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## EFFECT OF COPPER FUNGICIDE APPLICATION FOLLOWING HEDGING AND TOPPING ON MELANOSE INCIDENCE

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**Abstract.** Copper hydroxide fungicide was applied to white marsh grapefruit trees, immediately after hedging, and prior to rainfall, in experimental blocks in three groves in the Indian River area. Comparison plots did not receive copper fungicides. The copper fungicide applications were made by ground rig in an Indian River County grove as well as a Martin County grove, and by air in a St. Lucie County grove. Subsequent copper fungicide applications were made to all trees in the experimental blocks by the growers during normal production practices. Incidence of melanose, *Diaporthe citri*, was assessed on leaves and fruit. There was no difference in melanose lesion intensity between leaves collected from trees receiving post-hedging copper fungicide treatment and leaves from trees not receiving post-hedging copper fungicide treatment. There were fewer melanose lesions, however, on fruit harvested from trees treated with copper fungicide immediately after hedging as compared to fruit from trees not treated with copper fungicide immediately after hedging.

Infection of grapefruit by the melanose pathogen, *Diaporthe citri*, often reduces its marketability. Penetration of the pathogen

into fruit induces a protective response by fruit surface cells (Compendium of Citrus Diseases, 1988). This response eventually results in small, discrete, dark, raised lesions that in aggregate are unsightly and reduces marketability of fruit (Compendium of Citrus Diseases, 1988). The pathogen dies within a short time in these lesions, thus infected fruit do not serve as sources of inoculum for further infection. Instead, inoculum for infection of fruit and leaves is produced when *Diaporthe citri* saprophytically infests dead wood and twigs.

Studies have shown a direct relationship between extent of dead wood and incidence of melanose (Davis, 1983). Most of the reported studies on melanose control were conducted prior to the advent of frequent hedging and topping of citrus, and before the advent of closer plantings requiring hedging and topping. Hedging and topping results in damaged woody tissue that can serve as sites for development of inoculum of melanose.

Fungicides containing copper are the most commonly used materials to protect fruit against melanose infection (Florida Citrus Pest Management Guide, 1997). Copper fungicides have been reported to be most effective against melanose when applied at post-bloom (Ruehle & Kuntz, 1940; Timmer and Fucik, 1976; Whiteside, 1975). Current recommendations for control of melanose on grapefruit are to make the first application of copper fungicide when fruit are G to H diameter, with applications at 3-week intervals until the fruit becomes resistant (Florida Citrus Pest Management Guide, 1997).

Applications of copper fungicides during the dormant period, prior to spring leaf flush and bloom, were less effective in reducing melanose lesions than a postbloom application of copper fungicides (Ruehle & Kuntz, 1940). Cohen (1959) reported that a "dormant spray was totally ineffective in suppressing melanose spots." More recently (Whiteside, 1975), it was found that a dormant tribasic copper sulfate spray had no effect on melanose incidence. In one of the studies reported by Suit in 1948, there appeared to be an increase in acceptable fruit in one field test where a copper fungicide was applied during the dormant period on pruned trees. How-

ever, in a succeeding experiment, there was no effect on melanose control with a dormant copper application on pruned trees (Suit, 1948). In a search of the literature, no studies were found on the effect of fungicide application immediately after hedging and topping on subsequent extent of melanose. The objective of this study was to determine if copper fungicides applied after hedging and topping had any effect on melanose incidence.

### Materials and Methods

Mature plantings of white marsh grapefruit on sour orange rootstock at three sites, one site each in Indian River, St. Lucie, and Martin counties, were selected for the study. The experimental site in Indian River County was a 30 year old, 31.7 acre planting; in Martin County, a 37 year old, 40.3 acre planting, and in St. Lucie County, a 32 year old, 56.8 acre planting. At the Indian River site, trees were planted in 594 feet long north-south rows, two rows per bed, 27 feet between rows and 18 feet between trees within rows. At the St. Lucie County site, two separate 14.2 acre blocks, north-south in relation to each other, were used for the experiment. Trees in the two St. Lucie County blocks were planted in 615 feet long north-south rows, eight rows per bed, 27 feet between rows, and 15 feet between trees in a row. At the Martin County site, trees were in 650 feet long east-west rows, two rows per bed, 30 feet between rows, and 25 feet between trees in a row.

Following harvest of fruit in early 1996, trees at all three sites were topped by commercial hedgers and toppers. Trees were hedged 7 to 19 days following topping (Table 1). Copper fungicide (8 lb. Kocide DF per acre) was applied at all three sites within four days after hedging and before a rain period (Table 1). Copper fungicide was applied by ground application in the Indian River and Martin County sites, and by aircraft in the St. Lucie County site. At the Indian River and Martin counties sites, four rows were sprayed, and alternately eight rows left unsprayed. There were 7 sprayed blocks of four rows each at these two sites. At the St. Lucie County site, a whole block of 1,530 trees was sprayed with copper fungicide with a fixed wing aircraft immediately after hedging. A block of the same size to the south served as an untreated comparison. The northernmost tree of the south block was 2,400 feet from the southernmost tree of the north block. Table 1 shows other pertinent information for the three groves in the study.

The bloom period for these groves occurred from late March through mid-April. The application of copper fungicide following the post-hedging copper fungicide application was made at petal fall from 2 to 4 weeks after the post-hedging application, depending on the grove. In two of the groves the copper fungicide was aimed at scab control. The first postbloom application of copper

Table 1. Experimental sites, hedging and topping dates, spray dates, and first post-hedging rain period.

Location - County	Date Topped	Date Hedged	Date Sprayed	Spray Method	1st Rain After Hedging
Indian River	@ 2/20/96	2/28/96	2/29/96	ground	3/2/96 - 1.3"
St. Lucie	1/22/96	2/13/96	2/14/96	aircraft	3/2/96 - 1.6"
Martin	2/27/96	3/5/96	3/5/96	ground	3/9/96 - 3.9"

fungicide in the three groves was made between April 17 and 24, depending on the grove. A total of 5-6 applications of copper fungicide following post-hedging application of copper fungicide was made in each grove.

Newly matured leaves were collected from randomly selected trees in all three plantings in May, 1996. The leaves were collected from the sides of trees facing the middle of two-row beds in the Indian River and Martin plantings, and the sides of trees facing each other in the middle two rows of four-row beds in the St. Lucie plantings. The first tree selected for sampling in the two St. Lucie County blocks was 13 trees in from the row ends. This was done to reduce possibility of drift from aircraft application affecting results of the experiment. Twenty leaves were collected per row middle. Leaves were collected into plastic bags and brought back to the laboratory. The following rating system was used to indicate disease intensity per leaf: 0 = no visible lesions; 1 = up to 5 lesions; 2 = 6-10 lesions; 3 = 11-20 lesions; 4 = 21-40 lesions; 5 = 41-80 lesions; 6 = 81-160 lesions; 7 = 161-320 lesions. The detached leaves were compared with a chart made up of drawings depicting the different lesion intensities.

During September, 1996, twelve fruit, each from five randomly selected trees in the middle two rows of each treated and untreated block were harvested and rated for intensity of melanose lesions. Three randomly selected fruit were harvested from each quadrant of the selected trees. On each fruit, melanose incidence was rated in a 7-cm diameter surface area with the highest incidence of melanose lesions. The rating system was 1 = no visible lesions in a 7-cm diameter area; 2 = up to 10 lesions; 3 = 11-20 lesions; 4 = 21-40 lesions; 5 = 41-80 lesions; 6 = 81-160 lesions; 7 = 161-320 lesions; and 8 = 321 and more lesions in a 7-cm diameter area of fruit surface.

Data collected from the Indian River and Martin County sites were subjected to statistical analysis. No statistical analyses was conducted on data collected from the St. Lucie County experiment as the experiment in St. Lucie County involved one block sprayed with copper fungicide after hedging and one block not sprayed at that time. Prior to analysis of leaf lesion ratings and fruit lesion ratings, the ratings were transformed to the midpoint lesion number for each rating. For example, a rating of 4 on fruit lesion intensity was converted to 30 lesions, the midpoint of that rating. The SAS system was used for statistical analysis. A t-test was used to determine if a significant difference occurred between treatments.

The SAS system was also used to analyze the effect of the post-hedging copper fungicide treatment on the marketability of fruit from the Indian River and Martin County groves. Based on a survey of local packing houses, a US #1 rating tolerated up to a rating of 4 on our lesion rating scale. An analysis was conducted to determine if there was a difference in number of fruit that would pass as U.S. #1. A t-test was used to determine if a significant difference occurred between treatments.

### Results

There was no difference in melanose lesion intensity on newly matured leaves collected in May, 1996, between trees treated with copper fungicide immediately after hedging and those not treated until a later date. The number of lesions per leaf in post-hedging copper fungicide treated (PHCFT) plots in the Indian River grove was 23.2 and 18.0 in control plots; in the St. Lucie grove, 16.5 in

Table 2

Location	Fruit-Lesions/7 cm <sup>2</sup>		Putative U.S. #1 (%)	
	copper	control	copper	control
Indian River	12.4a	19.1b	87.0a	73.0b
St. Lucie	10.0	16.4	95.0	76.5

Table 2

Location	Fruit-Lesions/7 cm <sup>2</sup>		Putative U.S. #1 (%)	
	copper	control	copper	control
Martin	22.9a	31.6b	69.5a	61.0b

PHCFT plots and 15.3 in control; and in the Martin grove, 18.6 lesions per leaf in control and 16.5 in PHCFT plots.

There was significant difference in intensity of fruit lesions between fruit on trees in PHCFT plots and those not treated with copper until a later date (Table 2). There was also a significantly greater number of fruit from PHCFT plots that would pass as U.S. #1 as compared to those from plots not treated with fungicide immediately after hedging and topping (Table 2).

The data on Table 2 also shows that melanose was most severe in the Martin County planting.

### Discussion

Trees, in these experiments, sprayed with copper fungicide immediately after hedging, had fruit with fewer melanose lesions than fruit in hedged blocks receiving a first copper fungicide spray at O petal fall. This indicates some benefit may be obtained from "dormant" sprays, if they are applied immediately after hedging, prior to rainfall. Further studies are needed to confirm this result and to determine if the benefits of this extra treatment are cost effective.

We did not make an effort to determine if there was any difference in establishment of the melanose pathogen in hedging-damaged wood protected by copper fungicide and hedging-damaged wood unprotected by copper fungicide. Thus, we do not know if the reduction in melanose lesions was due to a reduction in

saprophytic invasion of hedging-damaged tissue or to some other factor. Previous reports indicate that newly infected tissue produce inoculum in about two months (Whiteside et. al.). The timing of hedging and topping in these groves, and the subsequent heavy rainfall in early March, would indicate that establishment of inoculum would have taken place in adequate time to serve as inoculum sources for infections for the current crop. Thus, studies are needed to determine if the application of the fungicide immediately after hedging and topping, and prior to rainfall had any effect on inoculum development.

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