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# Seedling Survival from Cottonseed Treatment Experiments at Several Locations[1]

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## ABSTRACT

**Cottonseed treatment containing both experimental and commercial seed protectants used alone and in combination with systemic fungicides were evaluated for their effects on percent seedling survival of *Gossypium hirsutum* L., 'Stoneville 213,' at several test sites. Although differences among fungicide treatments were not significant within some individual tests, the combined analysis of the data across tests at the same site; with different methods of delinting; with both methods of delinting and sites; or with one method of delinting at several sites, usually showed significant differences among fungicide treatments.**

**The combined analysis of the data across sites should more clearly define those fungicide treatments effective over a wide range of environments and soil types than did the individual-test analyses, because the combined experiments were conducted over a wide area. Analyses of the data within tests, across tests at the same site, and across sites, showed that fungicides for coating cottonseed, enabling higher stands than the standards, are being developed. Combination treatments, two or more fungicides, usually gave higher stands than treatments containing one fungicide. Some experimental materials, when used either alone or in combinations, gave stands equal to or better than the stands for the standards. By use of these methods of analysis, the time, cost, and amount of treated seed required to evaluate seed protestants would probably be reduced, because ineffective treatments could be identified and eliminated early in the research program, while effective treatments could be carried forward.**


***Additional index words:*** **Seed protectant, Fungicide, Seedling disease, Stand, Statistical analyses.**

IN the United States, most of the cottonseed from *Gossypium hirsutum* L., that is used for planting, is coated with a seed-protectant fungicide and may also have an overlay of a systemic fungicide, a systemic insecticide, or both (2, 3).

From the mid 1950's until 1971, alkyl mercury compounds were the principal fungicides used on cottonseed. However, the agricultural chemical industry in cooperation with state and federal plant pathologists continued to develop and evaluate new seed-protectant and systemic fungicides. Thus, they provided the cottonseed processor with several effective fungicides when the commercial usage of all alkyl mercury compounds was cancelled in 1971 (2). Evaluating the performance of new seed fungicides is both expensive and time-consuming, an experimental chemical might be withdrawn, and developing approved seed treatment fungicides is expensive. These reasons emphasize the need for a rapid, efficient, and low-cost evaluation technique. Seed treatments must be effective for efficient cotton production, and a better way to evaluate data can help in the development and use of new and more effective fungicides.

Since the founding of the Cotton Disease Council in 1935, plant pathologists and industry representatives interested in control of seedling diseases of cotton have met almost every year to discuss and plan methods to control these diseases. The council coordinates the research program through the chairman of the Seed Treatment Committee. The chairman treats small seed samples from a common seed lot, mails requested samples to cooperators, and compiles and presents the data at the annual meeting of the council. Cooperators in each cotton-producing state select fungicide treatments to evaluate from those nominated at the annual meeting and may also request other treatments. The cooperators are responsible for suggesting cottonseed treatments from research data collected primarily within their state and secondarily from other states. These suggestions, revised annually, are based on performance data for 3 years or more. Industry representatives supply the chemicals for treating the cottonseed.

Until now, data from extensive Beltwide cottonseed treatment tests, conducted annually since 1935, have been analyzed and presented as individual tests only. Although this approach gave valuable information for a site or test, it appears that the effectiveness of seed treatments could be more reliably evaluated from both within (individual) and combined analysis of data from several tests or sites.

The purpose of this study was to report the results as percent seedling survival obtained from seed treatment experiments conducted at several sites and to evaluate the results by analysis of the data from within tests, across tests at the same sites, and across tests at different sites. We assumed that performance across locations would give a more reliable indication of expected stands for specific treatments than the stands obtained for the treatments at the same location for 3 years or more. Also, the number of years required to evaluate an entry may be reduced by combined analysis across tests at the same or at different sites.

## MATERIALS AND METHODS

The seed lot of 'Stoneville 213' cotton, used in the 1973 experiments, was grown and processed by the Stoneville Pedigreed Seed Co., Stoneville, Miss. After the seed lot was machine-delinted, one-half of it was acid-delinted. Machine and acid-delinted seed were used for the treatments in the regional tests conducted in Louisiana and Texas, but only acid-delinted seed were used in the western states tests. Percent germination for the check and standards were determined by standard procedures.

Treatments included in the regional tests conducted in each cotton-producing state from Texas eastward had been nominated by chemical company representatives at the annual meeting of the Cotton Disease Council or requested by cooperators participating in the testing program. Many treatments had not been evaluated in the regional program previously. Overall average percent seedling survival, from the combined analyses from the regional tests conducted at Lubbock, Tex., with both

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types of delinted seed across two planting dates and two soil types, and in Louisiana with both types of delinted seeds and one planting date, are included in this report since the stands from these tests were analyzed within tests and across tests at the same site.

Treatments that had performed well in other tests and that cooperators believed would increase stands of cotton were included in the western states tests. Experiments were conducted at College Station, El Paso, Lubbock, and Weslaco, Tex.; New Mexico; Arizona; and California. The stands were analyzed within each test and across all test sites and the results are presented.

The nomenclature of the fungicides used in this report is given in Table 1. Untreated seed were included as check. Terra-coat L-21 and Ceresan M treated seed were included as standards. These entries have been used for several years to compare the effectiveness of other fungicides and to determine the progress being made in the development of more effective treatments.

In the tables, when two or three fungicides were used, a plus (+) between the fungicides shows that they were applied in separate, sequential applications; a minus (—) shows that they were mixed and applied in a single application. We applied the fungicides to small lots of seed in a rotating-drum treater. Except for Terra-coat L-21, all liquid formulations were diluted with water at 2% by weight of seed and were sprayed on the tumbling seed with an atomizer. Undiluted Terra-coat L 21 was applied directly to the seed with an atomizer. All powder formulations were mixed with water at rates equal to 2% by weight of seed and applied to the seed with a small hand-sprayer, which dispersed the suspension into small droplets. Water was used to reduce the loss of fungicides, while the seed was treated, and to insure uniform distribution of the chemicals on the seed. Water was not added to the untreated check seed. The treated seed was tumbled in the treater 5 min. or longer to distribute the fungicide and to aid in drying. Subsamples of each of the treated and untreated seed were mailed to the respective cooperators.

At Lubbock, seed receiving the fungicide treatments were planted April 20 on Amarillo loam soil on the Texas A&M Univ. Agric. Res. and Ext. Cen. (center) and May 3 on Amarillo fine sandy loam soil on Glover's field (Glover). Only one planting was made at the other locations. A uniform number of seed was planted in each plot. The experimental design for each test was a randomized, complete block with six replications for all sites, except Arizona and California where four and eight, respectively, and Louisiana where eight replications with special planting procedures (1) were used. About 40 days after planting, the number of surviving seedlings were recorded and were used in calculating an analysis of variance on stand counts within individual tests, and by combined analysis (4, 5) of stand counts across tests at the same site, and across test at different sites.

The expected df and $\bar{x}^2$ of variance due to sources are shown in Table 2 for the tests in Louisiana; Lubbock, Tex.; and the western states. Only the overall average percent seedling survival are present for the regional tests. In the western states test, the percent seedling survival for each treatment within and across all test sites are presented. This shows that significant

**Table 1. List of fungicides and the a.i. or source.**

| Common or registered name* | Active ingredient or source† |
|---|---|
| BUSAN 30 | 30% 2-[(thiocyanomethyl)thio]-benzothiazole; emulsifiable concentrate |
| BUSAN 72 | 60% 2-[(thiocyanomethyl)thio]-benzothiazole |
| Captafol F (DIFOLATAN) | 39% cis-*N*-[(1, 1, 2, 2-tetrachloroethyl)thio]-4-cyclohexene-1, 2-dicarboximide; flowable |
| Captafol-carboxin F | 10% cis-*N*-[(1, 1, 2, 2-tetrachloroethyl)thio]-4-cyclohexene-1, 2-dicarboximide - 20% 5, 6-dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide; flowable |
| Captan | 75% *N*-[(trichloromethyl)thio]-4-cyclohexene-1, 2-dicarboximide |
| Captan 4F | 38. 5% *N*-[(trichloromethyl)thio]-4-eyclohexene-1, 2-dicarboximide |
| Captan FP-700-R | 70% *N*-[(trichloromethyl)thio]-4-eyelohexene-1, 2-dicarboximide |
| Captan - carboxin (VITAVAX) | 25% N-[(trichloromethyl)thio]-4-cyclohexene-1, 2-dicarboximide<br>50% 5, 6-dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide |
| Captan-thiram | 43% N-[(trichloromethyl) thio]-4-cyclohexene-1, 2-dicarboximide<br>43% bis (dimethylthiocarbamoyl)disulfide |
| Carboxin | 75% 5, 6-dihydro-2-methyl-1, 4-oxathiin-3-earboxanilide |
| Carboxin F | 34% 5, 6-dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide |
| Carbosin LS | 29. 5% 5, 6-dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide; liquid suspension |
| CERESAN M | 7. 7% *N*-(ethylmercuri)-p-toluenesulfonanilide |
| CHE-1843 | 50% trans-1, 2-bis(propylsulfonyl)ethylene |
| Chloroneb (DEMOSAN) | 65% 1, 4-dichloro-2, 5-dimethoxybenzene |
| Chloroneb LS | 29. 5% 1, 4-dichloro-2, 5-dimethoxylbenzene; liquid suspension |
| Chloroneb-thiram (DEMOSAN T) | 43. 6% 1, 4-dichloro-2, 5-dimethoxybenzene - 22. 4% bis(dimethylthiocarbamoyl) |
| CLOROX | 37% sodium hypochlorite |
| Cufraneb (CUFRAM Z) | 80% mixed metal ethylenebis(dithiocarbamate)with copper, zinc, manganese and iron; also 40% wettable powder |
| DEXON | 70% P-(dimethylamino)benzenediazo sodium sulfonate |
| DEXON-chlorothalonil (DEXON D) | 32% P-(dimethylamino)benzenediazo sodium sulfonate + 40% tetrachloroisophthalonitrile |
| DITHANE M-45 | 80% coordination product of zinc ion, and manganese ethylenebis(dithiocarbamate) |
| DOWCO 263 | Dow Chemical Co. |
| KATHON (RH 893 LC90) | Rohm and Haas Co. |
| PCNB | 75% pentachloronitrobenzene |
| SN 43410 | NORAM Agricultural Products, Inc. |
| SN 43493 | NORAM Agricultural Products, Inc. |
| TERRA-COAT L-21 | 22. 8% pentachloronitrobenzene - 11. 4% 5-ethoxy-3-(trichloro=methyl)-1, 2, 4-thiadiazole |
| TERRA-COAT L-205 | 23. 2% pentachloronitrobenzene - 5. 8% 5-ethoxy-3-(trichloro=methyl)-1, 2, 4-thiadiazole; liquid |
| Thiram | 70% bis(dimethylthiocarbamoyl)disulfide |
| Thiram LS | 29. 5% bis(dimethylthiocarbamoyl)disulfide; liquid suspension |
| TH 7464 | 50% cyanomethyl benzenesulfonate |
| Triforine (CELA W524) | 20% $N, N^1$-[1, 4-piperazinediylbis(2, 2, 2-trichloroethylidene)] bis (formamide) |
| U-34, 910 | The Upjohn Co. |

* All caps = trade name. A plus (+) between the fungicides shows that they were applied in separate, sequential application; a minus (-) shows that they were mixed and applied in a single application.

difference can be obtained by the combined analyses, but not always by individual analysis.

Duncan's multiple-range test was used to indicate significant differences at the 0.05 level of probability among treatments.

Table 2. Analysis of variance for each fungicide group for each test.

| Source | df | $\bar{x}^2$ expectations |
|---|---|---|
| | Louisiana | |
| Replications | r-1 | $\sigma^2 + fd\sigma^2 r$ |
| Delintings | d-1 | $\sigma^2 + rf\sigma^2 d$ |
| Fungicides | f-1 | $\sigma^2 + rd\sigma^2 f$ |
| Delintings × fungicides | (d-1) (f-1) | $\sigma^2 + r\sigma^2 df$ |
| Error, residual | r(d-1) (f-1) | $\sigma^2$ |
| | Lubbock, Tex. | |
| Locations | l-1 | $\sigma^2 + rf\sigma^2 ld + rfd\sigma^2 l$ |
| Delintings | d-1 | $\sigma^2 + rf\sigma^2 ld + rfl\sigma^2 d$ |
| Locations × delintings | (l-1) (d-1) | $\sigma^2 + rf\sigma^2 ld$ |
| Fungicides | f-1 | $\sigma^2 + r\sigma^2 fdl + drl\sigma^2 f$ |
| Fungicides × delintings | (d-1) (l-1) | $\sigma^2 + r\sigma^2 fdl + rl\sigma^2 fd$ |
| Fungicides error | d(f-1) (l-1) | $\sigma^2 + \sigma^2 fdl$ |
| Error, residual | r(d-1) (f-1) (l-1) | $\sigma^2$ |
| | Western states | |
| Locations | l-1 | $\sigma^2 + rf\sigma^2 l$ |
| Fungicides | f-1 | $\sigma^2 + rl\sigma^2 f$ |
| Locations × fungicides | (l-1) (f-1) | $\sigma^2 + r\sigma^2 lf$ |
| Error, residual | r(l-1) (f-1) | $\sigma^2$ |

## RESULTS

*Laboratory Germination.* Percent germination at standard temperatures for acid-delinted seed was 78% for the check and 80 and 82% for the standards (Ceresan M and Terra-coat L-21) respectively. Germination for these entries for machine-delinted seed was 85%. These values were within the range expected as noted below and probably were not significantly different for method of delinting and fungicide treatment. Germination percent for machine-delinted seed was not increased by the fungicides when compared to no fungicide as was obtained with the fungicides for acid-delinted seed.

*Regional Test in Louisiana.* There were no significant differences among the stands for fungicide treatments within the test with acid or machine-delinted seed, and between the two methods of delinting. A combined analysis of the stand counts for the fungicide treatments across both types of delinted seed showed that combining the data across both types of delinting could be used to increase the number of

Table 3. Percent survival in the regional acid and machine-delinted tests in 1973.

| Fungicide† | Dosage‡ | Seedling survival: Louisiana | Seedling survival: Texas |
|---|---|---|---|
| | g or ml/kg | % | % |
| Check, untreated | -- | 33.13 h-k* | 29.6 k* |
| TERRA-COAT L-21, standard | 7.49 | 36.50 a-i | 35.4 a-k |
| CERESAN M, standard | 1.25 | 33.63 g-k | 36.0 a-i |
| Cufraneb (80%) | 5.00 | -- | 33.8 a-k |
| Cufraneb (80%) | 7.49 | -- | 30.0 ijk |
| Cufraneb (40% WP) | 5.00 | -- | 31.0 f-k |
| Cufraneb (40% WP) | 7.49 | -- | 34.0 a-k |
| Thiram LS-chloroneb LS | 2.75 - 6.37 | 37.18 a-h | 38.1 a-d |
| Thiram LS-chloroneb LS-carboxin LS | 2.75 - 6.37 - 2.68 | 38.94 ah | 36.0 a-i |
| Thiram-chloroneb | 1.75 - 3.75 | 36.81 a-i | 37.9 a-d |
| Thiram-chloroneb-carboxin | 1.75 - 3.75 - 2.50 | 38.56 a-d | 37.9 a-d |
| Chloroneb-thiram | 6.24 | 38.50 a-e | 35.9 a-i |
| TERRA-COAT L-205 | 7.49 | 37.38 a-g | 31.6 e-k |
| SN 43410 | 0.62 | 33.75 f-k | 32.6 d-k |
| SN 43410 | 1.25 | 35.44 b-k | 33.0 c-k |
| SN 43493 | 0.62 | 32.94 ijk | 34.7 a-k |
| SN 43493 | 1.25 | 32.94 ijk | 34.3 a-k |
| Captan FP-700-R | 2.12 | 35.19 b-k | 37.2 a-e |
| Captan FP-700-R + chloroneb | 2.12 + 3.75 | 36.31 a-i | 34.7 a-k |
| Captan FP-700-R + carboxin | 2.12 + 2.50 | 38.06 a-e | 33.5 a-k |
| Captan-thiram | 3.75 | 35.63 b-k | 33.0 c-k |
| Captan 4F | 1.87 | 35.00 b-k | 35.1 a-k |
| Captan 4F + carboxin F | 1.87 + 5.00 | 36.63 a-i | 36.4 a-h |
| Captan 4F + chloroneb | 1.87 + 3.75 | 36.06 a-i | 37.0 a-e |
| Captan + carboxin | 1.25 + 2.50 | 37.75 a-g | 36.6 a-h |
| DEXON - chlorothalonil | 1.25 | 37.00 a-i | 36.5 a-h |
| DEXON + PCNB | 1.25 + 1.87 | 33.81 f-k | 35.6 a-k |
| DEXON + CHE 1843 | 1.25 + 1.25 | 36.25 a-i | 34.5 a-k |
| DEXON + carboxin | 1.25 + 2.50 | 37.75 a-g | 33.3 b-k |
| DEXON | 1.25 | 31.69 k | 35.7 a-j |
| CHE-1843 | 1.25 | 36.88 a-i | 35.1 a-k |
| DEXON + chloroneb | 1.25 + 3.75 | 37.13 a-h | 36.0 a-i |
| KATHON | 1.25 | 35.81 b-j | 38.7 abc |
| KATHON | 1.87 | 35.88 b-j | 36.0 a-i |
| KATHON + chloroneb | 1.25 + 3.75 | 38.06 a-e | 38.8 abc |
| DITHANE M-45 | 1.87 | 35.44 b-k | 35.0 a-k |
| BUSAN 72 | 1.87 | 34.81 c-k | 30.9 g-k |
| BUSAN 72 + chloroneb | 1.87 + 3.75 | 36.38 a-i | 36.7 a-g |
| BUSAN 30 | 3.12 | 36.81 a-i | 36.5 a-h |
| BUSAN 30 + chloroneb | 3.12 + 3.75 | 39.88 a | 34.9 a-k |
| BUSAN 72 + TERRA-COAT L-205 | 1.87 + 3.75 | 36.38 a-i | 35.1 a-k |
| DOWCO 263 | 2.50 | 35.69 b-k | 36.1 a-h |
| DOWCO 263 + carboxin | 2.50 + 2.50 | 38.69 abc | 37.0 a-f |
| TH 7464 | 1.25 | 32.00 jk | 32.9 c-f |
| TH 7464 | 2.50 | 32.94 ijk | 33.5 a-j |
| Captan-carboxin | 3.75 | -- | 36.8 a-g |
| Captafol-carboxin F | 7.50 | 36.13 a-i | 39.4 a |
| TERRA-COAT L-205 + chloroneb | 7.50 + 3.75 | 35.81 b-j | 32.8 c-k |
| Carboxin F | 5.00 | 35.00 b-k | 36.5 a-h |
| Carboxin F + captan | 5.00 + 1.25 | 36.00 a-j | 37.7 a-d |
| Carboxin F + thiram | 5.00 + 1.87 | 37.88 a-f | 39.1 ah |
| Triforine | 6.24 | 35.75 b-j | 29.8 jk |
| Triforine | 15.51 | 34.38 d-k | 36.6 a-g |
| U-34,910 | 3.75 | 35.63 b-k | 36.7 a-g |
| U-34,910 | 7.49 | 35.81 b-j | 37.8 a-d |
| SN 43410 | 0.31 | -- | 30.6 h-k |
| SN 43493 | 0.31 | -- | 34.6 a-k |
| Thiram | 1.75 | 36.19 a-i | -- |
| CLOROX | 5% (soak 10 min.) | 34.06 e-k | -- |
| Chloroneb | 3.75 | 33.12 h-k | -- |

* Numbers followed by the same letter for each column are not significantly different at the 0.05 level of probability as determined by Duncan's new multiple-range test. † All caps = trade name. A plus (+) between the fungicides shows that they were applied in separate, sequential applications; a minus (-) shows that they were mixed and applied in a single application. ‡ Rates are for acid-delinted seed; higher rates were used for machine-delinted for some treatments.

**Table 4. Percent survival in the western states tests.**

| Fungicide† | Dosage, g or ml/kg | Ariz. | Calif. | N. M. | Texas | | | | | Wt, overall avg. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | College station | Lubbock | | El Paso | Weslaco | |
| | | | | | | Center | Glover | | | |
| Check, untreated | -- | 30 efg* | 47 a* | 34 a* | 59 a* | 18 a* | 44 a* | 32 a* | 49 a* | 39 c* |
| TERRA-COAT L-21, standard | 7.49 | 42 cd | 55 a | 37 a | 66 a | 20 a | 55 a | 30 a | 41 a | 45 b |
| CERESAN M, standard | 1.25 | 26 fg | 55 a | 29 a | 69 a | 25 a | 53 a | 33 a | 54 a | 44 b |
| Captan-thiram | 3.75 | 25 g | 57 a | 36 a | 73 a | 20 a | 64 a | 28 a | 48 a | 44 b |
| DEXON + CHE 1843 | 1.25 + 1.25 | 28 efg | 54 a | 33 a | 70 a | 20 a | 59 a | 31 a | 50 a | 44 b |
| DEXON + carboxin | 1.25 + 2.50 | 37 def | 57 a | 37 a | 70 a | 15 a | 55 a | 35 a | 55 a | 46 ab |
| DEXON + chloroneb | 1.25 + 3.75 | 61 a | 54 a | 43 a | 68 a | 22 a | 59 a | 32 a | 54 a | 49 a |
| KATHON | 1.87 | 38 def | 57 a | 37 a | 66 a | 15 a | 54 a | 34 a | 59 a | 46 ab |
| KATHON + chloroneb | 1.25 + 3.75 | 53 abc | 58 a | 32 a | 67 a | 17 a | 59 a | 27 a | 53 a | 47 ab |
| DOWCO 263 | 2.50 | 39 de | 57 a | 26 a | 72 a | 18 a | 55 a | 25 a | 50 a | 44 b |
| DOWCO 263 + carboxin | 2.50 + 2.50 | 46 bcd | 55 a | 37 a | 66 a | 18 a | 60 a | 29 a | 52 a | 46 ab |
| CAPTEFOL-carboxin F | 7.49 | 44 bcd | 61 a | 43 a | 68 a | 15 a | 58 a | 34 a | 52 a | 48 ab |
| DITHANE M-45 + chloroneb | 1.87 + 3.75 | 55 ab | 60 a | 37 a | 72 a | 14 a | 57 a | 28 a | 56 a | 48 ab |
| Captafol + chloroneb | 1.87 + 3.75 | 43 bcd | 60 a | 40 a | 70 a | 16 a | 59 a | 30 a | 50 a | 47 ab |
| DOWCO 263 + chloroneb | 2.50 + 3.75 | 51 abc | 60 a | 40 a | 67 a | 17 a | 56 a | 30 a | 44 a | 47 ab |
| KATHON + DEXON | 1.25 + 1.87 | 36 defg | 54 a | 30 a | 64 a | 20 a | 59 a | 31 a | 53 a | 44 b |

* Numbers followed by the same letter for each column are not significantly different at the 0.05 level of probability, as determined by Duncan's new multiple-range test. † All caps = trade name. A plus (+) between the fungicides shows that they were applied in separate, sequential applications; a minus (-) shows that they were mixed and applied in a single application.

replications, which gave significant differences among the fungicides. The highest overall percent seedling survival[3] was obtained with Busan 30 + chloroneb; which was followed by decreasing stands in the order listed by thiram LS — chloroneb LS — carboxin LS; Dowco 263 + carboxin; thiram + chloroneb + carboxin; chloroneb — thiram; captan FP-700-R + carboxin; Kathon + chloneb; carboxin F + thiram; captan + carboxin; Dexon + carboxin; and Terra-coat L-205 (Table 3). All of these treatments had significantly more surviving seedlings than the untreated check, and many treatments had stands as good as or better than the stands for the two standards.

*Regional Test at Lubbock.* Seedling survival ranged from 9 to 25% and differed significantly among fungicide treatments within the test with each type of delinted seed planted April 20. The low percentage seedling emergence and survival in these tests was attributed to the cloudy, cool, rainy weather for about 10 days after planting. Seedling survival ranged from 45 to 65% and differed significantly among fungicide treatments for each type of delinted seed planted May 3. The warm sunny weather after planting May 3 was more suitable for germination and emergence of cotton than the weather was after planting April 20. Both the weather and soil types contributed to the wide range in stands for the two planting dates.

The combined analysis showed that the method of delinting did not affect stands, but there were differences caused by fungicide treatments and by test sites at Lubbock. The overall average percent seedling survival by fungicide treatments for both planting dates and both types of delinted seed (Table 3) should give a better indication of the expected performance of specific fungicides for variable environments and soil types than the performance of the treatment within each test or site, even though there were differences among the fungicide treatments within tests. These analyses showed that differences can be obtained by both methods. Higher overall average percent seedling survival was obtained with all the fungicide treatments than with the check. Stands were increased significantly by 31 fungicide treatments when compared with the stand for the check.

The highest overall average percent seedling survival was obtained with captafol-carboxin F; which was followed in decreasing order by carboxin F + thiram; Kathon + chloroneb; Kathon; thiram LS — chloroneb LS; thiram — chloroneb — carboxin; and U-34,910. Four of these treatments were employed for the first time.

There were differences for the interactions of location × delinting and of location × fungicide treatment, but no differences occurred for the interactions of delinting × fungicide treatment and location × delinting × fungicide treatment. These data show that fungicide treatments and sites were the major factors affecting stands, apparently location had the most influence.

*Western States Test.* No differences occurred in stand within tests or across tests at the same site at Lubbock and within each test at other locations except for Arizona (Table 4). Nine fungicide treatments gave significantly more surviving seedlings than the untreated check in the test in Arizona. In general, differences in stands among the fungicide treatments usually occur in more of the test sites than was obtained in 1973. Also, these treatments are unique since they consisted of combinations of materials that had performed satisfactorily when used alone or in combinations in other tests. Syngeristic effects appear to be obtained from combinations of some fungicides. However, the combined analysis of all data showed that all fungicide treatments had significantly higher overall average percent surviving seedlings than the untreated check. Only Dexon + chloroneb gave significantly higher stand than the standards, but all fungicide treatments gave higher stands than the check. Also, overall seedling survival was increased $\geqslant 1\%$ by eight additional fungicide treatments, when compared with seedling survival for Terra-coat L-21, the most effective standard. Dexon + chloroneb gave the overall highest percent surviving seedlings in the tests. Captafol + chloroneb, Kathon, Dowco 263, Dithane M-45 + chloroneb, and captan — thiram gave the highest stand within one or more individual tests.

[3] This is a report on the current status of research concerning use of chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended by the Federal Environmental Pesticide Control Act. Not all of the chemicals mentioned here are presently so registered with the Environmental Protection Agency. No recommendations for use of these chemicals are implied in this report.

Percent seedling survival differed significantly among sites and for the interaction of fungicide treatment × site. In spite of these differences, combining the data across sites should give a much better indication of the performance of each fungicide treatment for commercial production where the weather, soil type, and microorganisms varied more than at individual sites.

## DISCUSSION

The significant fungicide treatment × location interaction obtained from the combined analyses across test sites indicated that different organisms, environmental conditions, and fungicides affected the stands. Variables likely to affect the microflora were soil type, moisture, temperature, cropping history, and organic matter. Because of this wide variability among test sites including the same number of entries with various kinds of fungicides, combining the data from experiments at the same site or across sites similar to the procedure indicated in Table 2 should reliably show the effectiveness of seed fungicides. Therefore, statistical analyses of the data within and across tests should give a better basis for suggesting suitable fungicide treatments for an area than only the analyses for individual test sites used previously. Similar soil types, microflora, and environmental conditions may occur during evaluation of treatments for several years within test sites. Evaluations across test sites should more nearly approach the varied soil types, environments, and microorganisms encountered by producers across an area, than those within a given site. All of these factors are important in establishing stands, and each may be a major contrbiuting factor for obtaining satisfactory stands within and across locations.

Although extensive cottonseed treatment test data have been collected and presented to the Cotton Disease Council meetings since 1935, analyses were on individual tests. Combining the data over a number of tests for an area, a state, a region, or Beltwide, should not only provide a more reliable basis for seed treatment recommendations, but also reduce the overall cost of the evaluation program by early identification of both ineffective and effective treatments and subsequently elimination of ineffective treatments. Our analyses within and across tests showed that the most effective fungicide treatments for first and advance evaluations can be selected from experiments containing from a few to several entries, even though in some of these evaluations several entries performed alike for a wide range in percent seedling survival and significant differences among fungicide treatments did not exist within tests. We separated the effectiveness of similar treatments, where narrow range in average stands occurred by combined analysis, but could not by analysis of individual tests. The combined statistical analyses used in this investigation should apply to experiments with seed fungicides and perhaps other treatments with several crops (4).

Additional investigations are needed where the performance data is compared across sites within and across years to more precisely predict the number of experiments needed to determine expected performance of new fungicide treatments with minimum evaluation. The statistical procedures outlined in this paper could be useful in interpreting the data from additional investigations needed.

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## REFERENCES

1. Pinckard, J. A., and J. Ivey. 1971. Chemical treatments for cottonseed. La. Agric. Exp. Stn. Bull. no. 655. 36 p.
2. Ranney, C. D. 1971. Effective substitutes for alkyl mercury seed treatments for cottonseed. Plant Dis. Rep. 55:285-288.
3. ————, and W. H. Heartley, Jr. 1972. Multiple cottonseed treatments: Effect of sequence of application of pesticide on germination, seedling growth and survival. Crop Sci. 12:847-850.
4. Rowe, P. R., and R. H. Andrew. 1964. Phenotypic stability for a systemic series of corn genotypes. Crop Sci. 4:563-567.
5. Steel, G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc. 481 p.