Cherry Leaf Spot Control With Selected Chemicals
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Cherry Leaf Spot Control With Selected Chemicals

COVER: Check tree defoliated by cherry leaf spot in 1970 compared with treated trees in the background.

SUMMARY

This report summarizes results of field experiments conducted from 1969 to 1973 on cherry leaf spot control in tart cherries. Several newer fungicide compounds and different application methods were tested.

All fungicides combated the leaf spot fungus. Benlate, Difolatan, Thynon, and Topsin M were the most persistent; Bravo and Cyprex were next, and Cela W524 and EL-273 were the least persistent of the fungicides tested. Adding a non-phytotoxic superior oil to Benlate and Topsin M increased their activity against leaf spot.

When ascospore discharge was unusually early and the weather was favorable for disease development, more than five spray treatments were required for control. Except in very dry years, a postharvest application improved leaf spot control.

Where brown rot occurred, Benlate with and without oil, and Bravo provided good control of both diseases.

Fruit quality as judged by fruit size and soluble solid levels was not affected by any of the fungicides tested.

Fruit injury was observed when Cyprex, Difolatan or Benlate were applied with liquid Guthion at the 60X concentration if high temperatures existed at the time of treatment or soon afterward. Damage was usually masked at harvest by the red coloration of mature fruits.

Cherry Leaf Spot Control With Selected Chemicals

by A. L. Jones and W. J. MacLean[2]

INTRODUCTION

Tart cherries are highly susceptible to attack by the cherry leaf spot fungus *Coccomyces hiemalis*. Leaf infection occurs during periods of wet weather through natural openings called stomata (Fig. 1) in the underside of leaves.[3] Infection is followed by purple spots, leaf yellowing, and defoliation.

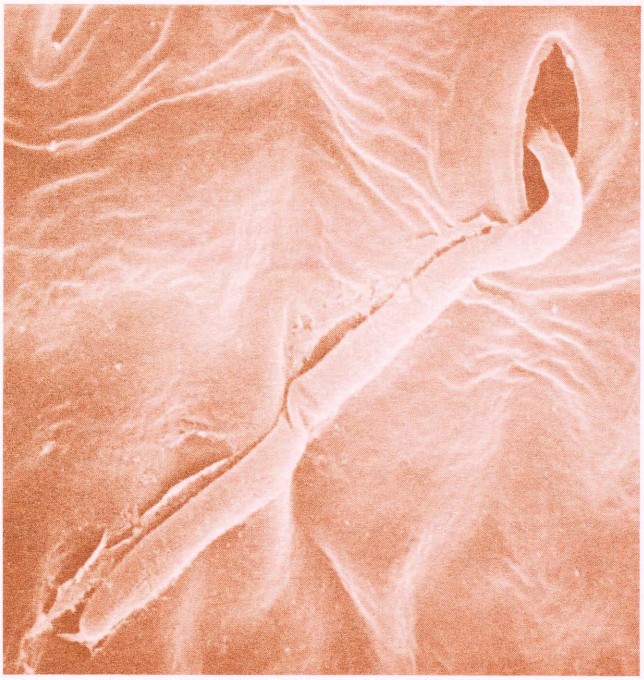

Fig. 1. Scanning electron microscope photograph of a germinating spore of the cherry leaf spot fungus soon after it entered the stomata of a mature tart cherry leaf (magnification approx. 2,000X).

Failure to prevent defoliation affects the hardiness of the tree in the current season and in subsequent years. A study by Howell and Stackhouse[4] found that trees defoliated by August 15 in Michigan were less hardy in fall and dehardened more quickly in spring than trees defoliated by a killing frost. Twigs from early-defoliated trees were as much as 18° F (10° C) less hardy than twigs from healthy trees. Flower bud hardiness was similarly reduced.

The effect on production of early defoliation and reduced hardiness was measured by Dutton and Wells[5] in an orchard near Traverse City. In the year following severe defoliation, fruit size was reduced 12%. Yield by weight on a per spur basis was reduced 58%. Total yield of the prematurely defoliated trees was further reduced as 18% of the spurs died during the winter following defoliation. Moreover, defoliation decreased spur development, fruit set, and bud survival in the second year (see footnotes 4 and 5). These effects were the most serious because they lowered fruit production for an indefinite period.

Fungicidal sprays are the principal means for preventing leaf spot infection and premature defoliation. Since Cyprex replaced ferbam, glyodin, sulfur, and copper fungicides for leaf spot control, several other fungicidal chemicals have been developed which show promise for controlling leaf spot. The results of field trials established of these new fungicides are summarized in this paper.

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[1] Names of pesticides are used in this publication solely to provide specific information. The information given does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. Mention of a trade name or product does not constitute a guarantee or warranty of the product by Michigan State University and does not imply approval to the exclusion of other products that may also be suitable.

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[3] For further detail on the symptomology and life history of cherry leaf spot see Extension Bulletin E-714, Disease of Tree Fruits in Michigan. This publication may be obtained from your county office of the Cooperative Extension Service or by writing the MSU Bulletin Office, P. O. Box 231, East Lansing, Michigan 48824.

[4] Howell, G. S. and S. S. Stackhouse (1973). The effect of defoliation time on acclimation and dehardening in tart cherry (*Prunus cerasus* L.) J. Amer. Soc. Hort. Sci. 98:132-136.

[5] Dutton, W. C. and H. M. Wells (1925). Cherry leaf spot residual effects and control. Michigan Agr. Expt. Sta. Special Bul. 147. 15 pp.

GENERAL PROCEDURE

Field trials were established in several mature Montmorency tart cherry orchards in the western Michigan fruit belt from 1969 to 1973. Spray applications were made with ground and air equipment. Ground spray trials were replicated three to four times. The aerial trials were made on 5-acre blocks.

The fungicides tested are described in Table 1. Rates for each material are for the formulated product and are based on a standard of 300 gal of dilute spray per acre. The number of applications per trial depended primarily on weather conditions. Four or five sprays were usually applied on a 10- to 14-day schedule.

Table 1. Nomenclature, formulation, suppliers, and registration status of fungicides evaluated for control of cherry leaf spot

Common name	Trade or experimental name and formulation (a)	Suppliers	Registration status (b)
benomyl	Benlate® 50WP	duPont	Yes (c)
chlorothalonil	Bravo 75WP and 6F	Diamond Shamrock	No
dodine	Cyprex 65 and 80WP	American Cyanamid	Yes
triarimol	EL-273 10 and 25WP	Elanco	No
captafol	Difolatan 4F	Chevron	Yes (d)
dithianon	Thynon 75WP	Thompson-Hayward	No
thiophante-methyl	Topsin M 70WP	Pennwalt	No
trioforine	Cela W524 20EC	E. Merck and FMC Corp.	No

(a) WP = wettable powder, F = flowable, EC = emulsifiable concentrate.

(b) Registration status with Environmental Protection Agency (EPA) as of January 1, 1974.

(c) Reduced rates of Benlate and non-phytotoxic superior type oil are not yet registered for stone fruits.

(d) Registered for mechanically harvested tart cherries only.

Data on leaf spot incidence were taken by examining 5 to 15 shoots per tree and counting the number of nodes, leaves, and diseased leaves per shoot. Percentages were computed for defoliation and remaining leaves infected. Statistical differences in the data were detected by the Analysis of Variance and Duncan's Multiple Range Test. Differences at the 5% probability level were considered significant.

CONCENTRATE GROUND SPRAY TRIAL

Sprays were applied with a speed sprayer set to deliver 30 gal of spray per acre (10X concentration) to trees located near Kalamazoo, Michigan (see cover photo). Plots consisted of two rows with four trees per row. Treatments (Table 2) were randomized and replicated three times. Spray treatments were applied on May 15, 28, June 9, 25, and July 9 (postharvest) except for one Benlate treatment where the May 28 and June 25 sprays were omitted. Data on leaf infection and defoliation were taken on September 18, 1970.

Table 2. Control of cherry leaf spot on tart cherry with 10X concentrate spray programs — Kalamazoo, Michigan, 1970

Treatment	Rate per acre	Leaf spot (a)	
		% Defoliation	% Infection
Thynon	1.5 lb	4.2 a	1.6 a
Difolatan	3.0 qt	4.6a	1.8 a
Benlate (b)	1.5 lb	11.1 a	5.9 a
Benlate	1.5 lb	15.8 a	0.8 a
EL-273	456 gm	20.7 a	32.0 a
Check		96.8 b	100.0 b

(a) Figures not followed by the same letter are significantly different at the 5% level. Data were taken on September 18.

(b) Three applications only; all other treatments were applied five times.

Leaf spot infection was well controlled by all treatments until early September. At that time, check trees exhibited severe defoliation and some treated trees had light to moderate defoliation (Table 2). EL-273 was the first treatment to develop leaf spot and trees sprayed with this compound were badly defoliated 10 days to 2 weeks after the counts were taken. Trees receiving Thynon, Difolatan, and Benlate (5 sprays) held their leaves until frost. No phytotoxicity was observed from any of the treatments.

HAND GUN SPRAY TRIALS

Fungicide spray trials were conducted in a mature Montmorency cherry orchard near Shelby, Michigan, from 1971 to 1973. Each treatment was replicated four times on single tree plots. All sprays were applied from the ground with a single nozzle handgun at 300 psi and each tree was wet to the point of drip (approximately 4 gal of spray per tree).

1971 Trial

The treatments (Table 3) were applied on May 21, June 3, 16, 30, and July 28 (postharvest). No postharvest spray was made to the Difolatan single application plots. Data on soluble solids and fruit size (weight/100 fruit) were taken at harvest. Damage from leaf spot was determined on September 15.

Leaf spot was light in the Shelby area in 1971 and all treatments provided good control (Table 3). Single treatment of Difolatan at 4 qt/100 gal developed more

infection and defoliation than the single spray treatment at 3 qt/100 gal. The reason for these differences is not known. Analysis of the soluble solids and fruit size data indicated no measurable effects on fruit quality from the spray treatments. Brown rot was not a problem in any plot.

Table 3. Control of cherry leaf spot on tart cherry with dilute fungicide sprays and the effect of sprays on fruit quality — Shelby, Michigan, 1971

Treatment	Rate per 100 gal	Percent Defoliation	Percent Infection	Weight/100 cherries (gm)	% Soluble Solids
Thynon	8.0 oz	3.2	0.0	412.3	12.75
Cyprex (65W)	8.0 oz	1.9	0.3	446.2	12.00
Cyprex (80W)	6.0 oz	1.8	0.0	444.7	13.25
EL-273	30 ppm	8.9	6.0	436.1	12.37
EL-273	40 ppm	5.8	3.7	427.6	12.62
Benlate	4.0 oz	6.5	0.0	448.6	12.75
Bravo	1.5 lb	5.8	0.0	395.2	12.87
Difolatan	1.5 pt	8.5	0.3	431.1	12.87
Difolatan (a)	3.0 qt	8.8	4.0	467.4	13.25
Difolatan (a)	4.0 qt	11.4	24.4	464.5	12.37
Check		9.0	51.0	455.3	12.87

(a) Single application treatment applied at petal fall. All other treatments were repeated five times. Leaf spot data were taken on September 15.

1972 Trial

The treatments (Table 4) were applied on May 24, June 7, 22, July 6, and 25. Extensive brown rot developed in the check treatment and fruit counts for decay were made on July 28. The brown rot counts were analyzed after a square root transformation on the data. Soluble solids and fruit size measurements were also taken on July 28. Counts for leaf spot were made on August 23 and September 14.

Nearly 10% of fruit on the check trees was naturally infected with brown rot, a relatively severe infection for tart cherries (Table 4). Benlate, with and without oil, and Bravo gave the best brown rot control. The Cela W524 and Cyprex treatments gave similar results and were not different statistically from the check.

Leaf spot was severe in the check plots on August 23 but was well controlled by all of the fungicide programs (Table 4). Since no sprays were applied after July 25, differences in the fungicide treatments on September 14 represent the ability of the different treatments to prevent infection early in the season and persist to give late season control. Benlate with and without oil and Bravo were most effective in preventing defoliation. Cyprex and Cela W524 were intermediate in effectiveness. The check was least effective. Infection was severe in all but the Benlate treatments.

An F-test showed that fungicide treatments did not significantly affect soluble solids and fruit size.

1973 Trial

Fungicide spray applications were made on May 15, 29, June 6, 19, July 3, 13, and 30. Examination of apothecia on leaves from the orchard floor indicated ascospore discharge had started before the first spray applications were applied on May 15 and well before the petal fall stage of bud development. Lesions were observed on the bract leaves in all plots on May 29, indicating infection had occurred from the early spore discharge. On June 6, 3 weeks after full bloom, lesions were plentiful on both the bract and the first true leaves of unsprayed trees. The check treatment had 73.6% defoliation on July 17, 2 weeks prior to harvest.

Table 4. Control of brown rot and cherry leaf spot on tart cherries with various fungicide spray programs and the effect of sprays on fruit quality — Shelby, Michigan, 1972 (a)

Treatment	Rate per 100 gal	Brown rot		Leaf spot				Fruit quality	
		% Fruits with infection	Square root	% Defoliation 8/23	% Defoliation 9/14	% Infection 8/23	% Infection 9/14	Wt/100 cherries (gm)	% Soluble solids
Benlate + 70 sec oil	4 oz + 2 qt	1.10	0.90 a	0.00 a	6.5 a	0.00 a	29.5 a	569.4	12.25
Benlate	4 oz	1.95	1.27 ab	0.50 a	10.8 a	0.50 a	37.9 a	520.8	12.62
Bravo	12 oz	1.94	1.33 ab	0.57 a	19.1 a	1.30 a	92.8 b	568.5	12.25
Cyprex	6 oz	4.45	2.07 bc	2.25 a	29.7 ab	6.33 a	99.5 b	580.0	12.37
Cyprex + ACCO-Hg	6 oz + 12 fl oz	4.84	2.12 bc	0.90 a	34.9 ab	2.19 a	99.6 b	603.3	11.93
CELA W524	8 fl oz	5.39	2.19 bc	1.05 a	61.2 b	10.21 a	100.0 b	507.7	12.25
CELA W524	12 fl oz	6.17	2.37 bc	3.43 a	36.1 ab	17.78 a	97.7 b	567.0	12.62
Check		9.58	3.02 c	50.80 b	97.0 c	79.46 b	100.0 b	555.5	11.87

(a) Figures not followed by the same letter are significantly different at the 5% level. Brown rot and fruit quality data were taken on July 28.

Fig. 2. Aerial application of fungicides for cherry leaf spot control as discussed in this report.

All fungicide treatments gave good control through July 17 under these severe disease situations (Table 5). On September 25, defoliation had not increased appreciably over the July count but infection levels had. Difolatan, Benlate, Benlate-oil, and Topsin M-oil performed best in preventing late season infection. Topsin M without oil was less effective than the Topsin M-oil combination. Bravo and Topsin M were intermediate in effectiveness followed by Cela W524 and Cyprex-sulfur treatments. Since the check treatment had 98.5% infection on July 17, the change in infection to September 25 is probably not significant. None of the fungicide treatments were phytotoxic.

Table 5. Control of cherry leaf spot on tart cherries with various fungicide spray programs — Shelby, Michigan, 1973

Treatment and rate per 100 gal (b)		Percent (a)			
		Defoliation		Infection (c)	
		7/17	9/25	7/17	9/25
Difolatan	1 pt	15.4 a	14.6 a	45.4 a	23.4 a
Benlate	4 oz	12.3a	20.7 a	37.0 a	29.1 a
Benlate + 70 sec oil	2 oz 1 pt	15.7 a	18.7 a	40.3 a	33.5 a
Topsin M	4 oz	22.0 a	21.3 a	40.8 a	70.0 bc
Topsin M + 70 sec oil	4 oz 1 qt	13.0 a	15.0 a	37.6 a	37.4 a
Bravo	12 fl oz	19.6 a	20.0 a	35.1 a	65.2 b
Cyprex + Sulfur	4 oz 3 lb	20.3 a	31.6 a	49.8 a	90.4 bcd
Cela W524	10 fl oz	19.5 a	32.2 a	32.1 a	96.4 cd
Check		73.6 b	98.3 b	98.5 b	100.0 d

(a) Means not followed by the same letter are significantly different at the 5% level.

(b) On May 29 only, application rates were Cyprex, 8 oz; Bravo, 1 pt; and Difolatan 1½ pt. All other treatments were applied at the rates given in the table.

(c) Percentage of leaves infected includes leaves lost by defoliation and those remaining with visible lesions.

AERIAL APPLICATION TRIALS

Fungicide was applied with aerial equipment over four growing seasons (Fig. 2). All trials were conducted in the same general vicinity but the same orchard was not used each year. Treatments were applied by custom applicators using 5 gal of spray mix per acre (60X concentration). Timing of individual applications was less precise than for the hand gun trials because the application equipment was not always available on the day it was needed.

1969 Trial

A Grumman Ag Cat was used to apply the aerial treatments. For comparison, Cyprex at ½ lb per 100 gal was applied by the grower with a high pressure ground sprayer.

The aerial program of Cyprex at ⅜ lb and the ground program of Cyprex at ½ lb gave similar control under severe leaf spot pressure (Table 6). Cyprex at ¼ lb and the Glyodin plus Ferbam pro-

grams were less effective. Disease control between the bottom and top halves of the trees was not uniform. Treatments applied by aircraft gave better leaf spot control in the top of the tree than the bottom. The ground treatment gave better control in the bottom of the tree than the top.

Table 6. Control of cherry leaf spot on tart cherries with various fungicide programs applied by fixed wing aircraft — Pentwater, Michigan, 1969

Treatment (a)	Rate per 100 gal	Concentration	% Defoliation	
			Throughout trees	Top only
Cyprex	⅜ lb (b)	60X	19	8.4
Cyprex	¼ lb (b)	60X	42	39.0
Glyodin + Ferbam	1½ pt ½ lb	60X	36	17.0
Cyprex (c)	½ lb	3X	20	42.0

(a) Guthion used as insecticide.

(b) Cyprex 80W was used but rates are listed as the commercially available 65W equivalent.

(c) Applied by ground sprayer with high pressure spray boom.

1970 Trial

Two fungicides, Difolatan and Cyprex, and three application methods, fixed wing aircraft, a helicopter with spray booms, and a speed sprayer were compared (Table 7). The ground sprays were applied by the grower using 250 gallons of spray per acre. Four fungicide applications were made starting at petal fall and no postharvest spray was applied. Spray dates were as follows: Airplane — May 18 and 28, June 8 and 22; helicopter — May 23, June 5, 15, and 24; speed sprayer — May 19 and 29, June 9 and 25.

Table 7. Air vs. ground spray treatments for control of cherry leaf spot on sour cherries — Shelby, Michigan, 1970

Treatment (a)	Rate per 100 gal	Rate per Acre	Method of application	Percent (b) Defoliation	Percent (b) Infection
Difolatan	2 pt	3 qt	Airplane	6.5 a	.56 a
Difolatan	2 pt	3 qt	Speed Sprayer	8.1 a	.00 a
Difolatan	2 pt	3 qt	Helicopter	11.2 a	1.36 a
Cyprex	1.5 lb	4.5 lb	Helicopter	29.1 a	69.24 b
Cyprex	1.5 lb	4.5 lb	Airplane	48.9 ab	88.80 b
Cyprex	1.5 lb	4.5 lb	Speed Sprayer	79.7 b	81.42 b

(a) Spray dates were as follows: Airplane — May 18 and 28, June 8 and 22; Helicopter — May 23, June 5, 15, and 25; Speed Sprayer — May 19 and 29, June 9 and 25.

(b) Figures not followed by the same letter are significantly different at the 5% level.

All treatments controlled leaf spot through harvest. On September 24, infection levels in plots sprayed with Difolatan were lower than in plots sprayed with Cyprex (Table 7). Defoliation from leaf spot was most severe in the Cyprex plot sprayed from the ground. Later, heavy defoliation was observed in all Cyprex plots. A more direct comparison between the three application methods is not possible due to differences in application dates.

1971 Trial

This experiment was similar to that in 1970 except a postharvest treatment was added to half of each block. Because of dry weather, leaf spot was light. However, all treatments provided excellent control of the disease until frost. Postharvest treatment made no significant difference in leaf spot control.

1972 Trial

Spray applications were made by helicopter on June 13, 26, July 8 and August 4 (postharvest) using 5 gal of spray per acre. The postharvest spray was only applied to half of each block. All blocks received a phygon-sulfur dust at bloom and, except for the Benlate block, just before harvest. Insecticides used were Guthion 2EC, 3 pt/A on June 13 and June 26 and Sevin 50WP, 6 lb/A on July 8. Data are for September 27.

All treatments provided good leaf spot control through harvest but frequent rains in August and early September were favorable for late season disease development (Table 8). Blocks receiving the postharvest applications had less defoliation and infection than blocks receiving the same chemical without the postharvest application. In descending order of effectiveness, the Benate and Cyprex blocks with a postharvest application, and the Benlate block without a postharvest application showed the least defoliation and leaf infection. Cyprex sprays containing ACCO-Hg, an experimental sticker, were less effective than Cyprex alone.

Table 8. Control of cherry leaf spot on tart cherries with 60X concentrate sprays applied by helicopter — Shelby, Michigan, 1972

Treatment	Rate per acre	Leaf spot (a) % Defoliation	% Remaining leaves infected	% Total of leaves infected (b)
With postharvest spray				
Benlate	12.0 oz	6.9 a	31.1 a	34.9 a
Cyprex	1.125 lb	11.4 ab	48.9 b	53.9 b
Cyprex + ACCO-Hg	1.125 lb 2.25 pt	42.5 c	93.7 d	94.3 d
No postharvest spray				
Benlate	12.0 oz	27.3 bc	72.1 c	77.8 c
Cyprex	1.125 lb	39.1 c	91.3 d	92.7 d
Cyprex + ACCO-Hg	1.125 lb 2.25 pt	63.2 d	86.2 cd	99.4 d

(a) Figures not followed by the same letter are significantly different at the 5% level.

(b) Includes infection on remaining leaves plus those that were removed by infection.

PHYTOTOXICITY OF AERIAL SPRAYS

Some aerial treatments were injurious to the cherry fruits causing necrotic areas in the fruit skin where chemical spray droplets had dried. At fruit maturity the injured areas were often masked by the red coloration. Some injured areas were sunken and were visible at harvest on close examination.

In 1971, injury resulted from combinations of Cyprex, Difolatan or Benlate with liquid Guthion. In 1972, spotting occurred with Cyprex-Guthion and Benlate-Guthion combinations. Injury was more extensive when high temperatures existed at the time of application or soon thereafter. Dilute sprays applied with conventional ground equipment on the same day and with the same pesticides were not injurious. The relation of temperature and chemical concentration to fruit damage was confirmed in laboratory studies.[6]

DISCUSSION AND CONCLUSIONS

Five years of experimental study under widely different conditions have demonstrated the effectiveness of several fungicides (Table 1) for the control of cherry leaf spot on tart cherries in Michigan. All tested fungicides controlled leaf spot fairly well from bloom to harvest. Differences in their performance, however, were detected following harvest.

Benlate, Difolatan, Thynon, and Topsin M were the most persistent of the compounds, preventing late season infection in wet years. The persistence of Topsin M was improved significantly by adding 1 qt of 70 second viscosity oil with each spray application. Control with Benlate at the 2 oz rate plus oil at 1 pt to 2 qt in each spray application was similar to that with Benlate at the 4 oz rate.

Cyprex, alone or with sulfur, and Bravo were intermediate in persistence compared to the compounds mentioned above. For best results during prolonged wet periods and in postharvest sprays, Cyprex should be used at the 8 oz rate. The rate of Bravo used in these trials, ¾ pt/100 gal, was low and should be increased to 1 pt/100 gal in wet years.

Cela W524 and EL-273, the newest fungicides tested, were the least persistent compounds. Future formulations may give longer lasting control.

These studies also reveal several factors that should be considered in leaf spot control programs.

The maturity of primary inoculum in the overwintering leaves is an important factor in timing the first spray of the season. Early maturation of the fungus fruit bodies (apothecia with ascospores) means that spray programs should start during bloom if weather is wet. Although the new leaves must have mature stomata before infection can occur, some susceptible tissue is usually present early in bloom. A few early infections can supply large amounts of secondary inoculum for disease cycles later in the summer and fall.

Leaf spot inoculum in the orchard where handgun trials were conducted was extremely high since large areas of the orchard were left unsprayed each year. Even under conditions of high disease potential, most treatments were effective in reducing leaf spot. In commercial tart cherry orchards inoculum levels are also high because disease is usually allowed to build up late in the growing season. Since high levels of leaf spot inoculum are normally present each spring, little latitude is possible in fungicide rates suggested in the Fruit Spraying Calendar, Extension Bulletin E-154.

A postharvest spray contributes to the success of the leaf spot program and is usually desirable. It prevents the harmful effects of early defoliation and decreases the level of overwintering inoculum. A postharvest application is critical if leaf spot is present at harvest or if rain has removed a significant amount of the fungicide deposit. In years, such as 1971, with unusually dry weather after harvest the postharvest treatment may not be as beneficial. Such years, however, are an exception.

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[6] Jones, Alan L (1973). Phytotoxicity of dodine and azinphosmethyl to cherry fruit. Plant Dis. Reptr. 57:428-431.

4-74—9.5M