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HISTORY AND OVERVIEW OF THE HARDLOCK PROBLEM IN HUMID AREAS OF THE DEEP SOUTH

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Abstract

Hardlock is a major problem for cotton producers in the humid regions of the cotton belt. In Florida, from 20- 60% of the cotton is lost due to hardlock almost every year. When hardlock is only 20%, yields of 2 bale lint are often made. Yields are often reduced more by hardlock than any other factor including drought. However, this is seldom reported since identification and means of control have not been developed. The Cotton Disease Council has put the total yield loss from disease in the U.S. at about 12% per year for all diseases. Research with hardlock and boll rot have identified several different bacteria and fungi associated with symptoms and the incidence seems to increase with rainfall, humidity, high nitrogen, plant size and density. 2002 was one of the most severe years for hardlock in the humid areas of the cotton belt in recent history, and yields in Florida averaged 346 lbs/A. Hardlock has been known to be a problem for years with unknown etiology and without any apparent means of control. Symptoms do not appear until the boll opens and the locks of cotton look more like a slice of an orange than a fluffed out boll of fiber. In many cases the quality of the fiber is not severely affected, but yields have been noted to be reduced by 50% or more in the lower Mississippi River delta of Mississippi and Louisiana as well as other humid areas because conventional cotton pickers either knock the hardlocks to the ground or do a poor job of picking them. Due to the common occurrence of hardlock along the Gulf coast, there has been interest in strippers in UNR that could harvest cotton regardless of hardlock. However, gin deductions, higher seed costs, and poor stands in narrow rows especially with reduced tillage have led to less interest and the dilemma of how to harvest the cotton produced. Boll rot has been mentioned in the literature since the early 1900's and has had many different organisms associated with it. However, no definite cause or control measure has been presented. Cotton was hand picked in the U.S. prior to 1950 and is now almost completely machine harvested. Most of the U.S. crop is harvested with spindle pickers which require that cotton be fluffed out to harvest it. New data from Florida has identified a cause of hardlock and a potential solution to the problem.

Discussion

Very little information is given in the literature on hardlock or boll rot of cotton. Most disease information focuses on seedling diseases which are known and can be controlled by fungicides and seed treatments. Other information focuses on plant diseases like the different wilts which are usually controlled by plant resistance or nematode control. Boll rots and hardlock has never been fully understood and some of the last intensive work was done by Sanders and Snow in 1978. Their work indicated that boll rots were more severe in wet years, and that most boll rots or hardlock were caused by *Diplodia* or *Fusarium* in all of the humid, high rainfall areas of the world. Severe hardlock in Florida usually occurs when major storms or rainfall occurs during boll opening but our data suggest that the infection may be set up during the day of bloom for each individual boll if weather conditions are conducive. Watkins (1981) suggested that insects can cause boll rot by creating wounds in the tissue and can transmit pathogens that cause boll rot. Florida data has shown that thrips can carry *Fusarium* that may be transmitted during the day of pollination. It has been suggested that boll rot can be controlled by eliminating early season sources of inoculum by seed treatment and clean tillage. However, there is no data to back this up since conservation tillage has been shown to reduce diseases in crops like peanuts where it was thought at one time to cause more disease. Fungi such as *Fusarium* are ubiquitous and may not be reduced by cultural practices. Likewise, McLean and Lawrence (1998) indicated that young bolls are generally resistant to fungi except for *Phomopsis* and *Diplodia* which may attack flowers or young bolls and turn them black. However, Wright et al. (2003) showed that flowers can be infected by *Fusarium* on the day of pollination, since the fungi has an open track into the flower with the pollen for about 24 hours before the carpel seals over the area where the pollen tube went inside the boll. The weather conditions on the day of bloom were highly correlated to the amount of hardlock, indicating infection through the bloom. Hardlock and boll rot normally occur on some of the most productive land in the field and in areas where plant growth can be excessive. Where a stripper was used to harvest cotton in studies in Florida where hardlock occurs yearly, yield increases were noted each year that was in the range of 300-400 lbs/A more lint each year (1997-1999) depending on the treatment. This was an average of about 30% hardlock for each of these years. Cotton taken from 4 transgenic varieties that was either hardlocked or fluffed was sent to Cotton Inc. to be ginned and graded. Even though cotton was hardlocked, grades were not too much lower and actually varied more between varieties than whether it was fluffed or hardlocked. However, since UNR has failed to be a mainstream production method with growers, our goal since then has been to find the cause of the damage from hardlock and develop a control strategy. There have not been reports of hardlock in the arid regions of the cotton belt even where crops are irrigated. Therefore, environmental factors are considered to be very essential for the organisms to initiate infection resulting in hardlock. With diligence and cooperative research efforts, the problem of hardlock control is being solved and weather models may be used to predict when or if fungicides should be used to control fungi causing hardlock during the bloom period.

Literature Cited

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McLean, K. S., and G. W. Lawrence. 1998. First report of premature boll rot associated with cotton in Louisiana. Plant Dis. 82: 711.

Watkins, G. M. (ed.) 1981. Compendium of cotton diseases. The American Phytopathological Society, St. Paul, Minn.

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Table 1. UNR vs. conventionally planted cotton at NFREC, Quincy, FL in 1997.

	Row spacing - 7 inch			**Row spacing - 36 inch**			
N rate (lbs/A)	**No-till**	**Conv.**	**Avg. (N rate)**	**No-till**	**Conv.**	**Avg.(N rate)**	**Avg.**
0	827	1176	**1001**	826	677	**751**	**876**
75	983	1046	**1014**	772	698	**735**	**875**
150	1196	1227	**1212**	788	953	**871**	**1041**
Avg.	**1002**	**1150**	**1076**	**795**	**776**	**786**	**931**

LSD(0.05) for row spacing	97.7	LSD(0.05) for tillage	ns
LSD(0.05) for N	119.6	LSD(0.05) for row spacing x tillage	ns
LSD(0.05) for row spacing x N	ns	LSD(0.05) for tillage x N rates	ns
LSD(0.05) for row spacing x tillage x N	293.3		

Table 2. Cotton lint yields (lbs/A) at NFREC, Quincy, 1998

N rate	**Row width**		
(lbs/A)	**7"**	**36"**	**Avg.**
0	714	224	**469**
50	577	228	**403**
100	548	200	**374**
150	522	156	**339**
Avg.	**590**	**202**	**396**

LSD(0.05) for row width	29.8
LSD(0.05) for N rate	42.1
LSD(0.05) for row width x N rate	59.6

Table 3. Lint cotton yield (lb/A), 1999 NFREC Quincy .

Fertilizer trt.	**Application**	**Row width (inch)**		**Mean**
(lb/A N)	**timing**	**7"**	**36"**	**(lbs/A)**
1. 0	-	426	464	**445**
2. 60	At plant	808	551	**680**
3. 60	1st square	816	412	**614**
4. 60	3rd week of bloom	746	291	**519**
5. 120	At plant	693	338	**515**
6. 120	1st square	735	545	**640**
7. 120	3rd week of bloom	663	333	**498**
8. 180	At plant	623	404	**513**
9. 180	1st square	630	491	**561**
10. 180	3rd week of bloom	652	325	**488**
Mean		**679**	**415**	***547***

LSD(0.05) for row width	127.2
LSD(0.05) for fertilizer treatment	ns
LSD(0.05) for interaction	ns

Table 4. HVI of 4 transgenic cotton varieties (hardlocked vs. fluffed) Quincy, FL

Variable	Hardlocked	Fluffed
MIC	3.96	4.38
UHM	1.13	1.14
STR (g/tex)	30.3	31.4
ELO	10.54	10.43
Rd	72.4	75.5
Yellowness (+b)	11.10	10.01
UI	84.3	85.6
CGRD	27-2	25-2