Published September, 1977

Seed Setting Efficiency in Eight Cultivars of Upland Cotton[1]

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ABSTRACT

Seed setting efficiency was determined for six cultivars of Upland cotton (*Gossypium hirsutum* L.) in 1974 and eight cultivars in 1975 at Jackson, Tenn. The number of ovules per ovary was determined by examining blooms at weekly periods. Simultaneously tagged blooms provided identifiable bolls from each bloom period to determine the number of seeds per boll. Seed setting efficiency (S.S.E.) was calculated from: (seeds/boll ÷ ovules/ovary) in percent.

Cultivars differed in ovules/ovary, seeds/boll, and S.S.E. both years. The influence of bloom periods, although significant for ovules/ovary both years, was less than cultivar influence. S.S.E. was also influenced by bloom period in 1974, with lower efficiency at the late bloom period. Cultivar × period interactions were detected for ovules/ovary and seeds/boll in 1974 and for ovules/ovary in 1975.

The combined analysis with six of the cultivars show that cultivars influenced ovules/ovary and seeds/boll far more than years or period of bloom. Year × cultivar and year × period interactions obscured the main effects upon seed setting efficiency.

Additional index words: **Ovules/ovary, Seeds/boll, Motes, Breeding centers, *Gossypium hirsutum* L.**

SEED production in Upland cotton (*Gossypium hirsutum* L.) has commanded only secondary attention by investigators. The current interest in protein sources, however, is stimulating research on several aspects of cottonseed.

In 1973 we made calculations at Knoxville, Tenn. from Regional Cotton Variety Test reports (14) that revealed the Jackson, Tenn. test generally produced more seeds/boll than other locations. Furthermore, we found that a group of diverse genotypes being grown at Jackson, Tenn. ranged from 30 to 45 seeds per boll. Therefore, we raised the question whether these differences were due to a seed setting differential or in the number of initial ovules, or both.

Rea (15) conducted a 2-year study of 16 cotton cultivars in the 1920's and found the 'mote' (aborted ovule) content varied from 14 to 47%. Seasons accounted for much of this variation, with the high percent of motes coming from the dry years. Pearson (13), in studies of seed cotton samples from cultivar tests at eight locations for 3 years, not only counted motes but classified them according to size and amount of

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Table 1. Ovule production and seed set over five periods of bloom for six cultivars, 1974.

Cultivar	Bloom period 1	2	3	4	5	Cultivar mean
Acala P18C						
Ovules/ovary (no.)	40.5	41.6	43.2	44.4	45.6	43.1
Seeds/boll (no.)	29.2	37.5	36.2	36.8	36.6	35.3
Seed set. efficiency (%)	72.1	90.1	83.8	82.9	80.3	81.8
PD 9223						
Ovules/ovary (no.)	29.6	31.7	31.9	32.1	32.9	31.6
Seeds/boll (no.)	28.1	28.4	29.0	28.1	29.2	28.6
Seed set. efficiency (%)	94.9	89.6	90.9	87.5	88.7	90.3
Dixie King 3						
Ovules/ovary (no.)	36.6	35.7	40.8	37.7	39.4	38.0
Seeds/boll (no.)	35.7	34.6	37.7	35.2	36.1	35.9
Seed set. efficiency (%)	97.5	96.9	92.4	93.4	91.6	94.4
Delcot 277						
Ovules/ovary (no.)	38.0	37.7	41.1	36.9	38.3	38.4
Seeds/boll (no.)	35.7	34.2	35.5	32.4	35.5	34.7
Seed set. efficiency (%)	93.9	90.7	86.4	87.8	92.7	90.3
Stoneville 213						
Ovules/ovary (no.)	34.9	34.8	34.7	34.5	36.0	35.0
Seeds/boll (no.)	32.5	32.2	34.2	31.8	32.0	32.5
Seed set. efficiency (%)	93.1	92.5	98.6	92.2	88.9	93.1
Coker 310						
Ovules/ovary (no.)	35.4	37.4	39.0	39.5	41.4	38.5
Seeds/boll (no.)	32.5	33.1	35.6	34.0	34.6	34.0
Seed set. efficiency (%)	91.8	88.5	91.3	86.1	83.6	88.3
Period Mean						
Ovules/ovary (no.)	35.8	36.5	38.4	37.5	38.9	
Seeds/boll (no.)	32.3	33.3	34.7	33.0	34.0	
Seed set. efficiency (%)	90.5	91.4	90.6	88.3	87.6	

L.S.D. 0.05	Cultivars	Periods	CXP
Ovules/ovary (no.)	3.0	2.1	6.1
Seeds/boll (no.)	2.7	N.S.	5.2
Seed set. efficiency (%)	5.4	2.9	N.S.

Table 2. Ovule production and seed set over five periods of bloom for eight cultivars, 1975.

Cultivar	Bloom period 1	2	3	4	5	Cultivar mean
Acala P18C						
Ovules/ovary (no.)	37.2	37.6	40.9	38.6	43.4	39.5
Seeds/boll (no.)	35.4	35.1	37.9	36.9	38.3	36.7
Seed set. efficiency (%)	95.2	93.3	92.7	95.6	88.2	93.0
PD 9223						
Ovules/ovary (no.)	30.9	32.0	34.1	32.4	33.5	32.6
Seeds/boll (no.)	26.7	27.9	32.0	30.3	31.1	29.6
Seed set. efficiency (%)	86.4	87.2	93.8	93.5	92.8	90.7
Dixie King 3						
Ovules/ovary (no.)	40.0	41.3	43.2	41.3	40.3	41.2
Seeds/boll (no.)	36.6	37.1	40.8	38.1	38.4	38.2
Seed set. efficiency (%)	91.5	89.8	94.4	92.2	95.3	92.6
Delcot 277						
Ovules/ovary (no.)	38.1	37.5	40.2	39.5	40.7	39.2
Seeds/boll (no.)	32.9	36.1	37.9	34.6	39.8	36.3
Seed set. efficiency (%)	86.3	96.3	94.3	87.6	97.8	92.5
Stoneville 213						
Ovules/ovary (no.)	35.7	36.2	37.4	36.0	37.3	36.5
Seeds/boll (no.)	33.7	33.7	33.5	34.3	33.9	33.8
Seed set. efficiency (%)	94.4	93.1	89.6	95.3	90.9	92.6
Coker 310						
Ovules/ovary (no.)	36.6	39.0	40.2	39.6	40.9	39.3
Seeds/boll (no.)	33.1	33.6	36.2	35.3	37.6	35.2
Seed set. efficiency (%)	90.4	86.1	90.0	89.1	91.9	89.6
Br 12						
Ovules/ovary (no.)	38.0	37.0	38.1	39.9	40.1	38.6
Seeds/boll (no.)	31.5	33.1	33.5	34.5	36.1	33.7
Seed set. efficiency (%)	82.9	89.4	87.9	86.5	90.0	87.3
Paymaster 909						
Ovules/ovary (no.)	41.3	42.1	43.2	43.9	44.5	43.0
Seeds/boll (no.)	37.5	37.6	38.8	37.6	38.8	38.1
Seed set. efficiency	90.8	89.3	89.8	85.6	87.2	88.6
Period Mean						
Ovules/ovary (no.)	37.3	37.8	39.7	38.9	40.1	
Seeds/boll (no.)	33.4	34.3	36.3	35.2	36.7	
Seed set. efficiency (%)	89.5	90.7	91.4	90.5	91.5	

L.S.D. 0.05	Cultivars	Periods	CXP
Ovules/ovary (no.)	2.7	2.5	2.8
Seeds/boll (no.)	2.8	1.8	N.S.
Seed set. efficiency (%)	4.9	N.S.	N.S.

Table 3. Mean squares for three cottonseed traits.

Source	d.f.	Ovules/ovary	Seeds/boll	S.S.E.
Years	1	18	68**	0.9
Cultivars	5	338**	248**	1.3
Y X C	5	34**	2	2.0*
Periods	4	60**	60**	0.2
Y X P	4	1	9*	0.8*
C X P	20	6*	6	0.4
Y X C X P	20	3	5	0.4
Error	120	3	4	0.3

*,** Significant at 5% and 1% probability levels, respectively.

fiber attached. The variance in her data attributable to environmental factors was far greater than that caused by cultivars.

Seed setting ability (fertility) has received more attention in other crop plants. Kao et al. (5) found that neither selection for increasing or reducing fertility was successful in barley (*Hordeum vulgare* L.). Busbice et al. (2) were, however, successful in selection for self-fertility and self-sterility in alfalfa (*Medicago sativa* L.). Aage and Davis (1) found that ovule number in peas (*Pisum sativum* L.) was controlled by a simple additive genetic system.

Neilson and Kalton (12), evaluating top-cross progenies of bromegrass (*Bromus inermis* Leyss.) for combining ability, found fertility to range from 44.3 to 74.8%. Lowe and Murphy (8), however, reported a range from 2.8 to 75.8 fertility with self-sterile clones of smooth bromegrass. Environmental influences were of minor consequence. In tetraploid ryegrass (*Lolium perenne* L.), Wit (17) showed that fertility ranged from 47.5 to 58.9%. Miller and Schonhorst (11), using two clones of alfalfa and their F_1, S_1, and S_2 progenies, found self-fertility of the F_1 plants to be 52.25%, and the clones were 27.10 and 22.48% self-fertile. Lin and Peterson (7) reported sterility in 296 rice (*Oryza sativa* L.) breeding lines, ranging from 3.6 to 96.8%.

In more recent work with cotton, Walhood and McMeans (16) showed that there is a minimum number of seed/boll required to assure boll retention in cotton. Kohel (6), using various methods of pollen application to cotton flowers, found that increased floral manipulation caused a reduction in number of seeds set per boll. McKenzie (9) made ovule counts in a study of progenies from a *G. hirsutum* - *G. barbadense* L. cross. He found that three out of four hybrid families possessed a greater number of fertilized ovules per ovary than parent strains. The hybrid families, however, made less efficient use of their potential. Unfortunately, for our comparison at least, he used Hopi monecopi as his *G. hirsutum* parent (a non-commercial type) that has only 18 to 20 ovules per ovary.

The purpose of this study was to determine the seed setting efficiency over five periods of bloom at Jackson, Tenn. for several cotton cultivars that vary widely for seeds/boll and crop maturity.

MATERIALS AND METHODS

In 1974, six cultivars of diverse origin that had previously exhibited a wide range in number of seeds/boll were grown at Jackson, Tenn. The cultivars were 'Acala P18C', 'PD 9223', 'Dixie King 3', 'Delcot 277', 'Stoneville 213', and 'Coker 310'. Two additional cultivars, 'Paymaster 909' and 'Br 12' were included in the 2nd year's test (1975). Three replicates were grown in

1974 and four replicates in 1975. Individual plots consisted of four rows 1 m wide and 10 m long. Plantings were made on 14 May both years.

Beginning 23 July (approximately 10 days after the earliest blooms) 10 random blooms from each plot were examined to determine the number of ovules present. On the same day dated tags were attached to randomly chosen blooms in each plot. This procedure was repeated weekly for five periods. At harvest 10 tagged bolls from each plot were plucked for each of the five bloom periods. The seed cotton was hand-picked in the laboratory, at which time the number of seed for each boll was counted. No yields were obtained from the plots. Neither were we concerned with boll size or locks per boll in this test.

The analysis of variance for each year and a combined analysis for the 2-year study was computed for ovules/ovary, seeds/boll, and seed setting efficiency in percent (S.S.E. = seeds/boll ÷ ovules/ovary) at the University of Tennessee Computer Center.

RESULTS AND DISCUSSION

1974 Season. The six cultivars differed in S.S.E., ovules/ovary and seeds/boll, as shown by the mean values in Table 1. S.S.E. was significantly lower for Acala P18C than that for the other cultivars. The ovule counts indicated Acala P18C had the highest potential for seed production, with PD 9223 having the lowest potential. Mature seed counts, however, revealed no significant difference in seeds/boll between Acala P18C, Dixie King 3, Delcot 277, or Coker 310. Stoneville 213 had fewer seeds/boll than Acala P18C and PD 9223 had fewer mature seed than any of the cultivars.

A general trend was shown for increased ovules/ovary as the season progressed, with the third and fifth bloom periods being significantly higher than the first period. No significant differences were detected for seeds/boll over the five bloom periods. This resulted from the significant loss in S.S.E. for the last period.

The cultivar × period interaction was significant for ovules/ovary and for seeds/boll. For ovule production, the differential response was most distinct between Acala P18C and two Delta region cultivars, Delcot 277 and Dixie King 3. Acala P18C increased in ovules/ovary as the season progressed, but a reduction was shown by Delcot 277 and Dixie King 3 the last two periods. The differential response for seeds/boll was even more noticeable in that Acala P18C was much lower in seed produced from the first period but fully equal to Delcot 277 and Dixie King 3 in the last two periods.

1975 Season. The cultivars differed in S.S.E. but not to the extent shown the previous season (Table 2). Br 12 (87.3% S.S.E.) was significantly lower than four of the cultivars, while Acala P18C had the highest efficiency (93.0% S.S.E.). Even with two additional cultivars in 1975 the range in ovules/ovary was not widened. Paymaster 909 had an average of 43.0 ovules/ovary, significantly more than all cultivars except Dixie King 3. PD 9223 was again the lowest (32.6) in ovule production of the entries. Paymaster 909 was higher also in the number of seed to mature than Br 12, Coker 310, Stoneville 213, and PD 9223.

The bloom periods differed for ovules/ovary and seeds/boll in much the same fashion as in 1974. Ovule counts were significantly higher for the fifth bloom period (40.1) than that for the first period (37.3). More seeds/boll were produced for the last three bloom periods than for the first period. S.S.E. was not changed significantly across the five periods of bloom in 1975. All periods were relatively high, ranging from 89.5 to 91.5%.

Data for the six cultivars that were tested both years were used in a combined analysis. Pertinent mean square values are given in Table 3. Cultivars exerted the major influence upon both ovule and seed production with periods and years also having significant influence. Interactions played a minor role, with a significant year × cultivar effect upon ovules/ovary and a small year × period effect upon seeds/boll.

No significance could be assigned to the main effects upon S.S.E., but significant interactions were shown for year × cultivar and for year × period. Probably the erratic setting efficiency of Acala P18C accounted largely for these interactions.

Considering the two most diverse genotypes among these cultivars (Acala P18C and PD 9223), it appears that both the number of ovules formed and the S.S.E. are worthy of breeders' attention. Harrell and Culp (3), the developers of PD 9223, have recognized a need to increase seeds/boll to improve yield in their breeding lines. As early as 1926, Kearney (4) noted the number of seeds/boll of 'Pima' (*G. barbadense* L.) was positively correlated with yield. In recent studies, however, Meredith and Bridge (10) found with four diverse genotypes that the highest yielding genotype produced the lowest number of seeds/boll. It may well be that in some breeding programs (or ecological regions) an increase in seeds/boll would be beneficial, while others might be deleterious.

Primarily, this study reveals the importance of ovule number to seed production and that genetic differences exist for ovules/ovary, which are altered to some extent by environmental conditions (seasons and periods of bloom). Screening of germplasm for ovules/ovary and setting efficiency at several breeding centers would provide breeders with useful information and could contribute substantially to more effective utilization of yield models, such as proposed by Worley et al. (18, 19).

ACKNOWLEDGMENT

We wish to express our appreciation to Janet Wilson for the care exercised in counting ovules and mature seed. Also a special thanks to Nellie Acres (statistical clerk, ARS, Knoxville) for organizing and programming the data for computation.

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