Evaluation of Various Control Measures for Cotton Boll Rot

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ABSTRACT

Four control measures for cotton boll rot were tested individually and in various combinations in field plots. Best control was obtained with an experimental line containing disease-escape and disease-resistance traits. Boll rot incidence in the experimental line was 70 to 72% less than that occurring in solid plantings of two commercial cultivars, Coker 201 and Deltapine 16. Erratic control was obtained with 2 × 2 skip-row plantings (leaving alternate pairs of rows vacant) and reduced nitrogen rates. Application of a protectant fungicide to the bolls was ineffective in controlling decay. Likewise, combinations of various control measures did not improve their performance over the best single treatment. Seed-cotton yield was highest in skip-row plantings, and was not significantly affected by other control measures or their combinations.

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Additional key words: *Gossypium hirsutum*, disease escape, disease resistance, fungicide.

Boll rot is one of the most serious cotton production problems when excess moisture is present just prior to and during the period of boll opening. Annual losses in the humid midsouthern and southeastern areas of the United States average 4-5% (11), but on a local basis may exceed 30%. Inadequate control has resulted in steadily mounting losses during the last 6 years (11). Disease incidence has been promoted by various cultural practices which not only increase fiber yield, but also stimulate excessive vegetative growth which forms a closed canopy over the stand.

Current control approaches include cultural measures that alter the dense stand canopy to promote rapid drying (9, 10, 13), application of protectant fungicides to bolls (8, 9, 10, 14), and incorporation of disease-escape and disease-resistance traits into specific breeding lines (1, 2, 3, 4, 6). Since the various control practices have been tested individually by different investigators, we simultaneously compared several of the more effective methods in single tests. We also attempted to improve their performance by combining various measures.

MATERIALS AND METHODS.—Field plots were established at Morven in the lower Coastal Plain of Georgia on 27 April 1972, and 8 May 1973, and at Midville in the upper Coastal Plain on 9 May 1973. In all tests, acid-delinted seed treated with 1.3 ml/kg Ceresan [2.8% methylmercury-2, 3-dihydropropylmercaptide and 0.62% methylmercury acetate (2.25% Hg)], and 6.2 g/kg Demosan 65 W (1, 4 - dichloro - 2, 5 - dimethoxybenzene) were planted at a rate of 17.2 kg/ha.

Treatments evaluated for disease control were compared with solid stands of two cotton (*Gossypium hirsutum* L.) cultivars, Coker 201 and Deltapine 16, which are widely used by growers and have a high boll rot potential. The nonisogenic experimental line OFN-1600, derived from Deltapine 16 and Deltapine Smooth Leaf parentage, was tested since it is the only known source with a combination of the okra-leaf, frego-bract, and nectariless (absence of extra-floral nectaries) traits. The okra-leaf pattern has considerably less surface area than leaves of standard commercial cultivars due to deep marginal indentations. The frego bract is elongated, narrow, and tends to twist outward and away from the boll, whereas standard bracts are wide and envelop the capsule. Therefore, both characters provide some degree of disease escape by facilitating rapid drying in the stand and in the vicinity of the boll (1, 2, 3, 4, 5). The nectariless trait eliminates a potential avenue of fungal penetration into the boll (6). Consequently, OFN-1600 will be referred to as a klendusic line.

The other control measures evaluated individually were alteration of the stand canopy by means of a 2 × 2 skip-row planting pattern (leaving alternate pairs of rows vacant), and reducing the nitrogen fertilization rate to 50% of that used in routine production. Normal nitrogen rates used by growers are 45 kg/ha at Morven and 30 kg/ha at Midville. Potential control by fungicides was tested by spraying bolls every 2 weeks with captan [N-(trichloromethyl)thio - 4 - cyclohexene - 1, 2-dicarboximide] (50% WP, Stauffer Chemical Co.) during the last 6 to 7 weeks of fruit maturity. At Morven, three applications were made beginning 27 July, 1972, and two applications were made beginning 7 August, 1973. At Midville the first of three applications was made on 10 August 1973. A captan spray was used at a rate of approximately 5.6 kg/ha in 329 liters of water [6.3 kg/cm^2 (90 psi)] at Morven and in 225 liters of water [4.1 kg/cm^2 (60 psi)] at Midville. The fungicide was applied with a high-clearance sprayer equipped with three vertically mounted nozzles facing the side of each row and arranged to form an overlapping pattern to cover the lower plant zone from 0.15 m to 0.91 m above the soil surface.

Certain control measures were combined to evaluate their performance (Table 1). To promote maximum aeration and drying within the stand, skip-row plantings were used jointly with either reduced nitrogen rates or the klendusic line. Skip-row planting was also combined with a captan spray to determine if rapid drying in the stand and fungicide protection would have an additive effect in decreasing losses.

Each treatment was replicated five times in a randomized complete block design with an individual replication consisting of eight rows, each 15.2 m long and 0.97 m apart. Data were collected from the two center rows of each replication. The number of rotted bolls were recorded after the lower portion of the crop had completely opened. Bolls that had two or more locks decayed and were free of insect injuries through the carpel wall were considered rotted. Boll rot losses were calculated by determining the estimated seed cotton weight of the decayed bolls and expressing the figure as a percentage of total seed cotton production.

The tests received routine cultural maintenance and

TABLE 1. Effect of various control measures on cotton boll rot and seed cotton yield

	Control measures			Morven 1972		Morven 1973		Midville 1973	
Cultivar or line	Planting pattern	Nitrogen rate[a] (kg/ha)	Fungicide applied[b]	Boll rot (%)	Seed cotton[c] (kg/row)	Boll rot (%)	Seed cotton[c] (kg/row)	Boll rot (%)	Seed cotton[c] (kg/row)
Coker 201	Solid	45-30	None	2.5 v[d]	9.3 x	12.9 v	8.3 xy	3.8 vwx	6.8 z
Coker 201	Solid	45-30	Captan	2.2 vwx	9.8 wx	11.1 v	8.0 xy	4.2 vwx	7.8 yz
Coker 201	Solid	22.5-15	None	2.2 vwx	10.1 vwx	7.5 wx	7.1 y	4.0 vwx	7.3 yz
Coker 201	2 × 2 skip	45-30	None	1.9 vwxy	13.2 vwx	10.8 vw	11.0 vw	4.4 vw	9.9 wx
Coker 201	2 × 2 skip	45-30	Captan	2.1 vwxy	11.7 vwx	9.8 vw	9.7 vwx	3.5 vwx	11.1 vw
Coker 201	2 × 2 skip	22.5-15	None	2.3 vw	13.6 vw	8.4 w	11.9 v	3.0 x	11.6 vw
Deltapine 16	Solid	45-30	None	1.4 wxyz	9.8 vwx	14.0 v	7.3 xy	5.4 v	8.6 xy
Deltapine 16	2 × 2 skip	45-30	None	1.3 xyz	13.7 v	7.6 wx	12.3 v	2.2 xy	12.0 v
OFN-1600	Solid	45-30	None	1.1 yz	10.2 vwx	3.9 xy	8.5 wxy	0.8 y	8.2 xyz
OFN-1600	2 × 2 skip	45-30	None	0.8 z	12.0 vwx	3.2 y	8.2 xy	0.6 y	11.2 vw

[a]Rates of 45 and 22.5 kg/hectare were used at Morven, and 30 and 15 kg/hectare were used at Midville.
[b]Captan (50% WP) applied at the rate of approximately 5.6 kg/hectare.
[c]Seed cotton yield (both fiber and seed) from 30.48 m row space.
[d]Column values followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's new multiple range test.

were defoliated prior to harvest. All plots were machine-harvested either during the last week of October or the first 2 weeks of November.

RESULTS.—Excessive stand growth, producing a closed canopy, was conducive to boll rot development in all tests. Highest incidence of boll rot (14.0%) occurred at Morven in 1973. However, lack of rainfall during the boll maturation period prevented more extensive rot development at Morven in 1972 (2.5%), and at Midville in 1973 (5.4%) despite the rank stand growth.

The klendusic line, OFN-1600, reduced disease losses more effectively than the other control measures (Table 1). In both solid and skip-row plantings in all tests, 70% less boll rot occurred in the klendusic line than in Coker 201. The effect of the klendusic line was less uniform in reducing boll rot losses when compared with Deltapine 16. An 81% decrease was evident in two of three solid plantings and a 58% reduction occurred in one of three skip-row plantings.

Skip-row planting as a boll rot control measure was effective only with Deltapine 16. Losses were significantly reduced by 20% in two of three tests. This planting pattern had no significant influence on boll rot incidence in Coker 201, where plants frequently lodged, and OFN-1600 which produced a partially opened canopy due to the okra-leaf pattern.

Lower nitrogen rates had an erratic effect in reducing boll rot losses in Coker 201. The treatment resulted in 42% less boll rot in one of three solid planted tests and a 32% reduction in one of three skip-row plantings. The use of reduced nitrogen rates did not prevent rank stand growth and, consequently, had little influence on microclimate within the stand.

The other control approaches had no effect on boll rot frequency. Spray applications of captan were ineffective regardless of the planting pattern (Table 1). Likewise, combinations of other control measures did not increase their performance above that observed for each individual measure.

Seed cotton yields (weight of both seed and fiber) were generally affected more by planting pattern than other control measures. Seed cotton yield was significantly greater in skip-row plantings than in solid stands (Table 1). Cultivar, lower nitrogen rates, fungicide application, and combined control measures had no marked effects on yield.

DISCUSSION.—Boll rot reduction with klendusic plant traits is a promising method of disease control. The individual beneficial effects of the okra-leaf, frego-bract, and nectariless traits have been shown (1, 3, 4, 6). Our tests demonstrated that a combination of these characters into a single line reduces boll rot more successfully than has been reported for any of these traits used alone (1, 3, 4, 6). However, Jones (3) was unable to further decrease boll rot losses by incorporating the okra-leaf and frego-bract traits into one line beyond those obtained with the frego-bract trait alone.

Although boll rot incidence was reduced by cultural practices such as skip-row planting and a lower nitrogen fertilization rate, their performance was erratic. Skip-row planting, particularly with the Coker 201 cultivar, was hampered by plant lodging which promoted boll rot when the fruit contacted the soil surface. Weed control was also a problem in the vacant row space because of the open stand canopy.

Inadequate economic boll rot control with fungicide applications has been frequently reported (8, 10, 14), and our test results were similar. Poor fungicide performance may be related to spray timing and poor coverage in rank stands, and possibly the complex of organisms involved (9). Initiation of a more intensive spray program at flowering, rather than near boll maturity, may be necessary since both bracts and young bolls are infected early in their development and may render the action of protectant fungicides ineffective (7, 12, 15). Uniform coverage of the infection court is also difficult due to excessive vegetative growth of plants. Lodging of plants may prevent the free movement of ground equipment through the stand resulting in the damage of plants and bolls and promote disease development. Consequently, boll rot control with captan, and perhaps other fungicides, does not appear to be feasible.

Treatments that resulted in a significantly lower boll rot level generally did not induce a proportional increase in seed cotton production, indicating that certain control measures had other effects on plant growth and yield. With skip-row plantings, yield increases were higher than would be expected solely from disease control, and are attributed to less competition among plants than that occurring in solid-planted stands. On the other hand, a marked decrease in boll rot in the resistant line was not reflected in significantly higher seed cotton yields. Further improvements in this line will be required to provide agronomic traits which would make it competitive with commercial cultivars.

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