NEW FUNGICIDES FOR THE CONTROL OF BLACK SPOT IN PROCESS PEARS

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SUMMARY

Several new systemic fungicides were evaluated in 1981 and 1982 for their effectiveness in controlling black spot (*Venturia pyrina*) of pear (*Pyrus communis*). When used alone or in combination with captan, bitertanol and triforine gave control equal to captafol. Captafol as a single application and a copper-based programme gave inadequate disease control. No significant detrimental effects on fruit set were noted nor was fruit russet affected, except with the copper programme. Bitertanol at 0.024% caused a marked reduction in the proportion of fruit with the typical elongated shape.

INTRODUCTION

Black spot or scab is one of the most serious fungous diseases of pear. It has a life cycle closely akin to the related apple black spot (*Venturia inaequalis*) but is particularly difficult to control under New Zealand conditions as, unlike apple spot, it can overwinter in bark lesions (Brook 1979). Once established in an orchard, therefore, control is difficult and may take several seasons. Spray programmes have relied on Bordeaux mixture and more recently on other copper-based fungicides such as copper oxychloride. Their use has continued particularly for the control of fireblight, caused by the bacterium *Erwinia amylovora*.

During the past few years a series of new systemic fungicides have been introduced, the ergosterol biosynthesis inhibitors (Siegel 1981), which have shown excellent protectant and eradicant activity against black spot (Fungicide and Nematicide Tests, Vol 34, 1979 - pg 25, 26, 27; Vol 35, 1980 - pg 29; Vol 37, 1982 - pg 23, 24). Overseas reports have demonstrated adverse side-effects, however, such as reduced pollen germination and fruit set with fenarimol (Marcucci *et al* 1980) and reduced fruit set and increased fruit russet with triforine (Rep. E. Malling Res. Stn for 1977 (1978)). These effects may be apparent in some varieties only, the East Malling report (1977) having shown that varieties such as Conference and Comice are affected while others show no effects e.g. William's Bon Chretien.

The first trial reported in this paper was undertaken to evaluate the efficacy of several of these ergosterol-inhibiting fungicides in an orchard where Bordeaux applications at post-harvest, bud-burst and petal-fall, with fortnightly captan cover sprays had failed to give adequate control.

With the possibility of resistance developing to these ergosterol-inhibiting fungicides (Jones 1981) a practice being recommended has been a formulated mixture or tank-mix combination with a protectant non-systemic fungicide having a different mode of action (Delp 1980; Hartill 1982). In the second trial the following season, therefore, mixtures with the protectant fungicide captan were evaluated, as well as some other fungicides. Treatments were restricted to the blossom period in both trials.

METHOD

Two trials were carried out on a commercial orchard in Hastings, in a block of 35 year old William's Bon Chretien pears planted at 7.3 m centres. Treatments were applied using a hand-gun sprayer at 2,000 kPa and applying 2,000 litres/ha.

Proc. 36th N.Z. Weed and Pest Control Conf.

Trial A

Single tree plots were replicated five times in a randomised complete block design. Treatments were applied five times at weekly intervals during blossom commencing at green tip (September 22, 1981) and finishing at petal fall (October 22). Captafol SAT (single application technique) was applied at green tip only.

The grower applied streptomycin sulfate at 9.4 g/100 litres at full bloom. Either captan or mancozeb were applied with insecticides at fortnightly intervals from first cover (October 29) until harvest over the trial area. "Mills Periods" (Mills and La Plante 1954) occurred on October 19 (severe), 28 (light); November 9 (severe), 29 (severe); December 25 (severe). An initial assessment of fruitlets was made on November 16 by counting the number of primary infected fruit per tree at head height. The pears were picked and weighed from each tree on two harvest dates (2, 18 February 1982) and counted and assessed for black spot and fruit russet (Table 1).

As the fruit was noticeably flatter in bitertanol treated trees, one case from three replicates and one case from an untreated and grower-sprayed tree was taken and the percentage of "atypically-shaped" fruit recorded. Length and diameter measurements were taken of ten "atypically-shaped" bitertanol treated fruit per case and ten "typically-shaped" grower-sprayed fruit.

The following season the grower applied his standard copper programme over blossom (but included metiram at 100 g/100 litres at 75% blossom) and captan cover sprays over the block. The fruit was assessed for black spot at harvest (Jan 31, 1983).

Trial B

Single tree plots were replicated four times in a randomised complete block design. Treatments were applied five times during blossom from green tip (September 17) until 90% petal fall (October 18, 1982). The grower applied streptomycin sulfate and Triton B 1956 at 9.4 g + 25 ml/100 litres on September 29 and October 12. From November 29 until harvest captan (0.1%) was applied at fortnightly intervals with insecticide cover sprays. "Mills Periods" occurred on September 20 (moderate); October 6 (moderate), 26 (moderate); November 13 (severe), 30 (moderate).

One limb from each tree was tagged and the number of flower clusters counted (September 30). The number of fruitlets with primary black spot were counted on December 6. At harvest (January 31, 1983) all the fruit from the tagged limbs and one bushel case from the rest of the tree were assessed for black spot and russet (Table 2). A second pick from each tree was assessed for "atypical shape" (Table 2).

RESULTS

In Trial A all treatments reduced black spot levels compared with unsprayed trees. Captafol SAT gave poor control of primary spot (November 16 assessment) (Table 1) and was inadequate at harvest, no doubt due to the long blossom period of pipfruit under New Zealand conditions. Bitertanol, captafol and triforine all gave excellent control. No significant differences in fruit russet or yield were evident between any treatments. Significantly reduced black spot levels had no effect on the levels of fruit infection the following season after a Bordeaux/captan spray programme.

The percentage of obviously flattened fruit increased from 11.5% (mean of untreated and grower's Bordeaux programme) to 23.7% with bitertanol. Lengths of treated fruit were reduced from 76.9 mm to 71.7 mm (statistically non-significant) and diameters increased from 65.6 mm to 72.5 mm (significant at 1% level).

In Trial B primary black spot infection levels were very low with no treatments being significantly better than untreated although the standard copper programme had the highest number of infected fruitlets (Table 2). At harvest all treatments except copper, were significantly better than untreated, the same result being obtained whether the tagged limb only or fruit from the rest of the tree was assessed. No significant differences in fruit set were evident between treatments. The copper programme increased fruit russet significantly thereby reducing the export grade. Triforine plus captan and dodine reduced the percentage of export grade fruit although not to a statistically significant extent. Dodine treated and untreated fruit had significantly fewer deformed fruit compared to copper and triforine plus captan.

TABLE 1: Black spot and yield assessments for Trial A (1981)

Treatment† (Rate g ai/100 litres)	Mean No. infected fruitlets (16 Nov)	% infected fruit	Mean No. fruit/tree	Mean fruit weight (g)	% Export grade*	Yield (t/ha)
bitertanol (24)	0.0 c	4.7 cd	840 ab	180 a	99 a	28.2 a
captafol (75)	1.4 c	2.4 d	755 ab	184 a	99 a	25.9 a
captafol SAT (281.5)	6.8 ab	16.2 b	949 a	179 a	98 a	31.7 a
fenarimol (3.0)	2.4 bc	11.3 bc	725 b	179 a	98 a	24.2 a
triforine (28.5)	0.6 c	6.0 cd	877 ab	177 a	99 a	28.7 a
untreated	12.2 a	28.6 a	868 ab	171 a	100 a	27.9 a
CV%	44.2	30.0	16.9	5.7	1.6	19.8

* New Zealand Apple and Pear Marketing Board allow 40% of the surface area with smooth russet. Downgrading due to black spot, insects, limb rub etc., were not included in the analysis

† Formulations used in the trial were: bitertanol (Baycor 300 EC), captafol (Difolatan 5F), fenarimol (Rubigan 12 EC), triforine (Saprol 19 EC).

TABLE 2: Effect of fungicide combinations on black spot and fruit in Trial B (1982)

Treatment† (Rate g ai/100 litres)	% infected fruitlets/ tagged limb* (6 Dec.)	% infected fruit/tagged limb (31 Jan.)	% infected fruit/tree (31 Jan.)	% fruit from flowers	% Export grade	% flat fruit
captan (120)	1.4 ab	0.7 b	0.7 b	13.7 a	87 a	8.3 bc
bitertanol + captan (18 + 80)	0.4 b	0.3 b	0.2 b	12.4 a	88 a	8.2 bc
CGA 71818 + captan (2.5 + 47.5)	1.2 ab	0 b	0.2 b	16.5 a	89 a	8.8 abc
fenarimol + captan (3.4 + 80)	0 b	0 b	0.2 b	11.1 a	91 a	12.1 abc
triforine+captan (19+80)	0.9 b	0 b	0 b	12.6 a	80 ab	17.1 ab
captafol (75)	1.2 b	0.5 b	0.2 b	13.7 a	89 a	10.4 abc
copper programme (**)	3.9 a	2.4 a	2.0 a	15.8 a	67 b	17.8 a
dodine (48)	0.8 b	0.4 b	0.2 b	16.2 a	80 ab	6.7 c
untreated	2.1 ab	2.0 a	1.6 a	10.0 a	91 a	5.0 c
CV%	44.2	31.6	26.0	21.6	11.4	28.5

** Standard grower programme used: Bordeaux mixture 10:8:100 (September 17); Bordeaux mixture 6:8:100 (September 23); cupric hydroxide 81 g/100 litres (October 18)

* The number of flower clusters/tagged limb range between 50 and 102 per treatment

† Formulations used in the trial were: captan (captan 80W), CGA 71818 + captan (Topas C), dodine (Syllit 40S).

DISCUSSION

Under the fairly high disease pressure in Trial A the sterol-inhibiting fungicides, bitertanol, fenarimol and triforine, all gave good control. Trees assessed at random in the adjacent grower's block revealed poor control with his copper programme, evident again under trial conditions the following season in Trial B. Unfortunately disease pressure was low in 1982 and even products such as captan and dodine performed well. Local experience and research work (Corbin *et al* 1974) has shown the ineffectiveness of these products in high pressure situations. Efficacy of the fungicidal combinations in high disease conditions should be further evaluated.

Corbin *et al* (1974) reported no evidence of resistance of *V. pyrina* to benomyl in his survey. A block adjacent to Trial A was sprayed on November 25, 1981 with benomyl at 0.22 kg/ha + spraying oil at 0.25% with poor results. Leaf samples sent to MAF Levin showed good fungal growth at 10 ppm benomyl and slight growth at 100 ppm (Laundon pers comm). The block has no history of benomyl usage, and no benomyl had been used on the property since 1979.

No loss of fruit set was recorded in either season with any of the fungicides. This result would need to be checked on other varieties as wide differences in varietal tolerance to fruit set reduction, foliage phytotoxicity and fruit russet have been demonstrated (East Malling 1977). Triforine, when combined with captan, showed more fruit russet. Dodine and copper were also slightly worse than untreated. No treatment was phytotoxic to the leaves.

The sterol-inhibiting fungicides are systemic and as such can influence other aspects of the crop. Bitertanol at 24 g/100 litres adversely affected fruit shape. This was no longer evident at the 18 g/100 litres rate although some trees still showed this tendency at harvest in Trial B. This was also evident in some triforine and fenarimol treated trees. The effect of the copper programme on fruit shape was not evident in the fruit sample in the 1981 season but the effect in Trial B could be related to the higher russet level due to application by hand-gun.

Although the sterol-inhibiting fungicides appear unlikely to have resistance develop to them (Fuchs and Drandarevski 1976), as a precaution these materials are being either formulated with or recommended as tank mixtures with protectant conventional fungicides such as captan or mancozeb. If these mixtures are applied for longer than just the flowering period leading to increased plant exposure then the possibility of resistance would be increased and their effect on foliar and fruit toxicity, fruit shape and other fruit characteristics could well be enhanced.

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