Rootstock Influence on Flower Bud Hardiness and Yield of 'Redhaven' Peach

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Abstract. 'Redhaven' peach trees [*Prunus persica* (L.) Batsch.] on their own roots or budded to seven rootstock ['Bailey', 'Siberian C', 'Lovell', 'Halford' (seedlings), GF 655.2, GF 677 ('Amandier'), or 'Damas' (GF 1869) (clonal)] were evaluated for rootstock influence on flower bud hardiness, live pistils at bloom, thinning requirements, marketable yield, and production efficiency after exposure to temperatures lower than -23C in 1987 and to -26C in 1988. In 1987, flower bud hardiness was as great on 'Siberian C' as on own-rooted 'Redhaven' and greater than on the other rootstock. Fewer live pistils were observed during bloom on GF 677 than on 'Siberian C', 'Lovell', 'Damas', or self-rooted trees in 1987. In 1988, flower bud hardiness was greater on 'Siberian C' and 'Bailey' than on GF 677. At bloom, 'Lovell' and 'Siberian C' rootstock carried more flowers with live pistils than 'Damas'. 'Siberian C' and 'Lovell' required significantly greater fruit thinning than all other rootstock and self-rooted trees. GF 677 produced a larger marketable crop than GF 655.2 or 'Damas'. In addition, 'Bailey', 'Lovell', and self-rooted trees produced a significantly larger crop than 'Damas'. No significant rootstock effect on production efficiency was detected in either year. Tree vigor during the growing season preceding each freeze did not significantly influence flower bud survival or productivity.

Peach production in much of the eastern United States varies from year to year due to insufficient flower bud hardiness during late winter when temperature fluctuations are extreme, and during bloom when pistils are susceptible to frost injury. One potential method of increasing cropping consistency is through the selection of rootstock that enhance flower bud hardiness in winter or pistil hardiness during bloom (Brown and Cummins, 1988; Durner and Rooney, 1988; Layne et al., 1977; Layne, 1987; Ormrod and Layne, 1977).

Brown and Cummins (1988) and War-mund and Slater (1988) evaluated 'Redhaven' flower bud hardiness on trees in the 1984 NC-140 peach rootstock planting after one test winter in New York, or after controlled laboratory freezing experiments in Missouri, respectively.

Two consecutive test winters in New Jersey provided the opportunity to evaluate rootstock influence on flower bud hardiness under field conditions in a corresponding 1984 NC-140 peach rootstock planting located at Rutgers Fruit Research Center in Cream

Ridge, N.J. The number of live pistils at bloom, thinning requirements, marketable fruit yield, and production efficiency were also evaluated after both winters.

Trees were planted in a randomized complete block design with 'Redhaven' as the scion. The soil was a well-drained sandy loam

with a pH of 6.2. Tree spacing was 4.6 × 6.1 m in rows oriented east-west with a slight westerly slope (<5°). Trees were dormant-pruned to an open center maintained at a 2-m tree height. The rootstock evaluated were 'Bailey', 'Siberian C', 'Lovell', 'Halford' (seedlings), GF 655.2 (*P. insititia*), GF 677 ('Amandier'), 'Damas' (GF 1869) (*P. domestica* × *P. spinosa* (clonal), or self-rooted 'Redhaven'.

On 28 Jan. 1987, the minimum temperature in the orchard 1 m above the soil surface went below -23C (thermograph limit) for 4 hr. On 15 Jan. 1988 the minimum orchard temperature at 1 m was -26C.

On 12 Feb. 1987 and 21 Jan. 1988, 30-cm terminal shoots were sampled from the canopy periphery 1 m from the ground from three trees per rootstock in 1987 and from seven in 1988. Four twigs per tree were sampled in 1987 and three in 1988. Flower bud viability in both years was determined by dissection. On 9 Apr. 1987 and 19 Apr. 1988, blossoms with live pistils were counted on four (1987) or five (1988) 30-cm terminal shoots around the canopy periphery 1 m from the ground on each of seven trees per rootstock. Fifty percent bloom occurred on 20 Apr. in 1987, and 21 Apr. in 1988. GF 655.2 and 'Damas' had a slightly advanced bloom, while 'Lovell' and 'Siberian C' had a slightly delayed bloom compared to the other rootstock in both years. Fruit were space-thinned by hand to 15 to 20 cm apart each year. Trees were individually rated for the amount of fruit thinning required in 1987. A rating scale was employed where 0 = no thinning, 1 = light thinning, 2 = moderate thinning, and 3 = heavy thinning. Ratings were assigned subjectively based on relative densi-

Table 1. Flower bud hardiness, fruiting, and tree characteristics after two consecutive test winters of 'Redhaven' peach on its own roots or budded to seven other rootstocks.¹

Rootstock	Live flower buds (%)	Live pistils (per 30 cm)	Fruit thinning ²	Marketable yield (kg/tree)	Production efficiency (kg-cm ⁻²)	Tree vigor (1986) (cm ² trunk growth)
1987						
Bailey	26 bc	6 ab	1.4	22.0	0.38	2.97 ab
GF 655.2	15 c	5 ab	1.6	18.2	0.36	2.03 ab
GF 677	27 b	3 b	1.8	15.8	0.24	4.41 ab
Siberian C	45 a	8 a	1.1	24.2	0.41	6.43 a
Self-rooted	34 ab	7 a	1.4	24.7	0.43	4.17 ab
Lovell	32 b	8 a	1.4	25.4	0.41	2.67 ab
Halford	31 b	5 ab	1.9	17.2	0.29	3.36 ab
Damas	28 b	7 a	1.7	16.0	0.33	1.12 b
1988						
Bailey	27 a	6 ab	2.9 b	47.9 ab	0.51	34.8 abc
GF 655.2	21 ab	5 ab	1.7 b	36.5 bc	0.52	24.6 cd
GF 677	11 b	6 ab	2.4 b	58.8 a	0.55	42.3 a
Siberian C	34 a	7 a	5.1 a	41.1 abc	0.48	27.9 bc
Self-rooted	23 ab	5 ab	3.0 b	48.9 ab	0.56	31.1 bc
Lovell	22 ab	7 a	5.4 a	54.0 ab	0.61	27.3 bcd
Halford	26 ab	6 ab	2.8 b	46.4 abc	0.50	34.9 ab
Damas	25 ab	4 b	1.8 b	27.1 c	0.39	17.8 d

¹Mean separation within columns by Ryan-Einot-Gabriel-Welsch F test. Absence of mean separation letters indicates lack of significance.

²Rating in 1987; thinning intensity (fruit/cm² of trunk cross-sectional area) in 1988.

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ties of fruits on the ground directly under the canopy after thinning. Fruits removed from each tree at thinning were counted in 1988. Thinning intensity for 1988 was determined by dividing the number of fruit removed at thinning by trunk cross-sectional area 30 cm above the bud union. Fruit were harvested from 24 July through 5 Aug. 1987 and 'from 29 July through 9 Aug. 1988. Production efficiency was estimated by dividing yield per tree by the trunk cross-sectional area 30 cm above the bud union. Tree vigor was estimated by calculating the increase in trunk cross-sectional area each growing season before the freeze. For data consisting of multiple observations per tree, mean values of the response variable per tree were calculated and used in the analysis. All data were analyzed using analysis of variance and rootstock means were separated with the Ryan-Einot-Gabriel-Welsch multiple F test (SAS Institute, Inc., 1985), a conservative mean separation technique that controls the experiment-wise error rate.

Flower bud survival was significantly affected by rootstock in both years (Table 1). In 1987, flower buds were harder on 'Siberian C' than on 'Bailey', GF 655.2, GF 677, 'Lovell', 'Halford', or 'Damas'. All stocks, except 'Bailey', imparted greater flower bud hardiness than GF 655.2. In 1988, bud hardiness was greater on 'Siberian C' and 'Bailey' than on GF 677.

The number of live pistils per 30 cm of terminal shoot, was also influenced by rootstock in both years. In 1987, fewer live pistils were observed on GF 677 than on 'Siberian C', 'Lovell', 'Damas', or self-rooted trees. In 1988, more live pistils were observed on 'Lovell' and 'Siberian C' than on 'Damas'. In both years, flower bud survival after the late-winter stress was not correlated with live pistils at bloom ($r = 0.58$, $P = 0.13$ for 1987 and $r = 0.20$, $P = 0.64$ for 1988). Additional bud injury must have occurred after sampling.

Fruit thinning in peach is an intensive, expensive operation. Any significant increase in bud hardiness due to rootstock might be offset by increased costs for fruit thinning. No significant rootstock effect on fruit thinning intensity was detected in 1987. All trees required light to moderate thinning. A significant rootstock effect was detected in 1988. 'Siberian C' and 'Lovell' required the greatest fruit thinning. Thinning intensity was correlated ($r = 0.84$, $P = 0.009$) with the number of live pistils per 30-cm shoot, but not with flower bud survival after the late-winter stress ($r = 0.42$, $P = 0.30$).

Marketable yield was not affected by rootstock in 1987, but was in 1988, when GF 677 produced a larger crop than GF 655.2 or 'Damas'. 'Bailey', 'Lovell', and self-rooted trees produced a significantly larger crop than 'Damas'. Marketable yield in 1988 was two to three times higher than yield in 1987 on all rootstock. No significant rootstock effect on production efficiency was detected in either year.

Clearly, rootstock influences tree vigor (Table 1); however, no clear relationship

could be discerned between flower bud hardiness and scion vigor the preceding summer.

Both flower bud survival and production efficiency were much lower than reported by Brown and Cummins (1988) for the same scion-rootstock combinations. This difference reflects the tremendous influence local environment has on rootstock performance.

In 1987, rootstock affected flower bud survival after a severe freeze, but not marketable yield. Similar results were observed in 1988. In 1988, the scion with the poorest flower bud survival, 'Redhaven' on GF 677, produced the highest yield. Thus, up to an 89% flower bud loss following a test winter may not give an adequate indication of potential yield the following growing season.

In a previous test (Durner and Rooney, 1988), rootstock did not significantly affect flower bud cold hardiness in 'Rio Oso Gem' or 'Loring' during the same 2-year test period. It appears that rootstock effects on flower bud hardiness under our climatic conditions have a minimal effect on production unless

bud loss is virtually complete.

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Holding Tomato Transplants in Plug Trays

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Abstract. Tomatoes (*Lycopersicon esculentum* Mill. cv. Jet Star) seedlings grown in small cells (plugs) in trays holding 200, 406, or 648 plants per flat (28 × 55 cm) were larger after 6 weeks as cell size increased, but all were acceptable. Other seedlings, transplanted at weekly intervals from plug trays to plastic cell packs (48 cells per 28 × 55-cm flat), were of similar size during weeks 1-3; seedlings from 648-plug trays were smaller than the others by week 5-6. Seedlings from 200-plug trays planted at weekly intervals into containers where plant-plant competition was absent were larger through 6 weeks than those from 406- and 648-plug trays. Early marketable and total yields were similar for plants held in 406-plug trays 1 to 4 weeks before their transfer to 48-cell flats, but yield decreased for those held 5 to 7 weeks.

Producing bedding plants in plug trays offers advantages of mechanization of planting and ease of transplanting to larger growing

containers. Increasing plants per unit area of greenhouse space during initial growth conserves space and lowers production costs. Plug seedlings, plants grown in small-volume cells, are used in the production of floricultural and vegetable crops (Koransky and Laffe, 1983). In the Great Plains of the United States, where variable spring freezes make scheduling of transplanting difficult, plug trays may be used to hold seedlings before transplanting them to larger containers or into the field. Cost efficiency of greenhouse bench space would increase because of the high plant density in plug trays. Tomatoes rapidly initiate roots following transplanting (Loomis, 1924). Other researchers have obtained equal or greater yields with young or small tomato transplants (Chipman, 1961; Cooper and

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