A NEW FUNGICIDE FOR THE PRE-PLANTING TREATMENT OF SUGARCANE SETTS

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Abstract

The suitability of Benlate as a replacement for the organo-mercurials in the pre-planting treatment of sugarcane setts was investigated. Both laboratory and field tests have shown Benlate at 0,25 kg / 500 litres water to be quite satisfactory and an effective means of protecting the setts against infection by the fungus *Ceratocystis paradoxa*, causal agent of pineapple disease.

Introduction

The South African sugar industry has had many years' experience in the use of fungicides in agriculture. Until now such chemicals have been mainly of the protectant type and the problem involved has been pineapple disease which causes a characteristic sett rot and resultant germination failure.

McMartin[1,2,3], carried out most of the pioneer work which led to the use of organo-mercurial fungicides becoming standard practice in the pre-planting treatment of sugarcane cuttings. These chemical compounds found favour for two main reasons — the ravages of pineapple disease were greatly reduced and the products appeared to give a measure of germination stimulation in addition to their fungicidal properties.

Now, after nearly 30 years of use in the sugar industry the organo-mercurial fungicides to which we have become accustomed are to be phased out. On 30th June, 1974, registration of these compounds is to be withdrawn and, when existing stocks are finally depleted, non-mercurial alternatives will have to come into use.

South Africa is not alone in this effort to limit the use of mercury compounds particularly in agriculture. Mercury pollution of waterways in some countries, notably Japan, Sweden and the U.S.A. has led to increasingly severe restrictions on the use of all products containing mercury (Hilton[5]). While it is not necessarily generally accepted that mercurial fungicides have constituted such a dire hazard in the sugar industry, it must be admitted that mercury is highly toxic and can accumulate in biological systems and in the soil.

In order to prepare for the eventual withdrawal of the mercurial fungicides from the sugar industry the Experiment Station has conducted a series of screening trials in which promising non-mercurial products have been tested for their effectiveness in protecting sugarcane sets against infection by pineapple disease.

Pineapple disease

Pineapple disease affects mainly the planted sett although under certain conditions standing cane may become infected. Infection is initiated from spores present in the soil surrounding the sett as well as those adhering to the sett itself. Typical symptoms of the disease are the black core seen in the sett when it is split open lengthwise, and the unmistakable fruity smell from which the disease derives its name.

The fungus pathogen *Ceratocystis paradoxa* gains entry through wounds in the sett such as cracks, borer tunnels and especially the cut ends. The fungus spreads through the tissues of the sett, its development being more rapid in the internodal areas and slightly retarded in the tougher fibrous tissues of the nodes. The affected tissues at first develop a red colour due to fermentation but, with the development of spores of the fungus, the colour changes to the characteristic black.

The main effect of infection is a failure in germination. Losses due to this disease are more severe when conditions are unfavourable for quick germination since a longer dormant period provides more time in which the pathogen can penetrate and destroy the whole cutting. For a similar reason, short setts are more liable to complete destruction than are longer setts carrying more buds.

The control of pineapple disease

In sugarcane cuttings the best means of controlling diseases such as pineapple involve the use of protective chemicals. In order to prevent infection the potential or susceptible host plant, in this case the planted sett, can be protected by the application of a chemical which will form a toxic barrier between the exposed plant tissues and the fungus. The chemicals used in this way are protectants and, to be effective, must be present before the inoculum arrives. To be acceptable as a good protectant any fungicide should also;

1. provide good coverage of the host surface concerned;
2. be economical;
3. be easy to apply, with little or no danger to the user;
4. be toxic to the pathogen but not to the host.

Benomyl (Benlate)

For some years the benzimidazole group of compounds has received considerable attention as fungicides. The member of this group known as benomyl, marketed as Benlate, has been tested and recommended for use in numerous crops and is now attaining a place in the control of sugarcane diseases. In Hawaii mercury fungicides alone have, in the past, successfully controlled pineapple disease. In recent years, when a substitute for these toxic chemicals was sought, benomyl, which has a lower mammalian toxicity, was the first non-mercurial found to be highly effective (Wismer[4]). Field tests showed that

germination after benomyl was equal to or better than after mercurial treatment.

SCREENING TRIALS WITH BENOMYL (Benlate)

Both laboratory tests and field trials were carried out to assess the performance of Benlate as a pre-plant fungicide for sugarcane. These tests are summarized as follows:—

Laboratory Test No. 1

Wells were made in thick potato dextrose agar (PDA) plates by means of a sterilized cork borer (8 mm diameter). The agar plates were then inoculated with the pineapple disease pathogen *Ceratocystis paradoxa* either centrally, where plates contained 4 wells, or at four separate points in plates prepared with single, central wells. On the following day the fungicide solutions and control solutions were prepared and pipetted into the wells. Controls consisted of sterile water and a commercially-available organo-mercurial fungicide containing 6% Hg (by weight). Benlate was prepared at four concentrations viz. 2,5, 1,25, 0,625 and 0,3125 g/litre and the control mercurial fungicide was prepared at the recommended concentration of 3,0 g/litre. After seeding with the fungus and application of the fungicide, the agar plates were incubated at 27°C for 2 to 3 days after which the degree of fungicidal and fungistatic activity was assessed.

TABLE 1

Benlate in agar plate tests
Diameter (mm) of zones of inhibition

Treatment	After 2-3 days	After 10 days
Sterile Water Control	8	8
Organo-mercurial Fungicide	42	21
Benlate 2,5 g/litre	40	40
Benlate 1,25 g/litre	36	34
Benlate 0,625 g/litre	35	34
Benlate 0,3125 g/litre	30	23

The organo-mercurial control produced a wide zone of inhibition around which the fungus grew well but after a few days the fungus was able to overcome the fungistatic effect and partially overgrew the zone of inhibition.

Benlate appeared to be as effective as the organo-mercurial against *Ceratocystis paradoxa* and, at all four concentrations tested, maintained a fungistatic effect even after ten days. At the rate of 0,625 g/litre Benlate appeared to give adequate control.

Laboratory Test No. 2

The test fungicide at 0,625 g/litre was incorporated in the agar medium and plates inoculated with *Ceratocystis paradoxa*. A few days later the fungus mycelium had completely overgrown the control plate (sterile water) and 12 days after inoculation no growth was apparent on the plates in which the organo-mercurial fungicide or Benlate had been incorporated in the potato-dextrose agar.

The experiment was repeated using larger discs of actively-growing mycelium for inoculation purposes and the excellent fungistatic properties of Benlate were still apparent 3 weeks after inoculation.

Laboratory Test No. 3

This experiment involved the use of sugarcane setts which were treated with the fungicide solutions before being inoculated with the pineapple disease organism.

Two-budded setts of the variety Co 331 were cut and then dipped in the respective fungicide preparations for 5 minutes. A spore suspension of *Ceratocystis paradoxa* was prepared from PDA cultures using distilled water. This suspension was sprayed onto the cut and treated ends of each sett. The setts were then sealed into plastic bags and incubated at 28°C for 10 days. In the control treatment setts were dipped in water before being sprayed with the spore suspension.

After the 10-day incubation one sett from each treatment was removed for examination. Ratings for degree of infection by pineapple disease and for root and shoot development were given since severe infections of *Ceratocystis paradoxa* inhibit the formation of roots and shoots.

TABLE 2

Screening tests with sugarcane setts inoculated with *Ceratocystis paradoxa* after treatment with various fungicide preparations

Treatment	Disease rating		Root growth		Shoot growth	
	After 10 days	After 16 days	After 10 days	After 16 days	After 10 days	After 16 days
Sterile Water Control	6	9	Nil	Nil	Nil	Nil
Organo-mercurial Fungicide	3	4-5	Nil	Slight	Nil	Nil
Benlate 1,25 g/litre	1	2	Slight	Good	Nil	Good
Benlate 0,625	2	7	Slight	Good	Nil	Nil

Disease rating: 0 = no infection
9 = severe infection

TABLE 3

The effects of agitation on the fungistatic activity of Benlate suspensions
Diameter (mm) of zones of inhibition

Treatment	Fresh preparation		Supernatant liquid after standing	
	Initial reading	After a few days with agitation	Initial reading	After a few days without agitation
Sterile Water Control	8	8	8	8
Organo-mercurial Fungicide	42	11	43	8
Benlate 1,25 g/litre	47	40	40	8
Benlate 0,625 g/litre	44	20	35	8

Benlate performed very well when compared with the control but 16 days after treatment with the lower concentration the degree of disease development was higher than that found in organo-mercurial control.

Laboratory Test No. 4

As Benlate is insoluble in water the prepared suspensions tend to settle out on standing. A further experiment using the PDA plate method was therefore carried out to compare freshly-prepared Benlate suspension with the supernatant produced by the product on standing.

In this test there are clear indications that the supernatant liquid is not as effective in controlling pineapple disease as is a freshly-prepared mixture or as one which is kept agitated.

Laboratory Test No. 5

A further comparison was made between fresh preparations and supernatant liquids using the inoculated sett/plastic bag technique. The results of this experiment are shown in Table 4.

The necessity for agitation of the Benlate preparation is again indicated by the results of this test. There was a marked increase in the degree of infection in setts which had been treated with the supernatant liquid left after the fungicide preparation had been allowed to settle out.

TABLE 4

The effects of agitation on the activity of Benlate preparations
A test using sugarcane setts inoculated with *Ceratocystis paradoxa* after treatment with fungicide

Treatment	Disease rating		Root growth		Shoot growth	
	Fresh preparation	Supernatant liquid	Fresh preparation	Supernatant liquid	Fresh preparation	Supernatant liquid
Sterile Water Control	9	9	Nil	Nil	Nil	Nil
Organo-mercurial Fungicide	2	2	Fair	Good	Good	Good
Benlate 1,25 g/litre	1	6	Fair	Slight	Very good	Slight
Benlate 0,625 g/litre	2	4	Fair	Fairly good	Fair	Fair

Disease rating: 0 = no infection
9 = severe infection

FIELD EXPERIMENTS

Two essentially similar experiments were planted during 1971 to test the effectiveness of Benlate in preventing pineapple disease infection. The first trial in which the treated setts were inoculated with the disease was planted at Mount Edgecombe and produced a useful assessment of the products under test.

In the second trial, planted in the Natal Midlands, the results were inconclusive since the canes were not inoculated and the level of natural infection on the planted setts and in the soil was apparently particularly low.

THE MOUNT EDGECOMBE EXPERIMENT

In this experiment the plot size was a single row of 3,7 m in which were planted ten 3-budded setts of the variety Co 331. The design was a randomized block with three replications. Freshly-cut setts were immersed in the various concentrations of Benlate and allowed to drain before planting in the field. When the setts had been laid out in the furrows all the cane, with the exception of untreated controls, was watered with a heavy spore suspension of *Ceratocystis paradoxa.*

Regular germination counts were made from about the fourth week after planting. After 16 weeks the plants were unearthed and the following observations made:—

1. number of buds germinated;
2. total number of shoots i.e. primary shoots and tillers;
3. degree of sett-rotting caused by *Ceratocystis paradoxa.*

In this experiment four concentrations of Benlate were tested — 2,5, 1,25, 0,625 and 0,3125 g/litre. In addition, Benlate preparations with and without a wetting agent were compared. Controls consisted of a commercially-available organo-mercurial fungicide at present commonly in use, and untreated setts planted either without further treatment or inoculated with pineapple disease as in the fungicide treatments.

TABLE 5

Germination, shoot development and degrees of disease infection in a field trial comparing Benlate with an organo-mercurial fungicide and untreated controls

Treatment	% Germination	Total Shoots	Disease rating
		After 16 weeks	
Benlate (+ wetter) 2,5 g/litre	60	99	1
Benlate (+ wetter) 1,25 g/litre	60	103	2
Benlate (+ wetter) 0,625 g/litre	49	89	3
Benlate (+ wetter) 0,3125 g/litre	47	79	5
Mean for Benlate + Wetter	54	93	
Benlate (— wetter) 2,5 g/litre	68	109	2
Benlate (— wetter) 1,25 g/litre	42	91	3
Benlate (— wetter) 0,625 g/litre	39	90	5
Benlate (— wetter) 0,3125 g/litre	34	56	6
Mean for Benlate — wetter	46	87	
Organo-mercurial Fungicide	61	111	2
Control — Not inoculated	35	70	8
Control — Inoculated	19	29	9

Disease rating: 0 = no infection
9 = severe infection

Initially the setts treated with Benlate were somewhat slower to germinate than those treated with the organo-mercurial control fungicide which appeared to stimulate germination. In the final analysis Benlate gave good control of pineapple disease at most concentrations although the application rate of about 0,6 g/litre was not quite as effective as the mercurial in this experiment. In addition there was some indication of improved Benlate performance with the addition of a wetting agent to the working suspension.

The use of Benlate in the field

Benomyl (Benlate) has now been registered for use in sugarcane.

Laboratory tests and field trials, in South Africa and in other sugarcane-growing countries have shown Benlate, at ½lb/100 gallon or 0,25 kg/500 litres water to be quite satisfactory and an effective means of protecting setts against infection by pineapple disease. The addition of a wetting agent to the suspension appears to be of some advantage in obtaining a good cover of the sett, and it is expected that the marketing company will provide a wetting agent incorporating a red dye for use with their product.

It is important to note that, while the mercurial fungicides which are being replaced are soluble in water and go into solution relatively easily, Benlate is insoluble and forms a suspension in water. For this reason Benlate preparations tend to settle out if left standing for any length of time and setts dipped in the resulting clear supernatant liquid do not receive the protection afforded by a well mixed preparation. It is therefore essential that Benlate preparations be kept stirred. In the case of large scale use such as after heat treatment, consideration may have to be given to the provision of mechanical agitation in the fungicide tank.

It may be possible to incorporate the Benlate in the hot water treatment process as is done in other countries and this aspect is being investigated.

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