FUNGICIDES FOR THE CONTROL OF SUGARCANE SMUT

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Eight fungicides, applied as wet treatment on sugarcane setts of four varieties infested with smut were effective in reducing the incidence of smut and had no significant detrimental effect on the germination and tillering of sugarcane. Formalin was the best fungicide in reducing incidence of smut and was followed by mercuric chloride, Tuzet, Cerenox Special and Granosan New Improved. In another test with nine fungicides applied as wet treatment on setts of Co 312, Dieldrex, Cerenox Special and Zerlate were the three best fungicides in reducing incidence of the smut.

Nine seed dressing fungicides applied as dust mixed with the soil at planting were generally effective in reducing the incidence of smut significantly without having detrimental effect on the germination and tillering of sugarcane. Zerlate, Agrosan GN, Granosan NI, Dieldrex A, Cerenox Special and Granosan M were among the more effective fungicides.

INTRODUCTION

Control of sugarcane smut by sanitary measures has received considerable attention, but the control of the smut by fungicides has not been adequately investigated.

Shepherd (1924) in Mauritus described the control of sugarcane smut by cutting and destroying infected canes. Similarly, Francis (1938) from Madras, India reported the removal of smutted canes and their destruction by immersing them in boiling water for 15 minutes for smut control. Fawcett (1941) from Tucuman advised the elimination of smutted canes by rouging or by rotation with non-susceptible crops. Systematic rouging, selection of seed material for three seasons and immersion of setts from smutted canes in water at 55-66°C. for 10 minutes before sowing have been recommended by Chona (1943). Rouging of smutted whips has likewise been advocated by Hopkins (1951) and Kar (1962), while the treatment of setts in hot water at 52°C. for 18 minutes has been reported by Joshi (1954).

On the other hand, a limited number of trials of fungicides for the control of sugarcane smut have been made. Luthra *et al.* (1938) reported the effectiveness of mercuric chloride and formalin solutions, whereas Kar and Srivasta (1957) and Kar and Varma (1963) described immersion of setts in 0.25 per cent Perenox and 1 per cent Agrosan GN suspension effective for smut control.

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The present paper summarises the results of trials with certain fungicides, applied as wet and dry treatment, for the control of sugarcane smut, and their effect on the germination of the treated setts, tillering and yield of cane. A preliminary report of the salient results of these trials has already been presented (Kausar *et al.*, 1960).

MATERIALS AND METHODS

The effectiveness of seed dressing fungicides, applied as wet and dry treatments, for the control of sugarcane smut and their effect on the germination of treated setts, tillering and yield of cane were investigated at Lyallpur during 1958 to 1960.

(a) Trial of the seed dressing fungicides as wet treatment

Studies on the effect of nine fungicides (applied as wet treatment) on the germination, tillering and smut control in four varieties of sugarcane were initiated in 1958.

The design of the experiment was a split plot, with three replications. Four varieties of sugarcane CoL. 54, CoL. 44, CoL. 312 and CoL. 29 formed the main blocks. Ten treatments including treatment with nine fungicides and an untreated check formed the sub-plots within the main plots of the varieties. The nine treatments comprised immersion of sugarcane setts in a solution of Agrosan GN, Ceresan, Tuzet or Cerenox Special at one kilogram per 100 litre water for two minutes; or Granosan M and Granosan NI at $\frac{1}{4}$ kilogram per 100 litre water for two minutes; or 0.1 per cent mercuric chloride for three minutes; or in 3.0 per cent formalin for two minutes and covering them by moist gunny-bags for two hours; or in hot water at 45°C. for two hours. The net size of the experimental plot was 50 feet by 2 feet. Each plot consisted of a single row planted with 75 setts. The buds of these setts were artificially infested with the chlamydospores of the sugarcane smut and were treated as detailed above, before sowing.

The experiment was repeated in 1959 with Co. 312 in quadruplicated, randomized blocks. Ten treatments including an untreated check comprised treatment of sugarcane setts in the solution of Agrosan GN, Ceresan, I and D, Dieldrex A; Spergon, Zerlate, Cerenox Special, Granosan M, or Granosan NI. The buds of sugarcane setts were artificially infested with the chlamydospores of the smut before treatment with the fungicides. Each plot consisted of a single row planted with 150 buds treated with different fungicides.

(b) Trial of seed dressing fungicides as dry treatment

The effect of nine seed dressing fungicides on the germination and tillering of setts and smut control was studied in 1958 and 1959. The experiment

was designed in randomized blocks with three replications in September, 1958, and with four replications in March, 1958 and March, 1959. The experimental plot consisted of a single row, 50 feet long, planted 2 feet apart from the other row.

The nine treatments excluding the untreated check comprised treatments of sugarcane setts with Agrosan GN, Ceresan, I and D, Dieldrex A, Spergon, Zeriate, Cerenox Special, Granosan M and Granosan, NI. The fungicides were applied at the rate of four ounces per acre except Granosan M and Granosan New Improved which were used at one ounce. The calculated quantity of the fungicides for each plot was mixed with five seers of fine silt. One-third of the silt including fungicides was placed in the furrow before planting the setts and two thirds was used for covering the setts after planting. The buds of the sugarcane setts were artificially infested with chlamydospores of the smut before sowing.

(c) Trial of selected seed dressing fungicides

The trials of 1960 were restricted to five fungicides. Four fungicides, Agrosan GN, Granosan M, Dieldrex A and I and D, were compared for their effectiveness with Formalin treatment. Treatment with these five fungicides and an untreated check formed the six treatments. The experiments were laid out in randomized block with four replications. The size of the experimental plot was 32 feet by 4 feet. In each plot two rows were planted, 2 feet apart.

The setts of sugarcane artificially infested with the chlamydospores of the smut were used in the experiments. For dry treatment of the setts, three fungicides Agrosan GN, Dieldrex A and I and D were applied at the rate of four ounces per acre, whereas Granosan M was applied at the rate of 1 ounce per acre. For wet treatment, the infested setts were soaked in the solution of the Dieldrex A, Agrosan GN, and I and D at the rate of 1 kilogram in 100 litres water, whereas Granosan M was used at the rate of $\frac{1}{4}$ kilogram in 100 litres water. For treatment with Formalin, the setts of sugarcane were immersed in 1.0 per cent Formalin solution for five minutes and was followed by two hours' covering under moist cloth.

RESULTS AND DISCUSSION

(a) Trial of seed dressing fungicides as wet treatment in 1958 and 1959

(*i*) The result of treatment of sugarcane setts with nine fungicides as wet treatment on the germination, tillering and smut control in four varieties

of sugarcane in 1958 are summarised in Tables 1 and 2.

TABLE 1.—*F values for germination, tillering and incidence of smut in respect of four varieties of sugarcane as affected by wet treatment with fungicides.*

Variation due to	Degrees of freedom	F values for		
		Smut	Germination	Tillering
Blocks	2	0.55 N.S.	0.97 N.S.	1.68 N.S.
Varieties	3	11.82 **	2.13 N.S.	1.65 N.S.
Error (*a*)	6			
Total	11			
Fungicides	9	14.57 **	6.62 **	7.17 **
Fungicides X varieties	27	2.32 **	2.04 **	8.61 **
Error (*b*)	72			
Total	119			

**Significant at 1 per cent.
N.S. Non-significant.

TABLE 2.—*Germination, tillering and incidence of smut on four varieties of sugarcane as affected by wet treatment with fungicides.*

Fungicides	Smut (per cent)	Germination (per cent)	Tillers per germinated bud
Agrosan GN	12.31	30.16	5.37
Ceresan	10.24	32.49	4.54
Granosan M	11.91	29.27	5.46
Granosan New Improved	9.14	31.11	5.30
Tuzet	4.15	25.27	5.66
Cerenox Special	7.13	31.33	5.19
Mercuric chloride	2.56	30.64	5.08
Formalin	1.21	24.72	5.94
Hot water	9.00	16.55	7.09
Check	23.87	29.49	5.14
Least significant difference			
1 per cent level	6.06	10.79	2.90
5 per cent level	4.70	8.12	2.19

F values for varieties, fungicides and their interaction in respect of smut control were significant. However, F values for germination and tillering in respect of varieties were non-significant, whereas those for fungicides and their interaction were significant.

Taking an average of four varieties, all the fungicides were effective in reducing the incidence of smut significantly (Table 2). Formalin and Mercuric chloride were the most effective followed by Tuzet, Cerenox Special, hot water and Granosan NI. Significant F value of the interaction between fungicides and varieties indicated a differential response of varieties to the fungicidal treatment.

Taking an average of four varieties, Ceresan, Cerenox Special, Granosan NI and Agrosan GN enhanced the germination of treated setts, but the increase was non-significant (Table 2). Granosan M, Tuzet, and Formalin decreased the germination of treated setts to some extent, but the decrease was non-significant. However, hot water treatment decreased the germination significantly. The significant interaction between fungicides and varieties indicated that some of the varieties responded differently to some of the fungicidal treatments.

Sugarcane setts treated with Formalin, Tuzet, Granosan M, Agrosan GN, and Cerenox Special produced a little higher number of tillers per germinated bud than the untreated check, but the increase was non-significant. However, treatment of sugarcane setts with hot water produced significantly higher number of tillers than the untreated setts.

(ii) The experiment was repeated in 1959 with Co. 312 in quadruplicated randomized blocks. Observations on the germination, tillering and smut control are summarised in Table 3.

Treatment of setts with the fungicides reduced the incidence of smut. The decrease was significant after treatment with six fungicides including Dieldrex A, Cerenox Special, Zerlate, I and D, Granosan NI, Agrosan GN. The three most effective fungicides were Dieldrex A, Cerenox Special and Zerlate.

The treatment of sugarcane setts with Dieldrex A and I and D significantly increased the germination of sugarcane setts. Spergon, Cerenox Special, Granosan NI and Agrosan GN enhanced the germination of setts, but the increase was non-significant. However, treatment of setts with Ceresan significantly decreased the germination.

With the exception of Granosan NI, other fungicides decreased tillering of treated setts to some extent but the decrease was non-significant statistically. The increase in the number of tillers from setts treated with Granosan NI was non-significant statistically.

TABLE 3.—*Effect of wet fungicides on the germination, tillering and smut control in Co. 312.*

Fungicides	Smut (per cent)	Germination (per plot)	Tillers (per germinated bud)
Agrosan GN	13.17	28.00	8.5
Ceresan	20.25	8.75	5.9
I and D	11.42	48.25	4.0
Dieldrex A	5.50	52.75	4.2
Spergon	12.25	45.50	7.9
Zerlate	8.77	25.00	8.4
Cerenox Special	7.77	36.50	6.8
Granosan M	22.87	20.75	7.9
Granosan NI.	12.65	29.25	11.7
Check	34.67	27.00	9.7
Least significant difference			
1 per cent level	20.64	22.85	8.50
5 per cent level	15.29	16.92	6.30

(b) Trial of fungicides as dry treatment in 1958 and 1959

(*i*) The effect of nine seed dressing fungicides on the germination and tillering of setts and smut control was studied during the year 1958 and 1959. Sowings were made in September, 1958; March, 1958 and March, 1959. Average tillering and smut control for these three trials are summarised in Table 4.

F value for fungicides in respect of smut control for the three crops during the year 1958 and 1959 were significant. F values of fungicides in respect of germination for the crops sown in March, 1958 and March, 1959 were significant, whereas that for September, 1958 was non-significant. F value for fungicides in respect of tillering in March, 1958 experiment was significant, but the F values for September, 1958 and March, 1959 sown crops were non-significant.

The nine fungicides under trial reduced the incidence of smut significantly. The fungicides ranked in order to their effectiveness as Zerlate, Agrosan GN, Granosan NI, Dieldrex A, Cerenox Special, Granosan M, Ceresan, I and D, and Spergon.

Dieldrex A and I and D enhanced the germination of sugarcane setts but the increase was non-significant statistically. The other fungicides did not have significant deleterious effect on the germination of setts. Ceresan, Cerenox

TABLE 4.—*Effect of fungicides on smut control, germination and tillering from setts.*

Fungicides	Smut (per cent)	Germination	Tillers per germinated bud
Zerlate	1.25	24.40	5.7
Agrosan G	3.71	24.79	6.3
Granosan NI	4.59	26.69	4.9
Dieldrex A	5.00	35.57	4.7
Cerenox Special	5.22	27.45	6.6
Granosan M	5.47	26.33	5.2
Ceresan	7.30	25.77	6.7
I and D	9.93	31.12	3.5
Spergon	10.66	25.12	5.9
Check	19.74	30.13	4.9
Least significant difference 1 per cent level	9.23	7.80	8.14
5 per cent level	6.94	6.87	6.13

Special and Agrosan GN, Spergon, Zerlate and Granosan M enhanced the number of tillers per bud, but the increase was non-significant statistically.

(c) Trial of 1960

Treatment of sugarcane setts with the fungicides enhanced germination, tillering and yield significantly (Table 5). Treatment of the setts with fungicides were generally effective in reducing the incidence of smut. Dieldrex A and Formalin proved to the best in this respect. Dry and wet treatments with Dieldrex A and Agrosan GN proved definitely better than the other fungicides in germination. Dieldrex A and I and D were the best in enhancing the number of tillers in both dry and wet treatments, Dieldrex A, I and D and Agrosan GN, significantly enhanced the yield in wet and dry treatments. Similar results were obtained in 1961.

TABLE 5.—*Effect of wet and dry application of fungicides on smut control, germination, tillering and yield of sugarcane in* 1960

Fungicides	Smut (per cent	Emergence (per plot)	Number of tillers per plot	Yield (lbs cane per plot)
	Dry Treatment			
Dieldrex A	1.38	136.50	535.00	139.50
Formalin	1.98	116.25	445.25	113.25
I and D	2.15	114.25	523.50	123.50
Agrosan GN	2.18	122.75	474.50	11.75
Granosan M	3.52	114.75	420.75	103.75
Untreated check	8.78	82.75	354.00	88.25
Least significant difference				
1 per cent level	3.45	37.72	142.11	32.01
5 per cent level	2.50	27.28	102.95	23.17
	Wet treatment			
Dieldrex A	0.38	144.50	453.75	139.00
Formalin	0.88	125.00	359.25	104.75
I and D	1.01	121.75	445.50	130.50
Agrosan GN	1.07	138.50	376.75	120.25
Granosan M	1.25	126.25	418.50	109.75
Check	5.02	101.50	354.25	100.25
Least significant difference				
1 per cent level	2.53	23.69	111.84	17.87
5 per cent level	1.83	17.16	81.00	12.95

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