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Inheritance of a Short-internode Mutant of 'Mainstream' Muskmelon

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Abstract. A short-internode mutant of 'Mainstream' muskmelon (*Cucumis melo* L.), designated Main Dwarf, was crossed with 13 normal and six short-internode cultivars or breeding lines. Regardless of whether Main Dwarf was crossed with a normal or short-internode line, the F₁ family was normal for internode length. From crosses of Main Dwarf with normal lines, the F₂ families segregated in a 3 normal : 1 short-internode ratio and the families from backcrosses to Main Dwarf segregated 1 normal : 1 short internode. Crosses of Main Dwarf with short-internode lines produced F₂ families that segregated in a 9 normal : 7 short internode ratio and families from backcrosses to Main Dwarf that segregated 1 normal : 1 short internode. The segregation data from crosses of Main Dwarf with normal lines indicate that Main Dwarf has a recessive gene that conditions short internode. The segregation data from crosses of Main Dwarf with short-internode lines (five conditioned by *si-1* and one conditioned by *si-2*) indicate that the recessive gene for short internode in Main Dwarf is not allelic to *si-1* or *si-2*. The gene for short internodes in Main Dwarf is designated *si-3*.

Two short-internode (SI) muskmelon genotypes have been reported, the *si-1* gene SI (Bohn and Principe, 1968; Denna, 1962) and the *si-2* SI (Paris et al., 1984). Representatives of the *si-1* gene are 'Topmark Bush' (Zink, 1978), 'Minnesota 266' (Davis et al., 1976), and 'Ky-P₇' (Knavel, 1988). The *si-2* gene occurs in 'Persia 202', a Birdsnest-type muskmelon (Paris et al., 1984).

I discovered another SI plant in Lexington, Ky., in 1980 in a planting of the normal-internode (NI) cultivar Mainstream and designated it as Main Dwarf. Plants from open-pollinated fruit of the mutant segregated ≈ 1 normal : 1 short internode. Plants from self-pollinated fruit produced by controlled hand pollination of SI plants were homozygous for the SI character. In addition to short internodes, the leaves of SI plants were smaller and darker green, and fruits were smaller than those of 'Mainstream'.

My objective was to study the inheritance of the SI trait in Main Dwarf and determine if it is allelic with *si-1* or *si-2*.

Crosses of homozygous Main Dwarf plants with NI and SI cultivars and breeding lines (see Table 1), and F₂ and backcross generations were made in the greenhouse over several years. Parents, F₂, and BC populations of each cross were grown together in field plots the same year; however, data were combined across years and plantings from 1984 through 1988.

Each year, seeds were sown in 3.5 × 3.5-cm plastic pots (0.05 liter) containing a commercial potting medium. The plants were grown in the greenhouse for ≈ 30 days before transplanting to the field onto black polyethylene mulch that was spaced 1.8 m apart, center to center. The plants were spaced ≈ 1 m apart in a single row. Each year, all plots received 112 kg N/ha and P and K, based on soil analyses and Univ. of Kentucky Experiment Station, Lexington, recommendations for the Maury silt-loam soil (fine, mixed, mesic, typic Paleudalfs). The pH ranged from 5.9 to 6.4 over the years. All fertilizer materials were disked into the soil before laying the mulch. Supplemental overhead irrigation water was added only in 1988, when 25 mm was applied on 28 June

and 8 July to overcome severe drought conditions.

Plants of parents and progeny for each generation were grown in the same block with two replications each year. In the first 4 years, NI and SI segregates in F₂ and backcross generations were observed at ≈ 60 days of age (30 days after field-setting). In 1988, segregates were observed 90 days after transplanting.

Chi-squares and homogeneity tests were calculated according to procedures presented by North (1979) and Mather (1963), respectively.

Internode length was normal in F₁ families from crosses of Main Dwarf with NI parents (Table 1). F₂ families from these crosses segregated in a 3 NI : 1 SI ratio. The backcross of F₁ (P₁ × P₂) to Main Dwarf segregated 1 NI : 1 SI. These segregations clearly indicate that SI in Main Dwarf is controlled by a single recessive gene.

Internode length was normal in F₁ families from crosses of Main Dwarf with SI parents (Table 1). These data indicate that the SI character in Main Dwarf is not allelic to *si-1* reported in cultivars (Bohn and Principe, 1968; Denna, 1962) Ky-P₇, Bushwhopper, and Bush Midget or *si-2* reported in 'Persia 202' (Paris et al., 1984).

If the SI gene in Main Dwarf were not allelic to *si-1* or *si-2*, the F₂ families from the crosses of Main Dwarf with the SI parents would have segregated in a 9:3:3:1 ratio, where the first class is NI. The last three classes are Main Dwarf, *si-1* or *si-2*, and the double recessive for SI, respectively. Because the SI phenotypes are similar, the three SI classes could not be distinguished. The F₂ families were, therefore, tested for goodness-of-fit to a 9 NI : 7 SI ratio. Although the two F₂ families from crosses of Main Dwarf with 'Ky-P₇' and 'Persia 202' fit poorly to the 9:7 ratios, the homogeneity chi-square indicated that the variation observed among the families was not greater than that due to chance (Table 1). It should also be noted that none of the families segregated in a 3 NI : 1 SI ratio (pooled across four *si-1* F₂ families: 950 NI : 656 SI; $\chi^2 = 215.1$, $P < 0.001$; homogeneity $\chi^2 = 2.60$, $P = 0.46$; and for the single *si-2* family: $\chi^2 = 6.94$, $P = 0.009$), which would be expected if the SI gene in Main Dwarf were allelic to *si-1* or *si-2*.

The relatively low probabilities for goodness-of-fit to a 9:7 ratio in four of the five

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Table 1. Segregation of normal and short internode in crosses of Main Dwarf mutant with normal and short-internode muskmelons.

Parent or genotype	Internode genotype ^a	No. plants		Expected ratio	χ^2	df	P
		Normal	Short				
Main Dwarf (P ₁)	3		120				
Mainstream (P ₂)	+	90					
TAM-Dew (P ₃)	+	30					
Chilton (P ₄)	+	60					
PI-140471 (P ₅)	1	30					
Ky-P ₇ (P ₆)	1		30				
Bushwhopper (P ₇)	1		30				
Bush Midget (P ₈)	1		30				
Persia-202 (P ₉)	2		12				
Main Dwarf x normal-internode parents ^b							
P ₁ x P ₂		90					
P ₁ x P ₃		30					
P ₁ x P ₄		30					
P ₁ x P ₅		30					
F ₂ (P ₁ x P ₂)		493	161	3:1	0.051	1	0.83
F ₂ (P ₁ x P ₃)		86	28	3:1	0.012	1	0.92
F ₂ (P ₁ x P ₄)		204	57	3:1	1.391	1	0.24
F ₂ (P ₁ x P ₅)		102	32	3:1	0.090	1	0.77
F ₂ total		885	278	3:1	0.745	1	0.41
F ₂ homogeneity					0.798	3	0.85
BC (P ₁ x P ₄)P ₁		146	134	1:1	0.514	1	0.48
Main Dwarf x short-internode parents ^b							
P ₁ x P ₆		30					
P ₆ x P ₁		30					
P ₁ x P ₇		30					
P ₁ x P ₈		30					
P ₁ x P ₉		30					
F ₂ (P ₁ x P ₆)		231	147	9:7	3.628	1	0.06
F ₂ (P ₆ x P ₁)		223	152	9:7	1.577	1	0.21
F ₂ (P ₁ x P ₇)		304	231	9:7	0.071	1	0.79
F ₂ (P ₁ x P ₈)		192	126	9:7	2.200	1	0.15
F ₂ (P ₁ x P ₉)		88	47	9:7	4.378	1	0.04
F ₂ total		1038	703	9:7	8.039	1	0.001
F ₂ homogeneity					3.819	4	0.44
BC (P ₁ x P ₆)P ₁		96	99	1:1	0.046	1	0.84
BC (P ₆ x P ₁)P ₁		203	196	1:1	0.122	1	0.73
BC (P ₁ x P ₇)P ₁		69	54	1:1	1.829	1	0.18
BC (P ₁ x P ₈)P ₁		107	114	1:1	0.222	1	0.65
BC total		475	463	1:1	0.154	1	0.70
BC homogeneity					2.060	3	0.56

^a+ = Normal internode; 1 = homozygous for *si-1*, 2 = homozygous for *si-2*, 3 = homozygous for *si-3*.

^bBC = backcross.

F₂ families could have been due to the genotypic differences of the SI parents. Internode measurements of the parents and progenies might increase accuracy in identifying NI and SI segregates. Paris et al. (1984) also reported difficulty in separating NI and SI plants in segregating families where 'Persia 202' was used as a parent.

Backcross families of F₁ (Main Dwarf x SI) Main Dwarf were expected to segregate 1 NI : 1 SI, conditioned by the gene in Main Dwarf. The four backcross family segregations fit well to the expected 1:1 ratio (Table 1).

Additional backcross segregation data obtained in 1988 from crosses of Main Dwarf with 'Extra-Early Green Flesh', 'Harvest Queen', 'Schoon's Hard Shell', 'Gulfstream', 'Rocky Ford', 'Honey Rock', 'Jumbo Hale's Best', 'Imperial-450', and 'Delicious-51', where Main Dwarf was the backcross parent, clearly supported the hypothesis of a single recessive gene for short-internodes in Main Dwarf (pooled across nine

backcross families: 412 NI : 422 SI; $\chi^2 = 0.120$, $P = 0.73$; homogeneity $\chi^2 = 3.89$, 8 df, $P = 0.86$). Similarly, additional data from backcrosses to Main Dwarf of F₁ families of crosses with 'Minnesota Midget', 'Honey Bush', and 'Bush Midget' supported the hypothesis of a recessive gene in Main Dwarf unique from *si-1* (pooled across three backcross families: 140 NI : 136 SI; $\chi^2 = 0.058$, $P = 0.81$; homogeneity $\chi^2 = 1.700$, 2 df, $P = 0.43$).

By rating plants later in the season in 1988, it was much easier to separate segregates according to internode type than when rating them earlier, as in previous years. This improvement is indicated by the low chi-squares obtained in the backcross populations grown out in 1988.

These data show that the gene for SI in Main Dwarf is not allelic to either the *si-1* or the *si-2* gene. Therefore, I propose that the SI gene for Main Dwarf be designated *si-3*.

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