Performance of New Peach Rootstocks for Ontario

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Introduction

For decades, peach cultivars grown in Ontario have been predominately grafted on Bailey peach seedling rootstocks. Bailey is a *Prunus* selection from Iowa that imparts cold hardiness and uniform and reliable yields (OMAFRA, 2021), but lacks vigour control and tolerance to several important abiotic and biotic stresses (Layne, 1987). New genotypes for peach rootstocks possessing diverse horticultural traits are being developed worldwide to increase productivity and improve efficiency through improved tree survival, controlled tree vigour, increased fruit size and quality (Reighard and Loreti 2008; Reig et al. 2020). A wider selection of rootstocks is becoming increasingly available which has improved tolerance to abiotic stresses (such as compacted and coarse-textured soils, high-pH soils and cold winter temperatures) and biotic stresses (such as parasitic nematodes, rot fungal pathogens and orchard replant problems) (Loreti and Massai 2006; Reighard and Loreti 2008; Jiménez et al. 2011; Iglesias et al. 2018).

As planting density and production costs increase, developing new size-controlling rootstocks with novel traits is also of interest to peach and nectarine producers. Size control in peaches has the potential to increase yield efficiency and reduce production costs by reducing the time to prune, thin and harvest trees (Reig et al. 2020). Similar benefits in apple production have been realized since the dwarfing East Malling rootstocks were introduced in the 20th century (Marini and Fazio, 2018).

Preliminary research conducted in other regions of North America by researchers affiliated with the NC-140 USDA technical committee, and other European researchers suggests that there are several new peach rootstocks with attributes suitable for the Ontario tender fruit industry (Font I Forcada et al. 2020; Reighard et al. 2015; Lordan et al. 2019). These include tolerance to drought, finer-textured (heavier) soils (which are often prone to wetter conditions than sandy soils), and resistance to parasitic nematodes and soil fungi, and replant disease (Iglesias et al. 2018).

This study focuses on a series of rootstock genotypes developed by Agromillora Group, (Agromillora Iberia S.L., Subirats, Spain), a commercial breeding program company in Catalonia, Spain. These rootstocks have been reported to have varying degrees of size control, adaptation to different types of soil, ease of vegetative propagation via tissue culture, and good compatibility with *Prunus* species. Rootpac®-20 (synonym Densipac), Rootpac®-40 (synonym Nanopac), Rootpac®-70, and Rootpac®-R (synonym Replantpac) specifically have different levels of size control, cold hardiness, tolerance to wet soils, and resistance to root-knot nematodes (*Meloidogyne incognita*, *Meloidogyne javanica*), root-lesion nematodes (*Pratylenchus penetrans* or *Pratylenchus vulnus*) and root rot (*Rosellinia necatrix*) (see Cline and Bakker, 2021 for more details). These inter-

specific peach, plum, and almond hybrid rootstocks have not been examined widely in North America.

Two multi-year orchard experiments were established in 2016 and 2017 to measure the performance of Redhaven and Cresthaven, on several Rootpac®, Controller series, Guardian, and to compare these with Bailey and Lovell, the current industry standards.

Materials and Methods

Experiment 1: 2016 Rootstocks Experiment

Redhaven peach trees on Rootpac®-R, Rootpac®-20, Rootpac®-40, Rootpac®-70 and Bailey rootstock were planted in the spring of 2016 at a spacing of 1.8 x 5.0 meters. Treatments are replicated 5 times with 7 trees per replicate and trained to central leader system. Trees are trickle irrigated and all aspects of crop management (pruning, fertilizer, pest control etc.) followed common commercial practices. Trees were hand thinned each year by removing all but one fruit per cluster and spacing fruit ~10-15 cm apart.

All fruit >2.25 inches in diameter were harvested in one to three picks on 9 Aug 2017, 14 Aug 2018, 20, 23 Aug 2019, 18, 21 Aug 2020, 11-12, 14-16 Aug 2021, 9-11 Aug 2022, 10-11, 14-16, 18-21 Aug 2023. Data on fruit number and yield, rootstock suckers, trunk circumference and tree longevity were recorded each year.

Experiment 2: 2017 NC-140 Rootstock Experiment

Cresthaven peach trees on Controller 6, Controller 7, Controller 8, Rootpac®-20, Rootpac®-40, Lovell, and Guardian rootstocks were planted in the spring of 2017 at a spacing of 1.8 x 5.0 meters. Regrettably, Bailey rootstock was not available to include in this experiment. Treatments are replicated five times with four trees per replicate and trained to a perpendicular ‘V’ system. Trees are trickle irrigated and all aspects of crop management (pruning, fertilizer, pest control etc.) followed common commercial practices. Trees are monitored annually for trunk circumference growth, yield, fruit size, suckering and mortality. Trees were thinned by hand after fruit set to ~18-20 cm spacing between fruits. This equated to a target of ~2 fruit per cm^2 TCSA.

Trees were defruited in 2018 and 2019 to aid tree establishment and growth. All fruit >2.25 inches in diameter were harvested in one to three picks on 9-10 Sept 2020, 2 Sept 2021, 31 Aug, 2 Sept 2022, 3-5, 6-8, 12 Sept 2023. Data on fruit number and yield, rootstock suckers, trunk circumference and tree longevity were recorded each year.

Results

Experiment 1: 2016 Rootstock Experiment

In 2019, several Redhaven trees on Rootpac®-40 trees were showing sudden decline (Figure 1). The cause was not clear – but is very likely related to cold injury or a pathogen. Symptoms observed in 2019 were not uniform across blocks, with only two of the five

replications affected. Additional trees died in 2020, 2022 and 2023 with symptoms observed in all replications of Rootpac-40. As of the fall of 2023, there has been no tree mortality for trees on Bailey, Rootpac®-20, Rootpac®-70, however 3% of Rootpac®-R trees have died, and 56% trees on Rootpac®-40 have died (data not shown).

Figure 1. Redhaven trees on Rootpac®-40 showing tree decline in their 4th leaf in August 2019. University of Guelph, Simcoe

Trees on Rootpac®-20 had the greatest number of rootstock suckers (an average of 3.3 per tree) in 2023 followed by Rootpac®-R (1.8 per tree). All the other rootstocks produced negligible (<0.6 per tree) suckers (data not shown).

As of 2023, the 8th year since planting, trees on Rootpac®-70 were more vigorous than the other rootstocks. Bailey trees were least vigorous but statistically similar to Rootpac®-20 and Rootpac®-R (Figure 2).

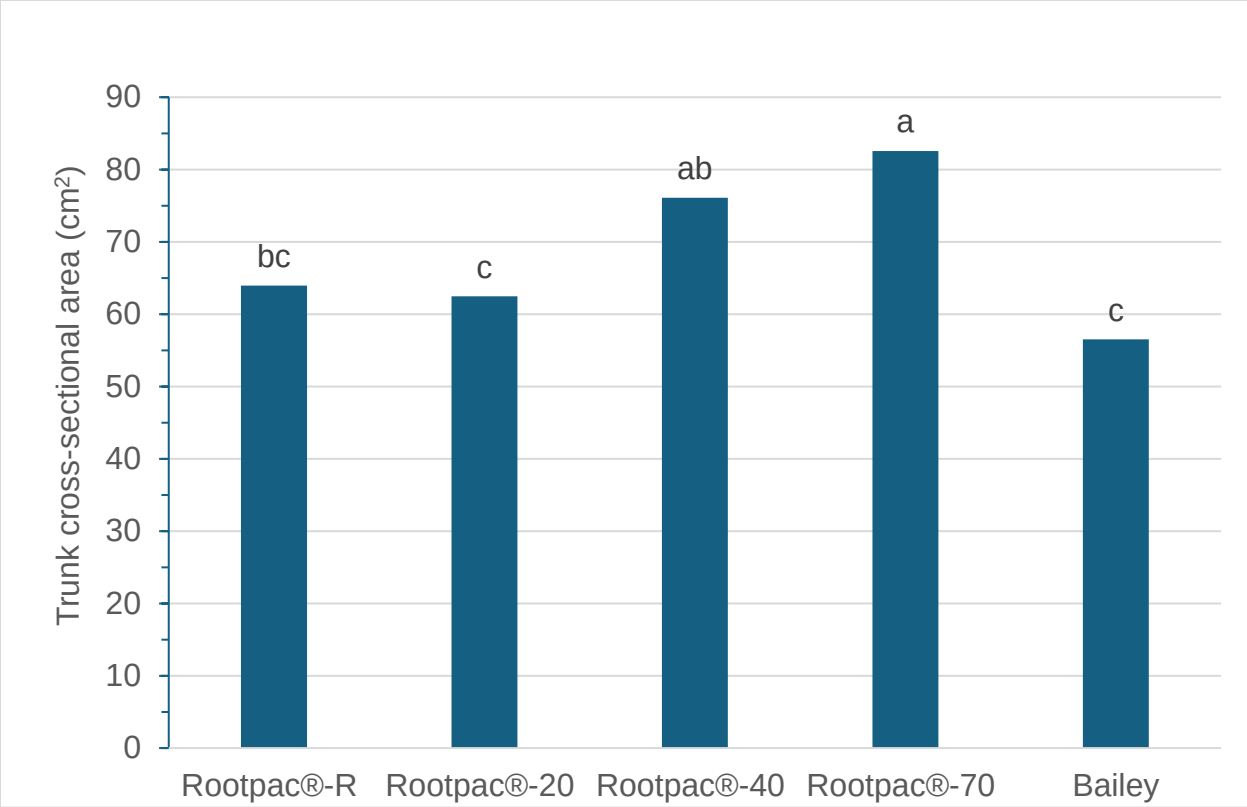

Figure 2. Tree vigor of Redhaven peach trees on various rootstocks after eight growing seasons at the University of Guelph, Simcoe (as of 2023). Mean values labelled with the same letter are not significantly different according to Tukey's HSD test at $P = 0.05$.

Cumulative yields have been greatest on Rootpac®-70 and Bailey followed by Rootpac®-R and Rootpac®-20. Trees on Rootpac®-40 rootstock have produced the lowest cumulative yields (Figure 3). Trees on Bailey rootstock have generated the greatest yield efficiency while trees on Rootpac®-40 have been least efficient.

Rootstocks had a significant effect on the average fruit weight of marketable fruit in all bearing years of the experiment except for 2017. Averaged over 2017-2023, trees on Rootpac®-40 rootstock had the highest average fruit weight of 187 g per fruit. Average fruit weight of the other rootstocks ranged from 152-165 g with no statistically significant differences among them (data not shown).

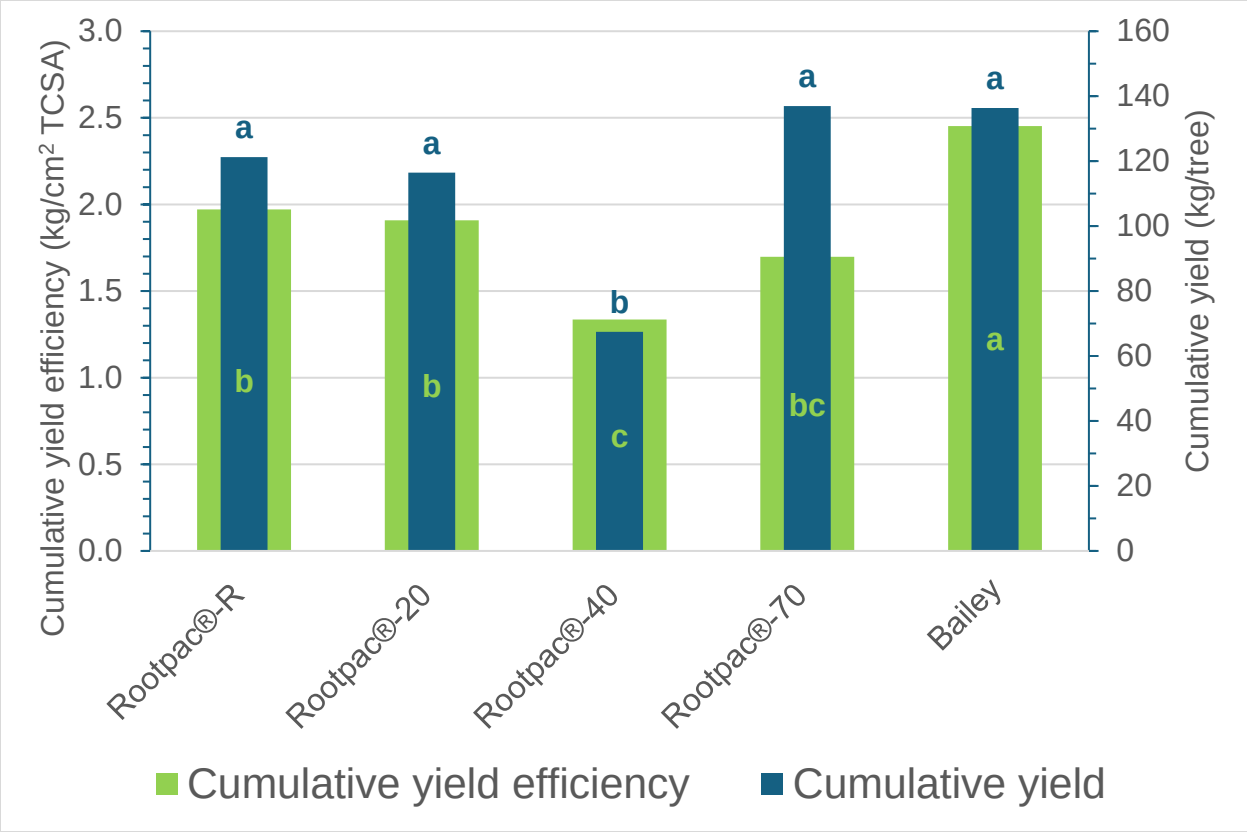

Figure 3. Cumulative yield and cumulative yield efficiency of Redhaven peach trees on various rootstocks after eight growing seasons at the University of Guelph, Simcoe (as of 2023). Mean values labelled with the same letter are not significantly different according to Tukey's HSD test at $P = 0.05$.

Experiment 2: 2017 NC-140 Rootstock Experiment

Trees were very small at planting in the spring of 2017. Trees on Rootpac®-40 and Controller 6 rootstocks were the smallest caliper trees at planting and mortality in the fall of 2017 for trees on these two rootstocks were 40% and 25%, respectively (data not shown). As of the fall of 2023, there has been no tree mortality on Lovell or Guardian rootstock. Trees on Rootpac®-20 and Rootpac®-40 have resulted in 10% and 53% tree mortality, respectively. Tree mortality on Controller 6, 7 and 8 is 44%, 15% and 32%, respectively (data not shown).

Rootstock suckers have been negligible to date, all less than 0.2 per tree annually (data not shown).

As of the fall of 2023, Cresthaven on Guardian rootstock were the most vigorous trees based on trunk cross-sectional area followed by Controller 6, Controller 8, Lovell and Controller 7 (Figure 4). Rootpac®-20 and Rootpac®-40 are similar in size and are the smallest of the rootstocks in this study.

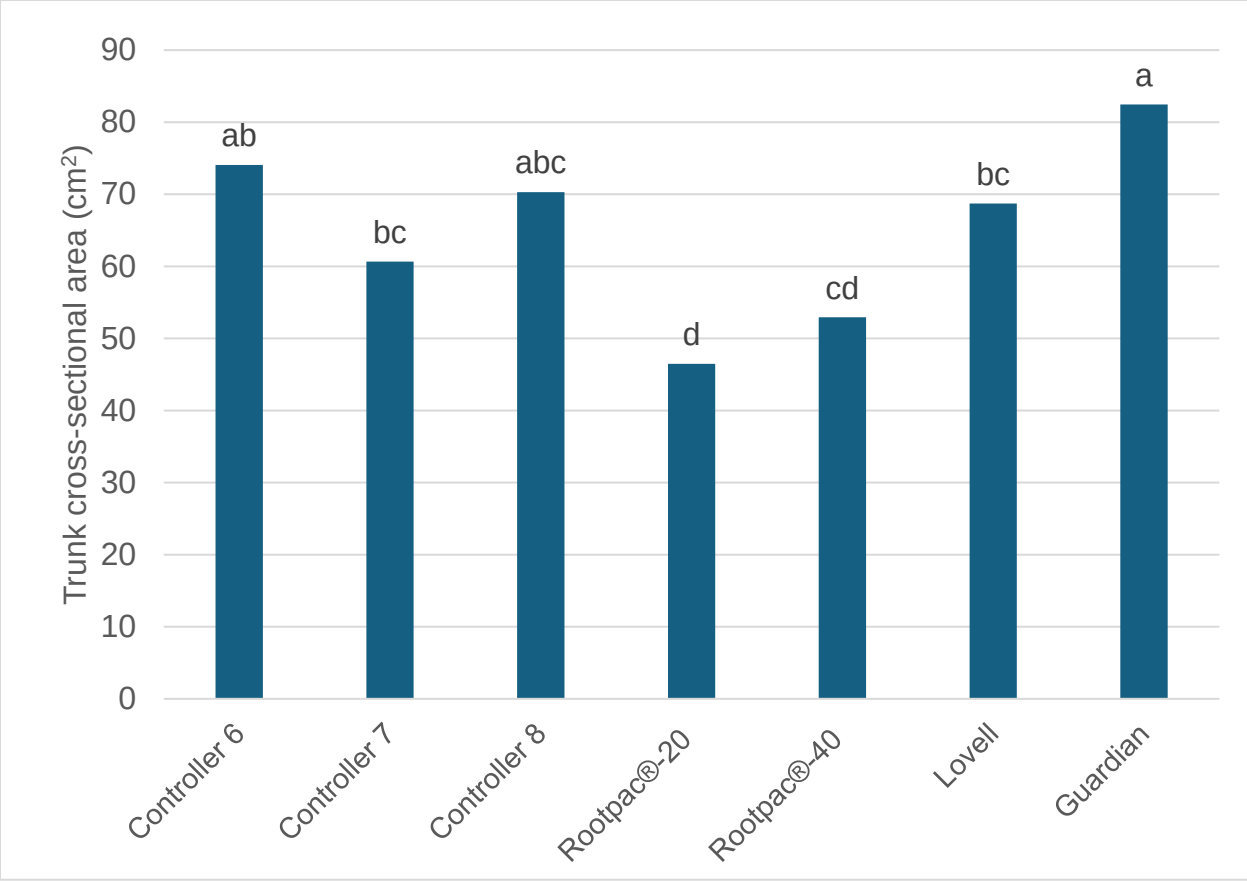

Figure 4. Tree vigor of Cresthaven on various Prunus rootstocks after seven growing seasons at the University of Guelph Simcoe Research Station. Mean values labelled with the same letter are not significantly different according to Tukey's HSD test at P = 0.05.

Rootstocks had a significant effect on fruit yield in all bearing years. Trees on Rootpac®-40 rootstock produced the lowest cumulative yield (2020-2023), followed by Rootpac®-20 (Figure 5). Lovell, Guardian and the Controller rootstocks produced higher yields ranging from 80-87 kg fruit per tree. Trees on Controller 7 rootstock have generated the greatest yield efficiency while trees on Rootpac®-40 have been the least efficient.

The average fruit weight of marketable fruit was also affected by the rootstocks in all harvest years. Averaged from 2020-2023, fruit weight was lowest for trees on Rootpac®-20 rootstock at 177 g per fruit compared to the other rootstocks which ranged from 199-215 g (data not shown).

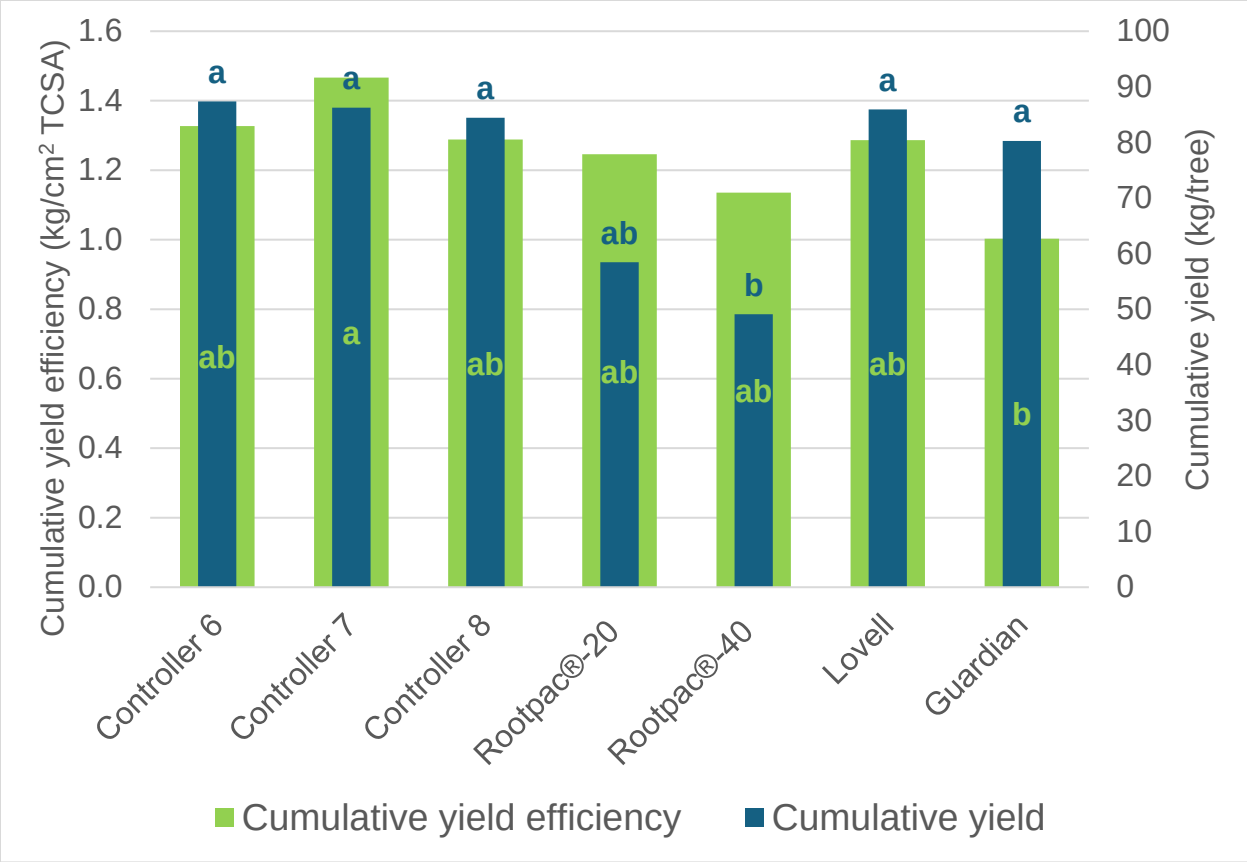

Figure 5. Cumulative yield and cumulative yield efficiency of Cresthaven peach trees on various rootstocks after seven growing seasons at the University of Guelph, Simcoe (as of 2023). Mean values labelled with the same letter are not significantly different according to Tukey's HSD test at P = 0.05.

Discussion

In this study, four inter-specific peach, plum, and almond hybrid clonal rootstocks (Rootpac®) from the Agromillora breeding program, three Controller series from the University of California, and Guardian were tested along with Bailey and Lovell peach seedling rootstock using the peach scions Redhaven and Cresthaven. After seven (Cresthaven) and eight (Redhaven) years there were significant effects in the metrics used to measure rootstock performance: tree survival, vigour, suckering, cumulative yield, cumulative yield efficiency and fruit size. A summary of these effects is shown in Tables 1 and 2.

Table 1. Summary characteristics of Rootpac and Bailey rootstocks on Redhaven after eight years. Ontario Crops Research Centre, Simcoe.

Rootstock	Tree survival after year 8	Vigor (cm^2 TCSA after year 8)[a]	Cumulative suckers (no/tree)	Cumulative yield (year 2-8) (kg/tree)	Cumulative yield efficiency (year 2-8) (kg/tree/cm2 TCSA)	Average fruit weight (g) (year 2-8)	Notable characteristics
Rootpac®-R	97	64	1.8	121	2.0	156	Good tree survival, lower tree vigour of Rootpac series, moderate cumulative yield and yield efficiency.
Rootpac®-20	100	62	3.3	116	1.9	152	Excellent tree survival, lowest tree vigour of Rootpac series, lower cumulative yields, greater tendency to form rootstock suckers
Rootpac®-40	44	76	0.4	67	1.3	187	High tree mortality, low cumulative yields, low cumulative yield efficiency, low crop load
Rootpac®-70	100	83	0.6	137	1.7	165	Excellent tree survival, highest tree vigour of Rootpac series, high cumulative yields, but lower yield efficiency
Bailey	100	57	0.1	136	2.5	158	Excellent tree survival, lower tree vigour than Rootpac-R, Rootpac-20, Rootpac-40, Rootpac-70, high cumulative yields and yield efficiency, low suckering

[a] Trunk cross-sectional area

Tree survival of Cresthaven on the Controller rootstock series tested in the 2017 NC-140 planting are a concern in this study. These data indicate that Controller 7 looks the most promising of those tested from this series, but still had 15% tree mortality. Controller 7 displayed slightly less tree vigour compared to Lovell, with comparable cumulative yields, yields, yield efficiency, and average fruit weight. Rootpac® 40, has had high tree mortality and poor cumulative yields, similar to the 2016 Redhaven experiment. Guardian had similar cumulative yields, but lower yield efficiency compared to Lovel, and was the most vigorous rootstock in this study.

In the 2017 NC-140 planting, Lovel was included as the standard seedling rootstocks, while Bailey was excluded from this study. Based on other studies and for comparison purposes, Bailey produces a tree approximately 90–95% the size of Lovell (Reighard et al., 2004; Minas et al., 2023). Lovell is a older standard peach seedling selected in California in 1882 but It is not widely used in the major peach-producing regions any more as it is not suitable for replanting without fumigation, as well as because of its root-knot nematode susceptibility. However, it is considered one of the best rootstocks in terms of resistance to bacterial canker. It produces a standard-vigour tree with good root anchorage, prefers well-drained soils, as it shows low tolerance to waterlogging and poor tolerance to calcareous soil. ‘Lovell’ exhibits good acclimation performance in autumn and moderate mid-winter hardiness (Minas et al., 2023).

Table 2. Summary characteristics of Controller, Rootpac, Guardian, and Lovell rootstocks on Cresthaven, after seven years. Ontario Crops Research Centre, Simcoe.

Rootstock	Tree survival after year 7	Vigor (cm^2 TCSA)[a]	Cumulative yield (year 4-7) (kg/tree)	Cumulative yield efficiency (year 4-7) (kg/tree/cm2 TCSA)	Average fruit weight (g) (year 4-7)	Notable characteristics
Controller 6	56	74	87	1.3	215	Poor tree survival, moderate vigour, good cumulative yield.
Controller 7	85	61	86	1.5	201	Moderate tree survival, vigour comparable to Lovell, good cumulative yield.
Controller 8	68	70	84	1.3	203	Poor tree survival, moderate vigour, good cumulative yield.
Rootpac®-20	90	46	58	1.2	178	Moderate tree survival, lower vigour, lower cumulative yields, smaller fruit size
Rootpac®-40	47	53	49	1.1	215	High tree mortality, lower vigour, low cumulative yields
Lovell	100	69	86	1.3	206	Excellent tree survival, high cumulative yields, high tree vigour
Guardian	100	82	80	1.0	198	Excellent tree survival, high vigour, good cumulative yields, low yield efficiency

[a] Trunk cross-sectional area

Summary

This study, the first to evaluate Agromillora germplasm in Canada, provides guidance on the early performance of these rootstocks after eight five years of production. Based on the results, Rootpac®-R, Rootpac®-20, Rootpac®-40 and Rootpac®-70 offer no dwarfing control or improved yield efficiency over the industry standard, Bailey. Therefore, there appears to be limited value in adopting the use of any of the Agromillora peach, plum, or almond interspecific rootstocks tested in this study in Ontario or regions with similar soils and growing regions. The exception would be that if the Rootpac series offered greater tolerance to abiotic and biotic soil factors than Bailey, such as nematode resistance, but further investigation would be warranted.

Because of its high mortality of Rootpac®-40 in both experiments, peach and nectarine producer would be prudent to exercise extra caution when considering this rootstock when using it in similar climatic regions. Further research examining the high mortality rate of Rootpac®-40 is required should this rootstock be adopted commercially in the northern climate regions of North America.

The results of this study will help inform peach and nectarine producers of the characteristics of these rootstocks to enable better rootstock selection for their orchard training systems. Since rootstock selection can profoundly impact orchard profitability and return on investment, peach and nectarine producers should be aware of the characteristics of new rootstocks when establishing new orchards.

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