THE EFFECT OF SOIL AND SEEDCANE APPLICATIONS OF TRIADIMEFON ON THE INCIDENCE OF SUGARCANE SMUT (*USTILAGO SCITAMINEA*)

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Abstract

Different methods of applying triadimefon to sugarcane setts and to the soil at planting for the control of smut were tested in field trials. Immersing healthy setts in cold water containing 250 μg/ml triadimefon was beneficial when the setts were subsequently inoculated with smut before planting or grown under low levels of the disease, but was ineffective when smut was severe. Treating seedcane for two hours in hot water (50°C) containing 250 μg/ml triadimefon was more effective than a similar treatment in cold water when smut was severe. The application of high rates of triadimefon to the soil at planting was beneficial under conditions of severe smut. The fungicides furmecyclox and propiconazole were similar to triadimefon in efficacy in a test using inoculated seedcane. Benefits from applying fungicides at planting persisted into ratoon crops.

Introduction

The use of the fungicide triadimefon (Bayleton) to control sugarcane smut (*Ustilago scitaminea* Sydow) was reported in an earlier paper (Bailey[4]). Good control was obtained in plant crops of the susceptible variety NCo 376 when seedcane was treated for two hours in hot water (50°C) containing triadimefon before inoculation with smut and also before planting in the field in a severely smut-contaminated environment. Where the disease had been controlled with triadimefon in plant cane, less smut occurred in the first ratoon crops. Inconsistent results were obtained when seedcane was treated with triadimefon for up to two hours in cold water. Treatment with triadimefon in cold water was effective when treated setts were inoculated with smut before planting but was either ineffective or less effective than treatment in hot water when the treated setts were planted in a locality where smut was severe.

In the trials already reported triadimefon was effective at concentrations of 125 to 500 μg/ml active ingredient. A concentration of 250 μg/ml is currently used both in hot and cold water treatment of seedcane in South Africa and Swaziland. The use of triadimefon for the control of smut is widely practised in both countries.

In investigations at Chiredzi in Zimbabwe into the effects of treating seedcane of NCo 376 with triadimefon in cold water, good control of smut was obtained when treated setts were inoculated before planting (Anon[2]), similar to results obtained at Pongola in South Africa (Bailey[4]). When seedcane was exposed naturally to smut at Chiredzi, treatment with triadimefon in cold water reduced levels of smut in plant crops but the benefits did not always persist in the ratoon crops. As a result of the work at Chiredzi, 250 μg/ml ai is the recommended concentration of triadimefon in Zimbabwe, and seedcane for commercial plantings is now generally treated with this concentration for five minutes in cold water (Cackett[5]).

It has been shown that smut in systemically infected seedcane is not controlled by triadimefon applied in cold water (Anon[2], Bailey[4]). However, treatment with triadimefon in hot water (50°C) for at least 30 minutes is effective (Anon[1], Bailey[4]), the disease being eliminated by the heat treatment and the fungicide affording protection after planting. The benefits of hot water treatment with triadimefon as an eradicative and prophylactic treatment for seedcane, have therefore been clearly demonstrated, but treatment with hot water is more laborious and expensive than a short treatment in cold water.

Initial tests with triadimefon applied to the soil at planting have also been reported previously. Some control of smut in plant cane occurred when 0,5 to 1 kg ai/ha was applied as a 1,25% granular formulation, over the seedcane in the open planting furrow at Big Bend (Bailey[4]) but no control occurred with 0,5ℓ ai/ha applied as a 25% ec formulation at Chiredzi (Anon[2]).

The experiments reported in this paper were conducted to investigate further the effect of treating seedcane with triadimefon in cold water under different intensities of natural infection in two distinct environments and of the efficacy of triadimefon when applied to the soil at the time of planting. The fungicide was tested on NCo 376 and two other smut-susceptible varieties. A number of new fungicides were also tested for efficacy against smut.

Materials and Methods

The seedcane used in all the experiments was obtained from special nurseries at Mount Edgecombe, where smut is uncommon, and was carefully inspected to ensure freedom from smut and other systemic diseases. All the experiments were conducted as field trials planted in the spring and summer months and were grown under fully irrigated conditions on a cutting cycle of approximately 12 months.

Experiments 3, 4, 5 and 8 were conducted at Big Bend in Swaziland, where smut is common and damaging to the predominant variety NCo 376. The experimental site was on a shallow, gravelly clay loam. All these trials were subjected to naturally occurring, severe infection pressure under poor growing conditions.

Experiments 1, 2, 6, 7 and 9 were conducted at Pongola, 70 kilometres from Big Bend, on a deep, clay loam soil. Here smut was widespread but occurred at much lower levels than at Big Bend. The Pongola trials were therefore subjected to a lower infection pressure and conditions for cane growth were better. The two sites have similar climates (hot, semi-arid) and at both, NCo 376 was the predominant variety grown commercially.

Triadimefon was applied to seedcane at a concentration of 250 μg/ml ai in Experiments 1 to 5, using a 25% wp formulation. Seedcane treatments varied from dips of a few seconds up to soaking for two hours. Where the fungicide was applied to the soil, 5% granular and 25% wp formulations were used.

In Experiments 1, 6 and 9, seedcane was inoculated by soaking the setts in a fresh suspension of smut spores (approximately 1 x 10^8/ml) for 15 minutes after treatment with fungicide and immediately before planting.

The varieties used were NCo 376, NCo 310 and N55/805, all of which are highly susceptible to smut.

The incidence of smut in all the trials was estimated by monthly counts of smut whips. In all the trials, germinating shoots were counted. Cane yields were determined in most of the trials but sucrose analyses were not made. In all the trials the entire length of row was harvested in each plot and the reported yields were therefore affected by the better growth of the cane at each end of the rows. Data on germination and yield are presented only where differences as a result of the treatments were significant or where they are considered pertinent.

Experiments 1 and 2

In these experiments, planted at Pongola in December 1979, the effect of treating seedcane with triadimefon in hot water for 30 minutes, or in cold water for 10 seconds and 30 minutes was tested on varieties NCo 376, NCo 310 and N55/805. In Experiment 1, the treated setts were inoculated with smut before planting. The cane in Experiment 2 was infected naturally but a fresh suspension of smut spores (approximately 1 x 10^{12}/ml) was sprayed over the open furrows at a rate of 1 000 ℓ/ha before the setts were placed. This was to simulate planting in soil infested with smut spores. Plots consisted of single rows each 6 m long and spaced 1,4 m apart. Twelve four-budded setts were planted in each plot and the experiment was replicated four times. The plant cane and first ratoon crops were harvested after 11,1 and 10,9 months respectively.

Experiments 3, 4 and 5

Experiments 3 and 4 were planted at Big Bend in November 1980 and were conducted under conditions of natural exposure to smut. In Experiment 3, seedcane of NCo 376 was treated with triadimefon in cold water for 10 seconds, five minutes or 30 minutes. Seedcane was also treated with triadimefon in hot water for two hours. In a further treatment, triadimefon was applied in cold water for five minutes after HWT for two hours.

In Experiment 4 the effect of treating seedcane with triadimefon in cold water for five minutes was tested on varieties NCo 376, NCo 310 and N55/805.

In both Experiments 3 and 4, plots consisted of five rows each 7,5 m long and spaced 1,5 m apart. Each row was planted with 20 four-budded setts and there were four replications. Data were collected from the inner three rows in each plot. The plant cane and first ratoon crops were harvested after 10,5 and 11,5 months respectively. Data on smut were also recorded from the second ratoon crop.

Experiment 5 was planted at Big Bend in December 1981 and was intended to confirm preliminary results from Experiments 3 and 4. Seedcane of NCo 376 was treated with triadimefon in cold water for five minutes, 30 minutes or two hours, and with triadimefon in hot water for two hours. In an additional treatment, triadimefon was applied in cold water for 30 minutes after HWT for two hours. Plots consisted of three rows each 7,5 m long and spaced 1,5 m apart. Each row contained 20 four-budded setts and there were six replications. Data were collected from all the rows. The plant crop was harvested after 10,6 months. Data on smut were also recorded from the first ratoon crop.

Experiments 6 and 7

These experiments were planted at Pongola in December 1979 to test further the effect of applying triadimefon in the furrow at planting. In Experiment 6 the variety used was NCo 376. Fungicide treatments were 20 and 40 kg of 5% triadimefon granules/ha (1 and 2 kg ai/ha), applied over the setts in the open planting furrow. There were two methods of exposure to smut, artificial inoculation of setts and natural infection, the latter supplemented by smut spores added to the soil, as in Experiment 2. Plots consisted of three rows, 6,0 m long and 1,4 m apart, with 12 four-budded setts in each row and there were four replications.

In Experiment 7, the effects of applying triadimefon to the soil as 5% granules at rates of 10, 20 and 40 kg/ha and as a 25% wettable powder at rates of 4 and 8 kg/ha (1 and 2 kg ai/ha) were tested on variety NCo 310. The granules were applied as in Experiment 6. The wettable powder was sprayed over the setts in the open furrow in 300ℓ water per hectare. Smut spores were added to the open furrows before the setts were planted, as in Experiments 2 and 6. Plots consisted of four rows, 6 m long and 1,4 m apart. Each row was planted with 12 four-budded setts and there were four replications.

Data were collected from all rows in Experiment 6 and the inner two rows of the plots in Experiment 7. The plant cane and first ratoon crops of both trials were harvested at 11,1 and 10,9 months respectively.

Experiment 8

This experiment, planted at Big Bend in December 1981, was intended to test the effect of triadimefon applied to the soil as 5% granules on variety NCo 376 under conditions of severe natural infection. The granules were used at a rate of 40 kg/ha and were applied as in Experiments 6 and 7. All the seedcane was treated with triadimefon in cold water for five minutes before planting. Plots consisted of single rows, 7,5 m long and 1,5 m apart. Each was planted with 20 four-budded setts and there were eight replications. The plant crop was harvested at 10,7 months. Data on smut were also recorded from the first ratoon crop.

Experiment 9

The purpose of this experiment, planted at Pongola in December 1979, was to compare the efficacy of several new fungicides with that of triadimefon. The fungicides tested were bitertanol 50% wp (Baycor), furmecyclox 50% ec (BAS 38901F), propiconazole 25% wp (CGA 64250, Tilt) and triadimefon 25% wp and 10% ec (Bayleton). All the fungicides were applied to seedcane for 30 minutes in both hot (50°C) and cold water at concentrations of 250 μg/ml ai. In a further treatment seedcane was dipped in cold water containing triadimefon 25% wp for 10 seconds. The variety used was NCo 376. The setts were inoculated with smut after being treated with the fungicides. The experimental design, layout, planting and harvesting were the same as in Experiments 1 and 2.

Results

Seedcane treatments:

- *Experiments 1 and 2*

Soaking the seedcane for 30 minutes in hot or cold water containing triadimefon at 250 μg/ml controlled smut completely in the plant crops of all three varieties following inoculation in Experiment 1, but the short dip treatment in cold water was not completely effective (Table 1). In the first ratoon crop high levels of smut occurred in all varieties where the fungicide was not used or was applied as a rapid dip (means of 78 000 and 65 000 whips/ha respectively). Low levels of smut occurred in the first ratoon crop where seedcane had been treated for 30 minutes (mean 6 900 whips/ha). In NCo 376 and NCo 310 triadimefon was equally effective when applied in hot and cold water for 30 minutes, but in N55/805 a greater degree of control resulted from treatment with the fungicide in hot water.

The plots subjected to natural infection in Experiment 2 contained little smut in the plant crop in all varieties (the mean of 250 whips/ha was equivalent to only 0,2 whips/plot), despite the addition of smut spores to the soil. In the first ratoon crop a mean of 9 300 whips/ha occurred in the plots without fungicide and a mean of 5 000 whips/ha occurred in plots where setts had received the short dip treatment. However, there was almost complete residual control in all the varieties following fungicide treatment for 30 minutes in hot and cold water (Table 2).

TABLE 1

Effect of treating seedcane of NCo 376, NCo 310 and N55/805 with triadimefon at 250 µg/ml ai in hot and cold water (inoculated seedcane, Experiment 1)

Treatment	% buds germinated at 8 weeks	Smut whips (1000's/ha)		Cane (tons/ha)	
		Plant	1R	Plant	1R
NCo 376, no fungicide	57	19,9	100,9	132	149
NCo 376, CWT/triadimefon rapid dip	43	0,9	24,1	144	187
NCo 376, CWT/triadimefon 30 min	54	0	3,3	139	177
NCo 376, HWT/triadimefon 30 min	64	0	2,4	166	211
NCo 310, no fungicide	51	13,1	72,3	119	162
NCO 310, CWT/triadimefon rapid dip	59	3,9	83,9	140	150
NCo 310, CWT/triadimefon 30 min	56	0	3,9	146	176
NCo 310, HWT/triadimefon 30 min	67	0	3,0	156	201
N55/805, no fungicide	52	4,5	59,8	119	138
N55/805, CWT/triadimefon rapid dip	59	5,1	86,0	125	141
N55/805, CWT/triadimefon 30 min	56	0	18,2	127	153
N55/805, HWT/triadimefon 30 min	76	0	10,7	150	179
LSD (P = 0,05)	11	5,4	36,8	25	32
No fungicide	54	12,5	77,7	124	150
CWT/triadimefon rapid dip	54	3,3	64,7	136	159
CWT/triadimefon 30 min	56	0	8,4	137	169
HWT/triadimefon 30 min	69	0	5,4	158	197
LSD (P = 0,05)	6	3,1	21,2	15	19

TABLE 2

Effect of treating seedcane of NCo 376, NCo 310 and N55/805 with triadimefon at 250 µg/ml ai in hot and cold water (natural infection, Experiment 2)

Treatment	% buds germinated at 8 weeks	Smut whips (1000's/ha)		Cane (tons/ha)	
		Plant	1R	Plant	1R
NCo 376, no fungicide	40	0	14,9	145	174
NCo 376, CWT/triadimefon rapid dip	48	1,5	9,8	140	163
NCo 376, CWT/triadimefon 30 min	38	0	0,3	134	146
NCo 376, HWT/triadimefon 30 min	52	0	0	169	201
NCo 310, no fungicide	68	0,3	9,8	146	187
NCO 310, CWT/triadimefon rapid dip	54	0	3,3	141	165
NCo 310, CWT/triadimefon 30 min	59	0,3	1,8	144	179
NCo 310, HWT/triadimefon 30 min	61	0	0,9	164	188
N55/805, no fungicide	54	0,9	3,3	139	166
N55/805, CWT/triadimefon rapid dip	48	0	1,8	137	174
N55/805, CWT/triadimefon 30 min	50	0	0	134	163
N55/805, HWT/triadimefon 30 min	73	0	1,5	149	174
LSD (P = 0,05)	15	1,4	7,8	28	26
No fungicide	54	0,4	9,3	143	176
CWT/triadimefon rapid dip	50	0,5	5,0	139	167
CWT/triadimefon 30 min	49	0,1	0,7	137	162
HWT/triadimefon 30 min	62	0	0,8	161	188
LSD (P = 0,05)	8	0,8	4,5	16	15

In both Experiments 1 and 2 germination of seedcane was significantly improved by treatment in hot water for 30 minutes. Yields of cane from the plant crops of all varieties in both experiments were highest where seedcane had been treated with triadimefon in hot water for 30 minutes. As a result of treatment with hot water and triadimefon the mean yield of the three varieties increased by 28% following inoculation and by 13% under conditions of natural infection (Tables 1 and 2). When seedcane was either dipped for a few seconds or soaked for 30 minutes in triadimefon in cold water the yield of the plant crop increased by about 10% in Experiment 1 and decreased (not significantly) by 3% in Experiment 2. The responses in yield of the first ratoon crops were similar to those of the plant crops. The yield of NCo 376 in these experiments (means of 15,1 and 17,1 tons/ha/month in the plant and first ratoon crops, respectively after hot water treatment for 30 minutes), is indicative of the excellent growing conditions at Pongola.

Experiments 3, 4 and 5

In the plant crop of NCo 376 in Experiment 3 at Big Bend, none of the seedcane treatments with triadimefon in cold water controlled smut under conditions of natural infection but a significant degree of control occurred when triadimefon was applied in hot water for two hours (Table 3). None of the treatments had much effect on cane yield, which averaged only 5,5 tons/ha/month. High levels of smut occurred in the first ratoon crop (mean of 63 000 whips/ha), where none of the cold water/triadimefon treatments had any effect on the level of smut (Table 3). Although as many as 32 000 whips/ha occurred in the first ratoon after treatment with triadimefon in hot water, this was still a significant degree of control. Treatment with triadimefon for five minutes following hot water treatment had a small but significantly beneficial effect in the first ratoon crop. A beneficial effect of applying triadimefon to seedcane in hot water for two hours was recorded in the second ratoon crop.

TABLE 3

Effect of treating seedcane of NCo 376 with triadimefon at 250 µg/ml ai (natural infection, Experiment 3)

Treatment	Smut whips (1000's/ha)		
	P	1R	2R
No fungicide	4,7	73,0	81,5
HWT/triadimefon 2 h	2,7	32,4	53,0*
HWT 2 h + CWT/triadimefon 5 min	4,9	52,7	64,7
CWT/triadimefon rapid dip	3,6	77,1	80,1
CWT/triadimefon 5 min	7,6	72,5	72,7
CWT/triadimefon 30 min	5,1	70,9	78,7
LSD (P = 0,05)	1,6	14,7	29,5

* Benefit statistically significant on analysis of $\sqrt{\ }$ transformed data

TABLE 4

Effect of treating seedcane of NCo 376, NCo 310 and N55/805 with triadimefon at 250 µg/ml ai in cold water (natural infection, Experiment 4)

Treatment	Cane (tons/ha) Plant cane	Smut whips (1000's/ha)		
		P	1R	2R
NCo 376, no fungicide	72,0	2,3	53,6	83,9
NCo 376, CWT/triadimefon 5 min	78,7	1,9	55,0	79,7
NCo 310, no fungicide	55,0	0,7	60,9	68,5
NCo 310, CWT/triadimefon 5 min	66,1	1,1	66,1	58,7
N55/805, no fungicide	74,3	0,4	30,1	79,9
N55/805, CWT/triadimefon 5 min	75,4	0	25,8	70,2
LSD (P = 0,05)	11,3	0,7	16,0	20,0
Mean, no fungicide	67,1	1,1	48,2	77,4
Mean, triadimefon	73,1	1,0	49,0	69,5
LSD (P = 0,05)	6,5	0,4	9,3	11,6

The results of Experiment 4 (Table 4), in which seedcane of three varieties was treated with triadimefon for five minutes in cold water, confirmed the lack of benefit of this treatment on NCo 376 in Experiment 3. There were approximately 1 000 whips/ha in the plant crop and with no variety was treatment of seedcane with triadimefon in cold water beneficial. High levels of smut occurred in the first and second ratoon crops of all varieties (mean of 49 000 and 73 000 whips/ha) and there was no indication of any residual benefit of treatment. Mean yield of the plant crop was increased by 9% by fungicide treatment.

In Experiment 5 (Table 5), where several methods of applying triadimefon to seedcane of NCo 376 were tested, the results were similar to those of Experiment 3 which had been planted the previous season. Only when seedcane had been treated with triadimefon in hot water was there a significant degree of smut control; 300 whips/ha compared with a mean of nearly 3 000 whips/ha with the other treatments in the plant crop and 19 500 compared with a mean of 36 000 in the first ratoon. Treatment with triadimefon in cold water for between five minutes and two hours was not beneficial. In this trial the germination of seedcane was improved by all the fungicide treatments and this appeared to result in an increase in cane yield, although the only significant response was that to fungicide treatment in hot water for two hours. Cane yields were again low in this trial, with a mean of 6 tons/ha/month.

TABLE 5

Effect of treating seedcane of NCo 376 with triadimefon at 250 µg/ml ai (natural infection, Experiment 5)

Treatment	% buds germinated at 8 weeks	Cane (tons/ha) Plant cane	Smut whips (1000's/ha)	
			P	1R
No fungicide	47,8	54,2	2,6	31,0
HWT/triadimefon 2 h	70,6	70,2	0,3	19,5
HWT 2 h + CWT/triadimefon 30 min	73,6	68,7	2,6	30,2
CWT/triadimefon 5 min	75,8	63,3	2,6	42,8
CWT/triadimefon 30 min	71,5	62,8	2,8	34,3
CWT/triadimefon 2 h	62,6	66,5	3,3	41,9
LSD (P = 0,05)	17,0	14,8	2,1	13,5

Soil treatment:

- *Experiments 6 and 7*

In the plant crop of Experiment 6 more smut occurred where the seedcane of NCo 376 had been inoculated than occurred with natural infection (means of 15 500 and 1 600 whips/ha, respectively, in plots without fungicide). A high degree of smut control was achieved with both 20 and 40 kg triadimefon 5% granules/ha, the higher rate being marginally better (Table 6). Yields of the plant crop were high; a mean of 16,7 tons/ha/month was obtained in plots where infection was natural, and slightly less in plots in which inoculated seedcane had been planted. Neither of the fungicide treatments had any effect on yield.

In the first ratoon crop of Experiment 6, high levels of smut occurred following inoculation in plots without fungicide (81 000 whips/ha). Substantial control of smut in first ratoon occurred from triadimefon applied to the soil at planting, with the higher rate being slightly more effective. A high degree of control of smut in the first ratoon crop was also obtained with both rates of triadimefon under natural infection (Table 6). Very high yields of cane were produced in the first ratoon crop in Experiment 6, with the mean being almost 200 tons/ha (18,3 tons/ha/month). Fungicide treatment increased the yield of cane in the first ratoon in the plots planted with inoculated seedcane by 12%, up to the yield of plots grown under conditions of natural infection.

TABLE 6

Effect of triadimefon applied to the soil at planting on NCo 376 (inoculated seedcane and natural infection, Experiment 6)

Treatment	% buds germinated at 8 weeks	Smut whips (1000's/ha)		Cane (tons/ha)	
		Plant	1R	Plant	1R
Inoculated seedcane					
No fungicide	54	15,5	80,9	162	178
Triadimefon granules, 2 kg/ha ai	50	1,9	15,6	158	200
Triadimefon granules, 1 kg/ha ai	50	5,2	26,5	151	200
LSD (P = 0,05)	4	5,8	20,9	21	13
Natural infection					
No fungicide	61	1,6	11,2	182	197
Triadimefon granules, 2 kg/ha ai	51	0	4,8	164	200
Triadimefon granules, 1 kg/ha ai	55	0	2,0	170	199
LSD (P = 0,05)	4	1,9	11,7	21	13

In the plant crop of Experiment 7, good control of smut in NCo 310 was obtained with all the fungicide treatments. The best control was achieved by the wettable powder treatments and the highest rate of granules (Table 7). Cane yield of the plant crop was not much affected by any treatment and averaged 144 tons/ha (12,9 tons/ha/month).

In the first ratoon crop of Experiment 7, the plots without fungicide contained 24 300 whips/ha. The best control of smut in first ratoon occurred where 40 kg granules/ha and 8 kg wettable powder/ha, both of which contained 2 kg active ingredient/ha, were applied at planting (Table 7). Cane yields in first ratoon were high for this variety, the mean being 163 tons/ha (15,0 tons/ha/month). All fungicide treatments increased the yield of cane, with the greatest increase, 11,5%, occurring at the highest rate of granules.

TABLE 7

Effect of triadimefon applied to the soil at planting on NCo 310 (natural infection, Experiment 7)

Treatment	% buds germinated at 8 weeks	Smut whips (1000's/ha)		Cane (tons/ha)	
		Plant	1R	Plant	1R
No fungicide	61	4,0	24,3	144	155
Triadimefon granules, 2 kg/ha ai	57	0	3,6	150	173
Triadimefon granules, 1 kg/ha ai	57	0,7	6,2	142	163
Triadimefon granules, 0,5 kg/ha ai	57	0,9	12,9	143	166
Triadimefon wp, 2 kg/ha ai	58	0,1	3,3	143	166
Triadimefon wp, 1 kg/ha ai	55	0	6,8	142	159
LSD (P = 0,05)	9	3,1	10,0	20	18

- *Experiment 8*

Good control of smut in NCo 376 was obtained with 40 kg 5% triadimefon granules/ha in the plant crop of Experiment 8, which was conducted under conditions of severe smut at

TABLE 8

Effect on NCo 376 of triadimefon applied to soil at planting (natural infection, Experiment 8)

Treatment	% buds germinated at 8 weeks	Cane (tons/ha) Plant cane	Smut whips (1000's/ha)	
			P	1R
CWT/triadimefon 5 min	65,8	62,6	3,6	47,8
CWT/triadimefon 5 min + 40 kg/ha 5% granules	83,1	74,0	0,1	21,3
LSD (P = 0,05)	11,0	14,8	2,5	22,3

Big Bend (Table 8). A significant degree of control also occurred in first ratoon. Treatment with the granules improved germination significantly, although all the setts had been treated with triadimefon in cold water. Mean cane yield in the plant crop was low (6,4 tons/ha/month) and the granular treatment resulted in an 18% (12 tons/ha) increase in yield.

New fungicides:

- *Experiment 9*

In the comparison of new fungicides with triadimefon, conducted at Pongola using inoculated setts, all the fungicide treatments resulted in excellent control of smut in the plant crop. None of the treatments affected germination adversely and all increased the yield of cane (Table 9). In the first ratoon crop the plots without fungicide contained 98 000 whips/ha. Differences in the efficacy of the treatments were apparent in the first ratoon crop. The least effective treatments were the rapid dip in triadimefon and both treatments with bitertanol. The most effective fungicides were triadimefon, propiconazole and furmecyclox, all of which gave similar, high degrees of control. The effect of the fungicides was the same whether applied in hot or cold water.

In the plant crop all the fungicide treatments increased the yield of cane, the mean increase being approximately 20%. High yields were obtained in the first ratoon crop, where plots without fungicide yielded 155 tons/ha (14,2 tons/ha/month), and the mean increase in yield from the use of fungicide was 18%.

TABLE 9

Effect of treating seedcane of NCo 376 with fungicides at 250 µg/ml ai in hot and cold water (inoculated setts, Experiment 9)

Treatment	% buds germinated at 8 weeks	Smut whips (1000's/ha)		Cane (tons/ha)	
		Plant	1R	Plant	1R
No fungicide	42	18,2	97,6	81	155
CWT/triadimefon rapid dip	49	0	26,5	116	187
HWT/triadimefon wp 30 min	48	0	0	101	190
CWT/triadimefon wp 30 min	35	0	2,1	93	167
HWT/triadimefon ec 30 min	52	0	5,7	109	177
CWT/triadimefon ec 30 min	49	0	0	125	192
HWT/bitertanol 30 min	63	1,8	13,7	116	194
CWT/bitertanol 30 min	55	0	25,0	100	175
HWT/furmecyclox 30 min	44	0	1,8	80	182
CWT/furmecyclox 30 min	51	0	4,5	100	185
HWT/propiconazole 30 min	48	0	0	93	183
CWT/propiconazole 30 min	41	0	2,1	93	180
LSD (P = 0,05)	16	3,4	12,1	42	29
Fungicides in hot water 30 min	50	0,4	4,2	100	186
Fungicides in cold water 30 min	46	0	6,7	102	180
LSD (P = 0,05)	6,9	1,5	5,4	19	13
Triadimefon wp 30 min	41	0	1,0	98	179
Triadimefon ec 30 min	51	0	2,8	118	186
Bitertanol 30 min	59	0,9	19,3	108	185
Furmecyclox 30 min	47	0	3,1	90	184
Propiconazole 30 min	42	0	1,0	93	182
LSD (P = 0,05)	11	2,4	8,5	29	21

Discussion

The different conditions at Pongola and Big Bend under which triadimefon was evaluated are illustrated by the differences in yield and in the severity of smut at the two sites. Cane yields were two to three times greater at Pongola than at Big Bend under similar conditions of weather and irrigation. The differences in yield can therefore be mainly attributed to the different soil conditions. The soil at Big Bend was shallow and stony, with the result that the crop was often stressed.

Higher levels of smut from natural infection occurred at Big Bend. At Pongola the mean numbers of smut whips occurring from natural infection in plant and first ratoon crops of NCo 376 without fungicide were 800 and 13 100 respectively (Experiments 2 and 6), whereas the means at Big Bend were 3 200 and 52 500 (Experiments 3, 4 and 5). More smut occurs where sugarcane suffers from stress (Bailey[3]); thus the higher levels of smut at the Big Bend site may have been due partly to the poorer soil conditions there. However, infection pressure was also much greater at Big Bend.

Both the yield of NCo 376 and the number of smut whips resulting from natural infection at Chiredzi (Anon[2]) were similar to those that occurred in this variety at Pongola. It appears therefore that at Chiredzi triadimefon was evaluated under conditions more similar to those at Pongola than those at Big Bend.

The application of triadimefon at 250 µg/ml as a seedcane dip or soak in cold water did not control smut at Big Bend, even as a prolonged treatment of two hours. Treating seedcane with triadimefon in cold water was effective at Pongola, both under conditions of natural infection and inoculation of setts, with a rapid dip treatment being less effective than treatment for 30 minutes. This performance of triadimefon when applied in cold water at Pongola was similar to that in the work conducted at Chiredzi.

Treating seedcane with triadimefon in hot water for two hours was more effective than treatment in cold water for two hours under the harsh conditions at Big Bend. The reason for this is not clear. Although seedcane treated in hot water has not been shown to absorb more fungicide (unpublished data), it must be assumed that it does do so and that the fungicide is active on or in the buds where infection occurs. The fungicide may also be more active systemically and possibly for a longer period if used in hot water. Both of these effects could be related to the amount of fungicide absorbed.

Based on the results of these experiments, hot water treatment with triadimefon (2 h at 50°C with 250 µg/ml ai) is recommended as being likely to give a high degree of control of smut. This treatment also controls any RSD in the seedcane and is recommended where seedcane of susceptible varieties is planted into nurseries. Hot water treatment with triadimefon for two hours may be too costly and laborious for commercial plantings, but treatment for 30 minutes may be worthwhile. The effect of the latter treatment on smut under conditions of severe contamination has yet to be determined but systemic smut in the seedcane would be controlled and substantial increases in yield could be expected.

The value of treating seedcane with triadimefon in cold water is less certain. This treatment may not be effective where susceptible varieties are planted under conditions of severe smut, such as occurred at Big Bend. The treatment is, however, likely to be beneficial where infection pressure is less intense, as was the case at Pongola. A further factor to consider is that tests of fungicides in small plots may not be completely reliable, because of the presence of disease in control plots and those receiving ineffective treatments. The efficacy of fungicides may therefore be underestimated. A greater degree of control might therefore be expected in large scale, commercial operations than is indicated by the results from small plots. Treating seedcane with triadimefon in cold water may also lead to improved germination and increased yields.

The treatment of seedcane of susceptible varieties with triadimefon in cold water is therefore recommended if application in hot water is not feasible. The doubt regarding the value of treatment with triadimefon in cold water under conditions of severe smut should soon be resolved when the results of field-scale trials which are in progress in the Big Bend area become available.

The results of Experiments 1 and 2 with NCo 376, NCo 310 and N55/805 confirm earlier results obtained under glasshouse conditions in South Africa (unpublished) suggesting that triadimefon is effective against smut on several susceptible varieties. It seems probable therefore that the fungicide is generally effective against sugarcane smut.

An increase in yield from the use of triadimefon on inoculated seedcane was not unexpected, considering the severe smut that develops where no fungicide is used. Increases in yield under conditions of natural infection are more pertinent to the field situation. In Experiment 2, only hot water treatment with triadimefon improved cane yield. In the plant crop this was probably mainly due to a stimulating effect of the short treatment in hot water on growth, since very little smut occurred, but in the first ratoon crop part of the increase in yield may have been because smut was controlled.

Increased yields in the first ratoon crop of Experiment 5 at Big Bend, after treating seedcane with triadimefon in hot water, and in the first ratoon crop of Experiment 7, at Pongola and the plant crop of Experiment 8, after applying triadimefon to the soil, were probably due to the control of smut. An increase in yield from the use of triadimefon in commercial practice could therefore be expected where smut is common.

Although a high degree of control of smut with triadimefon when inoculated seedcane was used was not unexpected, the occurrence of control under natural infection requires some explanation. Sugarcane tillers profusely and it is unlikely that triadimefon applied to seedcane would be present in amounts which would be effective against infection in tillers arising later and some distance from the initial buds. It is highly unlikely that enough fungicide would be present in ratooning sugarcane 12 months or more after planting to be effective. The high degree of control with triadimefon in the plant crops in some experiments and the persistence of control into ratoon crops therefore suggest that infection of the primary shoots and first tillers has a large influence on the subsequent development of the disease in ratoon crops.

The ineffectiveness of seedcane treatment with triadimefon in cold water at Big Bend was evidently due to insufficient fungicide being present at the germinating buds and tillers to protect them against the high pressure of infection.

In Experiment 6, 7 and 8 the substantial control of smut obtained by applying triadimefon to the soil at planting confirms the systemic activity of the fungicide reported previously (Bailey[4]). However, the price of the fungicide and the high rate at which it is needed for good control of smut, approximately 2 kg ai/ha, does not make this method of application economically worthwhile.

Conclusions

Treating seedcane of smut-susceptible varieties with triadimefon before planting is advisable in areas where smut is likely to occur. At a concentration of 250 μg/ml ai, the greatest degree of control can be expected from applying the fungicide in hot water for two hours. This treatment is especially valuable for seedcane nurseries. Where hot water treatment with triadimefon is considered impractical or uneconomic, treatment in cold water for at least five minutes is desirable, but it may not be effective if susceptible varieties are planted in areas where smut is severe.

High rates of triadimefon applied in the planting furrow can control smut effectively but at present this method of application is not economically worthwhile.

Two other fungicides, furmecyclox and propiconazole, were as effective as triadimefon in controlling smut after setts were inoculated. Further evaluation of new fungicides using different methods of application is needed.

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