WATERMELON (*Citrullus lanatus* 'Crimson Sweet')
Phytophthora fruit rot; *Phytophthora capsici*

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**Evaluation of fungicides for managing Phytophthora fruit rot in watermelon, Tift County, Georgia, 2019.**

Fungicides were evaluated for their efficacy to manage Phytophthora fruit rot, caused by *Phytophthora capsici*. The experiment was conducted in a field plot at University of Georgia, Tifton campus that had a history of epidemics of Phytophthora fruit rot. Watermelon 'Crimson Sweet'' were transplanted onto single row beds covered with 18-in. black plastic mulch on 28 Mar. Beds were on 6-ft centers with 3-ft plant spacing within rows. Plots were 20-ft long with and used 5-ft planted borders between plot ends. The trial was arranged in a randomized complete block design with four replications with 10 plants per replication. Plots were drip irrigated weekly and as necessary using a drip tape irrigation system. Fertility and insecticide treatments were applied according to the University of Georgia Extension recommendations. Natural infection was relied upon for initial inoculum. Fungicide treatments were applied using a John Deere 6155 sprayer calibrated to deliver 40 GPA at 125 psi through TX-10 hollow cone nozzles. The mean rainfall received during March and June was 3.5 in. and 5.2 in., respectively. The average high and low temperatures for the month of March were 75° and 63° F, respectively, and for the month of June were 91° and 74° F, respectively. On 24 Jun, fruit from each plot were harvested and incubated under standard room temperature (78° F) for 48-h. Ratings for fruit rot incidence were assessed on 26 Jun as percentage of fruits with visible symptoms typical of *P. capsici*. Data were analyzed using the software ARM (Gylling Data Management, Brookings, SD), analysis of variance (ANOVA) and the Waller-Duncan test to separate means.

*Phytophthora capsisi* fruit rot was not observed in the field for any of the treatments including non-treated check. Hence, post-harvest evaluation were conducted. Post-harvest ratings for Phytophthora fruit rot were taken on 26 Jun. The fruit rot incidence for fruits from the non-treated check plots (20.5%) were significantly higher than the fruits from fungicide treated plots. Among the treatments, the fruit rot incidence was significantly lower for the fungicide program that was comprised of Presidio, Orondis Ultra and K-Phite (3.5%) compared to other fungicide programs. Fungicide programs comprised of Actigard, Orondis Ultra and Presidio (6.5%); Presidio, Orondis Ultra and Elumin (5.8%); and Actigard, Elumin and Presidio (8.6%) were not significantly different from each other. Phytotoxicity was not observed with any of the treatments.

| Treatment and rate per acre | Application timing[z] | Fruit rot incidence (%)[y] 26 Jun |
|---|---|---|
| Presidio 4 fl oz | 1, 3 | |
| Orondis Ultra 8 fl oz | 2, 4 | |
| K-PHITE 4 qt | 1-5 | 3.5 c[x] |
| Actigard 0.75 fl oz | 1, 4 | |
| Orondis Ultra 8 fl oz | 2, 5 | |
| Presidio 4 fl oz | 3, 6 | 6.4 b |
| Actigard 0.75 fl oz | 1, 4 | |
| Elumin 8 fl oz | 2, 5 | |
| Presidio 4 fl oz | 3, 6 | 8.6 b |
| Presidio 4 fl oz | 1, 3 | |
| Orondis Ultra 8 fl oz | 2,4 | |
| Elumin 8 fl oz | 1-5 | 5.8 b |
| Untreated check | | 20.5 a |

[z]Application dates were: 1=16 May, 2=23 May, 3=30 May, 4=6 Jun, and 5= 13 Jun.
[y]Disease incidence was rated on a 0 to100 scale where 0=0% of fruit in a plot affected and 100=100% of fruit in a plot affected.
[X]Means followed by the same letter within each column are not significantly different according to Fisher's protected LSD test at $P \leq 0.05$.

**Development of integrated fungicide programs for managing Fusarium wilt of watermelon**

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## Introduction

Fusarium wilt of watermelon, caused by the fungal pathogen *Fusarium oxysporum* f. sp. *niveum* (FON), is responsible for significant yield loss in watermelon production in Georgia and the Southeast. The disease is also well established in nearly all watermelon growing regions in the United States and the world. Both seedless and seeded watermelon cultivars can be affected by the disease. In the field Fusarium wilt may appear early in the watermelon growing season and a characteristic symptom of the disease is wilting of one or two vines while other vines look healthy. Internal plant tissue discoloration can been seen when lower stems are sectioned. Eventually plants infected may become wilted completely especially if young plants get infected. Management of Fusarium wilt of watermelon is difficult. Reliable resistance to all the known races of FON (0, 1, 2, 3) is not available in commercial cultivars of watermelon.

Application of chemical fungicides is a significant component in developing effective disease management programs. As of today, however, limited fungicides are available for Fusarium wilt of watermelon. Prothioconazole (e.g., Proline) belongs to demethylation inhibitors (DMI) and affects sterol biosynthesis. Pydiflumetofen (e.g., Miravis) is a new succinate dehydrogenase inhibitors (SDHI) fungicide that inhibits respiration. Difenoconazole acts by inhibition of demethylation during ergosterol synthesis. In addition to the non-fumigant fungicides, chloropicrin showed some efficacy in reducing Fusarium wilt on watermelon in field studies. The objective of this study was to develop integrated programs incorporating the non-fumigant and fumigant fungicides for managing Fusarium wilt of watermelon under field conditions in Georgia.

## Materials and Methods

The field experiment was conducted at University of Georgia Coastal Plain Experiment Station in Tifton, GA, in 2019. The field site was infested by FON and had a history of Fusarium wilt of watermelon. Plant beds were formed using a commercial tractor-drawn bed-former. Polyethylene plastic mulch was laid and a single drip tape was installed 1-2 inch below the surface at the center of the beds as the plastic mulch was applied. In fungicide treatments without soil fumigation, Proline (a.i., prothioconazole), Miravis (a.i., pydiflumetofen), and difenoconazole were applied by soil drench at transplanting and directed spray targeting the base of the plants three weeks after transplanting. Proline and Miravis were applied at 5.7 and 8.6 fl oz/acre, respectively, and difenoconazole was applied at 1.7 fl oz/acre. For fumigant evaluation, chloropicrin (Pic 80: Pic + Telone) was applied at 300 lbs/acre at dual depth – 10 and 20 inches below the top of the formed bed. Plastic mulch was installed immediately after fumigant application. In treatments combining fumigant and non-fumigant, prothioconazole, pydiflumetofen, and difenoconazole were applied by directed spray three weeks after transplanting. Four-week old watermelon seedlings (cv. Sugar Baby) were planted 2 ft apart in a single row in the field, with 12 plants in each treatment plot. The following fungicide programs were evaluated:

1) Pic 80
2) Proline (At transplanting and 3 weeks after transplanting)
3) Miravis (At transplanting and 3 weeks after transplanting)
4) Difenoconazole (At transplanting and 3 weeks after transplanting)
5) Pic 80 + Proline (3 weeks after transplanting)
6) Pic 80 + Miravis (3 weeks after transplanting)
7) Pic 80 + Difenoconazole (3 weeks after transplanting)
8) Non-treated control

A randomized complete block design was used with four replications. Fusarium wilt incidence was recorded after first appearance of symptoms, and disease data were analyzed statistically using the GLM procedures of SAS and means were separated by the least significant difference test at $P = 0.05$.

**Results**

Final disease incidence reached 47.9% in the non-treated control plots (Fig. 1). All the treatments reduced disease significantly compared to the non-treated control. Application of Pic 80 in conjunction with directed spray of difenoconazole 3 weeks after transplanting resulted in the lowest disease. Combined use of Pic 80 with the non-fumigant fungicides showed a tendency to reduce disease incidence compared with application of the fumigant and non-fumigant fungicides alone.

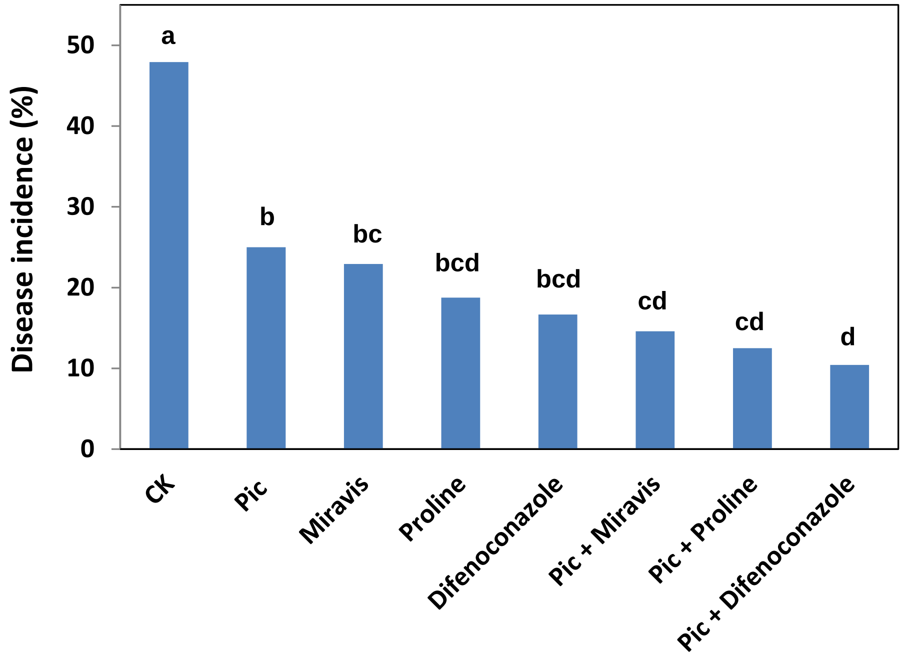


**Fig. 1.** Reduction of Fusarium wilt on watermelon by applications of fumigant and non-fumigant fungicides. Pic = Pic 80; CK = non-treated control. Different letters above the bars indicate significant difference according to least significant difference test ($P$ = 0.05).

# Assessment of role of seed infestation and seed treatment in development of Fusarium wilt of watermelon

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## Introduction

Fusarium wilt of watermelon, caused by *Fusarium oxysporum* f. sp. *niveum* (FON), is one of the most economically important diseases of watermelon in Georgia and the southeastern U.S. Symptoms of Fusarium wilt include damping-off and wilting during seedling stage. In the field, symptoms typically occur within 3 to 4 weeks, starting with graying of foliage followed by foliar chlorosis and wilt. Fusarium wilt is typically characterized by unilateral stem necrosis, which is easily visualized when runners or stems are sectioned.

The fungal pathogen FON is primarily soil-borne, and seed-borne nature of the pathogen has also been documented. Studies conducted in our lab at University of Georgia indicated that inoculation of flowers and immature watermelon fruit with FON resulted in infestation of seeds by the pathogen in asymptomatic watermelon fruit. Additionally, seeds collected from watermelon grown in commercial vegetable fields were found to be infested by FON. Studies are limited about transmission of FON from infested seeds to watermelon seedlings and what percentage of seedlings can get infected from infested seeds. If seed infestation causes significant Fusarium wilt on seedlings, infested seeds would serve as an important inoculum source for disease dispersal. In addition, it is unknown if fungicides can be used to treat infested seeds to significantly reduce Fusarium wilt development on watermelon seedlings. The objectives of this study were: 1) to determine transmission of Fusarium wilt pathogen from infested seeds to seedlings of watermelon to cause disease; and 2) to evaluate efficacy of seed treatment by fungicides for reduction of Fusarium wilt of watermelon.

## Materials and Methods

*Assessment of transmission of FON from seeds to seedlings*. Seeds of watermelon cultivars “Trevally”, “Tri X313” and “WDL 0201” that were found to be naturally infested by FON were used in the study. Seeds of watermelon cultivar “Sugar Baby” that were not infested by FON were used as a control. The seeds were sown in seedling trays containing a commercial potting mix. The plants were kept in a greenhouse and disease incidence (% infected plants) was recorded until 4 weeks after planting. Seed-to-seedling transmission rate (i.e., number of seedlings with Fusarium wilt symptom / total number of seeds germinated × 100) was calculated for each cultivar. The experiment was conducted twice under similar greenhouse conditions. Data were analyzed statistically using Fischer’s least significant difference test (LSD) by SAS ($P$ = 0.05).

*Evaluation of seed treatment by fungicides for disease reduction*. Seeds of "Sugar Baby" were artificially infested by FON in the study. FON spores were prepared and seeds were soaked in spore suspension ($10^5$ spores/ml) for 30 min. The seeds were then transferred to sterile Petri dishes and incubated overnight at room temperature. The infested seeds were treated with two fungicides, Proline (a.i., prothioconazole) and Miravis (a.i., pydiflumetofen). The seeds were soaked in solutions of the fungicides at 100 and 500 mg/liter (active ingredient) for 30 min. Seeds were sown in 10-cm pots containing the potting mix, one seed/pot, and the pots were arranged in randomized complete block design with four replicates. Seeds treated with water were used as a control. The pots were kept in a greenhouse and disease incidence (% infected plants) was recorded until 4 weeks after seedling emergence. Disease data were analyzed by LSD test using SAS.

**Results**

Seed-to-seedling transmission assay indicated that rates of transmission for "Tri X313" and "Trevally" were 5.3% and 2.9%, respectively, which were significantly higher than "WDL 0201" (0.76%) (Fig. 1). Non-infested seeds of "Sugar Baby" used as a control did not result in diseased plants in the experiments. The results indicate that planting watermelon seeds infested by FON could result in diseased seedlings, so infested seedlots can serve as inoculum sources that introduce the disease to fields where watermelon has never been grown before.

Seed treatment with Proline and Miravis reduced incidence of Fusarium wilt significantly compared to the non-treated control (Fig. 2). There was no significant difference between the two rates of fungicides in disease reduction.

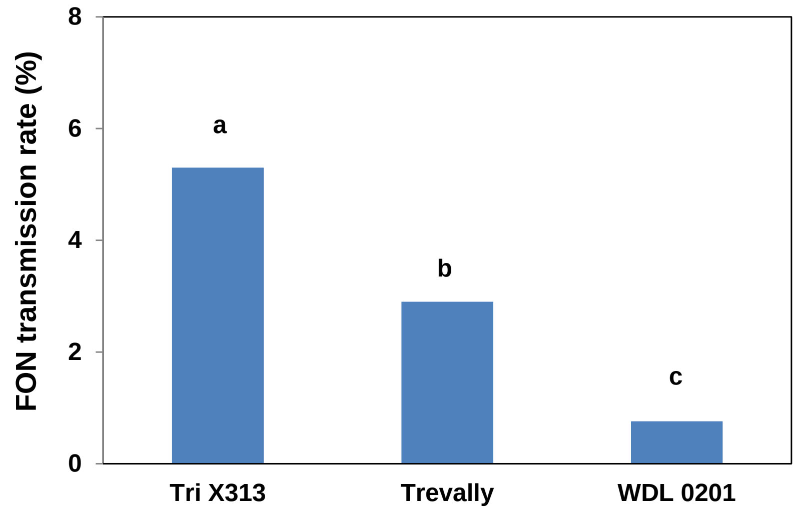


**Fig. 1.** Percentage of seedling transmission by *Fusarium oxysporum* f. sp. *niveum* (FON) in three watermelon cultivars under greenhouse conditions. Different letters above the bars indicate significant difference according to the least significant difference test (*P* = 0.05).

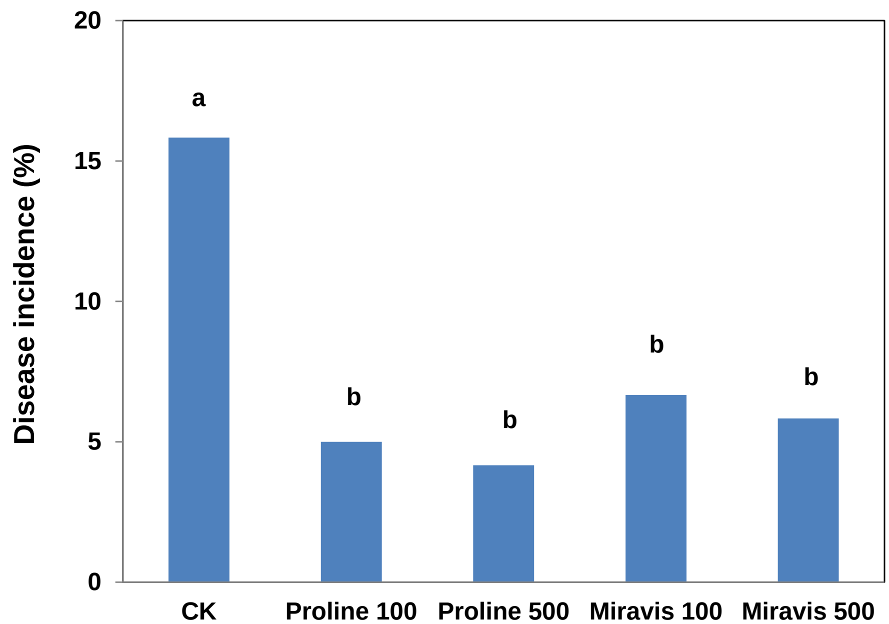


**Fig. 2.** Reduction of Fusarium wilt of watermelon by seed treatment with Proline (a.i., prothioconazole) and Miravis (a.i., pydiflumetofen) under greenhouse conditions. Proline and Miravis were applied at 100 and 500 mg/liter active ingredient. Different letters above the bars indicate significant difference according to the least significant difference test (*P* = 0.05).