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Field Performance of Cotton Grown from Filled and Partially Filled Seeds[1]

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ABSTRACT

The influence of seed fullness (degree to which kernels fill the space within the seed coat) upon emergence, vigor, maturity, and yield of cotton (*Gossypium hirsutum* L.) was studied under field conditions in 1971. Each of four lots of 'Acala SJ-1' cottonseed, was sorted by X-ray inspection into three classes: check (or unsorted), full, and partially filled seed.

Plants from filled seeds were superior to those from partially filled seeds for all emergence and vigor measurements. Plants from the filled class were also superior to those of the check seeds for vigor as measured by dry weight accumulation during 8 weeks of seedling growth.

An earlier-maturing cotton was produced from plants grown from filled seeds as measured by blooming rate and by first picking weights.

The four lots of seeds differed significantly for emergence rate and final number of plants, but no significant differences among lots could be detected for seedling vigor and maturity. No significant lot × class interactions were found.

No significant differences for final yield were detected, but in each of the four lots the mean yields were highest for the full seed class.

A general advantage in emergence, seedling vigor, and crop maturity was indicated for the full seed. Thus, cotton planting seeds that are completely filled should be desirable for obtaining and maintaining a stand of healthy seedlings and for earlier fruit production.

Additional key words: Seed classes, Seed lots, Emergence, Seedling vigor, Maturity, Blooming rate, Seed cotton yield.

A NUMBER of cotton (*Gossypium hirsutum* L.) workers have attempted to determine how certain seed factors affect germination and emergence (1, 2, 3, 4, 5, 10). In recent years some researchers have studied the relationship of seed qualities to the germination and emergence of cotton seedlings. The effect of early seedling development upon growth, maturity, and yield has also been studied (7, 8, 9, 11).

We recently reported that the degree to which kernels fill the space within the seed coat influenced emergence and seedling vigor in tests conducted in climate control chambers (6).

Our purpose in this phase of cottonseed quality research was to determine if similar responses occurred under field conditions, and also to ascertain the effects of seed fullness upon crop maturity and yield.

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MATERIALS AND METHODS

Four samples, or lots, of 1970-grown 'Acala SJ-1' planting seeds were obtained from the California Planting Cotton Seed Distributors for this 1971 study. These four lots of fuzzy seeds were secured from the same processing plant at four weekly intervals during the peak period of seed processing. Data obtained by the distributors indicate that the official germination percentages of these lots were 94, 86, 93, and 90%. The partially filled seed content was 14, 13, 9, and 17%, respectively, as determined by the X-ray method of Ferguson and Turner (6).

After acid delinting, three classes for each seed lot were established as follows: (i) Check, a portion of seed kept as received; (ii) Full, the seeds that sank when placed in a soda-water solution (50 g bicarbonate of soda to 500 ml of water); and (iii) Partial, the seeds that floated in the solution. This provided 12 entries for the 1971 experiment. An X-ray was made of each sample to determine the accuracy of the separation between "full" and "partial." Figure 1 shows the differences between the three classes for one of the lots. A portion of each sample was planted in a four-replicate test in greenhouse flats to determine emergence differences under favorable germination conditions.

A split-plot design with 10 replicates of the 12 entries was used for the field experiment with lots making up the main plots and classes assigned to subplots. Each of the 120 subplots consisted of four 17.3-m rows. Approximately 21 seeds per m of row were planted March 25, in Hesperia sandy loam soil at Shafter, Calif.

The rate of seedling emergence, mean emergence period, was obtained by daily counts at 10 AM throughout the 14 days after planting.

The vigor of seedlings was measured by obtaining the dry weight of the aerial parts of 40 randomly chosen seedlings per plot. This measurement of vigor was taken on May 6 and June 4.

The number of plants per unit area can greatly influence cotton plant performance during the fruiting stage. It was evident that a sufficient population for optimum yield was present in the partial class plots. Hence, all plots in five replications were hand thinned on May 7 to a plant stand equal to the number of plants per meter of row that was shown for the "partial" class within the same main plot. All measurements for bloom rate and yield came from the five thinned replicates, but emergence and vigor data represent 10 replicates.

Blooming rate in cotton is often used as a measure of earliness, but daily rates fluctuate considerably. Therefore, we used two 4-day periods to determine the rate of fruiting: early season, July 5-8; and midseason, July 18-21. The white blooms were counted daily during these periods from 13 m of row within each plot of the five thinned replications.

Crop maturity differences for cotton are usually measured by the amount of seed cotton harvested at an early date. Each of the plots in the five thinned replications was hand picked on September 22. The final harvest was made on November 12. The area in the center two rows that was used for bloom measurements was also used for these two hand pickings.

RESULTS AND DISCUSSION

Emergence

That germination percentage from laboratory tests is inadequate for estimating seedling emergence from soil was clearly demonstrated by the results of our greenhouse test. Even under optimum temperature and soil conditions a range of 66 to 80% emergence was obtained for the checks (Table 1). This is 6 to 24% lower than the official germination of the same lots.

All three measures of seedling emergence (Tables 1, A, B, and C) indicate that significant differences existed between the four lots and also between the three classes of seeds. No significant interactions were detected. Lot 4 was consistently inferior to the other lots for all three measurements. Also, the partially filled seeds were inferior to full seeds for all seedling emergence measures. The rate of emergence and the final emergence obtained in this field experiment

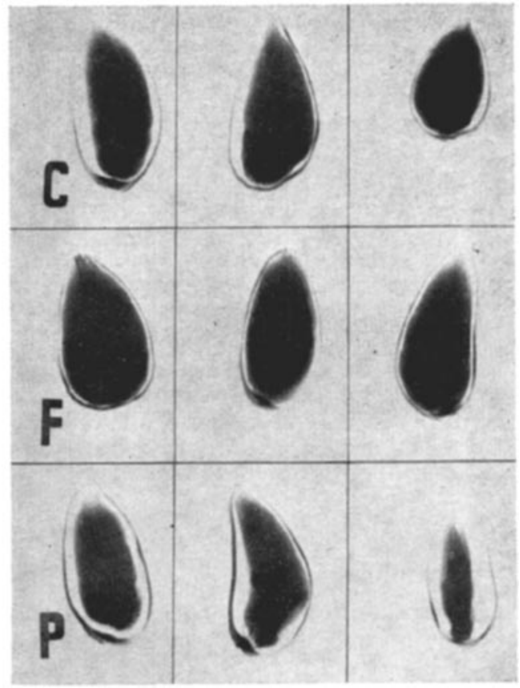

Fig. 1. X-ray photo of (C) check, (F) full, and (P) partial classes of seed filling.

Table 1. Mean values for emergence measurements for three classes of four lots of cotton seed.

Seed class	Seed lot 1	2	3	4	Class $\bar{x}$
	A — % of seed emerged in greenhouse flats				
Check	75	80	74	66	73.7 b*
Full	80	92	80	77	82.2 a
Partial	59	54	45	41	49.7 c
Lot $\bar{x}$	71.3 b*	75.3 a	66.3 c	61.3 d	
	B — Number of plants/m to emerge in field				
Check	10.4	10.5	10.3	10.0	10.30 a
Full	10.9	10.7	10.4	11.4	10.85 a
Partial	8.6	8.3	7.4	4.9	7.30 b
Lot $\bar{x}$	9.97 a	9.83 a	9.37 a	8.77 b	
	C — Mean emergency period, days**				
Check	10.03	10.33	10.12	10.84	10.33 b
Full	9.89	10.32	10.13	10.83	10.39 b
Partial	10.63	10.93	10.73	11.15	10.86 a
Lot $\bar{x}$	10.18 c	10.53 b	10.33 c	10.94 a	

* Means with a letter in common not significantly different at the 5% level according to Duncan's Multiple Range Test.

** $\text{M.E.P.} = \dfrac{\text{Sum of daily emergence} \times \text{days since planting}}{\text{total emergence}}$

closely parallel our previous data from *climate control chambers* (6). These data indicated that only small differences existed in the rate of emergence between full and partial seed classes, but an appreciable gain in favor of well-filled seeds was shown for final emergence. This confirmed the emergence results previously gained from climate control chambers, (6) which was especially gratifying since the 1971 temperatures prevalent during the 2-week emerging period were most favorable (12 of the 14 days gave temperatures in excess of our 49-year average for the same dates). The diurnal fluctuation for soil temperature at seed level was from 17 to 21 C.

Seedling Vigor

The term *seedling*, as used in this study, refers to the cotton plant from emergence to the appearance of the first floral bud (square), and covered a period of 8 weeks (April 8 to June 4). In contrast to the emergence period, the 8-week period of seedling growth was characterized by adverse temperatures. For 47 of the 56 days mean temperatures were below the 49-year daily averages.

Dry weights (Table 2A) clearly reveal the meager shoot growth made during the first 4 weeks after emergence. No significant differences were found between the four lots, but plants from the full and the check classes were significantly heavier than those from the partially filled seed class. An increased rate of growth took place in the second 4 weeks (Table 2B), but no significance could be detected between the four lots of seed. The full class, however, had produced plants that were heavier than those produced from either of the other two classes of seed.

At the time final dry weights were being obtained it was evident that the height of plants was more variable in the "partial" than in the "full" class, so we counted the total plants and the weak or stunted plants in the two center rows and determined the percentage of stunted plants. The results (Table 2C) indicate that a significantly higher percent of healthier plants was present in the full seed class plots at first square stage.

Maturity and Yield

Blooming rates of plants from the four seed lots were not significantly different for either period of bloom (Table 3A and B). Plants from the partial class of seed, however, showed a significantly lower bloom rate at both periods than the other two classes.

Lygus and other insects attacked the plants about July 4 and many young squares that would have reached bloom stage from July 15 to July 30 were shed. Hence, the total daily blooming was much below normal for the last half of July. After the insects were controlled, bloom rate and boll retention were excellent during the period from August 1 to 15.

Earlier maturity of plants from the full seed class was indicated, as they produced significantly more kg/ha of seed cotton on September 22 than did plants from the partial class (Table 3C). The analysis of final yields failed to detect any significant differences between the lots or classes, even though the full seeds produced the most cotton (Table 3D). A frost occurred on October 25. This caused some yield loss, but a differential effect on yield from the various classes and lots was not observed.

Based on the results discussed above, we are convinced that partially filled seeds are inferior to full seeds for obtaining and maintaining a stand of healthy plants. The inferior performance in the early stages undoubtedly contributed to the reduced rate of blooms in July and hence to the reduced yield at first harvest.

The more critical question, however, is how much benefit could be derived from planting seed that has been sorted as "full" rather than using standard (check) seed that contains from 7 to 20% partially filled seeds. The differences reported herein were not statistically significant in some cases. The mean values for "full" seeds, however, were better than the "check" in every measurement and trials in other years and locations may reveal a real difference.

Table 2. Mean values for seedling vigor measurements of three classes from four lots of cotton seed.

Seed class	Seed lot 1	2	3	4	Class $\bar{x}$
	A — Dry weight per plant, grams, May 6				
Check	.176	.192	.182	.182	.183 a*
Full	.190	.194	.186	.175	.186 a
Partial	.154	.161	.146	.155	.154 b
Lot $\bar{x}$	.173 a*	.182 a	.171 a	.171 a	
	B — Dry weight per plant, grams, June 4				
Check	1.19	1.13	1.18	1.13	1.16 b
Full	1.32	1.24	1.28	1.27	1.28 a
Partial	1.11	1.06	1.06	1.14	1.09 c
Lot $\bar{x}$	1.21 a	1.14 a	1.17 a	1.18 a	
	C — Percentage of stunted plants				
Check	11.4	11.5	11.0	13.0	11.7 b
Full	5.0	4.0	5.0	5.1	4.8 c
Partial	17.5	16.7	18.8	22.3	18.8 a
Lot $\bar{x}$	11.3 a	10.7 a	11.6 a	13.5 a	

* Means with a letter in common not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Table 3. Mean values for blooming rate, maturity and yield measurements for three classes of four lots of cotton seed.

Seed class	Seed lot 1	2	3	4	Class $\bar{x}$
	A — Blooms/m 7/5-7/8				
Check	2.69	2.64	2.82	2.60	2.69 a*
Full	3.19	2.58	3.23	2.88	2.97 a
Partial	1.98	2.32	2.33	1.83	2.14 b
Lot $\bar{x}$	2.62 a*	2.51 a	2.79 a	2.44 a	
	B — Blooms/m 7/18-7/21				
Check	5.28	6.23	6.62	5.51	5.91 a
Full	6.24	6.76	6.28	6.62	6.48 a
Partial	4.61	4.56	3.78	4.17	4.28 b
Lot $\bar{x}$	5.38 a	5.85 a	5.56 a	5.43 a	
	C — Yield - seed cotton kg/ha 9/22				
Check	956	1,050	999	946	988 a
Full	1,146	1,113	1,045	1,059	1,091 a
Partial	996	806	670	782	813 b
Lot $\bar{x}$	1,033 a	989 a	905 a	929 a	
	D — Total yield, Seed cotton kg/ha				
Check	2,897	2,912	2,760	2,744	2,828 a
Full	2,988	2,867	3,108	2,896	2,965 a
Partial	2,978	2,786	2,665	2,867	2,824 a
Lot $\bar{x}$	2,954 a	2,855 a	2,844 a	2,835 a	

* Means with a letter in common not significantly different at the 5% level, according to Duncan's Multiple Range Test.

The differences in emergence between the four seed lots failed to continue into the seedling stage. This indicates that differences commonly observed during the planting season between lots of Acala SJ-1 seed planted in this valley are not important if sufficient seedlings are obtained so that replanting is not necessary.

Results from this study and previous studies indicate the need for the exploration of environmental and genetic factors that are associated with seed filling and processors and engineers should continue their search for a practical means of removing unfilled cotton seeds at the time of processing.

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