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Yuma Glandless, an Allelomorph of Glandless-one in Cotton, *Gossypium hirsutum* L.[1]

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ABSTRACT

Yuma glandless, gl_1^y, forms a multiple allelomorphic series with Gl_1 and gl_1. Yuma glandless is recessive to Gl_1 but dominant to gl_1. Normal cotton plants have glands of two distinct sizes. Yuma glandless gene eliminates the smaller glands.

Additional index word: **pigment glands.**

ALL species of *Gossypium* L. normally have conspicuous pigmented glands in aboveground parts. In Upland cotton, *G. hirsutum* L., McMichael (2) found glandless-one, gl_1, which had no pigment glands in the hypocotyl, stem, petiole, or carpel walls. Pigment glands of the cotyledon and leaves were unaffected by gl_1. McMichael (3) discovered two additional genes, gl_2 and gl_3. The combined effect of these two genes produced completely glandless plants. Lee (1) reported two minor genes, gl_4 and gl_5, which reduced the number of glands in plant parts. Murray (5) obtained a 15:1 ratio in a cross of gl_1 with a normally glanded parent. He assumed that another locus, gl_6, was involved, although gl_6 was not isolated in a separate stock.

Previous papers dealt with the presence or absence of pigment glands, but did not mention size differences. In normal cotton plants, pigment glands occur in two sizes. Larger glands are found mainly in the hypocotyl and occasionally at nodes. Large glands are rarely found on internodes or carpel walls. The smaller glands, however, occur throughout the axial parts of the plant as well as on the hypocotyl and carpel walls. A gene in a new mutant, Yuma glandless, causes the absence of the smaller glands. This gene does not

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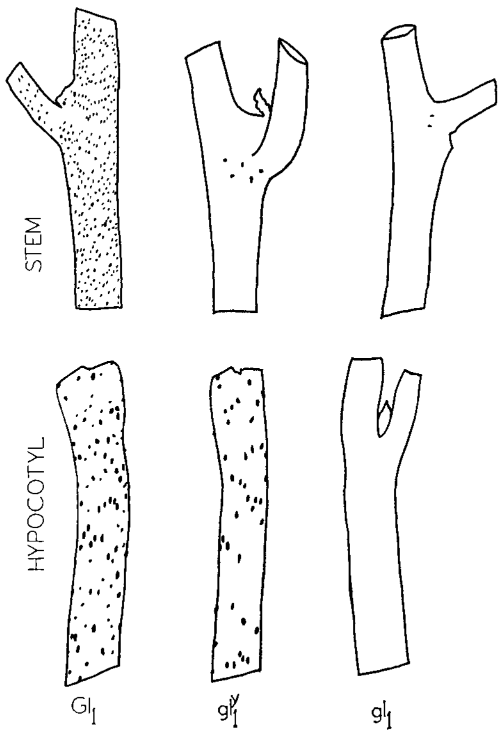

Fig. 1. Pigment glands found in hypocotyl and stem of normal glanded (Gl_1), Yuma glandless (gl_1^y), and glandless-one (gl_1) cotton plants. Hypocotyl (×2), stem (×1).

Table 1. F_2 and backcross segregation from crosses involving Yuma glandless. Presence of glands is dominant to fewer glands or absence of glands.

Cross	Expected ratio	Actual ratio	χ^2	P
Glanded plant × Yuma	3:1	1,125:381	.06	.90-.80
Yuma × gl-1	3:1	779:262	.02	.90-.80
Yuma × glandless plant	33:11:16:4*	1,276:420:603:160	.55	.95-.90
(Yuma × gl-1) × gl-1	1:1	42:39	.12	.80-.70

* See Table 2.

Table 2. Genotypic composition of four phenotypes in the F_2 of the cross between Yuma glandless and glandless plants.

Phenotype	Expected ratio	Genotype	Expected ratio
Glanded hypocotyl, cotyledons, and stems	33	$Gl_1 - Gl_2 - Gl_3$	27
		$Gl_1 - Gl_2\, Gl_2\, gl_3\, gl_3$	3
		$Gl_1 - gl_2\, gl_2\, Gl_3\, Gl_3$	3
Yuma glanded hypocotyl, glanded cotyledons, glandless stems	11	$gl_1^Y\, gl_1^Y\, Gl_2 - Gl_3 -$	9
		$gl_1^Y\, gl_1^Y\, Gl_2\, Gl_2\, gl_3\, gl_3$	1
		$gl_1^Y\, gl_1^Y\, gl_2\, gl_2\, Gl_3\, Gl_3$	1
Glandless hypocotyls, glanded cotyledon	16	$Gl_1\, Gl_1\, Gl_2\, gl_2\, gl_3\, gl_3$	2
		$Gl_1\, gl_1^Y\, Gl_2\, gl_2\, gl_3\, gl_3$	4
		$gl_1^Y\, gl_1^Y\, Gl_2\, gl_2\, gl_3\, gl_3$	2
		$Gl_1\, Gl_1\, gl_2\, gl_2\, Gl_3\, gl_3$	2
		$Gl_1\, gl_1^Y\, gl_2\, gl_2\, Gl_3\, gl_3$	4
		$gl_1^Y\, gl_1^Y\, gl_2\, gl_2\, Gl_3\, gl_3$	2
Glandless plants	4	$Gl_1 - gl_2\, gl_2\, gl_3\, gl_3$	3
		$gl_1^Y\, gl_1^Y\, gl_2\, gl_2\, gl_3\, gl_3$	1

affect the glands found in the cotyledons or leaves, just those that are affected by gl_1 (2).

The mutant, Yuma glandless, occurred naturally in a commercial cotton field near Yuma, Ariz. A newly-germinated seedling of Yuma glandless appears to be normally glanded. After hypocotyl elongation, the larger size, as well as the reduced number of glands, are readily discernible (Fig. 1). From the true leaf stage to maturity Yuma glandless is difficult to distinguish from gl_1.

Nodal glands have been reported on glandless-one plants $gl_1\, gl_1\, Gl_2\, Gl_2\, Gl_3\, Gl_3$ and even on glandless plants $Gl_1\, Gl_1\, gl_2\, gl_2\, gl_3\, gl_3$.[3] Nodal glands were found to be a definite feature of Yuma glandless $gl^y_1\, gl^y_1\, Gl_2\, Gl_2\, Gl_3\, Gl_3$. It is possible that on other backgrounds Yuma glandless may or may not have nodal glands, behaving in this respect similar to glandless-one and glandless plant.

Genetic Analysis of Yuma Glandless

Yuma glandless was crossed with three stocks of known glandless genotype in regard to gl_1, gl_2, and gl_3.

1. Normally glanded $Gl_1\, Gl_1\, Gl_2\, Gl_2\, Gl_3\, Gl_3$
2. Glandless-one $gl_1\, gl_1\, Gl_2\, Gl_2\, Gl_3\, Gl_3$
3. Glandless plant $Gl_1\, Gl_1\, gl_2\, gl_2\, gl_3\, gl_3$

The F_1 and F_2 generations were grown from each cross. The backcross (Yuma-glandless × glandless-one) × glandless-one was also studied.

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In the cross to normally glanded, Yuma glandless was recessive in the F_1, and the F_2 segregated 3 glanded:1 Yuma glandless (Table 1). In the cross to glandless-one, Yuma glandless acted as a domniant and segregated 3 Yuma glandless:1 glandless-one. The backcross segregated one Yuma glandless:1 glandless-one. I assigned the gene symbol, gl^y_1, to Yuma glandless which indicates that Gl_1, gl^y_1, and gl_1 form a multiple allelomorphic series at the gl_1 locus.

In the cross to glandless plant, the F_1 was dominant for Yuma glandless. The F_2 was classed into four easily recognized phenotypes with following genotypic-phenotypic relationship (Table 2).

Instead of four phenotypic classes in the F_2 of the Yuma cross with glandless plant we combine and make two classes: (a) glanded hypocotyl, and (b) glandless hypocotyl (Tables 1 and 2). This new ratio 11:5 (44:20) shows excellent agreement with actual count. It was shown previously (4) that the ratio of glanded hypocotyl to glandless hypocotyl is helpful in breeding for the glandless plant character in comercial cotton.

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