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Effects of Fungicide and Insecticide Seed Treatments on Germination, Stand, and Development of Cotton Seedlings[1]

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ABSTRACT

At standard germination temperatures (20 to 30 C), percent germination of cotton (*Gossypium hirsutum* L.) seeds was not increased by treatments containing cyano (methylmercuri) guanidine (Panogen 15)[3], pentachloronitrobenzene (PCNB), and O,O-diethyl S-2-[(ethylthio) ethyl] phosphorodithioate (disulfoton) as compared to the untreated check. Germination was reduced by some treatments containing PCNB and disulfoton used alone and in combinations. Germination at constant 18 C was not affected by any treatment. In field and greenhouse tests conducted at sub-optimum temperatures, seedling survival was increased by Panogen 15 used alone and in combination with either PCNB or disulfoton or both as compared to the check. However, stands were not increased significantly by overcoating Panogen 15-treated seeds with PCNB and disulfoton as compared to Panogen 15 used along. In field and greenhouse tests phytotoxicity ratings of seedlings were related to application of disulfoton. There was a slight increase in phytotoxicity ratings for treatments containing the three pesticides as compared to treatments with disulfoton or with the insecticide plus either of the fungicides.

***Additional index words:* *Gossypium hirsutum* L., Phytotoxicity.**

SYSTEMIC fungicides used in combinations with seed-protectant fungicides provided better cotton (*Gossypium hirsutum* L.) seedling disease control than protectant fungicides used alone (9). This development led to the investigation of multiple seed treatments with fungicides and systemic insecticides (8). Systemic fungicides usually reduced adverse effects obtained from treating seeds with systemic insecticides.

Ranney (10) found that several combinations of chemical seed treatments reduced stands of cotton, but most of the treatments increased lint production. Environmental conditions usually had more adverse effects on stands than rates of application of chemicals (2, 3, 4, 5).

Combinations of chemical seed treatments must be tested to identify desirable combinations. The objective of tests reported here was a comparison of the effects of rates of two fungicides and a systemic insecticide applied to cottonseed on germination, seedling survival, and phytotoxicity.

MATERIALS AND METHODS

Laboratory, field, and greenhouse tests were conducted. Acid-delinted seeds of cotton variety 'Paymaster 202' were treated with the fungicides, 2.2% cyano (methylmercuri) guanidine (Panogen 15), and 24% pentachloronitrobenzene (PCNB), and a systemic insecticide, 0.0-diethyl S-2[(ethylthio)ethyl] phosphorodithioate (disulfoton). The suggested rate and a double rate of each material were used alone and in all possible combinations. A triple rate of each chemical was tested alone.

Symptoms of chemical phytotoxicity (chlorosis, marginal burn, upward rolling of cotyledon, and stunting of seedlings) were graded in Field Test 2 and in all greenhouse tests. The grades used are as follows: 1 = none; 2 = slight; 3 = intermediate; and 4 = severe. Stand counts were recorded from 3 to 4 weeks after planting.

All experiments were randomized complete block designs, replicated twice. Each field plot consisted of one row, 10 m long. The data were analyzed for each test separately and stand data were analyzed across the field and greenhouse tests. Data were reported as percent of the seed planted.

On June 2 the laboratory tests were initiated. Two samples of 100 seeds of each treatment were placed in each of two germinators. One was set at standard temperatures (20 C for 16 hours and 30 C for 8 hours per 24 hours) for 12 days (1), and the other was set at constant 18 C for 7 days. The seeds were placed on germination paper.

Two field tests were conducted on an Amarillo loam soil at the Texas A&M University Agricultural Research and Extension Center at Lubbock. A four-row belt planter, equipped with seed press wheels and fish-tail covering drags, was used to distribute and cover seeds uniformly with 5 cm of soil. On April 28 and June 13 200 seeds per plot were planted in Field Tests 1 and 2, respectively.

The four temperature regimes listed below were used for the tests conducted in the greenhouse. On November 11 seeds were planted in sandy soil in a box (25 cm deep × 100 cm wide × 200 cm long) maintained at ambient temperatures (18 to 30 C) and in metal trays maintained at constant 18, 24, or 30 C (7). Fifty seeds were planted per plot in the box and were covered with 3 cm of soil. Twenty seeds were planted per plot for the constant temperatures, and they were covered with 3 cm of soil plus 0.5 cm of Perlite.

RESULTS

Data obtained from applications of double and triple rates of the chemicals were not included in this report. Percent germination and seedling survival was usually suppressed slightly by high rates of application of the chemicals used alone or in combinations as compared to the same chemical(s) applied at the suggested rate. The main differences and trends obtained among the chemicals are shown by the suggested rate of the pesticides used either alone or in combinations.

Percentage germination by standard procedures was not increased by any chemical treatment as compared to the check (Table 1). There were no differences in percent germination for Panogen 15 used alone or in combination with either PCNB or disulfoton. Germination was reduced by the treatment containing the three pesticides as compared to Panogen 15 alone. PCNB and disulfoton used alone and in combination suppressed germination as compared to Panogen 15 used alone or the check. The insecticide caused the most adverse effect. The adverse effects of PCNB and disulfoton were not additive for treatments containing both materials. Percentage normal seedlings obtained at constant 18 C for 7 days was not affected by the treatments (Table 1). A high percentage of ab-

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[3] Mention of a trademark or proprietary product does not constitute a guarantee or a warranty of the product by the US Department of Agriculture and does not imply its approval to the exclusion over other products that may also be suitable.

Table 1. Effects of seed treatments on germination of cottonseed at standard temperatures (20 to 30 C) for 12 days and constant 18 C for 7 days, average percent seedling survival, and phytotoxicity ratings for field and greenhouse tests.

Seed treatment	Rate, ml/kg seed	Germination 20-30C, %*	Germination 18C, %	Seedling Survival, %	Seedling, rating**
Check	---	96 a	70 a	44 b	1.0 b
Panogen 15	1.3	99 a	72 a	76 a	1.0 b
PCNB	7.8	84 b	58 a	47 b	1.0 b
Disulfoton	4.5	69 c	69 a	42 b	1.4 ab
Panogen 15 + PCNB	1.3 + 7.8	96 a	67 a	79 a	1.1 ab
Panogen 15 + Disulfoton	1.3 + 4.5	95 a	71 a	77 a	1.8 ab
PCNB + Disulfoton	7.8 + 4.5	83 b	64 a	39 b	1.6 ab
Panogen 15 + PCNB + Disulfoton	1.3 + 7.8 4.5	87 b	68 a	77 a	2.3 a

* Numbers followed by the same letter for each measurement are not significantly different at the 0.05 level of probability using Duncan's multiple range test.
**Phytotoxicity ratings: 1 - none, 2 - none 3= intermediate, and 4 = severe.

Table 2. Survival of cotton seedlings about 3 weeks after planting seeds treated with Panogen 15, PCNB, and disulfoton.

		% seedling survival					
		Greenhouse tests, by temperature				Field test	
Seed treatment	Rate, ml/kg seed	30 C*	24 C	18 C	Ambient	1	2
Check	---	90a	46c	5b	68bc	21c	32b
Panogen 15	1.3	92a	94a	67a	92ab	36b	79a
PCNB	7.8	95a	62bc	8b	69bc	8d	36b
Disulfoton	4.5	88a	40c	14b	66bc	3d	39b
Panogen 15 + PCNB	1.3 + 7.8	99a	94a	76a	87ab	33b	84a
Panogen 15 + Disulfoton	1.3 + 4.5	94a	77ab	74a	98a	49a	71a
PCNB + Disulfoton	7.8 + 4.5	88a	42c	7b	48c	8d	41b
Panogen 15 + PCNB + Disulfoton	1.3 + 7.8 + 4.5	97a	84ab	74a	85ab	38b	82a

* Numbers followed by the same letter for each test are significantly different at the 0.05 level of probability using Duncan's multiple range test.

normal (shortened-enlarged hypocotyl root tissues) seedlings occurred at this temperature.

There were significant increases in the average percentage seedling survival in all field and greenhouse tests for Panogen 15 used alone or in combinations with either or both PCNB and disulfoton as compared to the untreated check and to PCNB and disulfoton used alone or in combination (Table 1). The F value for treatments × tests was barely significant at the .01 level of probability. This indicated that the treatments did not perform similarly in all tests. The data for each test are shown in Table 2. A similar relationship in stand occurred among the treatments for each test with the exception of the constant 30-C greenhouse test where no differences occurred among the treatments. High percent seedling survival for the diverse environments used was associated with treatments containing Panogen 15.

Abnormal seedling was related to all treatments containing disulfoton (Table 1). The maximum rating for phytotoxicity was obtained for Panogen 15 + PCNB + disulfoton.

DISCUSSION

Effects of seed treatments with Panogen 15, PCNB, and disulfoton on percent normal seedlings occurred when the seeds were germinated at standard temperatures for 12 days but not when they were germinated at constant 18 C for 7 days. Percentage abnormal seedlings was much higher for the latter than the former temperature regime. Most of the abnormal seedlings probably would not emerge when grown in soil at temperatures sub-optimum for cottonseed. Laboratory, field, and greenhouse data from multiple chemical seed treatments showed that Panogen 15 alone gave higher percent germination and stands than either of the other chemicals used alone. Treatments containing two or three of the pesticides were not superior to Panogen 15 alone. Treatments containing disulfoton + either or both of the fungicides were more phytotoxic than for the insecticide used alone. Roark (11) reported that methyl parathion reduced dry weight of field-grown cotton plants, but seedlings appeared normal. Seed treated with Panogen 15 + PCNB increased seedling survival slightly in some of our field and greenhouse tests, but treatment combinations with disulfoton usually reduced stands as compared to treatment with Panogen 15. Other workers (2, 3, 4, 5, 6) have reported that systemic insecticides reduce stands of cotton; conversely, disulfoton protects seedlings from diseases (1). Our data show that disulfoton, when used in combination with Panogen 15 or PCNB, can either increase or decrease stands of cotton, depending on the environmental conditions. It is known that PCNB and disulfoton do not adequately protect seeds and seedlings against all seed- and soil-borne microorganisms. PCNB is used with other fungicides to provide additional protection to seeds and seedlings and to reduce the deleterious effects obtained with seed treatment with systemic insecticide. Disulfoton is used as a seed treatment for control of insects of seedlings. Our data indicated that a specific seed treatment does not always give the maximum number of normal seedlings in the germinator and highest stands in field and greenhouse tests conducted over a wide range of environmental conditions.

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