Table 2. Effect on top weight of 16 or 24 hr daily radiation at different levels but same total radiation.

Cultivar	Trial	Fresh wt (g)[z] 16 hr	Fresh wt (g)[z] 24 hr	% wt inc	Dry wt (g ± SE)[z] 16 hr	Dry wt (g ± SE)[z] 24 hr	% wt inc
RubyConn	1	112	165		6.09 ± 0.26	9.53 ± 0.31	
	2	138	168		7.27 ± 0.37	9.66 ± 0.43	
	Mean	125	167	33	6.68 ± 0.22	9.60 ± 0.26	44
Waldmanns Green	1	112	149		7.03 ± 0.47	9.47 ± 0.53	
	2	121	164		7.19 ± 0.59	10.74 ± 0.84	
	Mean	117	157	34	7.11 ± 0.36	10.26 ± 0.48	44
Grand Rapids Forcing	1	95	147		5.63 ± 0.48	8.95 ± 0.71	
	2	110	152		6.16 ± 0.65	8.94 ± 0.50	
	Mean	103	150	46	5.90 ± 0.40	8.95 ± 0.41	52
Salina	1	77	91	18	4.59 ± 0.25	5.87 ± 0.38	28
Salad Bowl	2	86	126	47	4.78 ± 0.33	7.40 ± 0.46	55

[z]Mean of 8 plants per trial.

crease in yield was obtained using continuous radiation while holding daily radiant input constant.

If the leaves had been radiation saturated, extension of the photoperiod from 16 to 24 hr should have increased top weight more than an increase of radiation intensity. The increased top weight however, was much more than predicted from the increased total radiation (50% in total radiation and 100% in top weight) (Table 1).

When plants receive the same total radiation, those grown under a 24 hr photoperiod would be expected to weight more than plants under a 16 hr photoperiod (Table 2) if the plants were near radiation saturation at the lower PPFD. However, data of Craker and Seibert (4) do not support radiation saturation at our PPFD level, since they obtained increased growth even without elevated CO_2 levels as the radiation was increased from 14.1 to 113 $W \cdot m^{-2}$, whether at 8, 16, or 24 hr photoperiods. With cool-white fluorescent lamps, 113 $W \cdot m^{-2}$ corresponds to a PPFD of 520 $\mu mol\ s^{-1}\ m^{-2}$, which is higher than we used.

Also not supporting radiation saturation at ambient CO_2 level, Knight and Mitchell (8) found that 'Salad Bowl' leaves increased in dry weight 50% under continuous radiation from fluorescent-incandescent lamps when the PPFD was increased 100% (from 455 to 918 $\mu mol\ s^{-1}\ m^{-2}$). Leaf necrosis that developed at the high PPFD was partly alleviated by adding more nitrogen to the nutrient solution. Plant spacing was 20 by 25 cm.

Generally, tipburn was more evident with continuous radiation; however, 'Grand Rapids Forcing' had very little tipburn, even with continuous radiation and 'Salad Bowl' had no tipburn. No bolting occurred.

Commercial production of loose-leaf lettuce would become significantly more feasible under continuous lighting as compared to the usual 16 or 18 hr photoperiod. Besides a greater yield per unit radiation energy input, fewer lamp fixtures would be required.

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Inheritance of Growth Habit in Progenies of 'Com-Pact Redhaven' Peach

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Abstract. **Inheritance of growth habit was studied in F_1, F_2, and backcross progenies of peach [*Prunus persica* (L.) Batsch 'Com-Pact Redhaven']. Segregation ratios indicate that compact growth habit is conditioned by a single dominant allele, for which 'Com-Pact Redhaven' is heterozygous. The symbol *Ct* is proposed for this locus.**

Peach trees with reduced stature offer the potential of precocity, high annual yields per unit area, and reduced cultural efforts to control tree size (5, 8, 9, 10). As such, they may become an integral part of high density orchard design systems. Several distinct trees types with reduced stature have been identified, although currently none are used in commercial production.

Brachytic dwarf trees were described as early as 1867 (12, 17). Brachytic dwarfism (DW) was found to be controlled by a single recessive gene (13). The dwarf gene (dw) is apparently affected by modifying genes, as DW trees exhibit a considerable range in plant height (11). Lammerts (13) described seedlings of 'Babcock' with a bushy growth habit characterized by short internodes and thickened branches. 'Babcock', self-pollinated, gave normal and bushy seedlings in the ratio 15:1. Two duplicate recessive factors (bu_1

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and bu_2), for which 'Babcock' is heterozygous, were proposed to control this trait. Monet and Salesses (14) selfed 'Robin', an offspring of 'Babcock' x 'Mayflower', and found erect seedlings with short internodes, presumably identical to the bushy seedlings of Lammerts (13). Monet and Salesses (14) also described a semidwarf seedling 'A72' which, when selfed, gave standard, semidwarf, and dwarf seedlings in the ratio 1:2:1, indicating imcomplete dominance. They proposed the symbol *n* for this locus.

Researchers have found other tree forms to be less simply inherited. Connors (6) selfed and crossed cultivars with a spreading (SP) or upright (UP) growth habit. When selfed, cultivars with either growth habit gave seedlings of the parental type. Crosses of SP with UP parents gave an intermediate (IN) growth habit. Connors (6) suggested that these hybrids when selfed would give UP, IN, and SP seedlings in the ratio of 1:2:1. Modern cultivars are rather homogenous for IN, and polygenic control is likely (7, 11).

Several seedlings and sports of 'Elberta' have reduced tree size. When Connors (6) selfed 'Elberta', several seedlings of the "semidwarf" 'J.H. Hale' type were recovered. Connors also described a bud mutation of 'Elberta' which was 2.1 m tall at 5 years at age, about 50% of the standard height. When open pollinated, this mutant gave dwarf and semidwarf seedlings. 'Elbertita' arose as an open pollinated seedling of a dwarf mutant of Elberta and has tree one-third to one-half the size of standard 'Elberta' (3).

Blake (1) described 'Japan Dwarf Blood' as having a compact growth habit. F_1 seedlings from the cross 'J.H. Hale' × 'Japan Dwarf Blood' were somewhat less compact than the male parent.

The difficulty with much of the information on peach tree growth habit lies in the absence of standards for classifying trees as SP, UP, IN, DW, semidwarf (SD), or compact (CT). Thus, classification usually is based on subjective evaluation of tree height, canopy size, or structure without reference standards. Recent work (15) has characterized in detail growth and branching pattern of DW, CT, and SD phenotypes arising from 'Com-Pact Redhaven' and 'Empress' dwarf germplasm.

'Com-Pact Redhaven' (CRH) peach was discovered in Orondo, Wash., in 1964 as a bud mutation of 'Redhaven' (2, 18). Compared to standard trees, compact seedlings of CRH have shorter internodes, very wide branch angles, and a high percentage of budbreak on primary and secondary branches, which results in a very dense canopy and reduced light penetration (15). The objective of this research was to study the inheritance of growth habit in progenies of 'Com-Pact Redhaven' and observe other characteristics in segregating progenies.

'Com-pact Redhaven' (CRH) was crossed by L.F. Hough and C.H. Bailey in 1975 and 1976 with several standard-sized selections in the New Jersey breeding program. Seedlings were grown at the Rutgers Fruit Research Center, Cream Ridge, N.J. Compact F_1 hybrids were crossed by Hough and Bailey to selections and cultivars with standard growth habit in 1980, 1981, and 1982, and the seedlings also were grown at Cream Ridge. Two compact F_1 selections from (standard x CRH) crosses were hybridized to produce a progeny designated NJ8104. An additional cross, 'Empress' dwarf x CRH, was made by H.W. Fogle at the USDA Beltsville Agricultural Research Center, Beltsville, Md., and seedlings were grown at the USDA Appalachian Fruit Research

Fig. 1. Representative peach seedlings segregating for compact and standard growth habit at the end of the 1st (**A**), 2nd (**B**), and 3rd (**C**) season.

Table 1. Segregation for growth habit in F_1, BC, and F_2 progenies of 'Com-Pact Redhaven' peach.

Progeny	Cross	Observed growth habit Compact	Standard	Chi Square[z]	Probability
F_1 (Standard x Com-pact Redhaven)					
7501	Jerseydawn x CRH	17	23	0.90	0.30–0.40
7503	NJN70 x CRH	6	3	1.00	0.30–0.40
7504	NJ590515 x CRH	14	24	2.63	0.10–0.20
7506	NJ211 x CRH	17	15	0.06	0.80
7507	NJN55 x CRH	11	15	0.62	0.40–0.50
76170	RR47-202 x CRH	23	14	2.19	0.10–0.20
76181	Babygold 8 x CRH	21	27	0.75	0.30–0.40
76184	RR51-194 x CRH	4	3	0.14	0.70
F_1 (Dwarf x Com-pact Redhaven)					
	Empress x CRH	91	96[y]	0.13	0.70–0.80
	Total of F_1 (9 progenies)	204	220	0.60	0.40–0.50
	Homogeneity			7.82	0.40–0.50
BC (Com-pact F_1 x Standard)					
80109	7503-1 x B7-2-129	13	11	0.17	0.60–0.70
8106	7501-1 x Sunhigh	34	41	0.65	0.40–0.50
BC (Standard x Com-pact F_1)					
8119	RR53-194 x 76181-1	16	17	0.03	0.80–0.90
8218	NJN78 x 7507-1	24	23	0.02	0.80–0.90
8229	NJC112 x (B9-16-88 x CRH)	7	2	1.39	0.20–0.30
	Total of BC (5 progenies)	94	94	0.00	1.00
	Homogeneity			2.26	0.60–0.70
F_2 (Com-pact F_1 x Com-pact F_1)					
8104	76181-1 x (B9-16-88 x CRH)	28	7	0.47	0.40–0.50
P_2 open pollinated					
	Com-pact Redhaven o.p.	62	25	0.65	0.40–0.50
	Total of progenies segregating 3:1	90	32	0.10	0.70–0.80
	Homogeneity			1.02	0.30

[z]Expected ratio 1 compact : 1 standard for F1 and BC progenies; 3 compact : 1 standard for F_2 and P_2 open pollinated.
[y]CtctDwdw genotypes appear to be semidwarf.

Center, Kearneysville, W.Va. Open-pollinated seeds of CRH also were collected by Fogle and grown at Kearneysville.

Seedlings of the F_1 and first backcross generations were observed to segregate into 2 growth habits (compact and standard) which could be distinguished easily on the basis of tree height, branch angle, and canopy density (Fig. 1). F_1 (both standard x CRH and 'Empress' x CRH) and BC_1 (compact x standard) progenies segregated in a ratio growth habit of 1 compact : 1 standard. When 2 compact F_1 hybrids were crossed, a ratio of 3 compact: 1 standard tree type was observed. Open-pollinated seedlings of CRH also were observed to segregate in a 3:1 ratio. Open pollination of peach normally results in less than 5% outcrossing (11), and so this progeny was assumed to have resulted from selfing.

The data presented in Table 1 indicate that compact growth habit is conditioned by a single dominant gene for which CRH is heterozygous. We suggest the symbol *Ct* for this locus.

Compact seedlings vary in height and canopy density. A few very dense trees of the crosses 'Pollardi' (PI113650, a peach x almond hybrid with standard growth habit) x CRH and 'Empress' x CRH were 30% of normal height. Compact seedlings in other progenies are about 70% of the height of normal peaches. CRH is homozygous *DwDw*, as no F_1 seedlings were dwarf. Generally, the fruit color and sugar content are poor, probably due to the dense canopy. There also is a tendency for the fruit to be densely pubescent, especially in progeny NJ76181. In New Jersey, trees tend to be unusually and uniformly susceptible to Cytospora canker. Compact selections in several progenies have died from canker, whereas nearby standard selections were little affected. The need for extensive pruning, susceptibility to canker, and poor fruit quality at the present stage of genetic improvement may limit the usefulness of this phenotype.

Other sports and selections exhibit a compact growth habit. 'Compact Elberta' arose as a mutant of 'Fay Elberta' (4). Based upon field observation, its tree type is indistinguishable from that of CRH. Compact sports of breeding selections are also known (T.K. Toyama, personal communication). Allelism tests will be necessary to determine if all compact growth types in peach are controlled by the *Ct* locus. While the compact genotype appears to produce a canopy of undesirable density (8, 16), more favorable growth characteristics may result from combination with other genes controlling canopy development. The interaction of *Ct* with *dw* and other genes determining tree growth type requires further investigation.

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