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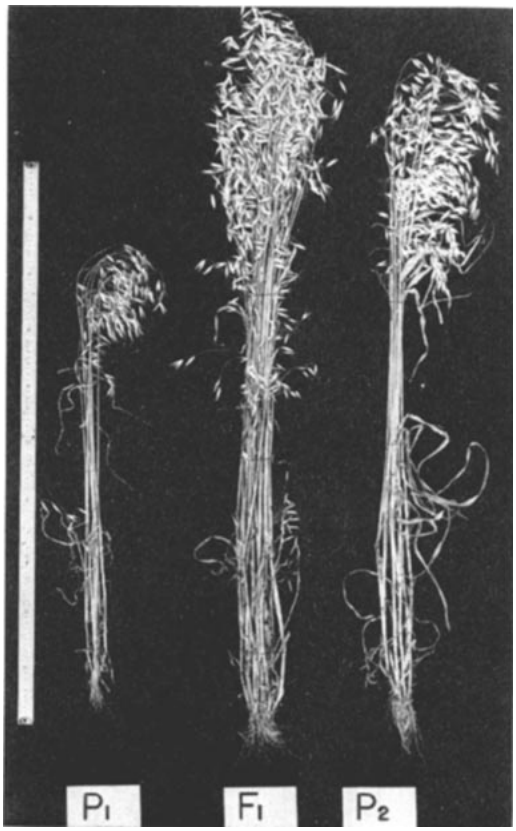

Fig. 1. Mature plants of *Avena* tetraploid C.I.7232 (P_1), hexaploid Black Mesdag (P_2), and their pentaploid F_1.

trated in Fig. 1. Most F_1 plants were taller and tillered more than Black Mesdag. The vigorous growth of F_1 plants was considered unusual in view of the relatively small stature of the tetraploid parent.

Chromosome pairing at metaphase I was extremely variable. Forty-seven different pairing arrangements were found among 79 cells examined. The most frequent arrangement was $21_I + 4_{II} + 2_{III}$ found in eight cells. The number of univalents per cell ranged from 12 to 26 with a mean of 18.6 and a mode of 21. The number of bivalents, including those in multivalents, ranged from 4 to 10 with a mean of 7.4 and a mode of 8. Multivalents, ranging from trivalents to a chain of seven, were found in all but one cell. Pairing in bivalents and multivalents was of the end-to-end type. Chromosome number and pairing such as this would account for the self-sterility observed.

These results provide decisive evidence that tetraploid C.I.7232 was not a parent of the hybrids described earlier[3]. The normal fertility reported for those F_1 hybrids and derivatives leads to the obvious conclusion that both parents were hexaploids. The late Dr. H. C. Murphy (personal communication) and Simons[5] have suggested that the parent in question might have been the hexaploid variety 'Ascencao'. Our observations on the reaction of X57BL-*A. sativa* hybrid derivatives to such diseases as crown rust and those caused by *Septoria avenae* Frank and *Helminthosporium victoriae* M. & M. support this suggestion.

SELECTION FOR GLANDLESS SEEDED COTTON PLANTS[1]

Scott C. McMichael[2]

ABSTRACT

I have presented methods helpful in identifying the glandless seeded character (gl_2 gl_2 gl_3 gl_3) in both the seedling and vegetative stages of the cotton plant, *Gossypium hirsutum* L. The stem (or hypocotyl) were found helpful in preliminary screening. The preliminary screening recovers both glandless genes in heterozygous or homozygous condition. The stipule was found to play a major role in identification of homozygous glandless seeded plants. Final proof of the homozygous genotype is based on a progeny test from self-pollinated seed.

Additional index words: ***Gossypium hirsutum*** **L., Gossypol, Cotton genetics.**

MANY cotton breeders in the United States and abroad are breeding for the glandless seeded condition. Although the mode of inheritance of glandless seeded cotton, *Gossypium hirsutum* L., is known (1, 2, 4, 5, 6, 7, 8), some breeders report difficulty with classification of the genotypes. I am able to select homozygous glandless seeded plants from a segregating population with virtually no misclassification. Practical suggestions on how this is done should be useful to breeders. First of all, the term glandless refers to the absence of the lysigenous, pigmented, gossypol-bearing glands of the cotton plant and seed. It should not be confused with the nectar-secreting glands described by Tyler (8) and Meyer (3). The initial cross used in this study was between glandless seed 23B, a primitive Hopi type and a commercial Acala cultivar. The glandless seed character on different cultivar backgrounds such as 'Acala,' 'Stoneville,' 'Missdel,' 'Coker,' and 'Pima S-1' all were found to segregate the same when crossed to the corresponding glanded variety. Modifying genes have been reported but these are minor except for gl_1.

Newly emerged seeddlings are easily suited for determining presence or absence of glands, particularly under greenhouse conditions. Figure 1 illustrates seedlings that are Gl_2 Gl_2 Gl_3 Gl_3 (normal glanded), gl_2 gl_2 gl_3 gl_3 (glandless), Gl_2 Gl_2 gl_3 gl_3 and Gl_2 gl_2 gl_3 gl_3. Seedlings of gl_2 gl_2 Gl_3 Gl_3 and gl_2 gl_2 Gl_3 gl_3 are comparable to Gl_2 Gl_2 gl_3 gl_3 and Gl_2 gl_2 gl_3 gl_3, respectively. Note that the hypocotyl of Gl_2 Gl_2 gl_3 gl_3 or gl_2 gl_2 Gl_3 Gl_3 is glanded but that the hypocotyls of Gl_2 gl_2 gl_3 gl_3, gl_2 gl_2 Gl_3 gl_3 and gl_2 gl_2 gl_3 gl_3 are glandless. Obviously, the first step in selecting for glandless seeded plants is to discard everything with glanded hypocotyls. An F_2 ratio of 11 glanded to 5 glandless hypocotyls is expected in a cross between glanded and glandless seed. A check of this ratio is important in order to guard against the presence of the gl_1 gene (4). The glandless expression of the gl_1 gene in the area of the hypocotyl (stem) is the same as that produced by both glandless seed genes (gl_2 and gl_3). The gl_1 gene is of no value in glandless seed production and, if present, should be eliminated from breeding stocks. An F_2

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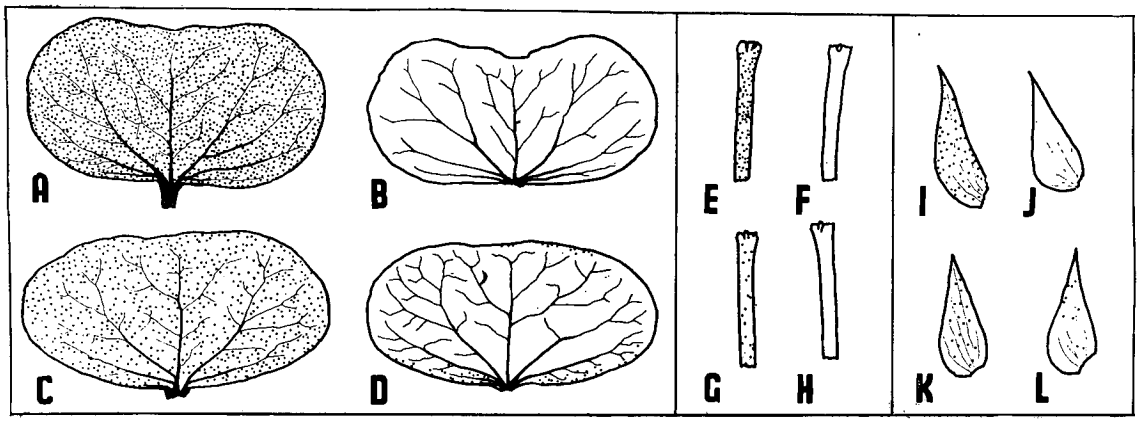

Fig. 1. Comparative number of pigment glands in cotyledons, hypocotyls, and stipules of cotton plants. A, E, and I represent a normal glanded plant Gl_2 Gl_2 Gl_3 Gl_3. B, F, and J are from a glandless seeded plant gl_2 gl_2 gl_3 gl_3. C, G, and K represent Gl_2 Gl_2 gl_3 gl_3 and gl_2 gl_2 Gl_3 Gl_3, and D, H, and L represent Gl_2 gl_2 gl_3 gl_3 or gl_2 gl_2 Gl_3 gl_3. Cotyledons (×1), hypocotyls (×1), and stipules (×3).

ratio of 33 glanded to 31 glandless hypocotyls or stems indicates that all three gene pairs (Gl_1 gl_1 Gl_2 gl_2 Gl_3 gl_3) are segregating. A further check on gl_1 segregation would be presence of fully glanded cotyledons or leaves on glandless hypocotyls or stems. After discarding all plants with glanded hypocotyls, only plants of constitution Gl_2 gl_2 gl_3 gl_3, gl_2 gl_2 Gl_3 gl_3 and gl_2 gl_2 gl_3 gl_3 remain. Note that in Fig. 1D the final vestige of glands is located at the base of the cotyledons. Sometimes a few glands may also be found at the apex of the cotyledon. These glands are not easy to see and can readily be overlooked. A three-power loupe and soft back lighting such as that from a draftsman's fluorescent lamp have been found helpful.

Selection for glandless seeded plants must often be made in the field. The cotyledons can be used for evaluation of glands, but this is not always practical. Adverse growing conditions, as well as age, produce thickened scarred cotyledons that are difficult to read.

Evaluation of a mature plant for glandless seed seems preferable for field use. The initial step is the same as with seedlings: discard the plants with glanded stems. This can easily be done at time of thinning.

The key to glandless seed evaluation in the mature plant is the stipule (Fig. 1), a triangular leaf-like appendage at each node. Plants of constitution gl_2 gl_2 gl_3 gl_3 (glandless seed) have a gland-free stipule. All other genotypes normally have a glanded stipule. Genotypes Gl_2 gl_2 gl_3 gl_3 and gl_2 gl_2 Gl_3 gl_3 have a glanded stipule in early season but may produce glandless stipules later in the season. The second step in mature plant evaluation for a glandless seed should be completed within 2 weeks after first bloom. A low-power magnifier and back lighting is useful in evaluating stipule glands. It has been found that stipules located two or three nodes from the growing point present maximum clarity of glands. A gland-free stipule, indicating a glandless seeded plant, should be confirmed by examining several more stipules from the same plant. In the F_2 generation of a cross between normally glanded and glandless parents the plants with gland-free stems are expected to be segregating in the ratio of four plants with glanded stipules to one plant with glandless stipules.

Table 1. Critical gl_2 and gl_3 genotypes and their expression in the cotyledon, hypocotyl (stem), and stipule that are useful in selecting for glandless cotton seed.

Genotype	Penotype		
	Cotyledon glands	Hypocotyl (stem) glands	Stipules glands
gl_2 gl_2 gl_3 gl_3	none	none	none
Gl_2 gl_2 gl_3 gl_3 or gl_2 gl_2 Gl_3 gl_3	few in base or margin	none	few
Gl_2 Gl_2 gl_3 gl_3 or gl_2 gl_2 Gl_3 Gl_3	reduced	reduced	reduced

The first step in glandless seed selection in both the seedling and mature plant stages are analogous. In the seedling discard those with glanded hypocotyl. In the mature plant discard those with glanded stem. The genetic constitution of the seedlings or mature plants that survive this initial screening are the same, namely: Gl_2 gl_2 gl_3 gl_3, gl_2 gl_2 Gl_3 gl_3 and gl_2 gl_2 gl_3 gl_3. It is readily apparent that the first step in selection of glandless stem screening is sufficient to retain both glandless genes. Omission of the second step in selection is feasible during years of backcrossing or other breeding work. Before seed increase, however, both steps in selection should be completed.

If selection for the homozygous glandless seed condition is carefully done on stems and stipules, misclassification rarely occurs. The absolute proof of homozygosity of a plant is a progeny test from self-pollinated seeds. Only the gl_2 gl_2 gl_3 gl_3 genotype will breed true for the glandless condition. Half of the progeny obtained by self-pollinating a plant of either the Gl_2 gl_2 gl_3 gl_3 or gl_2 gl_2 Gl_3 gl_3 genotype will have quite obvious and easily noticeable cotyledonary, stem (hypocotyl), and stipule glands as such plants are either Gl_2 Gl_2 gl_3 gl_3 or gl_2 gl_2 Gl_3 Gl_3. The presence of these glanded plants in a progeny is easily detected without resorting to the careful observations detailed above. Such segregating progenies may be entirely discarded.

In Table 1 genotypes useful in selecting for glandless seed, are presented with their phenotypic expression in the cotyledon, hypocotyl (stem), and stipules.

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