Effect of Field Exposure on Fungal Invasion and Deterioration of Cotton Seed

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ABSTRACT

Fungal invasion and deterioration of cottonseed exposed for 0 to 6 weeks after boll opening were determined at two different locations in the Piedmont and Coastal Plain of Georgia. Incidence of fungal colonization was similar at both locations and was associated with rainfall patterns. Decreased seed viability and high free fatty acid content were correlated inversely with fungal colonization only in the Coastal Plain. A low rate of deterioration in seed exposed in the Piedmont was attributed to lower temperatures which slowed autocatalytic changes of stored materials and may have retarded fungal invasion of the seed embryo.

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Field deterioration of seed is a serious problem in the humid areas of the cotton belt. The introduction of mechanical harvesting in recent years has made the production of high quality seed more difficult. Much of the seed cotton of the early bottom crop may be exposed to weathering for a month or more, since an efficient operation demands that the majority of the boll crop be opened prior to picking.

The deleterious effect of moist periods prior to harvest was documented by Simpson & Stone (4); however, they did not determine the role of microorganisms in seed deterioration. Although seed in commercially harvested seed cotton are often deteriorated and contain numerous fungi (1, 2), little is known about the time of fungal invasion and the effect of the field environment on their activity. Our study was designed to determine the time of fungal invasion of field-exposed seed as affected by the environment, and the resulting effect upon seed germination and free fatty acid content (FFA).

MATERIALS AND METHODS.—Field plots of *Gossypium hirsutum* L. 'Coker 201' were established at Athens in the Piedmont and at Midville in the Coastal Plain of Georgia. The plots consisted of five replications at Athens and four at Midville, each replication 15.2 m long and 29.9 m wide. Opening lower-crop bolls with green carpel walls were tagged 5 October at Midville and 9 October at Athens. Variation in time of boll opening was estimated at ± 1.5 days, with no rainfall occurring during the period. At 0, 2, 4, and 6 weeks after tagging, 100 bolls were collected from each replication. The Athens plot was defoliated 11 October, whereas the Midville plot was defoliated 15 October.

Seed cotton samples were air-dried and hand-ginned. Seed were delinted in concentrated H_2SO_4 for 3 min and washed in running water for 5 min. Moisture content was adjusted to 8 to 10% and the seed stored in double polyethylene bags at 15 C. Moisture content was determined by oven-drying the seed at 100 C for 24 hr.

Seed viability was determined by germinating 200 seed/replication in sterile sand for 12 days at alternating temperatures of 30 C for 8 hr and 20 C for 16 hr. Germination tests were run 5 weeks after collection to minimize the effect of dormancy (3). A

TABLE 1. Effect of field exposure on fungal invasion and deterioration of cottonseed at Midville and Athens, Ga.

Weeks of field exposure	Isolation of fungi, %	Seed germination, %	Free fatty acids (as oleic), %	Weather during 2 weeks prior to sampling[a]			
				Temp (C)			
				Max	Min	Mean	Total rainfall (cm)
Midville							
0	11 a[b]	73 a	0.85 a	31.8	18.2	25.0	0.00
2	54 b	59 ab	1.00 a	26.7	15.2	20.9	7.54
4	99 c	47 b	5.85 b	25.4	16.9	21.2	6.35
6	98 c	48 b	6.75 b	21.2	5.4	13.3	0.84
Athens							
0	13 a	59 a	1.10 a	28.8	14.7	21.8	0.64
2	64 b	76 b	1.15 ab	23.8	14.1	18.9	6.35
4	97 c	77 b	1.42 ab	23.0	12.5	18.0	5.92
6	87 c	73 b	1.58 b	18.8	5.8	12.3	0.69

[a]Temperature and rainfall for 0 days' exposure are for 1 week prior to boll opening.
[b]Column means followed by a different letter are significantly different according to Duncan's multiple range test ($P = .01$).

commercial seed-testing laboratory analyzed FFA content in seed oil as oleic acid.

Isolations were made from 200 seed/replication. The seed were surface-sterilized in an aqueous solution of 0.525% sodium hypochlorite and 5% ethanol for 2 min, drained, and placed on 2% water agar in petri dishes. Samples were maintained at room temperature (23 to 28 C) and observed after 5 days. Twenty five per cent of the isolates were transferred to potato-dextrose agar for identification.

RESULTS AND DISCUSSION.—At both locations, fungal invasion of seed increased with longer periods of field exposure, reaching a maximum after 4 weeks (Table 1). The increase in seed infection by 84 to 88% in the 2- and 4-week samples was associated with abundant rainfall during the exposure period. Lack of moisture and low temperatures apparently minimized embryo infection and seed deterioration during the last 2 weeks of exposure.

Fungi isolated most frequently at both locations were *Alternaria alternata* (Fr.) /Keissler, *Diplodia gossypina* Cke., *Fusarium oxysporum* Schlecht., *F. roseum* Lk. emend. Snyd. & Hans., *Glomerella gossypii* Edg., and *Nigrospora sphaerica* (Sacc.) Mason.

Reduced seed germination was associated with longer field exposure only at Midville. A significant decrease in germination occurred during the first 4 weeks after boll opening following periods of excessive rainfall. At Athens, seed germination was significantly lower at boll opening, but remained high during the remainder of the study. The effect of dormancy, usually associated with seed of freshly dehisced bolls (3), may have been involved in the lower germination in the initial sample.

Free fatty acid content of the seed increased with longer field exposure at both locations. The greatest increase occurred at Midville during the first 4 weeks, when maximum rainfall was also recorded. At Athens, FFA accumulated at a slower rate and reached a level significantly different from the initial content only after 6 weeks' exposure.

Although rainfall patterns and fungal invasion were similar at both locations, seed exposed at Midville deteriorated at a much faster rate than those at Athens. The variation in seed deterioration may have been influenced somewhat by temperature differences. During the period of maximum seed deterioration, the mean temperature was 2 to 3.2 C higher at Midville that at Athens; and consequently, could have accelerated autocatalytic conversion of stored compounds in seed at the warmer location. Cooler temperatures may have also retarded the degree of seed colonization. Our studies (S. M. McCarter & R. W. Roncadori, *unpublished data*) have shown 30 C as an optimum for vegetative growth and spore germination of *D. gossypina*, *F. oxysporum*, *F. roseum*, and *G. gossypii*, and poor response between 15 and 20 C. The possibility of less embryo infection in the Athens samples should be considered, since seed germination and FFA were not greatly affected. Roncadori et al. (2) have shown that reduced seed viability and high FFA content are correlated with embryo infection.

Since fungal invasion and seed deterioration are associated with unfavorable environmental conditions in the field, the problem may be minimized by harvesting as soon as is feasible after boll opening. Our study indicates that the Piedmont is a more favorable seed-producing area than is the Coastal Plain in Georgia, due to environmental differences.

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