REPORT OF THE COTTONSEED TREATMENT COMMITTEE FOR 1998

Compiled by C.S. Rothrock
Plant Pathologist
University of Arkansas
Fayetteville, AR

Introduction

The 1998 National Cottonseed Treatment Program evaluated cotton seedling survival for a number of fungicide seed treatment combinations over diverse environmental conditions and levels and types of cotton seedling pathogens. Fifteen fungicide seed treatments were nominated by chemical industry representatives for evaluation in the 1998 National Cottonseed Treatment Program. A standard fungicide treatment, Vitavax-PCNB + Apron, and a nontreated control were included to assess efficacy of the nominations and seedling disease pressure. In addition, the fungicide treatments Apron or PCNB were included to aid in determining the importance of *Pythium* spp. or *Rhizoctonia solani*, respectively. Disease ratings and pathogen isolations for seedlings and soil populations of selected soilborne fungi were included in the 1998 National Cottonseed Treatment Program by collecting seedlings and soil from the nontreated control plots at each location.

Materials and Methods

Fungicide Treatment

Acid-delinted seed of *Gossypium hirsutum* L., 'Deltapine 50' or 'Paymaster HS26', was provided by Delta and Pine Land Company, Scott, MS. Deltapine 50 was planted at all locations, with the exception of locations in Oklahoma and the College Station and Lubbock sites in Texas, where the cultivar Paymaster HS26 was planted. Fungicide treatments and dye (Pro-Ized seed colorant, Gustafson Inc.) were mixed with water at a rate of 2% water to seed weight (v/w). Water and dye also were applied to the nontreated seed treatment at the same rate. Treatments were applied to the cottonseed while the seed tumbled in a rotating drum. When two or more fungicides were applied, the fungicides were mixed and applied in a single application. The technical information for the fungicides is given in Table 1. Seed germination was evaluated for all treated and nontreated seed by rolling seed in moistened germination paper and incubating at 28°C.

Field Experiments

Twenty field experiments were conducted by 18 cooperators across the U.S. Cotton belt (Table 2). However, data was not collected at the South Carolina site, cooperator J. D. Mueller. Each location utilized a randomized complete block experimental design, with the number of replications ranging from 4 to 10 (Table 2). The stand counts used in the analyses were taken from 27 to 38 days after planting, average 31 days, depending on the location. A soil sample and seedling samples from plots containing nontreated seed were taken from 27 to 41 days after planting, average 33 days, depending on the location. Soil and seedlings were placed in insulated packages with refrigerated cool packs and mailed overnight to the University of Arkansas for processing. A subsample of soil was sent to T. L. Kirkpatrick, Southeast Research and Extension Center, Hope, Arkansas, for determination of populations of plant parasitic nematodes.

Approximately 49 seedlings (range 39 to 50 seedlings) per location were rinsed for 20 minutes in running tap water and rated for disease symptoms. The hypocotyl disease severity index was 1=no symptoms, 2=few pinpoint lesions or diffuse discolored areas, 3=distinct necrotic lesion, 4=girdling lesion, and 5=seedling dead. The root disease index was 1=no symptoms, 2=1-10% of the root system discolored, 3=11-25% of the root system discolored, 4=26-50% of the root system discolored, and 5>50% of the root system discolored. Seedlings were surface disinfested by immersion for 1.5 min in 0.5% NaClO, blotted dry on a paper towel, and plated on water agar (2%) amended with 10 mg and 250 mg of the antibiotics rifampicin and ampicillin, respectively, and 0.5 µl of the miticide Danitol (Valent Chemical Co.) per liter. Resulting colonies were transferred to PDA and identified to genus. Seedlings were subsequently transferred to the Thielaviopsis selective medium TB-CEN (Specht and Griffin, 1985), which was modified by adding Penicillin G (60 mg/L), to determine isolation frequency for *Thielaviopsis basicola*. Soil samples were assayed for populations of *Rhizoctonia* species by using the multiple-pellet soil method (Henis et. al., 1978), and Rhizoctonia populations were quantified on a modified Ko and Hora medium (Ko and Hora, 1971). Soil populations of *Pythium* species and *T. basicola* were detected by diluting 25 g of soil in 0.1% water agar to a total volume of 250 ml and placing on a wrist action shaker for 20 minutes. *Pythium* spp. were quantified by the spread plate method on the selective medium P_5ARP (Jeffers and Martin, 1986), and *T. basicola* populations were quantified using the pour plate method with the selective medium TB-CEN.

Statistics

Data were analyzed by the GLM procedure using SAS (SAS Institute Inc., Cary NC). Analysis of percent stand over locations indicated a significant location by treatment interaction (Table 3), thus subsequent analyses were done by location. Treatment means for a location were separated by using a protected LSD at P=0.05. The Pearson-product correlation method was used to examine the relationship among stand, disease, pathogen isolation frequency, and soil populations over locations.

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Results and Discussion

Seed germination for nontreated seed was 99% and 96% for Deltapine 50 and Paymaster HS26, respectively. After the seed were treated with the fungicide treatments, seed germination ranged from 98% to 100% for Deltapine 50, with an average germination of 99%. Seed germination ranged from 91% to 96% for Paymaster HS26, with an average germination of 94%, after the seed were treated with the fungicide treatments. There were no significant differences among the treatment combinations for germination.

There was a significant location, treatment, and location x treatment effect when cotton stands were analyzed over locations (Table 3), indicating that the treatment response was dependent on the environmental or pathogen pressures for a particular location. A significant difference between treatments was found for 12 of the 19 experiments (Table 4). In all of these experiments, except for the LA1a site, at least one of the fungicide treatments performed better than the nontreated control. The Apron treatment increased stands compared to the nontreated control in only 2 of the 11 experiments having a significant response compared to the nontreated control (MS1 and VA). In 5 of these 11 experiments (AR1, AR3, GA, MS2, and VA), the PCNB treatment increased stands over the nontreated control. The Vitavax-PCNB + Apron FL standard fungicide treatment increased stands compared to the nontreated control in 9 of 11 experiments (AR1, AR3, GA, LA2, MS1, MS2, OK3, TX1, and VA). The nominated treatments increased stands over the nontreated control for 64% of the sites (7 of 11 sites) to all of the sites (11 of 11 sites) depending on the treatment. Only one of the nominated treatments gave significant stand increased at all sites where stand responses were found, GI 30 + PR 40 + APRON FL. Treatments giving increases in stand compared to the nontreated control in 10 of the 11 sites were NU-FLOW ND + NU-FLOW M + APRON XL, LS001 + Baytan 30 + LS146, NU-FLOW T + NU-FLOW M + APRON XL, APRON XL + MAXIM 4FS + NU-FLOW M, and HM-9801. Selected nominated fungicide treatments performed significantly better than the standard fungicide treatment, Vitavax-PCNB + Apron, at four locations (AR1, MS1, TN, and VA). The HM-9801 treatment increased stand above the standard fungicide treatment for 3 of the 11 sites where a response was found (MS1, TN, and VA). Treatments increasing stands at two sites over the standard fungicide treatment were RTU BAYTAN-THIRAM + APRON FL + THIRAM 42S and WE 120C + NU-FLOW M + APRON XL. The number of fungicide treatments significantly increasing stands over the nontreated control ranged from 7 of the 15 nominated treatments for the TX1 site to all of the nominated treatments tested for 4 sites (AR1, AR3, MS1, and VA). The mean stand for a location was not related to locations where stands were increased by fungicide treatments.

Hypocotyl disease indices ranged from 1.7 at TX3 to 2.8 at FL and LA1a, average 2.2 (Table 5). Root disease indices ranged from 1.2 at TX3 to 3.4 at VA, average 2.4. *R. solani* was isolated from seedlings from the nontreated plots at 15 of 19 locations (Table 5). *R. solani* was isolated from 56% of the seedlings at the AR1 site, and 5 locations had isolation frequencies greater than 25% (AR1, FL, LA1a, MS1, and VA). *Pythium* spp. were isolated from seedlings at 15 of 19 locations (Table 5). Isolation frequencies for *Pythium* spp. were greater than 25% for only two sites (AR3 and TX3). *T. basicola* was isolated from seedlings at eight locations on the modified TB-CEN medium (Table 5). Four sites had isolation frequencies above 50% (AR1, AR3, MS1, and TX2). *Fusarium* spp. were isolated from seedlings at all locations (Table 5). Isolation frequencies for *Fusarium* spp. ranged from 44% to 100%. *Macrophomina phaseolina* was isolated from seedlings at 11 locations. Only the AL and LA1b sites had an isolation frequency above 10%.

Soil populations of *R. solani* were detected at 7 of the 18 sites assayed, range 5 to 15 CFU/100 g of soil (Table 6). *Pythium* spp. were detected in soils from 16 of 17 sites assayed, range 17 to 433 CFU/g of soil. *T. basicola* was detected in 8 of the 18 soils assayed, range 2 to 73 CFU/g soil. The root-knot nematode, *Meloidogyne incognita*, was detected in three soils (LA1a, TX2 and AR1). In addition, root galling was detected on seedlings from the AL site. The lance nematode was detected in soil from the LA1a site.

The mean stand for the locations was negatively correlated with the frequency of *R. solani* isolation, -0.46 (P=0.05). The negative correlation between stand and frequency of *R. solani* isolation is supported the significant stand response from the PCNB only treatment for 5 sites. The hypocotyl and root disease indices were positively correlated 0.59 (P=0.008). Frequency of isolation of *T. basicola* from roots was positively correlated with *T. basicola* soil populations, 0.61 (P=0.008).

Conclusions

The results from the 19 locations in the 1998 National Cottonseed Treatment Program indicated that seed treatment fungicides consistently improved stands of cotton compared to a nontreated control. Most of the nominated fungicide combinations improved stands over the nontreated seed at most of the sites where a response was found. PCNB alone increased stands for five sites, indicating an important role for *R. solani* in these tests. This is supported by the negative correlation between mean stand and *R. solani* isolation frequency. Differences in disease severity and the frequency of pathogen isolation over locations may partially explain the variation in cotton seedling survival observed among the fungicide treatments. *Rhizoctonia solani*, *Pythium* spp., and *Fusarium* spp. were isolated from seedlings over all or most locations.

Thielaviopsis basicola was isolated from seedlings from several locations and soil populations and isolation frequency were positively correlated.

Disclaimer

This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the University of Arkansas, Department of Plant Pathology, nor does it imply registration under FIFRA.

References

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Table 1. Fungicides, formulations and the active ingredients included in the 1998 National Cottonseed Treatment Program.

Common or registered name[1]	Formulation	Active ingredient (%)
APRON FL (Metalaxyl)	Flowable	28.35% *N*-(2,6-dimethylphenyl)-*N*-(methoxyacetyl) alanine methyl ester
APRON XL LS (Mefenoxam)	Liquid	33.3% (R,S)-2-[(2,6-dimethylphenyl)-methoxyacetylamino]-propionic acid methyl ester
BAYTAN 30 (Triadimenol)	Flowable	30% Beta-(4-Chlorophenoxy)-alpha-(1,1-dimethylethyl)-1*H*-1,2,4-triazole-1-ethanol
DIVIDEND 3MG (Difenoconazole)	Flowable	32.8% 1-{2-[4-(chlorophenoxy)-2-chlorophenyl-(4-methyl-1,3-dioxolan-2-yl)-methyl]}-1*H*-1,2,4-triazole
GI 30		Buckman Laboratories
HM-9801		Helena Chemical Company
HM-9802		Helena Chemical Company
LS001		Gustafson Incorporated
LS146		Gustafson Incorporated
LS151		Gustafson Incorporated
MAXIM 4FS (Fludioxonil)	Flowable	42% 4-(2,2-difluoro-1,3-benzdioxol-4-yl)-1*H*-pyrrole-3-carbonitrile
NU-FLOW M (Myclobutanil)	Emusifiable conc.	25.1% A-butyl-a-(4-chlorophenyl)-1*H*-1,2,4-triazole-1-propanenitrile
NU-FLOW ND (Chloroneb & TCMTB)	Flowable	23.5% 1,4-dichloro-2,5-dimethoxy-benzene, 9.0% 2-(thiocyanomethylthio)benzothiazole
NU-FLOW T		Wilbur-Ellis Company
PR-40		Buckman Laboratories
RTU-PCNB	Flowable	24% Pentachloronitrobenzene
RTU-BAYTAN-Thiram	Flowable	5% Beta-(4-Chlorophenoxy)-alpha-(1,1-dimethylethyl)-1*H*-1,2,4-triazole-1-ethanol, 15.3% Tetramethylthiuram disulfide
TCMTB	Emusifiable conc.	30% 2-(thiocyanomethylthio)benzothiazole
Thiram 42-S	Flowable	42% Tetramethylthiuram disulfide
VITAVAX (Carboxin) 200	Flowable	17% 5,6-dihydro-2-methyl-N-phenyl-1,4-oxathiin-3-carboxamide, 17% Tetramethylthiuram disulfide (Thiram)
VITAVAX (Carboxin) - PCNB	Flowable	17% 5,6-dihydro-2-methyl-N-phenyl-1,4-oxathiin-3-carboxamide, 17% Pentachloronitrobenzene
WE 120C		Wilbur-Ellis Company

[1] Registered chemical name, all capital letters.

Table 2. List of cooperators and procedures used in the 1998 National Cottonseed Treatment Program.

Cooperator	Location		Date Planted	Date Sampled	Date Counted	Reps.	Row length counted (ft)	Seed planted
W. S. Gazaway	Auburn, AL	(AL)	4/16	5/18	5/18	6	10	67
T. L. Kirkpatrick	Hope, AR	(AR1)	4/20	5/19	5/19	5	40	160
G. Palmer	Keiser, AR	(AR2)	5/12	6/16	6/12	8	25	150
C. S. Rothrock	Clarkedale, AR	(AR3)	5/5	6/1	6/1	6	50	250
F. M. Shokes	Quincy, FL	(FL)	4/28	5/27	5/27	6	23	100
D. R. Sumner	Tifton, GA	(GA)	4/28	6/8	5/22	5	25	100
P. D. Colyer	Bossier City, LA	(LA1a)	4/14	5/13	5/12	5	25	100
E. Burris	St. Joseph, LA	(LA1b)	4/19	5/19	5/19	4	25	100
K. S. McLean	Monroe, LA	(LA2)	4/25	5/28	5/28	5	40	200
W. E. Batson	Mississippi State, MS	(MS1)	4/22	5/25	5/25	5	80	240
G. L. Sciumbato	Stoneville, MS	(MS2)	4/15	5/15	5/15	5	40	200
L. Verhalen &	Tipton, OK	(OK1)	5/18	6/22	6/22	4	20	100
B. E. Greenhagen	Altus, OK	(OK2)	5/19	6/22	6/22	4	20	100
	Perkins, OK	(OK3)	5/13	6/16	6/16	4	20	100
A. Y. Chambers	Jackson, TN	(TN)	5/4	6/4	6/3	10	20	100
P. M. Thaxton	College Station, TX	(TX1)	4/3	5/12	5/11	7	30	100
H. W. Kaufman	Lubbock, TX	(TX2)	4/24	6/4	5/22	4	35.5	178
T. S. Isakeit	Weslaco, TX	(TX3)	3/3	4/2	4/2	4	20	100
P. M. Phipps	Suffolk, VA	(VA)	4/28	5/27	5/27	4	60	240

Table 3. Mean squares for combined analysis of variance across locations, 1998 National Cottonseed Treatment Program.

Source	Degrees of freedom	Mean squares
Location	18	16034[**1]
Replication(Location)	82	197[**]
Treatment	18	810[**]
Location*treatment	324	100[*]
Error	1469	83

[1] ** = significant *F*-test, *P*=0.0001. * = significant *F*-test, *P*=0.01.

Table 4. Cotton seedling stands for locations pf the 1998 National Cottonseed Treatment Program

Treatment	Rate (fl oz/cwt)	Plant stand (%) AL	AR1	AR2	AR3	FL	GA	LA1a	LA1b	LA2	MS1	MS2	OK1	OK2	OK3	TN	TX1	TX2	TX3	VA	Mean1[1]	Mean[2]
NU-FLOW ND + NU-FLOW M +APRON XL	7.5 + 1.75 + 0.32	69	64	61	81	58	86	77	68	60	91	83	80	76	75	55	78	68	63	35	70	72
LS001 + BAYTAN 30 + LS146	2.0 + 0.5 + 0.75	74	56	62	83	56	85	67	66	63	92	77	71	74	81	54	81	68	64	39	69	71
NU-FLOW T + NU-FLOW M + APRON XL	2.25 + 1.25 + 0.32	72	56	66	84	58	85	68	64	59	92	75	75	76	80	60	77	68	52	38	69	71
RTU BAYTAN-THIRAM + APRON FL + + THIRAM 42S + LS151	3.0 + 0.75 + 1.0 + 0.25	78	60	66	81	55	82	67	64	54	92	79	79	62	82	53	80	68	58	38	68	71
APRON XL + MAXIM 4FS + NU-FLOW M	0.42 + 0.08 + 1.75	76	57	59	78	56	85	66	73	61	93	80	74	66	77	57	77	75	70	34	69	70
VITAVAX-PCNB + BAYTAN 30 + APRON FL + THIRAM 42S	7.0 + 0.25 + 0.75 + 2.5	71	56	64	84	56	83	62	61	62	93	73	77	69	80	55	77	68	68	42	69	70
HM-9801	12.0	69	55	60	83	58	86	57	55	57	95	80	77	66	71	58	84	71	69	41	68	70
RTU BAYTAN-THIRAM + APRON FL + THIRAM 42S	3.0 + 0.75 + 1.0	76	54	72	82	58	75	67	66	60	96	72	72	66	77	60	81	65	62	38	68	70
WE 120C + NU-FLOW M + APRON XL	0.24 + 1.75 + 0.32	74	50	63	81	55	79	72	62	60	95	76	72	70	70	61	83	67	56	36	68	70
TCMTB + BAYTAN 30 + APRON FL	2.0 + 0.5 + 0.75	62	58	59	81	56	83	70	68	61	93	81	76	62	72	56	73	64	54	39	67	70
GI 30 + PR 40 + APRON FL	0.75 + 0.25 + 0.75	74	48	65	85	58	87	60	62	58	94	76	72	73	73	58	79	70	66	34	68	69
HM-9802	12.0	77	59	65	83	53	87	69	43	58	93	76	66	64	74	50	84	68	62	35	67	69
NU-FLOW T + MAXIM 4FS+ NU-FLOW M + APRON XL	2.25 + 0.08 + 1.75 +0.32	67	53	64	81	56	88	57	69	57	94	77	79	76	79	51	74	64	57	38	67	69
APRON XL + MAXIM 4FS + DIVIDEND 3MG	0.42 + 0.08 + 1.0	84	50	64	80	56	85	60	67	59	97	77	74	64	70	57	76	62	57	31	67	68
VITAVAX 200 + BAYTAN 30 + APRON FL	6.0 + 0.25 + 0.75	72	60	63	76	54	82	73	67	56	91	76	58	74	75	55	78	66	67	37	67	68
VITAVAX-PCNB + APRON FL	6.0 + 0.75	77	50	60	80	51	84	70	64	57	90	79	69	72	75	49	81	69	66	34	67	68
RTU-PCNB	14.5	75	55	68	77	56	84	59	70	48	83	75	64	57	71	49	60	71	60	31	64	63
APRON FL	1.5	73	40	68	70	45	79	53	62	48	89	66	53	62	60	50	76	67	55	32	60	60
NONTREATED	---	71	33	61	67	41	75	66	60	49	82	65	59	66	60	44	69	62	58	24	59	58
Location average		73	53	64	80	54	83	65	64	57	92	76	71	68	74	54	77	67	61	36		
LSD (*P*=0.05)		NS	13.6	NS	6.1	N	8.0	12.2	NS	7.3	4.4	8.7	12.7	NS	12.	8.7	9.3	NS	NS	5.6		
Coefficient of Variation (%)		18	20	18	7	17	8	15	19	10	4	9	13	16	12	18	11	10	16	11	14	12

[1]Mean1 = mean for all sites.
[2]Mean2 = mean for sites with a significant *F*-test.

Table 5. Disease ratings and isolation frequency of seedling pathogen groups for the 1998 National Cottonseed Treatment Program locations.

	Disease Index		Isolation frequency (%)[1]			
Location	Hypocotyl[2]	Root[3]	*R.* solani	*Pythium* spp.	*T.* basicola	*Fusarium* spp.
AL	2.5	2.7	8	6	0	78
AR1	2.3	2.8	56	13	51	77
AR2	2.2	2.9	2	0	0	96
AR3	2.3	3.0	6	32	72	44
FL	2.8	2.2	50	12	0	88
GA	2.0	2.0	0	6	0	90
LA1a	2.8	2.9	28	6	0	74
LA1b	2.4	2.4	17	0	2	79
LA2	2.2	1.8	0	4	0	77
MS1	1.9	1.3	34	4	88	28
MS2	2.5	3.3	4	0	0	92
OK1	2.0	2.3	2	18	34	96
OK2	2.0	2.5	22	18	0	84
OK3	2.0	2.2	2	14	16	94
TN	2.2	2.1	8	12	4	68
TX1	2.0	1.5	0	2	0	100
TX2	1.9	2.8	0	0	88	98
TX3	1.7	1.2	22	30	0	52
VA[4]	2.5	3.4	42	18	0	88

[1] Isolation frequency is based on approximately 50 seedlings per location.
[2] Hypocotyl disease severity index; 1=no symptoms, 2=few pinpoint lesions or diffuse discolored areas, 3=distinct necrotic lesion, 4=girdling lesion, and 5=seedling dead.
[3] Root disease index; 1=no symptoms, 2=1-10% of the root system discolored, 3=11-25% of the root system discolored, 4=26-50% of the root system discolored, and 5>50% of the root system discolored.
[4] Discoloration also may be associated with shipping.

Table 6. Soil populations of selected soilborne fungi from sites in the 1998 National Cottonseed Treatment Program.

Location	*Rhizoctonia solani*	*Pythium* spp.	*Thielaviopsis basicola*
	CFU[1]/100g	CFU/g	CFU/g
AL	5	17	0
AR1	ND[2]	33	73
AR2	ND	17	0
AR3	ND	375	66
FL	6	267	0
GA	ND	33	0
LA1a	ND	100	0
LA1b	ND	433	0
LA2	ND	83	0
MS1	15	50	23
MS2	--	--	--
OK1	ND	17	11
OK2	11	ND	8
OK3	ND	32	7
TN	ND	67	2
TX1	ND	--	0
TX2	5	33	2
TX3	14	17	0
VA	6	17	0

[1] Colony forming units.
[2] Populations were not detected in the soil sample; less than approximately 3 CFU/100 g and 8 CFU/g of soil for *Rhizoctonia solani* and *Pythium* spp., respectively.