Prostrate Growth Habit Enhances Fresh-market Tomato Fruit Yield and Quality

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Abstract. Two inbred lines of fresh-market tomato (*Lycopersicon esculentum* Mill.), NC 20G-1 and NC 53G-1, both exhibiting prostrate growth habit (PGH), were crossed with the upright growth habit cultivar Piedmont and advanced to the F₂ generation. Plants of each F₂ population were grown without plant support on black plastic and subjectively rated in field plots for PGH. Extreme upright and prostrate plants were chosen from each F₂ population for harvest. Mean comparisons between plants of extreme upright and prostrate habit showed increased total and marketable yields from plants with a prostrate habit. Decay and groundscarring of fruit were less in prostrate than in normally upright plants; the percentage of misshapen fruit was similar in both. The PGH character may be useful in increasing total and marketable yield of ground-culture tomatoes.

In ground culture, tomato plants are susceptible to lodging from wind and rain. Lodging reduces fruit yield and quality (Adelana, 1980). Common measures used to overcome this problem are staking and trellising, both being costly in materials, labor, and time (Adelana, 1976). In studies involving the effects of staking and pruning on yield of tomato, Jensen (1957) and Mangal et al. (1981) reported higher marketable and total yields, respectively, when plants were staked and pruned, rather than left lying on the ground. In contrast, Voinea and Bunesco (1957) reported lower total yields in staked and pruned plants. Adelana (1980) concluded there was a low correlation between lodging and total yield. However, lodging of unstaked plants does cause significant reductions in fruit quality (Adelana, 1976, 1980; Jensen, 1957). Alternative methods of improving yield and quality without mechanical support may increase profitability of fresh-market tomato production.

Several breeding lines with prostrate growth habit (PGH) have been developed in the North Carolina fresh-market tomato breeding program. PGH plants exhibit wide lateral branch

angles (Ozminkowski et al., 1990) that result in plants with an open, spreading habit not prone to lodging, as is common with the upright habit. The objective of this study was to determine the effects of PGH on tomato-fruit yield and quality.

Determinate inbred tomato lines NC 20G-1 and NC 53G-1 served as sources of prostrate growth habit. NC 20G-1 is early in maturity, whereas NC 53G-1 is late in maturity with larger plants than 20G-1. Both lines were crossed in the greenhouse with the determinate, upright growth habit 'Piedmont' as the male parent, and then advanced to the F₂ generation. F₂ populations were used to reduce genotype effects, since isogenic populations were not available.

Plants were started in a greenhouse and

transplanted into the field in Fletcher, N.C., on black plastic mulch as described by Ozminkowski et al. (1990). Each F₂ population (20G and 53G) contained 240 plants. The plants were not pruned. Plants of each F₂ population were subjectively rated for plant growth habit 9 weeks after transplanting to the field. The rating scale was based on whole numbers from 1 through 5, with 1 = plants with the extreme upright habit and 5 = those with extreme prostrate growth habit (Ozminkowski, 1988).

The first of two harvests was on 13 Aug. 1987, 9 weeks after transplanting. Fruit were harvested from 17 upright (rated 1) and 19 prostrate (rated 5) plants in the 20G F₂ population and 19 upright and 14 prostrate plants in the 53G F₂ population. All fruit were removed from the first and second fruit clusters (inflorescences) at the first harvest. The second harvest was 6 days later with all fruit >3.5 cm in diameter harvested. Total harvest values were computed as sums of both harvests.

Fruit from each plant were weighed and categorized as marketable, groundscarred, decayed, and/or misshapen. Marketable fruit were those of US #1 or US #2 grade (U.S. Dept. Agriculture, 1976). Fruit having blemishes without skin breakage were considered groundscarred. For decay, the blemishes penetrated the skin of the fruit but decayed tissue was not necessarily present. Only fruit having indentations caused by wedging between branches of the plant were classified as misshapen. A single fruit was placed into both the misshapen and groundscarred or decayed categories, as warranted. Differences between means of each yield attribute were tested using a two-tailed Student's *t* analysis with unequal variances (Steele and Torrie, 1980).

Total yield of prostrate plants was greater than that of upright plants (Table 1). Prostrate plants also exhibited a higher marketable yield than did upright plants in each F₂ population. The higher total and marketable

Table 1. Yield attributes of first, second, and total harvests in two field-grown F₂ tomato populations of plants selected for extreme expression of upright or prostrate growth habit.

Attribute and growth habit	Harvests, 20G F ₂			Harvests, 53G F ₂		
	First	Second	Total	First	Second	Total
Yield (kg/plant)						
Upright	1.4**	5.8 ^{NS}	7.3*	1.7*	5.3**	7.0***
Prostrate	1.9	6.6	8.4	2.1	7.8	9.9
Marketable (kg/plant)						
Upright	0.9***	3.8*	4.7**	0.8**	3.3***	4.0***
Prostrate	1.5	4.8	6.3	1.5	4.9	6.5
Marketable (%)						
Upright	62.5*	66.5*	65.2**	43.5***	61.7 ^{NS}	57.7**
Prostrate	78.7	73.5	74.4	74.0	65.0	66.2
Decayed (%)						
Upright	11.5 ^{NS}	6.8 ^{NS}	7.7 ^{NS}	33.9***	15.0 ^{NS}	19.2***
Prostrate	6.5	5.5	5.8	7.6	9.3	9.5
Groundscarred (%)						
Upright	7.6*	11.4*	10.8**	5.2 ^{NS}	7.5 ^{NS}	7.1 ^{NS}
Prostrate	1.4	5.0	4.2	6.3	9.7	9.6
Misshapen (%)						
Upright	23.3 ^{NS}	0.2 ^{NS}	5.2 ^{NS}	10.7 ^{NS}	0.0 ^{NS}	3.1 ^{NS}
Prostrate	13.3	0.7	3.6	5.1	0.0	1.5

NS, *, **, *** Pairwise comparisons nonsignificant or significant at *P* = 0.05, 0.01, or 0.001, respectively.

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yields of prostrate plants resulted in much higher marketable percentages for prostrate than upright plants. In the first and total harvests of the 53G F₂, unlike in the 20G F₂, there was a lower percentage of decayed fruit in prostrate than in upright plants. Only prostrate 20G F₂ plants produced significantly fewer groundscarred fruit than did upright plants. The percentage of misshapen yield was similar for upright and prostrate plants.

Increased total yield in prostrate plants may be related to the PGH trait, although the possibility of favorable yield linkages was not tested. The open, spreading growth habit likely resulted in better exposure of foliage to light, possibly increasing photosynthesis per plant, and leading to greater fruit production.

The crown set (first harvest) of prostrate plants is well-supported above the ground, more so than later fruit sets (second harvest), and thus appeared to be less susceptible to decay or groundscarring. The lower percentage of decay for prostrate plants in the 53G F₂ but not in 20G F₂ may have been related to the larger plant habit of the former. The large, upright plant may have had a higher relative humidity within its canopy relative to the smaller plant. Surface blemishes on fruit within a larger plant may have led to decay, whereas those in a smaller, upright plant did not. In addition to greater marketable yield, plants exhibiting PGH were notably easier to harvest, although no quantitative data were obtained. Increased solar injury might be a potential problem in prostrate plants in some environments, but was not detected in our experiment.

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