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Effects of Seed Density on Stand, Verticillium Wilt, and Seed and Fiber Characters of Cotton[1]

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ABSTRACT

Rapid germination and emergence and vigorous seedling growth enhance the opportunities for profitable production of cotton (*Gossypium hirsutum* L.). Within a seed lot, the heavier, more dense seed are most likely to exhibit these traits. In 1976, acid-delinted, gravity-graded seed of 'Paymaster 909' and 'Tamcot SP37' were separated into four density classes by a liquid separation process. These classes were: D1 = very low density (floaters); D2 = low density; D3 = medium density; and D4 = high density. Seed with cracked coats were included in the D4 class. Commercially gravity-graded (DG) seed of each cultivar were used as standards. All samples were treated with carboxin-captafol {(5,6-dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide plus *cis-N*-[(1,1,2,2-tetrachloroethyl) thio]-4-cyclohexene-1,2-dicarboximide)} 2-2 F SP (2 lbs. of each fungicide as a flowable seed protectant) at 8 g/kg of seed. Enough seeds of each class were obtained to conduct tests for 2 years. The Paymaster 909 select seed were representative of the type commonly planted by area farmers. Tamcot SP37 seed were obtained from a planting of registered seed that failed to mature properly and consequently failed to meet germination requirements for certification in Texas. Seed index, germination, and stand were highest and the prevalence of Verticillium wilt (caused by *Verticillium dahliae* Kleb.) was lowest in plants from D3 seed, but plants from D2 seed performed almost as well. The poorest overall performance was shown by plants from D1 seed, whereas the performance of plants from D4 seed lots equaled or slightly exceeded that of plants from DG seed. The liquid seed-separation process may enable seed processors to isolate seed for significantly improved germination, seedling survival, and lint yield, and reduced prevalence of Verticillium wilt. The liquid separation process may be used in breeding and seed-increase programs to select high-quality planting seed for performance evaluations. The process also may be used to isolate seed of acceptable quality for planting from seed that fail to meet quality standards after commercial gravity grading. Seed index may be used to select density classes for planting seed.

Additional index words: Seedling diseases, Seed Index, Seed processing, Plant vigor, Seed quality, *Gossypium hirsutum* L., *Verticillium dahliae* Kleb.

PRODUCTION of cotton (*Gossypium hirsutum* L.) depends upon obtaining a timely stand of uniform, healthy, vigorous plants. Seed quality is important in obtaining such stands. However, uniform, high-quality cottonseed is often difficult to obtain because seed quality can be affected by numerous factors during (11) and after production.[3] Many undesirable (light, immature, or damaged) seed can be removed by gravity grading during seed processing (4). Most cottonseed grading and seed-selection devices are mechanical and do not eliminate all undesirable seed, especially cracked ones. Germination, stand, and yield have been improved by use of the larger, heavier, or more dense seed from various lots, including seed previously graded for planting (6, 10, 12). Sufficient information is not available to accurately define the relationship of planting seed quality to the resulting cotton crop (9). However, in a typical field, about 75% of the yield of cotton is produced on less than 50% of the plants and about 8% of the plants produce no fruit.[4] Also the most productive plants are the ones that emerge first (13). Poor quality and low density seeds have been associated with a high incidence of diseases (1, 4, 7). Additional information is needed on the performance of seed separated into different density fractions by liquid separation. The objectives of this study were to determine the effects of seed density in seed of differing quality on stand, prevalence of Verticillium wilt, and yield of cotton.

MATERIALS AND METHODS

Seed of the Upland cultivars 'Paymaster 909' and 'Tamcot SP37' were used in this study. The Paymaster 909 seed were obtained from a planting of certified seed and were of good quality (germination exceeded 80%). The Tamcot SP37 seed were obtained from a planting of registered seed and the crop did not mature properly. Germination of Tamcot SP37 seed was too low (60%) for certification in Texas, and the seed were discarded by the seed producer. The seed of both cultivars had been acid-delinted, gravity-graded, and fungicide-treated by a commercial seed processor. A portion of each seed lot was separated into four density classes by the liquid (water) separation (5). The density classes were D1 = very low-density seed (floaters); D2 = low-density seed; D3 = medium-density seed; and D4 = high-density seed. Seed with cracked coats were included in the D4 class. Commercially gravity-graded (DG) seeds of each cultivar were used as standards. Carboxin-captafol {(5,6-dihydro-2-methyl-1,4-oxathiin-3-carboxanilide plus *cis-N*-[(1,1,2,2-tetrachloroethyl)thio]-4-cyclohexene-1,2-dicarboximide)} 2-2 F SP (2 lbs. of each fungicide as a flowable seed protectant) was applied at 8 g/kg of seed, since most of the fungicide applied previously was washed off during separation of the seed into the density classes.

The seed index (weight, g, of 100 seed) and percentage of germination were determined for each seed class of both cultivars in the laboratory. Six replications of 100 seed of each density class and cultivar were germinated at a constant 18 C and at an alternating 20/30 C for 12 days using standard procedures. The number of healthy and diseased (fungi and bacteria) seedlings was recorded on the 7th and 12th days. Observations were made on the overall size and general appearance of the seedlings.

The field experimental design was a randomized complete block, replicated six times. The plots were 4 m wide (four rows) × 12 m long in an Amarillo loam soil (a member of the fine loamy mixed, thermic Aridic Paleustalfs). During the 2nd week of May in 1976 and 1977, the seed were planted at the rate of 11 kg/ha or 435 seed/row. The percentage of seedling emergence and survival, the incidence of Verticillium wilt caused by *Verticillium dahliae* Kleb. and lint and seed yields were recorded from the two center rows of each plot. Yield and fiber measurements were from stripper-harvested samples. Verticillium wilt is reported as the percentages of the total number of plants with foliar symptoms of the disease. Stand and wilt counts were made several times each season, but only the data that show statistically significant differences are presented.

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Table 1. Effects of seed density on seed index, germination, stand, prevalence of verticillium wilt, yield, and lint percentage in cotton cultivars in 1976 and 1977.

Seed density class	Seed index	Germination		Stand (seedling survival)		Verticillium wilt		Lint	
		18 C	20/30 C	14 days	40 days	1 Sept.	20 Sept.	Yield	Proportion
	g	%						kg/ha	%
				Paymaster 909					
D1	10.3bc*	87ab	89ab	73b	58bcd	4bc	7b	927a	19.4cd
D2	10.9a	91a	94a	81a	75a	3c	6b	967a	19.1d
D3	10.0a	91a	92a	81a	71a	3c	6b	984a	20.5abcd
D4	10.4b	87ab	89ab	72b	62b	5b	8b	937a	20.3abcd
DG	10.4b	85ab	89ab	73b	64b	4bc	8b	930a	19.5bcd
				Tamcot SP37					
D1	8.5g	66d	68d	48e	35f	12a	23a	721b	20.0bcd
D2	9.8ef	76c	75cd	64c	55cde	10a	20a	847ab	19.9bcd
D3	10.1cd	81bc	83bc	70b	59bc	8a	15ab	908a	20.8abc
D4	10.0de	69d	75cd	57d	52de	10a	19a	903a	21.5a
DG	9.7f	68d	74d	60d	51e	11a	20a	877a	20.9ab

* Means within a column followed by the same letter are not significantly different at the 0.05 level of probability according to Duncan's multiple range test.

The data were subjected to analysis of variance, and Duncan's Multiple Range Test was used to identify significant differences among treatment means. Fiber span, strength, elongation, and micronaire readings were determined for each seed density class and cultivar.

RESULTS AND DISCUSSION

Seed Index. Seed index varied significantly among the density (D) classes of each cultivar (Table 1). The seed index within each cultivar was consistently highest for D3 and lowest for D1 seed. The index of DG seed exceeded only that of D1. Theoretically, the seed index should have increased with each successive density class from D1 through D4. It did so for D1 through D4 during and immediately after the separation. The coats of most D4 seed had mechanical damage, which permitted rapid uptake of water by the seed. The water increased the apparent density of the damaged seed, and they were included in the D4 class. Seed index was determined after the seed were air dried, the loss of water from D4 seed reduced the index below that of D3. Separation of damaged seed into a single class is an advantage of liquid process since this cannot be done by gravity grading.

Germination. Germination percentages of each cultivar were the highest but not always for D3 seed than for the other classes (Table 1). Germination varied more among seed density classes in Tamcot SP37 (low quality) than in Paymaster 909 (high quality) seed. The D1 and D4 seed classes were not suitable for planting because of reduced germination and frequent mechanical damage. Actually, the germination of the D3 class of Tamcot SP37 meet certification standards (imposed at that time) in Texas. Since the D3 class represented about 55% of the Tamcot SP37 seed, liquid separation of this seed lot could have benefited the seed processor. Additional techniques must be developed to improve the economics of drying the seed and disposing of the water.

Seed of all density classes were infected with fungi and bacteria, and these organisms reduced germination. These organisms occurred most frequently in D1 and D4 seed. Also, seedlings and cotyledons were smaller and the percentage of nub-root seedlings was higher from D1 and D4 seed than from D2 and D3 seed. Apparently, many of the D1 and D4 seedlings would not emerge under field conditions or would produce weak plants with relatively low production potential (2, 13).

Stand. Seedlings emerged more slowly from D1 and D4 seed than from the other seed classes. These responses are reflected in stand counts 14 and 40 days after planting (Table 1). The significant ($P = 0.01$) coefficient of correlation ($r = 0.965$) for stands at 14 and 40 days indicated that most damping-off occurred before seedling emergence. Within each cultivar, stands were similar for D2 and D3 seed classes, except in 14-day survival in Tamcot SP37. The higher plant stand in Paymaster 909 than in Tamcot SP37 for each respective seed class was attributed to the higher quality of Paymaster 909 seed. The genetic potential of Tamcot SP37 for production of acceptable plant stands (3) was not observed because of the lack of proper seed development.

Verticillium Wilt. The prevalence of Verticillium wilt varied slightly among the seed density classes for each cultivar (Table 1). The prevalence of foliar disease symptoms was lowest for the D2 and D3 seed classes. The coefficient of correlation ($r = -0.865$) between plant stand and prevalence of Verticillium wilt was negative and was significant ($P = 0.01$). Low plant populations have been related to a high prevalence of this disease (8).

The difference in prevalence of Verticillium wilt in Tamcot SP37 and in Paymaster 909 was related to the genetical susceptibility level of the cultivars. Reduced seed quality may have predisposed Tamcot SP37 seedlings to infection by *V. dahliae* and increased the disease.

Agronomic Properties. Lint yield varied among the seed classes of each cultivar, but differences were significant only for Tamcot SP37 (Table 1). Lint yields of Tamcot SP37 were 21% lower in plants from D1 than in those from D3 seed, but the latter seed class produced about 4% more lint than the DG seed. Paymaster 909 plants from the D3 seed produced about 6% more lint than those from either D1 or DG seed.

Lint percentage from stripper-harvested samples differed significantly among the seed classes within Tamcot SP37 but not within Paymaster 909 (Table 1). Prevalence of Verticillium wilt and seed density can both affect lint percentage. It was impossible to determine which factor had the most effect.

Fiber span length (2.5 and 50%), strength (T_1), and micronaire readings were not affected by seed densities but were representative of each cultivar (data not shown).

Fiber elongation (E_1) differed among seed density classes (data not shown). The E_1 values were indirectly related to seed density with Paymaster 909, but were directly related with Tamcot SP37. Additional tests are needed to evaluate the effects of seed density on fiber quality.

CONCLUSIONS

A major consideration of the seed producer should be the production of high quality planting seed. Seed should be harvested, ginned, processed, and stored in a manner to preserve its quality. Liquid grading of seed could be used to eliminate nondesirable cottonseed from seed lots after delinting but before treating with pesticides. This technique may be best suited for breeders' seed but can also be used to improve low-quality commercial seed. Our data show that liquid separation cannot be substituted for the use of only high-quality seed. Nevertheless, the technique may be used to advantage during years when the environment adversely affects seed quality and adequate supplies of high-quality planting seed are not available.

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