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Inheritance of the Ability of Cotton Seeds to Germinate at Low Temperature in the First Hybrid Generation[1]

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DIFFERENCES in the ability of cotton seeds of some varieties to germinate at low temperatures were reported by several authors (2, 3, 4). Ludwig (3) also found marked individual variation within each variety, but did not determine whether it was genetical or environmental.

Germination at low temperatures enables earlier sowing in temperate regions. Therefore, attempts should be made to include it in breeding programs. However, its mode of inheritance is still unknown. An attempt to study the inheritance of this property in the F_1 is herein reported.

MATERIALS AND METHODS

According to results of a preliminary experiment (4), the following crosses were made:

(1) Giza 7 × Acala 1517C
(2) Pima 32 × Acala 1517C
(3) Giza 7 × Coker 100A
(4) Pima 32 × Coker 100A
(5) Giza 7 × Malaki
(6) N.C. 58 × Acala 1517C

The first listed parent in each cross germinated better at low temperature than the second one. In the first four crossing combinations, a naked-seeded variety of *Gossypium barbadense* was crossed with a fuzzy-seeded variety of *G. hirsutum*. The fifth crossing combination is between naked-seeded varieties of *G. barbadense,* and the sixth between fuzzy-seeded varieties of *G. hirsutum*.

The crosses were made reciprocally in the summer of 1959. Selfed seeds of each parent were obtained from the same plants used for crossing. Thus selfed and cross-pollinated seeds were matured and harvested under nearly identical conditions. The seeds were ginned by an 8″ roller-gin and treated with "Agrosan GN" fungicide.

The selfed and cross-pollinated seeds were tested in two experiments. In Experiment I the seeds were held at 12° C. for 21 days, and after that the temperature was raised to 13° C. A randomized blocks design with 6 replicates of 50 seeds was used. In Experiment II the seeds were held at 14° C., the design being randomized blocks with 4 replicates of 50 seeds. In both experiments the seeds were germinated in rolled flannel-cloth in a refrigerating incubator. Temperature fluctuations were smalled than ±1° C.

Another sample of 200 seeds from each cross or parent was germinated for 12 days at 25° C. and served as a check. All results of experiments I and II were reported as percent of this 25° C. check germination, which ranged between 95% and 99%.

Seed germination was counted several times in each experiment and assessed by three different methods:

"A"—all seedlings showing split seedcoats and a slight elongation of rootlets were counted.

"B"—all seedlings having their cotyledons, at least partially, emerging from seedcoat were counted.

"C"—all seedlings that may be classed as "normal seedlings" according to accepted rules of seed-testing (6) were counted.

Analysis of variance was made after transforming percentage data to degrees (arc sin $\sqrt{\%}$). Significance of results was tested by the multiple range test (1).

EXPERIMENTAL RESULTS

The results of experiments I and II are presented in Tables 1, 2, and 3.

Parent varieties—The selfed seeds of the parents in all crossing combinations differed significantly from each other in their germination at 12–13° C., excepting Giza 7–Malaki and N.C. 58–Acala 1517C, which showed no significant differences when assessed by method C.

When germinated at 14° C., Giza 7 did not differ significantly from Malaki; the same was true in some counts of Pima 32 and Coker 100A, and also of N.C. 58 and Acala 1517C. The parents of all other crossing combinations differed significantly.

Giza 7 × Acala 1517C and Pima 32 × Acala 1517C—In these crosses H × L (i.e. F_1 hybrid with the higher germinating variety taken as female parent) was intermediate between the parents when germinated at 12–13° C. and assessed by method A, but nearer to Acala 1517C when assessed by methods B or C. When germination was conducted at 14° C., H × L was not significantly different from the higher germinating parent (Giza 7 or Pima 32).

L × H (i.e. F_1 hybrid with the lower germinating variety taken as female parent) did not differ significantly from Acala 1517C at 12–13° C., but was intermediate between the parents at 14° C.

A significant difference between reciprocal crosses was found in all cases (except when assessed by methods "B" and "C" at 29 days), both when germinated at 12–13° C. and at 14° C.

Table 1—Results of Experiment I (12–13° C.), counted by method A.

Parents*		Days after beginning of exper.	Germination, as percent of 25° C. check**			
H	L		H selfed	H × L	L × H	L selfed
Giza 7	Acala 1517C	29	34	[2	0	0]
		37	55	14	[0	0]
		43	58	21	[2	1]
		49	60	24	[2	1]
		53	63	24	[2	1]
Pima 32	Acala 1517C	29	30	[1	0	0]
		37	63	11	[0	0]
		43	72	23	[1	1]
		49	75	30	[2	1]
		53	79	31	[4	1]
Giza 7	Coker 100A	29	34	9	[1	1]
		37	55	25	[11	10]
		43	58	35	[15	15]
		49	[60	42]	[17	17]
		53	[63	47]	[17	17]
Pima 32	Coker 100A	29	30	14	[1	1]
		37	63	41	[9	10]
		43	72	47	[19	15]
		49	75	52	[21	17]
		53	79	57	[21	17]
Giza 7	Malaki	29	[34	19	26]	8
		37	[55	50	50]	28
		43	[58	61	57]	38
		49	[60	66	59]	41
		53	[63	71	61]	43
N.C. 58	Acala 1517C	29	0	0	0	0
		37	0	0	0	0
		43	[11	(4]	2	1)
		49	[11	(4]	2	1)
		53	[11	(4]	2	1)

* H is the higher germinating parent and L the lower one in each cross.
** Data joined by brackets or parentheses are not significantly different from each other by Duncan's multiple range test (1).

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[2] Instructor and former graduate student, respectively.

Table 2—Results of Experiment I (12–13° C.), counted by methods B and C.

Parents* H	Parents* L	Method of count	Days after beginning of exper.	Germination, as percent of 25° C. check** H (selfed)	H×L	L×H	L (selfed)
Giza 7	Acala 1517C	B	49	44	16	[0	0]
		B	53	50	16	[0	0]
		C	49	28	6	[0	0]
		C	53	28	6	[0	0]
Pima 32	Acala 1517C	B	49	54	16	[1	0]
		B	53	67	19	[1	0]
		C	49	26	6	[0	0]
		C	53	26	6	[0	0]
Giza 7	Coker 100A	B	49	44	26	[13	10]
		B	53	[50	32]	[13	10]
		C	49	28	[9	6	4]
		C	53	28	[9	7	4]
Pima 32	Coker 100A	B	49	54	38	[13	10]
		B	53	67	46	[13	10]
		C	49	[26	17]	[6	4]
		C	53	[26	20]	[6	4]
Giza 7	Malaki	B	49	[44	44	49]	30
		B	53	[50	60	49	31]
		C	49	[28	22	28	12]
		C	53	[28	26	28	12]
N.C. 58	Acala 1517C	B	49	[8	(3]	1	0)
		B	53	[8	(3]	1	0)
		C	49	[2	1	0	0]
		C	53	[2	2	0	0]

*, ** See footnotes to Table 1.

Table 3—Results of Experiment II (14° C.).

Parents* H	Parents* L	Method of count	Days after beginning of exper.	Germination, as percent of 25° C. check** H (selfed)	H×L	L×H	L (selfed)
Giza 7	Acala 1517C	B	14	[96	95]	1	60
		C	14	44	29	[12	14]
		C	17	[79	77]	46	28
		C	21	[91	90]	68	49
Pima 32	Acala 1517C	B	14	[95	93]	77	60
		C	14	[30	37]	20	14
		C	17	[70	79]	56	28
		C	21	[90	90]	70	49
Giza 7	Coker 100A	B	14	[96	99	94]	86
		C	14	[44	35	32]	13
		C	17	[79	80	71]	45
		C	21	[91	90	91]	72
Pima 32	Coker 100A	B	14	[95	98	93	86]
		C	14	[30	42	28]	13
		C	17	[70	83	76]	45
		C	21	[90	89	88]	72
Giza 7	Malaki	B	14	[96	94	97	95]
		C	14	[44	42	34	28]
		C	17	[79	79	73	69]
		C	21	[91	90	86	87]
N.C. 58	Acala 1517C	B	14	[93	90	83]	60
		C	14	[22	21	11	14]
		C	17	[55	54	(40]	28)
		C	21	[78	79	67]	49

*, ** See footnotes to Table 1.

Giza 7 × Coker 100A and Pima 32 × Coker 100A—In these crosses H × L was intermediate between the parents, when germinated at 12–13° C. and assessed by methods A, B and C. At 14° C. H × L was not significantly different from the higher germinating parent (Giza 7 or Pima 32).

L × H germinated at 12–13° C. was not significantly different from the lower germinating Coker 100A parent, but at 14° C. its germination was not significantly different from Giza 7 or Pima 32.

A significant difference between reciprocal crosses was found at 12–13 ° C. (except for Giza 7 × Coker 100A assessed by method C), but not at 14° C.

Giza 7 × Malaki—When germinated at 12–13° C. no significant difference was found between the reciprocals of this hybrid. Also, they were not significantly different from the higher germinating Giza 7 parent.

At 14° C. no significant results were obtained because of the very similar performance of both parents at this temperature.

N.C. 58 × Acala 1517C—No significant differences betwen reciprocals were found in this cross. At 12–13° C. both hybrids were much nearer to the lower germinating Acala 1517C parent when assessed by methods A and B, while no significant differences were found by method C. At 14° C. both hybrids were nearer to the higher germinating N.C. 58 parent.

DISCUSSION

Whenever a significant difference between reciprocals was found, a maternal influence was indicated. Pinnell (5) also found a strong maternal influence on the germination of corn seeds at low temperatures. He attributed differences between reciprocal crosses to differences in the nature of the endosperm, caused by the double genetic contribution from the female side. This cannot, however, explain the maternal influence in the case of cotton as the endosperm is almost completely absorbed during the development of the cotton seed.

Ludwig (3) and Gavrielit-Gelmond (2) found some indication that delinted cotton seeds germinate better at low temperatures than seeds with their fuzz on. This may explain the differences found between reciprocals when naked-seeded varieties (Giza 7, Pima 32) were crossed with fuzzy-seeded varieties (Acala 1517C, Coker 100A). In these crosses H × L seeds were, of course, without fuzz, while L × H seeds were fuzzy.

An indication of maternal influence, though not reaching statistical significance, was also found in the Giza 7 × Malaki cross, where both parents were naked-seeded, and in the N.C. 58 × Acala 1517C cross, where both parents were fuzzy-seeded. This may be explained by a possible influence of the nature of the seedcoat, which is of an entirely maternal origin, on the ability of the seeds to germinate at low temperatures.

Pinnell (5) found that the germination of corn hybrids at low temperatures exceeded that of the better parents, and explained this by an action of complementary factors. This was not found to be so in our work, as the cotton hybrids never exceeded the higher germinating parent, but in some instances almost complete dominance was indicated.

It should be pointed out that our results were strongly influenced by the temperatures at which the tests were conducted, as well as by the method used to assess the germination. Generally, the hybrids were relatively nearer to the high germinating parent at 14° C. than at 12–13° C.

Though similar trends were evident at both temperatures and with all assessment methods, it seems that a temperature of 12–13° C. and assessment method A would be more efficient for studying the inheritance of the ability of cotton seeds to germinate at low temperatures.

SUMMARY

The inheritance of the ability of cotton seeds to germinate at low temperatures was studied in the F_1 hybrid generation.

Reciprocal crosses were made in six different combinations, and the hybrids were compared to the selfed parents of each cross.

Germination tests were conducted at 12–13° C. and at 14° C., and germinating seedlings were counted by 3 different assessment methods.

The performance of the hybrids was either intermediate or showed partial or almost complete dominance.

A strong maternal influence was found, which might be explained by the effect of the fuzz and the nature of the seedcoat.

Conducting the test at 12–13° C. was found to be more efficient than at 14° C. in differentiating between varieties or hybrids in respect to this property.

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