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FUNGICIDE APPLICATION TO COTTONSEED USING METHYLENE CHLORIDE CARRIER[1]

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ABSTRACT

A method is described for quantitative application of chemicals to cottonseed (*Gossypium hirsutum* L.), using methylene chloride as a carrier. The objective of this study was to compare the performance of fungicides applied with methylene chloride with those of fungicides applied in wettable powder formulations in field studies. Nonsystemic fungicides used were PCNB (pentachloronitrobenzene) and ETMT [5,ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole]. Systemic fungicides used were chloroneb (1,4-dicholoro-2,5-dimethoxybenzene) and carboxin (5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide). Germination of cottonseed was reduced by methylene chloride, apparently because it killed mechanically damaged seeds. This reduction was reflected in field studies where stands from seeds treated with fungicides in the solvent averaged 6% less than stands from seeds treated with fungicides in wettable powder formulations. Solvent-applied fungicides, both systemic and nonsystemic, gave no more seed protection than wettable powders.

Additional index words: Seedling disease, Damping-off, Seed rot, Organic solvent infusion, *Gossypium hirsutum* L.

RECENT research has demonstrated that the organic solvents, acetone and methylene chloride, may be used for application of chemicals, including fungicides (1, 6, 7, 11), to seeds. However, these previous studies either failed to compare the efficacy of solvent infusion with alternative methods of fungicide application or failed to employ equivalent dosages with alternative application methods. These studies, with one exception (7), involved laboratory evaluations against specific pathogens rather than field studies in which a diversity of pathogens and climatic conditions is encountered.

We evaluated the efficacy of methylene chloride as a solvent for application of fungicides to cottonseed. The field performances of both systemic and nonsystemic fungicides applied by this method were compared with the performances of equivalent dosages of fungicides applied as wettable powders at six diverse locations. Although combinations of fungicides are normally used in cottonseed treatments (5, 8), we used the fungicides individually in order to facilitate interpretation of results and to limit the number of necessary treatments.

MATERIALS AND METHODS

Acid-delinted cottonseed (*Gossypium hirsutum* L., 'Stoneville 213') used in these experiments were produced by Stoneville Pedigreed Seed Co., Stoneville, MS. Twenty-eight percent of the seeds were shrivelled or had mechanically damaged seed coats.

Nonsystemic fungicides used were PCNB[3], (pentachloronitrobenzene; as Terraclor Technical and Terraclor 75 WP, Olin Corp., Little Rock, AR), and ETMT [5,ethoxy-3-(trichloromethyl)-1,2,4-thiadiazole; as Terrazole Technical and Terrazole 35 WP, Olin, Corp.]. Systemic fungicides used were chloroneb (1,4-dichloro-2,5-dimethoxybenzene; as Technical chloroneb-B-90 and Demosan 65 W, E. I. DuPont DeNemours & Co., Wilmington, DE), and carboxin (5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide; as Vitavex Technical and Vitavax 75 W, Uniroyal Inc., Naugatuck, CT).

Wettable powder formulations were applied to seeds as dry powders, and technical grade materials were applied as methylene chloride solutions. All fungicides were applied at 1.25 and 0.125 g of active ingredient per kg of seeds. Before application of fungicides it was determined that the seed lot imbibed 69 ml of mehtylene chloride per kg of seeds. This imbibition was completed within 15 min, and did not increase for at least 24 hours. Therefore, for application of methylene chloride solutions, seeds were immersed in solutions containing 1.25 or 0.125 g of active ingredient per 69 ml of ethylene chloride. This assured quantitative comparability of fungicide treatments. After immersion for 1 hour the seeds were air dried for 48 hours. Controls were nontreated seeds and seeds immersed for 1 hour in methylene chloride alone.

Germination in the laboratory was tested with 250 seeds from each treatment. Seeds were germinated for 7 days at alternating temperatures of 30 C for 14 hours and 20 C for 10 hours. Seedling survival (stand) was determined in field plantings at Auburn, AL, Stoneville, MS, Portageville, MO, College Station and Lubbock, TX, and Shafter, CA. Six replications of 100 seeds each were planted at each of these six locations. Stand was counted 30 to 40 days after planting and is expressed as a percentage of seeds planted. The experiment was designed as a split plot. Comparisons between means were made using Tukey's (HSD) procedure (9).

Table 1. Seed germination and stand of cotton as influenced by fungicides, applied as wettable powders (WP) or as methylene chloride solutions (MC).

	Fungicide rate (g/kg seed)			
	0.125		1.25	
Fungicide	WP	MC	WP	MC
	Percentage germination†			
PCNB	84	63	86	80
ETMT	80	70	82	67
Chloroneb	81	71	80	73
Carboxin	85	68	84	73
Control	90	70	90	70
HSD (0.05)*	7.4		7.4	
	Percentage stand‡			
PCNB	36	24	31	28
ETMT	35	23	33	31
Chloroneb	31	25	34	29
Carboxin	30	27	39	33
Control	28	21	28	21
HSD (0.05)	8.1		8.1	

* Values which differ by more than the HSD value are significantly different by the honestly significant difference procedure. † Values based on 250 seeds germinated for 7 days at alternating temperatures of 30 C for 14 hours and 20 C for 10 hours. ‡ Values are the mean of six replications of 100 seeds each, at each of six locations and are expressed as a percentage of seeds planted.

RESULTS AND DISCUSSION

Immersion of cottonseed in methylene chloride reduced germination (Table 1). Germination of seeds immersed in methylene chloride solutions of fungicides averaged 12% less than that of seeds treated with wettable powders. None of the individual fungicides had any significant effect on germination. Methylene chloride apparently reduced germination by disrupt-

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[3] This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended.

ing membranes in damaged embryos as described by Halloin (2).

Effects of fungicides and methods of application on stand are summarized in Table 1. Stands averaged 6% less with fungicides applied as methylene chloride solutions than with fungicides applied as wettable powders. This reduction in stand with methylene chloride application was observed with all fungicides and, as with reduced germination, was apparently a manifestation of killing of embryos by the solvent. Recalculation of results to correct for effects of the solvent on controls revealed no significant differences in seed or seedling protection between methods of fungicide application at either fungicide concentration. Size of stands at various locations ranged between an average of 51% at College Station, TX, to an average of 8% at Shafter, CA. At College Station, TX, rainfall within 24 hours following a first planting caused severe crusting of the soil, which prevented seedling emergence. Subsequent replanting in warmer soil probably accounted for the high stand percentages observed at that location. At Shafter, CA, low stands were attributed to a severe infestation of *Pythium* sp. (R. H. Garber, personal communication). No significant interactions between treatments and locations were observed. Thus, based on the criterion of seedling disease control, solvent infusion of fungicides imparted no advantage over the more conventional method of dusting with wettable powders, even at the lower fungicide concentrations.

The increased deposition of fungicides within (1, 10) or in close proximity to (2, 4) embryo tissues is one of the proposed benefits of the solvent infusion method of fungicide application. This should be particularly advantageous with systemic fungicides. Halloin (2) found that the dye, oil red 0, dissolved in methylene chloride or acetone, was deposited on the interior of the seed coat and on the nucellar layer surrounding cotton embryos, but not within embryo tissues. Our results suggest that enhanced uptake of the systemic fungicides chloroneb and carboxin is not achieved in cottonseed with solvent infusion.

Increased use of pneumatic planting equipment (3) may present a situation favoring the solvent-infusion method of applying pesticides to cottonseed. Powder formulations of pesticides might be removed from the seeds by the air streams, whereas those applied by solvent infusion would not be removed.

Although the solvent infusion method of fungicide application may offer an advantage with some fungicides, this was not evident in our studies. When used on cottonseed containing a high proportion of mechanically damaged seeds, methylene chloride may cause reductions in stand due to killing of seeds by the solvent.

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