Distribution and control of

Cotton Boll Rots

in California cotton growing areas

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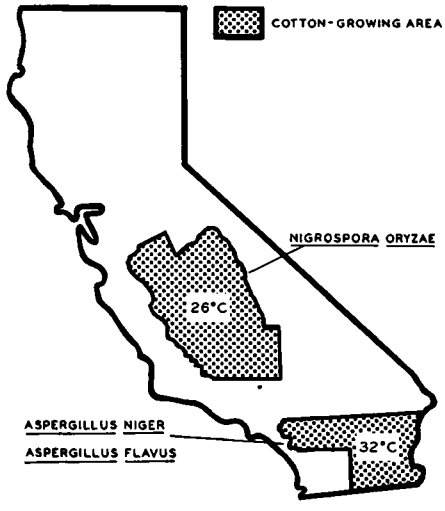
Each year the California cotton crop suffers quality reduction and yield losses —estimated at 3.5% to 4.0%—due to fungus boll-rotting organisms.

Boll rots cause losses by reducing yields, by staining and reducing the strength of the lint, and by infecting the seed with disease-producing organisms which later may cause seedling blights. During some seasons of hot, humid weather in the irrigated valleys of California, fungus diseases may destroy up to 15% of the entire boll crop. These high losses are not uncommon in the Palo Verde and Imperial valleys of the state.

Surveys of cotton diseases in California during 1957–60 showed that a number of boll rot diseases occur here. However, the severity of damage and the distribution of the different rots vary in the different regions of the state.

The major boll rot fungus in the San Joaquin Valley—*Nigrospora oryzae*—was found in 94% of the diseased bolls examined. Only 1.0%–2.0% of the rotted bolls there were infected by the fungi *Aspergillus flavus* and *Aspergillus niger*, which were the most prevalent fungi in the Palo Verde and Imperial valleys, occurring on 68% of the diseased bolls examined. In contrast, *Nigrospora oryzae* was found in only 12% of the rotted bolls there. These three fungi constitute the major boll-rotting organisms in the California cotton crop. In addition, the surveys revealed a general distribution of secondary wound parasites—*Fusarium moniliforme* and *Rhizopus nigricans*—occurring in trace amounts and invariably associated with insect punctures in the cotton bolls.

Map showing the prevailing summer temperatures and major boll-rotting fungi in the two cotton growing areas of California.



Temperature Studies

Pure cultures of five boll-rotting fungi were obtained from field collections of diseased bolls. The growth rates of the fungi were determined on potato dextrose agar at 10 temperatures ranging from 54°F to 102°F. It was found that the boll-rotting fungi could be separated into low- and high-temperature groups according to their growth in culture. *Nigrospora oryzae* and *Fusarium moniliforme*, in the low-temperature group, grew optimally at 75°F—24°C—whereas *Aspergillus flavus*, *Aspergillus niger*, and *Rhizopus nigricans* in the high-temperature group grew optimally at 91°F—33°C.

The effect of temperature on boll-rot development was also studied in the laboratory. Bolls of Acala 4-42 cotton were inoculated with the respective fungi and incubated at five constant temperatures. The severity of internal decay and the rapidity of rotting were determined by assigning different grades to deterioration. Rotting was graded from 0, indicating no rot, to 4, indicating severe rot. The results of this study of temperature effect on boll-rot development again indicated two distinct temperature groups. In the lower temperature group, boll rotting by *Nigrospora oryzae* and *Fusarium moniliforme* was optimal at 75°F whereas in the higher temperature group, *Aspergillus flavus*, *Aspergillus niger*, and *Rhizopus nigricans* rotted bolls most severely at 91°F. *Nigrospora oryzae* was the only fungus that rotted bolls internally without extensive external damage.

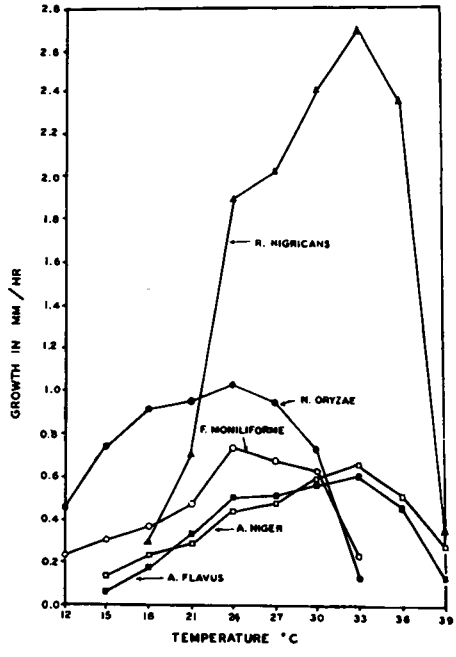
Distribution

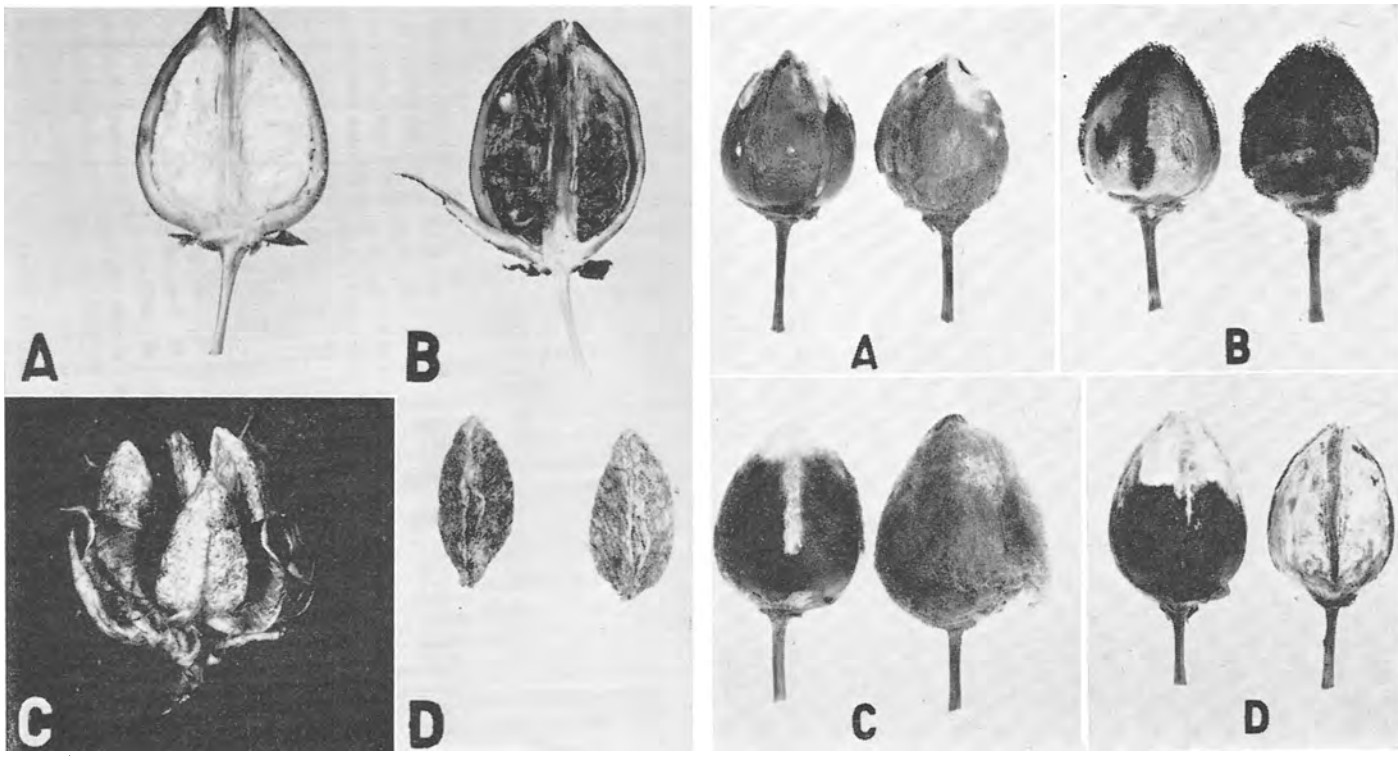
The average summer temperature in the San Joaquin Valley has been calculated to be about 79°F—26°C—and the average summer temperature in the Coachella, Palo Verde, and Imperial valleys to be about 90°F—32°C.

Results of combined laboratory and field studies suggest that the differences in severity and distribution of the major boll rots in California are directly related to the temperature requirements of the fungi involved and the average summer temperatures in the cotton-growing areas of the state.

It appears that *Aspergillus flavus* and *Aspergillus niger* are more widespread

Graph showing comparative growth rates of five boll-rotting fungi incubated on potato-dextrose agar at ten constant temperatures.





***Left*—Internal boll rot of cotton caused by *Nigrospora oryzae* showing A) cross section of a healthy boll, B) cross section of a diseased boll, C) mature boll with the tight-lock symptom of the disease, and D) diseased locks which remain unfluffed and drop to the ground. *Right*—Four common boll rots of cotton caused by A) *Aspergillus flavus*, B) *Aspergillus niger*, C) *Rhizopus nigricans*, and D) *Fusarium moniliforme*, showing surface sporulation of the respective fungi.**

in southern California because the higher summer temperatures favor their development there. This relationship accounts for the high incidence of the yellow stain disease in southern California. Yellow stain, caused by *Aspergillus flavus*, is of considerable economic importance to cotton growers. Cotton fiber is weakened by the yellow stain fungus, and the germinability of seed from infected bolls is sometimes greatly reduced. Potentially, yellow stain is one of the most important diseases of cotton in southern California. Reports four years ago—in 1957—indicated that 53.6% of the samples received at the federal classing office in El Centro contained yellow stain.

Experimental data also suggest that the major boll rot, caused by *Nigrospora oryzae*, is more severe in the San Joaquin Valley because lower summer temperatures favor the development of the fungus there. Thus the temperature requirements for fungus growth and for boll rot development explain in part the differential severity and distribution of the major boll rots in different parts of California.

The distribution of the two minor boll rots, *Rhizopus nigricans* and *Fusarium moniliforme*, is dependent primarily on insect punctures or other mechanical injury to the bolls. Their distribution is apparently not regulated by temperature differentials but rather by the prevalence of cotton insects such as the common boll worm, *Heliothis armigera*.

Although some boll rotting fungi have different temperature preferences, all require high relative humidity for development. In the desert regions periods of high relative humidity occasionally occur due to climatic conditions. More commonly, however, high atmospheric humidity is intensified by excessive irrigation and maintenance of dense stands of cotton.

Practices that have proved of value in reducing losses from boll rots include:

1. Control of rank growth by reduction of fertilization and irrigation.
2. Cotton fields kept free of weeds and grasses that hinder air circulation.
3. Bottom defoliation, since removal of the leaves permits rapid drying of the bolls and lint after rains and dews.
4. Skip-row planting — four rows planted, four rows skipped—improves aeration.
5. Selection of cotton varieties with small leaves and an open growth habit.
6. Control of insects that damage cotton bolls, especially the common boll worm.

Differences in Severity of Internal Rotting of Acala 4-42 Cotton Bolls by Five Fungi at Different Incubation Times and Temperatures

Temperature °F	Fungi and severity of boll rotting[a]				
	Fusarium moniliforme	Nigrospora oryzae	Aspergillus flavus	Aspergillus niger	Rhizopus nigricans
70	2.4	2.8	1.0	1.4	1.2
75	3.4	4.0	2.0	1.4	2.0
81	1.8	4.0	2.2	2.4	2.4
86	2.2	2.4	4.0	2.4	3.6
91	2.6	1.2	4.0	3.6	4.0
Incubation time (hrs)	184	144	160	144	92

[a] Severity of internal rotting of bolls was determined by the degree of both fiber and boll deterioration. Degree of rotting was measured on a scale of 0–4, from no rot to severe rot. The numbers in the table showing severity of rot are an average of 5 replicates at each fungus-temperature combination.

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