PROCHLORAZ — A NEW BROAD SPECTRUM FUNGICIDE

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SUMMARY

Prochloraz is a new fungicide belonging to the carbamoyl imidazole group of compounds. With particular activity against ascomycetes and fungi imperfecti, prochloraz is effective against a wide range of diseases in orchard, cereal and horticultural crops. It possess both protectant and eradicant activity and shows strong translaminar action. Over a period of 2 years, trials in New Zealand have demonstrated its effectiveness against blackspot (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*) of apples at 10g and 20g/100 litres (respectively), brown rot (*Sclerotinia fructicola*) of peaches at 15g/100 litres, eyespot (*Pseudocercospora herpotrichoides*) and speckled leaf blotch (*Mycosphaerella graminicola*) of wheat at 500 g/ha.

INTRODUCTION

Prochloraz is a new fungicide of the carbamoyl imidazole group of chemicals discovered by The Boots Co., U.K. in 1974. Previously coded BTS40542, the product is now being developed by FBC Ltd. It is available commercially in Europe as an emulsifiable concentrate formulation for controlling a wide range of cereal diseases. More recently a wettable powder formulation was developed for use on broadleaf crops and russet-prone fruit using a manganese metal complex of prochloraz to give an acceptable margin of crop safety.

A seed protectant formulation is also available for trial work to control seed borne diseases.

Prochloraz has a broad spectrum activity against a wide range of important crop diseases and shows particular activity against ascomycetes and fungi imperfecti. During the last 2 years, field trials in N.Z. have demonstrated its effectiveness in orchard, horticultural and cereal crops as follows: Apples; blackspot, (Pennycooke pers comm) and powdery mildew. Peaches; brown rot. Brassicas; light leafspot, (*Pyrenopeziza brassicae*) (Cheah *et al* 1980). Black currants; leaf spot (*Mycosphaerella ribis*). Cereals; eyespot, powdery mildew (*Erysiphe graminis*), speckled leaf blotch, spot blotch (*Cochliobolus sativus*), net blotch (*Pyrenophora teres*) (Sheridan pers comm) and glume-mould complexes (*Alternaria* spp, *Cladosporium* spp and *Fusarium* spp). Results from some of these trials will be reported in this paper.

Chemistry

Empirical formula: $C_{15}H_{16}Cl_2N_3O_2$, MW: 376.5

The pure chemical is a colourless, odourless crystalline powder, readily soluble in most organic solvents but virtually insoluble in water. Prochloraz is stable in water at neutral pH and is slowly degraded on exposure to air and light.

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Mode of action

Prochloraz inhibits the synthesis of ergosterol necessary for fungal cell-wall production. It possesses both protectant and eradicant activity and shows strong translaminar action.

Toxicology

Prochloraz is of low mammalian toxicity. Approximately 40% of ingested prochloraz is excreted within 24 hours of dosing. In male rats, the acute oral LD₅₀ is 1600 mg/kg and the acute dermal LD₅₀ is 5000 mg/kg. The toxicity to birdlife is also minimal; acute oral LD₅₀ Mallard duck is 3,132 mg/kg.

METHODS

In orchard trials, single tree plots were used and treatments were applied to run off using a motorised pump sprayer at 1500-2000 kPa pressure. Cereal trial treatments were applied in a spray volume of 300 litres/ha with a precision sprayer and hand held boom, through Teejet 730-154 fan spray nozzles.

In all trials, treatments were randomised and replicated four times. Tukey's studentised range test was used to test for treatment differences at the 5% level of significance in all 1981/82 trials. Where results are expressed as percentages, an arc sin transformation was used.

Apples

Trials for 2 years on four apple cultivars (Gala, Golden Delicious, Granny Smith and Red Delicious) have been conducted in three localities (Nelson, Hastings and Auckland) with two rates of prochloraz wettable powder (10 and 20 g/100 litres). Between 16 and 19 applications were made each season from green tip to 14 days pre-harvest. Spray date intervals varied from 5 - 10 days early in the season (depending on Mill's periods) and 10 -16 days after December. In the second year, Golden Delicious apples were sprayed to bloom only and then the standard treatment (captan + dinocap) was applied through to harvest.

Secondary powdery mildew infections were assessed on the new season's leaves in mid-December and the percent area infected of 100 leaves per plot was recorded. Blackspot lesions on the leaves were also assessed in mid-December. At harvest, the number of apples with blackspot lesions were recorded.

Fruit finish assessments were made at harvest in all trials.

Stonefruit

During 1981/82 one trial on Golden Queen peaches tested two rates of prochloraz (15 g and 30 g/100 litres). Bloom sprays were applied to all plots on 3, 11, 15, 22 and 29 September, and pre-harvest sprays were applied on 10, 22, 27 February.

Between petal fall and pre-harvest the orchardist applied by airblast sprayer, cover sprays of captafol or captan on 16 October, 27 November, 24 December and 24 January.

Bactericides, insecticides and miticides were applied where necessary by the grower.

Crop safety factors of fruit set, yield and fruit size and the control of brown rot both at harvest and post-harvest were assessed. Fruit set was assessed by comparing the number of flowers on tagged limbs at full bloom (15 September) with the number of fruitlets set on 21 October, before natural drop had occurred.

Fruit size was assessed on 26 March when 50 ripe fruit were picked at random from each tree and weighed.

Pre-harvest brown rot control and yield were assessed during harvest picks. Fruit picks were carried out on 15, 19 26 March, when the number of fruit of commercial maturity was recorded as well as the number infected with brown rot. Fruit which had fallen to the ground was also assessed.

On 26 March, the effect of pre-harvest treatments on post-harvest disease was assessed by selecting 50 ripe peaches from each tree and storing them in boxes at ambient temperature. After 7 days, the percentage of fruit infected with brown rot lesions, was recorded.

Wheat

In 1980/81, one eyespot control trial was conducted in Southland on a third year cv. Rongotea crop. Treatments, as outlined in table 3, were applied on 4 December when the wheat was between the 1-2 node stage. Plot sizes measured 8 x 4 m.

Eyespot control was assessed just before harvest by counting the number of wheat tillers lodged in four 0.2m² quadrats per plot and the number of tillers with eyespot lesions from a subsample of 100 tillers per plot. Three 1m² quadrats were cut and threshed on a stationary "Kurt Pelz" machine. Yield measurements and 1000 grain weights were recorded.

Two trials in 1981/82 for the control of speckled leaf blotch were conducted in the Ellesmere region, on early autumn-sown Hilgendorf crops. Treatments, as outlined in Table 4, were applied at the six leaf stage during the first week of September. Spore counts on 20 lowest leaves per plot were made 14 days after treatment using a technique adapted by Plant Diseases Division, DSIR, Lincoln (Sanderson pers comm).

RESULTS AND DISCUSSION

Fruit trials

Representative results for the two seasons' work are in Tables 1 and 2.

TABLE 1: Disease control in apples. Variety — Granny Smith.

Treatment	Rate g/100 litres	Mean % area of powdery mildew per leaf		Mean % apples with blackspot at harvest	
		1980/81	1981/82	1980/81	1981/82
prochloraz	10 g	4.1 b	0.2 b	29.3 b	0.3 b
prochloraz	20 g	0.4 c	0.5 b	11.7 c	0.0 b
standard		0.8 c	1.0 b	34.7 b	1.4 b
untreated		15.4 a	3.5 a	97.8 a	79.6 a
TSR calc.			0.10		0.15
CV%		44.8		21.6	

TABLE 2: Crop safety and post harvest disease control in peaches.

Treatment	Rate g/100 litres	% Fruit Set	Total Fruit per tree (harvest)	Wt. of 50 fruit at harvest (kg)	Mean % brown rot harvest + 7 days
triforine	20	92 a	531 a	10.0 a	31 b
prochloraz	15	93 a	511 a	10.0 a	16 b
prochloraz	30	90 a	495 a	10.2 a	15 b
untreated		86 a	406 a	10.2 a	50 a
TSR calc.		0.32	303	1.49	0.34

Prochloraz has shown excellent control of both pip and stonefruit diseases and the N.Z. results are consistent with overseas experience (Klos *et al* 1981, Zuck and Caruso 1981).

The 1980/81 results in the apple trials indicated that only the high rate of prochloraz matched the control of powdery mildew given by the standard treatment. In 1981/82, mildewcides were added to the low rate of prochloraz, resulting in acceptable mildew control.

The low rate of prochloraz matched the control of blackspot afforded by the standard programme. In both years the disease pressure was very high.

Fruit finish was acceptable in all of the varieties tested except Golden Delicious. In the 1980/81 season, a full season programme of prochloraz at both rates caused an

unacceptable reduction in exportable Golden Delicious apples. In 1981/82, where prochloraz treatments were applied up to 75% bloom followed by the standard programme for the rest of the season, the resulting fruit finish was acceptable.

In the peach trial, disease pressure was very low and no differences between treatments could be seen at harvest. However, 50% of untreated fruit picked and stored for 1 week after harvest, became infected with brown rot (Table 2). Both rates of prochloraz afforded the same post harvest rot control as the standard triforine treatment. Prochloraz applied five times over flowering as well as pre-harvest showed no adverse effects on fruit set, yield or fruit size.

In the control of blackspot on apples, prochloraz has been found to be both an eradicant, controlling disease after infection has taken place (Szkolnik 1981) and a protectant (Zuck and Caruso 1981). In the trials reported in this paper and other N.Z. trials (Pennycooke pers comm), the eradicant action of prochloraz was apparent in the superior control of disease given by prochloraz sprays, compared with the standard protectant sprays.

Fungal disease control on fruit trees is traditionally afforded by applying protectant fungicides at 7-10 day intervals. Protectant treatments must be immediately reapplied following heavy rain. Brown rot, black spot and powdery mildew are most infective in warm wet weather when reapplication of sprays is often a problem due to slippery ground conditions. The use of eradicant fungicides lessens the danger of infection when there is a delay in applying sprays to unprotected foliage.

Cereal trials

Rain interrupted the spraying of the eyespot trial, and prevented the application of the standard commercial treatment. Heavy rain immediately followed prochloraz treatments, but all rates provided a significant reduction in disease and an increase in yield over untreated (Table 3). The assessment of percent tillers infected suggests that there is no advantage in applying prochloraz at more than 500 g/ha.

Sporulation of speckled leaf blotch was reduced by all treatments and prochloraz at 500 g/ha matched the control afforded by two standard commercial treatments (Table 4).

TABLE 3: Eyespot control and crop yields.

Treatments	Rate g/ha	Eyespot control		Crop yield	
		% tillers infected	% tillers lodged	% of untreated	1000 grain weight (g)
untreated	—	80 a	88 a	100 b	33 b
prochloraz	250	61 ab	8 b	148 a	42 a
prochloraz	500	41 b	5 b	145 a	43 a
prochloraz	750	40 b	5 b	154 a	43 a
CV%		17	25	11	6

TABLE 4: Speckled leaf blotch spore numbers

Treatments	Rate g/ha	Spore No. as % of Untreated	
		Trial A	Trial B
untreated	—	100 a	100 a
prochloraz	250	24 b	27 b
prochloraz	375	25 b	16 bc
prochloraz	500	10 bc	6 d
triadimefon	125	11 bc	10 cd
benomyl	250	8 c	4 d
CV%		25	58

At the time of spraying a low level of stripe rust disease was present in these trials. Prochloraz and triadimefon treatments suppressed the rust infection but by 28 days after treatment further evaluations for speckled leaf blotch were not possible because stripe rust had infected all plots.

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