Effect of SAR Elicitors on Lemon Tree Resistance to Brown Wood Rot – 2015[1]

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Abstract

Brown wood rot (Coniophora eremophila and Antrodia sinuosa) are serious diseases affecting lemon trees in Southwest Arizona. We applied K-Phite (Mono- and di-potassium salts of Phosphorous Acid), Saver (Potassium acetate), Sonata (Bacillus pumilus), Actigard (Acibenzolar-S-methyl: Benzo (1,2,3) thiadiazole-7-carbothioic acid-S-methyl ester) and Serenade WP (Bacillus subtilis) to trees infested with Antrodia sinuosa in the hopes of eliciting an SAR response and reducing the length of the disease in infested branches. Application of the products did not improve yield in treated trees, nor did they, reduce the length of infestation in inoculated branches.

Introduction

Coniophora eremophila, a wood rotting fungus, was first reported in lemons in 1992 (Matheron *et al*., 1992). Another species, *Antrodia sinuosa* was found to be infesting lemons, and was isolated in 1997. Further research (Bigelow, *et al*., 1996; Bigelow, *et. al*, 1998) found that *Coniophora* has been found sporulating on desert plants, but not been found sporulating on lemon wood, while *Antrodia* has been found sporulating on decaying fallen wood within lemon groves. Furthermore, the optimum temperature range for growth of *Antrodia* and *Coniophora* is 30-35C (86-95F), and the rate of decay for *Coniophora* and *Antrodia* in Lisbon lemon is higher than that for orange, tangelo and grapefruit trees. Finally, wood decay experiments suggest that *Antrodia* is more aggressive and a greater threat to lemon trees than is *Coniophora* (Matheron, *et al.,* 1996). Both are known collectively as "brown wood rot".

Neither of the fungi is particularly difficult to control using commonly available fungicides. Artificial inoculation of excised branches with mixtures of fungi and fungicide led to significant control (Matheron, *et al*., 1996). Length of *Coniophora* wood decay columns was reduced by 94% and 80%, following treatment with Propaconizole and Azoxystrobin, respectively. Length of Antrodia decay columns was reduced by 79% and 71% following treatment with the same materials. The difficulty in controlling these diseases in the field is that there appeared to be no effective way to apply the fungicides to the diseased interior wood of a living tree in the orchard.

Attempts to control disease progression in the field using low-pressure injection were not successful (Wright, 2015a, Wright, 2015b). These results along with the high cost of the system led to the realization that there needs to be an alternative method of control of brown wood rot

Systemic acquired resistance (SAR) is a natural plant defense mechanism, and a natural biological defense response to fungal attack. Several products are currently sprayed on citrus for suppression of citrus greening disease, or Huanglongbing (HLB) in Florida, on citrus that are also involved in eliciting SAR. These include K-Phite (Mono-

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and di-potassium salts of Phosphorous Acid), Oxidate/Dioxysolv (H_2O_2), SAver (Salicylic acid), Sonata (*Bacillus pumilus*), and Serenade WP (*Bacillus subtilis*). For the 2014-15 season, we tested some of these to determine if their application would reduce growth of brown wood rot in a living tree in the field (Wright, 2016). Although in some cases, application of these materials increased yield and reduced the length of the fungal infestations, these results in treated trees were not significantly different than the untreated trees. It is possible that the SAR effect might take more than one year to lead to a reduction in disease, thus an additional year of experimentation was initiated.

The objective of this study is to test several products currently used on citrus that are involved in inducing the SAR pathway to control the growth of brown rot fungi.

Materials and Methods

Four treatments, each comprising 5 trees are were planned for this experiment:

1. Untreated Control
2. Foliar application of Sonata – 3 qt. per acre; Renew (3-18-20 with Boron, K-phite and Saver) – 2 gal. per acre; and additional K-Phyte – 4 qt. per acre; and a soil application of Serenade Max WP – 5 qt. per acre; and Actigard – 3.2 oz. per acre, applied on 6/30 and 7/30/15. This treatment was applied prior to infestation with the fungi (See below).
3. Foliar application of Sonata – 3 qt. per acre; Renew (3-18-20 with Boron, K-phite and Saver) – 2 gal. per acre; and additional K-Phyte – 4 qt. per acre; and a soil application of Serenade Max WP – 5 qt. per acre; and Actigard – 3.2 oz. per acre, applied on 8/27 and 9/25/15. This treatment was applied after infestation with the fungi (See below).
4. Foliar application of Sonata – 3 qt. per acre; Renew (3-18-20 with Boron, K-phite and Saver) – 2 gal. per acre; and additional K-Phyte – 4 qt. per acre; and a soil application of Serenade Max WP – 5 qt. per acre; and Actigard – 3.2 oz. per acre applied on 6/30. 7/30, 8/27 and 9/25/15. This treatment was applied prior and after infestation with the fungi (See below).

Applications of Sonata, Renew and K-Phyte were made to the foliage using an air-blast sprayer. Applications of Serenade and Actigard were made to the orchard floor using a boom-sprayer. Treatment 2, initiated prior to infestation indicates whether these compounds can be used as preventatives. Treatment 3, initiated following infestation indicates whether these compounds can be used as curatives. Treatment 4 initiated before and after infestation indicates whether preventative application and curative application together is more effective than preventative and/or curative alone.

The foliar and soil treatments were each applied to blocks of 15 trees, and there were five blocks per treatment, thus each treatment was applied to 75 trees, and thus for the four treatments, there were 300 trees in the entire experiment.

Meanwhile, in July 2015, we collected some *Antrodia sinuosa* from a fallen tree limb in a local lemon orchard, and made several cultures of the fungus on agar in petri plates. Then, we purchased some 1/8-inch wood dowels, cut them into ½-inch lengths, and placed them in the petri plates, for the purpose of infesting the wood with the fungus. Within 2 weeks, all the dowel pieces were well-infested. Then, we chose and marked five trees from each of the blocks of 15 mentioned above. For each treatment, *Antrodia* was applied to at least four branches of each treated tree on 8/10/15 as follows: Holes were drilled in branches, and dowels were tightly inserted in holes, then holes were covered with pruning compound. Thus, the tree branches were "inoculated" with the fungus. This is the methodology used by Matheron *et al.* (2006), and by Wright, 2016. Photos of the inoculation procedure and branches can be found in Wright, 2016.

There were two harvests for 2015, the first was on 9/29/15 and the second was on 11/16/15. For each block of 15 trees, five trees were selected for harvest. In each case, total yield per tree was calculated by tallying the number of 30 lb. picking sacks per tree. Then, approximately 70 lbs. of fruit from the entire five-tree subsample was passed through an automated portable fruit sizer, which provides fruit size and exterior quality data.

On January 20, 2016, infected branches were cut from trees, split, and the length of infestation in each branch was measured. Sometimes, if the infestation was severe, the branch broke while we were attempting to split it.

Data was analyzed using the SPSS statistical package. Analysis of variance and means separation tests were used with a p value of 0.05.

Results and Discussion

Yield for the trees is shown in Figure 1. First harvest yield on 9/29 ranged from 81 to 106 lbs. per tree for the treated trees, and 103 lbs. per tree for the control. These values did not represent a significant difference. For the second harvest on 11/16, yields ranged from 227 to 279 lbs. per tree for the treated trees, while the yield for the control trees was 272 lbs. per tree. These values were also not significantly different. Overall, the yields ranged from 327 lbs. per tree for the August and September treatments to 374 lbs. per tree for the control.

There was no significant effect of treatment upon first harvest, second harvest or cumulative packout (data not shown). The majority of the lemons harvested were of size 140 (28 to 30%), followed by size 165 (23 to 27%) and size 115 (21 to 23%)

There was no effect of the treatments upon infection length. Control trees averaged 22.3 cm of infection. Trees treated in June and July averaged 21.4 cm of infestation, those treated in August and September averaged 25.0.cm, and those treated in all four months averaged 27.2 cm infestation.

It is disappointing that there was again no effect of the treatments upon the length of inoculated fungal infestation. It is apparent that yet another approach must be taken. Considering that the *Antrodia* has been found sporulating in lemon orchards, field sanitation appears to be particularly important. The effects of removal of diseased wood from the orchard floor must be investigated. Applications of fungicides to the orchard floor and to the trees may be helpful in reducing inoculum as well. Treatments such as these will be a part of upcoming experiments.

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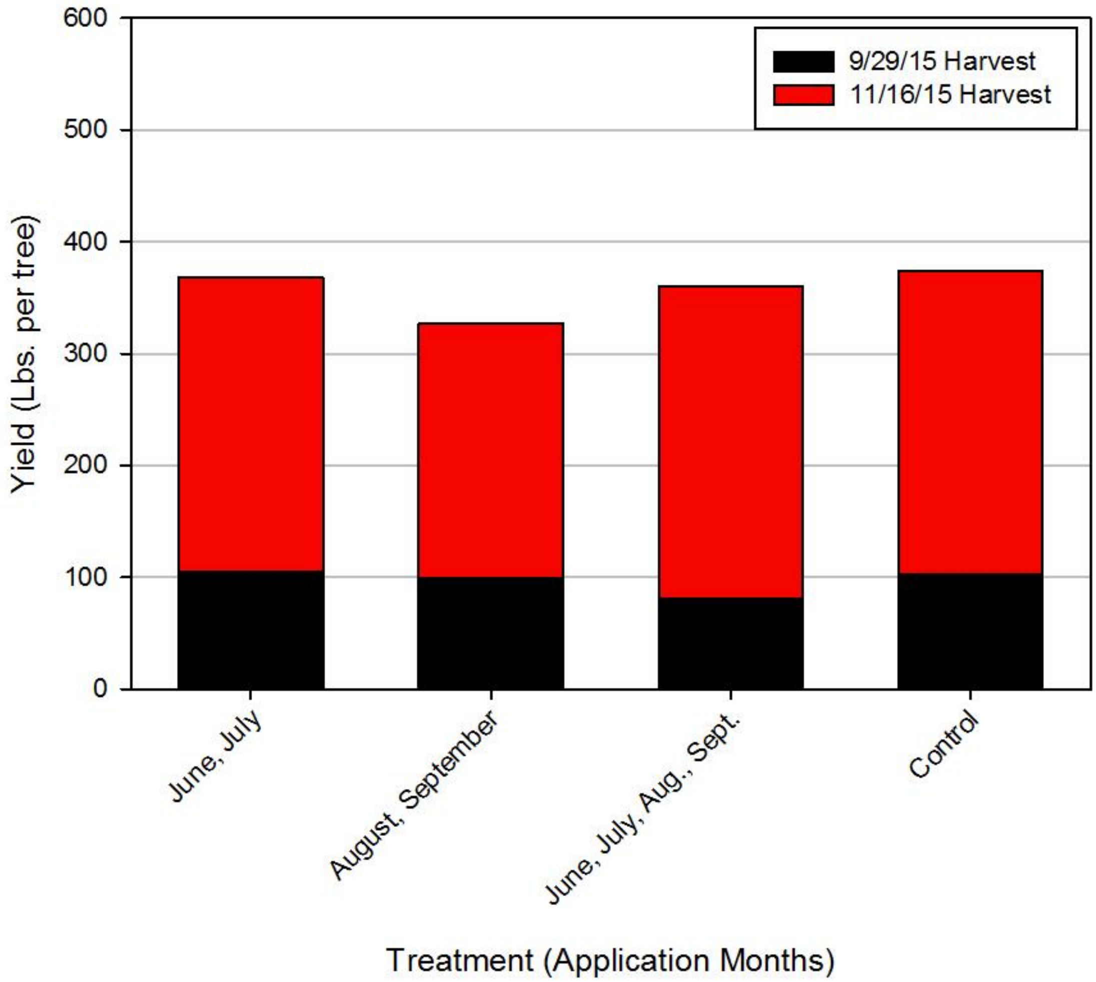

Figure 1. Yield of lemon trees subject to applications of SAR elicitors.