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CHEMICAL CONTROL OF *PHYTOPHTHORA CINNAMOMI* IN ORNAMENTAL WOODY SPECIES

Pauline M. Smith
Glasshouse Crops Research Institute, Littlehampton, W. Sussex

Summary Copper and chlorine-releasing compounds were the most fungitoxic of the materials tested for the control of *Phytophthora cinnamomi* in water. Etridiazole, aluminium tris(ethyl phosphonate), sodium ethyl phosphonate and furalaxyl were the most effective of eight compounds when applied as protectant drenches to the roots of *Chamaecyparis lawsoniana* cv. Ellwoodii, for the control of infection by zoospores of *P. cinnamomi*. Furalaxyl showed the longest residual protectant activity but irrespective of fungicide treatment disease incidence increased with increasing amount of inoculum. None of the materials when tested as a single drench application eradicated *P. cinnamomi* in soil infested with root debris.

Résumé Dans les conditions d'essais le plus fongitoxique des matériaux pour lutter contre *Phytophthora cinnamomi* dans l'eau furent le cuivre et les compositions à chlore-déchargeant.

Parmi 8 compositions, ceux d'etridiazole, aluminium tris(ethyl phosphonate), sodium ethyl phosphonate et furalaxyl se sont révélées le plus efficace appliqué en arrosage aux racines de *Chamaecyparis lawsoniana* cv. Ellwoodii, pour lutter contre l'infection par les zoospores de *P. cinnamomi*. Furalaxyl s'est révélé d'avoir l'activité protecteur le plus durable, mais sans égard su traîtment fongicide l'incidence de maladie s'est accentué avec plus de l'inoculum.

Quand mis à l'épreuve comme un arrosage unique, aucun des matériaux détruit *P. cinnamomi* dans le sol infesté avec le débris de racines.

INTRODUCTION

Compounds which are specifically fungitoxic to Phycomycetes are now available some showing systemic activity (Williams et al., 1977; Schwinn et al., 1977; Benson, 1979). These materials have been assessed for the control of *Phytophthora cinnamomi*, which causes root-rotting, and subsequent wilt and die-back in a world-wide host range of over eight hundred species (Zentmyer, 1979). In the U.K., this pathogen accounts for an estimated annual loss of £½ million to producers of woody ornamentals (including many high value crops of e.g. conifers, rhododendrons). Moreover, some infected plants do not develop wilt and die-back until after they have been sold and serious loss of amenity plantings can occur.

P. cinnamomi is a soil and water-borne fungus and is spread by contaminated irrigation water, soil, plants or propagation material. The tests described in this paper were designed to assess the effectiveness of chemicals in controlling this pathogen in root environments and water.

METHODS AND MATERIALS

Table 1

Compounds used in experiments

Common name/Active ingredient	Code number and/or (proprietary name)
aluminium tris(ethyl phosphonate)	LS 74-783 (Aliette)
cuprammonium compound (1)	(Cheshunt Compound)
" " (2)	(Fungex)
1-(2-cyano-2-methoxyiminoacetyl)-3-ethyl urea	DPX 3217 (Curzate)
drazoxolon	(Mil-Col 30)
etridiazole (35%, 25% or 30%)	(Aaterra), (Truban 25), (Truban 30)
furalaxyl	A5430 (Fongarid 50 WP)
prothiocarb	SN 41 703 (Dynone)
sodium dichloriso cyanurate dihydrate	(Fi-Tab R/D)
sodium ethyl phosphonate	LS 73-1038
sodium hypochlorite	(Chloros)

The fungitoxicity of compounds to *P. cinnamomi* in water was tested using methods described by Smith (1979a). Mycelial mats were immersed in dilutions of the chemicals for 1, 3 and 6 days before transferring to carrot agar and soil leachate to determine growth rate and sporangium production respectively. Chlorine toxicity to zoospore suspensions was also assessed using different chlorine compounds and exposure times.

The protectant efficiencies of compounds were determined as a single drench application to the rooting medium of container-grown, 1-year-old *Chamaecyparis lawsoniana* cv. Ellwoodii and the roots were subsequently inoculated with one standardized dose of *P. cinnamomi* zoospores at predetermined intervals (Smith, 1979b). The eradicant activities of materials were tested by drenching compost containing root debris infested with *P. cinnamomi* and assessing the development of wilt and die-back in 1-year-old *C. lawsoniana* cv. Ellwoodii which were planted into the treated compost in 127 mm pots six days after drenching (Smith, 1979b). Disease incidence was recorded for 9 - 13 months following inoculation and foliar damage was graded on a 0 to 5 scale:-

0.5 Damage only just detectable on a few shoots as a very slight fading of colour, wilting.

1.0 Symptoms as above but detectable on c. 5% of foliage.

2.0 Symptoms as above and affecting c. 15% of foliage.

3.0 Moderate wilt, fading and/or browning of foliage, slight die-back of c. 45% of plant.

4.0 Severe wilt, browning, desiccation of foliage and die-back of c. 75% of plant.

5.0 Plant dead.

The methods used for the isolation of *P. cinnamomi* from roots and compost are described by Smith, (1979b).

RESULTS

Fungitoxicity of compounds to mycelium of *P. cinnamomi* in water

Table 2 summarises data from six experiments in which the test materials were applied in glass-distilled water to mycelial mats of *P. cinnamomi*. Chlorine and copper compounds killed mycelium within 24 h at 100 and 13-24 mg a.i./l respectively. Furalaxyl 600 mg a.i./l, prothiocarb 1500 mg a.i./l and etridiazole 25% e.c. 1000 mg a.i./l completely suppressed growth of mycelial mats when transferred to carrot agar after 3, 3 and 6 days immersion in the fungitoxicants respectively. At about half the concentration of active ingredient these treatments suppressed sporangium production.

Table 2

Toxicity of compounds to mycelium of *Phytophthora cinnamomi* in water

Minimum concentration mg a.i./l which ...

Fungicide	Mycelial growth killed or suppressed	Sporangium production suppressed
cuprammonium (1)	24*	< 4.5*
sodium hypochlorite	100**	100 **
DPX 3217	>2000	>2000+
drazoxolon	>1500	>1500+
sodium dichloriso cyanurate dihydrate	100**	100 **
furalaxyl	500	300
cuprammonium (2)	13*	< 6.5*
aluminium tris(ethyl phosphonate)	>4000	<1000
sodium ethyl phosphonate	>4000	<1000
prothiocarb	1500	<1000
etridiazole 25	1000	500
etridiazole 30	>2000	< 250

**= free residual chlorine * = copper
+ Denotes very sparse sporangium production

Aluminium tris(ethyl phosphonate) and sodium ethyl phosphonate at 1000 mg a.i./l prevented sporangium production in mats immersed for 3 days but this treatment did not prevent subsequent mycelial growth. Increasing the concentration to 4000 mg a.i./l did not increase fungitoxicity.

Fungitoxicity of chlorination compounds to zoospores of *P. cinnamomi*

Sodium hypochlorite and sodium dichloriso cyanurate dihydrate were added to standardized suspensions of zoospores in glass-distilled water to give 0.25, 0.5, 1.0 and 2.0 mg Cl_2/l and after 1, 2 and 5 min at 18°C the chlorinated suspensions and untreated control were 'plated' onto P 10 VP selective medium. No colonies developed when zoospores were treated with either compound at 2 mg Cl_2/l for 1 min and the fungitoxicity of both compounds increased directly with chlorine concentration and duration of treatment.

Phytotoxicity tests carried out by ADAS at Efford E.H.S. showed that sodium dichloriso cyanurate dihydrate was less phytotoxic than sodium hypochlorite and when added to irrigation water (from July-Nov) at 5, 10 and 20 mg Cl_2/l caused no damage to container-grown *Calluna vulgaris* cv. Ruth Sparkes, *C. lawsoniana* cv. Ellwood's Gold, *Berberis* x *ottawensis* superba and deciduous *Azalea* cv. Bright Forecast. Sodium hypochlorite at 20 mg Cl_2/l reduced growth of *Calluna* and caused marginal chlorosis in *Berberis* and led to a larger increase in chloride content in foliage and compost of all species than sodium dichloriso cyanurate dihydrate (Miss M. Scott - personal communication).

Fungitoxicity of compounds to *P. cinnamomi* in the root environment

In Exp. 1 all fungicide drench treatments (Table 3) were applied 2 days before roots of *C. lawsoniana* cv. Ellwoodii were inoculated with *P. cinnamomi* zoospores (c. 1,200,000/plant). Etridiazole 25 e.c. at 250 and 500 mg a.i./l controlled disease during the 9 months from inoculation to final assessment and significantly increased shoot extension. *P. cinnamomi* was not isolated from any etridiazole-treated or uninoculated plants. A prothiocarb drench at 2000 mg a.i./l did not prevent root infection but delayed development of wilt and die-back. Drenches of cuprammonium (1) at 90 mg copper/l or cuprammonium (2) at 100 mg copper/l were ineffective in controlling disease.

Table 3

Control of *Phytophthora cinnamomi* in *C. lawsoniana* cv. Ellwoodii by fungicides applied as drenches to the rooting medium 2 days before inoculation with zoospores. Assessments made 9 months after inoculation

Fungicide	mg a.i./l*	Inoculated *P. cinnamomi*** Mean increase height (mm)	Mean foliage damage index	Uninoculated*** Mean increase height (mm)	Mean foliage damage index
cuprammonium (1)	90****	46	5.0+	405	0.3-
cuprammonium (2)	100****	88	4.1+	370	0.8-
prothiocarb	1000	6	5.0+	375	0.0-
	2000	122	4.2+	350	0.0-
etridiazole 25	250	320	0.6-	340	0.5-
	500	404	0.1-	290	0.8-
No fungicide	-	6	5.0+	310	1.0-
L.S.D. (P=0.05)		141.4	1.33	ns	ns

* = 400 mls/152 mm pot
** = 5 replicate plants
*** = 2 replicate plants
**** = mg copper/l
\+ *P. cinnamomi* isolated from roots
\- *P. cinnamomi* not isolated

In Exp. 2 the residual toxicity of fungicides to *P. cinnamomi* zoospores in the root environment was tested by increasing the interval between drenching and inoculating from 1 to 4 and 12 weeks. One batch of *C. lawsoniana* cv. Ellwoodii was inoculated with c. 650,000 zoospores/plant (inoculum I) and the other with 650 zoospores/plant (inoculum II). Table 4 shows the effect of treatments on disease development and the incidence of *P. cinnamomi* isolated from roots.

When plants received inoculum I, furalaxyl at 500 and 1000 mg a.i./l applied 1 week before inoculation was the only treatment which prevented wilt/die-back during the following 12 months. Irrespective of fungicide, disease incidence was reduced when the weaker inoculum (inoculum II) was applied but furalaxyl was more consistent than the other fungicides in maintaining protectant activity against zoospore infection.

Table 4

The effect of fungicide drench treatment on onset of wilt/die-back in *C. lawsoniana* cv. Ellwoodii when inoculated with *P. cinnamomi* zoospore suspension I or II at 1, 4 or 12 weeks after fungicide application

Fungicide	mg a.i./l***	Weeks from fungicide treatment to inoculation				
		Inoculum I*			Inoculum II**	
		1	4	12	4	12
		No. wk from inoculation to onset of wilt/die-back				
furalaxyl	250	9+	28+	5+	$>52^{-}$	$>52^{-}$
	500	$>52^{-}$	30+	6+	$>52^{-}$	$>52^{-}$
	1000	$>52^{-}$	19+	6+	$>52^{-}$	$>52^{-}$
LS 74-783	250	2+	5+	NT	12+	15+
	500	7+	6+	7+	9+	$>52^{-}$
	1000	13+	30+	5+	$>52^{-}$	$>52^{-}$
	2000	35+	30+	7+	$>52^{-}$	40+
etridiazole 35%	500	2+	3+	NT	$>52^{-}$	$>52^{-}$
No fungicide		2+	3+	4+	7+	3+
No fungicide	no inoculation	$>52^{-}$	NT	NT	NT	NT

+ = *P. cinnamomi* isolated   - = No *P. cinnamomi* isolated   NT = Not tested
* = 4 replicates   ** = 2 replicates   *** = 150 mls/127 mm diameter pot

In Exp. 3 the fungicide drenches used in the previous experiment were applied to compost containing root debris infested with *P. cinnamomi*. Six days after treatment healthy *C. lawsoniana* cv. Ellwoodii were planted into the treated compost. None of the fungicide treatments prevented *P. cinnamomi* root infection but they delayed the onset of wilt and die-back from 6 weeks in the control plants to 17-53 weeks in fungicide-treated plants (Table 5).

Table 5

The effect of fungicide drenches applied to compost infected with *P. cinnamomi* on (a) incidence of foliage damage and number of dead plants and (b) onset of wilt/die-back in *C. lawsoniana* cv. Ellwoodii

Fungicide	mg a.i./l**	(a) Mean* grade foliage damage and (No. dead and severely damaged plants)	(b) Duration (wk) from planting to onset of wilt/die-back
furalaxyl	250	3.0 (2)$^{+}$	37
	500	2.1 (1)$^{+}$	37
	1000	3.6 (3)$^{+}$	28
LS 74-783	250	5.0 (5)$^{+}$	17
	500	3.6 (3)$^{+}$	21
	1000	5.0 (5)$^{+}$	21
	2000	2.3 (1)$^{+}$	53
etridiazole 35%	500	2.8 (2)$^{+}$	30
No fungicide	-	4.1 (4)$^{+}$	6
No fungicide	uninfested compost	0.2 (0)$^{-}$	>64

* Mean of 5 replicate plants + *P. cinnamomi* isolated - No *P. cinnamomi* isolated

** 100 ml/200 ml infested compost

DISCUSSION

In this series of experiments, furalaxyl was more toxic to the mycelium of *P. cinnamomi in vitro* and showed longer protectant activity against zoospore infection of roots of a conifer species than the other specific *Phycomycete* fungicides, prothiocarb, etridiazole, aluminium tris(ethyl phosphonate) and sodium ethyl phosphonate. The marked residual effect of furalaxyl treatments is of particular value in the production of hardy nursery stock where protection against *Phytophthora* infection may have to be maintained for several years.

The fungistatic rather than truly fungicidal action of these *Phycomycete* fungicides on the mycelium of *P. cinnamomi* prevents or reduces sporangium production and must therefore reduce the potential for spread of the pathogen. However, the application of these fungicides to infected but symptomless woody plants may delay the development of wilt/die-back until after the crop has been sold and planted into untreated ground. The satisfactory control of *Phytophthora* wilt/die-back using the present *Phycomycete* fungicides may, therefore, depend on prophylactic treatment.

Chlorination is a promising method of eradicating *Phytophthora* zoospores from contaminated water supplies and preliminary data indicate that sodium dichloriso cyanurate dihydrate is less phytotoxic than sodium hypochlorite.

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NOTES

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2 CYANO-N-[(ETHYLAMINO)CARBONYL]-2-(METHOXYIMINO)ACETAMIDE (DPX 3217), A NEW FUNGICIDE FOR THE CONTROL OF TOMATO AND POTATO LATE BLIGHT, HOP DOWNY MILDEW AND OTHER PERONOSPORALES

M. Absi
Du Pont de Nemours International S.A., Geneva, Switzerland

Summary 2 cyano-N-[(ethylamino)carbonyl]-2-(methoxyimino)acetamide (DPX 3217) has been investigated in trials for the last three seasons. Results from Europe show that in mixtures with reduced rates of contact fungicides, it gave good control of potato and tomato late blight and hop downy mildew. Best efficacy shows up on early and severe disease infection.

Résumé Au cours des trois dernières années, de nombreuses expérimentations furent réalisées avec le 2 cyano-N-[(ethylamino)carbonyl]-2-(methoxyimino)acetamide) (DPX 3217). En association avec des doses réduites de fongicides de contact l'efficacité sur les mildious de la pomme de terre, tomate et houblou est très satisfaisante. Les résultat européens sont rapportés. La meilleure efficacité est obtenue sur des infestations précoces et sévères de ces mildious.

INTRODUCTION

No common name has yet been established for 2 cyano-N-[(ethylamino)carbonyl]-2-(methoxyimino)acetamide. It has a code number of DPX 3217 and a trade name "Curzate". The effectiveness of this chemical for the control of various diseases caused by the peronosporales group of fungi has been previously reported (J.M. Serres and G.A. Carraro, 1976). Experiments in Europe showing excellent control of *Plasmopara viticola* have been described by J.P. Douchet et al (1977).

Following promising results in Europe in which high levels of both eradicant and protectant activity against grape downy mildew and other pathogens were demonstrated, a series of detailed field trials was laid down starting in 1976, to evaluate the efficacy of DPX 3217 against potato and tomato late blight, hop downy mildew and other pathogens. This paper reports the results of representative trials carried out in different countries in Europe since 1976.

DPX 3217 has been tested in the field since 1974 and is now currently used in several European countries for grape downy mildew and potato late blight control. It is characterised by three main points: low use rate, short residual action and post infection curative activity. Numerous tests have shown that this product is active at a dosage as low as 10-12 g a.i./hl on grapes as well as on potatoes. Higher rates do not significantly improve the disease control. DPX 3217 has a short residual action. It breaks down quickly and becomes inactive after 4 to 6 days. This period of activity is generally too short to develop the product on its own under practical conditions.

Thus, it has been tested in combination with preventive fungicides whose function is to improve persistence.

METHODS AND MATERIALS

All experiments were conducted in each country according to the local evaluation method and to the guidance of the respective registration boards. The trials reported below vary in experimental design according to crops and disease. Data presented come mainly from small scale, replicated trials using standard techniques. Comparison was made with relevant standard materials.

Table 1

Control of Potato *Phytophthora infestans* in Romania

		Experiment 1 Brasov (1977)		Experiment 2 Suceava (1978)	
Product	rates g a.i./ha	% of Diseased Tubers	Yields Tonnes per ha	% of attack on foliage	Yields Tonnes per ha
DPX3217+mancozeb	125+880	0.14 b	24.8abc	5	22
DPX3217+mancozeb	90+880	0.67ab	24.2abc	5	22.5
DPX3217+copperoxy	125+1250			6	22.1
mancozeb	1600	0.78ab	23.7abc	10	21.4
copper oxychloride	2500	0.58ab	22.1 bc	5	20.5
Nil	-	1.00ab	21.3 c	70	19.7

Experiment 1 and 2 (Table 1) Experiment 1 conducted in Romania at the Brasov Potato Research Institute was of randomised block design with 4 replications. Treatments on Bintje variety for late blight control (*Phytophthora infestans*) consisted of eight sprays applied weekly, starting on June 22 till August 9, 1977. Trials were harvested on September 2 when yields were assessed and diseased tubers were scored. Experiment 2 conducted also in Romania at the Suceava Research Station, involved the same design and cultural procedure as Experiment 1. Seven weekly sprays were applied on the Bintje variety, starting on July 4 till August 21, 1978. The yields and disease were assessed on August 25, four days after the last spray.

Table 2

Post infection activity on Potato Late Blight - Brasov, Romania
Experiment 3

Product	rates g a.i./hl	% Frequency of attack	% Intensity of attack
a) Treated 2 days after inoculation:			
DPX3217+mancozeb	24+80	10	1.5
mancozeb	160	90	39.6
copper oxychloride	250	100	90.0
Nil	-	100	97.0
b) Treated 4 days after inoculation:			
DPX3217+mancozeb	24+80	90	44.7
mancozeb	160	100	95.1
copper oxychloride	250	100	96.9
Nil	-	100	98.0

Experiment 3 (Table 2) Experiment 3 on potato late blight conducted under glass in Brasov consisted of post infection curative treatment carried out 2 and 4 days after an artificial inoculation. Twenty Bintje plants were sprayed with a single application and scorings were carried out one week after. Assessments were made for the percentage frequency of attack (number of leaves infected/total number of leaves), and for percentage leaf area destroyed.

Table 3

Control of Potato *Phytophthora infestans* in France, 1978
Experiment 4

Product	rates g a.i./hl	% foliage area damaged			Yields	
		13 July	28 July	8 Aug.	Tonnes per ha	% of Check
DPX3217+folpel+captafol	10+33+22	8	14a	20a	35.68a	140
mancozeb	160	10	32b	44b	31.5 b	124
Nil		14	57c	75c	25.4 d	100

Experiment 4 (Table 3) This trial for potato blight control was carried out at Crespières in the South West of France in 1978. A pre-

mixture of DPX 3217+folpel+captafol, presently registered on grapes and potato was compared with the local standard mancozeb. The crop was sprayed ten times starting July 4 until August 8. Scoring consisted of assessing the foliage destroyed by the fungi. Yields were expressed in Tonnes/ha.

Table 4

Control of Potato *Phytophthora infestans* in The Netherlands, 1978
Mean of two experiments

Experiment 5-6

Date of planting : May 11, 1978 - May 9, 1978
Date of harvest : Oct. 3, 1978 - Nov.28,1978

Products	rates g a.i./ha	%foliage blight	%Tuber blight	Relative yield healthy tubers
DPX3217+mancozeb+fentinacetate	100+850+275	15	4.5	134
DPX3217+mancozeb	100+2400	16	11.1	117
DPX3217+chlorothalonil	100+1168	28	12.5	129
mancozeb	3200	11	8.6	121.5
maneb+fentinacetate	1080+264	13	4.6	123
Nil	-	77	15.8	100

Experiments 5 and 6 (Table 4) Field experiments 5 and 6, for potato blight control, conducted in The Netherlands at Haren and Oudeschip. Weekly sprays of 3 DPX 3217 based mixtures were compared to 2 local standards maneb+fentinacetate and mancozeb on its own. Both trials on Bintje variety were of a block design with 4 replications. Scoring consisted of (a) percentage foliage destroyed, (b) percentage blighted tubers and (c) yield of healthy tubers as a percentage of untreated plot yields.

Experiments 7 and 8 (Table 5) Both experiments were conducted in France in 1978, for the control of tomato late blight (*Phytophthora infestans*). Experiment 7 was a field trial on transplanted tomato. A total of six sprays were applied and scoring consisted of evaluating blight spots on the foliage. Experiment 8 was a glass house trial located in Montfavet in which scorings were carried out in the laboratory. Leaves were collected 1 day and eight days after the single treatment to investigate initial and residual effect of the product. Results are expressed in percentage of foliage attacked.

Table 5

Control of Tomato Phytophthora infestans in France, 1978

Product	rates g a.i./hl	Expt. 7 No.of blight spots on 10 plants Sept.7	Expt. 7 No.of blight spots on 10 plants Sept.26	Expt. 8 % disease on leaves A	Expt. 8 % disease on leaves B
DPX3217+captafol+copper	12+24+60	2.75	4.75	1.0	3.4
DPX3217+folpel+captafol	12+36+24	2.75	3.0	4.3	3.2
captafol	160	1.5	4.75	4.3	3.7
Nil	-	56	158	26	64

Location: Sainte Bazeille/Montfavet
variety: St. Pierre/Montecarlo
treatment: Aug. 7, 12, 22 and Sept. 1,9, 15/July 20
date of transplanting: June 11
4 replications, plots of 4 rows of 17 plants

A= leaves collected 1 day) after treatment
B= leaves collected 8 days)

Table 6

Control of Hop downy mildew in Czechoslovakia

Products	rates g a.i./hl	1977 Expt. 9 % healthy cones	1978 Expt. 10 % disease control	1978 Expt. 11 % disease control
DPX3217+mancozeb	12.5+160	88.7	96.5	98.4
copper oxychloride	375	83.9	91.8	94.7
control	-	44	-	-

Experiments 9, 10 and 11 (Table 6) Field experiments number 9, 10, 11 conducted in Czechoslovakia at the Zatëc Hops Institute, consisted of four and five sprays at 14 days interval of the DPX 3217 + mancozeb mixture at 12.5+160 g a.i./hl which was tested for effectiveness on hops downy mildew (Pseudoperonospora humuli), versus local standard copper oxychloride at 375 g a.i./hl. Results are expressed as percentage of healthy cones and percentage of disease control.

Table 7

Control of Hop downy mildew in Hungary Field Trial
1977

Products		May 27	cone % infection June 16	July 7
DPX3217+mancozeb	40+320	18	10	5
mancozeb	640	12	12	11.5
untreated		91	100	100

variety: Brewers Gold
date of treatment: May 27; June 2, 9, 23, 30; July 7

disease appeared at the beginning of the vegetation till beginning of flowering.

Experiment 12 (Table 7) Experiment 12, conducted on hops in Hungary in 1977 by the Testing Group of the Plant Protection Administration of Baranya, consisted of six weekly fungicide sprays for the control of *Pseudoperonospora humuli*. Results are expressed as percentage of cone infection.

RESULTS AND DISCUSSIONS

a) Potato Results on potato for late blight control (*Phytophthora infestans*) are given in Tables 1 to 4. DPX 3217 + mancozeb at 90+880 g a.i. per ha gave excellent control of the disease in Romania when sprayed on a prophylactic weekly basis. Results are more spectacular when the mixture is applied up to two days after artificial inoculation. Similar results cannot be achieved with preventive fungicides. The product does not control the disease when sprayed four days after inoculation. In France, results in Table 3 show that the mixture DPX 3217+folpel+captafol at 10+33+22 g a.i./hl performs better than the standard. In Table 4, DPX 3217+mancozeb+fentinacetate developed in The Netherlands, at 100+850+295 g a.i./ha, has given the best results on foliage blight as well as tuber blight protection.

The superior efficacy of DPX 3217 products, compared to the standard protectants, shows up on early and/or severe infections. Under mild disease incidence or late infections, their performance is equivalent to the standards. DPX 3217 does not control early blight (*Alternaria solani*) and mixtures should be used in a program containing traditional contact fungicides to control this disease.

b) Tomato Results from trials carried out in France (Table 5) indicate that DPX3217+folpel+captafol at 12+36+24 g a.i./hl and DPX 3217+captafol+copper at 12+24+60 g a.i./hl give outstanding control of tomato late blight (Phytophthora infestans). Effectiveness and persistence of these two products are better or at least equal to those of the standard captafol at full rate (160 g a.i./hl). Results from Italy have demonstrated that DPX 3217 has a post infection activity of about two days on tomato late blight. It has to be used as a traditional fungicide and the spray program should not be modified with regard to timing and spray interval.

c) Hops As tested in Czechoslovakia (Table 6) in field trials DPX 3217+mancozeb at 12.5+160 g a.i./hl gave better control than the standard copper oxychloride at 375 g a.i./hl. In addition, copper, which is the most widely used product for hop downy mildew control, reduces "beer quality". Results indicate that the DPX 3217 mixture does not alter the "beer quality". Similar results were also obtained in Hungary (Table 7).

d) Other Crops On lettuce, for Bremia lactucae control, a trial in France has shown that DPX3217+mancozeb at 10+116 g a.i./hl gave disease control equivalent to the standard mancozeb at 160 g a.i./hl under severe disease pressure. On onions, results from Hungary have shown DPX3217+mancozeb 8+70 g a.i./hl to be more active than mancozeb straight at 130 g a.i./hl on downy mildew (Peronospora destructor): 14% infection versus 57% for mancozeb. Products were sprayed four times during the season.

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