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Genetic Effects in the Control of Floral Abscission in *Nicotiana*

ROBERT E. YAGER¹

Abstract. Lizard's Tail and Little Turkish varieties vary considerably as to time for floral abscission, anatomy of the abscission zone, and the controlling chemical agents. When the two varieties are crossed, a homogeneous F_1 generation is intermediate in anatomical characteristics and time required for abscission of unfertilized flowers. The F_2 individuals are widely heterogeneous. External anatomy and time of abscission vary considerably and in some instances are unlike either parental type or the F_1 offspring. Simple laws of genetics do not apply to the genetic effects upon floral abscission in these varieties. Multiple genes appear to be involved, as well as several instances of lack of dominance of individual genes.

Several differences in the mode of floral abscission have been reported between Lizard's Tail and Little Turkish varieties of *Nicotiana tabacum* (1, 2). This paper reports the effects of crossing the two varieties upon floral abscission and general external anatomy in the F_1 and F_2 generations.

METHODS

Hybrids were secured by crossing Lizard's Tail and Little Turkish varieties. In one instance, Lizard's Tail pollen was used to fertilize the ovules of Little Turkish plants. At other times Little Turkish pollen was used to fertilize ovules of Lizard's Tail plants. The seed was collected and the F_1 generation grown with five pure Lizard's Tail and seven Little Turkish plants. The growing conditions have been described previously (3).

When the F_1 generation was matured, additional crosses were made. In some cases two hybrid plants (F_1) were crossed. In others, samples of the F_1 generation were crossed with each of the parent types.

Fertilization was prevented in a manner previously reported (4). Time between anthesis and abscission was recorded for several flowers on each plant. General appearance of the plants was noted and recorded. This included plant height, leaf size and shape, general coloration, growth rate, and flower anatomy.

RESULTS AND DISCUSSION

The F_1 generation produced a homogeneous group of plants with characteristics intermediate between Lizard's Tail and Little Turkish (Figure 1). The heights were intermediate as

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were the shape and size of leaves. The stigmas and anthers were of equal height intermediate between the conditions found in the two parental varieties. Also, the time between anthesis and abscission of unfertilized flowers was intermediate (Table 1). The differences between the means of the parents and the F_1 generation are significant at the 0.01 level of confidence (Table 2).

Table 1. Abscission time for parents and F_1 generation.

Type of Plant	Number of Plants	Number of Flowers	Days from Anthesis to Abscission (\pm Standard Error)
A. Lizard's Tail	5	164	5.8 \pm 0.68
B. Little Turkish	7	159	9.9 \pm 1.87
C. Hybrid (Lizard's Tail pollen)	25	975	7.9 \pm 1.71
D. Hybrid (Little Turkish pollen)	24	770	8.2 \pm 1.56

The F_2 generation produced a group of plants with widely varying characteristics. The heights ranged from 90 cm to 219 cm. Lower mature leaves varied from 6 cm to 22 cm wide and 16 cm to 42 cm long. Coloration of leaves ranged from the dark green of Lizard's Tail to the lighter yellow-green of Little Turkish. The size of the petiole ranged from non-existent (which is usual for Lizard's Tail) to 11 cm in length (which is larger than that normally found in Little Turkish). Stigma size ranged from 3 mm below to 3 mm above the anthers. Shape of leaves varied from the typical parental and F_1 types to extremes unlike any previously identified. Figure 2 illustrates a phenomenon which appeared in several of the F_2 offspring. The leaf blades failed to expand and a ruffled condition resulted. This occurred in various degrees in one-third of the plants. In some it occurred only near the blade-petiole juncture causing a slightly coiled appearance. The condition occurred regardless of the shape or color of the leaf (Figures 3 and 4).

Table 2. Determination of significance between means in Table 1.

Means Compared	(t) Values
A and B	6.86*
A and C	11.59*
B and C	13.79*
A and D	14.37*
B and D	12.60*
C and D	4.21*

* Significant at 0.01 level of confidence.

In addition to the gross anatomical differences observed in the F_2 generation, great variation occurred in the times of abscission. In the cross $F_1 \times F_1$, the number of days from anthesis to abscission was determined on 1,933 flowers from 47 plants. The means for individual plants ranged from 4.0 ± 0.33 to 11.7 ± 0.90 . This difference did not accompany a particular anatomical variation. Further, a plant judged to be Lizard's Tail by leaf shape and color sometimes displayed an abscission time comparable to Little Turkish variety.

Similar variations arose from backcrosses of F_1 hybrids with either parental variety. In the cross $F_1 \times$ Lizard's Tail, the number of days from anthesis to abscission was determined on 1,018 flowers from 24 plants. The means for individual plants ranged from 4.3 ± 0.57 to 11.4 ± 1.20 . Similar values were determined for the cross $F_1 \times$ Little Turkish from 880 flowers on 24 plants. The means ranged from 4.9 ± 0.42 to 11.1 ± 0.34 . A hybrid crossed with Little Turkish did not prevent the appearance of Lizard's Tail characteristics with respect to time required for floral abscission. Similarly, a hybrid crossed with Lizard's Tail did not prevent the appearance of characteristic Little Turkish patterns of abscission. In this instance, the hybrid crossed with Lizard's Tail produced more plants that resembled Lizard's Tail anatomically. When Little Turkish and an F_1 hybrid were crossed, all plants resembled either the hybrid or Little Turkish although some flowers abscised in the time usually required for Lizard's Tail. Results of comparing abscission times arising from the various crosses are shown in Table 3.

Table 3. A comparison of times of abscission of F_2 generation.

Type of plant	Numbers of Plants		
	6.4* days or less	6.5-7.9 days	8.0** days or more
$F_1 \times F_1$	22	8	17
$F_1 \times$ Lizard's Tail	15	6	3
$F_1 \times$ Little Turkish	5	14	5

* One standard error above mean for Lizard's Tail (5.8 ± 0.68)

** One standard error below mean for Little Turkish (9.9 ± 1.87)

The segregation of genes governing the time of abscission appears to be independent of genes controlling the appearance of the plant. There is further suggestion that most of the factors identified are controlled by multiple genes since so many variations in abscission and external appearance occur in the F_2 generation. Also, several of the genes appear to lack dominance, which results in numerous intermediate varieties.

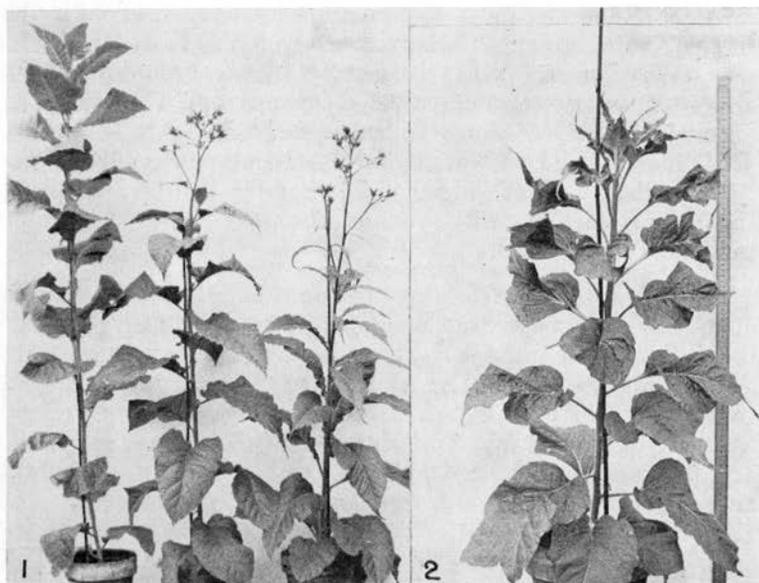


Figure 1. Comparison of Little Turkish (left), F₁ hybrid (center), and Lizard's Tail (right).

Figure 2. One of the F₂ plants displaying extreme ruffling of the leaves.

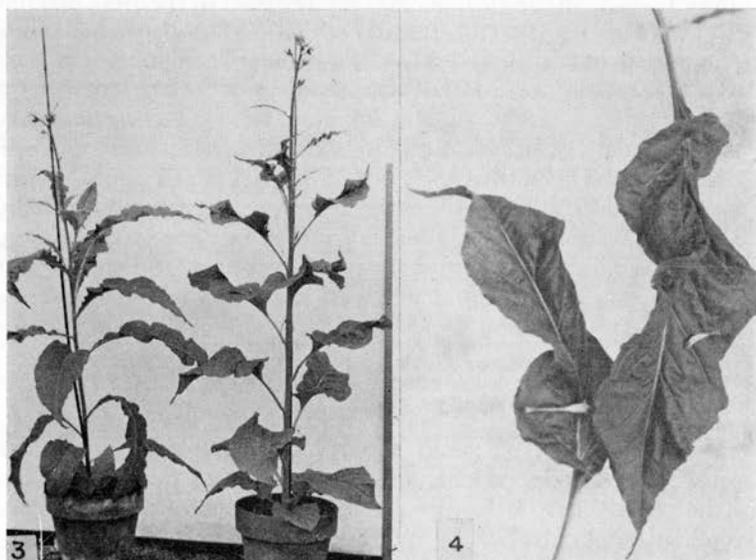


Figure 3. F₂ plants like Lizard's Tail (left) and F₁ hybrid (right) with some ruffling appearance.

Figure 4. Leaf samples from F₂ plants like the leaves of F₁ plants, except for

Variations in enzyme and hormone levels between Lizard's Tail and Little Turkish varieties have been reported earlier (5). These results suggest that a genetic effect also must be considered in determining the mechanism involved in abscission. Possibly the retardants and accelerants as well as the immediate enzymatic reactions in abscission are affected by genetic factors and hence account for some of the extreme variation between Lizard's Tail and Little Turkish varieties.

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