Inheritance of Purple Petiole in Carrot, *Daucus carota* var. *sativa*[1]

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Abstract. **Dominant monogenic control of purple petiole (*G*) over green (*g*) was found in the carrot. Variations observed in intensity of purple suggested presence of modifier genes. Plants having purple petioles were easily identified at all stages of growth following true-leaf formation.**

Marker genes have been utilized in many ways to attain greater efficiency in genetic studies and breeding programs. The purple petiole characteristic observed in carrot (*Daucus carota* var. *sativa* L.) is a potentially useful marker. Laferriere and Gabelman (1) stated that purple petiole was controlled by a single dominant gene. They used the purple petiole to detect hybrid progeny in their genetic study of root color. The study reported herein was conducted to determine genetic control of purple petiole and stages of plant growth exhibiting purple petiole.

The inbred carrot lines used as parents for the inheritance study were purple petiole TS1, derived from the cultivar 'Tendersweet', and green petiole WCR1, derived from the cross ('Yellow Belgian' x 'Imperator') x ('Waltham Hi-Color' x 'Tendersweet').

Cross pollinations were made in the greenhouse during winter and early spring. Male sterility was not present in either parent; thus, protandry and emasculation were used to obtain crosses. An umbel from each plant of a cross was enclosed in a cylindrical wire cage covered with 128 gauge white muslin. Fly pupae were placed in each cage twice weekly for a period of 3-4 weeks to effect cross pollination. Self pollination of single plants was done in the same manner except that 2-4 umbels were enclosed in a cage. Each plant in a cross was simultaneously self-pollinated to determine if it was true breeding for petiole color.

The parents, F_1 hybrids, and F_2 and backcross progenies were grown in the field and in the greenhouse. Standard commercial practices for carrot production on peat soil were used in the field. In the greenhouse, the carrots were grown in vermiculite in porcelain crocks. Nutrients were supplied to the seedlings by a twice weekly application of Hoagland nutrient solution.

The field-grown carrots were classified for petiole color when root diameter was about 1/4 inch and at harvest time. Those grown in the greenhouse were classified when seedlings were in the 2-3 true-leaf stage.

The data from greenhouse and field classification for petiole color for parents, F_1 hybrids and F_2 and backcross populations are presented in Table 1. There were no differences in the data from the 2 times of petiole classification in the field; thus, only one set of data is presented. Complete dominance of purple to green petiole is shown in both the greenhouse and field data. All F_1 plants had purple petioles and could not be distinguished on the basis of petiole color from the purple parent. Maternal effects were not observed in any of the progeny from reciprocal crosses. There were no significant (5% level) deviations from the 3:1 ratio in F_2 progenies and the 1.1 ratio in test cross progenies. The homogeneity Chi-squares for pooled data for F_2 progenies were non-significant at the 5% level. The 4 green petiole plants from the backcross to the purple parent possibly resulted from pollen contamination or from seed mixture during time of seed cleaning or planting in the field. The symbol "*g*" is proposed for the recessive allele (green) and "*G*" for the dominant allele (purple).

The complete agreement between the data from the greenhouse and the field indicated that purple petiole could be used as a marker at any stage of plant growth after true-leaf formation. In this study purple petiole plants were easily identified at the 2-3 true-leaf stage, when root diameter was approximated 1/4 inch, and at harvest time. The presence of the purple petiole characteristic throughout the entire growth period of the plant makes it more valuable as a marker for carrot studies.

There were variations in intensity of purple in the parent TS1 and in progeny having purple petioles. This was observed in both the greenhouse and the field. This variation indicates the possible presence of modifer genes in addition to the one major gene controlling the presence or absence of purple (anthocyanin) in the petioles. In the presence of a dominant allele, the modifer genes apparently control the quantity of anthocyanin produced. Additional information concerning the modifer genes could possibly be obtained from quantitative measurements of anthocyanin in the petioles.

Literature Cited

1. Laferriere, L., and W. H. Gabelman. 1968. Inheritance of color, total carotenoids, alpha-carotene, and beta-carotene in carrots, *Daucus carota*. *Proc. Amer. Soc. Hort. Sci.* 93:408-418.

Table 1. Inheritance of purple petiole in carrot.

Parents	Generation	No. of progenies[a]	No. of Plants: Greenhouse[b] Purple	Greenhouse[b] Green	Chi Square[d]	Field[c] Purple	Field[c] Green	Chi Square[d]
TS1	P_{1_p}		38	0		80	0	
WCR1	P_{1_g}		0	65		0	28	
P_{1_p} selfed	S_{1_p}		85	0		175	0	
P_{1_g} selfed	S_{1_g}		0	112		0	137	
$P_{1_g} \times P_{1_p}$	F_1		148	0		176	0	
$P_{1_p} \times P_{1_g}$	F_1		208	0		110	0	
$(P_{1_g} \times P_{1_p})$ selfed	F_2	10	602	183	1.19	641	230	0.92
$(P_{1_p} \times P_{1_g})$ selfed	F_2	6	358	114	0.18	392	133	0.03
$(P_{1_g} \times P_{1_p}) \times P_{1_g}$	BC_1	1	--	--		36	29	0.75
$P_{1_g} \times (P_{1_g} \times P_{1_p})$	BC_1	1	--	--		18	24	0.86
$(P_{1_g} \times P_{1_p}) \times P_{1_p}$	BC_1	2	44	0		163	4	

[a]Number of plants selfed or number of backcrosses.

[b]Classified when seedlings were in 2-3 true-leaf stage.

[c]Classified when root diameter was about 1/4 inch and at harvest time.

[d]Chi-square tests for 3:1 ratio in F_2 and 1:1 ratio in test crosses. F_2 test calculated on basis of pooled data (homogeneity chi-square's for pooled data non-significant at 5% level). All values non-significant at 5% level.

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