Time of Infection of *Gloeodes pomigena* and *Schizothyrium pomi* on Apple in North Carolina and Potential Control by an Eradicant Spray Program

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ABSTRACT

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Infection of apples (*Malus* × *domestica*) by *Gloeodes pomigena* (cause of sooty blotch) occurred by mid-May, 10–21 days after petal fall. Infection by *Schizothyrium pomi* (cause of flyspeck) occurred by late May or early June. Infection by both pathogens was extensive by the first week of June. The time that sooty blotch and flyspeck symptoms became visible was related to the frequency of rainfall in June. Benomyl combined with captan or mancozeb applied when sooty blotch first was observed in the orchard demonstrated eradicant activity in 1987 but not in 1989 or 1990. At harvest, coverage of the fruit surface with sooty blotch and flyspeck (severity) in eradicant treatments which included benomyl was not significantly different from the standard protectant treatments. An eradicant spray program for sooty blotch and flyspeck on fresh fruit was not cost effective but may be a viable option for growers of processing fruit.

Sooty blotch (SB), caused by *Gloeodes pomigena* (Schwein.) Colby, and flyspeck (FS), caused by *Schizothyrium pomi* (Mont. & Fr.) Arx (anamorph: *Zygophiala jamaicensis* E. Mason), are the most common summer diseases of apple (*Malus* × *domestica* Borkh.) in North Carolina and other southeastern states. These diseases affect 5–15% of the fruit annually (8,9) and require a strict, summer-long 10–14-day protectant fungicide program for control.

Symptoms of SB and FS have been observed in early June in eastern and midwestern apple-growing areas (3,5). Baines and Gardner (3) observed conidia of *G. pomigena* in pycnidia on twigs in late May in Indiana, and suggested that fruit infection occurs early in the season. However, they stated that the colonies remain "invisible" until late in the season. In North Carolina, primary infection of FS can occur on reservoir hosts in late April, and conidia are produced on conidiophores within colonies by late May (15). Secondary infection on apple fruit by conidia is probably more important than primary infection by ascospores (15). Although symptoms of SB and FS have been observed in June in North Carolina, the exact time of infection is not known. Knowing the time of fruit infection by *G. pomigena* and *Z. jamaicensis* would be useful to apple growers for timing fungicide sprays for SB and FS control.

Fungicides applied after-infection or presymptom have been used or proposed for the management of apple scab (*Venturia inaequalis* (Cooke) G. Wint.), cedar apple rust (*Gymnosporangium juniperi-virginianae* Schwein.), and black rot (*Botryosphaeria obtusa* (Schwein.) Shoemaker) (1,2,10); however, this approach has not been investigated widely for the control of SB and FS. Hickey (6) found that applications of benomyl + zineb, benomyl + fenarimol, or captan + zineb, initiated when SB and FS were "uniformly established on a high percentage of the fruit," suppressed subsequent symptom development. In another test (7), SB and FS symptom development was also arrested by applications of folpet or captan + zineb once symptoms were visible. Rosenberger et al (13) found that a single application of benomyl + metiram in mid-July eradicates infections of *G. pomigena* and *Z. jamaicensis* that were established prior to fungicide application. Applications of benomyl made when fruit had just begun to show FS symptoms arrested subsequent SB development but were not as effective for arresting FS (12). A postinfection or eradicant spray program for SB and FS would be very useful as an IPM tactic in the southeastern United States where SB and FS are chronic, severe problems requiring eight to 10 fungicide applications yearly.

The objective of this study was to determine the time of infection of apple fruit by *G. pomigena* and *S. pomi,* the time of symptom appearance, and the feasibility of using a postinfection/eradicant fungicide spray program for disease control. For the purpose of this paper, we will use the term eradicant to refer to after-infection, presymptom and post-symptom activity (sensu Szkolnik [18]).

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MATERIALS AND METHODS

Location. Apples were collected for incubation from a Golden Delicious orchard in 1985, 1986, 1987, and 1990, and from an abandoned Golden Delicious orchard in 1987 and 1990, at the Mountain Horticultural Crops Research Station (MHCRS), Fletcher, North Carolina. The Golden Delicious orchard was composed of 24 groups of five trees in three rows of equal length. Trees were spaced 3 m apart in the row; groups were 6 m apart. The cross-row-spacing was 9 m. Trees were planted in 1972 and pruned annually to a central leader. The abandoned orchard consisted of 12 trees in two rows with alternating Delicious and Golden Delicious. Trees were planted in 1974, spaced 3 m apart in rows 6 m apart, and were unpruned for 9 yr before they were pruned to a central leader in 1989. Tests to evaluate protectant and eradicant activity of fungicides were conducted in the Golden Delicious orchard at MHCRS in 1987, 1989, and 1990.

Fruit collection and incubation. There was a light crop of fruit in 1985 as a result of freeze damage. Consequently, 40 fruit were collected arbitrarily from throughout the Golden Delicious orchard on 7 and 23 May and 6 and 20 June. Thirty fruit were collected arbitrarily in a similar manner on 3 July 1985. Fifteen fruit were collected from three five-tree groups on 10 June and 8 July 1986; on 11, 18, and 29 May, and 8 and 16 June 1987; and on 22 and 29 May and 5 and 19 June 1990. Each 15-fruit sample was selected arbitrarily from the middle three trees within each five-tree group. Three 15-fruit samples were picked arbitrarily from three single-tree plots in the abandoned orchard on the same dates as above for 1987 and 1990.

Fruit were incubated at room temperature (~22 C) on wire mesh screens over water in sealed plastic boxes to maintain constant high humidity. Fruit were observed for disease incidence and percentage of surface area covered (severity) with SB and FS after 4 wk.

Fungicides tested and rates used. Fungicides tested for eradicant activity were mancozeb (Dithane M-45 80WP), captan (Captan 50 WP), and benomyl (Benlate 50 WP) in combination with either mancozeb or captan. The standard preventative treatment in 1987 and 1989 was mancozeb + benomyl. Captan + benomyl was used in 1990. The tree-row-volume model (TRV) (17) was used to determine the volume of water necessary to provide dilute fungicide coverage of the trees. The orchard TRV was 1,871 L/ha (200 gal/acre).

Fungicides were applied with a Swanson DA 500A airblast sprayer driven at 67 m/min. The sprayer delivered 793 m^3/min of air with an air speed of 217–233 km/hr. The pump operated at 862 kPa (125 psi). An appropriate combination of nozzle numbers and core sizes was chosen to deliver the volume of water as determined by TRV.

Each orchard was sprayed with fenarimol (Rubigan 1E) at 28 mg a.i./L (3.0 oz Rubigan 1E per 100 gal) through petal fall for apple scab control. Previous studies have shown that fenarimol has little or no activity on *G. pomigena* or *S. pomi.* No additional fungicides were used through petal fall. An arbitrary sample of 100 fruit was examined weekly beginning the first week of June, and eradicant treatments were applied immediately when either SB or FS were observed in the orchard. Fungicides and rates used (mg a.i./L [lb or oz of formulated product per 100 gal]) in eradicant treatments in 1987 were mancozeb at 1,900 mg a.i./L (2.0 lb/100 gal), captan at 1,200 mg a.i./L (2.0 lb/100 gal), mancozeb at 950 mg a.i./L (1.0 lb/100 gal) + benomyl at 113 mg a.i./L (3.0 oz/100 gal), and captan at 600 mg a.i./L (1.0 lb/100 gal) + benomyl at 113 mg a.i./L (3.0 oz/100 gal). Mancozeb at 950 mg a.i./L (1.0 lb/100 gal) + benomyl at 113 mg a.i./L (3.0 oz/100 gal) and captan at 600 mg a.i./L (1.0 lb/100 gal) + benomyl at 113 mg a.i./L (3.0 oz/100 gal) were used in eradicant treatments in 1989, while only captan at 1,200 mg a.i./L (2.0 lb/100 gal) + benomyl at 75 mg a.i./L (2.0 oz/100 gal) was used in 1990 because of the voluntary withdrawal of apples from the mancozeb label by the manufacturers in September 1989. The change in the rate of benomyl in 1990 reflects the imposition of a seasonal allowance by the manufacturer. Eradicant treatments which included benomyl were followed in 1 wk with a single application of benomyl at 150 mg a.i./L (4.0 oz/100 gal) in 1987, 1989, and 1990. Subsequent applications of eradicant treatments were made 1 wk later and thereafter followed the preventative treatment schedule for the remainder of each season.

The fungicides and the rates applied in the preventative treatment were mancozeb at 950 mg a.i./L (1.0 lb/100 gal) + benomyl at 113 mg a.i./L (3 oz/100 gal) in 1987 and 1989, and captan at 1,200 mg a.i./L (2.0 lb/100 gal) + benomyl at 75 mg a.i./L (2.0 oz/100 gal) in 1990. Mancozeb was not used in 1990 and the rate of benomyl changed from previous years for the reasons cited above.

SB was first observed in the Golden Delicious orchard on 15 June 1987, 23 June 1989, and 16 July 1990. Eradicant treatments were begun on 24 June 1987 (fourth cover), 23 June 1989 (fourth cover), and 17 July 1990 (sixth cover). Treatments in the standard fungicide program were made at appropriate 14-day intervals beginning 10–14 days after petal fall. Application dates for the preventative treatments were 15 and 28 May, 10 and 24 June, 8 and 22 July, and 6 and 19 August 1987; 8 and 25 May, 8 and 23 June, 7 and 20 July, and 3 and 17 August 1989; and 7 and 21 May, 6 and 18 June, 5 and 17 July, and 2 and 16 August 1990.

The non-fungicide-treated groups of trees received no fungicide after the early-season fenarimol. Each orchard was sprayed with a standard insecticide program (22).

Plot design and data collection. Each fungicide was applied to two groups of five trees in 1987 and 1990, and to three groups of five trees in 1989. Data on SB and FS incidence and severity were collected from 20 apples selected arbitrarily from two of the three center trees within each group in 1987. Data were collected from 25 apples selected arbitrarily from each of the five-tree groups in 1989 (crop load light), and from 25 apples selected arbitrarily from two of the three center trees within each group in 1990. Fruit were evaluated on 28 July and 8 September 1987 (harvest), 12 July and 11 September 1989 (harvest), and 18 July and 12 September 1990 (harvest). Data were also collected on samples at harvest for percentage of apples affected with the following diseases: bitter rot (caused by *Colletotrichum* species), black rot, and white rot (bot rot, caused by *Botryosphaeria dothidea* (Moug.:Fr.) Ces. & De Not.). Some diseases were sporadic: data were collected on Brooks fruit spot (caused by *Mycosphaerella pomi* (Pass.) Lindau) in 1987 and 1990, black pox (caused by *Helminthosporium papulosum* A. Berg.) in 1989, and apple scab in 1990.

Each fungicide trial was conducted in a completely randomized design. Data were analyzed with an analysis of variance, and treatment means were compared with a Waller-Duncan *k*-ratio *t* test (14). Environmental data were monitored by a weather station located 0.5 km from the orchards.

Economic analyses. Fruit from all treatments were separated at harvest into five groups based on the severity of SB and FS (0–2% of surface area covered, 3–5%, 6–10%, 11–20%, and >20%). US Fancy grade standards permit up to 10% of the surface to be covered with SB and FS (11). However, packers usually pack the "top of the grade," and apples with SB or FS severity over 2–3% are usually removed in the packing line and sold as processing apples. We assumed in this study that fruit with <5% SB and FS severity would pack as US Fancy because some SB and FS are removed when the fruit are washed and brushed in the packing line; fruit with >5% disease severity were designated as processing. If more than 30% of the fruit in a treatment had >5% SB and FS severity, we assumed all fruit in the treatment would be sold directly to processors.

The value of the fruit from each treatment was calculated based on a hypo-

Table 1. Percent fruit affected with sooty blotch (caused by *Gloeodes pomigena*) or flyspeck (caused by *Schizothyrium pomi*) following collection from a Golden Delicious orchard and an abandoned Golden Delicious orchard at Mountain Horticultural Crops Research Station in 1985, 1986, 1987, and 1990 on various sampling dates and incubated for 1 mo in a moist chamber

	Golden Delicious orchard		Abandoned Golden Delicious orchard	
Year Sample date	Sooty blotch (%)	Flyspeck (%)	Sooty blotch (%)	Flyspeck (%)
1985[y]				
7 May	0	0	...	...
23 May	2	0	...	...
6 June	50	7	...	...
20 June	80	35	...	...
3 July	90	87	...	...
1986[z]				
10 June	96	37	...	...
8 July	100	98	...	...
1987[z]				
11 May	0	0	0	0
18 May	0	0	0	0
29 May	4	7	9	20
8 June	73	78	60	78
16 June	87	85	100	76
1990[z]				
22 May	22	0	2	2
29 May	42	0	4	2
5 June	71	4	9	0
19 June	36	4	22	0

[y] Based on a sample of 40 fruit collected arbitrarily.

[z] Based on a sample of 15 fruit collected arbitrarily from three five-tree groups (Golden Delicious orchard) or three individual trees (abandoned orchard).

thetical orchard with a yield of 23,533 kg/ha (500 42-lb bushels per acre). This is slightly more than the North Carolina average (M. L. Parker, Department of Horticultural Science, North Carolina State University, *personal communication*). Chemical costs per kilogram of active ingredient for 1987, 1989, and 1990 were approximately $4.83 for mancozeb, $6.14 for captan, and $44.09 for benomyl. USDA estimates of fresh-market and processing prices (in dollars per kilogram) were, respectively, 0.207 and 0.097 in 1987, 0.278 and 0.146 in 1989, and 0.337 and 0.185 in 1990 (19,20,21).

RESULTS AND DISCUSSION

Fruit collected the third or fourth week of May 1985, 1987, and 1990, and incubated in a moist chamber, developed SB. This indicates that infection occurred by mid-May in North Carolina, 10–21 days after petal fall (approximately first cover) (Table 1). SB typically developed earlier and with higher incidence than FS. FS was first observed in samples collected in late May or early June. Because many fruit collected before mid-May shriveled during incubation, incidences of SB and FS were likely underestimated for the early sample dates. Infection was extensive during May; 50% of the fruit collected from the Golden Delicious orchard had been infected by *G. pomigena,* and 4–78% by *S. pomi* by the end of the first week of June. Thus, growers with orchards with a chronic SB and FS problem should initiate a control program by first cover.

SB was first observed in the arbitrary sample of 100 fruit from the Golden Delicious orchard on 15 June 1987 (third cover), 23 June 1989 (fourth cover), and 15 July 1990 (sixth cover). FS was first observed at the same date in 1990 but was not observed until 1 mo after SB in 1987 and 1989. The time of summer that SB and FS were observed appeared to be related to the amount and frequency of rainfall in May and June. Rain occurred on only 6 days in June 1990 (2.41 cm of rainfall), as opposed to 17 days in both 1987 (34.4 cm) and 1989 (29.89 cm), and symptom expression was delayed 3–5 wk.

Neither mancozeb nor captan demonstrated any eradicant activity on SB and FS in 1987 when sprayed after SB was observed in the orchard (Table 2). The incidences of SB and FS were not significantly different from the non-fungicide-treated check on 28 July, 34 days after initiation of the eradicant treatments. However, initiation of the mancozeb and captan eradicant treatments did result in less disease severity at harvest compared to the check. These results are similar to those of Hickey (6) and Hickey et al (7), who found that captan + zineb and folpet arrested symptom development.

Both eradicant treatments including benomyl demonstrated eradicant activities on SB in 1987, as evidenced by a decrease in SB incidence between July and September (Table 2). However, the incidences of SB and FS in the eradicant treatments during 1989 and 1990 generally increased between July and September, and the incidences of SB and FS were consistently higher at harvest in all eradicant treatments compared to the protectant treatment (Tables 3 and 4). The weather following the initiation of the eradicant treatments was wetter in 1989 and 1990 than in 1987, suggesting the efficacy of the eradicant treatments is dependent on the frequency of moisture after the treatments begin.

The severities of SB and FS in the eradicant treatments including benomyl were consistently greater but never significantly different from the disease severities in the standard treatments at harvest. These treatments, begun after SB was observed, demonstrated enough activity to minimize the coverage of the fruit with SB and FS (severity) even though the incidence was high. There was no significant difference between the efficacies of mancozeb + benomyl and captan + benomyl on SB and FS, al-

Table 2. Fungicides used, treatment schedules, and sooty blotch and flyspeck incidences and severities at Mountain Horticultural Crops Research Station in 1987

	Sample date					
	28 July			8 September		
	Fruit affected (%)			Fruit affected (%)		
Fungicide and treatment schedule[x]	Sooty blotch	Flyspeck	Severity[y]	Sooty blotch	Flyspeck	Severity[y]
Mancozeb-e	100.0 a[z]	96.3 a	17.8 ab	100.0 a	100.0 a	20.3 c
Captan-e	100.0 a	91.3 a	11.5 ab	99.0 a	99.0 a	29.3 b
Mancozeb + benomyl-e	91.3 b	42.5 b	6.0 ab	48.0 b	46.0 b	2.3 d
Captan + benomyl-e	96.3 ab	57.5 b	21.0 ab	75.0 a	65.0 b	2.8 d
Mancozeb + benomyl-p	6.3 c	2.5 c	1.8 b	14.0 c	15.0 c	1.0 d
No fungicide	100.0 a	100.0 a	31.0 a	100.0 a	100.0 a	62.5 a

[x] e = Eradicant schedule; p = protectant schedule. Eradicant treatment initiated on 24 June. Five applications + one benomyl application were made in the eradicant schedule; eight applications were made in the protectant schedule.
[y] % Surface affected with sooty blotch or flyspeck.
[z] Means within the same column followed by the same letter are not significantly different at $P = 0.05$, as determined by the Waller-Duncan k-ratio t test (k-ratio = 100).

Table 3. Fungicides used, treatment schedules, and sooty blotch and flyspeck incidences and severities at Mountain Horticultural Crops Research Station in 1989

	Sample date					
	28 July			8 September		
	Fruit affected (%)			Fruit affected (%)		
Fungicide and treatment schedule[x]	Sooty blotch	Flyspeck	Severity[y]	Sooty blotch	Flyspeck	Severity[y]
Mancozeb + benomyl-e	66.7 a[z]	16.0 b	3.7 ab	82.7 a	22.7 bc	4.7 b
Captan + benomyl-e	65.3 a	17.3 b	5.7 ab	89.3 a	37.3 b	6.0 b
Captan + benomyl-p	0.0 b	0.0 b	0.0 b	45.3 a	4.0 c	1.3 b
No fungicide	100.0 a	64.0 a	16.0 a	100.0 b	98.7 a	42.7 a

[x] e = Eradicant schedule; p = protectant schedule. Eradicant treatment initiated on 23 June. Five applications + one benomyl application were made in the eradicant schedule; eight applications were made in the protectant schedule.
[y] % Surface affected with sooty blotch or flyspeck.
[z] Means within the same column followed by the same letter are not significantly different at $P = 0.05$, as determined by the Waller-Duncan k-ratio t test (k-ratio = 100).

Table 4. Fungicides used, treatment schedules, and sooty blotch and flyspeck incidences and severities at Mountain Horticultural Crops Research Station in 1990

	Sample date					
	18 July			12 September		
	Fruit affected (%)			Fruit affected (%)		
Fungicide and treatment schedule[x]	Sooty blotch	Flyspeck	Severity[y]	Sooty blotch	Flyspeck	Severity[y]
Captan + benomyl-e	92.0 a[z]	5.0 a	2.5 a	89.0 a	51.0 b	5.5 b
Captan + benomyl-p	4.0 b	0.0 a	0.3 b	23.0 b	28.0 c	1.3 b
No fungicide	88.0 a	11.0 a	3.0 a	98.0 a	98.0 a	53.8 a

[x] e = Eradicant schedule; p = protectant schedule. Eradicant treatment initiated on 17 July. Three applications + one benomyl application were made in the eradicant schedule; eight applications were made in the protectant schedule.
[y] % Surface affected with sooty blotch or flyspeck.
[z] Means within the same column followed by the same letter are not significantly different at $P = 0.05$, as determined by the Waller-Duncan k-ratio t test (k-ratio = 100).

though mancozeb + benomyl generally demonstrated greater activity. We found that the eradicant treatments which included benomyl were more effective on FS than on SB. This is in contrast to Rosenberger et al (12), who found that benomyl was less effective on FS.

There was generally more black rot, white rot, and bitter rot in the eradicant treatments which included benomyl than in the protectant treatment, but the amounts of rot were not significantly greater (Table 5). Infection by *Colletotrichum* species, *B. dothidea,* and *B. obtusa* can occur early in the growing season and may be a problem in poorly pruned orchards with dead wood and mummied fruit. In 1987 and 1990, there was significantly more Brooks fruit spot in the eradicant treatments. In 1987, the percent fruit with symptoms of Brooks spot ranged from 40 to 71%, compared to 3% in the protectant treatment; in 1990, Brooks spot incidence in the captan + benomyl eradicant treatment was 45%, compared to 20% in the protectant treatment. This disease could be a problem in an eradicant program where protectant fungicides are omitted after petal fall, because infection by *M. pomi* can occur as early as petal fall (4,16). Data on black pox were collected only in 1989. Black pox incidence was 9.3 and 20% for the mancozeb + benomyl and captan + benomyl eradicant treatments, respectively, compared to 0% for the mancozeb + benomyl protectant treatment. Apple scab occurred only in 1990 and was satisfactorily controlled by the early-season fenarimol spray program. Secondary apple scab is seldom a serious problem on Golden Delicious in North Carolina, but orchards should be monitored weekly to ensure that it does not become a problem.

The packout of apples based on the severity of SB and FS demonstrated the effectiveness of the protectant treatments in 1989 and 1990 when compared to the eradicant treatments (Table 6). In 1987, two fungicide applications were omitted in the eradicant treatments; a grower utilizing the standard protectant program would have made approximately 12% more money than a grower using the eradicant program with mancozeb + benomyl. Although three complete fungicide sprays were saved in 1989 and five in 1990, a grower would have made 6% more money in 1989 and 10% more in 1990 if he had utilized the protectant program. Thus, based on our economic analysis, we conclude that an eradicant program for SB and FS for fresh fruit is not cost effective under conditions in North Carolina. However, the program may be a viable option for growers of processing fruit, because only a small number of fruit in the eradicant treatments had over 10% SB and FS severity. Savings in chemical costs ranged from $74 to $165 per hectare. Application costs were not included in the calculations because of the likelihood of the need for insecticide and/or miticide applications. If some of these applications were not needed, the cost of the eradicant program would be lowered further. The program will also result in reduced fungicide use on processing fruit, an objective currently sought by many processors.

In conclusion, infection of SB and FS can occur soon after petal fall in North Carolina, and symptom development is

Table 5. Percent fruit affected at harvest with black rot (caused by *Botryosphaeria obtusa*), white rot (caused by *B. dothidea*), or bitter rot (caused by *Colletotrichum* spp.) in the Golden Delicious orchard at Mountain Horticultural Crops Research Station in 1987, 1989, and 1990

Year Fungicide and treatment schedule[y]	Fruit affected (%)		
	Black rot	White rot	Bitter rot
1987			
Mancozeb-e	6.0	24.0 a[z]	12.0 ab
Captan-e	1.0	13.0 ab	25.0 ab
Mancozeb + benomyl-e	3.0	13.0 ab	8.0 ab
Captan + benomyl-e	9.0	9.0 b	13.0 ab
Mancozeb + benomyl-p	0.3	5.0 b	0.0 b
No fungicide	10.0	8.0 b	20.0 ab
	NS		
1989			
Mancozeb + benomyl-e	0.0	2.7 ab	2.7
Captan + benomyl-e	1.3	1.3 b	4.0
Mancozeb + benomyl-p	0.0	0.0 b	0.0
No fungicide	0.0	5.3 a	12.0
	NS		NS
1990			
Captan + benomyl-e	0.0	2.0	2.0
Captan + benomyl-p	0.0	0.0	0.0
No fungicide	0.0	2.0	3.0
	NS	NS	NS

[y] e = Eradicant schedule; p = protectant schedule.
[z] Means within the same column by year followed by the same letter are not significantly different at $P = 0.05$ as determined by the Waller-Duncan k-ratio t test (k-ratio = 100).

Table 6. Packout of Golden Delicious fruit from eradicant and protectant fungicide treatments in the orchard at Mountain Horticultural Crops Research Station for 1987, 1989, and 1990 based on severity of sooty blotch (caused by *Gloeodes pomigena*) and flyspeck (caused by *Schizothyrium pomi*)

Year Fungicide and treatment schedule[y]	Sooty blotch and flyspeck severity					Fungicide cost ($/ha)	Value ($/ha)
	0–2%	3–5%	6–10%	11–20%	>20%		
1987							
Mancozeb-e	1[z]	6	19	45	29	173	2,291
Captan-e	1	2	9	24	64	148	2,291
Mancozeb + benomyl-e	82	12	6	0	0	204	4,722
Captan + benomyl-e	73	23	4	0	0	192	4,774
Mancozeb + benomyl-p	99	1	0	0	0	287	5,411
1989							
Mancozeb + benomyl-e	60	21	11	4	4	204	5,948
Captan + benomyl-e	40	37	12	10	1	192	5,822
Mancozeb + benomyl-p	95	3	2	0	0	287	6,407
1990							
Captan + benomyl-e	33	40	19	4	4	151	6,973
Captan + benomyl-p	95	5	0	0	0	336	7,939

[y] e = Eradicant schedule; p = protectant schedule. Five applications + one benomyl spray were made in the eradicant schedule in 1987 and 1989, three applications + one benomyl spray in 1990; eight applications were made in the protectant schedule each year.
[z] % Fruit in severity class.

largely dependent on the frequency of moisture in June. Eradicant treatments of mancozeb or captan combined with benomyl can arrest symptom development of both diseases, and the treatments resulted in a decrease in visible SB symptoms in a year when conditions became dry in July. The eradicant treatments did not provide control of SB and FS that was as good as the standard protectant treatment, and the use of eradicant treatments does not appear economically feasible for fresh-market fruit growers. However, severities of SB and FS were minimized in eradicant treatments with benomyl; and these treatments may be applicable for processing fruit, where some SB and FS is allowed. Other areas of the country where moisture and temperature conditions are less favorable for SB and FS development may have more success with these eradicant programs.

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