Effects of Postharvest Oil and Fungicide Application on Storage Fungi in Corn Following High-Temperature Grain Drying

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ABSTRACT

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Three experiments compared the efficacy of the fungicides thiabendazole or iprodione with a water carrier before or after drying, and with an oil carrier at dust-control rate before drying for control of storage fungi. A fourth experiment compared the efficacy of thiabendazole applied in water, degummed soybean oil, food-grade soybean oil, or white mineral oil carrier before grain drying, and measured the efficacy of each oil without fungicide. After high-temperature drying, grain was stored for 40–42 wk in modified grain bins. The incidence of storage fungi was determined following plating of kernels on malt salt agar. All fungicide treatments reduced the incidence of *Penicillium* and *Aspergillus* spp. when compared to non-fungicide-treated controls. All three oils alone also reduced the incidence of *Penicillium* and *Aspergillus* spp. compared to the untreated sample. The control of storage fungi resulted in fewer damaged kernels as determined by a licensed federal grain inspector. The best control of storage fungi was achieved by the application of fungicide in oil rather than in a water carrier. Results indicate that fungicides applied in a soybean or mineral oil carrier prior to high-temperature drying can be integrated with currently used storage fungi control techniques, thus allowing for maintenance of quality grain.

Additional keywords: maize, *Zea mays*

Following harvest, corn grain (*Zea mays* L.) is subject to infection and damage by numerous fungi, primarily *Aspergillus* and *Penicillium* spp. (12). The incidence of infection and severity of damage by these fungi depend on numerous factors, including storage temperature, grain moisture, relative humidity of air in the grain mass, fungal species present, levels of preharvest fungal infection, and mechanical damage to kernels. Since *Aspergillus* and *Penicillium* spp. grow actively when grain moisture is greater than 16%, high-temperature drying of corn to less than 15% moisture immediately after harvest is commonly used in the midwestern United States to control these fungi (2,16). Grain is dried to 14% grain moisture or below if it is to be stored through the spring and summer. Although high-temperature drying may prevent growth of fungi by rapidly reducing grain moisture, it can cause stress cracking of kernels. Stress cracking of kernels results in greater amounts of mechanical damage (broken corn) each time the grain is handled (14). Additionally, corn grain dried to lower moisture is more susceptible to mechanical damage during grain handling in market channels, regardless of how it is dried (3).

Small particles of broken corn are a major component of grain dust, which is a serious problem in grain facilities. Grain dust may cause worker respiratory problems; pollute the environment; and more immediately can cause explosions and fires in grain handling, storage, and processing facilities (18). Thus, even though drying corn grain to low moisture may effectively control damage due to fungi, high-temperature drying and storage at low moisture contribute to the additional problem of grain dust.

Control of dust can be achieved by the application of additives to grain and/or by the use of mechanical devices. Mechanical devices that remove dust from grain are useful; however, the storage, handling, and utilization of grain dust becomes an additional problem since it cannot be added back into grain (Grain Quality Improvement Act of 1986, P.L. 99-641). The use of water applied as a mist through a series of nozzles in dusty areas has been used to control dust; however, this practice is being reviewed within the USDA and may be prohibited (10). In 1982, the U.S. Food and Drug Administration approved the use of food-grade white mineral oil at 0.02% (200 μg oil/g grain) on grain used for human consumption, or 0.06% (600 μ/g) on grain used for animal feed (4). The U.S. Food and Drug Administration also has issued an advisory opinion allowing the use of vegetable oils such as vegetable-grade soybean oil (food grade) in dust-control formulations (Rudolph Harris, Petition Control Branch, Bureau of Foods, FDA, *personal communication*).

Because storage fungi usually do not invade kernels prior to harvest (11,15), fungicides applied at harvest may be useful as grain protectants and could result in the storage and shipment of grain at slightly higher grain moisture. The use of fungicides also could increase the use of low-temperature drying (20,21), which causes less stress cracking of kernels than high-temperature drying. Laboratory experiments with corn (1,5–8,19,22) and barley (9) have shown that several fungicides, including iprodione and thiabendazole, prevent infection by storage fungi. Soybean oil alone also reduces infection by storage fungi (1,5). Studies in experimental grain bins have demonstrated the effectiveness of several fungicides for control of storage fungi during low-temperature drying and storage (20,21).

The application of a fungicide with an oil carrier at the dust-control rate rather than with a water carrier could provide control of both dust and storage fungi, thus contributing to the control of two major problems of stored grain. Also, it must be determined whether fungicides would be best applied before or after drying because of the possibility that the high temperatures during drying could affect the efficacy of a fungicide. Thiabendazole applied with a mineral oil carrier at the dust-control rate of approximately 23 ml/quintal (200 μg/g) was not as effective as thiabendazole applied with a water carrier at 350–470 ml/quintal before low-temperature drying (D. G. White, *unpublished*). Therefore, we did not apply oil treatments after drying. The objective of this research was to determine the effectiveness of fungicides in water or oil carriers in conjunction with a type of high-temperature drying referred to as combination drying.

MATERIALS AND METHODS

Experiments were done in modified, commercially available grain bins at the Agronomy-Plant Pathology South

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the use discussed here has been registered. All uses of pesticides must be registered by appropriate state and federal agencies before they can be recommended.

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Farm, Urbana, Illinois. Bins are 5.7 m high at the eve and 4.6 m in diameter. Bins have false bottom drying floors that are divided in half. Each half of the bin is equipped with a fan to deliver 0.07 m^3/min/quintal (0.64 ft^3/min/bu) at 248.8 Pa (1.0-in) static pressure. Each bin is divided into 16 wedge-shaped experimental units (eight under the control of each fan) to accommodate various treatments. Each fan is controlled with a programmed aeration controller that turns the fan on when the temperature and relative humidity of ambient air are conducive for drying and/or storage of grain. Each wedge-shaped compartment has sampling ports that allow access to the grain at various grain depths. Treatments in all experiments were arranged in a randomized complete-block design with two replicates.

The corn hybrid B73 × LH38 was used in all experiments. Fungicides in water carrier were applied at a rate of approximately 350 ml/quintal total volume of water carrier and fungicide using the "modern flow spraying system" (Pauls Machine and Welding Shop, Villa Grove, IL). Thiabendazole (20 μg/g, a.i. fungicide to grain weight adjusted to 15% moisture) was applied as Mertect 340F, and iprodione (20 μg/g, a.i. fungicide to grain weight adjusted to 15% moisture) was applied as Rovral 4F. After the application of fungicides to grain with water carriers, the grain was augered into a grain wagon, transported to a batch dryer, and dried to the desired moisture with a plenum temperature of approximately 93 C. After high-temperature drying, grain was loaded into grain bins. When the fungicide was applied with a water carrier after drying, the grain was first dried, then treated in the same manner and augered into the bin. The oils, food-grade white mineral oil or soybean oil, used either alone or as carriers for fungicides, were applied at approximately 23 ml/quintal (200 μg/g) using a peristaltic squeeze pump and an air-assist nozzle (air supplied at 137.9 kPa [20 psi]). The air-assist nozzle was fitted in a plexiglass hood built over the upper part of an auger boot. The hood restricted grain flow and allowed for a spray chamber at the auger base where grain is tumbling due to the action of the auger. Thiabendazole or iprodione was applied at a rate of 20 μg/g (a.i. fungicide to grain weight adjusted to 15% moisture) using fungicide formulations provided by the manufacturer. Grain was augered into a wagon, transported to the dryer, and dried. After drying, grain was augered into the bin.

All grain was further dried with continuous aeration for 2 wk. Aeration for the remainder of the experiment was controlled by the programmed aeration controller set to Storage I mode. The desired moisture was set at 15.5% with an average of 0.5 hr/day fan run time. The programmed aeration controller turned fans on whenever the relative humidity and temperature of ambient air favored an equilibrium grain moisture content of 15.5%. The controller will accumulate a backlog of fan run time and turn on fans whenever the best ambient air conditions exist.

Four experiments were done in 1986–87, 1987–88, and 1989–90. For the 1986–87 thiabendazole experiment, corn was harvested at an average grain moisture of 20.5% on 23 September 1986 and dried to an average of 17.1%. In this experiment, the four treatments were the following: untreated, thiabendazole in water carrier before drying, thiabendazole in water carrier after drying, and thiabendazole in white mineral oil carrier before drying. The 1987–88 experiments were done with thiabendazole or iprodione. In the thiabendazole experiment, corn was harvested at an average grain moisture of 20.4% on 9 September 1987 and dried to an average of 16.6% grain moisture. The four treatments were the following: white mineral oil, thiabendazole in white mineral oil carrier, thiabendazole in vegetable-grade (food-grade) soybean oil carrier, and thiabendazole in water carrier. All treatments were applied before drying. In the iprodione experiment, corn was harvested at an average grain moisture of 19.9% on 9 September 1987 and dried to an average of 16.6% grain moisture. The four treatments were the following: untreated, iprodione in water carrier before drying, iprodione in water carrier after drying, and iprodione in white mineral oil carrier before drying. For the 1989–90 experiment, corn was harvested on 9 October 1989 at a grain moisture of 20.6% and dried to an average of 17.9% grain moisture. The eight treatments were the following: untreated, thiabendazole in water carrier, degummed soybean oil, thiabendazole in degummed soybean oil carrier, vegetable-grade soybean oil, thiabendazole in vegetable-grade soybean oil carrier, white mineral oil, and thiabendazole in white mineral oil carrier. All treatments were applied prior to grain drying.

In the 1986–87 and 1987–88 experiments, grain samples were taken before and after treatment and at weekly intervals for 40 wk. In the 1989–90 experiment, grain samples were taken at biweekly intervals for 42 wk. In all experiments, samples were taken from 1.2 m (bottom level), 2.4 m (middle level), and 3.6 m (top level) above the grain bin drying floor. Samples were evaluated for grain moisture with a Dickey-John GAC II moisture meter. Fifty whole, randomly selected kernels from each sample were surface-sterilized in a 1.575% sodium hypochlorite solution (30% commercial bleach) for 1 min and then plated, 10 kernels to a plate, on malt salt agar. After 1 wk at room temperature (approximately 23 C), the numbers of kernels infected with particular fungal species were recorded. In the 1986–87 and 1987–88 experiments, samples taken before and after treatment, and every 4 wk, were sent to a licensed federal grain inspector for determination of percent damage (17). In the 1989–90 experiment, samples for determination of percent damage were taken every 6 wk.

The number of kernels from which *Penicillium* spp. were isolated was converted to percentage. The number of kernels from which various *Aspergillus* spp. were isolated (*A. flavus* Link:Fr., *A. glaucus* Link:Fr. group, *A. niger* Teigh., *A. ochraceus* K. Wilh.) was summed for the total *Aspergillus* spp. to provide an estimate of incidence of all *Aspergillus* spp. The area under the curve (AUC) was calculated (13) from data of the percent *Penicillium* spp., total *Aspergillus* spp., and percent damage for each sampling level and averaged over sampling levels for each replicate. AUC values were also calculated for the grain moisture of each treatment at each sampling level and for treatments combined at each sampling level. Treatments were compared by analysis of variance using the AUC value for percent *Penicillium* spp., total *Aspergillus* spp., percent damage and grain moisture for each sampling level, average of the three sampling levels, and average grain moisture of all treatments at each sampling level.

RESULTS

Grain moisture. In all four experiments, AUC values for grain moisture were not significantly different among treatments at any sampling level or averaged over sampling levels (AUC values not shown). AUC values for moisture were significantly different among sampling levels in all experiments except for the 1987–88 thiabendazole experiment. Grain at the bottom sampling level was lower in moisture than grain at the middle sampling level, and grain at the middle sampling level was lower than grain at the top sampling level (Figs. 1 and 2). In 1986–87, moisture averaged approximately 15.5% until week 32, when it was reduced to approximately 13.5% (Fig. 1). In the 1987–88 thiabendazole experiment, moisture at the various sampling levels varied greatly during the experiment with no significant differences between levels. In general, moisture was between 14 and 16% until week 37, after which it was lower. In the 1987–88 iprodione experiment, average moisture was lower and differences between sampling levels were greater than in the thiabendazole experiment, even though the two experiments were in the same bin with corn harvested from the same field (Fig. 1). In the 1989–90 thiabendazole experiment, moisture was higher than in earlier experiments, because moisture was not reduced to less than

15% until week 32 of the experiment (Fig. 2).

Percent *Penicillium* spp. In all four experiments, fungicides reduced the percent kernels from which *Penicillium* spp. were isolated (Figs. 1 and 2). In general, the most effective control was achieved by the use of oil as a fungicide carrier applied before drying (Table 1). In the 1986–87 and 1987–88 thiabendazole experiments, the AUC-percent *Penicillium* spp. for all treatments with fungicide were significantly lower than treatments without fungicide. There were no significant differences in AUC values among the fungicide treatments. In the 1987–88 iprodione experiment, AUC-percent *Penicillium* spp. values for fungicide treatments were significantly lower than for the untreated control. The AUC-percent *Penicillium* spp. value of the treatment with iprodione in mineral oil carrier applied before drying was significantly lower than for the treatment with iprodione in water carrier after drying when comparisons were made at the bottom sampling level and averaged

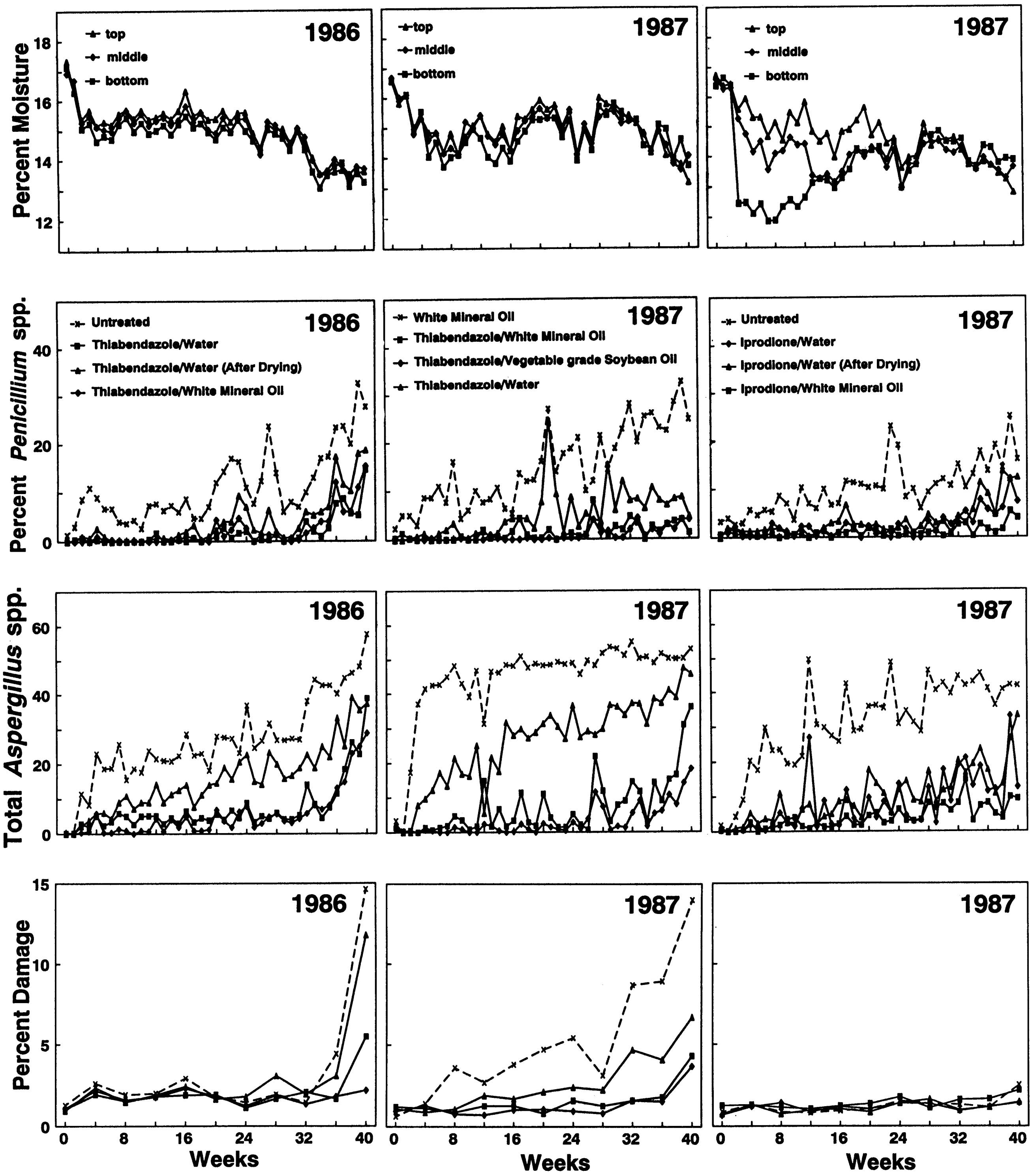

Fig. 1. Effect of fungicide applications with water or oil carrier on corn grain high-temperature dried in 1986 and 1987. Percent moisture of corn grain from three bin sampling levels averaged over two replicates and all treatments. Percent kernels (n = 50) from which *Penicillium* spp. and total *Aspergillus* spp. (sum of the number of kernels [n = 50] for different *Aspergillus* spp.) were isolated averaged over two replicates and three bin sampling levels. Percent damage as determined by a licensed federal grain inspector averaged over two replicates and three bin sampling levels. Sampling levels, bottom, middle, and top, were 1.2, 2.4, and 3.6 m, respectively, above the grain bin drying floor.

over all sampling levels (Table 1). In the 1989-90 thiabendazole experiment, AUC-percent *Penicillium* spp. values for all fungicide treatments were lower than for the untreated control. AUC values for treatments with thiabendazole in any of the three oil carriers were generally lower than other treatments. The use of oil alone also resulted in lower incidence of *Penicillium* spp., as expressed by AUC values, compared to the untreated control (Table 1).

Total *Aspergillus* spp. Thiabendazole and iprodione also provided effective control of *Aspergillus* spp. (Figs. 1 and 2). *A. glaucus* was the most prevalent species in all experiments. In the 1986-87 experiment, total *Aspergillus* spp. of the untreated sample and of the treatment with thiabendazole in water carrier after drying increased steadily during the entire experiment. Total *Aspergillus* of the grain treated with thiabendazole in water or mineral oil carrier after drying was less than 10 until after week 32. The AUC-total *Aspergillus* spp. values were significantly lower for thiabendazole treatments than for the the untreated samples, except at the top sampling level, where treatment with thiabendazole in a water carrier after drying was not significantly different from the untreated control (Table 1). At the middle sampling level and averaged over all levels, AUC-total *Aspergillus* spp. values for treatments with thiabendazole in water or in mineral oil carrier applied before drying were significantly lower than those for treatment with thiabendazole in water carrier applied after drying. In the 1987-88 experiment, thiabendazole effectively controlled *Aspergillus* spp., especially when applied in an oil carrier (Fig. 1). AUC-total *Aspergillus* spp. values were significantly different at the top sampling level and averaged over all sampling levels. AUC-total *Aspergillus* spp. values of treatments with thiabendazole in mineral oil or in soybean oil carrier before drying were significantly less than the values for treatment with thiabendazole in water carrier or the treatment with mineral oil alone. In the 1987-88 iprodione experiment, all fungicide treatments effectively reduced the total *Aspergillus* spp. compared to the untreated control (Fig. 1). AUC-total *Aspergillus* spp. values were significantly less for all fungicide treatments than for the untreated controls. At the top sampling level, the AUC-total *Aspergillus* spp. value for treatment with iprodione in mineral oil carrier was significantly less than for treatment with iprodione in water carrier after drying. In the 1989-90 experiment, thiabendazole applied in any of the three oil carriers provided the best control of *Aspergillus* spp. (Fig. 2). AUC-total *Aspergillus* spp. values for each of the three treatments with thiabendazole in oil carrier were significantly less than for the untreated control (Table 1). The use of thiabendazole in water carrier applied before drying was not as effective for control of *Aspergillus* spp. as it was for *Penicillium* spp. Only at the top sampling level and averaged over all levels was the AUC-total *Aspergillus* spp. value of the treatment with thiabendazole in water carrier significantly lower than the

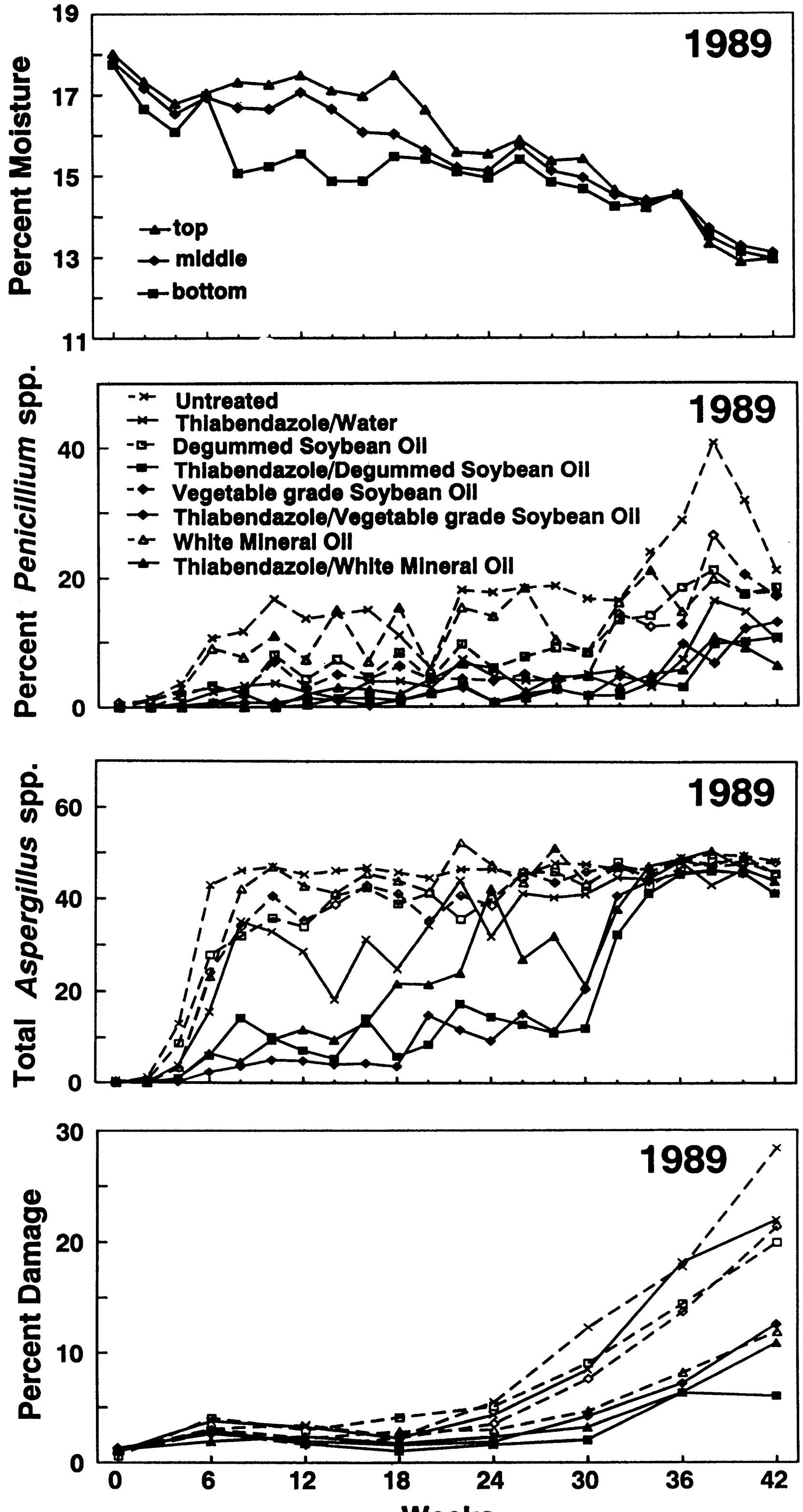

Fig. 2. Effect of oil and fungicide with water or oil carrier on corn grain high-temperature dried in 1989. Percent moisture of corn grain from three bin sampling levels averaged over two replicates and all treatments. Percent kernels (n = 50) from which *Penicillium* spp. and total *Aspergillus* spp. (sum of the number of kernels [n = 50] for different *Aspergillus* spp.) were isolated averaged over two replicates and three bin sampling levels. Percent damage as determined by a licensed federal grain inspector averaged over two replicates and three bin sampling levels. Sampling levels, bottom, middle, and top, were 1.2, 2.4, and 3.6 m, respectively, above the grain bin drying floor.

untreated control. Oils alone were not as effective in controlling *Aspergillus* spp. as they were in controlling *Penicillium* spp., even though the AUC-total of *Aspergillus* spp. value of the three treatments using oil alone were significantly less than the control at some sampling levels.

Damage. Damage to kernels in the 1986–87 and 1987–88 experiments was generally less than 5% for all treatments throughout much of both experiments (Fig. 1), and AUC-percent damage values did not differ significantly among treatments (Table 1). In the 1989–90 thiabendazole experiment, grain moistures were higher and significant differences in AUC-percent damage values occurred with significantly lower AUC values for treatment with thiabendazole in any of the three oil carriers than for the untreated control. Thiabendazole applied in water carrier was not as effective as thiabendazole applied in oil carrier. The AUC-percent damage value of treatment with thiabendazole in water carrier was significantly lower than the AUC value of the untreated control only at the middle sampling level. AUC-percent damage values of treatments with any of the three oils alone were significantly lower than the value of the untreated control averaged over levels and at the top sampling levels where fungal incidence was highest.

DISCUSSION

Treatment with thiabendazole or iprodione resulted in lower incidence of both *Penicillium* and *Aspergillus* spp. compared to no fungicide treatment. In some experiments, the difference in incidence of fungal infection also was reflected in lower percent damage, as determined by a licensed federal grain inspector. The best control of storage fungi was achieved when fungicides were applied in an oil carrier before drying grain. When water was used as the carrier, fungicides were more effective when applied before drying, indicating that the heat of the drying process was not detrimental to fungicidal efficacy.

The 1989–90 thiabendazole experiment provides for comparison of oils with and without fungicides applied before drying. In this experiment, the application of thiabendazole in a soybean oil or mineral oil carrier resulted in effective control of *Aspergillus* and *Penicil-*

Table 1. The area under curve (AUC)[a] for incidence of *Penicillium* spp., total *Aspergillus* spp., and percent damage of corn grain treated with oil and fungicides with water or oil carrier

Year	% *Penicillium* spp.[b]				Total *Aspergillus* spp.[c]				% Damage[d]			
Treatment[a]	B[e]	M[f]	T[g]	A[h]	B	M	T	A	B	M	T	A
1986–87												
Untreated	380	436	505	440	989	1,058	1,165	1,070	89	123	127	113
Thiabendazole/water	63	51	67	60	345	224	237	268	70	66	91	76
Thiabendazole/water (after drying)	85	138	229	150	315	597	941	618	76	97	140	105
Thiabendazole/white mineral oil	63	76	96	78	159	201	248	203	70	68	71	70
P[i]	<0.001	0.018	0.014	0.005	0.043	0.001	0.030	0.002	0.085	0.076	0.511	0.177
LSD[j] (*k*-ratio = 100)	44	162	168	103	458	134	524	178				
1987–88												
White mineral oil	531	607	646	595	1,755	1,810	1,850	1,805	167	185	249	200
Thiabendazole/white mineral oil	47	65	66	59	234	241	341	274	55	50	66	57
Thiabendazole/vegetable-grade soybean oil	11	49	41	34	62	118	172	117	43	48	54	48
Thiabendazole/water	169	205	234	203	967	1,024	1,136	1,042	76	93	130	100
P	0.013	0.031	0.009	0.016	0.077	0.073	0.012	0.047	0.177	0.067	0.055	0.064
LSD (*k*-ratio = 100)	192	286	201	226			616	1,005				
1987–88												
Untreated	360	404	465	410	985	1,261	1,536	1,260	43	42	55	47
Iprodione/water	78	94	118	96	189	327	425	314	42	51	46	46
Iprodione/water (after drying)	94	154	162	137	214	444	531	396	46	41	44	44
Iprodione/white mineral oil	28	42	66	43	58	131	283	158	51	52	62	55
P	0.001	0.007	0.008	0.003	0.006	0.009	0.002	0.004	0.069	0.312	0.352	0.290
LSD (*k*-ratio = 100)	52	105	121	75	255	352	240	278				
1989–90												
Untreated	522	654	889	688	1,723	1,772	1,765	1,753	304	283	473	353
Thiabendazole/water	150	197	266	205	1,356	1,436	1,237	1,343	281	239	404	308
Degummed soybean oil	219	274	574	356	1,555	1,616	1,453	1,541	238	273	385	298
Thiabendazole/degummed soybean oil	98	84	128	103	650	770	808	742	115	92	136	114
Vegetable-grade soybean oil	227	281	423	310	1,538	1,581	1,515	1,544	296	194	273	255
Thiabendazole/vegetable-grade soybean oil	93	69	207	123	686	584	855	708	132	116	223	157
White mineral oil	373	419	681	491	1,599	1,683	1,714	1,655	188	153	202	181
Thiabendazole/white mineral oil	121	108	224	151	866	929	1,197	997	118	121	188	143
P	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	0.026	<0.001	<0.001	<0.001
LSD (*k*-ratio = 100)	84	61	98	57	433	410	235	284	136	43	77	47

[a] All treatments applied before drying, unless otherwise noted.
[b] % *Penicillium* spp. is based on 50 kernels evaluated in each of two replicates.
[c] Total *Aspergillus* spp. is the sum of *Aspergillus* spp. (*A. flavus, A. glaucus, A. niger*, and *A. ochraceus*) from 50 kernels in each of two replicates.
[d] % Damage as determined by a licensed federal grain inspector.
[e] Bottom sampling level, 1.2 m from the drying floor.
[f] Middle sampling level, 2.4 m from the drying floor.
[g] Top sampling level, 3.6 m from the drying floor.
[h] Averaged over all three sampling levels.
[i] Probability of greater *F* statistics for treatments from one-way analyses of variance.
[j] Waller Duncan Bayesian LSD test (*k*-ratio = 100).

lium spp., and resulted in significantly less damage to kernels as expressed by AUC-percent damage values. In addition, treatment with oil alone suppressed fungal growth and resulted in significantly lower AUC-percent damage values at some sampling levels and averaged over sampling levels.

Our studies support the results of studies done in the laboratory that indicate that soybean oil alone, at dust-control rates, provides limited control of storage fungi (1,5); but the magnitude of control is not great enough to suggest that oils be recommended for control of storage fungi. In another study done in experimental bins at the University of Illinois, thiabendazole applied in a mineral oil carrier was not as effective as thiabendazole applied in a water carrier in conjunction with low-temperature grain drying (D. G. White, *unpublished*). We believe that the less effective control with thiabendazole in an oil carrier prior to low-temperature drying is due to the low volume of the carrier resulting in inadequate distribution of fungicide. In contrast, when oil is used as a fungicide carrier prior to high-temperature drying, the oil is heated and likely redistributed on the surface of kernels during the drying process, whereas water carrier would evaporate very rapidly. The more effective control by fungicides applied in oil carrier compared to fungicides applied with water carrier can be due partially to synergism between oil and fungicide.

Significant differences in AUC-percent damage were detected only in the 1989–90 thiabendazole experiment. In the 1986–87 and 1987–88 thiabendazole experiments, the percent damage of nonfungicide-treated grain was greater than that of fungicide-treated, although the difference was not significant. In general, the 1989–90 thiabendazole experiment was the only experiment where moisture was maintained at higher than recommended levels, thus allowing for greater damage. Damage occurs after fungal infection, and kernels not infected by *Penicillium* or *Aspergillus* spp. would not be damaged if conditions became favorable for additional fungal growth. It would be expected, therefore, that corn treated with fungicide would be less subject to mold damage if grain moisture and temperature were to favor fungal growth as grain is moved through marketing channels.

At present, oils for dust control are applied prior to high-temperature drying at grain elevators but not on farms (D. G. White, *personal observation*). Fungicides applied with oil carriers would be most effective if applied immediately after harvest, since the fungicides function as protectants. Fungicides applied with oil carriers on-farm would provide for dust control, thus reducing the exposure of the farmer to grain dust.

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