HORTSCIENCE 26(8):1074-1075. 1991.

Genetics of Semideterminate Growth Habit in Tomato

Yonatan Elkind, Arie Gurnick[1], and Nachum Kedar
Department of Field Crops, Vegetables, and Genetics; Faculty of Agriculture; Hebrew University of Jerusalem; P.O. Box 12; Rehovot 76 100, Israel

Additional index words. Lycopersicon esculentum, breeding, determinate growth, epistasis, *sdt,* major gene

Abstract. **The objective of this study was to elucidate the genetic control of the semideterminate growth habit in tomato *(Lycopersicon esculentum* Mill.). A semideterminate tomato line was crossed with determinate and indeterminate lines; their F1, F2, and backcrosses were grown; and the growth habit recorded and analyzed. Plants with six or more inflorescences on the main stem were defined as semideterminate, while those with fewer were defined as determinate. The F2 and backcross to determinate were bimodal, indicating a single recessive gene for semideterminate, which was denoted as *sdt.* The goodness-of-fit chi square for a single recessive gene model was 88% and 69% for F2 and backcross generations, respectively. In the cross between semideterminate and indeterminate types, the results indicated control by two genes, *sp* and *sdt,* with the *sp*+ indeterminate type epistatic over semideterminate. The goodness-of-fit to this model was 70% and 82% for F2 and backcross generations, respectively.**

The stem of the tomato plant is a sympodium composed of a series of sympodial shoots, each developing from the bud below the terminal inflorescence of the preceding shoot (Picken et al., 1985; Silvy, 1974). Two main plant growth habits have been described in tomato: indeterminate and determinate, or self-pruning (Atherton and Haris, 1986; MacArthur, 1932). The indeterminate growth habit is characterized by an apparently continuous extension of the main shoot by side shoots. After an initial period, the inflorescence in each shoot is formed after three leaves have emerged. In the determinate type, the growing point in the axil of the last-formed leaf on the primary shoot may transform into an inflorescence, whereupon no further leaves are initiated (MacArthur, 1932; Picken et al., 1985; Silvy, 1974). Thus, the extension of the shoot axis is usually halted with the formation of the second inflorescence. Each sympodial shoot, except the last, consists of one or two leaves. The determinate type is controlled by a single recessive gene, termed *sp* for self-pruning (MacArthur, 1932).

The indeterminate type is grown in greenhouses, allowing continuous production of high-quality fruits (van der Vooren et al., 1986). The determinate type is often used for processing and fresh-market outdoor cultivars, where its concentrated yield is advantageous (Giesenberg and Stewart, 1986).

Within the determinate type, genetic differences have been observed for the number of inflorescences on the main shoot, resulting from the timing of formation of the final two inflorescences. Those differences are thought to be due to genetic background (Cuartero and Cubero, 1985). Plants exhibiting determinate growth habit with delayed termination of the main stem are termed semideterminate. The purpose of the present

Received for publication 24 July 1990. We thank Tchia Gurnick for her assistance in the experiments. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

[1]Present address: Rehovot District Extension Service, Ministry of Agriculture, Herzl Street 4, Rehovot 76-120, Israel.

Table 1. Segregation of tomato plants for growth habits" in various populations and the expected ratio assuming a single recessive gene *sdt* that modifies the growth habit of *sp/sp* plants (see Table 2).

Population	Observed (plants) I	D	S	Expected ratio I : D : S	χ^2	*P*
Cross P1 x P2						
P1 (UC-97-3)	0	82	6	0 : 1 : 0		
P2 (70T82-1)	0	3	95	0 : 0 : 1		
F1	0	38	1	0 : 1 : 0		
F2	0	299	98	0 : 3 : 1	0.021	0.88
BCP1	0	96	4	0 : 1 : 0		
BCP2	0	47	51	0 : 1 : 1	0.163	0.69
Cross P2 x P3						
P3 (Potentate)	58	0	0	1 : 0 : 0		
F1	39	0	0	1 : 0 : 0		
F2	76	15	6	12 : 3 : 1	0.705	0.70
BCP3	47	0	0	1 : 0 : 0		
BCP2	24	10	13	2 : 1 : 1	0.404	0.82

[z]The phenotypic groups were: I = indeterminate—three or more leaves between inflorescences; D = determinate—fewer than six inflorescences on the main stem, one or two leaves between them; S = semideterminate—six or more inflorescences on the main stem, two leaves between them.

Table 2. The genetic combinations of two tomato genes and the corresponding growth habit phenotype.

Genotype		Phenotype
sp$^+$/−	*Sdt*/−	Indeterminate
sp$^+$/−	*sdt*/*sdt*	Indeterminate
sp/*sp*	*Sdt*/−	Determinate
sp/*sp*	*sdt*/*sdt*	Semideterminate

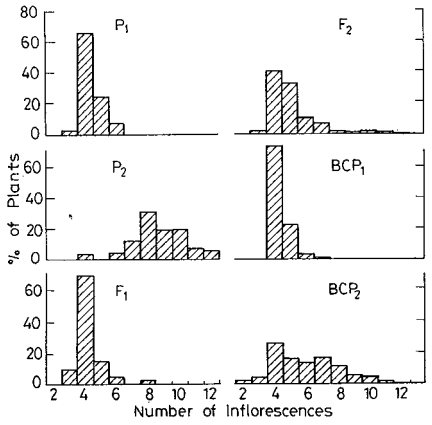

Fig. 1. Plant distribution for number of inflorescences on the main shoot in various populations derived from P1 and P2 (determinate and semideterminate, respectively).

study was to elucidate the genetics of the semideterminate growth habit.

The three paternal lines used were: P1-UC-97-3, a processing cultivar from Davis, Calif. (A.M. Stevens); P2-70T82-1, a fresh-, market line also from Davis (P. Smith); and P3-'Potentate', a greenhouse cultivar from Glasshouse Crops Research Inst., Littlehampton, England (T.J. Hall), representing determinate, semideterminate, and indeterminate types, respectively. P1 and P3 were crossed with P2 and F2, and backcross populations were prepared (Table 1). The material was planted during early spring in Rehovot, Israel. The arrangement of the plots was randomized, with five plots per population, except F2 of P1 × P3 with 10 plots. Plants were grown nonstaked and were not pruned. Three months after planting, the leaf and flowering patterns of the main shoot of each plant were recorded.

There were three to six inflorescences on the main shoot in P1, with a mode of four, as compared with four to 12 in P2, with a mode of eight (Fig. 1). F1 and BCP1 were very similar to P1. The F2 population was strongly skewed to a high inflorescence count on the main stem. The BCP2 population was a bimodal, with two peaks at four and seven. These findings suggested the involvement of a major recessive gene for the semideterminate growth habit. The plants were thus defined as follows: determinate-plants with up to five inflorescences with an average of one to two leaves between them; semideterminate-plants with six or more inflorescences and two leaves between them; and indeterminate-plants with three leaves between inflorescences.

The great majority of P1, P2, and F1 plants fell into the expected phenotypic groups, with a few exceptions classified into the alternative group (Table 1). F1 was similar to P1, indicating that determinate was dominant over semideterminate. The segregation of the F2 and BCP2 populations was in agreement with the model for genetic control by a single recessive gene for semideterminate growth habit (Table 1).

In the P2 × P3 cross, semideterminate with indeterminate, F1 and BCP3 were indeterminate. In F2 and BCP2, segregation fit a completely dominant, two-gene model, with one dominant gene *(sp+)* epistatic to the second gene (12:3:1 and 2:1:1, Table 1) and with the probabilities of x^2 being 0.70 and 0.82, respectively.

Based on the above results, we concluded that the semideterminate growth habit in breeding line 70T82-1 is controlled by a major recessive gene. This gene, denoted as *sdt*, modifies the expression of the *sp/sp* genotype by increasing the number of leaves between inflorescences and the number of inflorescences before termination of main stem growth. The *sdt* gene is not expressed in the presence of the dominant allele *sp+* for indeterminate growth. Thus, the semideterminate phenotype is exhibited in plants with *sp/sp, sdt/sdt* (Table 2).

There is some variation in the number of inflorescences in plants of the same genotypes (Fig. 1), probably due to environmental factors. There is some overlap between the determinate and semideterminate genotypes, mostly in plants with six inflorescences on the main stem. One should, therefore, avoid determining the genotype of a single plant based solely on the presence of six inflorescences on its main stem. Furthermore, being affected by environment, the distinction between genotypes may be different under other environments, making it necessary to grow the parent lines as controls. We also cannot exclude the possibility that genetic background might have some effect on the number of inflorescences on the main stem.

Many modem outdoor cultivars are characterized by more leaves and a longer growing period, which allows for improved fruit quality. These cultivars are most likely of the semideterminate type. An elucidation of the genetic control of the semideterminate growth habit should improve breeding procedures for cultivars of this type.

Literature Cited

Atherton, J.G. and G.P. Haris. 1986. Flowering, p. 167-200. In: J.G. Atherton and J. Rudich (eds.). The tomato crop. Chapman and Hall, London.

Cuartero, J. and J.I. Cubero. 1985. Genetics of growth habit in tomato. Z. Pflanzenzüchtung 94:288-297.

Giesenberg, C. and K. Stewart. 1986. Field crop management, p. 511-558. In: J.G. Atherton and J. Rudich (eds.). The tomato crop. Chapman and Hall, London.

MacArthur, J.W. 1932. Inherited characters in the tomato. I. The self pruning habit. J. Hered. 23:395-396.

Picken, A.J., R.G. Hurd, and D. Vince-Prue. 1985. *Lycopersicon esculentum.* p. 330-346. In: A.H. Halevy (ed.). Handbook of flowering. CRC Press, Boca Raton, Fla.

Silvy, A. 1974. A study of modes of sympodial ramification in *Lycopersicon esculentum* and *Lycopersicon pimpinellifolium.* Can. J. Bot. 52:2207-2218.

van der Vooren, J., G.W.H. Welles, and G. Hayman. 1986. Glasshouse crop production, p. 581-623. In: J.G. Atherton and J. Rudich (eds.). The tomato crop. Chapman and Hall, London.