Proceedings 1979 British Crop Protection Conference - Pests and Diseases

SOIL AND SEED TREATMENTS ON MAIZE AND SMALL GRAINS WITH BENDIOCARB

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Summary Results obtained in the U.K. show that bendiocarb seed treatment at 4 g a.i./kg is effective in controlling frit fly (Oscinella frit) in maize and gives some protection against wireworm (Agriotes spp.). Trials with bendiocarb 3% granules in both France and the U.K. have demonstrated that at a rate of 300 g a.i./ha, applied in-furrow with the seed excellent control of soil pests and frit fly can be obtained. Bendiocarb has also shown promising activity as a seed treatment against wireworm and leatherjackets in spring barley and wheat and against frit fly in spring oats and winter wheat.

INTRODUCTION

Bendiocarb is a broad-spectrum carbamate insecticide the general properties of which were described by Lemon (1971). It was first introduced in 1972 as a public health insecticide and is registered for this use in many countries.

More recently, bendiocarb has been developed as a seed treatment for the control of certain soil pests of sugar beet (Hull, 1975 and 1976) and is commercially available in several European countries as an in-pellet treatment and in Holland as a dry powder treatment.

Bendiocarb as a seed treatment for frit fly (Oscinella frit) control on maize was first examined in 1975 and work carried out between then and 1977 was reported by Lemon et al (1978). In trials conducted by the Ministry of Agriculture, Fisheries and Food, Agricultural Development and Advisory Service in 1977 (Anon, 1978) bendiocarb seed treatment was compared with a number of other experimental treatments and with standard phorate granules. All treatments significantly reduced damage but bendiocarb seed treatment was consistently the best. This early work resulted in an experimental recommendation of 4 g a.i./kg seed which was confirmed in reliability trials in the U.K. during 1978.

Recent trials throughout Europe, involving a large number of research organisations, have shown that a 3% granular formulation of bendiocarb gives effective protection to maize seedlings against a range of soil and seedling pests. In five trials carried out in France in 1977 by the Service de la Protection des Vegetaux, bendiocarb at 300 g a.i./ha was as good as carbofuran 600 g a.i./ha in four trials and was significantly superior in the fifth trial (Simonin et al, 1978).

In 1977, the possibility of using bendiocarb for the control of pests in small grain cereals was examined for the first time in the U.K.. Control of soil pests such as wireworms (Agriotes spp.) and leatherjackets (Tipula spp.) has been demonstrated in spring-sown barley and wheat.

Bendiocarb seed treatments have also been tested for frit fly control in spring oats and for both wheat bulb fly and frit fly control in winter wheat. The best data on spring oats have been obtained by independent workers in Wales and Scotland where the frit fly problem is most pronounced. Lewis et al (1979) reported that seed treatment of late-sown crops with bendiocarb can protect oats from serious losses due to frit fly.

METHODS AND MATERIALS

Seed treatment

Most of the experimental work has been done with bendiocarb 80% w.p. The required weight of formulation was suspended in a 0.5% solution of sodium carboxymethyl cellulose sticker to produce a slurry.

For seed quantities of up to 1 kg, the slurry was applied to the seed in a cylindrical glass jar which was rolled for five minutes, after which the seed was air-dried. The volume of slurry was adjusted according to crop to give as uniform a distribution as possible in the seed bulk. Thus, for maize, slurry was applied at 25 ml/kg and for small grain cereals at 50 ml/kg.

The maize trial programme in the U.K. in 1978 required treatment of approximately 400 kg seed. For these trials, seed of cultivar LG 11 treated at source with captan and anthraquinone was treated on a Gustavson machine at Nickersons Seed Specialists of Grimsby. The target dose was 4 g a.i./kg but it was calculated that a mean of 3.7 g a.i./kg was actually applied.

For intermediate quantities of seed, a cement mixer of about 20 kg capacity was found to be ideal for seed treatment with slurries.

Granule application

Applications to maize were carried out using a wide range of commercially available granule applicators. In all cases the insecticide granules were applied into the furrow with the seed.

Trial design

For the maize trials in the U.K. in 1978, equal quantities of treated and untreated seed were distributed to farmers in 50,000 seed packs for drilling in single large blocks (approx. 0.4 ha) or in alternating 4-row strips. Frit fly damage and forage maize yield were assessed on 10 x 10 m row lengths per treatment.

All other trials were based on a randomised block design with four, five or six replicates and, unless otherwise stated, were drilled with tractor-mounted equipment. In France, the majority of trials were set out as detailed in the provisional protocol of the Commission des Essais Biologique (CEB) de la Société Française de Phytiatrie et de Phytopharmacie (Velleroy, 1975).

Assessments

The identity of soil pests present in each trial was determined by examination of soil samples before drilling or from observations and investigations on the guard rows. A number of different assessments were made.

Frit fly damage in maize was assessed visually on individual plants, damage being categorised as slight, moderate or severe.

Angular transformation of percentages was used for the analyses. The detransformed percentages in the tables of results do not therefore have standard errors attached to them.

RESULTS

Maize seed treatment

The results of 21 unreplicated grower trials in the U.K. in 1978 on maize variety LG 11 are summarised in Table 1. There was no evidence of phytotoxicity. In some trials there was a reduction in plant stand on treated compared with untreated maize but this was attributed to the effect of the seed treatment on flow rate and pick up in some types of seed drill. Bendiocarb reduced frit fly damage in 19 of the 21 trials. More than 50% reduction in damage was obtained in 15 trials and more than 90% in four trials. Obvious visible differences between treated and untreated areas were apparent in eight trials.

Table 1

Bendiocarb seed treatments on forage maize, U.K., 1978.

	Mean % plants damaged by *O. frit* (21 trials)		Mean yield d.m. t/ha (11 trials)
	all categories	moderate and severe	
Bendiocarb, 3.7 g a.i./kg	16.9	5.5	11.25
Untreated	62.5	20.6	10.76

In three replicated trials in 1978, bendiocarb seed treatments at three rates of application were compared for control of wireworm. Assessments for frit fly damage were made on two of these. The results are summarised in Table 2.

Table 2

Control of wireworm and frit fly with bendiocarb in forage maize, U.K., 1978.

	Debden			Ingoldsby			Godmanchester	
Treatment	Mean % wireworm	damage frit fly	Mean yield d.m.t/ha	Mean % wireworm	damage frit fly	Mean yield d.m.t/ha	Mean % damage wireworm	Mean yield d.m.t/ha
Bendiocarb 4g ai/kg seed	2.68	13.20	9.30	2.43	1.50	6.92	13.26	1.24
Bendiocarb 6g ai/kg seed	2.00	9.26	10.73	2.81	1.88	5.96	12.33	1.74
Bendiocarb 8g ai/kg seed	1.96	14.14	8.81	1.10	1.06	6.48	11.70	2.20
Bendiocarb 3G 300g ai/ha	1.87	38.74	10.01	1.83	5.22	8.87	5.44	1.53
Phorate 10G 1700g ai/ha	0.32	3.74	10.70	1.19	8.68	8.54	6.20	2.92
Carbofuran 5G 600g ai/ha	4.36	40.44	9.57	2.54	7.04	7.62	6.05	2.51
Untreated	12.31	55.56	8.00	10.32	35.92	6.15	46.36	0.62
Significance	++	+++	+	+	+++	N.S.	+++	+++
S.E. ±			0.53			0.94		0.30

Estimated wireworm populations: Debden 750,000/ha, Ingoldsby 2,500,000/ha, Godmanchester 2,500,000/ha.

Phytotoxicity trials have been done on 18 varieties of forage maize in the laboratory and on 13 varieties in the field. Slight phytotoxic effects occurred in some varieties in laboratory tests but these did not occur under field conditions.

Treated seed of 13 varieties has been stored for periods of up to one year. Where the recommended rate of 4 g a.i./kg was used both efficacy and crop safety were satisfactory after the maximum storage period.

A number of alternative stickers have been examined including polyvinyl alcohol, dextrin and milk. None adversely affected efficacy or crop safety but some gave less effective adhesion to the seed.

Granules in maize

The data in Tables 3-6 illustrate the good activity of bendiocarb against some important maize pests.

Tables 3 and 4 show some results obtained against wireworm in both the U.K. and France.

Table 3

Wireworm control with bendiocarb granules on maize, Debden, U.K. 1977.

Treatment	g a.i./ha	Mean wireworm damage		Mean yield kg/plot	
		%	angular transformation	cobs	stover
Bendiocarb 3G	100	10.1	18.03	15.74	13.32
"	200	5.1	12.67	21.12	17.98
"	300	2.9	9.53	24.86	22.56
"	400	1.8	7.5	19.46	17.58
Carbofuran 5G	600	5.3	13.12	20.22	18.52
Chlormephos 5G	313	3.3	10.34	23.96	22.30
Terbufos 3G	135	4.9	11.87	19.98	19.00
Untreated		14.8	23.06	15.84	13.06
Significance			+++	++	++
SE $\pm$			1.26	2.21	2.34

Table 4

Wireworm control with bendiocarb granules on maize, Saint Firmin sur Loire, France, 1976.

Treatment	g a.i./ha	No. plants June 1	No. plants June 15	% plants destroyed	angular transform.	No. plants/ha at harvest
Bendiocarb 3G	200	221 ab	192 b	13.1	21.2 b	80,200 b
"	300	227 a	209 ab	7.8	15.8 ab	87,200 ab
Carbofuran 5G	600	229 a	222 a	2.7	9.4 a	92,700 a
Fonofos 5G	350	221 ab	113 c	48.6	44.1 c	47,300 c
Untreated		217 b	30 d	85.9	69.3 d	12,700 d

Figures followed by the same letter are not significantly different at P = 0.05.

The results in table 4 are from a trial on cultivar Fronica done by the Association Générale des Producteurs de Mais (AGPM).

Symphylids (Scutigerella immaculata) affect the emergence, growth and vigour of maize plants. The results presented in Table 5 are from an AGPM trial carried out in 1976 on cultivar U 530 in which symphylids were the main pest.

Table 5

Symphylid control with bendiocarb granules in maize, Aubagnan, France, 1976.

Treatment	g a.i./ha	Mean no. plants/plot emergence	Mean no. plants/plot 5-6 leaves	Mean no. plants/ha at harvest	Mean Yield of grain Qx/ha
Bendiocarb 3G	200	148 a	147 a	61,300 a	81.6 b
"	300	143 a	141 a	58,800 a	82.2 b
Chlormephos 5G	310	144 a	144 a	60,000 a	103.2 a
Fonofos 5G	350	137 a	136 a	56,700 a	95.2 ab
Untreated		109 b	107 b	44,600 b	40.7 c

Figures followed by the same letter are not significantly different at P = 0.05.

Although control of frit fly in maize with bendiocarb granules has not been consistently good, and may be dependent on soil type, Table 6 together with Table 2 shows that effective control of this pest can be obtained.

Table 6

Frit fly control with bendiocarb granules in maize, Alixan, France, 1977.

Treatment	g a.i./ha	Mean frit fly damage %	Mean frit fly damage angular transformation
Bendiocarb 3G	100	5.8	13.78
"	200	4.3	11.28
"	300	3.6	10.91
"	400	3.8	11.35
Chlormephos 5G	400	4.0	11.58
Carbofuran 5G	600	3.7	10.98
Untreated		33.5	35.13
Significance			+++
SE ±			1.16

Further data from Europe indicate that bendiocarb 3% granules can give good protection of maize seedlings against attack by other soil pests such as millipedes (Blaniulus guttulatus) and white grubs (Melolontha melolontha). Excellent results have also been reported against soil pests of maize from other countries, especially USA and South Africa.

No phytotoxicity to maize from bendiocarb 3% granules has been reported from the large trials programme.

Spring sown barley and wheat

Table 7 gives results of trials with bendiocarb seed treatments on spring barley in 1978.

Table 7

Wireworm control with bendiocarb seed treatments on spring barley, 1978.

Treatment	g ai/kg seed	Debden Mean % damaged plants	Debden Mean yield of grain kg/plot	Braughing Mean % damaged plants	Braughing Mean yield of grain kg/plot	Godmanchester Mean % damaged plants	Godmanchester Mean yield of grain kg/plot
Bendiocarb	0.5	10.4	3.22	2.4	1.78	8.8	1.26
"	1.0	8.8	2.94	1.8	2.07	6.5	1.34
"	2.0	6.9	3.10	2.0	2.22	4.0	1.70
"	4.0	3.3	3.95	0.7	2.20	2.7	1.42
HCH	0.12	6.1	2.88	2.4	2.13	6.7	1.51
Untreated		17.5	2.95	3.2	2.07	8.4	1.19
Significance		+++	N.S.	++	N.S.	+++	+
SE ±			0.26		0.12		0.14

Estimated wireworm populations: Debden 750,000/ha
Braughing 2,200,000/ha
Godmanchester 2,500,000/ha

Similar results have been obtained on spring wheat.

Results on leatherjackets have been limited by the difficulties in obtaining sites. However, results of a trial in 1978 are given in Table 8.

Table 8

Leatherjacket control with bendiocarb seed treatments on spring barley, Lincs, 1978.

Treatment	g a.i./kg seed	Plant stand on dates indicated* May 10	Plant stand on dates indicated* May 22
Bendiocarb	0.5	51.4	28.9
"	1.0	51.2	36.5
"	2.0	61.8	55.7
"	4.0	68.7	61.8
Untreated		43.6	22.9
Significance		+++	+++
SE ±		3.57	4.76

* Date of drilling April 19.

Crop safety has generally been satisfactory in these trials. However, a trial in 1979 with 21 varieties of spring barley indicated that at 4 g a.i./kg, bendiocarb may have phytotoxic effects on certain varieties.

Spring oats

Best results have been obtained by independent workers in areas where the problem is most pronounced. Some of these have been published and are referred to elsewhere in this paper. The results presented in Table 9 were obtained by the Agricultural Development and Advisory Service (ADAS Development Work (Wales) - unpublished data) and by the North of Scotland College of Agriculture (Dr. M. Shaw, personal communication).

Table 9

Frit fly control with bendiocarb seed treatments on spring sown oats

Rate of application g a.i./kg	% damaged tillers at: (cultivar in brackets) Trawsgoed (Margam)	Trawsgoed (Maris Oberon)	Taliesin (Maris Tabard)	N. Scotland (two drilling dates) May 16	May 31
1	49.5	48.4	-	4.6	7.5
2	29.8	23.9	7.5	3.0	1.9
4	23.5	16.5	1.4	2.3	1.3
Untreated	77.7	73.6	21.4	54.0	47.8

Winter wheat

Trials in the winter of 1975-76 showed that bendiocarb seed treatment at rates of 2 and 4 g a.i./kg was effective in controlling wheat bulb fly but only following late drilling i.e. December or January. In a November drilling on the same site, no control of wheat bulb fly attack was obtained even at 4 g a.i./kg.

Persistence is, however, sufficient to give control of frit fly when winter wheat follows grass. A number of very promising results were obtained in co-operative trials by ADAS and colleges of agriculture. These have not yet been published but they show that bendiocarb is active as a seed treatment at rates of between 2 and 4 g a.i./kg. However, some trials indicated that bendiocarb may be phytotoxic as a seed treatment on certain varieties of winter wheat and this problem is currently being investigated.

Residues

Samples of maize and small grain cereals were taken at harvest from a large number of trials with both granules applied at planting and seed treatments. There was no detectable bendiocarb residue in any of the samples.

DISCUSSION

The results with bendiocarb seed treatments against frit fly in maize have led to a commercial recommendation of 4 g a.i./kg seed and the product was first used in commercial trials in the U.K. in 1979. A new formulation with certain advantages for seed treatment is currently under development. The results in Table 2 are of interest because they show that whereas the seed treatment tends to be more effective than the granule application against frit fly the granules give somewhat better control of wireworm. Table 5 shows that granule treatments are also effective against symphylids. In the U.K. and other N. European countries where maize is grown mainly for silage, frit fly tends to be the most important pest (Cook, 1978). Timing of spray treatments is very critical and few growers of forage maize have granule application equipment. The advantages of bendiocarb as a seed treatment are therefore considerable. However in the grain maize growing areas of S. Europe, frit fly is less common and soil pests such as wireworm and symphylids are predominant. In such situations bendiocarb is likely to be more useful in its granular form. Thus bendiocarb 3% granules were registered in France in 1978 to be applied at 300 g a.i./ha (10 kg product).

A further aspect of seed treatment which is receiving considerable attention is that of wildlife hazard and detailed investigations on maize were made in the U.K. this year. It was concluded that if the seed is drilled as recommended to a depth of at least 5 cm, the hazard to wildlife is small. At the time it was available to most species in these trials, i.e. after seedling emergence, considerable quantities were eaten without ill effects. Rooks were able to find and eat the seed before plant emergence but the trials showed that they do not take large quantities of bendiocarb-treated maize seed even when it is readily available.

The work on small grain cereals is at an earlier stage than that on maize. Activity against soil pests and frit fly is very promising but further work on crop safety and wildlife hazard is required.

This paper has reviewed the work being done in the U.K. and France. Trials are also in progress in many other parts of the world. Of particular interest is the work in the U.S.A. where a large programme has shown that bendiocarb granules applied as a conventional surface band treatment are very effective in reducing damage from corn rootworm (*Diabrotica* spp).

Acknowledgements

The authors wish to thank the many colleagues at Chesterford Park Research Station who contributed to the results reported in this paper. They also wish to thank the Association Générale des Producteurs de Mais, the Agricultural Development and Advisory Service (Wales) and the North of Scotland College of Agriculture whose unpublished data are quoted.

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Proceedings 1979 British Crop Protection Conference - Pests and Diseases

IPRODIONE, ALONE AND IN MIXTURE WITH A BENZIMIDAZOLE, FOR THE CONTROL OF CEREAL SEED BORNE DISEASES

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Summary Used alone at between 30 and 100g a.i./100 kg seed, iprodione gives notable control of Helminthosporium avenae, Helminthosporium gramineum, Helminthosporium sativum and Tilletia caries.

A mixture containing 35% iprodione plus 17.5% carbendazim (Rovral TS ®) has a spectrum of activity covering all the major seed borne diseases of cereals. Used at 53 plus 26.5g a.i./100 kg seed this mixture shows very good activity against H.gramineum, H.avenae, H.sativum, T.caries, Fusarium roseum and Septoria nodorum. To control F.nivale on seed the rate needs to be increased to 70 plus 35g a.i./100 kg. An equivalent or even higher dose is necessary to obtain satisfactory control of Ustilago nuda on winter barley. Similar results are obtained with a mixture of iprodione plus thiophanate-methyl at 100 plus 100g a.i./100 kg seed.

Résumé Employé seul à des doses comprises entre 30 et 100 g m.a./100 kg de graine l'iprodione maitrise remarquablement Helminthosporium avenae, Helminthosporium gramineum, Helminthosporium sativum et Tilletia caries.

Une association contenant 35% d'iprodione plus 17.5% de carbendazime (Rovral TS ®) possède un champ d'activité couvrant l'ensemble des maladies importantes des semences de céréales. Utilisée à 53 plus 26.5 g m.a./100 kg de graine cette association fait preuve d'une très bonne activité sur H.gramineum, H.avenae, H.sativum, T.caries, Fusarium roseum et Septoria nodorum.

Pour lutter contre F.nivale la dose d'emploi devra être portée à 70 plus 35 g m.a./100 kg pour désinfecter les semences contaminées. Une dose égale ou même supérieure est nécessaire pour obtenir un contrôle satisfactant d'Ustilago nuda sur orge d'hiver. Des résultats similaires sont obtenus avec une association iprodione plus methyl-thiophanate à 100 plus 100 g m.a./ 100 kg de graine.

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INTRODUCTION

Disinfection of cereal seed is a simple and cheap process which can protect crops from many diseases known to occur wherever cereals are cultivated. Until recent times organomercury fungicides were widely used for this purpose. They have the advantages of a wide spectrum of activity, good efficacy and low cost but concern about environmental pollution has led many countries to restrict or prohibit their use.

It is for this reason that iprodione (3-(3,5-dichlorophenyl)-N^1-isopropyl-2,4-dioxoimidazolidine-1-carboxamide), a synthetic fungicide with very low toxicity and active against several seed borne diseases of cereals, including Tilletia caries, Helminthosporium spp., Fusarium spp. and Septoria spp. (Lacroix et al ,1974; Burgaud et al, 1975), has been developed as a seed treatment.

Iprodione has an oral LD_{50} in the rat of about 3500 mg/kg. It is not teratogenic, does not cause cateracts and is not mutagenic. None of the many long-term toxicological studies with iprodione have revealed any undesirable effects. Its' low toxicity has been recognised by the WHO/FAO Joint Committee who have indicated an acceptable daily intake for iprodione which is equivalent to 0.3 mg/kg of body weight for man. Iprodione also has the advantage that it is not toxic to wildlife or fish and in particular has no effect on predatory insects, bees and worms.

METHODS AND MATERIALS

Iprodione has been tested in pot/tray trials and in the field using both artificially or naturally infected seed. Seed was treated with dry dressings of iprodione and mixtures of iprodione and carbendazim (35% and 17.5% respectively), and iprodione and thiophanate-methyl (48.5% and 48.5% respectively).

Trials with bunt, Helminthosporium spp.and the smuts, were usually done in the field using fully randomised block designs with 3-6 replicates. Plot areas, in different trials, were from 2 - 25m^2. Seed was sown by hand or with a precision seed drill.

Trials with Fusarium spp., Septoria spp. were done in pots/trays. In addition several trials were done in pots/trays with Helminthosporium spp. using the mixture of iprodione plus thiophanate-methyl. Trial design consisted of fully randomised blocks using 3-4 replicates with plots containing 25 or 50 plants, sown by hand.

In smut and bunt trials disease was measured as the percentage of diseased ears. In trials with Septoria spp., Fusarium spp. and Helminthosporium spp. the percentage of diseased plants was determined (Bourdin & Ventura, 1971).

RESULTS AND DISCUSSION

Initial experiments were done with iprodione alone, as a wettable powder containing 50% active ingredient (Rovral®). It was applied at from 30 to 100g a.i./100 kg of seed and was tested against Helminthosporium gramineum, H.avenae, H.sativum and Tilletia caries (Tables 1-3).

Table 1

Control of H.gramineum with iprodione

Treatment	Rate (g a.i./100 kg seed)	% control Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7
Iprodione	30	99	100	100	98.4	99.4	99.5	99.1
	60	100	100	-	-	-	-	-
	100	100	-	-	-	-	-	-
Copper oxinate + carboxin	30 + 100	98.5	100	97.4	95.2	100	94.4	90.0
Mercury methoxy-ethyl silicate	3	-	-	100	100	100	100	100
Untreated (% attack)		68.5	4.0	30.6	25.0	35.9	39.1	53.8

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At 30g a.i./100 kg of seed, iprodione gave excellent control of H.gramineum, even when infection levels were high (Trial 1). Control was similar to that achieved with mercury methoxyethyl silicate and superior to that obtained with the mixture of copper oxinate and carboxin.

Table 2

Control of H.avenae and H.sativum with iprodione

Treatment	Rate (g a.i./100 kg seed)	% control H.avenae Trial 1	% control H.avenae Trial 2	% control H.sativum Trial 3
Iprodione	100	84.4	95.7	100
Mercury methoxy-ethyl silicate	3	75.8	23.2*	100
Untreated (% attack)		21.2	13.8	11.6

* Strain of H.avenae resistant to organomercury compounds.

Iprodione is also effective against H.avenae and H.sativum (Table 2), including strains of H.avenae resistant to organomercurys. Other trials have shown that iprodione is equally effective against H.oryzae.

Table 3

Control of T.caries with iprodione

Treatment	Rate (g a.i./100 kg seed)	% control Trial 1	Trial 2	Trial 3	Trial 4
Iprodione	30	78.8	85.5	-	-
	60	100	89.7	-	-
	100	91.5	92.8	100	96.8
Benomyl	60	100	100	100	98.3*
Copper oxinate + carboxin	30 + 100	95.1	98.5	-	-
Untreated (% attack)		14.2	19.4	16.5	11.8

* Thiophanate-methyl instead of benomyl at 100g a.i./100 kg seed.

At rates of 30 to 100g a.i./100 kg seed, iprodione provides good control of T.caries. Activity at 60 to 100g a.i./100 kg seed was equivalent to that of the reference products (copper oxinate plus carboxin and benomyl or thiophanate-methyl).

Other trials have demonstrated useful, additional activity of iprodione against seed borne Septoria spp. and Fusarium spp. At 100g a.i./100 kg seed, iprodione frequently gives 30 to 50% control of S.nodorum and 70 to 90% control of F.roseum.

Evidence of the considerable activity of iprodione alone against H.gramineum, H.avenae, H.sativum and T.caries, but an awareness of the need to achieve complete disinfection of seed against all diseases with a single treatment, led us to examine iprodione in mixtures with benzimidazoles (carbendazim or thiophanate-methyl) in order to obtain a wider spectrum of activity.

A powder dressing containing 35% iprodione and 17.5% carbendazim is active against many of the most frequently encountered cereal seed pathogens including Helminthosporium spp., Tilletia caries, Fusarium spp., Septoria spp. and Ustilago nuda of winter barley (Tables 4 & 5).

Table 4

Control of F.roseum and S.nodorum with a mixture of iprodione plus carbendazim

Treatment	Rate (g a.i./100 kg seed)	% control F.roseum	F.nivale	S.nodorum
Iprodione+carbendazim	35 + 17.5	84.8	-	98.3
	53 + 26	90.2	-	98.3
	70 + 35	90.2	100	99.2
Mercury methoxy-ethyl silicate	3	85.9	98	99.3
Untreated (% attack)		27.6	25.0	72.4
Number of trials		5	2	7

Table 5

Control of H.gramineum, T.caries and U.nuda* with a mixture of iprodione plus carbendazim

Treatment	Rate (g a.i./100 kg seed)	% control H.gramineum	T.caries	U.nuda*
Iprodione+carbendazim	35 + 17.5	99.7	95.0	-
	54 + 46	100	97.5	-
	70 + 35	-	-	80.3
Mercury methoxy-ethyl silicate	3	100	91.5	-
Copper oxinate+carboxin	30 + 100	-	-	99.8
Untreated (% attack)		36.9	51.8	43.5
Number of trials		5	3	4

* winter barley

Our results show that a mixture of iprodione plus carbendazim is, at the lowest rate tested (35 plus 17.5g a.i./100 kg seed), very active against the principal fungal pathogens on cereal seeds. At the recommended rate of 53 plus 26g a.i./100 kg seed, almost complete control of Helminthosporium spp., T.caries, S.nodorum and F.roseum is achieved. It may be necessary to increase this dose to at least 70 plus 35g a.i./100 kg seed if seed is contaminated by F.nivale. To obtain complete protection against U.nuda on winter barley even higher rates seem to be necessary.

Other trials have tested a mixture of iprodione and thiophanate-methyl, in the form of a powder dressing containing 48.5% of each active ingredient. Three rates were tested and the results are given in Tables 6 - 8.

Table 6

Control of H.avenae, H.gramineum and H.sativum with a mixture of iprodione plus thiophanate-methyl

Treatment	Rate (g a.i./100 kg seed)	% control H.avenae*	H.gramineum	H.sativum
Iprodione+thiophanate-methyl	50 + 50	65.0	-	-
	100 + 100	81.8	91.4	-
	150 + 150	-	-	96.7
Organically combined mercury	3	39.4	-	-
Organically combined mercury + carboxin	2 + 75	-	98.3	98.1
Untreated (% attack)		13.7	11.6	36.8
Number of trials		5	3	2

* Strain resistant to organomercury compounds

Table 7

Control of T.caries, F.nivale and S.nodorum with a mixture of iprodione plus thiophanate-methyl

Treatment	Rate (g a.i./100 kg seed)	% control T.caries	F.nivale	S.nodorum
Iprodione+thiophanate-methyl	100 + 100	98.9	88.9	96.8
	150 + 150	-	88.9	97.1
Organically combined mercury	3	-	100	100
Organically combined mercury + carboxin	2 + 75	96.1	-	100
Untreated (% attack)		18.0	6.3	34.7
Number of trials		2	1	1

Table 8

Control of Ustilago spp. with a mixture of iprodione plus thiophanate-methyl

Treatment	Rate (g a.i./100 kg seed)	% control U.nuda winter wheat	U.nuda winter barley	U.nuda spring barley	U.avenae oats
Iprodione + thiophanate-methyl	100 + 100	90.4	70.2	17.4	94.1
Organically combined mercury	3	-	-	-	75.3
Organically combined mercury + carboxin	2 + 75	93.2	99.0	75.2	-
Untreated (% attack)		7.3	20.1	12.1	17.0
Number of trials		2	3	3	1

A mixture of iprodione plus thiophanate-methyl at 100 plus 100g a.i./100 kg seed is especially valuable for the control of H.avenae where strains resistant to organomercury compounds are known to occur (Table 6). The activity of this mixture against H.gramineum and H.sativum is similar to that of the reference material (Table 6). It also provides good control of T.caries, F.nivale and S.nodorum (Table 7).

Activity of the mixture against loose smuts differs between cereal species (Table 8). At 100 plus 100g a.i./100 kg seed it gave good control of U.nuda on winter wheat and U.avenae on oats. Activity against U.nuda on winter barley was less good and there was little effect against U.nuda on spring barley.

CONCLUSIONS

Mixtures of iprodione plus carbendazim and iprodione plus thiophanate-methyl have a wide spectrum of activity covering a range of seed borne diseases. They are particularly active against Helminthosporium spp., Tilletia spp., Fusarium spp., Septoria spp. and U.nuda on winter barley and winter wheat.

Because iprodione has a low mammalian toxicity and there are no undesirable effects on the environment, mixtures based on iprodione are seen to be ideal replacements for the organomercury compounds which have, until now, been so widely used for the disinfection of cereal seed.

Acknowledgments

We thank all our colleagues from Rhône-Poulenc Research & Development who have contributed to the work reported here.

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