INFLUENCE OF CHEMICAL FUNGICIDE TREATMENT OF OAT SEED ON SEEDLING EMERGENCE, SEED YIELD, AND KERNEL WEIGHT[1]

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Abstract

Treating sound seed of five oat (Avena sativa) varieties with six fungicide chemicals in field trials over a period of 3 years resulted in seed yields and kernel weights not significantly different from those of the untreated controls. Seedling emergence was increased slightly. Average seed yields were significantly different over the 3-year period but kernel weights were not. Varietal seed yields and kernel weights were significantly different each year and this difference was entirely attributable to variable responses of the varieties to the numerous environmental factors involved each year.

Introduction

The benefits from the treatment of diseased and damaged seed with fungicides have been recognized for many years (1). It is particularly important to treat diseased cereal seed since many cereal diseases are seed-borne and their control must be achieved by seed treatment rather than by foliage treatment later in the growing season as no practical foliar treatments are presently available. Therefore considerable emphasis is placed on treating all cereal seed regardless of condition. In recent years some people have questioned the value of treating healthy cereal seed. It has been suggested that treatment of sound seed provides little or no protection against soil organisms and no increase in yields. Rawlinson and Colhoun (8) recently found that the only beneficial effects of treating uncontaminated cereal seed occurred with oats and this happened only when the crop was grown under natural or simulated winter conditions and subjected to periods of frost.

Field trials were conducted for three years to determine the effects of treatment of sound oat seed with chemical fungicides on seedling emergence, seed yield, and kernel weight.

Materials and methods

Samples of oat (Avena sativa L.) seed were treated with mercury compounds at the following rates, Ceresan M (7.7% ethyl mercury p-toluene sulfonanilide) 0.5 oz/bu; Liqui-San 10L (1.9% methyl mercury 2-3 dihydroxy propyl mercaptide and 0.42% methylmercurie acetate) 0.75 oz/bu; and Pandrinox Liquid Combination (0.75% methylmercuric dicyandiamide and 2 5/8 lb heptachlor/imp gal) 2.0 oz/bu. The nonmercury fungicides Chemagro 4497 (50% bis [1, 2, 3-trichloroethyl sulfoxide]) and HRS-1591A (ethylene bis [tetrahydrothyophenonium] dibromide were applied at the rate of 3 oz/100 lb of seed. A 3% solution of methyl cellulose (Methocel) was applied as a sticker with each of the fungicides[3] at the rate of 1 part sticker to 15 parts seed by weight. Controls included untreated seed and seed treated with methyl cellulose sticker alone.

Sound seed of uniform size of the varieties Stormont, Dorval, Russell, Garry and Rodney was treated each year. All the seed was produced at Ottawa the season prior to planting; on the basis of plating tests the seed used was free from seed-borne pathogens. In one or two cases 1- and 2-year old seed was bulked to provide a large enough sample to treat. A minimum of 0.33 lb of seed was used each time a sample was treated. A rotary type treater having a tumbling action was used to apply the fungicides and sticker to the seed uniformly.

Four replicates of 4-row plots with 100 seeds per row were planted for each treatment. The rows were 10 ft long and 12 inches apart. Seedling emergence counts were taken on the two center rows of each plot approximately 1 month after planting. At

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[3] Ceresan M was supplied by Dupont of Canada Ltd., Toronto, Ontario; Liqui-San 10L by Green Cross Products, Montreal, Quebec; Pandrinox Liquid Combination by Morton Chemical Co. of Canada Ltd., Winnipeg, Manitoba; Chemagro 4497 by Chemagro Limited, Toronto, Ontario; HRS-1591A by Hooker Chem. Corp., Niagara Falls, New York; and Methocel by Dow Chemical Co., Midland, Michigan.

maturity the same two rows of each plot were harvested and the seed yield and 1000-kernel weight data were determined. The entire two center rows were harvested the first year but in the two following years a 1-ft portion was removed from the ends of each row before the remainder was harvested. Threshing was done with a cyclone thresher.

Results

In tests with cereals, seed yields serve as a means of comparing the overall performance of the crop while emergence and 1000-kernel weight data provide a means of comparing early seedling growth and the final condition of the harvested seed. In the present tests oat seed yields and kernel weights were obtained for 3 years and seedling emergence for 2 years. The data on seed yield and 1000-kernel weight were analyzed statistically, both separately and combined. Some adjustments had to be made to the yield data for the combined analysis as larger plots were employed in the first year, and only three replicates were suitable for use in the third year.

The relative seed yields (Table 1) showed that no fungicide gave a consistent increase or decrease during the 3-year period. The combined analysis and the individual analyses (Table 2) showed that the yields of plants from fungicide treated seed were not significantly different from the controls. Yields were variable each year and, as a result, the coefficient of variation was high (approximately 30%). Treatment of the seed with the methyl cellulose sticker increased yields in 2 of the 3 years (Table 1) and produoed a more consistent improvement in yield than the fungicidal chemicals. There were no consistent differences between the mercury and nonmercury chemicals in regard to their increase or decrease of yields.

Seed yields were significantly different from year to year (Table 2). They were highest the first year of the tests and lowest the third year. The yields of the varieties were significantly different each year but in the combined analysis the differences were not significant (Table 2). The two first order interactions between years X varieties and years X treatments were significant also. The treatment X variety interaction was not significant so the various treatments behaved the same way regardless of variety.

Seedling emergence data were obtained for the first 2 years and, in general, emergence of the treated seed was slightly better than that of the controls (Table 3). Seedling emergence was very poor the first year due to dry weather at the time of seeding and a second planting was done later in the season in the same field. Emergence was much improved in the later seeding and seedling counts among treatments were more or less in the same order as in the first planting. Because of extensive tillering, the low emergence levels did not reduce seed yields.

Kernel weight data were obtained on bulked samples the first year, so only the results of the second and third years' tests could be included in the combined analysis (Table 2). The analysis showed that treatment of the seed with chemicals did not significantly change the kernel weight of the subsequent crop. As was the case with the seed yields, the kernel weights of the varieties were significantly different in the 2 years the analysis was done but the differences were not Significant in the combined analysis. Comparing the relative kernel weights of the seed from the three tests (Table 4) shows that they were lowest in Test 1 and highest in Test 3. This was the reverse of the seed yields for these tests.

Table 1. Effects of seed treatment on oat seed yields over a 3-year period

Treatment*	1965† Yield (g)	1965† Rank	1966 Yield (g)	1966 Rank	1967 Yield (g)	1967 Rank	Average Yield (g)	Average Rank
Control (untreated)	437.3	4	304.9	5	232.9	2	325.0	3
Methocel (sticker)	455.7	2	320.5	1	209.0	6	328.4	2
Ceresan M	430.8	5	316.1	2	213.6	5	320.1	5
Chemagro 4497	426.0	6	288.7	7	233.6	1	316.1	7
HRS-1591A	463.1	1	310.0	3	214.2	4	329.1	1
Liqui-San	423.2	7	300.4	6	230.1	3	317.9	6
Pandrinox	449.0	3	306.5	4	205.2	7	320.2	4

* Fungicides were applied to seed following treatment with Methocel.

† Data adjusted for plot size.

Table 2. Combined analysis and individual analyses of variance on 3 years of yield and 2 years of kernel weight data

	Seed yield			Kernel weight		
source of variation	df	MS	F	df	MS	F
Combined						
Years	2	1483277	11.7**	1	14.4	2.6
Reps/years	8	126815		5	5.6	
Treatments	6	2073	0.17	6	5.6	2.2
Varieties	4	55804	1.87	4	20.9	0.9
Years x treat	12	11860	2.7**	6	2.6	1.2
Years x var	8	29908	6.9**	4	21.9	10.6**
Treat x var	24	5575	1.3	24	3.4	1.6*
Treat x var x years	48	2451	0.5	24	2.9	1.4
Error (pooled)	272	4283		170	2.1	
Test 1						
Treatments	6	4767	0.7			
Varieties	4	18650	2.9*			
Treat x var	24	6973	1.1			
Error	102	6339				
Test 2						
Treatments	6	2189	0.7	6	2.8	1.1
Varieties	4	15496	5.2**	4	22.8	8.7**
Treat x var	24	3604	1.2	24	2.9	1.1
Error	102	2989		102	2.6	
Test 3						
Treatments	6	2171	0.7	6	3.1	2.4*
Varieties	4	56344	17.9**	4	16.5	13.2**
Treat x var	24	4089	1.3	24	3.9	3.1**
Error	68	3140		68	1.2	

* Significant 5% level.

** Significant 1% level.

Diseases such as septoria leaf blotch (Septoria avenae Frank f.sp. avenae) and crown rust (Puccinia coronata Cda.) were present in the plots each year but there was no indication that the rates of infection varied among treatments or varieties. Some variation in crown rust development was noted among replicates. The incidence of both of these diseases varied from year to year.

Discussion

There has been controversy over the years on the value of treating cereal seed with chemical fungicides. In some areas much of the cereal grain seeded is treated with fungicides whether it is known to be diseased or not. This is done frequently as a safety precaution to avoid possible losses from seed and soil-borne pathogens. There are numerous examples of seed-borne diseases of cereals that have been controlled by treatment of the seed with fungicidal chemicals (1), but in most instances the effects of such treatment on seed yields have not been determined. In cases where data are available (2, 3) the results indicate that with the exception of the cereal smuts significant yield increases often do not occur, even when the seed is heavily infected by a pathogen such as Cochliobolus sativus.

With the exception of the recent paper by Rawlinson and Colhoun (8) there are very few reports on the effect on yield of treating sound seed with fungicides. Most unpublished data that the writer has seen from several sources suggest that significant yield increases do not occur; the present work agrees with this. The relative yields of the five fungicidal treatments compared over the 3 years show an increase over the controls six times and a decrease nine times. The main problem in this work was the variability encountered in the yield data and this is, no doubt, one of the reasons why few published reports are available. Because of the amount of labor involved, small plots have been employed in tests of this type, usually using a randomized block design. As more mechanized equipment becomes available

Table 3. Effects of seed treatment on oat seedling emergence for 2 *years*

	1965*		1965†		1966	
Treatment	Emergence (%)	Rank	Emergence (%)	Rank	Emergence (%)	Rank
Control (untreated)	47	7	89	6	79	7
Methocel (sticker)	52	2			82	6
Ceresan M	49	5	92	1	85	1
Chemagro 4497	53	1	89	5	85	2
HRS-1591A	52	3	90	3	83	4
Liqui-San	49	6	91	2	83	5
Pandrinox	51	4	90	4	84	3

* First seeding.

† Second seeding (for emergence data **only**).

Table 4. Effects of seed treatment on the 1000-kernel weight of oat seed over a *3-year* period

	1965†		1966		1967		Average	
Treatment	Weight (g)	Rank	Weight (g)	Rank	Weight (g)	Rank	Weight (g)	Rank
Control (untreated)	29.5	3	31.4	7	31.9	7	30.9	7
Methocel (sticker)	30.1	1	32.0	3	32.0	6	31.3	3
Ceresan M	28.9	7	31.7	5	32.8	3	31.1	4
Chemagro 4497	29.1	5	31.8	4	32.2	5	31.0	5
HRS-1591A	29.3	4	32.1	2	32.9	2	31.4	2
Liqui-san	29.0	6	31.4	6	32.5	4	31.0	6
Pandrinox	29.9	2	32.3	1	33.2	1	31.8	1

† 1965 kernel weight data not included in the statistical analysis.

for plot work, larger plots can be employed, possibly using improved sampling designs to minimize within-test variability. Even though the within-test variability was large, varietal response was in agreement with other oat yield tests grown at Ottawa and at other locations in Ontario during these years (4, 5, 6). However the variability in varietal response! over the 3 years was also large, as can be seen by the fact that differences among varieties in both seed yield and kernel weight were significant each year but when subjected to the combined analysis were not (Table 2). This varietal variability was due to variable yearly responses, which no doubt resulted because of the presence each year of different uncontrolled environmental factors, such as temperature, rainfall, and foliage diseases.

Treatment of the seed improved seedling emergence slightly. However at the seeding rates currently recommended, improved emergence appears to be of little importance, as it has been found that more than a 50% reduction in emergence is needed before a significant decrease in yield will occur (2, 3). A recent study by Pelton (7) shows that in Western Canada under conditions of moisture stress, low seeding rates of wheat (0.3 and 0.6 bu/ac) produced significantly more grain than the higher rates generally used. In such a situation maximum emergence could be important.

Kernel weights were low in the first test and higher in the next two (Table 4). A decrease in kernel weight is usually associated with an increase in the number of tillers produced; this occurred in the first test, where poor emergence resulted in widely spaced plants that tillered profusely. This decrease in plants and increase in tillers did not lower grain yield but it did reduce kernel weight.

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