EFFECT OF CARBOXIN ON LOOSE SMUT OF WHEAT

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Summary

Loose smut of wheat (*Ustilago nuda*) which has been present in New Zealand for many years is still prevalent but at low levels. Treatment of seed with carboxin at 1875 ppm effectively reduced infection in highly infected lines. Treatment at 938 ppm is adequate at the levels of infection found in seed lines.

INTRODUCTION

LOOSE SMUT of wheat (*Ustilago nuda*) is a world-wide problem and has been known in New Zealand since the beginning of the century (Kirk, 1894).

The mycelium of the fungus penetrates into the embryo of the seed and makes the disease difficult to control by conventional seed-dressing methods. Hot water treatment (HWT) was found to give reasonable control of smuts in oats and barley, and, later, of loose smut in wheat (Jansen, 1888). This method has been employed in New Zealand for many years (Neill, 1933) on nucleus seed. Blair (1956) reported that loose smut was still present in about 50% of wheat crops in New Zealand, although only at low levels, and supported the continuance of HWT of nucleus seed by DSIR at Lincoln.

Losses in yield are in direct proportion with the percentage of infection because the whole head is ruined. As an infected plant continues to compete with its neighbours for moisture and nutrient, compensatory growth does not occur.

Von Schmeling and Kulka (1966) first described carboxin and its activity. Edgington and Reinberg (1966) reported on its activity against loose smut on barley, and Hansing (1967) reported on the control of loose smut of wheat and showed that 837 ppm carboxin eliminated high levels of loose smut in five varieties of Canadian wheat. Many other authors have since reported the same sort of results.

EXPERIMENTAL

To evaluate the effectiveness of carboxin in controlling loose smut of wheat, a line of wheat var. Triple Dirk, was located which had had a high level of infected heads during the previous summer and had subsequently been found to have 19% of embryos infected. This line was studied for three generations as follows:

Year 1 (1969): Eight 3 bu bags of seed were treated in an A and B seed treater, applying 1875 ppm carboxin. One bag was hot-water-treated at DSIR, Lincoln.

Each of eight farmers in the Manawatu-Rangitikei area were given one bag of the carboxin-treated seed, which was drilled at the normal seeding rate, alongside the farmer's own crop. One of these farmers also planted the HWT bag. An untreated bag was planted in Nelson.

An assessment of the level of infection was made in December by counting the total number of heads and the number of infected heads in one metre of row. This was repeated ten times in each area. The results of this count are shown in the first column of Table 1.

One bag of grain was saved from each area, for the following season's work.

Year 2: One bushel from each Year 1 property was treated with carboxin at the rate of 187.5 g/100 kg of seed (1875 ppm) in a concrete-mixer using water as for a seed treater with 46 ml cups.

Treated and untreated seed from each line was planted side by side in plots three drill swathes wide and 123 m long on October 20, and assessed for loose smut in December as described for Year 1.

The plots were harvested in February by taking two cuts with a combine harvester down the centre of each plot. Yield (from 0.09 ha) as kg/ha and infection counts are shown in Table 1.

One sack of grain was saved from each of three plots.

Year 3: The three samples from Year 2 were from plots having 16.13% (untreated-untreated), 3.98% (untreated-treated) and 2.85% (line 5 treated) infected heads (see Table 1). These were designated Heavy, Medium and Light infection and split into three one-bushel lots. One bushel from each line was treated at 1875 ppm carboxin, one at 938 ppm carboxin, and the other left untreated.

Each level of infection was planted in a separate area. Four replicates, in randomized blocks, of the three treatments were used for the Heavy and Medium lines and eight replicates for the Light line. Plots were one drill swathe wide and 50 m long.

TABLE 1: PERCENTAGE LOOSE SMUT INFECTED HEADS AND WHEAT YIELD

	<i>Year 1</i>	<i>Year 2</i>		<i>Year 2</i>	
	<i>% Infected Heads</i>	<i>Infected Heads (%)</i>		<i>Yield (kg/ha)</i>	
		<i>Treated</i>	<i>Untreated</i>	<i>Treated</i>	<i>Untreated</i>
Untreated	11.40	3.98	16.13	4096	3206
Line 1	0.47	—	—	—	—
2	1.65	0.02	6.45	4083	3807
3	3.29	0.55	6.84	4076	3955
4	3.85	0.72	3.62	4116	3962
5	3.67	2.85	6.44	4412	3403
6	2.96	0.17	4.93	4029	3820
7	2.62	—	—	—	—
8	2.40	0.02	5.49	3134	3289
HWT	2.00	0.01	6.04	3995	3854
			Av.	3995	3726

The means of yield are not significantly different at the 5% level.

TABLE 2: EVALUATION OF SAMPLING GRAIN FOR LOOSE SMUT INFECTION

<i>No. Infected</i>	<i>No. Clean</i>	<i>% Infected</i>	<i>T*</i>
14	244	5.74	13.86
19	265	7.17	15.53
10	219	4.57	12.35
10	217	4.61	12.40
12	189	6.35	14.50
12	245	4.90	12.79
13	173	7.51	15.90
19	274	6.93	15.26
			Mean 14.085
			S.D. of Mean 0.49

*Transformation by arc sin $\sqrt{\%}$.

In February, counts were made of total number of heads and number of infected heads in two samples per plot, samples being 3 m $\times$ one row and located towards opposite ends of the plots.

Yields were not obtained because of heavy bird damage to the area.

SMUT TESTING SERVICE

At the commencement of work, methods of testing seed for loose smut infection were investigated. A method supplied by R. I. Mulholland (pers. comm.) was found to require very exacting conditions to obtain an accurate result so the method of Popp (1958) was used and found to be easier although it took longer to carry out.

To check the reproducibility of results, a conveniently sized sample of grain (about 300 grains) was taken and run through the procedure. Eight determinations from the same line were carried out. The results are shown in Table 2.

TABLE 3: DISTRIBUTION OF INFECTION

							<i>Barley</i> (76 Crops)	<i>Wheat</i> (33 Crops)
% Range of infection of samples:								
0	....	....	....	....	....	....	27	30
0.1-1.0	....	....	....	....	....	....	23	29
1.1-2.0	....	....	....	....	....	....	21	7
2.1-3.0	....	....	....	....	....	....	17	14
3.1 +	....	....	....	....	....	....	11	20
North Island:								
% Clean lines		....	....	....	....	....	19	0
% Infected lines		....	....	....	....	....	81	100
South Island:								
% Clean lines		....	....	....	....	....	52	41
% Infected lines		....	....	....	....	....	48	59

On this basis, a Loose Smut Testing Service was offered to merchants in the winter of 1971. A total of 109 samples were forwarded for assessment, of which 76 were barley and 33 wheat. The results are summarized in Table 3. The highest infection found was 5.4% in a wheat sample.

DISCUSSION

Seed certification puts a limit on the number of generations that a seed line may pass through before destruction by processing or feeding, thus keeping the level of loose smut relatively low. With the increase of bulk storage on farms and the growing of grain for stock feeding, there has been an increase in the use of seed from outside the certification scheme and the incidence of loose smut appears to have become more widespread. Table 3 shows a very high incidence of loose smut in samples of grain submitted from the North Island. Even the South Island samples show a disturbingly high level for lines being considered for seed.

The results obtained at the end of the first year were expected to be better than they were on the basis of other workers' results. It is considered that the commercial machine used was not adjusted correctly and did not treat the seed as efficiently as is possible. Because this is often likely to be the case, the results may be regarded as typical of the practical situation.

In view of the low level of infection reached at the end of the second year and on the basis of work being done by Mulholland (1972) and the excellent results obtained with 938 ppm carboxin by Walz (1970) the lower rate treatment was introduced in the third year. Both rates used eliminated loose smut in the three lines of seed. Though infection had dropped to 0% on the untreated Light infected plots it was still 3.2% on the Heavy and 1.2% on the Medium untreated plots. While the lower rate of 938 ppm has been effective it is probably desirable to use the 1875 ppm rate for infection levels above, say 3%, although only a drastic situation would require such heavily infested seed to be used.

The method used for the detection of loose smut was very satisfactory in that infected embryos were readily seen even with the naked eye.

CONCLUSION

The efficient application of carboxin to wheat seed at a rate of 938 ppm provided excellent control of loose smut and is a suitable substitute for hot water treatment.

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