SEED DEVELOPMENTAL PROBLEMS AND SEED ROT IN SOUTH CAROLINA

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Abstract

Seed developmental problems have occurred in many cotton fields in South Carolina during the past three seasons. Five replicated field experiments were conducted at the Pee Dee Research & Education Center during the 2001 growing season. Experiments were designed to determine the impact of the environment, varieties, and management practices on seed abnormalities, as well as the relationships between seed problems, stink bug feeding, and other new cotton disorders. Experiments revealed seed developmental problems occurred in all varieties examined. This list of varieties included a conventional variety released in the early 1920's (Dixie Triumph), conventional varieties adapted to S.C. and developed at the Pee Dee Station during the 1970's (SC 1, PD 1, PD 2, PD 2164), conventional varieties not adapted to the Southeastern U.S. (Maxxa, Sphinx, Tamcot SP21), conventional varieties currently grown in S.C. (DPL 5690 and ST 474), and transgenic varieties currently grown in S.C. (DPL 655BR and PM 1218BR). The only cultivar which appeared to be consistently more susceptible than the other varieties to seed abnormalities was Maxxa, a variety which is grown primarily in the Western U.S. Few seed developmental problems were found in bolls younger than three weeks of age. Seed rot symptoms appeared to increase as boll age increased. High levels of seed abnormalities during boll development were generally associated with increased problems with hardlock cotton at maturity and problems with mechanical picking at harvest. The occurrence of seed abnormalities and seed rot symptoms was unaffected by the various management inputs applied during the growing season such as: increasing the boll load per plant (Low plant population), decreasing the boll load per plant (early fruit removal with Prep), applying plant growth regulators (Messenger or PixPlus), increasing the potassium rate by 100 lbs/A, increasing the boron rate by 0.5 lb/A, reducing the nitrogen rate from 90 lbs/A to 40 lbs/A.

Introduction

During the past three years, Clemson University cotton researchers and extension personnel have investigated numerous reports of seed developmental problems in many cotton fields in South Carolina. Seed developmental problems were first detected in South Carolina during the last week of July 1999 in cotton fields near the town of Luray in Hampton County. Growers and crop consultants monitoring insect feeding and boll maturity detected poorly developed and discolored, "rotting" seed in bolls of several transgenic varieties. Affected fields appeared normal when observed at a distance; however, detailed plant mapping observations from several of the affected fields revealed extensive seed problems in large, normal-looking bolls from these fields. Affected seed were poorly developed and often hollow, while less affected seed were pinkish in color and partially hollow. Some seeds exhibited uneven thickening and development of the seed coat. Bolls with abnormal seed were found at every nodal position examined (ie. throughout the entire plant canopy), but appeared to be more prevalent at nodal positions located at the bottom of plants and at positions closer to the main stem. Symptoms were only detected in bolls older than three weeks of age. Symptoms were not observed in bolls younger than three weeks of age. Bolls in which abnormal seed development was detected did not mature normally and often were hard-locked, i.e. unharvestable with a mechanical picker.

A list of possible causes for this poor seed development includes 1) incomplete pollination and/or fertilization of the seed; 2) deterioration of the seed by a bacterial or fungal pathogen; 3) late-season seed abortion due to low carbohydrate supplies and boll competition; 4) genetic susceptibility in one or more varieties, genetic backgrounds, and/or "value-added" traits; 5) environmental conditions associated with moisture and temperature; 6) insect feeding and/or transmission of a pathogen; 7) the occurrence of supernumerary carpels; 8) nutrient deficiencies or toxicities; and 9) secondary effects from the presence of other diseases, such as nematodes or cultural practices. Preliminary research information revealed that seed development problems were not limited to a particular variety or seed brand, and showed that seed development problems occurred in over 40 varieties examined, which includes both transgenic and conventional cotton varieties. Data collected from random surveys of cotton fields throughout the state showed that this phenomenon occurred to some extent in every cotton growing county in 1999 and 2000. Seed development problems have occurred both in the presence and absence of supernumerary carpels and/or insect feeding. Isolations of bacteria

and fungi from affected seed and other plant parts have not identified a specific pathogen as a causal agent for these problems. Poor pollination and fertilization associated with specific weather patterns or events do not appear to be contributing factors to these seed problems; however, problems with carbohydrate distribution to developing seeds has not been fully examined. Because of the seriousness and urgency of this problem and the potential negative economic impacts of this disorder to South Carolina and the cotton industry, research evaluating this new cotton disorder is desperately needed by cotton growers. Preliminary research information has found that these problems with seed development do not appear to be variety specific; however, many questions still need to be addressed concerning the susceptibility and/or tolerance of specific varieties to this seed problem. The objectives of this research were to evaluate the susceptibility of specific cotton varieties to seed developmental problems, to evaluate the response of this phenomenon to various management inputs, to assess changes in lint quantity and quality associated with this seed problem, to determine the potential economic impact of this disorder, and to identify the causal factor(s) and/or organism(s) associated with this problem.

Materials and Methods

Five replicated field experiments were conducted at the Pee Dee Research & Education Center during the 2001 growing season. Experiments were designed to determine the impact of the environment, varieties, and management practices on seed abnormalities, as well as the relationships between seed problems, stink bug feeding, and other new cotton disorders. In order to determine the susceptibility of various varieties to seed rot, six cotton varieties (DPL 5690, DPL 655BR, PM 1218BR, ST 474, Maxxa, and Sphinx) representing a range of maturities, seed companies, technologies, and genetic backgrounds were planted in four separate studies. Other varieties (SC 1, PD 1, PD 2, PD 2164, Tamcot SP21, Coker 310, Dixie Triumph, and a 1991 bag of DPL 5690) were also included for comparison purposes. These four variety experiments consisted of early- and late-planted fields grown under irrigated and non-irrigated conditions. A management input experiment was also conducted. Treatments consisted of an untreated check (managed under local extension recommendations for fertility, plant population, pest control, etc.), a low plant population (2 plants m-2), a high potassium rate (recommended plus 100 lbs K/A), a high boron rate (recommended plus 0.5 lbs B/A), Messenger PGR applied 3 times at 2.25 oz/A each, PixPlus PGR applied twice at 8 oz/A each, low N rate (40 lbs N/A total), and a low boll load treatment (Prep applied at 1.33 pt/A at pinhead square). Plots consisted of 4 row plots 40-feet long on 38-in. rows with 4 replications of each treatment. Weekly applications of pyrethroids beginning at first flower and continuing until defoliation were used to minimize insect feeding and damage. Seed abnormalities were evaluated weekly to determine the timing of seed problem occurrence. Plants were mapped at season's end to determine linkages between seed abnormalities, fruit retention, and boll load. Plots were machine-harvested to determine relationship between seed abnormalities, yield components, and lint quality.

Summary

Seed developmental problems occurred in all varieties examined. This list of varieties included a conventional variety released in the early 1920's (Dixie Triumph), conventional varieties adapted to S.C. and developed at the Pee Dee Station during the 1970's (SC 1, PD 1, PD 2, PD 2164), conventional varieties not adapted to the Southeastern U.S. (Maxxa, Sphinx, Tamcot SP21), conventional varieties currently grown in S.C. (DPL 5690 and ST 474), and transgenic varieties currently grown in S.C. (DPL 655BR and PM 1218BR).

The only cultivar which appeared to be consistently more susceptible than the other varieties to seed abnormalities was Maxxa, a variety which is grown primarily in the Western U.S.

Few seed developmental problems were found in bolls younger than three weeks of age. Seed rot symptoms appeared to increase as boll age increased.

High levels of seed abnormalities during boll development were generally associated with increased problems with hardlock cotton at maturity and problems with mechanical picking at harvest.

The occurrence of seed abnormalities and seed rot symptoms was unaffected by the various management inputs applied during the growing season:

- Increasing the boll load per plant (Low plant population) = Not statistically different from untreated check.
- Decreasing the boll load per plant (early fruit removal with Prep) = Not statistically different from untreated check.
- Applying plant growth regulators (Messenger or PixPlus) = Not statistically different from untreated check.
- Increasing the potassium rate by 100 lbs/A = Not statistically different from untreated check.
- Increasing the boron rate by 0.5 lb/A = Not statistically different from untreated check.
- Reducing the nitrogen rate from 90 lbs/A to 40 lbs/A = Not statistically different from untreated check.

Table 1. Total bolls, reproductive:vegetative ratio, percent hard lock bolls, lint yield, and percent lint unharvested of various cotton varieties - Seed Rot Monitoring Plots, **Early-planted[1] Dry Land Study**, Pee Dee Research and Education Center, 2001.

	Sampling Date			Sampling Date		% Hardlock	Lint	Lint	% Lint
Cultivar	**7/16**	**8/7**	**9/14**	**7/16**	**8/7**	**Bolls**	**Yield**	**Unpicked**	**Unpicked**
	- - - - - Bolls m^{-2} - - - - RVR - -					**% - -**	**lbs acre^{-1} - -**		**%**
DPL 5690	69	102	32	0.2	0.8	18	642	236	30
DPL 655 BR	82	115	45	0.2	0.6	21	676	165	21
PM 1218 BR	80	98	56	0.3	1.1	16	1105	116	10
ST 474	79	141	61	0.2	0.9	57	886	183	20
MAXXA	58	58	36	0.3	0.8	47	680	158	19
SPHINX	90	101	41	0.3	0.9	36	892	176	17
PD 2	131	102	61	0.4	1.2	37	889	143	15
SC 1	105	145	52	0.3	1.2	42	804	143	16
TAMCOT SP 21	94	80	39	0.4	1.0	50	763	178	20
PD 2164	87	99	52	0.3	0.8	45	793	125	14
LSD(0.05)	NS	NS	NS	0.1	NS	22	NS	NS	NS

[1] planted April 23rd

Table 2. Total bolls, reproductive:vegetative ratio, percent hard lock bolls, lint yield, and percent lint unharvested of various cotton varieties - Seed Rot Monitoring Plots, **Early-planted[1] Irrigated Study**, Pee Dee Research and Education Center, 2001.

	Sampling Date			Sampling Date		% Hardlock	Lint	Lint	% Lint
Cultivar	**7/17**	**8/7**	**9/14**	**7/17**	**8/7**	**Bolls**	**Yield**	**Unpicked**	**Unpicked**
-	**- - - - Bolls m^{-2} - - - - -**			**- - RVR - -**		**%**	**- - - - lbs acre^{-1} -**		**%**
DPL 5690	60	108	97	0.2	1.0	23	1472	148	9
DPL 655 BR	69	109	84	0.3	1.1	15	1463	114	7
PM 1218 BR	64	101	78	0.3	1.6	11	1540	130	7
ST 474	65	143	92	0.2	1.6	15	1641	166	9
MAXXA	21	57	55	0.3	0.9	72	767	209	21
SPHINX	77	104	78	0.4	1.6	30	1249	173	12
PD 2	94	110	83	0.5	1.8	20	1393	137	9
SC 1	86	113	83	0.3	1.5	25	1297	96	7
DPL 5690 (0LD)*	54	151	83	0.2	1.1	29	1174	119	9
PD 2164	71	138	64	0.5	1.8	20	1243	117	8
LSD(0.05)	35	39	19	0.1	0.5	14	238	NS	6

[1] planted April 23rd

*1991 Bag of seed

Table 3. Total bolls, reproductive:vegetative ratio, percent hard lock bolls, lint yield, and percent lint unharvested of various cotton varieties - Seed Rot Monitoring Plots, **Late-planted**[1] **Dry Land Study**, Pee Dee Research and Education Center, 2001.

	----Sampling Date----			%			% Lint
	8/16	9/14	8/16	Hardlock Bolls	Lint yield	Lint Unpicked	Cultivar Unpicked
	- Bolls m^{-2} -		- RVR -	%	- - - - - lbs $acre^{-1}$ - - - -		%
DPL 5690	82	36	1.3	21	480	184	29
DPL 655 BR	66	39	1.1	17	529	153	22
PM 1218 BR	66	30	1.4	10	714	175	20
ST 474	69	33	1.3	21	585	269	31
MAXXA	52	32	1.3	38	397	177	31
SPHINX	58	39	1.9	34	497	231	32
DIXIE TRIUMPH	47	26	1.1	38	288	231	45
COKER 310	37	45	0.4	21	468	139	23
TAMCOT SP 21	61	35	2.1	59	410	206	33
PD 1	75	41	1.4	32	458	235	34
LSD(0.05)	**NS**	**NS**	**0.5**	**15**	**101**	**71**	**9**

[1] planted May 23rd

Table 4. Total bolls, reproductive:vegetative ratio, percent hard lock bolls, lint yield, and percent lint unharvested of various cotton varieties - Seed Rot Monitoring Plots, **Late-planted**[1] **Irrigated Study**, Pee Dee Research and Education Center, 2001.

	----Sampling Date----			%			
Cultivar	8/20	9/14	8/20	Hardlock Bolls	Lint yield	Lint Unpicked	% Lint Unpicked
	- Bolls m^{-2} -		- RVR -	%	- - - - - lbs $acre^{-1}$ - - - -		%
DPL 5690	140	77	0.4	53	927	251	22
DPL 655 BR	77	87	0.4	47	910	235	21
PM 1218 BR	117	79	0.5	48	1042	244	19
ST 474	108	95	0.4	48	1085	278	21
MAXXA	62	52	0.2	74	493	137	22
SPHINX	120	78	0.8	52	943	229	20
DIXIE TRIUMPH	93	65	0.3	63	663	256	30
COKER 310	36	70	0.1	64	226	94	20
DPL 5690 (OLD)*	127	78	0.3	43	870	146	14
PD 1	96	92	0.6	50	1157	242	17
LSD(0.05)	52	25	0.2	19	222	97	NS

[1] planted May 23rd

* 1991 bag of seed

Table 5. Total bolls, reproductive:vegetative ratio, percent hard lock bolls, lint yield, and percent lint unharvested in response to various management inputs, **Seed Rot Management Input[1] Study**, Pee Dee Research and Education Center, 2001.

Management Input	Sampling Date					% Hardlock Bolls	Lint Yield	Lint Unpicked	%Lint Unpicked
	7/16	8/7	9/14	7/16	8/7				
	- - - Bolls m^{-2} - -			- - RVR - -		%	- - - lbs $acre^{-1}$ - - --		%
Untreated Check	87	80	57	0.5	1.3	29	1082	137	11
Low Plant Pop. (2 plts m-2)	97	138	58	0.4	1.5	37	808	165	17
High K Rate (Rec.+100lbs/A)	87	90	65	0.5	1.3	28	1089	85	7
High B Rate (Rec.+0.5lbs/A)	113	91	51	0.5	1.4	19	1076	128	11
Messenger (3 @ 2.25oz/A each)	87	62	60	0.5	1.4	16	1055	115	10
PixPlus (2 @ 8oz/A each)	91	67	45	0.5	1.3	23	1060	91	8
Low N Rate (40 lbs N/A total)	99	71	58	0.5	1.5	22	1073	83	7
Low Boll Load (Prep @ PHSQ)	22	88	61	0.2	0.8	68	602	302	35
LSD(0.05)	34	33	NS	0.2	0.4	16	127	62	6

[1] planted April 23rd; untreated check – (plant population = 12 plants m^{-2}; N rate = 90 lbs/A; K rate = 100 lbs/A; B rate = 1.0 lbs/A; No PGRs applied).