Field tests of cereal seed treated with nonmercurial fungicides[1]

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Several seed treatment chemicals were assessed in the field at Ottawa for their effects on seedling emergence, disease development, and yield of oats, barley, and wheat. None of the chemicals consistently increased seedling emergence or yield of the three cereals over the controls, although one chemical was effective one year. Yield response of individual cultivars varied considerably to treatment of the seed. Seedling blight ***[Pyrenophora avenae]*** of oats was present in trace amounts in in these tests and its significance could not be determined. Seedling blight ***[Cochliobolus sativus]*** of barley was prevalent in certain years and was reduced by treatment. More uniform data were obtained with the use of large plots and mechanical equipment than with small plots, and hand labor.

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On a évalué l'incidence de plusieurs produits chimiques (traitement des semences) sur la levee des plantules, l'évolution des maladies et le rendement de l'avoine, de l'orge et du blé en plein champ a Ottawa. Aucun des produits testes n'a regulierement accéléré la levee des plantules, ni accru le rendement de ces trois céréales en regard des parcelles temoins, bien que l'un des produits se soit révélé efficace au cours d'une année. Le rendement des cultivars a varie considerablement avec le traitement de la semence. On a constaté la presence de la rayure des feuilles ***[Pyrenophora avenae]*** de l'avoine au cours des tests, mais on n'a pu évaluer son importance. La brûlure des semis ***[Cochliobolus sativus]*** s'est manifestée certaines années, mais le traitement a reussi a en attenuer la gravite. L'utilisation de grandes parcelles et de machines a permis d'uniformiser davantage les données que celle des petites parcelles et du travail manuel.

The withdrawal of mercury compounds for use in treating cereal seed for the control of seed and soil-borne diseases has turned attention to other, less toxic chemicals. The withdrawal has resulted in considerable concern over the control of seedling blight ***[Pyrenophora avenae*** Ito & Kurib.] of oats because previous work (1), as well as growth room and laboratory studies (unpublished data), have shown that this disease is readily controlled by several mercury compounds; the effectiveness of nonmercurial compounds for controlling seedling blight is not known. Seedling blight has occurred occasionally in Ontario especially on the cultivar Gemini. Seed samples of this cultivar collected from a number of locations in eastern Canada in 1970 were found to contain trace to light amounts of ***P. avenae.*** For this reason field trials were run in 1971 and 1972 comparing several registered and experimental nonmercurial seed treatments on three cultivars of oats. In 1973-75 the investigation was expanded to include oats, wheat, and barley in large plots. This paper reports on the methods used and the effects of the chemicals on emergence, disease development, and seed yields.

Materials and methods

The source, composition, and application rate of the seed treatment chemicals assessed are listed in Table 1. They were applied at recommended concentrations to 225-g samples of seed in 1-liter widemouth erlenmeyer flasks which were rotated for 5 min on a custom-made treater that provided a tumbling action.

Garry, Gemini, and Scott oats ***(Avena sativa*** L.); Bonanza, Brock, Fergus, Galt, Herta, Paragon, Trent, and Vanier barley (***Hordeum vulgare*** L.); and Opal, Selkirk, and Glenlea wheat ***(Triticum aestivum*** L.) were used in different years. Whenever possible, local high quality seed of a uniform size and condition was used.

In 1971 and 1972, 4-row plots 3.0 m long were planted at the recommended rates for Ontario with a 10-row mechanical plot seeder with the rows 17.8 cm apart. Treatments were replicated four times and a randomized block design was employed. From 1973 to 1975 large plots (7.6 x 2.5 m) were employed using three replicates in a split plot design with cultivars as main plots and chemical treatments as subplots. In 1973 and 1974 seeding was done with a commercial farm drill in plots of 13 rows 17.8 cm apart. Because of planting difficulties in 1974 with the commercial drill, seeding was done in 1975 with a 4-row plot seeder having a bulk hopper attachment. Each plot consisted of 12 rows 22.8 cm apart. In 1974 and 1975 two seeding rates, the recommended rate (oats 76.2, wheat 100.9, barley 107.6 kg/ha) and one-half the recommended rate, were used.

Emergence counts were taken on duplicate 1.5 m portions of row selected at random within each replicate 3 to 4 weeks after seeding. At this time the seedlings were examined for the presence of seedling blight of oats [***P. avenae*** 3 and seedling blight of barley [***Cochliob-***

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Table 1. Seed treatment materials assessed at Ottawa, 1971-75

Year	Number	Source*	Product	Chemical Name	Dosage (oz/bu)
1971	1	Du Pont	Ceresan M	ethyl mercury p-toluene sulfonanilide 7.7%	0.5 & 1.0
	2	Uniroyal	Vitaflo	carbathiin 17.3% + thiram 15.4%	2.0 & 4.0
	3	Chipman	Agrox NM	maneb 37.5% + hexachlorobenzene 10%	2.0 & 4.0
	4	Buckman	TCMTB	2-(thiocyanomethylthio)benzothiazole 30%	0.85 & 1.7
1972	5	Uniroyal	Vitaflo	carbathiin 17.3% + thiram 15.4%	2.0
	6	Merk	ME-77	identity not available	1.5
1973	7	Uniroyal	Vitaflo	carbathiin 17.3% + thiram 15.4%	2.0
	8	Chipman	Agrox NM	maneb 50%	2.0
	9	Chipman	TF3219	BAS 3270F(2,5 dimethyl-furane 3-carboxylic acid cyclohexylamide) 15% + maneb 25%	2.0
	10	Chipman	TF3222	pyracarbolid 15% + maneb 25%	2.0
	11	Interprovincial	Busan 30	2-(thiocyanomethylthio)benzothiazole 37.5%	0.85
	12	Interprovincial	Busan DP	2-(thiocyanomethylthio)benzothiazole 18.75% + lindane 26.65%	0.85
	13	Merk	ME-77	identity not available	1.5
1974	14	Chipman	Agrox NM	maneb 50%	2.0
	15	Chipman	TF3222	pyracarbolid 15% + maneb 25%	2.0
	16	Uniroyal	Vitaflo	carbathiin 17.3% + thiram 15.4%	1.5
1975	17	Chipman	Agrox flowable	maneb 25%	2.5
	18	Chipman	TF3262	pyracarbolid 10% + maneb 16.7%	2.5
	19	Uniroyal	Vitaflo	carbathiin 17.3% + thiram 15.4%	1.5
	20	Uniroyal	UBI 2078	identity not available	1.5

* E. I. Du Pont de Nemours & Co., Inc., Wilmington, Delaware; Uniroyal Chemical Division, Elmira, Ontario; Chipman Chemicals Ltd., Hamilton, Ontario; Buckman Laboratories, Inc., Memphis, Tennessee; Merck & Co., Inc., Rahway, New Jersey; Interprovincial Cooperatives Ltd., Winnipeg, Manitoba.

olus sativus (Ito & Kurib.) Drechsl. ex Dastur]. When these diseases were present in more than trace amounts percentage counts of infected seedlings in a given area were made. The prevalence and severity of foliage diseases were determined at growth stages 10.5 to 11.1 on the Feeke's scale (3) by assessing the percentage of leaf area affected by each disease on the top three leaves of 10-15 plants picked at random from rows that were not to be used for determining seed yields. In 1971 and 1972 the two center rows of each plot were harvested by hand, excluding the plants in the 30 cm portion at the ends of each row. From 1973 to 1975, yields were determined by harvesting a 1.25 m wide center portion of each plot with Hege combine after a 0.8 m border had been removed from each end. The harvest portion of each plot measured 6 x 1.25 m or approximately 0.74 x 10^{-3} ha. The thousand kernel weight of harvested seed was determined on duplicate 250-seed samples.

Results and discussion

In the 1971 and 1972 trials none of the treatments used (Table 1) significantly improved emergence or seed yield of the three cultivars of oats. However, practically no seedling blight was found even in the untreated susceptible check Gemini.

From 1973 to 1975, the seed treatments were assessed on oats, barley, and wheat cultivars and particular eimphasis was placed on the use of mechanical equipment and large field plots so that conditions would be more comparable to farming operations. Planting, weed control, and harvesting were done mechanically. In 1973 seven chemicals (Table 1) were compared on Herta and Vanier barley, Garry oats, and Opal wheat, while additional cultivars of barley (Bonanza, Brock, Galt, Pisragon, and Trent), oats (Scott and Gemini), and wheat (Selkirk) were treated with Agrox NM and Vitaflo only. On the average, the treatments had no effect on the emergence of the various cultivars (Table 2). The chemical TF3222 consistently improved the yields of the three crops while the other fungicides were variable in this respect (Table 3). However individual cultivars varied considerably in their yield response to treatment, as evidenced by the response of the barley cultivars (Table 4); in this test treated plots of Bonanza and Paragon barley showed no increase in yield, while treated plots of Galt and Trent showed a 20% increase over the check. The variation in the kernel weight of seed of these same cultivars was not as great as the variation in yield.

In 1974 and 1975 fewer chemical treatments were used, with two seeding rates, the recommended rate and one-half the recommended rate. With one or two exceptions emergence counts were not affected by treatment (Table 2). In 1974 there were a significant improvement in emergence of treated compared with untreated barley at the half-rate seeding. The incidence

Table 2. Emergence counts (avg no. seedlings/1,5 m of row) of several cultivars of wheat, barley, and oats grown in the field for 3 years using seed treated with various chemical fungicides

1973					1974								1975							
						Wheat		Barley		Oats				Wheat		Barley		Oats		
						Sdg rate §		Sdg rate		Sdg rate				Sdg rate		Sdg rate		Sdg rate		
Treat. no.†	Wheat	Barley	Oats	Mean	Treat. no.†	1	2	1	2	1	2	Mean	Treat. no.†	1	2	1	2	1	2	Mean
7	48	75	69	64	14	112	63	106	74	77	44	79	17	82	49	91	53	72	50	66
8	52	77	66	66	15	107	62	102	69	75	50	77	18	78	39	87	46	74	53	63
9	50	83	52	82	16	104	64	104	78	84	46	80	19	85	41	94	51	93	55	70
10	52	83	64	66	Control	105	68	102	58	80	52	77	20	72	39	84	54	68	35	59
11	35	78	51	55		NS	NS	NS	**	NS	NS		Control	63	46	85	53	80	52	63
12	48	74	78	66										•	•	NS	NS	**	**	
13	48	77	47	57																
Control	52	77	63	82																
	NS	NS	NS																	

† See Table 1 for chemical identification.
§ Seeding rate 1, recommended rate; rate 2, half recommended rate, see text.
• Significant at the 5% level
** Significant at the 1% level
NS Not significant

Table 3. Yield (g/plot) of several cultivars of wheat, barley, and oats grown in the field for 3 years using seed treated with various chemical fungicides

1973					1974								1975					
						Wheat		Barley		Oats				Barley		Oats		
						Sdg rates		Sdg rate		Sdg rate				Sdg rate		Sdg rate		
Treat. no.†	Wheat	Barley	Oats	Mean	Treat. no.?	1	2	1	2	1	2	Mean	Treat. no.†	1	2	1	2	Mean
7	1967	1944	1192	1701	14	1662	1150	2367	2496	1536	1394	1767	17	2803	1513	573	552	136C
8	1684	2011	1304	1666	15	1307	1461	2624	2307	1598	1522	1803	18	2865	2025	606	659	1539
9	2214	1446	833	1498	16	1556	1355	2417	2505	1697	1401	1822	19	2742	1547	583	633	1376
10	2219	2073	1206	1833	Control	1599	1186	2448	2385	1703	1393	1786	20	2771	1230	427	665	1273
11	1499	1821	1227	1516									Control	2609	1830	588	469	1374
12	1657	1943	1193	1598														
13	1723	2020	952	1565														
Control	1800	1898	1180	1626														

† See Table 1 for chemical identification.
§ Seeding rate 1, recommended rate; 2, half recommended rate. see text.

of root rot and seedling blight was approximately the same at the two seeding rates (Table 5). Therefore the overall control attained was proportionally greater at the lower seeding rate. Vitaflo was more effective than the other two chemicals in reducing the amount of seedling blight. However at maturity comparable differences in seed yields were not evident, especially between the two seeding rates of barley (Table 3). The yield response to the chemical TF3222 was not as consistent as in the previous year.

In 1975 emergence differences were more evident with oats and wheat than with barley. The differences with oats were significant because the chemical UBI 2078 reduced emergence below the control. In contrast to 1974, the yield of barley at the half-rate seeding was much lower than at the recommended rate. Oat yields on the other hand, were not affected by rate of seeding or by chemical treatment even though emergence counts were different.

The prevalence of the leaf diseases powdery mildew *[Erysiphe graminis* D.C. ex Mérat] of barley and wheat, spot blotch [*Cochliobolus sativus]* of barley and wheat, and crown rust [*Puccinia coronata* Cda. f. sp. *avenae* Erikss. & E. Henn.] of oats was determined near maturity each year, and there was no evidence of any differences, in disease development among the treatments. However, in the larger plots it was observed occasionally that at approximately the time of heading the foliage of plants in treated plots was often somewhat lighter in color than the foliage of plants from untreated seed, particularly among the barley cultivars.

In these tests treatment of seed containing low levels of seed-borne diseases with chemicals generally did not

Table 4. Yield (g/plot) of five barley cultivars in the field in 1973 using seed treated with two chemical fungicides

Treatment	Bonanaza		Brock		Galt		Paragon		Trent		Mean	
	Yield (g)	%of check	Yield (g)	%of check	Yield (g)	%of check	Yield (g)	%of check	Yield (g)	%of check	Yield (g)	%of check
Check	1974		1766		1549		2248		1933		1858	
Agrox NM	1794	97.5	1932	109.4	1853	119.6	2224	98.9	2236	115.7	1999	107.6
Vitaflo	1873	104.4	1977	111.9	1861	120.1	2227	101.0	2281	118.0	2052	110.4

Table 5. Percent root rot and seedling blight infection [*Cochliobolus sativus*] on Herta and Vanier barley grown in the field in 1974 using seed treated with three chemical fungicides

	Herta Seeding rate		Vanier Seeding rate'		Mean
	1	2	1	2	
Agrox NM	12	22	15	9	14.5
TF3222	15	16	20	19	17.5
Vitaflo	3	7	13	9	8.0
Control	28	19	22	8	19.2

'Seeding rate 1, recommended rate; rate 2, half recommended rate, see text.

improve emergence or seed yield. Even when emergence was increased by treatment improvement in yields did not necessarily follow. In some situations the use of the lower seeding rate resulted in reduced yield but in other cases it did not. It would be difficult to predict when the lower rates could be used safely especially if a seed-borne disease was present. Cultivar response to seed treatment was also quite variable, indicating that specific treatments should be assessed on a considerable number of cultivars before recommendations are formulated. The use of large plots for assessing the merits of seed treatment chemicals is recommended, especially since the problem of interplot interference (2) is probably reduced when plots of this size are employed.

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