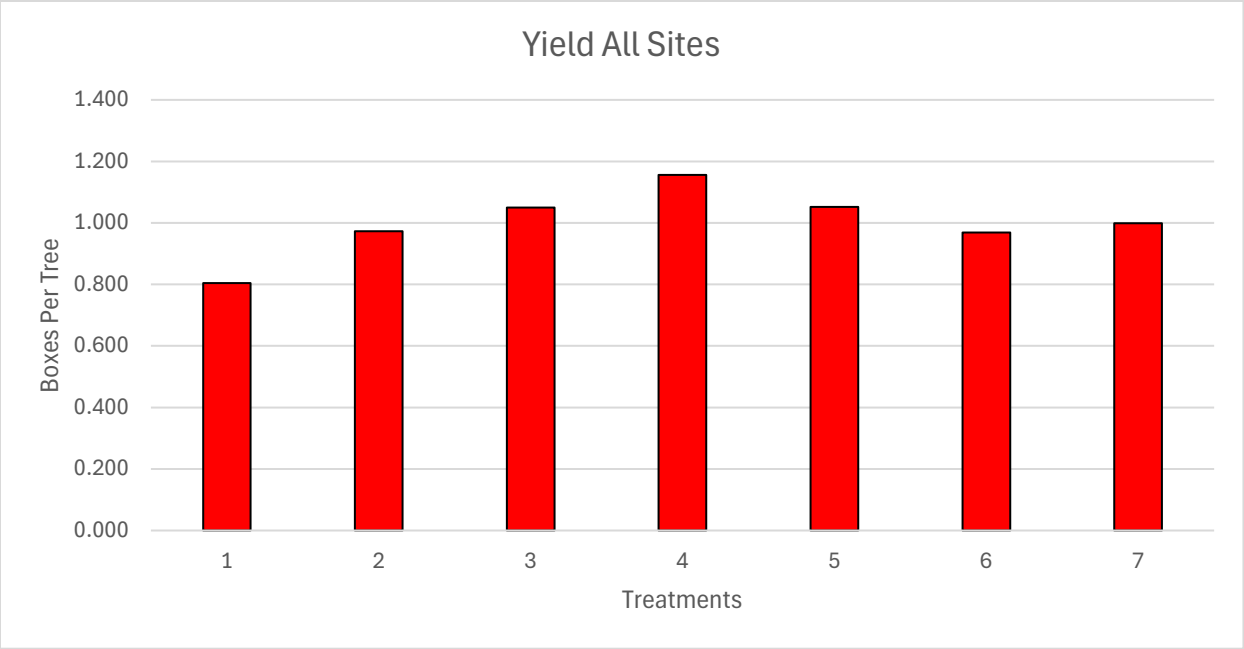
Table 26. Percent Fruit Drop All Sites Combined



Treatment	Percent Fruit Drop	
1	41.37258	A
2	35.55719	AB
3	28.67507	BC
4	24.75452	C
5	33.41977	ABC
6	33.41188	ABC
7	29.78742	BC
Model p>F	<.0001	

Treatment 1 (untreated control) had the significantly highest percentage fruit drop and Treatment 4 the lowest.

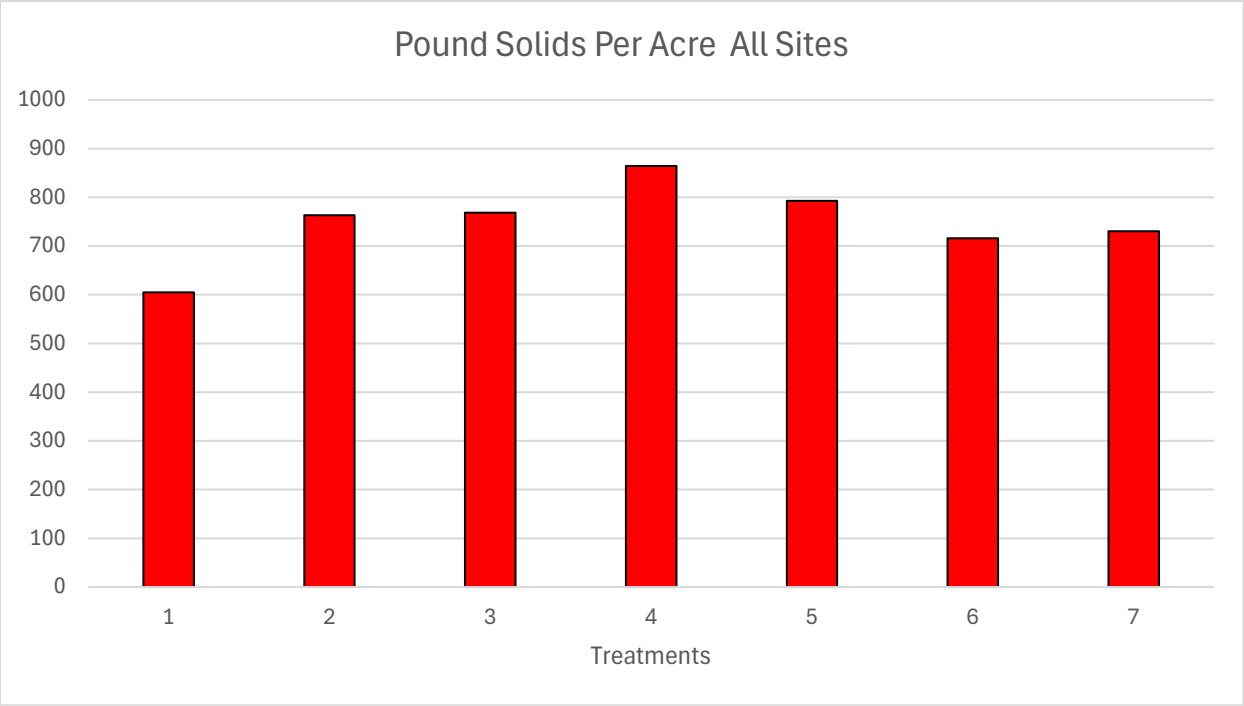
Table 27. Boxes Per Tree All Sites Combined



Treatment	Boxes Per Tree	
1	0.804	B
2	0.973	AB
3	1.050	AB
4	1.156	A
5	1.052	AB
6	0.968	AB
7	0.999	AB
Model p>F	<.0001	

Yield was significantly higher in Treatment 4 and lowest in the Untreated control (Treatment 1). There were no significant differences between Treatments 2 – 7.

Table 28. Pound Solids per Acre All Sites Combined



Treatment	Pound Solids Per Acre	
1	604.798	B
2	763.301	AB
3	768.451	AB
4	864.66	A
5	792.93	AB
6	715.934	AB
7	730.037	AB
Model p>F	<.0001	

Pound Solids per Acre was significantly higher in Treatment 4 (2,4-D with 435 oil) than in the control Treatment 1. There were no significant differences between Treatments 2 – 7

Discussion:

Year 2 of this project saw fewer significant differences compared to Year 1. The performance of the PGR treatments varied greatly from one trial site to another. In the Hamlin sites, the Southwest site in Immokalee had significant differences for all evaluations except for Fruit Quality and DI Ratings. The Ridge Hamlin site had no significant differences for any evaluation. This is likely due to the April 2023 hailstorm.

A significant difference in percent of fruit drop was observed in 2 of the 5 trial sites. The Southwest Hamlin site saw Treatments 5 (7.8%) and 4 (9.2%) produce the lowest values for percentage of fruit drop. All the PGR treatments at the Southwest Hamlin site were significantly different from the untreated control. Treatments 4 and 5 were significantly different from Treatment 2, which was the treatment that followed the manufacturer's recommendations on the label. These differences were the most dramatic separation of performance by treatment for the entire project. The Ridge Valencia site saw a significant difference in percentage of fruit drop. Treatments 3, 4, and 5 were significantly different from the untreated control. The three other trial sites had no significant differences for percentage of fruit drop.

The evaluation of yield for the Valencia sites varied greatly. The Southwest and East Coast Valencia sites yielded similar amounts despite the blocks being very different in age. The Ridge Valencia site saw significant difference in boxes per tree, with Treatment 4 yielding more fruit than the untreated control. The Hamlin site's yields were not remarkable except for the Southwest site providing one significant difference between Treatment 3 (1.06 boxes per tree) and Treatment 1 (0.69 boxes per tree).

Fruit quality analysis for the second year of the project produced no remarkable results. The Hamlin fruit quality at the Southwest site was not as good as the previous season. Still, the pound solids per box values were acceptable for the HLB era. The Ridge Hamlin site had slightly less pound solids per box. The Valencia fruit quality was best at the Southwest site with some Pound Solids per Box values being above 6. The Ridge site and East Coast site's fruit quality numbers were typical of industry averages. Treatment 7 at the Ridge site did produce a Brix value that averaged less than state maturity standards. Looking at the fruit quality data on a site-by-site basis does show uniformity regardless of treatment. The East Coast Valencia site was harvested at the end of January 2024. The fruit was still green and did not exhibit noticeable signs of color break. It is logical to conclude that fruit quality could have possibly improved if harvesting had been delayed 2 – 4 months.

Pound Solids per Acre is a calculation made by using the pound solids per box values combined with a calculation of boxes per acre. This is a reasonable approach for calculating the potential monetary output for each treatment in a research project.

At the southwest Hamlin site, Pound Solids per Acre ranged from 864 down to 541. There was much nonsignificant overlap for most of the treatments. The untreated control was significantly different (lower) than Treatments 3.

The Hamlin site on the Ridge produced pound solids per acre values lower than the industry average. The April hailstorm had a significant impact on yield and thus pound solids per acre. There were no significant differences identified at this site.

The Valencia sites produced pound solids per acre values at the Southwest site and East Coast site that were not far apart. The age difference between these two sites is 19 years. The East Coast Valencia averaged 950-pound solids per acre across all treatments while the Southwest site averaged 774-pound solids per acre. The Ridge Valencia site ranged from 1505-pound solids per acre in Treatment 4 down to 858-pound solids per acre in Treatment 1. The statistical analysis indicates these values were not significantly different, but it is likely a grower would consider the difference significant. Pound solids per acre is equal to a projection of cash flow per acre, so any meaningful difference between treatments amounts to a monetary difference.

Conclusions

The quantity of significant differences in year 2 of this project were considerably less than in year 1. Year 1 of the project was impacted by Hurricane Ian. It is likely that year 2 of the project is still impacted by lingering effects of the hurricane. Another factor contributing to the uniformity of the site-by-site data is the trunk injections of oxytetracycline. The 2023 – 2024 crop year was the first year OTC therapy was commercially available to the Florida citrus industry. Most growers in the state implemented this therapy, including the sites utilized in this project. The effect of the trunk injections can be seen in the DI ratings. The DI ratings were uniform across all treatments for each site in August 2023. Historically, DI ratings are lower in the summer months when HLB symptom expression is less. This year the DI ratings in the winter and spring improved or were mostly unchanged at all sites. This indicates the visual appearance of the trees did not decline in the winter, contrary to the historical trend of the past decade.

Treatments 3 and 4 evaluated the use of 2,4-D with 435 spray oil (2% v/v). These treatments produced the best results for yield at all sites. In some cases, those differences were not significant, but the trend of higher yield and less fruit drop with 2,4-D mixed with 435 spray oil identified with year 1 of the project carries over to year 2.

The combination of the Gibberellic acid and 2,4-D produced comparable results for many evaluations across most of the trial sites. The exact ratio of Gibberellic acid to 2,4-D and the correct timing which maximizes the treatment efficacy is not known. This project evaluated several combinations of the PGRs in year 1 and year 2 but none were consistently efficacious on fruit drop and yield.

Combining all the data from each site into a single combined data set showed Treatment 4 (2,4-D and 435 oil) to be the best performer and significantly different from the Treatment 1 (untreated control) for yield and pound solids per acre. The same combined data analysis showed significant differences in percent fruit drop. Treatment 4 was significantly different from Treatment 1 and 2. This combined site analysis further supports the site-by-site analysis showing 2,4-D with 435 spray oil to be effective on several key factors. In addition, results from the combined data set implied that a larger sample size at the individual sites may have overcome the large variations in treatment data and resulted in more significantly different treatment effects.

Appendix - Treatment details by site.

Hamlin Site – Southwest, Immokalee

TRT.	COLOR	APPLICATION CODE	COMPOUND.	RATE	SURFACTANT/SPRAY OIL	APPLICATION TIMING	EXACT APPLICATION.
1	WHITE		WATER CONTROL				
2	BLUE	**C**	2,4-D	3.2 FL OZ/A	NONE	OCTOBER	NOV 1 2023
3	RED	**A**	2,4-D	1.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	JULY	AUGUST 24 2023
		B	2,4-D	1.0 FL OZ/A	435 CITRUS OIL 2% (V/V)	SEPTEMBER	SEPTEMBER 20 2023
		C	2,4-D	1.0 FL OZ/A	435 CITRUS OIL 2% (V/V)	OCTOBER	NOV 1 2023
4	GREEN	**A**	2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	AUGUST	AUGUST 24 2023
		C	2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	OCTOBER	NOV 1 2023
5	ORANGE	**A**	Gibberellic Acid	20 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	2 MONTH BEFORE COLOR BREAK	AUGUST 24 2023
			2,4-D	1.5 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	2 MONTH BEFORE COLOR BREAK	
		C	Gibberellic Acid	20 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	COLOR BREAK	NOV 1 2023
			2,4-D	1.5 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	COLOR BREAK	
6	YELLOW	**A**	Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	2 MONTH BEFORE COLOR BREAK	AUGUST 24 2023
			2,4-D	1.5 FL OZ/A	435 CITRUS OIL 2% (V/V)	2 MONTH BEFORE COLOR BREAK	
		C	Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	COLOR BREAK	NOV 1 2023
			2,4-D	1.5 FL OZ/A	435 CITRUS OIL 2% (V/V)	COLOR BREAK	
7	BLUE/WHITE STRIPE	**B**	Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	SEPTEMBER	SEPTEMBER 20 2023
			2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	SEPTEMBER	

Hamlin Site – Central Ridge, Lake Wales

TRT.	COLOR	APPLICATION CODE	COMPOUND.	RATE	SURFACTANT/SPRAY OIL	APPLICATION TIMING	EXACT APPLICATION.
1	WHITE		WATER CONTROL				
2	BLUE	**C**	2,4-D	3.2 FL OZ/A	NONE	OCTOBER	OCTOBER 27 2023
3	RED	**A**	2,4-D	1.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	JULY	AUGUST 23 2023
		B	2,4-D	1.0 FL OZ/A	435 CITRUS OIL 2% (V/V)	SEPTEMBER	SEPTEMBER 27 2023
		C	2,4-D	1.0 FL OZ/A	435 CITRUS OIL 2% (V/V)	OCTOBER	OCTOBER 27 2023
4	GREEN	**A**	2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	AUGUST	AUGUST 23 2023
		C	2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	OCTOBER	OCTOBER 27 2023
5	ORANGE	**A**	Gibberellic Acid	20 FL OZ/A	organosilicone surfactant0.05 % (V/V)	2 MONTH BEFORE COLOR BREAK	AUGUST 23 2023
			2,4-D	1.5 FL OZ/A	organosilicone surfactant0.05 % (V/V)	2 MONTH BEFORE COLOR BREAK	
		C	Gibberellic Acid	20 FL OZ/A	organosilicone surfactant0.05 % (V/V)	COLOR BREAK	NOVEMBER 3 2023
			2,4-D	1.5 FL OZ/A	organosilicone surfactant0.05 % (V/V)	COLOR BREAK	
6	YELLOW	**A**	Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	2 MONTH BEFORE COLOR BREAK	AUGUST 23 2023
			2,4-D	1.5 FL OZ/A	435 CITRUS OIL 2% (V/V)	2 MONTH BEFORE COLOR BREAK	
		C	Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	COLOR BREAK	NOVEMBER 3 2023
			2,4-D	1.5 FL OZ/A	435 CITRUS OIL 2% (V/V)	COLOR BREAK	
7	BLUE/WHITE STRIPE	**B**	Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	SEPTEMBER	SEPTEMBER 27 2023
			2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	SEPTEMBER	

Valencia – Southwest, Immokalee

TRT.	COLOR	COMPOUND.	RATE		SURFACTANT/SPRAY OIL	APPLICATION TIMING	EXACT APPLICATION.
1	WHITE	WATER CONTROL					
2	BLUE	2,4-D	3.2 FL OZ/A		NONE	LATE DECEMBER	DECEMBER 21 2023
3	RED	2,4-D	1.2 FL OZ/A		435 CITRUS OIL 2% (V/V)	AUGUST	AUGUST 24 2023
		2,4-D	1 FL OZ/A		435 CITRUS OIL 2% (V/V)	OCTOBER	NOVEMBER 1 2023
		2,4-D	FL OZ/A		435 CITRUS OIL 2% (V/V)	DECEMBER	DECEMBER 12 2023
4	GREEN	2,4-D	3.2 FL OZ/A		435 CITRUS OIL 2% (V/V)	SEPTEMBER	SEPTEMBER 20 2023
		2,4-D	3.2 FL OZ/A		435 CITRUS OIL 2% (V/V)	NOVEMBER	NOVEMBER 1 2023
5	ORANGE	Gibberellic Acid	20 FL OZ/A		organosilicone surfactant 0.05 % (V/V)	2 MONTHS BEFORE COLOR BREAK	SEPTEMBER 20 2023
		2,4-D	1.6 FL OZ/A		organosilicone surfactant 0.05 % (V/V)	2 MONTHS BEFORE COLOR BREAK	SEPTEMBER 20 2023
		Gibberellic Acid	20 FL OZ/A		organosilicone surfactant 0.05 % (V/V)	COLOR BREAK	NOVEMBER 1 2023
		2,4-D	1.6 FL OZ/A		organosilicone surfactant 0.05 % (V/V)	COLOR BREAK	NOVEMBER 1 2023
6	YELLOW	Gibberellic Acid	20 FL OZ/A		435 CITRUS OIL 2% (V/V)	2 MONTHS BEFORE COLOR BREAK	SEPTEMBER 20 2023
		2,4-D	1.6 FL OZ/A		435 CITRUS OIL 2% (V/V)	2 MONTHS BEFORE COLOR BREAK	SEPTEMBER 20 2023
		Gibberellic Acid	20 FL OZ/A		435 CITRUS OIL 2% (V/V)	COLOR BREAK	NOVEMBER 1 2023
		2,4-D	1.6 FL OZ/A		435 CITRUS OIL 2% (V/V)	COLOR BREAK	NOVEMBER 1 2023
7	BLUE/WHITE STRIPE	Gibberellic Acid	10 FL OZ/A		435 CITRUS OIL 2% (V/V)	LATE DECEMBER	DECEMBER 21 2023
		2,4-D	3.2 FL OZ/A		435 CITRUS OIL 2% (V/V)	LATE DECEMBER	DECEMBER 21 2023

Valencia – East Coast, Ft. Pierce

TRT.	COLOR	COMPOUND.	RATE	SURFACTANT/SPRAY OIL	APPLICATION TIMING		EXACT APPLICATION.
1	WHITE	WATER CONTROL					
2	BLUE	2,4-D	3.2 FL OZ/A	NONE	LATE DECEMBER		DECEMBER 22 2023
3	RED	2,4-D	1.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	AUGUST		AUGUST 18 2023
		2,4-D	1 FL OZ/A	435 CITRUS OIL 2% (V/V)	OCTOBER		OCTOBER 20 2023
		2,4-D	FL OZ/A	435 CITRUS OIL 2% (V/V)	DECEMBER		DECEMBER 13 2023
4	GREEN	2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	SEPTEMBER		SEPTEMBER 20 2023
		2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	NOVEMBER		NOVEMBER 22 2023
5	ORANGE	Gibberellic Acid	20 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	2 MONTHS BEFORE COLOR BREAK		SEPTEMBER 20 2023
		2,4-D	1.6 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	2 MONTHS BEFORE COLOR BREAK		SEPTEMBER 20 2023
		Gibberellic Acid	20 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	COLOR BREAK		DECEMBER 13 2023
		2,4-D	1.6 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	COLOR BREAK		DECEMBER 13 2023
6	YELLOW	Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	2 MONTHS BEFORE COLOR BREAK		SEPTEMBER 20 2023
		2,4-D	1.6 FL OZ/A	435 CITRUS OIL 2% (V/V)	2 MONTHS BEFORE COLOR BREAK		SEPTEMBER 20 2023
		Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	COLOR BREAK		DECEMBER 13 2023
		2,4-D	1.6 FL OZ/A	435 CITRUS OIL 2% (V/V)	COLOR BREAK		DECEMBER 13 2023
7	BLUE/WHITE STRIPE	Gibberellic Acid	10 FL OZ/A	435 CITRUS OIL 2% (V/V)	LATE DECEMBER		DECEMBER 22 2023
		2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	LATE DECEMBER		DECEMBER 22 2023

Valencia – Central Ridge, Frostproof

TRT.	COLOR	COMPOUND.	RATE	SURFACTANT/SPRAY OIL	APPLICATION TIMING	EXACT APPLICATION.
1	WHITE	WATER CONTROL				
2	BLUE	2,4-D	3.2 FL OZ/A	NONE	LATE DECEMBER	DECEMBER 14 2023
3	RED	2,4-D	1.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	AUGUST	AUGUST 25 2023
		2,4-D	1 FL OZ/A	435 CITRUS OIL 2% (V/V)	OCTOBER	OCTOBER 27 2023
		2,4-D	FL OZ/A	435 CITRUS OIL 2% (V/V)	DECEMBER	DECEMBER 14 2023
4	GREEN	2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	SEPTEMBER	SEPTEMBER 27 2023
		2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	NOVEMBER	NOVEMBER 7 2023
5	ORANGE	Gibberellic Acid	20 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	2 MONTHS BEFORE COLOR BREAK	SEPTEMBER 27 2023
		2,4-D	1.6 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	2 MONTHS BEFORE COLOR BREAK	SEPTEMBER 27 2023
		Gibberellic Acid	20 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	COLOR BREAK	NOVEMBER 7 2023
		2,4-D	1.6 FL OZ/A	organosilicone surfactant 0.05 % (V/V)	COLOR BREAK	NOVEMBER 7 2023
6	YELLOW	Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	2 MONTHS BEFORE COLOR BREAK	SEPTEMBER 27 2023
		2,4-D	1.6 FL OZ/A	435 CITRUS OIL 2% (V/V)	2 MONTHS BEFORE COLOR BREAK	SEPTEMBER 27 2023
		Gibberellic Acid	20 FL OZ/A	435 CITRUS OIL 2% (V/V)	COLOR BREAK	NOVEMBER 7 2023
		2,4-D	1.6 FL OZ/A	435 CITRUS OIL 2% (V/V)	COLOR BREAK	NOVEMBER 7 2023
7	BLUE/WHITE STRIPE	Gibberellic Acid	10 FL OZ/A	435 CITRUS OIL 2% (V/V)	LATE DECEMBER	DECEMBER 14 2023
		2,4-D	3.2 FL OZ/A	435 CITRUS OIL 2% (V/V)	LATE DECEMBER	DECEMBER 14 2023