REPORT OF THE COTTONSEED TREATMENT COMMITTEE FOR 2020

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Abstract

The 2020 National Cottonseed Treatment Program evaluated cotton seedling survival for a number of fungicide seed treatment combinations over diverse environmental conditions and populations of cotton seedling pathogens. Thirteen fungicide seed treatments were nominated by chemical industry representatives for evaluation in 2020, along with 4 control-check treatments.

Introduction

The National Cottonseed Treatment Program evaluates cotton seedling survival for a number of fungicide seed treatment combinations that are nominated by chemical industry representatives over diverse environmental conditions and populations of cotton seedling pathogens. Neither of the historical standard fungicide treatments, Vitavax-PCNB + Allegiance nor RTU Baytan-Thiram + Allegiance, were able to be included in the 2020 trials. A new standard was evaluated beginning in 2018 that included Alleigance + EverGol Prime + Spera + Proline. A non-treated control (insecticide only) was included to assess efficacy of the fungicide treatments and seedling disease pressure. Allegiance (metalaxyl-only) and EverGol Prime (penflufen-only) were also included to aid in determining the importance of *Pythium* spp. and *Rhizoctonia solani*, respectively. Disease ratings and pathogen isolations for seedlings and soil populations of selected soilborne genera were conducted by collecting seedlings and soil from the non-treated control plots at each location. Soil temperature and plant development data were also collected for each location included in the 2020 National Cottonseed Treatment Program.

Materials and Methods

Fungicide treatment

Acid-delinted seed of *Gossypium hirsutum* L. cv 'DP 1646 B3XF' were provided by Bayer, St. Louis. Fungicide treatments were mixed with Color Coat Red (1 oz/cwt) and Gaucho 600 (16 oz/cwt) (Bayer Crop Science) in a total slurry rate of 30 oz/cwt (i.e., the amount of water added to each treatment was adjusted to have a 30 oz/cwt slurry). Water, Gaucho 600, and dye also were applied to the non-treated check at the same rate. Treatments were applied to the cottonseed while the seed mixed in a Kobalt 4-cu ft 0.5-HP Cement Mixer (model # SGY-CM1) used as a Liquid Seed Treater. When two or more fungicides were applied, the fungicides were mixed and applied in a single application. The technical information for the fungicide treatments is provided in Table 1. Seed germination was evaluated for all treated and non-treated seed by rolling seed in moistened germination paper and incubating for 3 days at 27°C.

Field experiments

Ten field trials were conducted by 10 cooperators across the U.S. Cotton Belt (Table 2). Each location utilized a randomized complete block experimental design, with the number of replications ranging from 4 to 8. The stand counts used in the analyses were taken from 28 to 43 days after planting, averaging 33 days after planting. A soil sample and ~100 seedlings were collected from plots containing non-treated seed and were collected from 28 to 53 days after planting, averaging 34 days after planting. Soil and seedlings were placed in insulated packages with refrigerated cool packs and mailed overnight to the West Tennessee Research and Education Center for processing. A subsample of soil from each location was sent to the Southwest Research and Extension Center in Hope, Arkansas to screen for plant parasitic nematodes. Soil moisture and temperature data were obtained through the use of WaterScout SM100 soil moisture and external temperature sensors connected to WatchDog 1200 micro stations (Spectrum Technologies, Aurora, IL), or the nearest weather station (National Weather Service) (see Table 2).

Isolations

A total of 100 seedlings were sampled from non-treated plots at each location. Seedlings were evaluated for growth by recording the number of nodes from five arbitrarily selected seedlings and the aboveground portions of all seedlings were removed and discarded. Seedlings were then rinsed for 20 minutes in running tap water. Approximately 50 seedlings were 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, 5=51-75% of the root system discolored, and 6>75% of the root system discolored.

Following rating, 2 subsets of 25 seedlings each were dipped 3 times in sterile water, blotted dry with a sterile paper towel, and plated onto *Pythium* selective media, P_5ARP (Jeffers and Martin, 1986), and *Rhizoctonia solani* selective media, TSM (Spurlock et al., 2011), respectively. The remaining seedlings were divided into 2 subsets of 25 seedlings, surface sterilized by immersion for 60 secs in 1% NaClO, blotted dry with a sterile paper towel, and plated onto *Fusarium* selective media, MGA (Castellá et al., 1997), and *Thielaviopsis basicola* selective media, TB-CEN (Specht and Griffin, 1985), respectively. Plates were incubated at ~27°C for 3-5 days (MGA and TSM) or 7-14 days (P_5ARP and TB-CEN) prior to screening for colonies.

Soil samples evaluated for populations of *R. solani* were screened using the toothpick-baiting method (Paulitz and Schroeder, 2005). Nine toothpicks were baited per sample and populations were quantified on the *Rhizoctonia*-selective media, TSM (Spurlock et al., 2011).

Pathogenicity Assays

The *Pythium* pathogenicity assay developed by Zhang and Yang (2000) for soybean and corn was modified for cotton as follows. *Pythium* isolates were taken from initial seedling platings onto P_5ARP and saved in long term storage via freezing on filter paper. Two isolates per location were then selected at random to be screened for pathogenicity. Two replications were completed for each isolate. Isolates were plated onto 1% water agar to grow out at room temperature for 7 days. After 7 days, 10 black cottonseeds were placed towards the outer edge of each plate containing a *Pythium* isolate and incubated at 16°C for 7-8 days. Seeds were sterilized before plating by rinsing in tap water, submerging in 1% bleach solution for 60 secs, and dipping in sterile purified water before placing on sterile paper towels to dry. After 7-8 days, the plates were moved to room temperature for an additional 2 days to allow for additional mycelial growth and possible seed germination. During each pathogenicity assay, 10 sterilized seeds were plated on 1% water agar and

incubated at room temperature as a germination control. After the completion of each assay, data were collected on the seedling germination rate for each isolate. A scale of 0-4 was used to determine the pathogenicity of each isolate, where 0=seed germinated without visible infection, 1=germinated with light discoloration on roots, 2=germinated with short severely discolored roots, 3=died after germination, and 4=died before germination.

The corresponding protocol was adapted to assess the pathogenicity of *Fusarium* isolates collected from all locations. Adjustments to the procedure included: 1) isolates plated on 1% water agar were incubated at 27°C for 3 days prior to sterile seed addition, 2) plates housing isolates and sterile seed were not parafilmed during the incubation step to not disrupt seed placement, and 3) the 2-day mycelial growth period at room temperature was unnecessary and therefore omitted.

Nematode screening

Subsamples of soil (150 cc) from field sites were sent to Cathy Howard at the Arkansas Nematode Diagnostic Laboratory for analysis. Fourteen parasitic nematodes (soybean cyst, dagger, lance, lesion, ring, reniform, spiral, sting, stubby-root, stunt, root-knot, needle, sheath, and pin) were included in the screening process and the results are reported in number of nematodes per 100 cm^3 of soil (Table 5).

Statistics

Data were analyzed with JMP 15 Pro (SAS Institute Inc., Cary NC). Percent stand was analyzed across and by locations using Mixed Model – Tukey HSD means separation with alpha = 0.05. The Pearson product-moment correlation method was used to examine the relationship among soil temperature, early season growth (nodes), percent stand, disease hypocotyl and root ratings, pathogen isolation frequency, and soil populations over locations.

Table 1. Fungicides, formulations, and active ingredients in the 2020 National Cottonseed Treatment Program

No.[Y]	Common or registered name	Formulation	Active ingredient (%)	Rate oz/cwt	Target Pathogen
1	Gaucho 600	F	Imidacloprid (47.8)	12.8	*No target*
2	AllegianceFL	F	Metalaxyl (28.35)	1.5	*Pythium*
3	Evergol Prime	F	Penflufen (22.7)	0.64	*R. solani*
4[Z]	Spera 240FS	F	Myclobutanil (22.37)	1.85	*R. solani, T. basicola*
	Proline 480 SC	F	Prothioconazole (41.0)	0.16	*R. solani, Fusarium*
	Evergol Prime	F	Penflufen (22.7)	0.32	*R. solani*
	Allegiance FL	F	Metalaxyl (28.35)	0.75	*Pythium*
5	"Vibrance CST Plus"				
	Apron XL	F	Mefenoxam (33.3)	0.32	*Pythium*
	Maxim 4FS	F	Fludioxonil (40.3)	0.08	*R. solani, Fusarium*
	Rally 40WSP	WP	Myclobutanil (40)	1.61	*T. basicola*
	Dynasty	F	Azoxystrobin (9.6)	0.68	*Pythium, R. solani*
	Vibrance CST	F	Mefenoxam (6.71), Azoxystrobin (6.71), Sedaxane (3.13), Fludioxonil (1.12)	4.08	*Pythium, R. solani, Fusarium*
6	"Vibrance CST Plus PCBX"				
	Apron XL	F	Mefenoxam (33.3)	0.32	*Pythium*
	Maxim 4FS	F	Fludioxonil (40.3)	0.08	*R. solani, Fusarium*
	Rally 40WSP	WP	Myclobutanil (40)	1.61	*T. basicola*
	Dynasty	F	Azoxystrobin (9.6)	0.68	*Pythium, R. solani*
	Vibrance CST	F	Mefenoxam (6.71), Azoxystrobin (6.71), Sedaxane (3.13), Fludioxonil (1.12)	4.08	*Pythium, R. solani, Fusarium*
	Vayantis	F	PCBX	0.15	-
7	"Vibrance CST Plus Adepidyn"				
	Apron XL	F	Mefenoxam (33.3)	0.32	*Pythium*
	Maxim 4FS	F	Fludioxonil (40.3)	0.08	*R. solani, Fusarium*
	Rally 40WSP	WP	Myclobutanil (40)	1.61	*T. basicola*
	Dynasty	F	Azoxystrobin (9.6)	0.68	*Pythium, R. solani*
	Vibrance CST	F	Mefenoxam (6.71), Azoxystrobin (6.71), Sedaxane (3.13), Fludioxonil (1.12)	4.08	*Pythium, R. solani, Fusarium*
	Saltro	F	Adepidyn/Pydiflumetofen (41.7)	12.8	-
8	Allegiance FL	F	Metalaxyl (28.35)	0.75	*Pythium*
	Evergol Prime	F	Penflufen (22.7)	0.33	*R. solani*
	Fluoxastrobin FS 480	F	Fluoxastrobin (40.3)	0.38	*Pythium, R. solani*
	Proline 480 SC	F	Prothioconazole (41.0)	0.16	*R. solani, Fusarium*
	Spera 240FS	F	Myclobutanil (22.37)	1.8	*R. solani, T. basicola*
9	Allegiance FL	F	Metalaxyl (28.35)	0.75	*Pythium*
	Evergol Prime	F	Penflufen (22.7)	0.33	*R. solani*
	Fluoxastrobin FS 480	F	Fluoxastrobin (40.3)	0.38	*Pythium, R. solani*
	Proline 480 SC	F	Prothioconazole (41.0)	0.16	*R. solani, Fusarium*
	Spera 240FS	F	Myclobutanil (22.37)	1.8	*R. solani, T. basicola*
	Evergol Xtend	F	Penflufen (14.26), Trifloxystrobin (14.26)	1.0	*R. solani*
10	CeraMax + Fungicide Standard	F	Natamycin (13.46)	1.2	*Fusarium, R. solani, T. basicola, Pythium*
11	Kabina ST	F	Penthiopyrad (40)	0.87	*R. solani*
	Spera 240FS	F	Myclobutanil (22.37)	1.8	*R. solani, T. basicola*
	Allegiance FL	F	Metalaxyl (28.35)	1.5	*Pythium*
	Maxim 4FS	F	Fludioxonil (40.3)	0.16	*R. solani, Fusarium*
12	Kabina ST	F	Penthiopyrad (40)	0.7	*R. solani*
	Spera 240FS	F	Myclobutanil (22.37)	1.8	*R. solani, T. basicola*
	Dynasty CST	F	Azoxystrobin (6.64), Fludioxonil (1.11), Mefenoxam (3.32)	3.1	*Pythium, R. solani, Fusarium*

13	Pyraclostrobin	F	Pyraclostrobin (18.4)	1.5	*Fusarium, R. solani, Pythium*
	Xemium	F	Fluxapyroxad (28.78)	0.94	*R. solani, T. basicola, Fusarium*
	Allegiance FL	F	Metalaxyl (28.35)	0.75	*Pythium*
	Spera 240 FS	F	Myclobutanil (22.37)	1.96	*R. solani, T. basicola*
14	Pyraclostrobin	F	Pyraclostrobin (18.4)	3.0	*Fusarium, R. solani, Pythium*
	Xemium	F	Fluxapyroxad (28.78)	0.94	*R. solani, T. basicola, Fusarium*
	Allegiance FL	F	Metalaxyl (28.35)	1.5	*Pythium*
	Spera 240 FS	F	Myclobutanil (22.37)	1.96	*R. solani, T. basicola*
15	Pyraclostrobin	F	Pyraclostrobin (18.4)	3.0	*Fusarium, R. solani, Pythium*
	Xemium	F	Fluxapyroxad (28.78)	0.94	*R. solani, T. basicola, Fusarium*
	Allegiance FL	F	Metalaxyl (28.35)	1.5	*Pythium*
	Spera 240 FS	F	Myclobutanil (22.37)	1.96	*R. solani, T. basicola*
	COPeO Prime	F	Fluopyram (48.4)	5.55	*Fusarium,* nematode spp.
16	Albaugh Premium Fungicide Blend 1	F	Myclobutanil (63.34), Metalaxyl (28.35), Fludioxonil (3.78)	12	*Pythium, R. solani, T. basicola, Fusarium*
17	Albaugh Premium Fungicide Blend 2	F	Myclobutanil (63.34), Metalaxyl (28.35), Fludioxonil (3.78)	4.9	*Pythium, R. solani, T. basicola, Fusarium*

[Y]All treatments included GAUCHO 600, Flowable, Imidacloprid (48.7%), 12.8 oz/cwt.
[Z]Treatment 4 is “Fungicide Standard” listed in later treatments

Table 2. List of cooperators and procedures for each location in the 2020 National Cottonseed Treatment Program

Cooperator	Location	Site	Date			Seed planted/ft	Length row counted/plot	Seed planted/row length counted	Soil temp.[V]	Soil moisture[X]	Avg. % stand[Z]
			Planted	Sampled	Counted						
Kathy Lawrence	Auburn, AL	AL	4/22	5/22	5/22	4	25	100	17 (14)	--[Y]	31
Alejandro Rojas	Fayetteville, AR	AR1	6/3	7/6	7/6	5	50	250	16 (15)[W]	--[Y]	72
Terry Spurlock	Kelso, AR	AR2	5/21	7/13	6/25	3	20	60	24 (18)[W]	--[Y]	42
Robert Kemerait	Tifton, GA	GA	5/13	6/11	6/11	3	50	150	--[Y]	--[Y]	53
Trey Price	Winnsboro, LA	LA1	4/15	5/18	5/18	4	25	100	16 (9)	--[Y]	31
Tessie Wilkerson, Tom Allen	Stoneville, MS	MS1	5/12	6/12	6/24	4	70	280	--[Y]	--[Y]	90
Tessie Wilkerson, Tom Allen	Stoneville, MS	MS2	5/14	6/15	6/16	4	70	280	24 (17)	--[Y]	79
Melanie Bayles	Perkins, OK	OK	5/21	7/1	7/1	5	20	100	23 (19)	14 (6)	74
Heather Kelly	Jackson, TN	TN	4/21	5/19	5/19	4	60	240	16 (14)	33 (28)	33
Cecilia Monclova-Santana	Lubbock, TX	TX2	5/18	6/16	6/16	4	35	140	22 (9)	40 (33)	37

[V]Mean (Minimum) soil temp. (°C); 3-day average following planting.
[W]Weather data collected from local weather station.
[X]Mean (Minimum) soil moisture (%VWC).
[Y]Information not available.
[Z]Percent stand based on plants counted 30 days after planting across all treatments.

Results and Discussion

For the 10 locations in the 2020 National Cottonseed Treatment Program, location and treatment significantly affected seedling emergence ($P < 0.0001$ and $P = 0.0014$, respectively); but not the interaction (location x treatment, $P = 0.68$). Seedling emergence ranged from 12 to 96% across locations, with an average of 52% across all locations (Table 3). Across all locations, the following treatments significantly protected seedling emergence (compared to the non-treated check): 4-Standard Base Fungicide, 5-Vibrance CST Plus, 6-Vibrance CST Plus PCBX, 7-Vibrance CST Plus Adepidyn, 9-Bayer Treatment , 10- CeraMax+Fungicide Standard , 11- Kabina ST+Spera+Allegiance+Maxim, 14-BASF treatment, 15- BASF+COPeO Prime treatment, 16- Albaugh Premium blend 1, and 17- Albaugh Premium blend 2; the remaining treatments were not significantly different from the non-treated check or other treatments (Table 3). Seed germination evaluated in the lab across all treatments was not significantly different, although there was a 25% difference on average from the greatest and lowest treatment.

Seedling development across the locations at the time of disease assessment and isolation ranged from 1.0 nodes to 8.6 nodes with an average of 4.7 nodes (Table 4). Hypocotyl disease indices ranged from 1.7 (AR1 and LA1) to 2.4 (GA), averaging 2.1 across all locations. Root disease indices ranged from 3.0 (OK) to 5.3 (AR2), averaging 3.9 across all locations. *T. basicola* was isolated from seedlings at 4 of the 10 locations with isolation frequencies ranging from 4 to 96%, averaging 28%. *Fusarium* spp. were detected at all sites using selective media and had ≥88% isolation frequency at all sites (Table 4). Even though there was such high isolation frequency only 4 of the 20 isolates screened for pathogenicity were pathogenic (significantly different than controls). Pathogenicity of *Fusarium* spp. ranged from 1.4 to 3.0, averaging 2.3 across all isolates tested (Figure 2). *Fusarium* spp. pathogenicity assay was conducted in the same fashion as the *Pythium* spp. pathogenicity assay. A more accurate method of assessing pathogenicity of *Fusarium* spp. would be a root dip assay, and such a method will be evaluated in 2021. *Rhizoctonia solani* was detected in soil screened from all sites, ranging from 0.7 to 32.4 propagules/100 cm^3 of soil, averaging 19.8. *Rhizoctonia solani* was detected from seedlings from 8 of the 10 sites with isolation frequency ranging from 4 to 44%, averaging 12% (Table 4).

Pythium spp. were isolated on selective media from seedlings from all locations, ranging in isolation frequency from 20% to 100%, averaging 71% across locations (Table 4). Based on the pathogenicity assay, only 5 of the 20 isolates tested (2 from each location) were pathogenic (significantly different than controls). These included 1 isolate each from AL, MS2, and OK, along with 2 isolates evaluated from AR1. Similar to isolates from TX location in 2019, this year one of the sites with the lowest isolation frequencies of *Pythium* spp. (MS2 at 52%) had an isolate with one of the greatest pathogenicity ratings (Figure 1). Pathogenicity of *Pythium* spp. ranged from 1.3 to 4.0, averaging 2.5 across all isolates tested.

Isolation frequency of *Pythium* spp. and *Fusarium* spp. were positively correlated with a correlation coefficient of 0.72 (P=0.019), which could indicate co-infection/colonization at some locations. This is the opposite as what was observed in 2019, where isolation frequency of *Pythium* spp. and *Fusarium* spp. were negatively correlated with a correlation coefficient of -0.70 (P=0.01), which could indicate competition between these pathogens in colonizing seedlings. In 2020, isolation frequencies of *T. basicola* from seedlings and *R. solani* soil isolations were also positively correlated with a correlation coefficient of 0.68 (P =0.046). Relatively warmer soil temperatures the first 3 days after planting had a positive correlation with isolation frequencies of *Fusarium* spp. (0.72, P=0.04). There were contrasting correlations with *R. solani* isolation from soil vs. seedlings in regard to average soil temperature 3 days after planting, where isolation from seedlings had a positive correlation with average soil temperature (0.90, P=0.002) and isolation from soil had a negative correlation (-0.72, P=0.043).

Table 3. Cotton seedling stands for locations of the 2020 National Cottonseed Treatment Program

No.[Y]	AL		AR1	AR2	GA	LA1	MS1	MS2	OK	TN		TX2	Mean
1	13	b	68	28	60	25	91	76	48	12	c	27	46 a
2	22	ab	68	33	48	41	84	79	78	34	abc	25	55 ab
3	22	ab	70	39	52	52	89	86	74	18	bc	25	54 ab
4	37	a	62	47	52	37	95	81	86	33	abc	43	59 a
5	31	ab	74	42	52	25	92	80	74	40	a	41	58 a
6	40	a	67	45	58	29	85	80	79	38	ab	33	58 a
7	40	a	73	39	55	24	96	82	82	48	a	38	60 a
8	29	ab	74	45	52	31	89	83	57	26	abc	49	56 ab
9	34	a	66	54	51	29	88	83	79	29	abc	36	58 a
10	32	ab	73	45	50	33	89	73	82	41	a	56	60 a
11	30	ab	73	45	49	41	92	80	71	33	abc	51	59 a
12	32	ab	78	41	49	24	92	86	57	27	abc	24	54 ab
13	26	ab	72	44	50	27	88	73	75	29	abc	35	55 ab
14	35	a	77	40	56	23	92	83	76	35	ab	34	58 a
15	31	ab	77	41	58	36	86	77	78	42	a	35	59 a
16	30	ab	75	43	57	27	88	72	85	35	ab	33	57 a
17	42	a	72	45	54	22	92	77	80	36	ab	40	59 a
Average	31		72	42	53	31	90	79	74	33		37	52
COV	0.24		0.06	0.14	0.07	0.27	0.04	0.05	0.14	0.27		0.25	0.06
P>F	0.0004		ns	ns	ns	ns	ns	ns	ns	<0.0001		ns	Ns

[Y]See Table 1 for treatment details.
[Z]Data were analyzed with JMP 15 Pro (SAS Institute Inc., Cary NC), values with the same letter within a column are not significantly different, where percent stand was analyzed across locations using Mixed Model – Tukey HSD means separation with alpha = 0.05 and by location using the Fit Model – Standard Least Squares procedure – Tukey HSD means separation with alpha = 0.1.

Table 4. Disease ratings and isolation frequencies of seedling pathogen groups for the 2020 National Cottonseed Treatment Program locations

	Dis. index			Isolation frequency (%)					
Location	Nodes[T]	Hyp[U]	Root[V]	*Pythium* spp.[W]	*T. basicola*[W]	*Fusarium* spp.[W]	*R. solani*		Avg. % Stand[Y]
AL	--[Z]	2.1	4.2	20	88	88	32.4[X]	4[W]	31
AR1	--[Z]	1.7	4	81	4	100	29.5	0	72
AR2	8.6	1.8	5.3	100	0	100	23.0	20	42
GA	6.0	2.4	4.4	100	0	96	2.2	4	53
LA1	1.2	1.7	4.5	40	0	88	29.5	4	31
MS1	5.6	2.3	3.9	92	0	96	5.0	4	90
MS2	4.2	1.9	3.4	52	0	100	0.7	44	79
OK	9.0	2.2	3	88	0	100	--[Z]	40	74
TN	1.0	2.2	4.9	68	96	96	27.4	0	33
TX2	2.2	2.8	4	68	88	100	28.1	4	37
Avg	4.7	2.1	3.9	70.9	27.6	96.4	19.8	12.4	52

[T]Nodes based on five seedlings per location.
[U]Hypocotyl index; 1=no symptoms, 2=few pinpoint lesions or diffuse discolored areas, 3=distinct necrotic lesion, 4=girdling lesion, and 5=seedling dead.
[V]Root 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, 5=51-75% of the root system discolored, and 6>75% of the root system discolored.
[W]Isolation frequency from selective media is based on 25 seedlings per location and reported as a percentage.
[X]Soil populations from toothpick baiting method reported in no. propagules/100 cm^3.
[Y]Percent stand based on plants counted 30 days after planting across all treatments.
[Z]Information not available.

Table 5. Number of nematodes/100 cm^3 soil[Z]

Location	Lance	Lesion	Ring	Reniform	Spiral	Stunt	Root-knot
AL	0	8	0	0	31	0	0
AR1	0	0	0	15	0	0	0
AR2	0	0	0	0	8	0	0
GA	0	0	27	0	4	0	0
LA1	0	8	0	8	62	23	0
MS1	0	0	0	116	0	0	0
MS2	0	0	0	23	0	0	0
OK	--[Y]	--[Y]	--[Y]	--[Y]	--[Y]	--[Y]	--[Y]
TN	8	8	0	0	62	0	23
TX2	0	0	0	8	4	0	0
Avg	1	3	3	19	19	3	3

[Y]Information not available.
[Z]Nematodes screened for but not found include soybean cyst, dagger, sting, stubby-root, needle, sheath, and pin.

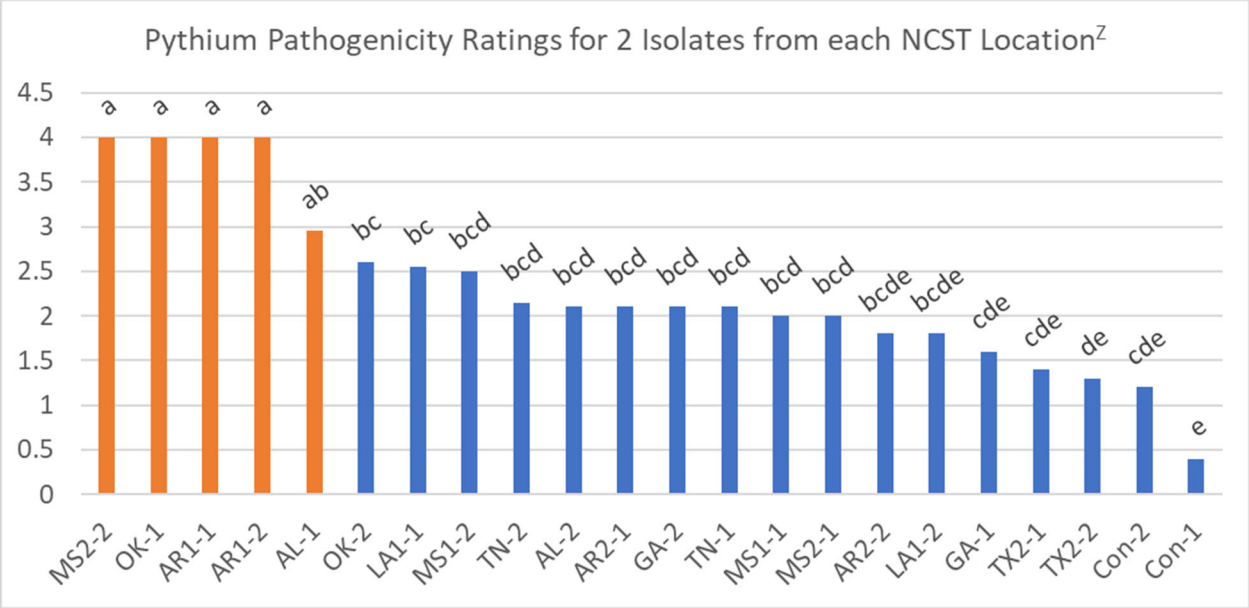

Figure 1. Pathogenicity results from randomly selected isolates of *Pythium* spp. from locations in 2020. Bars with the same letter are not significantly different at $P \leq 0.05$.

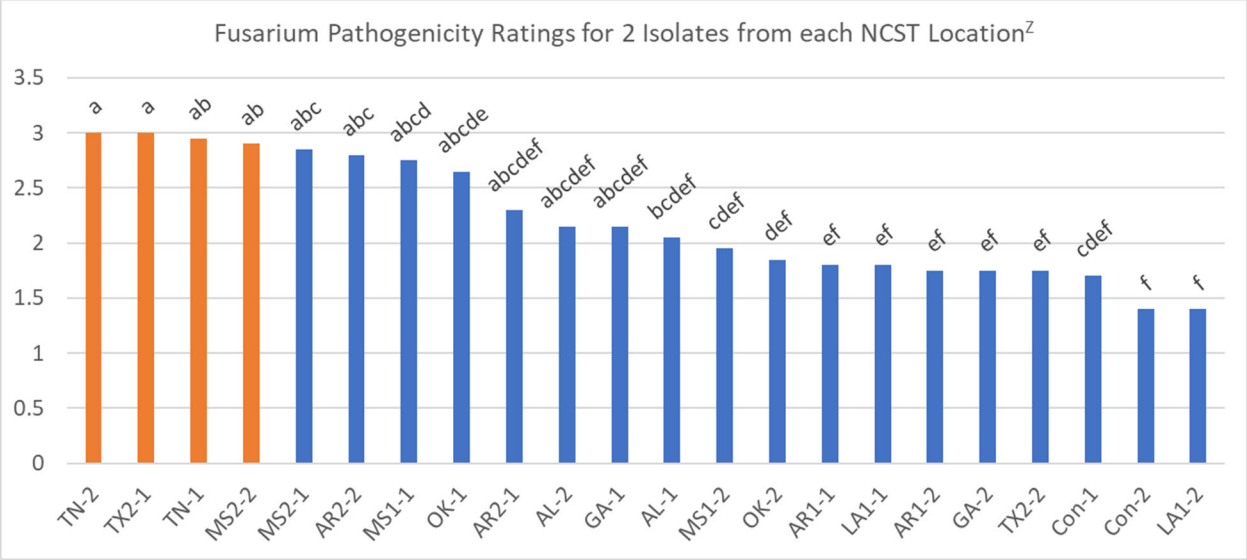

Figure 2. Pathogenicity results from randomly selected isolates of *Fusarium* spp. from locations in 2020. Bars with the same letter are not significantly different at $P \leq 0.05$.

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 Tennessee Institute of Agriculture or additional academic institutions represented herein, nor does it imply registration under FIFRA.

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