Stability of Peracetic Acid from Bioside HS 15% in two Fungicides

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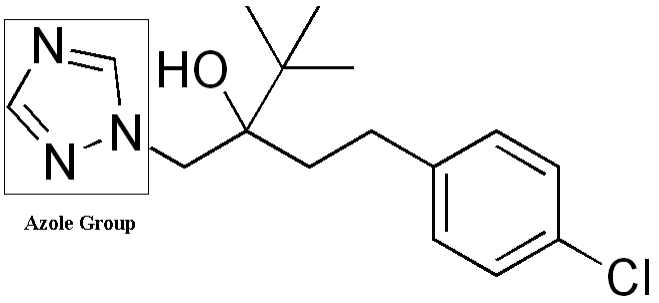
Background

In the past few decades the consumption of fruit and vegetable products in the United States has increased drastically by 30%. With increased production of fruits and vegetables comes increased spoilage due to bacterial and fungal diseases. On average 20% of all fruits and vegetables produced each year is lost to microbial spoilage[1]. The prevention of bacterial and fungal disease is an important practice. The problem lies in whether the active ingredients in the fungicide and bactericide will inactivate one another. Two fungicides used in the fruit and vegetables production are Elite® 45 DF Foliar Fungicide and Scholar® Fungicide.

Elite® 45 DF Foliar Fungicide come in a fine powder and is used for a wide variety of powdery mildew, black rot, cherry leaf spot, and many others. This fungicide is one of the more common fungicides. The active ingredient is Tebuconazole at a 45% concentration. Tubuconazole is a triazole fungicide. Though the U.S. Food and Drug Administration (FDA) considers this fungicide to be safe for humans, it may still pose a risk. Tebuconazole is listed as a possible carcinogen in the United States Environmental Protection Agency Office of Pesticide Programs (OPP) Carcinogen List with a rating of C. The fungicidal property of Tebuconazole is attributed to the azole functional group of the molecule (see Figure 1). Azole functional group is found in many antifungal medications such as ketoconazole, fluconazole, and isoconazole. The functional group inhibits ergosterol which is important to the cell wall of fungi. Theoretically, the azole functional group attached to the molecule should react with a strong oxidizing agent like peracetic acid (PAA). The oxidation of the azole group would limit or destroy the antifungal properties of the molecule, rendering it useless. Even though we know scientifically that the antifungal agent in Elite® 45 DF Foliar Fungicide has the potential to react with strong oxidizers like peracetic acid, there is no research on the rate at which the reaction will proceed.

[1] **Microbiological Spoilage of Fruits and Vegetables**
Margaret Barth, Thomas R. Hankinson, Hong Zhuang, and Frederick Breidt 2010

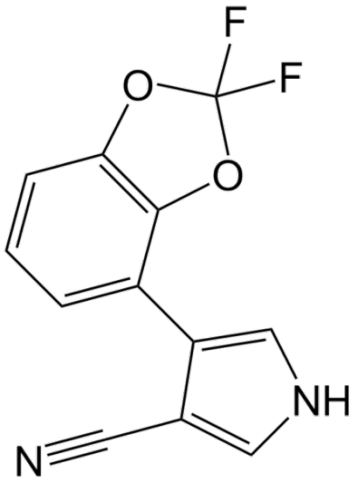
Figure 1 Tebuconazole, the active ingredient in Elite® 45 DF Foliar Fungicide



Scholar® Fungicide is an emulsion fungicide used in the fruit and vegetable industry. The active ingredient is Fludioxonil which is a phenylpyrrole fungicide that contains fluorine. Phenylpyrroles have a very unique mode of action, which prevents fungal respiration. Sygenta, the company that produces Scholar® Fungicide claims that it is compatible with chlorinated water. The molecular structure (see Figure 2) of Fludioxonil is absent oxidizable functional groups. Therefore, it can be concluded that Scholar® Fungicide will not degrade in the presence of peracetic acid.

The purpose of this study is to show that the rate reaction between the peracetic acid and the Elite® 45 DF Foliar Fungicide is slow and would not affect the efficacy of either of the two products in the contact time required for fruits and vegetables. Also, the purpose of this study is to prove that peracetic acid and Scholar® Fungicide will not degrade or lose efficacy when in the presence of one another.

Figure 2 Fludioxonil, active ingredient in Scholar® Fungicide.



Materials and Methods

Enviro Tech Chemical Services obtained a sample of powder Elite® 45 DF Foliar Fungicide and liquid sample of Scholar® Fungicide. Three solutions were made. Sample solution 1 contained only Modesto city water, sample solution 2 contained Elite® 45 DF Foliar Fungicide dosed at 2 oz/100 gallons as specified on the Elite® 45 DF Foliar Fungicide label under "Stone Fruits". Sample solution 3 was dosed with Scholar® Fungicide at 16 oz/100 gallons as specified by the label for "Stone Fruits". Solutions were allowed to mix thoroughly before the addition of peracetic acid. All three samples were then dosed with a nominal 80 ppm peracetic acid from BioSide HS 15%® and the residual peracetic acid was tracked for 180 minutes.

Results and Discussion

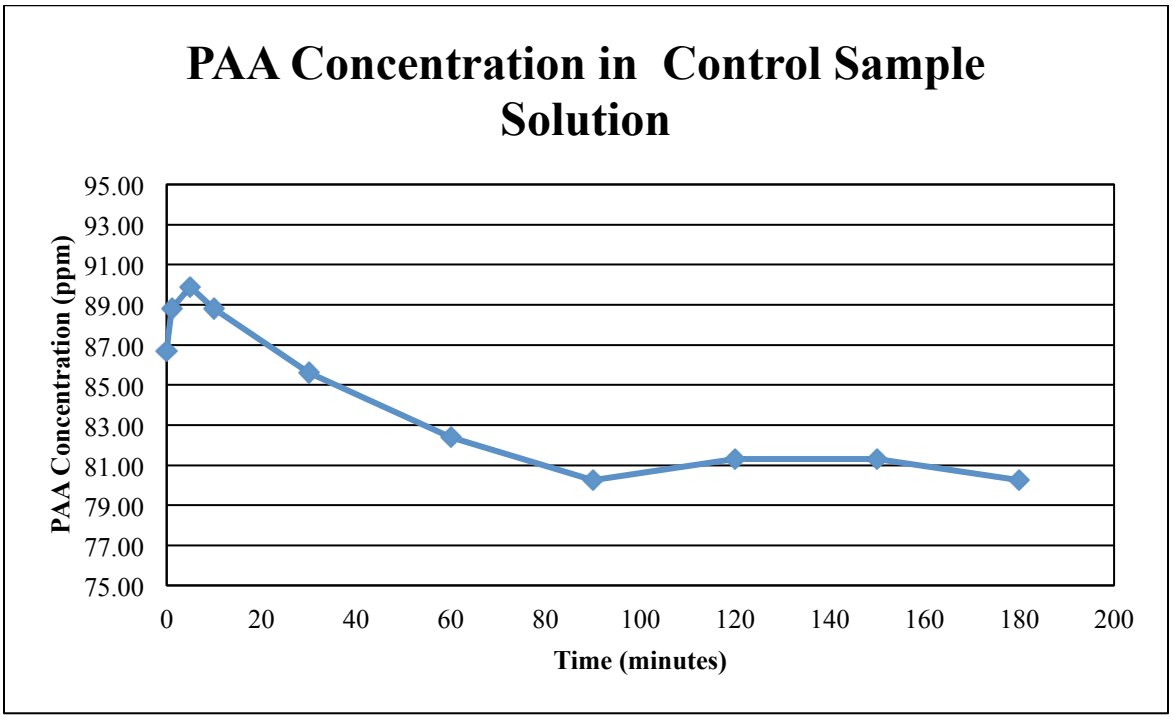
Control sample solution:

Immediately after the addition of the nominal 80ppm peracetic acid the pH was 6.33. The immediate recovery of PAA was 86.70 ppm. After 60 minutes the concentration of PAA decreased slightly to 82.39ppm. By 180 minutes the concentration was down to 80.25 ppm PAA (see Table 1). The average PAA concentration was 84.53 ppm with a standard deviation of 3.84 The final pH was 6.86. Table 1 shows the complete data of the residual concentrations of PAA in the control sample solution and Figure 3 is the graphical representation of the data.

Table 1 The residual concentration of PAA tracked over 180 minutes in the control solution

Time (minutes)	PAA Concentration (ppm)
0	86.70
1	88.80
5	89.88
10	88.80
30	85.60
60	82.39
90	80.25
120	81.32
150	81.32
180	80.25

Figure 3 A graphical representation of the PAA concentration in the control solution over a 180 minute time interval



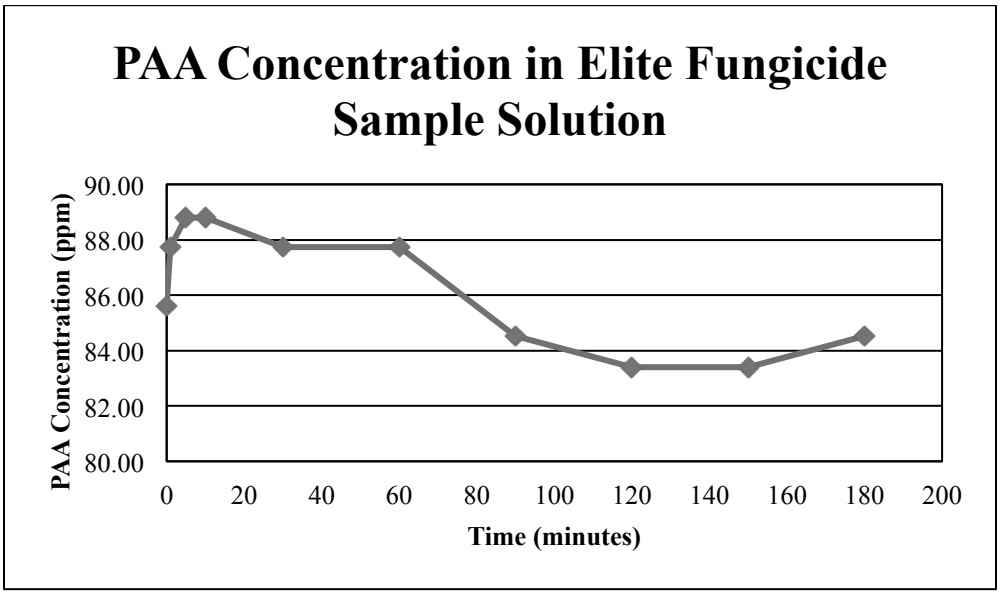
Elite® 45 DF Foliar Fungicide Solution

The pH immediately after the addition of the nominal 80 ppm was 6.02. The immediate recovery of PAA was 85.60 ppm. The concentration of PAA varied slightly over the 180 time interval. The lowest the concentration of PAA recorded at 120 minutes and was 83.40 ppm PAA. The highest concentration was recorded after 5 minutes and was 88.80 ppm PAA. Over the 180 minute time interval the average concentration was 86.23 ppm with a standard deviation of 2.17 ppm PAA. The results show that the concentration of peracetic acid showed no significant change when in the presence of Elite® 45 DF Foliar Fungicide in a 180 minute time interval. The final pH was 6.63. Table 2 shows the complete data of the residual concentrations of PAA in Elite® 45 DF Foliar Fungicide sample solution and Figure 4 is the graphical representation of the data.

Table 2 The residual concentration of PAA tracked over 180 minutes in the Elite® 45 DF Foliar Fungicide solution.

Time (minutes)	PAA Concentration (ppm)
0	85.60
1	87.74
5	88.80
10	88.80
30	87.74
60	87.74
90	84.53
120	83.40
150	83.40
180	84.53

Figure 4 A graphical representation of the PAA concentration in the Elite® 45 DF Foliar Fungicide over a 180 minute time interval



Scholar® Fungicide

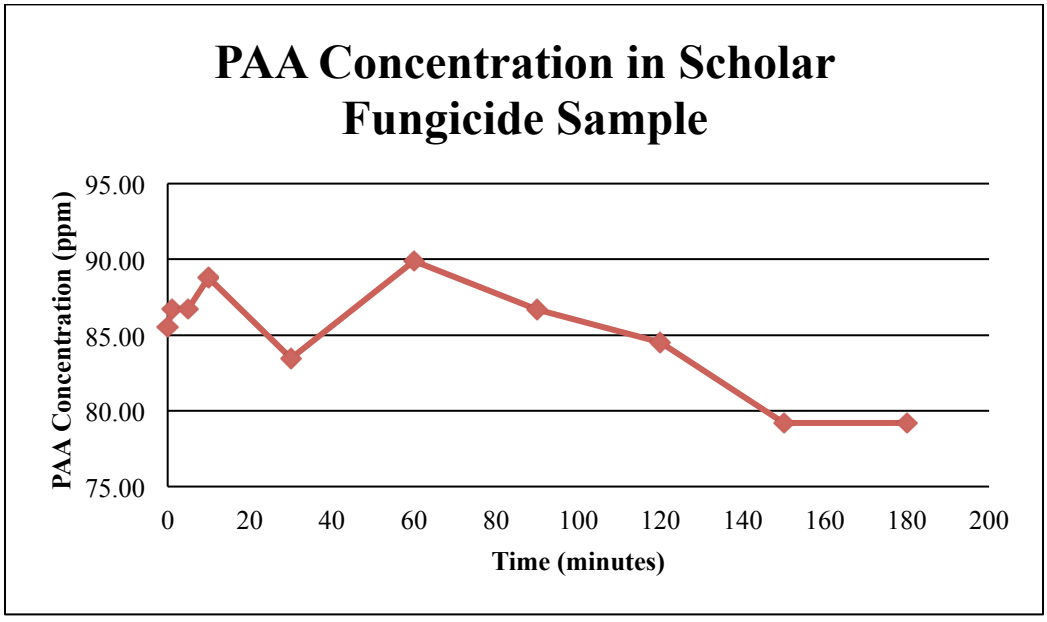
The pH immediately after the addition of the nominal 80 ppm was 6.03. The immediate recovery of PAA was 85.53 ppm. The concentration on PAA varied slightly over the 180 time interval. The lowest the concentration of PAA recorded at 30 minutes and was 83.46 ppm PAA. The highest concentration was recorded at 60 minutes and was 89.88 ppm PAA. Over the 180 minute

time interval the average concentration was 85.06 ppm with a standard deviation of 3.16 ppm PAA. The results show that the concentration of peracetic acid showed no significant change when in the presence of Scholar® Fungicide in a 180 minute time interval. The final pH was 6.86. Table 3 shows the complete data of the residual concentrations of PAA in the Scholar® Fungicide sample solution and Figure 5 is the graphical representation of the data.

Table 3 The residual concentration of PAA tracked over 180 minutes in the Scholar® Fungicide solution.

Time (minutes)	PAA Concentration (ppm)
0	85.53
1	86.70
5	86.70
10	88.80
30	83.46
60	89.88
90	86.67
120	84.53
150	79.18
180	79.18

Figure 5 A graphical representation of the PAA concentration in the Scholar® Fungicide over a 180 minute time interval



Conclusion

- The immediate recovery of PAA after a nominal 80 ppm was dosed in the Elite® 45 DF Foliar Fungicide sample solution was 85.60 ppm. At 180 minutes the concentration was 84.53 ppm. The concentration of peracetic acid showed no significant change in the PAA when in the presence of Elite® 45 DF Foliar Fungicide compared to the control. These results suggest that 80ppm peracetic acid from BioSide HS 15% is stable in Elite® 45 DF Foliar Fungicide at a concentration of 2 oz/100 gallons within 180 minutes.
- In the Scholar® Fungicide the immediate recovery of PAA after the nominal 800ppm dose was 85.53 ppm. The concentration varied slightly over the 180 ppm but was never below 79.18 ppm. Therefore, it can be concluded that 80 ppm Peracetic acid from BioSide HS 15% is stable in Scholar® Fungicide at a concentration of 16 oz/100 Gallons.