The effect of chlorothalonil on alternaria leaf spot of crucifers under laboratory conditions

Andres A. Reyes[1] *and Austin E. Maitland*[2]

Chlorothalonil was as effective as maneb and zineb in controlling alternaria leaf spot on cauliflower when plants were sprayed at least 3 h before inoculation. However, it did not prevent development of the disease when applied 2 or 3 days after inoculation. Control of leaf spot was not affected by mixing chlorothalonil with an insecticide. Chlorothalonil was not phytotoxic to crucifers.

Can. Plant Dis. Surv. 58: 75-76. 1978

Le chlorothalonil (tetrachloroisophthalonitrile) agit avec autant d'efficacite que le manèbe (ethylene bis- (dithiocarbamate) de manganese) et le zinebe (ethylene bis- (di-thiocarbamate) de zinc) dans la lutte contre la tache noire *(Alternaria brassicae)* du chou-fleur lorsqu'il est pulvérisé sur la plante au moins trois heures avant l'inoculation. Toutefois, il n'empêche pas l'evolution de la maladie lorsqu'il est applique deux ou trois jours apres l'inoculation. Le melange du chlorothalonil avec un insecticide n'a pas diminué son efficacite contre la tache noire et le chlorothalonil n'a pas manifeste de toxicité envers les cruciferes.

The fungicides recommended in Ontario, Canada, in 1977 for the control of alternaria leaf spot of crucifers, caused by the fungus ***Alternaria brassicae*** (Berk.) Sacc., were maneb, zineb and fixed copper (2). However, notice of rebuttable presumption against registration involved maneb and zineb (3). Fixed copper was reported to produce poor control of alternaria leaf spot (1).

Chlorothalonil, registered in the U.S.A. for control of this disease, was given a temporary registration for crucifers in Canada in 1977 on condition that Canadian efficacy data are obtained. This study was initiated for this purpose.

Materials and methods

The fungicides used were chlorothalonil (tetrachloroisophthalonitrile, Bravo), maneb (manganese ethylene bisdithiocarbamate), zineb (zinc ethylene bisdithiocarbamate) and tricop (tribasic copper sulphate). The insecticides used were endosulfan (Thiodan 4 EC), azinphos-methyl (o,o-dimethyl S-(4-oxo-1,2,3-benzotriazin-3(4H)-ylmethyl) phosphorodithioate, Guthion), Dipel *(Bacillus thuringiensis* Berliner), methamidophos (o-S-dimethylphosphoramidothioate, Minotor), dimethoate (Cygon), mevinphos (Phosdrin Liq. Insect.), and carbaryl (Sevin). These chemicals were sprayed onto each of four plants at 140 kPa (20 psi) until runoff occurred. Maneb, zineb and tricop were used as standards because of their general use (2). Check plants were sprayed with water only.

Seven-wk old seedlings of broccoli *(Brassica oleracea* L. var. *italica* Plenck) cv. Cleopatra, cabbage *(B. oleracea* L. var. *capitata* L.) cv. Early Marvel, and cauliflower *(B. oleracea* L. var. *botrytis* L.) cv. Idol Original each grown in 10-cm pot of soil were used. Unless otherwise indicated, treated plants were maintained in a growth-room. After each treatment the plants received 3 days of continuous dark (22 C, 98% relative humidity, RH) followed by 4 days of alternating periods of light (14 h, 32,000 lux, 75% RH) and dark (10 h). The plants were watered as required.

The inoculum was prepared as follows: Spores of ***A. brassicae*** were collected by vigorously shaking 50 g of severely infected leaves of greenhouse grown cauliflower plants for 5 min in 500 ml tap water in 2,800-ml flask. The number of spores in the suspension was adjusted to 15×10^4 spores/ml of water by dilution. Test plants were inoculated with this suspension using a vaporizer (Mastercraft, Toronto). Usually, inoculation followed chemical spraying by 3 h.

Disease severity was rated 0 when there was no leaf spot on the leaves, and 1, 2, 3 and 4 when there were 0.5, 1-2, 3-10 and more than 10 spots/4 cm^2 of the leaf, respectively. The number of fungal spores/4 cm^2 of leaf was determined by vigorously shaking 45 leaf squares (2 X 2 cm) from each plant for 5 min in 100 ml water in a 250-ml flask and counting the spores in the suspension with a haemacytometer.

Four tests were made. In Test 1, cauliflower plants were sprayed weekly with the fungicides and inoculated weekly with ***A. brassicae.*** Disease severity and fungal spores/4 cm^2 of leaf were recorded 28 days after the initial spraying and inoculation. In Test 2, broccoli plants were sprayed with chlorothalonil flowable at different times before or after inoculation. The results were recorded 7 days after spraying. In Test 3, cauliflower plants were sprayed with chlorothalonil flowable and

[1] *Research Scientist, Agriculture Canada, Vineland Station, Ont. LOR 2E0 and* [2] *Commercial Development Manager, Biochemicals, Diamond Shamrock Canada Ltd., Willowdale. Ont. M2J 4R3.*

Accepted for publication June 6, 1978.

Table 1. Effect of chlorothalonil, maneb, zineb and tricop on the development of alternaria leaf spot on cauliflower

Active ingredient fungicide/liter		Leaf spot*	Spores/4 cm^2 leaf (x 10^4)
Chlorothalonil			
Wettable powder	1.8 g	0.1 c**	0 c
	3.7 g	0 c	0 c
Flowable	1.4 ml	0.1 c	0 c
	2.7 ml	0 c	0 c
Maneb	2.6 g	0.5 c	0 c
Zineb	2.5 g	0.3 c	0.2 c
Tricop	1.8 g	3.1 b	1.8 b
Water check	—	3.5 a	7.6 a

*0 = no leaf spot on the leaves; 1, 2, 3 and 4 = respectively, 0.5, 1-2, 3-10 and more than 10 spots /4 cm^2 leaf.

**Figures followed by the same letter are not significantly different ($P = 0.05$).

each of seven chlorothalonil–insecticide combinations. Disease severity was recorded 7 days after inoculation. In Test 4, broccoli, cabbage and cauliflower plants were sprayed twice at 7 days interval with 0.6, 1.2, 3.7 or 7.4 g active chlorothalonil wettable powder per liter water. The plants were not inoculated with A. ***brassicae*** but maintained for 14 days in the greenhouse (14 h. light, 10 h dark, 25 ± 2 C). Data were analyzed statistically (Duncan's multiple range test).

Results and discussion

Leaf spot and fungal spores/4 cm^2 leaf area of cauliflower plants that received weekly sprays of the fungicides and inoculations with A. ***brassicae*** were less on chlorothalonil, maneb and zineb treated plants than on those treated with tricop (Table 1). There was significantly more leaf spot on the check plants than on any of the fungicide treated ones. The results of the second test indicated that chlorothalonil was a protectant (Table 2). There was significantly less leaf spotting on plants sprayed 1 day after inoculation with A. ***brassicae*** than on those sprayed 2 or 3 days after inoculation. The disease was absent on those treated 3 h, 1 and 3 days before inoculation. Water treated check plants were heavily defoliated.

Table 3 data indicated that chlorothalonil was compatible with the insecticides used. Leaf spot was controlled equally by treatments of plants with chlorothalonil alone and any of the **chlorothalonil-insecticide** combinations. Significantly more leaf spot occurred on the checks than on any of the other treated plants.

Chlorothalonil proved not to be phytotoxic to the crucifers used in Test 4 in the greenhouse (data not presented). No abnormal symptoms on the foliage nor significant weight differences of chlorothalonil treated and nontreated check plants were observed.

Our work demonstrated that under laboratory conditions chlorothalonil effectively controlled leaf spot of crucifers.

Table 2. Effect of time of application of chlorothalonil (2.7 ml/liter water) on the development of alternaria leaf spot on broccoli

Time of spraying (days)	Leaf spot*	
	treated	ater check
Before inoculation		
3	0 c**	4.4 a
1	0 c	3.5 a
0 (3 h)	0 c	**3.6** a
After inoculation		
1	1.8 b	**3.6** a
2	4.1 a	4.4 a
3	4.0 a	4.2 a
Noninoculated check	0 c	0 b

*0 = no leaf spot on the leaves; 1, 2, 3 and 4 = respectively. 0.5, 1-2, 3-10 and more than 10 spots/4 cm^2 leaf.

**Figures followed by the same letter are not significantly different ($P = 0.05$).

Table 3. Effect of chlorothalonil alone and chlorothalonil-insecticide combinations on the development of alternaria leaf spot on cauliflower

Active ingredient fungicide or insecticide/liter	Leaf spot*
Chlorothalonil flowable only (1.4 ml)	**0.3** b**
Chlorothalonil flowable (1.4 ml) + insecticide	
Endosulfan (1.3 ml)	0 b
Azinphos-methyl (0.9 g)	0.5 b
Dipel (1.7 g)	0.5 b
Methamidophos (1.3 ml)	0.5 b
Dimethoate (0.6 ml)	0.3 b
Mevinphos (0.2 ml)	0.3 b
Carbaryl (1.7 g)	0 b
Water only (check)	3.5 a

*0 = no leaf spot on the leaves; 1, 2, 3 and 4 = respectively, 0.5, 1-2, 3-10 and more than 10 spots/4 cm^2 leaf.

""Figures followed by the same letter are not significantly different ($P = 0.05$).

However, it was not determined whether this fungicide can be used as an effective substitute for maneb, zineb and tricop for leaf spot control in the field.

Acknowledgment

We thank W. P. Skoropad, University of Alberta, Edmonton T6G 2E3, for supplying cultures of *A. brassicae* and Judy Shaw for technical help.

Literature cited

1. Abdel-Rahman, M. 1977. New fungicide evaluations on crucifers, 1976. Fungicide and Nematicide Tests. Am. Phytopathol. Soc. 32: 76-77.
2. Ontario Ministry of Agriculture and Food. 1977. Vegetable production recommendations. Ont. Min. Agric. Food Publ. 363. 68 p.
3. Pesticide & Toxic Chemical News. 1977. EBDC RPAR notice based on oncogenicity, teratogenicity about to be issued. August 3rd. p. 38.