

# Control of Postharvest Diseases in Lemons<sup>1</sup>

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## Abstract

*Lemons treated with a Penbotec + Imazalil fungicide mixture or Graduate A+ were stored for 39 days. After 21 days, treated fruit had significantly less incidence of Penicillium digitatum (green mold) than untreated fruit. For the fruit that was infected, Graduate A+ treatments resulted in less lesion growth and sporulation than either untreated fruit or those treated with the Penbotec +Imazalil.*

## Introduction

Fungicides are commonly used on lemons as a postharvest application to protect the fruit against disease, particularly green mold (*Penicillium digitatum*). However, disease resistance can be a problem, if one fungicide, or several fungicides with the same mode of action are used. It is always better if fungicides are rotated, or if fungicides with more than one mode of action are used to control disease in citrus.

Graduate A+™ is a fungicide product that utilizes two active ingredients, fludioxonil and azoxystrobin, with unique modes of action. to protect citrus fruit from decay and guard against disease resistance, and is purported to provide effective sporulation control. Our objectives in this study were to evaluate Graduate A+ as a control for *Penicillium* versus untreated fruit, and to evaluate Graduate A+ as a control for *Penicillium* sp. versus a Pyrimethanil-Imazalil mix (the industry standard).

## Materials and Methods

We selected about 500 “weak lemons” directly from the harvest bins at Ventura Pacific Co., Oxnard, CA on 8/27/09. Weak lemons are those that are harvested late in the season that are more likely to become infested with disease. Fruit had no apparent injuries.

The experimental design for the experiment included six treatments and four replications – 18 fruit per individual treatment (6 x 4 x 18 = 432 fruit total). The treatments were untreated control, Graduate A+ at 150, 300, 600, and 1200 ppm, and a mixture of Pyrimethanil (Penbotec) at 350ppm + Imazalil at 350 ppm. Fungicides were applied on 9/2/09 as a drench, and the fruit was stored at 38F for 48 hours.

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Meanwhile, we had collected *Penicillium* (green mold) swipes from an infested grapefruit, and grew out colonies on agar-filled petrie plates for four weeks. On 9/4/09, we harvested the infested agar and mixed it with distilled water to make a *Penicillium* “slurry”. Then, we applied the slurry to fruit through a spray bottle “to drip”. Fruit was returned to 38F cold room for one week.

Fruit were analyzed on 9/11 (7 DAT), 9/18 (14 DAT), 9/25 (21 DAT), 10/6 (32 DAT) and 10/13 (39 DAT). There was a cooler failure about 35 DAT – temperature inside reached 80F. At each analysis date, we collected the number of fruit infested per group of 18, the % of peel covered with lesion, the % of peel covered with sporulation, the diameter of any lesion. Measuring the diameter of a lesion on a curved surface is not easy, especially since the lesions were non contiguous. Also, as a lesion covered the entire fruit, the fruit shrank, decreasing the lesion size.

All data was analyzed using SPSS 11.0 for Windows (SPSS Inc., Chicago, Illinois).

## **Results and Discussion**

Before day 21, no treatment had a significant effect upon disease incidence (Figure 1). However, after day 21, all fungicides had significantly less infested fruit as compared to the untreated control. All fungicides were able to limit the spread of the disease from infested to non-infested fruit. There was no significant effect of the fungicides upon the numbers of infested fruit until after day 32, yet by day 39, the Penbotec + Imazalil treatment and the Graduate A+ at 1200 ppm had slightly less infested fruit than did the Graduate A+ treatments at lower rates.

Expansion of the *Penicillium* lesions was generally significantly less with the Graduate A+ products as compared to the untreated control, or the Penbotec + Imazalil treatment (Figure 2). For the few fruit that had disease, the Graduate treatments kept the spread of the disease across the peel in check, but for the few fruit that had the disease, the Penbotec + Imazalil treatments did not stop the spread of the disease across the peel.

Expansion of the sporulation was generally significantly less with the Graduate A+ products as compared to the untreated control, or the Penbotec + Imazalil treatment (Figure 3). For the few fruit that had disease, the Graduate treatments kept the sporulation of the disease on the peel in check, but the Penbotec + Imazalil treatments did not stop the sporulation of the disease across the peel.

Photographs of the treated fruit at the dates of analysis are shown in Figure 4.

## **Conclusions**

All treatments were quite successful in controlling green mold. However, the Graduate A+ treatments were more effective in controlling lesion expansion and sporulation than the Penbotec + Imazalil treatments. Assuming that the costs of the fungicides are similar, both are registered and the maximum residue limits for the domestic and export markets are similar, then Graduate A+ should be considered as a suitable replacement for the Penbotec + Imazalil.

### Increase in lemons infested with *P. digitatum* over time

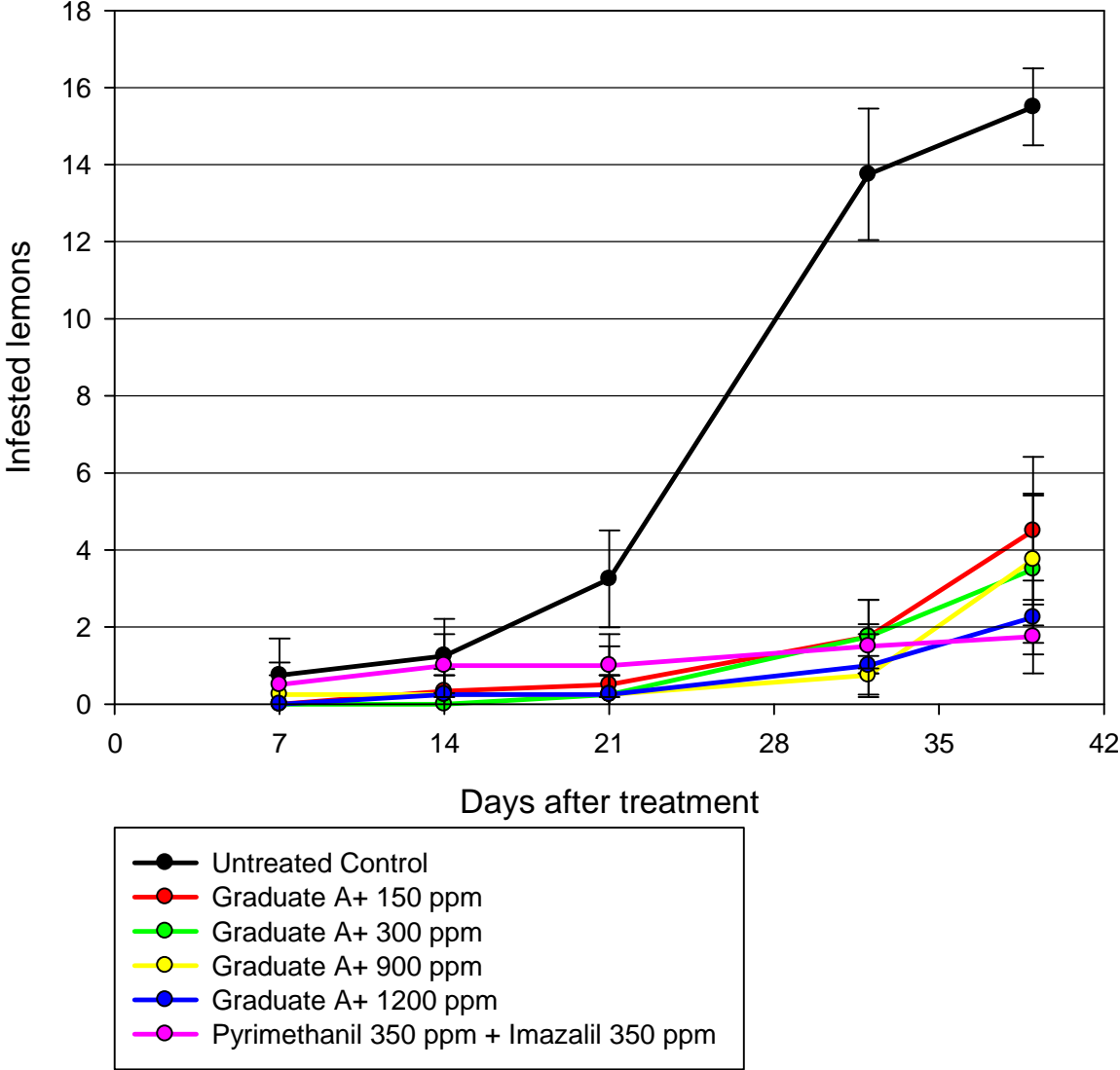


Figure 1. Lemons infested with *P. digitatum* following treatment with four rates of Graduate A+ and a combination of Pyrimethanil and Imazalil, as compared to untreated fruit.

## Penicillium sp. lesion expanse over time

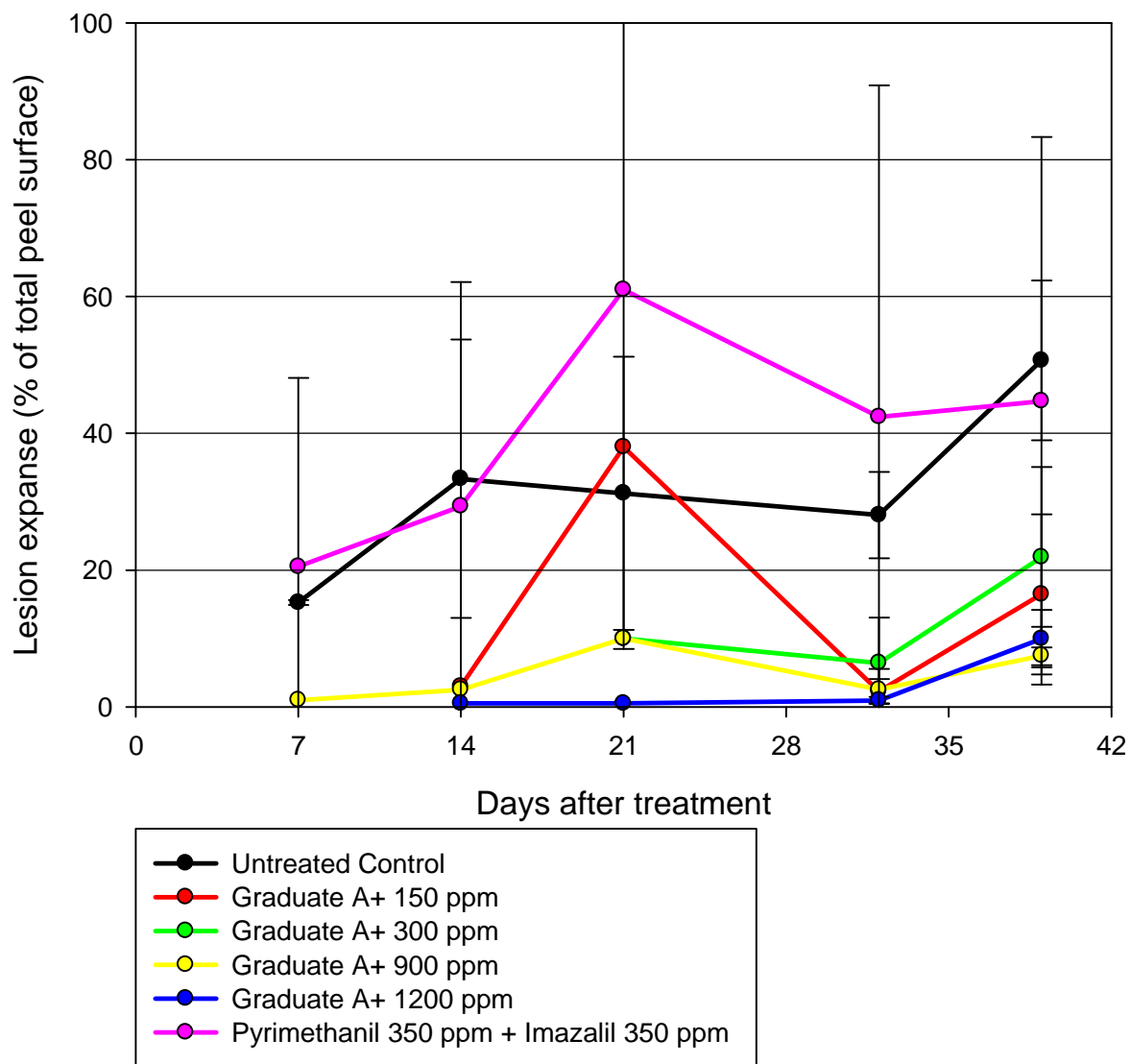


Figure 2. Lesion expanse of *P. digitatum* on lemons following treatment with four rates of Graduate A+ and a combination of Pyrimethanil and Imazalil, as compared to untreated fruit.

### Sporulation of *Penicillium* sp. over time

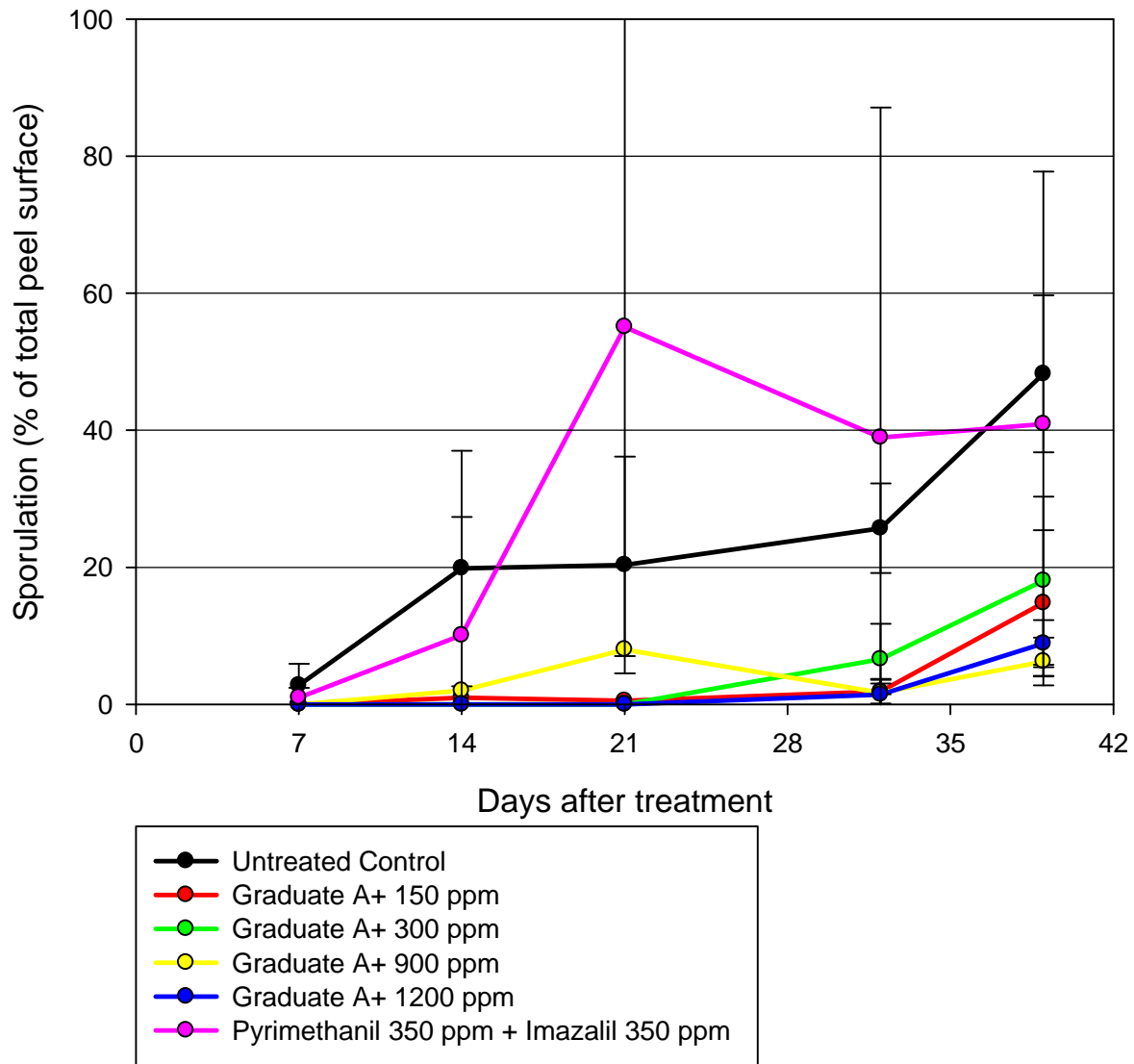


Figure 3. Sporulation of *P. digitatum* on lemons following treatment with four rates of Graduate A+ and a combination of Pyrimethanil and Imazalil, as compared to untreated fruit.

Figure 4. Treated fruit at the dates of analysis.

	Untreated Control	Graduate A+ 300 ppm	Pyrimethanil (350 ppm)+ Imazalil (350 ppm)
7 DAT			
14 DAT			
21 DAT			
32 DAT			
39 DAT			