AGRONOMIC PERFORMANCE AND BACKGROUND EFFECTS OF THE AFILA-TENDRILLED ACACIA PEA FOLIAGE TYPE: EVALUATION ON WIRE TRELLISES

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The afila (af) and tendrilled-acacia (tac) genes radically modify leaf morphology of the pea (Pisum sativum L.) plant and offer alternatives to the normal foliage type. The af gene, first described in 1965 (1), replaces leaflets with tendrils when present in the homozygous recessive condition. The tac gene, isolated in 1972 following chemical mutagenesis with diethyl sulfate (3), restores small leaflets to the tendrils of af plants when similarly homozygous. The resulting af-tac phenotype (2) is characterized by a proliferation of tendrils which terminate in either small, cup-shaped leaflets or leaflets similar in shape but slightly smaller than those found on normal-foliage plants.

Despite world-wide use, the normal pea foliage type is known to exhibit several disadvantages; e.g. a dense canopy that shades lower plant parts, a reduction of light penetration into the understory and corresponding decreases in photosynthetic activity of the lower leaves, a lack of color uniformity of shelled peas due to shading, and a potential buildup of pathogens due to reduced drying in the moist lower-canopy environment. Efforts to remedy these disadvantages have resulted in adoption of the af foliage type in many regions of the world. Despite the potential benefits that the tac gene could offer the already-established af foliage type in the form of increased photosynthetic area, there have been no studies which have evaluated the potential utility of the af-tac gene combination. The objective of this investigation was to evaluate the performance of af-tac lines in comparison with af and normal foliage near-isolines in a range of genetic backgrounds.

Included in the study were normal foliage, af foliage, and af-tac foliage near-isogenic lines in three genetic backgrounds: 'Alsweet', 'Frontier', and 'Dark Skin Perfection'. All near-isolines were BC6-F5 derived. Four replications of a split-plot design were planted in 3.05 m linear plots along wire trellises in 1988 at Arlington, WI and in 1989 at West Madison, WI and Arlington WI. In each experiment, genetic background was assigned to the whole plot and foliage type was ascribed to the sub-plot. A 0.91 m section was removed from the plot center at the green pea harvest stage (approximately 100 tenderometer), placed in an airtight plastic bag, and transported to the laboratory at Madison, WI for analysis. Five plants were chosen randomly from the harvest sample and separated for their constituent foliage and yield components. In this way, yield components such as pods per node, pods per plant, lowest pod-bearing node, peas per pod, and green pea yield were recorded. The foliage components of a five-plant sample were bulked and areas of stem, stipule, tendril, leaflet, and tac leaflet were measured on a leaf area meter. These components were then dried for 48 h at 56°C and weighed. Additional agronomic data measured included stand counts and dry seed yield on a plot basis. Dry seed yield data were measured at Arlington in 1988 and 1989. Data presented in this report are means based on 9 observations from 9 harvestable replications: 4 at Arlington in 1988, 3 at Arlington in 1989, and 2 at West Madison in 1989. Dry seed yield data are means based on 7

observations from only the Arlington locations. All statistical analyses were performed using the GLM procedure of SAS.
Years and locations were designated 'environments'. Comparisons among means were made with an LSD value at the 5% level.

Table 1. Mean performance of pea foliage types on wire trellises averaged over three backgrounds and three environments.

Foliage type	Trait				
	Pods (number)	Foliage area (cm^2)	Plant dry weight (g)	Green pea yield (g)	Dry seed yield (g)
		5-plant	sample		total plot
Normal	22.2	2194.9	33.3	34.4	224.0
Afila	22.6	1544.2	29.3	34.3	190.8
Afila-tac	25.2	2173.4	34.5	33.0	201.6
LSD.05	2.1	218.9	3.3	4.7	17.4

Table 2. Means of yield components for the 'Dark Skin Perfection' genetic background averaged over three environments.

Foliage Type	Trait					
	Pod nodes (number)	Pods (number)	Peas (number)	Pods/plant (number)	Green pea yield (g)	Dry seed yield (g)
		5-plant	sample			total plot
Normal	17.7	24.0	130.7	4.8	39.5	285.8
Afila	17.6	23.9	121.9	4.8	37.3	236.8
Afila-tac	24.7	32.4	163.9	6.5	43.1	271.2
LSD.05	2.9	3.7	18.7	0.7	8.1	30.2

Results and Discussion

Averaged over the three genetic backgrounds and three environments, green pea yield of plants with af-tac foliage did not differ significantly from af or normal plants on a per sample basis (Table 1). Total number of pods, total foliage area, and total plant dry weight were, however, higher for af-tac than af plants. Expression of the tac gene varied significantly with genetic background. In Alsweet, which has the earliest maturity of the three backgrounds, af plants out-performed af-tac plants for most traits. The af-tac combination in the Dark Skin Perfection background showed higher values for nearly all yield component traits than the af_ or normal foliage types (Table 2). Data which we have collected in other experiments suggest that, unlike other foliage components, phenotypic expression of the tac gene increases with plant ontogeny. Thus it seems likely that the tac expression would reach its maximum and make its largest overall contribution in performance in a late maturing background such as Dark Skin Perfection. This may be due, though, simply to the greater number of nodes in the Dark Skin Perfection background (data not shown). Dry seed yield data further illustrated that the benefit of tac is realized with later maturity. Averaged across backgrounds, more pronounced (though non-significant) differences were noted between af-tac and af_ foliage types (Tables 1 and 2) at the dry seed stage than were present at the green pea stage. In general, our results of experiments conducted on trellises

indicate that the af-tac gene combination is equal or superior to the af type, and compares favorably in performance to the normal foliage type. At present, the mid to late-season cultivars should benefit most from the af-tac combination. Dry seed yield data indicate that field pea cultivars and other Pisum genotypes grown for their dry seed may be able to take full advantage of the af-tac foliage type.

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