FURTHER EVALUATION OF FUNGICIDES FOR CONTROL OF PINEAPPLE DISEASE OF SUGARCANE

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Abstract

In a series of screening trials a number of new, non-mercurial fungicides have shown promising results in controlling pineapple disease of sugarcane (*Ceratocystis paradoxa*). Several of the fungicides tested are as effective as Aretan and Benlate and are now registered for use in sugarcane. Growers now have a choice of effective non-mercurial fungicides for sett dip treatment.

Introduction

Poor germination of sugarcane setts under conditions that are not optimum for rapid germination can often be attributed to pineapple disease, caused by the fungus *Ceratocystis paradoxa*.

Whenever conditions for germination are adverse, because of low soil temperatures, drought or waterlogged soils, infection of the setts can affect germination considerably. Varieties differ in their susceptibility to pineapple disease but germination failures can occur in most varieties under adverse conditions if control measures are not applied before planting.

An effective way of controlling the disease is by dipping the setts in a protective fungicide before planting. Because of the high costs of gap filling and the deleterious effects of poor and slow germination on cane growth, sett treatment is always advisable. Treatment is particularly recommended for autumn planting, when conditions are often adverse, and after hot water treatment, when susceptibility may be increased.

The withdrawal of registration of compounds based on mercury for use in sugarcane in South Africa, and the phasing out of these materials in recent years, have necessitated a search for alternative, effective fungicides. Benlate (benomyl) was the first non-mercurial fungicide found to provide effective control of pineapple disease, (Mitchell-Innes and Thomson[2]) and it has now been used by growers for several years. A number of other fungicides have also been reported to show promise (Mitchell-Innes and Thomson[3]).

This paper describes three recent field trials for the evaluation of fungicides for control of pineapple disease.

Methods

Trials to screen and test new fungicides are regularly carried out at the Experiment Station of the S.A. Sugar Association. Fungicides, after successfully passing preliminary agar plate tests (Mitchell-Innes and Thomson[3]) and glasshouse trials (Anon[1]), are promoted to field trials at several concentrations, and are evaluated several times before being recommended for use in sugarcane. Three such field trials were established during the period 1974-76.

Experiment 1

This trial was established on a sandy loam at the Experiment Station, Mount Edgecombe, in August 1974. Each plot consisted of a single row, four metres in length, in which were planted ten, 3-budded setts. The design was a randomized block with three replications. The variety used was NCo 376 obtained from a hot water treated nursery.

Freshly cut setts were dipped in prepared aqueous dilutions of the various fungicides, allowed to dry and then inoculated by spraying with a concentrated spore suspension of *C. paradoxa*, grown on PDA plates. The setts were planted immediately after treatment. Also included in the trial were two controls, one inoculated with *C. paradoxa*, and the other not inoculated.

The following treatments were included in the trial:

Aretan (methoxyethylmercury chloride, 6% Hg) at 3,0 g/ℓ
Benlate (benomyl 50% wp) at 0,5 g/ℓ
Bavistin (carbendazim 50% wp) at 0,6 g/ℓ
Fongorene (quinacetol sulphate 80% gran.) at 0,75, 1,5, 3,0 g/ℓ
Panoctine (guazatine triacetate 40% ws) at 1,25, 1,75, 2,5 ml/ℓ
Tecto 40 (thiabendazole 40% susp.) at 1,5, 3,0 g/ℓ
Topsin 44 (thiophanate methyl 70% wp) at 3,0, 4,0, 5,0 g/ℓ
Untreated, inoculated
Untreated, not inoculated.

Regular germination counts were made. After three months, final counts of emerged shoots and germinated setts as well as measurements of shoot height were carried out.

Experiment 2

This observation trial was established in January 1975 on a red recent sand, under conditions of natural infection. It was an unreplicated trial, consisting of one line of 15 metres for each treatment, except for Aretan and the untreated control, where there were two lines and four lines respectively. Fifty, 3-budded setts of the variety NCo 376 were planted in each line. The setts were dipped in the various treatments, allowed to dry and then planted. The following fungicides and concentrations were used:

Aretan at 3,0 g/ℓ
Benlate at 0,5, 0,75, 1,0, 2,0 g/ℓ
Bavistin at 0,6, 0,75, 1,0, 2,0 g/ℓ
Panoctine at 1,0, 2,0, 3,0, 4,0 ml/ℓ
Control, untreated.

Regular germination counts were carried out, a final count of emerged shoots and germinated setts taking place eight weeks after planting.

Experiment 3

This trial also was established on a red recent sand and was planted in March 1976. The plot size was a single row of 6 metres in which twenty, 3-budded setts of the variety NCo 376 were planted. The design was a 5 × 6 lattice with four replications.

The freshly cut setts were dipped in the fungicides at various concentrations and were allowed to dry before being dipped in a spore suspension of *C. paradoxa*. The setts were planted immediately after preparation.

The trial included two fungicides additional to those in Experiments 1 and 2, Bayleton (triadimefon, 25% wp) and

Funginex (triforine, 20% ec). The treatments included in the trial were as follows:

Aretan at 3,0 g/ℓ
Bavistin at 0,5, 0,75, 1,0, 2,0 g/ℓ
Bayleton at 0,5, 1,0 g/ℓ
Benlaté at 0,5, 0,75, 1,0, 2,0 g/ℓ
Fongorene at 0,5, 1,0, 2,0 g/ℓ
Funginex at 2,0, 4,0, 8,0 ml/ℓ
Panoctine at 1,0, 2,0, 4,0 ml/ℓ
Tecto 40 at 1,0, 2,0, 4,0 ml/ℓ
Topsin 44 at 0,5, 1,0, 2,0 g/ℓ
Aretan (not inoculated) at 3,0 g/ℓ
Benlate (not inoculated) at 0,75 g/ℓ
Untreated, inoculated
Untreated, not inoculated.

The germinated shoots were counted regularly and a final assessment of shoots and germinated setts was made three months after planting.

Results

Experiment 1

A severe drought prevailed for several weeks after the trial was planted, and the overall germination was poor. The control setts which were inoculated but not treated with a fungicide almost entirely failed to germinate.

A summary of the results as assessed three months after planting is presented in Table 1.

TABLE 1

Effect of fungicides on control of *C. paradoxa:* % bud and sett germination and shoot height, three months after planting.

Experiment 1

Fungicide and concentration (g or ml per litre)		% Bud germination	% Sett germination	Mean shoot length, cm
Panoctine	2,5 ml	31	60	17,2
	1,75 ml	27	50	17,9
	1,25 ml	18	33	18,0
Bavistin	0,6 g	24	56	15,8
Aretan	3,0 g	20	33	19,3
Tecto	3,0 ml	18	36	17,6
	1,5 ml	13	30	17,2
Topsin	5,0 g	9	23	15,6
	4,0 g	18	36	16,4
	3,0 g	12	33	16,3
Fongorene	3,0 g	8	20	16,4
	1,5 g	10	33	19,0
	0,75 g	4	9	19,0
Benlate	0,5 g	6	16	17,0
Control — not inoculated		23	50	16,7
inoculated		2	6	16,0
	LSD (0,05)	8	30	
	(0,01)	16	40	

The co-efficients of variation were high, but there were statistically significant differences among treatments. The highly significant differences in germination between the uninoculated and the inoculated control treatments indicates that the method of inoculation with *C. paradoxa* was effective.

All the fungicide treatments, except Benlate at 0,5 g/ℓ, Fongorene at 0,75 and 3,0 g/ℓ and Topsin at 5 g/ℓ, significantly increased bud germination. Panoctine at 1,75 and 2,5 ml/ℓ and Bavistin at 0,6 g/ℓ were the most effective of the non-mercurial treatments and were at least as good as, if not better than, Aretan.

The treatments had little effect on mean shoot length, but there was some evidence that Aretan had produced a stimulating effect.

The poor performance of Benlate at 0,5 g/ℓ in this trial is to be noted. It has on several occasions, in both glasshouse and field trials, been observed that this concentration of Benlate is too low, particularly as an instant dip, when conditions are very adverse for germination. However, it must be pointed out that the harsh conditions that prevailed in this trial, which included an additive effect of inoculation and drought, are seldom encountered naturally.

Experiment 2

In this trial the conditions for germination were more favourable than those of Experiment 1, and this resulted in a higher rate of germination of both buds and setts. However, the level of natural infection was sufficient to suppress germination of both buds and setts in the untreated plots.

A summary of the results obtained eight weeks after planting is presented in Table 2.

TABLE 2

Effect of fungicides on control of *C. paradoxa:* % bud and sett germination eight weeks after planting.

Experiment 2

Fungicide and concentration (g or ml per litre)		% Bud germination	% Sett germination
Panoctine	4,0 ml	61	98
	3,0 ml	49	98
	2,0 ml	57	98
Bavistin	2,0 g	47	92
	1,0 g	56	98
	0,75 g	50	94
	0,6 g	53	92
Benlate	2,0 g	44	88
	1,0 g	44	92
	0,75 g	58	96
	0,5 g	51	96
Aretan	3,0 g	54	90
Untreated	Nil	35	75

All the treatments improved germination when compared with the control under the natural infection conditions of the trial, and the non-mercurial treatments were as effective as Aretan. A slight drop in bud germination occurred at the higher concentrations of Benlate and Bavistin and the optimum rate of these two closely related fungicides appeared to be approximately 0,75-1,0 ml/ℓ. In the better treatments most of the setts (98%) and about 60% of the buds germinated, while in the control 75% of the setts and only 35% of the buds germinated.

The results of this trial demonstrate the beneficial effect of a fungicide dip on cane emergence, even when the conditions are not too adverse for germination.

Experiment 3

In this trial also, the germination conditions following planting were adverse. The additive effect of several weeks of drought and of inoculation suppressed both bud and sett germination. There was also a high incidence of natural infection in the setts that had not been inoculated.

A summary of the results assessed three months after planting is presented in Table 3.

TABLE 3

Effect of fungicides on control of *C. paradoxa:* % bud and sett germination three months after planting.

Experiment 3

Fungicide and concentration (g or ml per litre)		% Bud germination	% Sett germination
Tecto	4,0 ml	31	60
	2,0 ml	20	39
	1,0 ml	20	43
Bavistin	2,0 g	24	41
	1,0 g	28	54
	0,75 g	29	56
	0,5 g	14	26
Benlate	2,0 g	14	26
	1,0 g	26	49
	0,75 g	18	38
	0,5 g	9	25
	0,75 g (not inoculated)	21	41
Funginex	8,0 ml	21	41
	4,0 ml	23	45
	2,0 ml	17	33
Topsin	2,0 g	23	41
	1,0 g	18	39
	0,5 g	18	35
Panoctine	4,0 ml	18	35
	2,0 ml	20	45
	1,0 ml	15	30
Aretan	3,0 g	9	19
	3,0 g (not inoculated)	20	43
Bayleton	1,0 g	16	31
	0,5 g	7	13
Fongorene	2,0 g	5	10
	1,0 g	5	14
	0,5 g	1	3
Control	not inoculated	2	6
	inoculated	2	3
	LSD (0,05)	10	17
	(0,01)	13	23

The results were broadly similar when assessed as either bud or sett germination and, although variability was again high, the majority of the fungicide treatments increased both bud and sett germination significantly when compared with the inoculated control. There was, in general, statistically significant evidence of differences among treatments.

Bavistin at 0,75 g/ℓ, Tecto at 4 ml/ℓ and Benlate at 1,0 g/ℓ gave very good control of the disease and, on a basis of rates of active ingredient, Bavistin at 0,75 g/ℓ gave the best control. Funginex, Topsin 44 and Panoctine effectively controlled the disease at the higher concentrations used, although results were not as good as in previous trials with Topsin and Panoctine. Fongorene, Bayleton and Aretan performed poorly at the rates used. As in Experiment 1, Benlate at 0,5 g/ℓ again did not significantly increase bud germination and Bavistin at 0,5 g/ℓ was less effective than at higher rates. The optimum rate for both Bavistin and Benlate was 0,75-1,0 g/ℓ, while at the higher rate of 2,0 g/ℓ a decline in germination, similar to that indicated in Experiment 2, was again apparent.

Discussion

Two of the three field trials described in this paper were conducted under conditions adverse for sett germination, and the trials are considered to have been satisfactory tests of the various fungicide treatments. Even under the extremely adverse conditions of Experiment 3, in which the unprotected setts virtually failed to emerge, the optimum rates of the better fungicides assured appreciable germination, particularly on a sett germination basis.

The results demonstrate that there are now a number of effective, non-mercurial fungicides for the control of pineapple disease, several of which are now registered and are available to growers. Most of the registered materials have a safety margin, but application rates should be strictly controlled because at lower rates poor control is achieved, while at higher rates germination may be suppressed and material wasted.

The following additional comments are made on the more effective of the fungicides tested:

Benlate (benomyl) was the first fungicide successfully tested as a replacement for Aretan. It is used with good results for dipping sugar cane setts before planting in most sugarcane growing countries, including South Africa. There is evidence that the present registered concentration of 0,5 g/ℓ is often too low to be effective as an instant dip for setts. Dipping at a higher concentration of 0,75 g/ℓ has resulted in improved germination under all conditions favouring disease development. Being a wettable powder, Benlate must be constantly agitated while in use. It can be incorporated in hot water tanks at half the usual concentration.

Bavistin (carbendazim) has given consistently good results in all the glasshouse and field trials conducted at the Experiment Station. It has been registered for use in sugarcane at a concentration of 0,6 g/ℓ. Bavistin is also a wettable powder and it is again essential that preparations are agitated before and during dipping of setts. It has been tested with good results for use in hot water tanks. (Mitchell-Innes and Thomson[3].)

Panoctine (guazatine) is a liquid formulation. It has been registered for use in sugarcane at a concentration of 2 ml/ℓ. It has been tested several times, has always given satisfactory control of the disease, and has occasionally shown a stimulating effect on shoot development. There has been no sign of phytotoxicity within the range of concentrations tested.

Topsin 44 (thiophanate methyl) is a wettable powder and must be agitated before and during dipping of setts. Registration of Topsin for use as a sett dip has been applied for by the agents. It has given effective control of the disease at concentrations ranging from 2-4 g/ℓ water and the recommended rate will most probably be 2,5 g/ℓ.

Tecto (thiabendazole) is a broad spectrum, systemic fungicide, similar to Benlate and Bavistin. It is a liquid formulation and has given very promising results at 3 and 4 ml/ℓ. Stimulating effects on germination when it was used in hot water tanks have been reported from other countries, but have not been observed in South Africa. It is not registered for use in sugarcane.

Funginex (triforine) is a liquid formulation. Results in previous trials at rates below 2 ml/ℓ were not satisfactory (unpublished data) but in Experiment 3, at higher concentrations, the results were comparable to those of Benlate at 0,75 g/ℓ. There was very little difference between the three concentrations tested. These results will have to be confirmed in other field trials. Funginex is not registered for use in sugarcane.

Conclusion

Several new products are now available for dipping sugarcane setts before planting in order to protect them against

pineapple disease. The products now registered are all effective at recommended rates but at lower rates they are less effective. Excessively high concentrations, apart from being uneconomic, may have undesirable effects on germination.

Preplanting treatment of seed material is strongly advised at all times, so as to ensure uniform and vigorous germination and optimum yield. It is particularly recommended for autumn planting and after hot water treatment.

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