DICLOBUTRAZOL FOR STRIPE RUST CONTROL IN WHEAT.**D.J.I. JACOBSON,***ICI Tasman Limited, Christchurch***SUMMARY**

Diclobutrazol, a new triazole fungicide for the control of certain cereal diseases, is described. In a series of trial and block evaluations in the 1981-92 season, foliar applications of diclobutrazol 125 g/ha provided comparable control of stripe rust (*Puccinia striiformis*) on wheat to triadimefon 125 g/ha. A two spray regime in one trial with Rongotea provided superior stripe rust control and yield responses as compared to a single treatment applied early (Feekes 3-6) or late (Feekes 7-10).

INTRODUCTION

Diclobutrazol, (2*R*, 3*R*)- and (2*S*, 3*S*)-1-(2, 4-dichlorophenyl)-4, 4-dimethyl 1-2-(1, 2, 4-triazol-1-yl) pentan-3-ol, is a new fungicide discovered at the Jeallott's Hill Research Station of ICI Plant Protection Division, England in 1976 (Bent and Skidmore 1979). It has been widely tested in the field under the code PP296, and is being introduced under the trade name 'Vigil'.

Chemical and Physical Properties

Diclobutrazol is an odourless, colourless, crystalline solid. It is stable under normal storage conditions.

Toxicology and Residues

Diclobutrazol is of low toxicity to mammals and other animals. The acute oral and dermal LD50 for rats are 4000 mg/kg and 1000 mg/kg respectively. It is non-irritant to rat skin and mildly irritant to the skin and eye of rabbit. Ames and cell transformation tests gave negative results. A no-effect level of 50 ppm was established when rats were fed diets containing diclobutrazol for 90 days. Diclobutrazol is also of low toxicity to birds, bees, fish and invertebrates.

Extensive residue data have been obtained from cereal crops. Applications at 125-250 g/ha to barley at Feekes growth stage 6-7 and to wheat at Feekes 9-11.1 have resulted in very low or non-detectable grain residues (0.01 - 0.02 ppm) and low levels (< 0.3 ppm) in straw.

Biological Activity

In glasshouse and growth-room tests greatest activity was shown against rust (on cereals, beans and coffee), powdery mildews (on cereals, apple, grape and cucumber) and apple scab. Complete protection against cereal rusts was conferred by sprays at concentrations down to 1-5 ppm, and for powdery mildews 0.1 - 0.5 ppm was effective. There were marked curative effects at slightly higher rates. Translaminar movement and acropetal translocation from stem and leaf deposits were also observed in several species. Foliar deposits exerted a marked vapour action over several centimetres against powdery mildews and a weaker vapour action against rusts, despite the extremely low vapour pressure. Diclobutrazol, as with some other members of triazole group, has been shown to have some soil residual properties, and studies are in progress to determine the effects of the chemical's soil life on crops following cereals treated with diclobutrazol.

Mode of Action

Mode of action studies on common smut (*Ustilago maydis*) indicate a marked and specific interference with ergosterol biosynthesis in the fungus. The major block involves the removal of the 14 α -methyl group from 24 methylene dihydrolanosterol. This effect has been reported for other fungicides (Buchenaur 1977). The reduction in ergosterol content is believed to upset the stability and properties of the cell membranes and thereby inhibit mycelial growth.

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METHOD

The New Zealand evaluation of diclobutrazol has included replicated trials and block evaluation on three wheat cultivars.

In the 1981-82 season three trials were in Canterbury — two on Rongotea and one on Kopara wheat cultivars, and all crops were autumn sown with seed treatments not effective against stripe rust.

All trials had four replicates arranged in a randomised block design with a plot size of 20 x 5 m on two trials and 10 x 5 m on the other. Diclobutrazol and triadimefon were applied as foliar sprays using a modified Oxford plot sprayer applying 225-256 litres/ha using D2/25 hollow cone nozzles at 333 kPa, or Teejet 730154 nozzles at 200 kPa. Standard area diagrams were used for the stripe rust assessments on 10 main tillers per replicate. Trials were harvested by taking 30 m² per plot with a small plot harvester. The four block evaluations reported were carried out during the 1981-82 season in Southland and Canterbury. The wheat cultivar on both Southland block was Takahe and the diclobutrazol treated area was 2 ha on Block 1 and 1 ha on Block 2, and the triadimefon area 6 ha and 4 ha respectively. All applications in Southland were by fixed wing aircraft applying 67 and 112 litres/ha. The wheat cultivar in Canterbury was Rongotea on both blocks, with the diclobutrazol treated area being 1 ha and 2 ha respectively. Both blocks were treated by ground application using Teejet 730154 nozzles delivering 200 litres/ha. The stripe rust assessments were on 40 main tillers selected at random per treatment.

In all trials and block evaluations diclobutrazol was a suspension concentrate formulation containing 125 g/litre and triadimefon a 250 g/litre emulsifiable concentrate.

RESULTS

In the trial on Kopara, Table 1 shows at the first assessment both diclobutrazol and triadimefon were similar in effect on stripe rust on leaf 4. However, on leaves 3 and 2 low levels of stripe rust were present and no significant reduction in stripe rust resulted from either fungicide.

At the second assessment the effectiveness of the early treatments of both fungicides was declining on leaves 3 and 2. The early plus late treatment regimes of both fungicides provided a similar reduction in stripe rust. There was no significant difference between any treatment and the untreated on the flag leaf at the second assessment.

At the third assessment all treatments assessed were similar but significantly superior to untreated. There was no significant difference between treatments in grain yield or 1000 grain weights.

TABLE 1: Mean Percentage Leaf Area Infected with Strip Rust — Kopara.

Treatment	Assessed Rate g/ha	Leaf No.	21 DAEA**		41 DAEA — 21 DALA***		61 DAEA—41 DALA			
			4		3	2	4	3	2	Flag
untreated			24 a		28 a	12 a	67	28 a	21 a	11 a
triadimefon	125	E	13 b		21 ab	10 ab	-	-	-	-
triadimefon	125	E + L*	-		11 c	6 b	6	4 b	3 b	2 b
diclobutrazol	125	E	11 b		20 abc	9 ab	-	-	-	-
diclobutrazol	125	E + L	-		14 bc	6 b	5	4 b	3 b	2 b
diclobutrazol	125	L	-		19 abc	6 b	6	5 b	2 b	2 b
CV %			31		32	41	-	58	47	99

* Early application applied 30-9-81 at Feekes 3-4

** Days after early application

Late application applied 20-10-81 at Feekes 6-7

*** Days after late application

TABLE 2: Rongotea wheat (Trial 1) mean percentage leaf and spikelets/ear area infected with stripe rust, yields and 1000 g weights.

Treatment	Assessment Rate g/ha	23 DAEA		42 DAEA — 20 DALA		61 DAEA — 41 DALA		Yield t/ha 23.1.82	1000 Grain wgt (g)
		Leaf No.	2	2	Flag	2	Spikelets***		
untreated			6 a	52 a	43 a	84 a	63 ab	37 ab	3.9 e
herbicide***			2 b	40 b	30 b	75 a	81 a	52 a	4.3 de
triadimefon	125	E	2 b	24 c	17 c	69 a	70 ba	32 abc	4.8 bcde
triadimefon	125	E + L**	-	4 f	2 e	11 bc	8 c	9 cd	6.0 a
triadimefon	125	L	-	12 def	4 de	21 bc	12 c	15 bcd	4.8 bcde
diclobutrazol	94	E	1 b	24 cd	14 cd	78 a	63 ab	37 ab	4.8 bcde
diclobutrazol	94	E + L	-	6 ef	2 e	7 bc	3 c	11 cd	5.4 ab
diclobutrazol	94	L	-	14 cdef	5 de	35 bc	4 c	14 bcd	4.9 bcd
diclobutrazol	125	E	1 b	18 cde	14 cd	76 a	73 a	38 ab	4.6 bcde
diclobutrazol	125	E + L	-	5 f	2 e	8 bc	5 c	17 bcd	5.5 ab
diclobutrazol	125	L	-	15 cdef	5 de	12 bc	3 c	11 cd	5.4 abc
diclobutrazol	250	E	1 b	19 cd	12 cd	75 a	76 a	24 bcd	4.7 bcde
diclobutrazol	250	E + L	-	4 f	2 e	5 c	3 c	6 d	5.8 a
diclobutrazol	250	L	-	13 cdef	6 de	38 b	3 c	7 cd	4.5 cde
CV %			38	45	56	46	39	68	12
									4

* 225 g bromoxynil + 225 g ioxynil + 1125 g mecoprop/ha. Grain yields adjusted to 15% moisture

** Early application applied 12-10-81 at Feekes 6-7

Late application applied 3-11-81 at Feekes 9-10

*** Percent spikelets infected per ear

In Trial 1 on Rongotea at the first assessment the herbicide treatment and all fungicide treatments significantly reduced stripe rust severity on leaves 2, 3 and 4 compared with untreated (leaf 2 results only in Table 2). However, all diclobutrazol treatments on leaves 3 and 4 were significantly better than herbicide alone.

At the second assessment the early plus late treatment of triadimefon provided similar stripe rust control compared with the three rates of diclobutrazol applied early and late. The early treatments of the three diclobutrazol rates provided significantly better stripe rust control compared with the early treatment of triadimefon on leaf 3, whereas late treatments of both fungicides were similar on leaf 3. On leaf 2 (Table 2) there was no significant difference between the early plus late treatments and the late treatments. However, the results indicate less disease on leaf 2 on all the early plus late

TABLE 3: Rongotea (Trial 2) — Mean percentage of leaf area infected with stripe rust, yields and 1000 grain weights.

Treatment	Rate g/ha	Leaf No.	Assessed 41 3	DAT** 2	Flag 39	Yield t/ha Harvested 15-2-81	1000 Grain Weights in grams
untreated			*11	*28	*39	2.8	35.5 a
triadimefon	125		2	3	6	3.0	34.9 a
diclobutrazol	94		1	2	2	2.9	36.1 a
diclobutrazol	125		1	2	4	2.9	35.8 a
diclobutrazol	250		1	2	4	3.0	35.1 a
CV%						11	29

* All treatments significantly differed to untreated

** Days after treatment. Growth stage at treatment on 28.10.81 was Feekes 4.

treatments. Less disease was recorded on the herbicide treatment on leaf 2 and the flag leaf compared with untreated, however it was inferior to all fungicide treatments.

At the second assessment there was no significant difference between any early plus late treatments and late treatments on the flag leaf. The late treatment of triadimefon was superior to the early treatment of triadimefon, whereas all diclobutrazol late treatments were statistically similar to all early treatments of diclobutrazol, indicating a possible longer period of protection.

No significant differences existed at the third assessment between untreated, herbicide, and all early fungicide treatments on leaf 2 and the flag leaf. However, all early plus late and the late treatments significantly reduced stripe rust on leaf 2 and the flag. Fewer spikelets were infected with stripe rust on all early plus late and late applications. Table 2 also shows triadimefon and all rates of diclobutrazol applied early and late and diclobutrazol 125 g/ha applied late to have provided similar yet significantly better yields than any other treatments, and there appears to be a positive correlation between yields and 1000 grain weights.

Table 3 shows that all treatments greatly reduced the level of stripe rust on all leaves when assessed 41 days after treatment. All diclobutrazol treatments appear to have had a greater effect on stripe rust than triadimefon, with all diclobutrazol rates being similar. Yields and 1000 grain weights show all treatments to be similar to untreated.

In Table 4 on Block 1 at 30 days after the early application, both fungicides recorded similar levels of stripe rust on the leaves assessed. However, 39 days after the late application, diclobutrazol recorded lower levels of stripe rust on leaf 2 and flag leaf compared to triadimefon. On Block 2 at both assessments diclobutrazol recorded lower levels of stripe rust on all leaves compared to triadimefon.

In Table 5 Block 3, the assessments show the early plus late treatment regimes to have greatly reduced the level of stripe rust compared with the early treatments, but all to have markedly less stripe rust than untreated. On Block 4, diclobutrazol has slightly reduced stripe rust severity on all leaves assessed compared to triadimefon.

DISCUSSION

Both diclobutrazol and triadimefon have demonstrated comparable efficacy in reducing stripe rust severity in Kopara wheat. However, no yield differences occurred compared to untreated, and this was probably due to Kopara's partial resistance to stripe rust. Diclobutrazol at the lowest rate evaluated (94 g/ha) in Trial 2 has demonstrated comparable efficacy to triadimefon at 125 g/ha against stripe rust. The early plus late regimes of all treatments generally afforded better control of stripe rust compared with a single application, applied either early or late, and this was reflected in yield increases. The assessments of stripe rust severity in the block evaluations show diclobutrazol to have provided control of stripe rust at a level at least comparable to that afforded by triadimefon.

No phytotoxicity or any other adverse effect was evident on any wheat cultivar from any treatment. Diclobutrazol proved biologically and physically compatible with benomyl fungicide and three commonly used cereal broadleaf herbicides when used in tank-mixes on the block evaluations.

The possible effect of carry-over soil residues of diclobutrazol onto subsequent crops has been given prominent attention throughout the development programme. Pot and plot trials have demonstrated an absence of growth effects on many crops likely to follow cereals in the crop rotation. Cereals, ryegrass, maize, brassicas, peas, lucerne and white clover have all displayed nil growth effects from soil residues equivalent to eight applications of 125 g/ha.

TABLE 4: Southland block evaluations — Takahe Mean percentage leaf area infected with stripe rust.

Treatment	Assessed	Rate g/ha	Leaf No.	Block No 1 12-12-81 & 9-1-82 Feekes 4 & 9				Block No 2 26-12-81 & 17-1-82 Feekes 4 & 9			
				30 DAEA		39 DALA		16 DAEA		31 DALA	
				3	2	2	Flag	3	2	2	Flag
diclobutrazol	125		12	9	13	13	7	3	6	2	
triadimefon	125		18	8	27	24	15	7	10	11	

TABLE 5: Canterbury block evaluations — Rongotea Mean percentage leaf area infected with stripe rust.

Treatment	Assessed	Rate g/ha	Leaf No.	Block 3 12-10-81 & 3-11-81 Feekes 6-7 & 9-10			Block 4 19-10-81 & 28-11-81 Feekes 3 & 5		
				46 DAEA-24 DALA			56 DAEA-16 DALA		
				3	2	Flag	3	2	Flag
untreated	-			53	48	34	-	-	-
diclobutrazol	125 E			15	28	17	-	-	-
diclobutrazol	125 E + L			6	7	3	4.0	3	2
triadimefon	125 E			18	23	13	-	-	-
triadimefon	125 E +			5	4	2	-	-	-
diclobutrazol	125 L								
triadimefon	125 E + L			-	-	-	6	4	3

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