POSSIBILITIES FOR THE CONTROL OF SUGARCANE SMUT (*USTILAGO SCITAMINEA*) WITH FUNGICIDES

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Abstract

Results are described of field trials in which attempts were made to control sugarcane smut with fungicides. Smut was successfully controlled in the plant cane crop when seedcane was treated in hot water containing the fungicide triadimefon. Control occurred when treated setts were subsequently either inoculated with smut or were planted into soil infested with smut spores. A triadimefon/hot water treatment for seedcane is suggested as a means of controlling both smut and ratoon stunting disease (RSD). In areas where smut is severe this treatment may allow hot water treatment (HWT) to be used to eliminate RSD and smut from sugarcane while also protecting the treated seedcane from subsequent infection by smut.

Introduction

Sugarcane smut (*Ustilago scitaminea* Sydow) is becoming a more important problem in many cane growing areas of the world. In recent years smut has spread to the Caribbean and it first appeared in the continental United States in 1978. The disease is common in all cane growing countries in southern and central Africa, where production is largely based on the susceptible varieties NCo 310 and NCo 376. The incidence of smut is increasing in Swaziland and in the more northerly parts of the South African sugar industry and in some areas has reached an economically serious level.[3, 5]

Experience from Rhodesia and some parts of Swaziland has shown that smut can be contained by the intensive application of field control measures, provided that the varieties grown are not extremely susceptible and that smut is not allowed to reach a very serious level of development. These measures include the production and planting of healthy seedcane, in addition to the roguing of diseased plants and the ploughing out of severely smutted fields to reduce the inoculum concentration of the disease.

The smut pathogen usually infects the cane plant through the buds[1, 6] and the infection of the buds of seedcane at or shortly after planting is likely to be an important factor in the development of epidemics.

A successful fungicide treatment that aided in the production of healthy seedcane and that protected seedcane from infection at planting could make a useful contribution to the control of smut. Application to seedcane at planting is also likely to be the simplest and cheapest method by which chemicals could be used for disease control in sugarcane.

Hot water treatment is well known to eliminate smut from infected seedcane. However, there is much evidence from South Africa that HWT increases the susceptibility of seedcane to subsequent infection[4]. Thus treated seedcane can be rapidly infected if it is planted into soil that is severely contaminated with smut spores and the resulting crop can develop more smut than if the seedcane were untreated. It is for this reason that HWT has not been used in the northern, irrigated production areas of South Africa and in Swaziland since 1976. In these areas smut is widespread in the dominant variety, NCo 376, but RSD is not a production problem under fully irrigated growing conditions. A fungicide treatment for seedcane that afforded protection against smut after HWT would permit the re-introduction of HWT into these areas.

Most investigations of the use of fungicides for the control of smut have been carried out with setts that were inoculated by dipping in spore suspensions, either before or after treatment with fungicides.[2, 7, 8, 9] Partial control has been reported for the fungicides Aretan[7, 8] pyracarbolid[2] and several coded compounds.[7, 9] Under such conditions of testing, with the fungicide in close contact with the smut spores on the setts, the fungicides are most likely to appear effective. However, complete control has not been obtained in tests with inoculated setts. Little or no work has been reported on the testing of fungicides applied to healthy or diseased setts that have been planted in the field under severely smut-contaminated conditions.

Materials and Methods

The six experiments reported in this paper were all conducted under irrigated conditions in an arid environment. Experiments 1 to 5 were conducted at Big Bend, Swaziland. In this area smut is endemic and is developing into a major production problem in variety NCo 376. The experimental site was on a Somerling series soil, a shallow, gravelly clay loam. The incidence of smut at this site was high. Experiments 1 and 2 were conducted from August 1976 to August 1978 and experiments 3, 4 and 5 from November, 1977 to November, 1978. Experiment 6 was carried out at Pongola during 1978/79 on a deep, Makatini series clay loam. Smut is also endemic in this area but the incidence of infection at the trial site was lower than at the Big Bend site.

The variety used in all the experiments was NCo 376, which is highly susceptible to smut when inoculated or when exposed to a high inoculum concentration of the disease. NCo 376 has a resistance rating of 9 (on a scale of 0, immune to 9, very highly susceptible) from its reaction after the inoculation of seedcane setts, when 50% or more plants usually develop smut. With the exception of most of the treatments in experiment 4, all the NCo 376 seedcane used was obtained from nurseries grown in a smut-free area. This seedcane was free from all systemic diseases before planting or before inoculation with smut.

Experiments 1 and 2

The first two experiments were intended to investigate whether the addition of fungicides to a long HWT (2 h/50°C) could overcome the deleterious effects of HWT on the reaction of seedcane to smut. The five fungicides tested were benomyl 50% wp (Benlate), carboxin 75% wp (Vitavax), fenfuram 80% wp, (Panoram), pyracarbolid 40% ec (Sicarol) and triadimefon 25% wp (Bayleton). Carboxin was also applied to seedcane that had not been heat treated and as foliar sprays on to young cane. The treatments were :

HWT (2 h/50°C), no fungicide.
HWT + benomyl in HWT tank (500 µg/ml ai).
HWT + pyracarbolid in HWT tank (500 µg/ml ai).
HWT + fenfuram in HWT tank (500 µg/ml ai).
HWT + triadimefon in HWT tank (500 µg/ml ai).
HWT + carboxin in HWT tank (500 µg/ml ai).
HWT + carboxin foliar sprays, 1,6 kg/ha at 4, 6 and 8 weeks after planting.

HWT + carboxin in HWT tank + carboxin foliar sprays.
No HWT, no fungicide.
No HWT + carboxin, 2 h cold soak (500 µg/ml ai).

Plots consisted of single rows of 7,5 m at a spacing of 1,5 m. Each plot contained 20, 4-budded setts and the treatments were replicated four times. In experiment 1, after the hot water and fungicide treatments had been carried out, the setts were inoculated with smut by soaking for 15 minutes in a fresh suspension of smut spores (approximately 5 x 10^6/ml) immediately before planting. In experiment 2 the treated setts were planted in furrows into which smut spores had been incorporated (one fresh smut whip per row of 7,5 m). Considerable natural contamination of the soil of the trial site from infected surrounding cane was likely.

These first experiments were conducted over the plant and first ratoon crops on a growing cycle of 12 months. Smut whips developing in the plots were counted at monthly intervals. In the plant crop the whips were removed at each inspection and a cumulative total of the whips in each plot was determined. In the first ratoon crop the smut whips were not removed and the maximum number of whips in each plot was recorded.

Experiment 3

This experiment was intended to confirm some of the results from the plant crop of experiments 1 and 2. Fenfuram and triadimefon were again added to the hot water tank. Aretan (methoxyethylmercury chloride, 6% Hg), benomyl, carboxin, fenfuram and triadimefon were applied as cold soak treatments for two hours. Triadimefon was also tested as a cold soak treatment for seedcane after HWT. Aretan was used at a concentration of 0,3% of the formulation and the other fungicides were used at concentrations of 500 µg/ml ai.

Plots consisted of single rows (7,5 m at 1,5 m spacing), each containing 20, 3-budded setts. There were five replications. The treated setts were planted in soil into which smut spores had previously been incorporated, as in experiment 2. Smut whips that developed in the 12 month plant crop were removed and counted at monthly intervals and a cumulative total for each plot was determined.

Experiment 4

In this experiment smut-infected seedcane was subjected to various fungicide and hot water treatments. The seedcane had been selected from stools that showed symptoms of smut in a commercial field of NCo 376 at Big Bend. The treatments were :

Healthy seedcane, no HWT or fungicide.
Infected seedcane, no HWT or fungicide.
Infected seedcane, HWT 2 h/50°C.
Infected seedcane, HWT 0,5 h + triadimefon in HWT tank.
Infected seedcane, HWT 1 h + triadimefon in HWT tank.
Infected seedcane, HWT 2 h + triadimefon in HWT tank.
Infected seedcane, HWT 2 h + fenfuram in HWT tank.
Infected seedcane, no HWT + triadimefon 2 h cold soak.
Infected seedcane, no HWT + fenfuram 2 h cold soak.
Infected seedcane, no HWT + triadimefon 80 kg/ha 1,25% granules.
Infected seedcane, no HWT + triadimefon 0,5 h soak + 80 kg/ha triadimefon granules.

Triadimefon and fenfuram were applied at concentrations of 500 µg/ml ai in the HWT tank and as cold soaks. The triadimefon granules were applied over the setts in the planting furrow. Smut spores were not added to the soil before planting in this experiment, but surrounding cane was severely infected. Each treatment was applied to four, single-row plots of 7,5 m at a spacing of 1,5 m. Each plot contained 20 3-budded setts. Smut whips that developed in the plant crop of 12 months were recorded as in experiment 3.

Experiment 5

Various methods of application of triadimefon to healthy seedcane were tested in this experiment, to investigate possible methods for the treatment of seedcane for planting in commercial fields. The fungicide treatments were 20, 40 and 80 kg/ha of 1,25% granules applied over the setts in the planting furrow; seedcane soaks for five minutes, 30 minutes, one hour and two hours at a concentration of 500 µg/ml ai, 0,5 and 1,0 kg/ha triadiamefon 25% wp sprayed over the setts in the furrow and a combination of a five minute seedcane soak and 40 kg/ha of granules.

The plots were single rows of 7,5 m, 1,5 m apart, and each plot contained 20 3-budded setts. There were five replications. The soil had been contaminated with smut spores before planting, as in experiments 2 and 3. Smut incidence in the 12 month plant crop was determined as in experiments 3 and 4.

Experiment 6

In this experiment, planted at Pongola in October 1978, the effects of various combinations of HWT and concentrations of triadimefon on seedcane were investigated. The treatments included all combinations of 0,5 h and 2 h HWT at 50°C with 0, 125, 250 and 500 µg/ml ai concentrations of triadimefon added to the hot water tank. There was also a cold soak treatment for two hours at a concentration of 500 µg/ml ai without HWT. After the seedcane treatments had been carried out the setts were inoculated by soaking in a fresh suspension of smut spores (approximately 5 x 10^6/ml) for 15 minutes before planting. Individual plots were single rows of 10 m, at a spacing of 1,4 m. Each plot contained 20 3-budded setts and there were five replications. Smut whips were counted periodically but were not removed.

Results

Experiment 1 and 2

Very few of the setts that had been treated with pyracarbolid germinated. Subsequent experience with other fungicides has shown that it was probably the oil component of the emulsifiable concentrate formulation of pyracarbolid that was phytotoxic. Smut occurred in some of the plants that grew from setts treated with pyracarbolid and this treatment is not considered further. Germination was satisfactory in the plots of all other treatments, with means of 64% buds germinated afer inoculation in exeriment 1 and 68% buds germinated in experiment 2. Differences in germination among the plots of the other treatments were not significant.

The first smut whips appeared 3,3 months after planting. Whip development reached a maximum in both experiments in February 1977, six months after planting.

In the plant crop of experiment 1 large differences in smut incidence occurred between replicates of the various treatments (Table 1). Plots planted with seedcane treated with triadimefon in the HWT tank were free of smut throughout the plant crop. Some control of smut was apparent in the plots planted with seedcane treated with fenfuram and benomyl. The incidence of smut in these plots, however, was still substantial, (means of 29 000 and 87 000 whips/ha respectively compared with 178 000 whips/ha in the control plots that were planted with heat treated seedcane). Carboxin applied in the HWT tank or as foliar sprays was ineffective.

Much more smut developed in the plots planted with heat treated seedcane compared with seedcane that was not heat treated in experiment 1. Carboxin provided some control of smut when applied in a cold soak treatment to setts that had not been heat treated, although the number of whips that developed in plots of this treatment was still high. Yield of cane in the plant crop of experiment 1 was closely related to smut incidence. Yields varied from approximately 110 tons/ha in plots with the least smut to approximately 60 tons/ha in the most severely affected plots (mean, 83 t/ha).

In experiment 2, in which the setts had been exposed to natural infection, a total of approximately 15 000 smut whips developed in the most severely affected plots in the plant cane crop (Table 2). However, much less smut developed in this experiment than in experiment 1 (means of 6 000 and 90 000 whips/ha respectively). Triadimefon applied in the HWT tank again completely prevented the development of smut in the plant cane crop. There was an indication that fenfuram applied in the HWT tank was partly effective but carboxin applied in the HWT tank or as foliar sprays was again ineffective. Heat treatment also increased the incidence of smut in this experiment. No effect of smut on cane yield was apparent in experiment 2 and mean yield was 116 tons/ha.

In the first ratoon crops of experiments 1 and 2 smut whips first appeared in November 1977, three months after cutting and numbers of whips reached a peak after six months. The maximum numbers of whips that occurred in the plots of the various treatments are shown in Tables 1 and 2. In experiment 1 the incidence of smut in first ratoon was generally similar to that in the plant crop. (The different method of assessing smut incidence compared with the plant crop should

TABLE 1

Effect of fungicides and HWT on smut incidence and cane yield in NCo 376 (inoculated setts, Experiment 1)

Treatment	Plant cane			First ratoon		
	Total whips/ha (1 000's)	Whips √ trans	Tons cane/ha	Maximum whips/ha (1 000's)	Whips √ trans	Tons cane/ha
HWT 2 h/50° C	178,4	13,3	58,3	68,4	8,7	51,0
HWT + benomyl in HWT tank	86,9	9,3	68,3	60,9	8,2	46,9
HWT + fenfuram in HWT tank	22,9	4,7	108,9	35,8	6,3	92,6
HWT + triadimefon in HWT tank	0	0	111,7	18,4	4,5	108,5
HWT + carboxin in HWT tank	137,6	11,6	65,3	72,9	9,0	44,5
HWT + carboxin foliar sprays	116,0	10,8	67,2	—	—	—
HWT + carboxin in HWT tank + foliar sprays	176,9	13,3	77,2	—	—	—
No HWT	64,9	7,8	77,8	43,6	7,0	66,0
No HWT + carboxin 2 h soak	26,2	5,0	113,3	24,4	5,2	101,6
LSD (P = 0,05)	—	2,1	24,5	—	1,1	26,2
Mean HWT	102,7	9,0	—	51,3	7,3	—
Mean No HWT	45,6	6,4	—	34,0	5,6	—
LSD (P = 0,01)	—	1,6	—	—	0,9	—

TABLE 2

Effect of fungicides and HWT on smut incidence in NCo 376 (healthy seedcane planted in infested soil, Experiment 2)

Treatment	Plant cane		First ratoon	
	Total whips/ha (1 000's)	√ trans	Max. whips/ha (1 000's)	√ trans
HWT 2 h/50°C	9,3	2,9	20,0	4,7
HWT + benomyl in HWT tank	8,2	2,9	22,7	4,9
HWT + fenfuram in HWT tank	4,9	1,6	23,3	5,1
HWT + triadimefon in HWT tank	0	0	16,4	4,3
HWT + carboxin in HWT tank	8,2	2,7	22,0	4,7
HWT + carboxin foliar sprays	5,8	2,0	28,2	5,5
HWT + carboxin in HWT tank + foliar sprays	14,9	3,8	19,8	4,7
No HWT	3,3	1,3	11,3	3,5
No HWT + carboxin 2 h soak	1,1	0,7	15,6	4,1
LSD (P = 0,05)	—	1,5	—	1,6
Mean HWT	7,3	2,3	21,8	4,8
Mean No HWT	2,2	1,0	13,5	3,8
LSD (P = 0,05)	—	0,8	—	0,9

be noted). Although smut did occur in the plots treated with triadimefon that had been previously smut-free, the triadimefon plots had the lowest incidence of smut. There was also a residual beneficial effect of carboxin applied as a cold soak treatment to seedcane that had not been heat treated.

In the first ratoon crop of experiment 2 the general incidence of smut increased considerably compared with that in the plant cane crop (Table 2). Smut occurred in plots treated with triadimefon that had been free of smut in the plant crop, but the incidence of smut in these plots was the lowest among those that had been planted with heat treated seedcane. However, differences in smut incidence between the various treatments were not significant.

In the first ratoon crops of both experiments significantly more smut occurred in plots that had been planted with heat treated seedcane.

As in the plant cane crop, cane yield in first ratoon was highly correlated with smut incidence in experiment 1 but no differences in yield due to smut were apparent in experiment 2. Yields were similar to those of the plant cane crops.

Experiment 3

The germination of seedcane was generally satisfactory in this experiment (57% of buds germinated on average) and differences in germination among treatments were not significant.

Smut first developed in March 1978, four months after planting. Plots planted with seedcane treated with triadimefon in the HWT tank were free of smut throughout the plant crop (Table 3). In the other plots there was a mean of over 4 000 whips/ha. This level of smut, due to natural infection, is equivalent to fewer than five whips in each of these small plots. No other treatment significantly affected the level of smut but there was an indication that triadimefon was effective when applied as a cold soak. The failure of fenfuram in the HWT tank and carboxin as a cold soak differed from the results of the first experiments.

Cane yields in experiment 3 were comparatively low (mean, 89 t/ha) but no effects of the treatments on yield were apparent.

TABLE 3

Effect of fungicides and HWT on smut incidence in NCo 376 (healthy cane planted in infested soil, Experiment 3)

Treatment	Smut whips	
	Total/ha	√ trans
No HWT	7 500	2,5
HWT 2 h/50° C.	4 100	1,8
HWT 2 h + triadimefon in HWT tank	0	0
HWT 2 h + 2 h cold soak triadimefon	2 100	1,3
HWT 2 h + fenfuram in HWT tank.	5 200	2,3
Not HWT, Aretan 2 h cold soak	3 600	1,9
Not HWT, benomyl 2 h cold soak	7 800	2,8
Not HWT, carboxin 2 h cold soak	4 300	2,1
Not HWT, fenfuram 2 h cold soak	4 400	2,1
Not HWT, triadimefon 2 h cold soak	2 700	1,6
LSD (P = 0,05)	—	1,2

Experiment 4

Germination of both the healthy and infected seedcane in experiment 4 was satisfactory and uniform, with the proportion of buds germinating similar to that in experiment 3 (63%). Smut first appeared in April, 1978, 4,5 months after planting. There were significant differences in the numbers of smut whips among the plots of some of the treatments (Table 4). Triadimefon in the HWT tank for 0,5 to 2 h and the cold soak treatment with triadimefon effectively controlled smut. The mean number of whips in these treatments, 670/ha, is equivalent to only one whip in every 10 m of row. The control by the cold soaks with triadimefon was in contrast to the results of experiments 3 and 5. The apparent difference in the efficacy of this treatment may have been related to the planting of infected seedcane in experiment 4, compared with the planting of healthy seedcane in infested soil in experiments 3 and 5.

There was a tendency for more smut to occur in the plots planted with infected rather than healthy seedcane (the difference between the mean number of whips in the "healthy" plots and the mean number in the "infected" plots where smut was not controlled just failed to reach significance). However, it appears that the degree of infection of the seedcane used in this experiment was low.

Cane yields were variable (mean, 92 t/ha) but were apparently not affected by smut.

TABLE 4

Effect of fungicides and HWT on smut incidence in NCo 376 (infected seedcane, Experiment 4)

Treatment	Smut whips	
	Total/ha	√ trans
Healthy seedcane, no HWT or fungicide	2 000	1,5
Infected seedcane, no HWT or fungicide	4 200	2,1
Infected seedcane, HWT 2 h/50° C	5 400	2,0
Infected seedcane, HWT 0,5 h + triadimefon	400	0,4
Infected seedcane, HWT 1 h + triadimefon	1 100	0,8
Infected seedcane, HWT 2 h + triadimefon	700	0,4
Infected seedcane, HWT 2 h + fenfuram	4 900	2,3
Infected seedcane, no HWT + 2 h cold soak triadimefon	700	0,6
Infected seedcane, no HWT + 2 h cold soak fenfuram	9 100	3,2
Infected seedcane, no HWT + triadimefon granules	3 300	1,9
Infected seedcane, no HWT + 0,5 h soak triadimefon + triadimefon granules	400	0,5
LSD (P = 0,05)	—	1,1

Experiment 5

In this experiment, in which various possible methods of applying triadimefon to seedcane for commercial fields were tested, germination of buds was satisfactory and uniform (mean, 63%). Smut whips first appeared in April, 4,5 months after planting. Comparatively little smut developed in the plant crop (mean maximum number in each plot, 1 900 whips/ha). Differences in smut incidence among the plots of the various treatments were generally not significant (Table 5). The cold soak treatments were ineffective but there were indications of some control at the higher rates of soil-applied granules (40 and 80 kg/ha) and the higher rate of the spray treatment (1 kg/ha 25% wp). The mean number of whips in the plots where granules had been applied (1 000/ha) was significantly lower than that in the plots planted with seedcane that had undergone cold soak treatments (3 100/ha). Cane yields were low (mean 80 t/ha) but no effect of the treatments on yield was apparent.

TABLE 5

Effect of triadimefon applied to setts or to the soil at planting on smut incidence in NCo 376 (healthy cane planted in infested soil, Experiment 5)

Treatment	Smut whips	
	Total/ha	√ trans
No fungicide	1 960	1,1
80 kg/ha 1,25% granules in furrow	530	0,6
40 kg/ha 1,25% granules in furrow	710	0,7
20 kg/ha 1,25% granules in furrow	1 780	1,2
2 h cold soak 500 ug/ml ai	3 560	1,7
1 h cold soak 500 ug/ml ai	1 780	1,2
30 min in cold soak 500 ug/ml ai	3 730	2,0
5 min cold soak 500 ug/ml ai	3 200	1,7
1 kg/ha 25% wp sprayed over setts in furrow	890	0,9
0,5 kg/ha 25% wp sprayed over setts in furrow	1 780	1,2
5 min soak + 40 kg/ha granules	1 240	0,9
LSD (P = 0,05)	—	1,1
Mean granular treatments	1 070	0,8
Mean cold soak treatments	3 070	1,6
LSD (P = 0,05)	—	0,6

TABLE 6

Effect of duration of HWT and concentration of triadimefon on stalk population and smut incidence in NCo 376, 6 months after the inoculation of treated setts (Experiment 6)

Treatment		Stalks/ha (1 000's)	Smut whips/ha (1 000's)
HWT (50° C) and duration (h)	Triadimefon (μg/ml)		
HWT 0,5	0	117	35,3
HWT 2	0	105	30,8
HWT 0,5	125	161	0
HWT 2	125	158	0
HWT 0,5	250	155	0
HWT 2	250	169	0
HWT 0,5	500	158	0
HWT 2	500	149	0
No HWT 2	0	145	15,8
No HWT 2	500	155	0

Experiment 6

The results available from this experiment up to six months after planting are shown in Table 6. Excellent germination occurred in the plots of all the treatments, with a mean of 82% buds germinating.

Smut whips were first observed in the trial in February 1979, three months after planting. At six months after planting smut had not occurred in any of the plots that had been planted with seedcane treated with triadimefon, whereas the plots planted without fungicide treatment were severely affected.

These results indicate that a HWT/triadimefon treatment of as little as 30 minutes and 125 ug/ml ai may be effective in protecting treated seedcane from infection at planting. In this experiment triadimefon appplied as a cold soak for two hours completely prevented infection after treated setts were inoculated. This result differs from those of experiments 3 and 5, in which the treated setts were planted in smut-infested soil. Triadimefon granules (80 kg/ha, 1,25% ai) applied in the guard rows of experiment 6 failed to protect inoculated setts from smut. In the plots without triadimefon approximately twice as many smut whips occurred in plots planted with heat treated seedcane compared with plots planted with seedcane that had been soaked in cold water.

Stalk populations at six months were approximately 30% lower in the plots with the most smut whips than in the plots without smut.

Discussion and conclusions

The small plots used in all the experiments and the relatively low levels of smut in all but the first and last experiments, in which inoculation was used, were not suitable for the detection of any but large differences in the effects of the various treatments. Slight or moderate, but non-significant, effects of some of the treatments may well have been real. However, the experiments were successful in identifying treatments that exerted substantial control of smut resulting from the infection of seedcane and the planting of infected seedcane.

The relevance of the results to a natural disease situation in the field must be considered. All the experiments were conducted in areas that are favourable for the development of smut. The infection of seedcane, when it is planted into infested soil, is probably an important factor in smut epidemiology. Thus the results of experiments 1 and 6, in which treated setts were dipped in a spore suspension immediately before planting, are also likely to have been a useful guide to the benefits of the treatments under natural conditions.

Triadimefon applied to seedcane in the hot water tank consistently provided complete or excellent protection against smut in the plant cane crops in the five experiments in which this treatment was tested. This treatment was effective for infected seedcane and for healthy seedcane that was inoculated, or planted in soil containing smut spores. The treatment, therefore, is both eradicative and protective in action. Control throughout the plant cane crop from a triadimefon/hot water treatment and the efficacy of the soil-applied granules indicate that triadimefon has some systemic activity against smut. Trials under glasshouse conditions have shown that triadimefon/HWT is effective on several other smut-susceptible varieties, in addition to NCo 376.

Variable results were obtained when triadimefon was applied as a cold soak treatment. The reason for the much greater protection when the fungicide was applied in hot water is not known. It is possible that hot water increased the uptake of triadimefon by the sett or increased the availability of the fungicide at the buds. It is also possible that exposure to heat altered the properties of the fungicide and so increased its efficacy.

The partial control obtained with fenfuram applied in the HWT tank and carboxin applied as a cold soak in experiments 1 and 2 were not confirmed in the later experiments. The failure of Aretan to protect setts from infection in experiment 3 differs from published results of work with inoculated setts.

The benefits of a HWT of two hours with triadimefon include the elimination of RSD from seedcane as well as both the elimination of smut and protection against re-infection by smut. This treatment therefore allows the re-introduction of HWT of seedcane into the smut-affected, northern irrigated areas of the South African sugar industry.

The benefits of applying triadimefon to seedcane for planting into commercial fields are less certain than those of a treatment for seedcane to be planted in nurseries. Some promising results were obtained when triadimefon was applied as a cold soak treatment to setts and also when the fungicide was applied over the setts in the planting furrow as granules or sprays. Further investigation of these methods of application is necessary.

The results of experiment 6 indicate that a short HWT (0,5 h) with triadimefon may be effective in protecting setts. If these results are confirmed, this method of application may be suitable for use when planting commercial fields, although it may be inconvenient compared with more usual planting techniques.

Other questions which require elucidation are the concentration of triadimefon in the HWT tank and the duration of the period over which triadimefon retains activity in the HWT tank. These aspects have considerable economic significance.

The relative importance of the infection of seedcane at planting and of the planting of infected seedcane in the development or maintenance of a smut epidemic are uncertain. Hence the contribution that the treament of seedcane with fungicides can make towards the control of smut is difficult to assess. However, the ability to ensure that seedcane planted is free of smut and does not develop symptoms during the plant crop is likely to be an important aid in the control of this disease.

Although smut developed in first ratoon in plots that had been treated with triadimefon and were free of smut in the plant crop, this occurred under constant infection pressure from adjacent infected cane. The benefits of effective seedcane treatment might persist into a ratoon crops to a greater degree when a large area is treated, as would occur in commercial practice.

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