BUREAU OF SUGAR EXPERIMENT STATIONS

QUEENSLAND, AUSTRALIA

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DEVELOPMENT OF A FUNGICIDE SPRAY SCHEDULE TO DETERMINE THE EFFECT OF SUGARCANE RUST (*PUCCINIA MELANOCEPHALA*) ON YIELD

by

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CONTENTS

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1. INTRODUCTION

Sugarcane rust (*Puccinia melanocephala* H. & P. Syd) has been recorded in the major sugarcane producing countries in the world (Egan, 1981). However, there has been very little work published on the effects of the disease on yield. This is probably partly due to rust being regarded as a minor factor in crop loss (Ricaud & Autrey, 1979).

Rust disease is most severe in young cane shortly after planting or ratooning (Ricaud & Autrey, 1979; Liu, 1980). In most cases affected crops will grow away from an early infection with little damage being evident providing environmental conditions are favourable to plant growth (Bailey, 1979; Ricaud & Autrey, 1979; Taylor, 1983). Nevertheless, Bailey (1976, 1979) has reported losses due to rust disease from 5 to 20%.

To determine accurately the influence of rust disease on yield, adequate control of the pathogen must be attained which will then enable a comparative study to be made between diseased and non-diseased plants of the same crop under similar environmental conditions.

Several studies have reported on the effect of various fungicides on rust (Sarma & Rao, 1979; Liu, 1980, 1981; Ryan & Ledger, 1981). Liu noted that chlorothalonil and oxycarboxin gave good control of rust and that oxycarboxin was the most effective fungicide in inhibiting rust pustule formation. Trials in North Queensland to screen various fungicides for the control of sugarcane rust showed that chlorothalonil and oxycarboxin were the most effective (Ryan & Ledger, 1981).

This study reports on work carried out to develop a fungicide spray program which is suitable for yield loss assessment investigations. Aspects examined include the efficacy of various concentrations of chlorothalonil and oxycarboxin on rust, the frequency of application of one concentration of chlorothalonil or oxycarboxin on level of infection, and arrangement of spray nozzles to give good coverage of fungicides.

2. EXPERIMENTAL DETAILS

The following fungicides were used in all trials.

Common name	Trade name and supplier	Chemical name and active ingredient	Form
chlorothalonil	Bravo Agchem Aust. Pty Ltd	Tetrachloroisophthalonitrile; 72% a.i.	Emulsifiable concentrate
oxycarboxin	Plantvax ICI Aust. Pty Ltd	5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide-4, 4-dioxide; 75% a.i.	Wettable powder

2.1 Bench trial to examine the efficacy of different concentrations of chlorothalonil and oxycarboxin on rust

A bench trial was carried out in July 1981 at Tully Sugar Experiment Station to investigate different concentrations of the fungicides oxycarboxin and chlorothalonil for the control of rust disease.

2.1.1 Trial design

There were three replications of each of seven treatments (Table I) and a randomised complete block design was used. Each replicate contained four plants of the varieties Q84, Q90 and Q105. The entire trial was bordered by a single row of pots of Q90.

TABLE I

Fungicides and concentrations used in bench trial

Treatment	Concentration of formulation used (% a.i.)
chlorothalonil	0.108
	0.126
	0.144
oxycarboxin	0.113
	0.150
	0.188
Control	untreated

2.1.2 Planting

Single-node cuttings of each variety were planted in 8 cm peat pots filled with a sandy river loam and fertilised with three to four month N-P-K formulation of Osmocote ® at a rate of 7.5 g per pot. The pots were arranged on a bench which had automatic watering.

2.1.3 Fungicide application

The plants were sprayed at nine day intervals for five weeks with the appropriate fungicide at the rate of 10 mL/plant. The untreated controls were not sprayed. To avoid spray drift contamination at each fungicide application, the plants were removed from the bench, sorted into each treatment, sprayed and then returned to the bench.

2.1.4 Assessment

The treatments were assessed by measuring the level of rust infection of the top four fully expanded leaves of each plant. The percentage infection on these leaves was estimated using a set of rust key diagrams developed by Peterson, Campbell & Hannak (1948). The mean level of infection for each plant was calculated and this was used to determine the mean for each treatment in each replicate. Dead leaves were rated as 100% affected.

2.1.5 Analysis

Analysis of variance was performed on arcsin transformed data.

2.2 Field trials to assess the efficacy of several spray schedules in controlling rust

Field trials at Mourilyan, northern Queensland and at Isis, southern Queensland were carried out in August/September 1981 to assess the efficacy of several spray schedules in controlling rust.

® = Registered Trade Name.

(a) ISIS TRIAL

2.2.1 Trial design

The trial was set down at J. Cardillo's, Folleys Road, Farnsfield, in three to four month old autumn plant cane of the variety Q103. The trial design was a randomised complete block with three replications of seven treatments (Table II). Each treatment consisted of three rows, 20 m in length with five row buffers between replicates.

TABLE II

Fungicides and spray schedule used in field trials

Treatment and concentration of formulation used (% a.i.)	Number of days between sprays
chlorothalonil, 0.108	6
	9
	12
oxycarboxin, 0.113	6
	9
	12
Control	untreated

2.2.2 Fungicide application

The fungicides were applied at six, nine and 12 day intervals for five weeks using a three-row boom spray. The boom spray contained 12, 80°, size LF3 flat fan nozzles directed towards the adaxial side of the leaves and 12, 80°, size LF5 flat fan nozzles directed towards the abaxial side of the leaves. At a working pressure of 200 kPa the rate of flow for the LF3 nozzle was 1.0 L/min and 1.6 L/min for LF5. Tractor speed was 4 km/h thus it would take 35.1 min for a three-row sprayboom to cover one hectare of sugarcane plants*. Application rate was 1095 L/ha. The untreated controls were not sprayed.

*One hectare of sugarcane plants is 7020 m (1.42 m row spacing).

2.2.3 Spray coverage assessment

The coverage of the leaf surfaces by the fungicides was assessed to determine the optimum coverage obtained by the nozzle arrangement prior to the spray schedules.

A solution of the fluorescent dye Rhodamine FB (0.002% w/v) was prepared. Parchment papers 2 cm by 5 cm, embossed with 1 mm^2 graph paper, were stapled onto the adaxial and abaxial sides of the first and sixth fully expanded leaves of Q103 plants adjacent to the trial. The papers were placed on the basal, middle and distal sections of the leaves. These plants were sprayed with the dye solution at the same application rate as above. The parchment papers were then examined under a 254 mm ultraviolet light and the spray coverage was then assessed by calculating the area of the papers covered by fluorescent particles. However, these artificial surfaces are not morphologically the same as the leaf surface, and can only give an estimate of the coverage (UK, 1977).

2.2.4 Assessment

The level of rust infection was determined 16 days after the last spraying. Four plants were randomly selected in the middle of each plot. The percentage infection on the basal, middle and distal sections of the abaxial side of the top six fully expanded leaves was estimated by comparing the pustule densities on the leaves with a set of rust key diagrams (Peterson, Campbell & Hannah, 1948). Dead leaves were rated as 50% affected. The optimum coverage obtained by the nozzle arrangement was assessed prior to the trial.

2.2.5 Analysis

Analysis of variance was performed on arcsin transformed data.

(b) MOURILYAN TRIAL

2.2.6 Trial design

The trial was set down at A. Bisbal's, New Harbour Line Road, Mourilyan Sands, on three month old autumn planted Q90 cane. The trial design was similar to the Isis trial (Table II) with each treatment consisting of three rows, 15 m in length with three row buffers between replicates.

2.2.7 Fungicide application

The fungicides were applied at six, nine and 12 day intervals for seven weeks using a three row boom spray. The application rate was 460 L/ha and the untreated controls were not sprayed.

2.2.8 Assessment

The level of rust infection in this trial was determined in a similar way to that described for the Isis trial except that 10 plants were assessed. Dead leaves were rated as 100% affected. The height of the 10 plants to the top visible dewlap was also measured and the number of shoots in 10 metres of rows in each plot was counted. Assessments were carried out one day after the completion of the spray program.

2.2.9 Yield assessment

At the completion of the program to assess different spray schedules a growth response was evident in some treated plots. Spraying with oxycarboxin was continued in some of the plots which had previously been treated with chlorothalonil and oxycarboxin at six day intervals. The treatment was applied at 205 g/L applied at 920 L/ha at seven day intervals. The spraying continued for four weeks until the cane was too tall for the boom spray to clear.

The plots which had the extra treatment of oxycarboxin and the untreated controls were harvested in July 1982. Harvest data (tonnes of cane per hectare, tonnes of sugar per hectare and commercial cane sugar (c.c.s.)) were calculated from a 10 m section of the middle row of each plot.

2.2.10 Analysis

Data recorded were analysed using an analysis of variance except for the level of rust infection data which were analysed using an analysis of variance with an arcsin transformation.

3. RESULTS

3.1 Bench trial to examine the efficacy of different concentrations of chlorothalonil and oxycarboxin on rust

A summary of the results from testing oxycarboxin and chlorothalonil to control rust in the bench trial at Tully Sugar Experiment Station is shown in Table III. Detailed results and analysis of variance are in Appendix I.

TABLE III

Level of rust infection in Q84, Q90 and Q105 treated with various concentrations of Bravo and Plantvax fungicides

Treatment and concentration of formulation used (% a.i.)	Percentage rust infection* (arcsin transformation) Q84	Q90	Q105
Control (untreated)	$28.83^{b\dagger}$	25.75^{cb}	40.04^{a}
chlorothalonil 0.108	18.47^{ef}	16.87^{ef}	19.83^{cd}
chlorothalonil 0.126	20.35^{cde}	18.00^{ef}	19.54^{de}
chlorothalonil 0.144	24.70^{bcd}	21.75^{cde}	18.80^{de}
oxycarboxin 0.113	8.10^{gh}	6.47^{h}	13.05^{fg}
oxycarboxin 0.150	7.66^{gh}	7.60^{gh}	9.84^{gh}
oxycarboxin 0.188	6.56^{h}	5.94^{h}	9.68^{gh}
LSD 5% for any two treatment means = 6.10			

*Treatment means are based on four replicates.

†Means followed by a common letter are not significantly different ($p = 0.05$)

3.2 Field trials to assess the efficacy of several spray schedules in controlling rust

(a) ISIS TRIAL

Results from the Isis trial to assess the frequency of application of chlorothalonil and oxycarboxin fungicides to control rust disease and to assess the optimum coverage of the leaves by fungicide are shown in Tables IV and V and Figure 1. Detailed results and analysis of variance are in Appendix II.

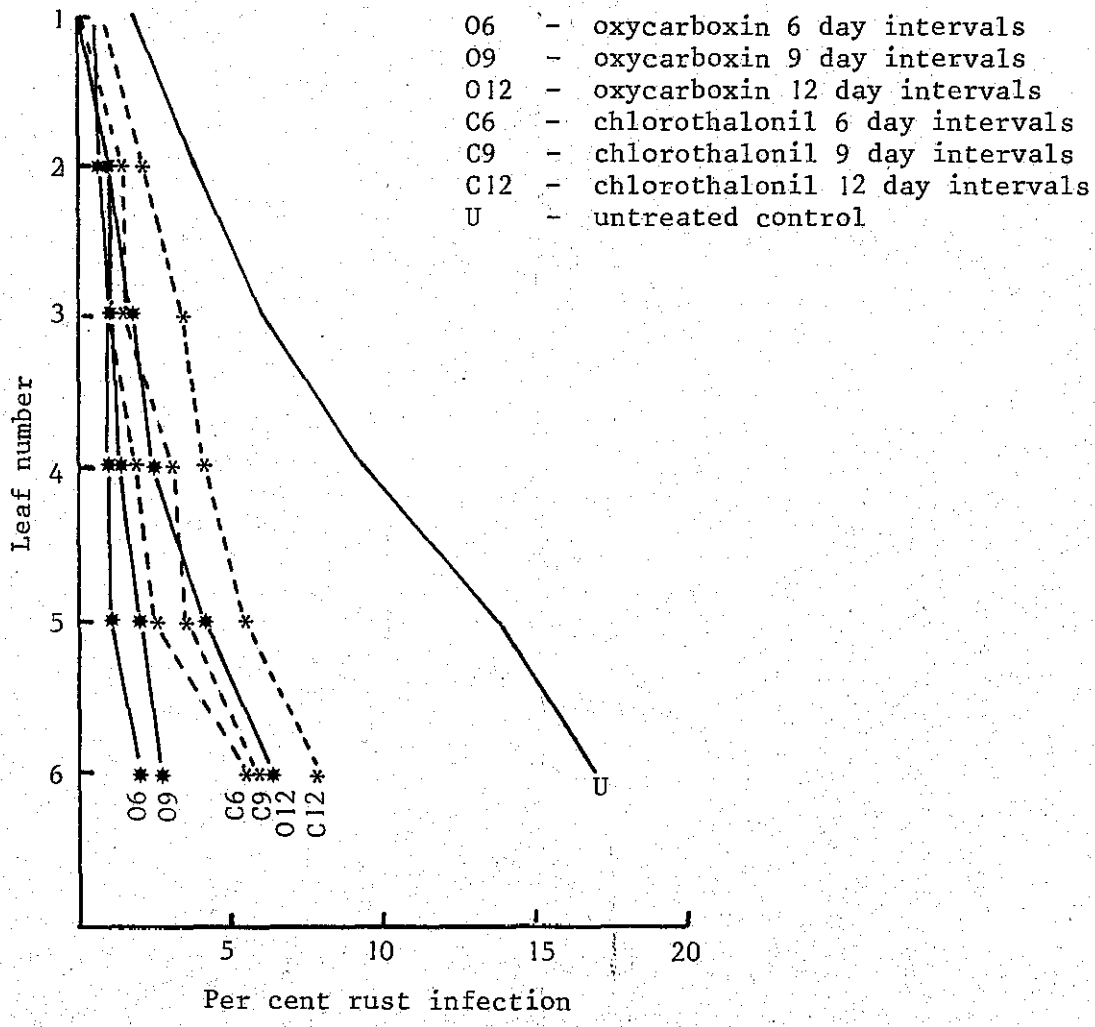

FIGURE 1 - Per cent rust infection on top six leaves of five to six month old field-grown sugarcane plants treated with chlorothalonil and oxycarboxin at six, nine and 12 day intervals - Isis trial

TABLE IV

Per cent rust infection on top six leaves of five to six month old field grown sugarcane plants treated with chlorothalonil and oxycarboxin at six, nine and 12 day intervals - Isis trial

Leaf number	Per cent rust infection (arcsin transformation)*						
	Control	Oxycarboxin 12 days	Chlorothalonil 12 days	Oxycarboxin 9 days	Chlorothalonil 9 days	Oxycarboxin 6 days	Chlorothalonil 6 days
1	$7.33^{ijk\dagger}$	1.91^{m}	3.83^{lm}	1.91^{m}	0	0	0
2	10.96^{defgh}	5.74^{kl}	8.13^{hijk}	3.83^{lm}	6.54^{jkl}	5.74^{kl}	5.74^{kl}
3	14.05^{cd}	7.33^{ijk}	10.50^{efghi}	5.74^{kl}	6.54^{jkl}	5.74^{kl}	5.74^{kl}
4	17.59^{b}	8.47^{hijk}	11.48^{defgh}	6.54^{jkl}	9.73^{fghi}	5.74^{kl}	7.33^{ijk}
5	21.56^{a}	11.28^{defgh}	13.27^{cde}	8.13^{hijk}	10.34^{efghi}	5.74^{kl}	8.74^{hijk}
6	24.25^{a}	14.39^{bcd}	15.79^{bc}	9.27^{hij}	13.11^{cdef}	8.13^{hijk}	12.99^{cdefg}

LSD 5% for any two treatment means = 3.45

*Means are based on nine replicates for the control and three replicates for the treatments.

†Means followed by a common letter are not significantly different (p = 0.05).

TABLE V

Coverage of the leaves by Rhodomin FB fluorescent dye

Leaf section	Per cent coverage (square root transformation)*			
	First leaf		Sixth leaf	
	Adaxial	Abaxial	Adaxial	Abaxial
Basal	$8.79^{a\dagger}$	7.01^{ab}	7.47^{ab}	6.45^{ab}
Middle	6.99^{ab}	7.24^{ab}	6.67^{ab}	4.49^{bc}
Distal	6.76^{ab}	7.01^{ab}	5.12^{bc}	2.22^{c}
LSD 5% for any two treatment means = 3.13				

*Treatment means are based on four stalk replicates.

†Means followed by a common letter are not significantly different (p = 0.05).

The average fungicide coverage of the entire first leaf was 58% and for sixth leaf, 36% (Appendix II).

(b) MOURILYAN TRIAL

Results from the Mourilyan trial to assess the frequency of application of chlorothalonil and oxycarboxin fungicides to control rust disease and the effect of the fungicides on stalk height and stalk number are shown in Table VI and Figure 2. Detailed results and analysis of variance are in Appendix III.

FIGURE 2 - Per cent rust infection on top six leaves of five-month old field-grown sugarcane plants treated with chlorothalonil and oxycarboxin at six, nine and 12 day intervals - Mourilyan trials

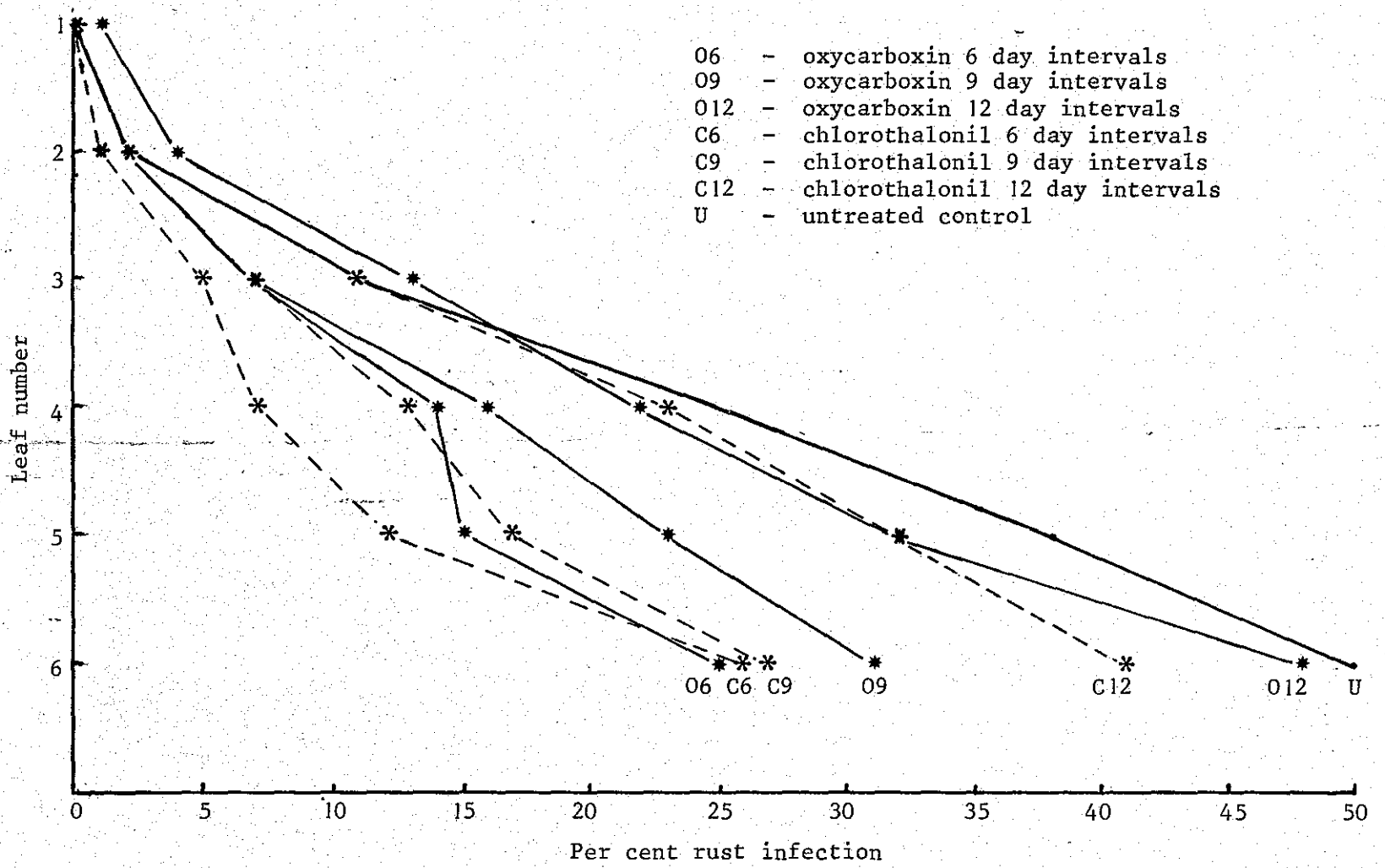

TABLE VI

Per cent rust infection on top six leaves of five month old field grown sugarcane plants treated with chlorothalonil and oxycarboxin at six, nine and 12 day intervals - Mourilyan trial

Leaf number	Percentage rust infection (arcsin transformation)*							LSD 5%
	Control (untreated)	Oxycarboxin 12 days	Chlorothalonil 12 days	Oxycarboxin 9 days	Chlorothalonil 9 days	Oxycarboxin 6 days	Chlorothalonil 6 days	
1	0	3.83^{tv}	0	0	0	1.91^{v}	0	5.39
2	$8.74^{rst\dagger}$	10.96^{qrs}	8.56^{rst}	8.13^{rst}	7.33^{st}	7.95^{rst}	6.54^{stv}	
3	18.23^{mnop}	21.02^{lmn}	19.41^{lmno}	15.34^{opq}	14.90^{opq}	15.60^{opq}	12.88^{pqr}	
4	30.59^{efgh}	27.63^{hijk}	28.25^{ghij}	23.28^{jklm}	21.11^{lm}	22.15^{lm}	15.68^{nopq}	
5	38.36^{bcd}	34.65^{cde}	34.10^{def}	28.76^{fghi}	24.53^{ijkl}	22.47^{klm}	20.02^{lmno}	
6	45.38^{a}	43.66^{ab}	39.92^{bc}	33.55^{defg}	31.50^{efgh}	30.21^{efgh}	29.98^{efgh}	
Stalk height (cm)	38.27^{d}	41.67^{c}	40.67^{c}	42.47^{bc}	44.90^{a}	43.57^{ab}	41.93^{bc}	1.73
Stalk number	115.83^{c}	122.67^{bc}	116.67^{c}	124.33^{bc}	126.33^{b}	143.33^{a}	143.00^{a}	9.23

*Means based on six replicates for the control and three replicates for the treatments.

†Means followed by a common letter are not significantly different (p = 0.05).

At the assessment of this trial there was an obvious reduction in growth in the unsprayed plots (controls). Therefore, selected plots continued to be sprayed and were then harvested. Harvest data from the control plots and those plots which had the extra treatment of oxycarboxin are shown in Table VII and analysis of variance results in Appendix III.

TABLE VII

Effect of rust on yield

Treatment	Treatment means*		
	Tonnes cane per hectare	C.C.S.	Tonnes sugar per hectare
Untreated control	63.81[a†]	13.15[a]	8.39[a]
oxycarboxin/oxycarboxin	83.85[a]	13.28[a]	11.16[a]
chlorothalonil/oxycarboxin	81.08[a]	12.97[a]	10.59[a]
LSD 5%	28.96	0.53	4.23

*Treatment means for untreated control are based on six replicates and on three replicates for the treatments.

†Means followed by a common letter in each column are not significantly different (p = 0.05).

4. DISCUSSION

In the bench trial at Tully Sugar Experiment Station it was found that both oxycarboxin and chlorothalonil fungicides, at all concentrations, significantly reduced the level of rust infection. However, oxycarboxin at all concentrations except at 0.113% a.i. on the variety Q105 produced significantly better control of rust than did chlorothalonil. There was very little difference in the level of rust infection between the higher and lower concentrations of each fungicide. Thus the lower concentrations of oxycarboxin (0.113% a.i.) and chlorothalonil (0.108% a.i.) were used in the field trials.

In the field trial at Isis, chlorothalonil applied at six day intervals and oxycarboxin applied at six and nine day intervals produced the best control of rust, while in the Mourilyan trial chlorothalonil and oxycarboxin applied at six and nine day intervals produced the best control of rust. Oxycarboxin at six and nine day intervals also produced slightly better control of rust in the lower leaves of the canopy in the Isis trial. Moreover, in the Isis trial the level of rust infection from the second to the sixth leaf in the canopy sprayed

with oxycarboxin at six day intervals was not significantly different; while in the Mourilyan trial both oxycarboxin and chlorothalonil at six and nine day intervals produced good control of rust in the lower leaves of the canopy. The difference in efficacy of fungicidal control at Mourilyan and Isis suggests the fungicides are less effective when the level of infection is relatively high in the crop. However, this difference could also be due to differences in spray coverage or environment.

The arrangement of spray nozzles to produce the best coverage of fungicide on the leaf surfaces was assessed prior to the spray schedule. The plants were then sprayed over a five week period and in this time the crop did not grow enough to warrant any alteration in the nozzle arrangement. A leaf coverage of 58% was attained for the first leaf while 36% coverage was attained for the sixth leaf of the three to four month old sugarcane crop. These results correlate with the findings of Ricaud, Sullivan, Soopramanien & Julien (1979) who obtained a leaf coverage of 25 to 30% in the first seven leaves of a sugarcane crop when sprayed with benomyl and a fluorescent dye.

Poor coverage was obtained on the abaxial side of the lower leaf and this was probably due to the leaf resting against the soil surface thus preventing fungicide from reaching that side of the leaf. Poor coverage of the lower leaves of the canopy may explain the decrease in the control of rust especially for the plants treated with the contact fungicide chlorothalonil. For those plants treated with oxycarboxin, adequate disease control of the lower leaves in the canopy would eventuate due to the redistribution of the fungicide. This would occur by run-off and more importantly by translaminar dispersion due to the systemic properties of oxycarboxin fungicide (Ricaud et al, 1979).

Oxycarboxin and chlorothalonil at six and nine day intervals in the Mourilyan trial produced a significant increase in stalk height and stalk number compared to the unsprayed controls. A preliminary pot trial with chlorothalonil failed to show any stimulatory influence from the fungicides on plant growth (Ryan & Croft, unpublished data). Although an increase in yield occurred in the fungicide-treated plots this yield response was not significantly different to the untreated controls. The lack of significant difference may have been due to an unsatisfactory trial design for yield studies since yield determinations were not within the objectives of the trial.

The results obtained in this study showed that oxycarboxin applied at 0.113% a.i. and at an application rate of 406 or 1095 L/ha at six or nine day intervals gave satisfactory control of rust for yield loss assessment studies. Oxycarboxin has several advantages over chlorothalonil in that it has systemic properties and some specificity for controlling rust fungi (Thomson, 1982).

5. CONCLUSIONS

(i) Oxycarboxin at 0.113, 0.150 and 0.188% a.i., and chlorothalonil at 0.108, 0.126 and 0.144% a.i. of product significantly reduced the level of rust disease in young sugarcane compared to untreated controls.

(ii) Oxycarboxin applied at six and nine day intervals and chlorothalonil applied at six day intervals produced the best control of rust in the Isis trial. Oxycarboxin and chlorothalonil applied at six and nine day intervals produced the best rust control in the Mourilyan trial.

(iii) Oxycarboxin produced slightly better control of rust throughout the canopy and especially in the lower leaves of sugarcane plants than chlorothalonil in the Isis trial.

(iv) Oxycarboxin at 0.113% a.i. and 1095 L/ha applied at nine day intervals is the recommended treatment for further use in rust/yield loss assessment trials.

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7. ACKNOWLEDGEMENTS

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8. RECOMMENDATIONS

A manuscript should be prepared on the results of the bench trial and the two field trials for assessing the efficacy of the fungicides to control rust.

APPENDIX I

Data for the percentage rust infection from Q84, Q90 and Q105 treated with various concentrations of chlorothalonil and oxycarboxin fungicides*, and analysis of variance tables†

Treatment and concentration of formulation used (% a.i.)	Replicate	% rust infection		
		Q84	Q90	Q105
Control (untreated)	1	22.34	11.46	41.41
	2	32.16	25.91	42.30
	3	16.21	20.41	40.44
chlorothalonil, 0.108	1	10.29	13.90	9.23
	2	5.21	5.47	12.94
	3	15.90	6.88	12.51
chlorothalonil, 0.126	1	7.63	12.05	12.52
	2	16.81	7.41	10.02
	3	12.61	9.44	11.07
chlorothalonil, 0.144	1	19.50	13.33	14.42
	2	27.30	15.44	8.26
	3	7.96	12.51	8.93
oxycarboxin, 0.113	1	1.77	1.15	2.75
	2	1.05	0.76	4.88
	3	3.49	2.06	8.40
oxycarboxin, 0.150	1	2.47	1.48	5.56
	2	2.99	4.81	1.36
	3	0.48	0.30	2.54
oxycarboxin, 0.188	1	2.31	0.89	2.67
	2	1.14	1.31	1.90
	3	0.70	1.03	4.12

*Each value is the mean of the top four leaves from four plants.

†Analysis of variance with an arcsin transformation was used to analyse the per cent rust infection.

Analysis of variance table for percentage rust infection

Source	d.f.	SS	MS	F
Treatments	6	4207.80	701.30	51.29**
Replicates	2	10.13	5.07	0.37
Varieties	2	173.82	86.91	6.36**
Treat. x var.	12	343.92	28.66	2.10*
Error	40	546.96	13.67	1.00

* Significant at 5% level of probability
** Significant at 1% level of probability

APPENDIX II

Data for the percentage rust infection of plants sprayed with oxycarboxin and chlorothalonil at various intervals*, and analysis of variance table† for the Isis trial

Treatment	Replicate	Per cent rust infection					
		Leaf number					
		1	2	3	4	5	6
Control (untreated)	1	1	5	7	13	18	21
	2	3	6	10	15	20	22
	3	1	3	7	10	15	19
	4	1	3	5	9	16	20
	5	1	2	4	7	9	12
	6	3	5	8	10	15	19
	7	1	4	5	7	12	14
	8	0	1	3	3	5	9
	9	1	3	5	7	14	17
chlorothalonil 12 days	1	1	2	4	5	7	12
	2	0	2	3	3	4	5
	3	1	2	3	4	5	6
chlorothalonil 9 days	1	0	2	2	5	5	11
	2	0	1	1	2	3	3
	3	0	1	1	2	2	3
chlorothalonil 6 days	1	0	1	1	2	3	9
	2	0	1	1	2	2	4
	3	0	1	1	1	2	3
oxycarboxin 12 days	1	1	1	2	4	6	9
	2	0	1	2	2	4	6
	3	0	1	1	1	2	4
oxycarboxin 9 days	1	0	0	1	1	2	2
	2	0	1	1	1	2	2
	3	1	1	1	2	2	4
oxycarboxin 6 days	1	0	1	1	1	1	2
	2	0	1	1	1	1	2
	3	0	1	1	1	1	2

*Each value is the mean of four stalks.

†Analysis of variance with an arcsin transformation was used to analyse the percentage rust infection.

Analysis of variance table for percentage rust infection

Source	d.f.	SS	MS	F
Treatments	6	1458.87	243.14	18.16**
Replicates	2	104.84	52.42	3.91*
Error 1	12	160.71	13.39	1.00
Leaves	5	1745.08	349.02	159.92**
Treatment x leaves	30	216.13	7.20	3.30**
Error 2	70	152.77	2.18	1.00

* Significant at 5% level of probability
** Significant at 1% level of probability

Data for the percentage coverage of the first and sixth fully-expanded leaves by the fluorescent dye, and analysis of variance table+

Leaf section	Replicate	% coverage by fungicide and dye			
		First leaf		Sixth leaf	
		Adaxial	Abaxial	Adaxial	Abaxial
Basal	1	41	18	52	81
	2	100	55	82	25
	3	79	44	52	52
	4	97	95	41	21
Middle	1	46	91	50	16
	2	75	55	33	3
	3	7	18	30	8
	4	97	60	70	88
Distal	1	54	88	48	0
	2	38	40	24	2
	3	13	20	48	4
	4	98	62	3	30
Average		62	54	44	28

+Analysis of variance with a square root transformation was used to analyse the percentage coverage.

Analysis of variance table for percentage leaf coverage

Source	d.f.	SS	MS	F
Replicates	3	35.20	11.73	1.59
Leaf number (N)	1	43.09	43.09	5.85
Error 1	3	22.11	7.37	1.00
Leaf side(s)	1	18.16	18.16	4.35
N x S	1	7.79	7.79	1.87
Error 2	6	25.00	4.16	1.00
Leaf section (P)	2	37.00	18.50	4.02*
N x P	2	11.09	5.54	1.21
S x P	2	0.43	0.22	0.05
N x S x P	2	8.64	4.32	0.94
Error 3	24	110.40	4.60	1.00

* Significant at 5% level of probability

APPENDIX III

Data for the percentage rust infection; stalk height and stalk number of plants sprayed with oxycarboxin and chlorothalonil at various time intervals*, and analysis of variance table† for the Mourilyan trial

Treatment	Replicate	% rust infection						Stalk height to top visible dewlap cm	Stalk number
		Leaf number							
		1	2	3	4	5	6		
Control (untreated)	1	0	3	13	23	48	55	37.3	112
	2	0	2	11	32	39	45	38.0	118
	3	0	2	6	23	29	52	39.8	110
	4	1	3	15	25	42	58	42.2	118
	5	0	2	11	23	40	49	35.9	122
	6	0	2	7	23	32	42	36.4	115
chlorothalonil 12 days	1	0	1	9	15	22	30	42.3	117
	2	0	3	17	26	39	48	38.5	137
	3	0	3	8	27	34	46	41.2	96
chlorothalonil 9 days	1	0	1	8	11	17	25	46.1	129
	2	0	2	7	14	21	26	43.9	116
	3	0	2	5	14	14	31	44.7	134
chlorothalonil 6 days	1	0	1	5	6	7	13	46.7	146
	2	0	2	6	8	13	36	41.0	135
	3	0	1	4	8	16	28	38.1	148
oxycarboxin 12 days	1	1	3	12	23	33	56	44.2	118
	2	1	5	17	26	33	45	39.3	123
	3	0	3	10	16	31	42	41.5	127
oxycarboxin 9 days	1	0	2	7	13	18	25	42.8	112
	2	0	2	7	11	22	29	42.7	124
	3	0	2	7	24	30	38	41.9	137
oxycarboxin 6 days	1	0	2	8	18	17	23	44.6	144
	2	1	3	9	14	15	26	44.4	157
	3	0	1	5	11	12	27	41.7	129

*Each value is a mean of 10 stalks.

†Analysis of variance with an arcsin transformation was used to analyse the percentage rust infection.

Analysis of variance table for percentage rust infection

Source	d.f.	SS	MS	F
Treatments	6	1514.56	252.43	9.31**
Replicates	2	80.26	40.13	1.48
Error 1	12	325.30	27.11	1.00
Leaves	5	18370.99	3674.20	550.26**
Treatment x leaves	30	815.72	27.19	4.07**
Error 2	70	467.40	6.68	1.00

Analysis of variance table for stalk height

Source	d.f.	SS	MS	F
Treatments	6	115.73	19.29	4.28*
Replicates	2	26.52	13.26	2.94
Error	15	67.58	4.51	

Analysis of variance table for stalk number

Source	d.f.	SS	MS	F
Treatments	6	2691.85	448.64	3.51*
Replicates	2	36.00	18.00	0.14
Error	15	1918.15	127.88	

* Significant at 5% level of probability
** Significant at 1% level of probability

Data for the tonnes cane per hectare, c.c.s. and tonnes sugar per hectare of the selected plots that continued to be sprayed with oxycarboxin fungicide; and analysis of variance tables

Treatment	Replicate	Tonnes cane per hectare	C.C.S.	Tonnes sugar per hectare
Untreated control	1	78.04	13.04	10.18
	2	62.43	13.21	8.25
	3	57.14	13.23	7.56
	4	40.29	13.09	5.27
	5	71.19	13.08	9.31
	6	73.76	13.22	9.93
oxycarboxin/ oxycarboxin	1	79.16	12.54	9.93
	2	95.51	13.83	13.21
	3	76.89	13.46	10.35
chlorothalonil/ oxycarboxin	1	61.51	11.98	7.37
	2	81.93	13.80	11.31
	3	99.80	13.12	13.09

Analysis of variance table for the mean tonnes of cane per hectare for the Mourilyan rust trial

Source	d.f.	SS	MS	F
Treatments	2	1055.79	527.90	2.35
Replicates	2	322.10	161.05	0.72
Error	7	1573.80	224.83	

Analysis of variance table for the mean c.c.s.

Source	d.f.	SS	MS	F
Treatments	2	0.15	0.07	0.39
Replicates	2	1.31	0.65	3.52
Error	7	1.30	0.19	

Analysis of variance table for the mean tonnes sugar per hectare

Source	d.f.	SS	MS	F
Treatments	2	19.07	9.54	1.99
Replicates	2	6.27	3.14	0.65
Error	7	33.57	4.80	