

Fungicide Evaluations for Pepper Powdery Mildew Control

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Introduction.

Powdery mildew infects the leaves of peppers, resulting in a whitish powdery cast and curling of leaves that eventually turn yellow and brown. The most significant impact of powdery mildew is that the diseased leaves drop from the plants, resulting in exposure of the fruit to the sun and burning of the fruit. The disease can occur wherever peppers are grown, though coastal fields in the San Benito and Santa Clara counties often can have severe cases. Though the disease is not severe every season in coastal counties, powdery mildew is a persistent issue that continues to affect crops and forces growers to make several spray applications. Several pepper field operators are concerned that presently available fungicides may be losing their efficacy in managing the disease. Field reports indicate possible resistance or shift in the fungus tolerance to certain fungicides like Rally or Cabrio.

Materials and Methods

The main goal of this study is to screen several fungicides and assess their impact on the control of powdery mildew (PM).

Materials.

In this field study we screened several fungicide and contrasted them to the control. All chemicals used were tested at the maximum label rate.

Table 1 shows the different fungicides used in this field study.

Code	Product	chemical (and FRAC group #)	label rates per acre	rate to be tested
1	Quintec	quinoxifen (15)	4 to 6 oz	6 oz
2	Quadris Top	azoxystrobin (11) + difenoconazole (3)	8 to 14 oz	14 oz
3	Kumulus DF	dry flowable sulfur		
4	Rally	myclobutanil (3)	2.5 to 5 oz	5 oz
5	non-treated control	---	---	---
6	Taegro	Taegro (biological)	5.2 oz	5.2 oz
7	Indar 2F	fenbuconazole (3)	12 fl oz	12 fl oz

Methods.

Three field trials were established in commercial fields of peppers with the cooperation of growers. Two trial sites were set in the Gilroy area (south Santa Clara County) and a third in the Brentwood area (western Contra Costa County). The Brentwood trial was lost due to the trial field being disked because of severe Tomato Spotted Wilt Virus (TSWV). The trial was in a late-season bell pepper field adjacent to a processing tomato field as well as multiple blocks of earlier-planted Maccabi-type peppers. The expectation was that this area would provide some good powdery mildew pressure for the test. Unfortunately, no mildew developed, but TSWV severely affected the field beginning before fruit development. This trial included 12 fungicide treatments; two spray applications were made before the field was disked in early October.

In the Gilroy-area trials, treatments (table 1) were randomly assigned to plots measuring one bed wide by 20 feet long. Each treatment was replicated four times in field 1 and five times in field two. Field 1 was planted to McCabe type pepper and field 2 had Baron variety pepper. Fungicides applications started prior to the onset of disease and continued at 12-14 day-intervals. Treatments ended 2 weeks prior to harvest. Treatment dates were the following: July 11, 25, August 8, 22, September 7, 18.

We applied all fungicides using a CO₂-pressurized backpack sprayer with a hand-held boom. A surfactant (Silwet) was included as recommended by the manufacturer. Because the goal of the project was to determine overall efficacy of individual products, materials were not applied in various rotations or combinations.

Evaluation of foliar disease level was done after the final spray, which was four weeks before harvest. We collected 25 leaves from the top of the canopy and another 25 leaves from lower part of the canopy and evaluated them for PM presence and severity. The severity rating scale is listed in Table 2. For field 1, the plots were accidentally sprayed with white wash, which made visual evaluation impossible. Therefore, for this field we collected and counted fallen leaves for each plot so as to obtain some idea of the impact of PM disease.

Table 2. Pepper Powdery Mildew Rating

Category	% of leaf covered with PM
1	0%
2	1 to 10%
3	11 to 25%
4	26 to 50%
5	51 to 75%
6	76 to 100%

In addition to foliar disease assessments, we harvested peppers from a 5-foot section in all plots and graded fruit as either marketable (economic) or unmarketable (due to sunburn). For each category we counted and weighed fruit.

Results

Leaf rating

Based on the leaf evaluation rating, Quintec offered the best protection in this study. The great majority of leaves had no visible PM for both the upper (99%) and lower (90%) canopy. Quadris Top showed a good overall effect with over 51% of the leaves under 10% presence of PM. As seen in figure 1, Quintec and Quadris were effective in suppressing PM in the upper canopy. Sulfur also provided significant protection. However all other treatments were not statistically different from the control.

Similarly, Quintec showed a greater level of control in the lower canopy foliage. Sulfur and Quadris were equivalent in providing disease control. All other treatments were not statistically better than the control. In contrasting the effectiveness of powdery mildew control in upper and lower canopy at the highest bracket of infection (75-100% leaf infection), Quintec excelled in suppressing PM. Sulfur, like all other treatments, provided less control in lower foliage than in the upper canopy. This difference in control between upper and lower canopies could be directly related to product spray coverage and penetration.

Leaf drop.

One of the effects of powdery mildew is leaf drop that results in fruit sun-scalding. In counting fallen leaves in 3-foot lengths of beds in field 1, the control treatment had the greater number of fallen, dead leaves with a count of 200 leaves. Taegro, Rally and Indar 2F followed with leaf drop counts of 125 to 160. Table 3 shows that sulfur- and Quadris Top-treated plants dropped less than 50% leaves when calculated as a percent of the control. Quintec-treated plants dropped around 50% of leaves as compared to the untreated plots.

Table 3. Powdery Mildew Field Study -2012 Leaf drop per 3 ft of Bed

Name	Leaf Count	% of Control
Kumulus DF	47.5	37%
Quadris Top	60.8	34%
Quintec	74.8	52%
Indar 2F	124.8	99%
Rally	127.3	81%
Taegro	163.0	98%
control	203.3	100%
LSD (5%)	99.1	NS

Fruit Weight.

Sunburned fruit weight far exceeded marketable fruit weight for all treatments in both fields. In field 2, the weight ratio was 2:1 sunburned to salable fruit. In field 1, the ratio climbed to as much 10:1 pounds of sunburned to healthy fruit.

Fruit weight fluctuated widely, especially in field 1. Here, the control had a higher calculated tonnage (16 T/A) than all treatments. Quintec provided lower yield (12 T/A). High fluctuation and variation from plot to plot are the likely reasons why field 1 fruit weight showed no statistical differences. For further details, consult tables 3 and 4.

In field 2 the range of differences was small. Sulfur resulted in the highest yield (18 T/A). Rally, despite poor disease control, resulted in as good a production (15 T/A) as Indar 2F and Quadris Top, but not statistically better than the control (14 T/A).

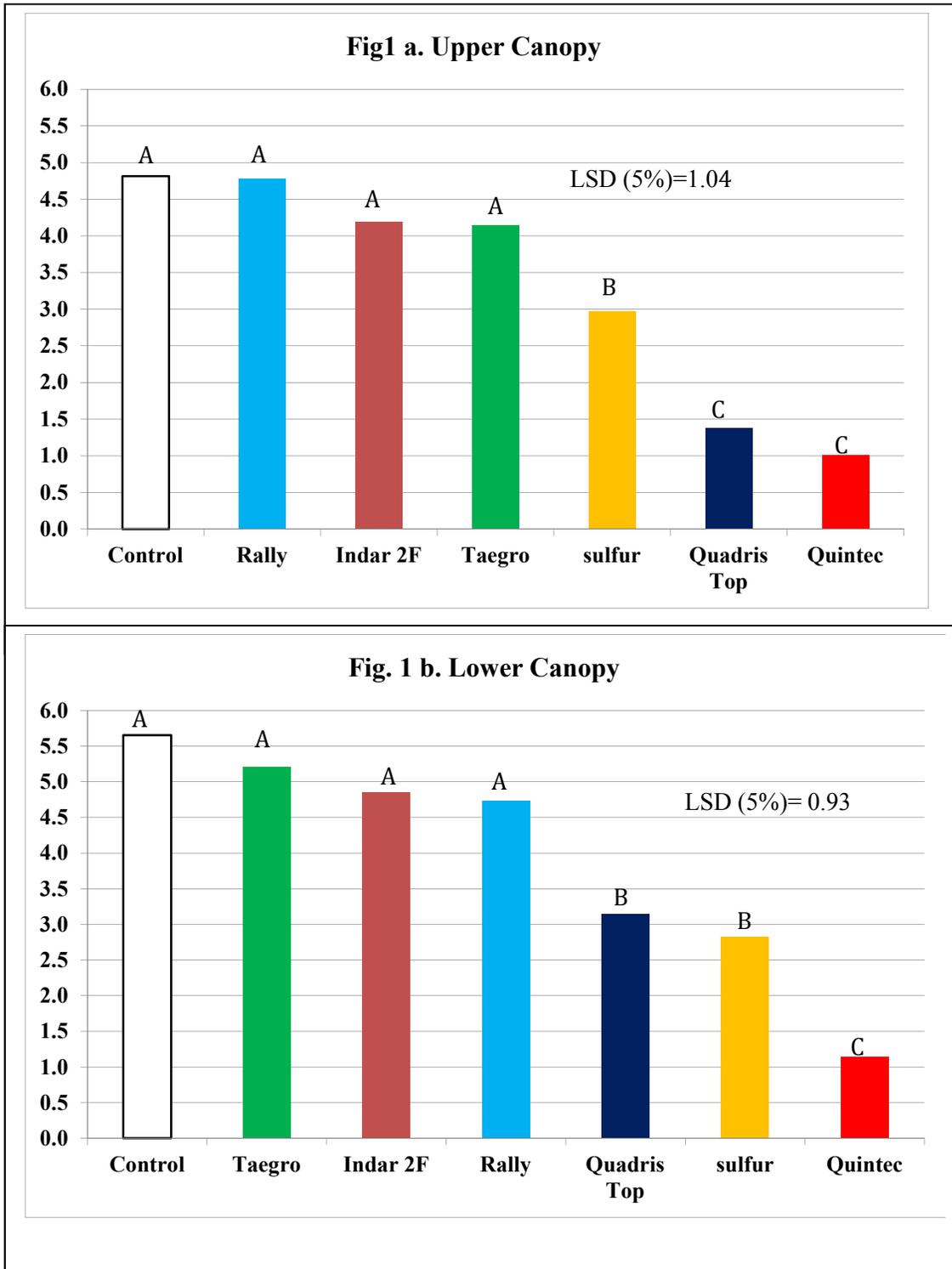
Conclusions.

The results of this field study indicate the following findings:

1. Quintec, Quadris Top and Kumulus DF provided excellent to good control of powdery mildew.
2. Rally, a commonly used fungicide to manage PM, provided poor control in this trial.
3. This protection is contingent on coverage and canopy penetration. For example, sulfur showed a dramatic contrast in providing excellent control of PM in the top canopy, and worse than the untreated control effect in lower leaves.
4. If no control is provided, leaf drop can be severe and would result in more sunburned fruit. All treatments provided reduction in leaf drop when compared to untreated check. Sulfur, Quadris Top, and Quintec significantly reduced leaf drop as compared to the control.
5. Marketable yield in both fields was low because of the high sunburned fruit count. Though not significantly different, economic (marketable) fruit weight in field 2 was higher in plots treated with sulfur and Rally. In field 1, all treatment were statistically similar to the control.

Appendices

Figure 1. PM Severity rating (1-6 scale)* in upper or lower canopy.



*Severity scale--1= 0%; 2= 1-10%; 3= 11-25%; 4= 26-50%; 5= 51-75%; 6= 76-100%
 Bars with the same letter are not statistically different from each other

Table 3- Field 1 Bell Pepper-Baron Variety Response to PM treatments

Name	Total wt-g	Econ. Wt-g	Econ. Fruit size-g	SB Fruit size-g	Econ.. Yield-T/A	Econ yield as % of total
Rally	16,949	1,585	242.3	206.1	4.5	10.7
QuadrisTop	18,315	1,688	236.4	221.2	4.9	11.0
Kumulus DF	18,417	3,305	245.0	241.8	9.5	16.3
Taegro	18,997	2,001	234.9	244.2	5.8	11.1
Quintec	19,807	4,223	241.7	245.7	12.2	20.4
Indar 2F	21,034	3,786	267.0	235.3	10.9	17.7
control	23,154	5,642	259.3	254.1	16.3	22.9
LSD (5%)	5,540	NS	NS	26.7	NS	NS

Table 4. Field 2- Bell Pepper-Maccabi-type Variety Response to PM treatments

Name	Total wt-g	Econ. Wt-g	Econ. Fruit size-g	SB Fruit size-g	Econ.. Yield-T/A	Econ yield as % of total
Taegro	15,514	3,203.0	280.7	256.0	9.2	21.1
Quintec	16,033	4,185.0	279.9	254.5	12.1	26.0
QuadrisTop	15,308	4,567.8	234.0	240.3	13.2	28.3
Indar 2F	15,579	4,873.0	247.7	246.6	14.0	29.1
control	17,336	4,906.0	272.2	258.9	14.2	27.8
Rally	16,929	5,259.0	259.7	251.4	15.2	31.4
Kumulus DF	17,152	6,212.2	300.8	249.0	17.9	34.8
LSD (5%)	NS	2,786	NS	NS	8.0	NS