Field Trials to Reduce Brown Wood Rot — 2022-23[1]

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Introduction

Citrus wood rot fungal diseases have been a problem in Arizona for several years. The causal agents are *Fomitopsis meliae* and *Hypoxylon macrocarpum* which cause brown and white wood rot (BWR and WWR) respectively. All these rots produce wind-borne spores that infest citrus trees, producing hyphae that consume the wood or bark, leading to tree collapse and death. Of these, BWR is the most destructive.

Originally a problem in orchards over 25 years old, these diseases are now being found in orchards less than 20 years old, and occasionally in those less than 10 years old. First noted and described in Arizona by Drs. Robert Gilbertson, Mike Matheron and Ms. Donna Bigelow, BWR is pervasive on the Yuma Mesa, causing losses of entire orchards, usually between 20 and 25 years old. Left unchecked, wood rot-infested orchards in Arizona will continue to decline Tree limbs become infested following breakage due to the weight of heavy fruit loads, high winds and farm-implement-caused mechanical damage. Once infested, branches and trunks will weaken further and collapse, leading to entire crop loss.

The current recommended practices of tree removal, field sanitation and pruning are important and expensive components of a wood rot control program, but they must be accompanied by suitable fungicides that will control the diseases. This project initiated the field testing of some suitable fungicides and other materials and is subdivided into parts A, B and C.

Materials and Methods

A. Part A of the trial was the application of fungicides and other products applied as foliar sprays or soil drenches to prevent disease infestation of whole mature trees. This trial was approximately three acres, in Block 16 at the Yuma Mesa Agriculture farm. For these tests, we applied several products to whole trees. Each material was applied to twelve mature trees in the orchard. The treatment list is found in Table 1. The fungicides used were those found by Dr. Jiahuai Hu to be effective against *F. meliae* in petri plates in the laboratory. Additionally, the Bioflora products were included at the request of one Arizona citrus producer. All products were applied using an air-blast sprayer using a rate of 250 gpa, or as a soil drench where applicable. Trees were monitored and inspected regularly for appearance of the disease. When the disease appeared, the affected branches were removed. We had originally planned to apply treatments in February, May, and August 2022, but we wanted to have approval from the manufacturers before we used their products in the trial, and some of those materials were not approved until July 2022, and others not approved until September 2022, Therefore, we were only able to make a 2022 treatment in July, August or September, but results from the 2023 treatments in February and May are included in this report.

B. Part B of the trial was a test of the same materials as used in the first portion of the experiment (Table 1) but applied as foliar sprays or soil drenches to cure diseased trees. This was a 0.5-acre trial located in Block 24 of the Yuma Mesa Agriculture farm. For these tests, we artificially infested wooden dowels in the lab in July 2022 with *F. meliae.* Once infested, the dowels were inserted into branches of living trees in August 2022 ,

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Table 1. Materials applied to mature lemon trees to reduce Brown Wood Rot in Blocks 16 and 24 - 2022.

Treat. No.	Material/Rate per acre	Treat No.	Material/Rate per acre
0	Untreated Control	8	Bioflora Sea Isolates + Isogard + Minera (8 gal per season foliar spray) + GO Isolates + Gogreen + Isogard (22 gal. per season soil drench).
1	Ceyva 4 fl. oz/AC	9	Tebuconazole 6 fl. oz/AC
2	Headline SC 12 fl. oz/AC	10	Cannonball WG 7 oz/AC
3	Priaxor 8 fl. oz/AC	11	Mentor 8 oz/AC
4	Pristine 16 oz/AC	12	Quadris Top 15.4 fl. oz/AC
5	Serifel 12 oz/AC	13	QuiltXcel 21 fl. oz/AC
6	Serenade 14 oz/AC		
7	Flint 2 oz/AC		

and sealed closed. We then sprayed the individual trees with the same 13 fungicides as used in the tests of part A. Applications were made in August 2022, February 2023, and May 2023. In June 2023, the branches were cut from the trees, split, and the growth of the fungus was measured.

C. Part C of this trial was the application of Zinkicide to trees. Zinkicide is a Zn-based nanoparticle that has been developed by a University of Central Florida research group (Naranjo et al., 2020). In the laboratory, it has been shown to be a bactericide that may be effective against citrus greening (Candidatus liberibacter asiaticus), in the phloem. However, there was some indication that Zinkicide might be active in the xylem as well, meaning that there would be a possibility that BWR could be controlled. The author contacted the Florida researchers and acquired some Zinkicide to apply on trees. This portion of the project was not funded by the ACRC.

Table 2, Zinkicide treatments made to lemon trees in 2022.

Treatment No.	Treatment
1.	UTC
2.	125 ppm foliar
3.	125 ppm foliar + soil
4.	125 ppm soil
5.	250 ppm foliar
6.	250 ppm foliar + soil
7.	250 ppm soil
8.	500 ppm foliar
9.	500 ppm foliar + soil
10.	500 ppm soil

The Zinkicide, known as Zinkicide TMN 110 was applied to 6-year-old lemon trees (4 trees per treatment, 4 replications (16 trees total per treatment)) on the UA Mesa farm in Block 4A. The first application of Zinkicide was applied in July 2022, and the inoculation was made in August 2022 with 3 fungal inoculations per tree, 3-weeks post-inoculation, using the same methodology as in part B. A second application of Zinkicide was made in October 2022, 6-weeks post-inoculation. Foliar applications were made with a backpack sprayer "to drip". Soil drench treatments were made with five gallons of water.

Results and Discussion

A. Incidences of Brown Wood Rot from November 2022 through June 2023 are found in Figure 1. While there were no significant differences between the treatments, applications of Mentor, Flint and to a lesser extent Headline had a strong trend toward fewer discase incidences as compared to the control.

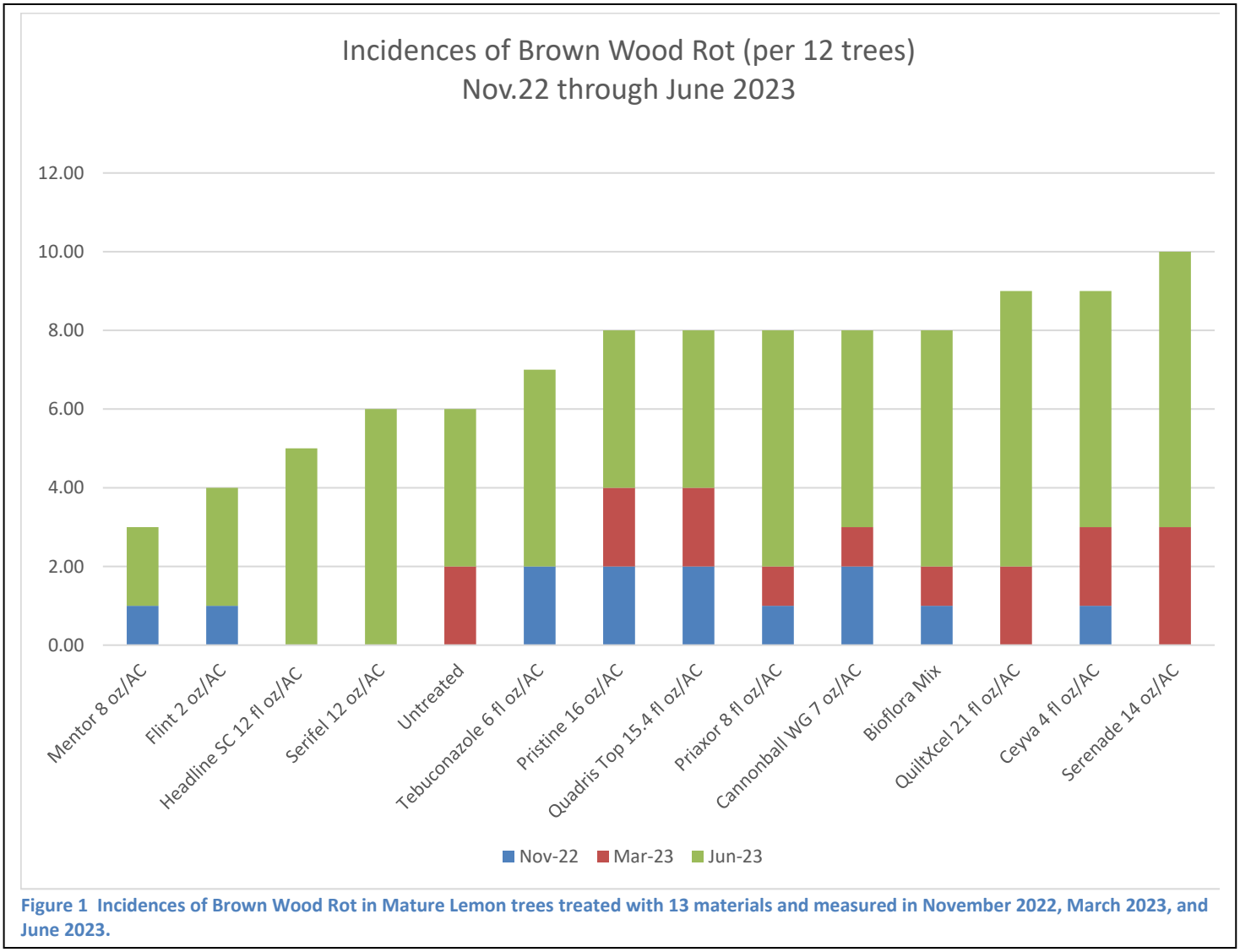
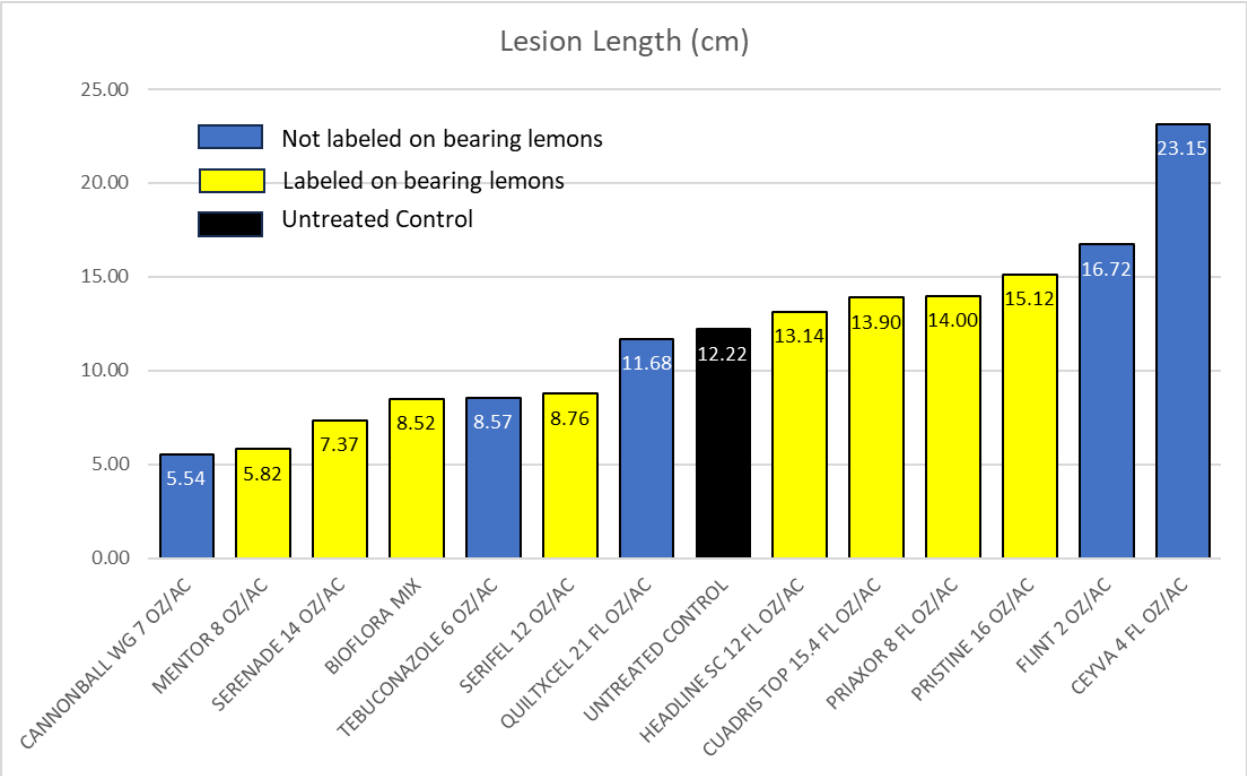


Figure 1 Incidences of Brown Wood Rot in Mature Lemon trees treated with 13 materials and measured in November 2022, March 2023, and June 2023.

B. Results from part B are found in Figure 2. While there were some significant differences, high variability among the treatments was limiting. Nevertheless, treatment with Cannonball, Mentor, Serenade the Bioflora Mix, Tebuconazole and Serifel led to less lesion growth in length versus the control. The same trend was observed for the lesion areas. These products deserve additional testing.



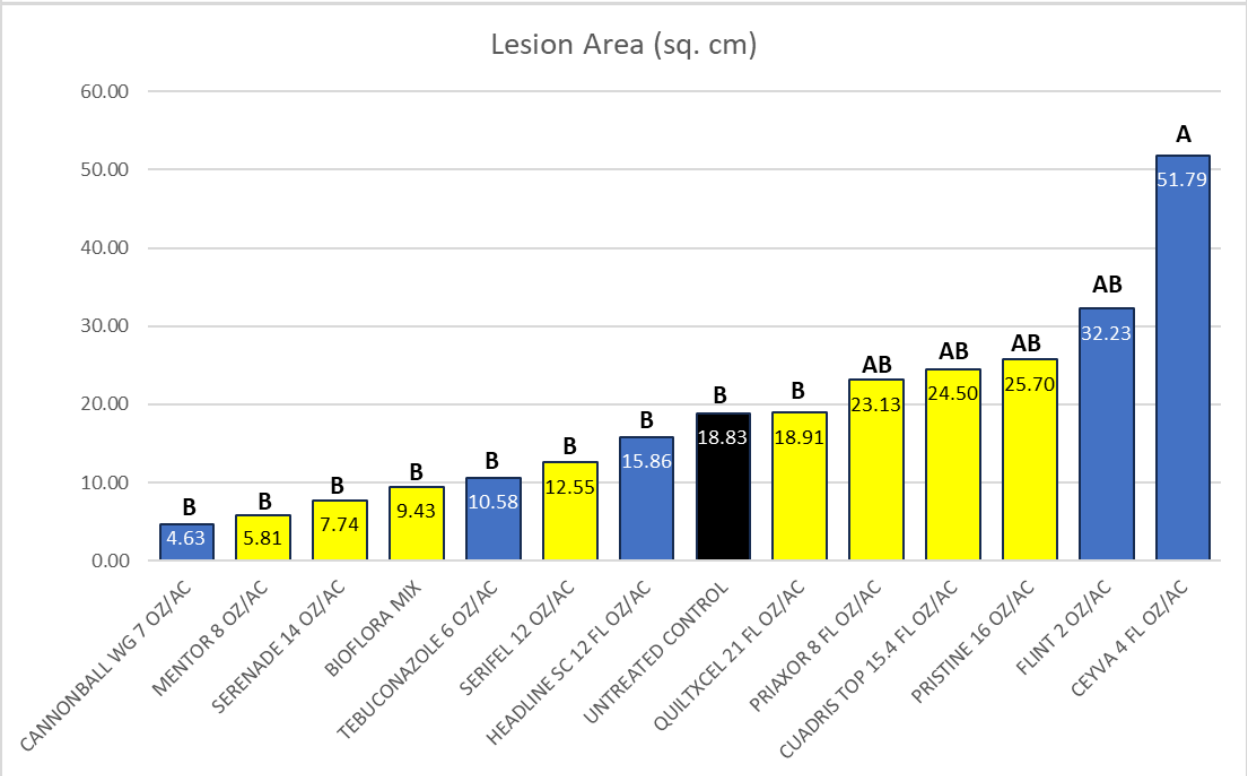
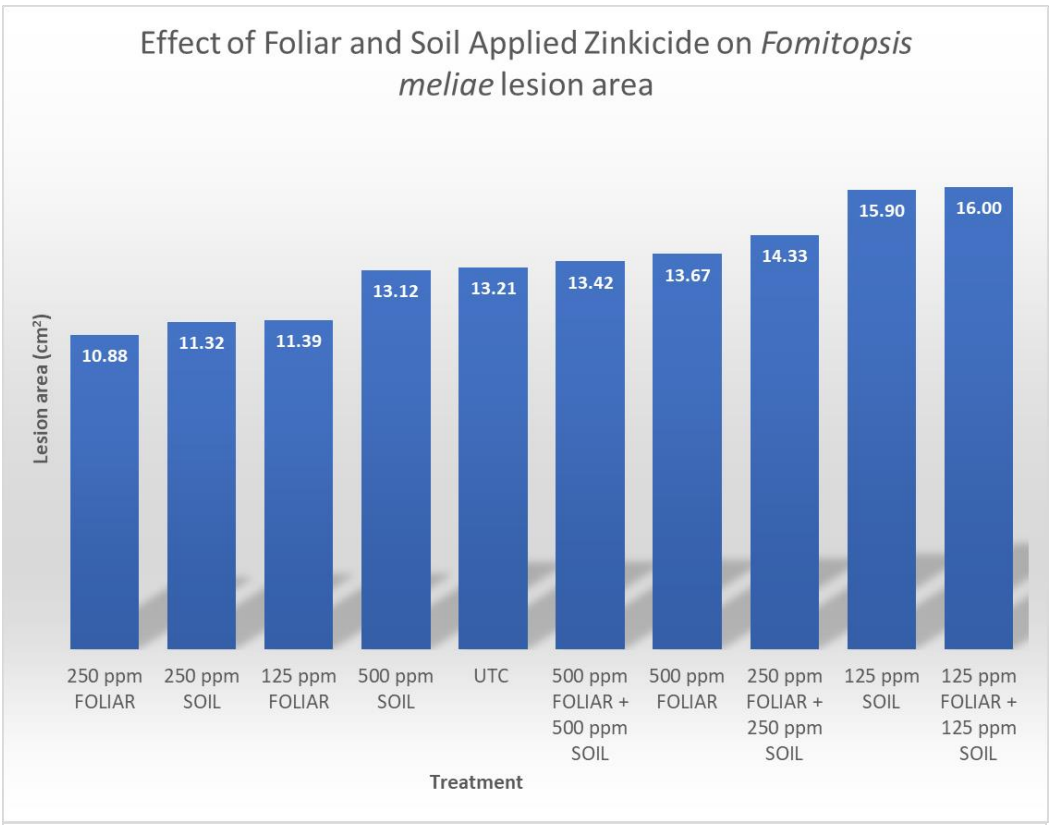


Figure 2. Wound lesion length and area of lemon branches infested with F. meliae and treated with several materials for the reduction of fungal growth.



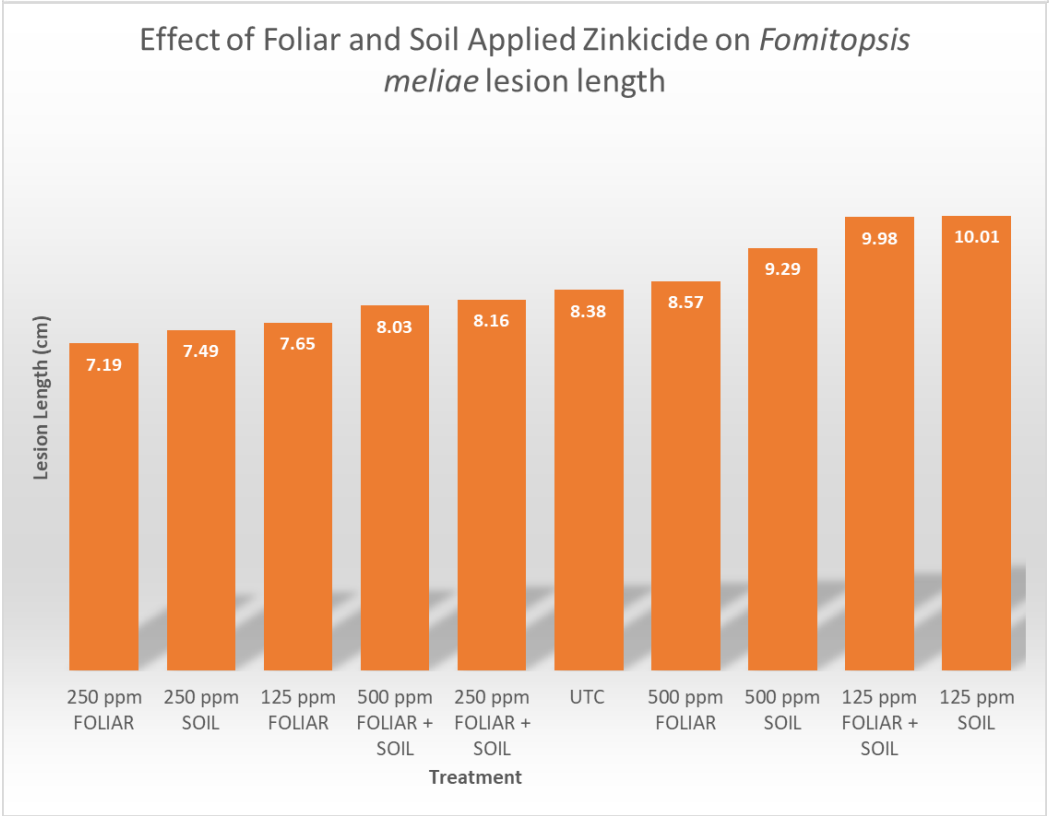


Figure 3. Wound lesion length and area of lemon branches infested with F. meliae and treated with Zinkicide the reduction of fungal growth.

C. Results from the Zinkicide experiment are found in Figure 3. Unfortunately, there was no effect of the treatments on either lesion length or area.

Plans for 2023-24

For 2023, we expect to continue with part A of the experiment. The effectiveness of the materials over the long term must be evaluated to determine which are the best. We also hope to engage the California Citrus Research Board in October 2023 with a project to test several of these fungicides, as well as others, on a larger scale. As for part B, we will not be continuing with the work as part of this project. We hope to combine this work with the CRB as well. As for part C, considering that there was no effect of the treatments, we will not be continuing testing with Zinkicide.

References

Naranjo E, Merfa MV, Santra S, Ozcan A, Johnson E, Cobine PA, De La Fuente L. Zinkicide Is a ZnO-Based Nanoformulation with Bactericidal Activity against Liberibacter crescens in Batch Cultures and in Microfluidic Chambers Simulating Plant Vascular Systems. Appl Environ Microbiol. 2020 Aug 3;86(16):e00788-20. doi: 10.1128/AEM.00788-20. PMID: 32561578; PMCID: PMC7414956.