IJTA © Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3.03

A New Dwarf Rootstock for Stone Fruits

K. K. Pramanik, A. K. Shukla, Santosh Watpade, Jitender Kumar and Rameswar Singh

Abstract: *The choice of rootstocks depends mostly on climatic and soil conditions, which are usually more unsatisfactory in north-western Himalayan region. The length of the vegetation period, sum of temperatures and rain precipitations have significant effects on the rootstock performance. Over the last so many years many Prunus species and hybrids have been tested as potential dwarfing and semi dwarfing rootstocks for stone fruits particularly. The most promising selections so far tested at IARI Research Farm, Dhanda, Shimla have been* Prunus persica *Japan. This rootstock has shown high yield efficiency, precocity, graft compatibility and smaller in size than the standard rootstock. Based on the performance of this rootstock on plant architecture (dwarfing), graft / budding compatibility, precocity, productivity, fruit size, fruit colour and quality, abiotic stress resistance (cold), it has been recommended to use this promising dwarfing rootstock for stone fruits cultivation in high density orcharding and low chilling areas. Even it can be grown in pots, kitchen garden where little space is available for any kind of cultivation.*

INTRODUCTION

Economic viability of a fruit production enterprise is linked directly to orchard productivity and management efficiency. To increase productivity and efficiency requires tree survival, managed vigor and increased marketable yields over the expected life span of the orchard. Several surveys have been undertaken to determine the relative importance of the various "problems" facing stone fruit industries around the world. The different problems associated with the rootstocks of stone fruits are soils having high bulk density, parasitic nematodes, root rot fungal pathogens, other edaphic or replant but the major being incompatibility of the rootstock with the scion. In India, the restrictions for the cultivation of stone fruits are mainly due to lack of compatible rootstocks. The major production of stone fruits in India is in the North-Western Indian States of Jammu and Kashmir (J&K), Himachal Pradesh (H.P.), Uttrakhand hills and to some extent in the North-Eastern Hills region.

MATERIALS AND METHODS:

Prunus japonica used as rootstock for different stone fruits viz. apricot, peach, nectarine, plum, cherry, almond. The grafting was done during dormancy of both rootstock and scion cultivars. 10 pots with grafted same stone fruit (same cultivars) contained each replication. There were three replications in Completely Randomized Design. The experiment was conducted in pot which was filled with standard growing media. All agronomic practices and irrigation was done as per recommended packages.

RESULTS AND DISCUSSION

Different rootstocks have been reported for different problems in stone fruits. Additionally, many "problem" sites have more than one limitation and require that a new rootstock incorporate resistance to multiple problems for successful adaptation. In many cases, new rootstocks are probably best suited for regional or prescription/niche planting rather

* Indian Agricultural Research Institute, Regional Station (Cereals & Hoticultural Crops), Amartara Cottage, Cart Road, Shimla-171004 (H.P.), *E-mail: kallolpramanick@gmail.com and kallol_pramanick@yahoo.co.in*

than broad use over a large industry. Regional testing is the only way to determine each rootstock's best adaptation. Priorities vary from one stone fruit crop to another. Several studies have shown that the rootstock requirement for apricots (*P. armeniaca*) and plum (*P. domestica, P. salicina)* are similar to the rootstock requirement of peach. For sweet cherry (*P. avium*), the first and foremost need in rootstocks is for size reduction followed by increased scion precocity and compatibility so sour cherry (*P. cerasus*), which has low inherent vigor (compared to sweet cherry) can be used as a rootstock for sweet chery. Fortunately, many stone fruit species can be budded onto other Prunus species. As a result peaches, plums, apricots and almonds (*P. amygdalus*) often can be budded onto rootstocks developed for each other. In this way, progress made in developing waterlogging tolerant rootstocks for plum also can be used advantageously as a rootstock for peaches, apricots or almonds.

Not all stone fruit scions are compatible with available *Prunus* rootstocks namely: *P. cerasifera*, *P. cerasifera* x *P. munsoniana*, *P. domestica*, *P. insititia*, *P. americana*, *P. pumila*, *P. besseyi*, *P. spinosa*, *P. dulcis*, *P. amygdalus* x *P. persica*, *P. insititia* x *P. domestica*, *P. armeniaca*, *P. salicina*, *P. persica* x *P. davidiana* and *P. amygdalus* x *P. nemared* (*P. persica* x *P. davidiana*) used as rootstocks for peach, plum, apricot and almond in different countries. Wild forms of peach, apricot, plum and almonds are also used as rootstock in India depending on varietal graft compatibility and soil types. Almond as rootstock shows better resistance to limestone and drought conditions, and peach induces tree vigour and nematode resistance, whereas, different plum species as rootstock are more resistant to waterlogging and various diseases. Peach almond Titan Hybrids (Titan almond x Nemaguard hybrid seedling) namely: Red and Green Leaf Titan are extremely vigorous, resistant to nematode, tolerant to calcareous soil and cold. Guardian is another peach rootstock which exhibits nematode and peach tree short leaf resistance and moderatly cold hardy. Bailey is another hardy peach rootstock. Studies have suggested that a wide range of *Prunus* rootstocks resistant to nematode which includes Argot, P.S. Series Cadaman, Ishatara, Marianna 2624 and Garnem. In other countries, wild apricot selections namely: INRA Manihot and North African wild apricot are commonly used as rootstock. Apart from wild biotypes, seedlings or clonal selections of different species which are used as root stocks are Royal, Higgith, Siberian C, Rubira, Harrow Blood, GF 677, Marianna series, Myrobalan series, Damas GF 1869, Rutger's Red Leaf, St. Julien series, Myram, Nemaguard, Nemared, Lovell, Pixy, Citation, Brompton, Pershore, Julior, Flordaguard etc. Seeds of *P. cerasoides* easily germinate and commonly used as seedling rootstock for sweet cherry in India. *P. cornuta* is a very good rootstock for cherry and has been found to be compatible.

Mazzard seedlings and F/12 produce larger tree as rootstock having longer life span. Mahaleb induces precocious bearing on scion cultivars and gives very good performance on light textured sandy to sandy loam or calcareous soil and even under water stress condition. Trees on these rootstocks are better in hardiness, survival and yield in comparison to Mazzard and Stockton Morello. In some countries, Mahaleb seedlings such as CEMA (C500) and Korponay seedling are commercially used. A new series under *P. cerasus* was raised from seeds of 'Weiroot 11' namely: 53, 72 and 158 (Stehr, 1998). Many rootstocks are in use in different countries evolved from *P. cerasus* namely: Edabriz, Weiroot 10, Weiroot 13, Weiroot 53, Weiroot 72 and Weiroot 158. Some other rootstocks are Gisela 5 (*P. cerasus* x *P. canescens*), Giesela 6 (*P. cerasus* x *P. canescens*), LC-52 [*P. cerasus* x (*P. cerasus* x *P. maackii*)], Colt (*P. avium* x *P. psedocerasus*) and OCR and CAB series. Graft union success is evaluated by the vigor, productivity and longevity of the scion. Some rootstocks might have undesirable influences on the scion including reduced fruit size, delayed leaf growth, and delayed ripening. Typically, several years after peach scions are grafted onto plum rootstocks the graft union develops a "shoulder" and trees topple over in high winds. Other signs of incompatibility include low scion vigor, shoot dieback, premature leaf drop, or excessive root suckering.

Major portion of the total stone fruits production in Himachal Pradesh is confined mainly to the mid hill region falling in the altitude range of 1000 – 1700 meters above mean sea level where the summer are moderately hot (31.8 to 34.8 °C) during

May-June and winters are cold (2.4 to 3.7 °C) during December–January. The average annual rainfall ranges from 100-130 cm, 90% of which is limited to two months of the monsoon (July–August) and during the rest of the year plants remain under water stress. Most of the orchards are on sloppy land where irrigation is difficult to practice and due to scarcity of water and uneven distribution of rainfall throughout the growing season drought conditions are commonly prevalent, which results in poor fruit set, heavy fruit drop and sometimes even cause the death of the plants. Like majority of fruit crops, stone fruits are also multiplied clonally by grafting the scion cultivar on the desired rootstock and beneficial effects of rootstock on the grafted plant. Wild relatives of the stone fruits e.g. wild peach (Kateru), wild apricot (Chulli) and Behmi have remained the first choice as rootstock in case of stone fruits on commercial level and have adapted in this region for ages.

Thus, in India the productivity of peach, plum and apricot is 8.10 tonnes/hac, 5.7 tonnes/hac and 4.17 tonnes/hac respectively which is considerably low as compared to other countries where these fruits are grown commercially. Non-availability of good rootstocks suitable for the local climatic conditions for mid hills of Himachal Pradesh is one of the major reasons for the low productivity of these crops. Since there is huge variations available in form of wild peach (kateru), wild apricot (Chulli) and Behmi from which suitable clonal rootstock could be evolved which are suitable for the local climatic conditions and benefit the orcharding enterprise to a larger extent.

Numerous studies have demonstrated that rootstocks influence foliar nutrient content of stone fruit scion varieties (Couvillon, 1982; Werner and Young, 1987; Hanson and Perry, 1989; Brown, 1989; Rozpara *et al.*, 1990; Ugolik and Holubowicz, 1990; Caruso *et al.*, 1996; Neilsen and Kappel, 1996; Webster, 1996; Boyhan *et al.*, 1998; Callesen, 1998). Initially, the use of high vigor peach × almond hybrids, such as GF677, gave vigor sufficient for satisfactory peach production in these situations. However, after a generation or two, even greater vigor is needed. At this time, peach × P. davidiana hybrids appear to be promising alternatives for this problem. In cherry, evaluations of the physiological efficiency of nitrogen uptake and/or use by standard and new hybrid rootstocks are currently underway (Zavalloni and Flore, 2002).

Low temperature stress involves two issues: first, the hardiness of the rootstock itself. In extreme northern latitudes with adequate snow pack, this is generally not a problem. However, in locations where winter snowfall is inadequate or comes after the occurrence of extreme low temperatures, rootstock damage can be a threat to tree survival. Layne (1974) has documented significant differences in cold hardiness of peach stocks. The second issue is the influence of the rootstock on the hardiness of the scion. A number of rootstocks have been identified which enhance the cold hardiness of peach, 537 plum, apricot and cherry varieties (Layne *et al.,* 1977; Layne and Ward, 1978; Layne, 1987; Crossa-Raynaud and Audergon, 1987; Perry, 1987; Iezzoni et al., 1991). Cold hardiness evaluation methodology is a significant limitation to progress, as reliance on 'test' winters is particularly slow and highly variable. Alternative lab-based methods (Strauch and Gruppe, 1985) offer greater efficiency, though difficulties of their own (Palonen and Buszard, 1997).

Several new stone fruit production systems have been introduced in recent years, including palmette, fusetta, perpendicular-V, spindle, solaxe, Spanish bush, and others (Balmer, 2001; Long, 2001). On high fertility sites with vigorous scion cultivars, some reduction in vigor is highly desirable if only for reduced pruning, thinning and picking costs. As an added benefit, vigor reductions are often accompanied by improved fruit quality, in particular red blush, and increased size and sweetness due to reduced shading. New rootstocks, too numerous to list here, have been introduced with varying levels of dwarfing for peach, plum, apricot, cherry, and almond, some imparting scion vigor that is 50% or less than current industry standards. Many more are in development. Of those materials released for commercial trial, probably none have enjoyed a more enthusiastic reception than the new interspecific hybrid rootstocks for sweet cherries, as typified by the Giessen/Gisela and Gembloux clonal series (Lang, 2000). When used with sweet cherries, formerly the largest and most difficult of the stone fruit species to manage, these new rootstocks offer significant possibilities to tame these former giants, and vastly improve labor efficiencies for pruning, training, and harvesting. In general, the greatest levels of vigor control are with rootstocks having significant P. cerasus or P. fruticosa parentage (Webster, 1996; Callesen, 1998; Wertheim, 1998). Dwarfing, however, is not the only industry need for vigor manipulation. At the other end of the spectrum are rootstocks which induce higher vigor in scion varieties on low fertility sites, as noted above under "Nutrition and Low Fertility."

The potential for a rootstock to either promote or delay bloom probably deserves more attention than it receives. While these effects typically are subtle for scion cultivars grafted onto rootstocks of the same species, such as peach on peach or sweet cherry on sweet cherry, the use of other rootstock species (e.g., peach on interspecific hybrids or sweet cherry on sour cherry) can produce more significant shifts in bloom time (Young and Olcott-Reid, 1979; Young and Houser, 1980; Beckman *et al.,* 1992; Reighard *et al.,* 2001). Such bloom date alterations can translate into proportional harvest date alterations, and/or can be important for spring frost susceptibility or avoidance (Lang *et al.,* 1997).

This is a recently reported phenomenon (Spring Shock Syndrome) by Malcolm *et al.,* 1999), the cause of which is still understood incompletely. During atypically cool springs in low-chill areas of Australia when soils are slow to warm, peaches on high-chill rootstocks (e.g. 'Golden Queen') lag well behind those on low-chill rootstocks (e.g. 'Okinawa'). This does not appear to be a simple case of delayed bloom, as foliation and tree development lag profoundly through the entire growing season, resulting in delayed 538 ripening and significant reductions in total crop and fruit size. This is of particular concern since much of the recent growth in stone fruit production, principally peach, has been in low to moderate chilling climatic zones (Fideghelli *et al.,* 1998), which often have unique combinations of disease and edaphic limitations, i.e., coastal regions having sandier soils, root-knot nematodes, and/or nutritional and soil water-holding limitations.

Precocity and Productivity. Perhaps just as important as vigor control, many of these new rootstocks, particularly in cherry, induce profound increases in precocity and productivity, which have challenged researchers and growers to develop appropriate crop load management strategies to prevent excessive cropping, reduced fruit size, and insufficient annual growth (Choi and Andersen, 2001; Lang, 2001; Lang and Ophardt, 2000). However, with certain light-bearing cherry cultivars (e.g. 'Tieton', 'Cavalier'), the ability of some new rootstocks to increase flowering spur formation can be the difference between commercial success and failure (Lang, 2000).

Scion/rootstock graft compatibility is a critical issue for orchard performance and longevity. It is perhaps more of a problem in cherry, almond, and especially apricot, than in peach or plum. It has been such a particularly vexing issue in apricot that Duquesne (1969) suggested it might be easier to breed apricot varieties with less specific rootstock needs, than rootstocks having compatibility with a wide selection of apricot varieties. Rapid industry adoption of new sweet cherry cultivar releases, before widespread rootstock graft compatibilities have been tested, has increased the prevalence of reports (e.g. 'Lapins', 'Chelan', 'Tieton') of graft incompatibility, particularly with 'Mahaleb' seedling rootstocks. While these appear to be genetic, it is likely (Lang, 2000) that the ilarvirus sensitivity of some of the interspecific cherry rootstocks (discussed above) may explain several of the reports of "delayed graft incompatibility" in European rootstock trials (Wertheim *et al.,* 1998). As all stone fruit rootstock development tends more toward the creation of interspecific hybrids, these compatibility issues will likely take on greater importance. Field trials and direct examination of excised unions are the mainstay of many programs, but these tedious methodologies need to give way to a better physiological understanding of the mechanisms involved so that more efficient evaluation methodologies can be developed, possibly in conjunction with marker assisted selection (MAS). Graft compatibility between scion and rootstock materials of the same species is often taken for granted, although in some species (e.g. apricot), this is not necessarily a safe assumption.

Surprisingly, in several peach rootstock trials reported from the US and Canada and a cherry trial from Poland, the most efficient performer was the own-rooted scion cultivar, which often displayed lower vigor, both desirable characteristics. Whether this is an indication of incompatibility in the traditional sense, or more an expression of mechanical interference due to imperfect joining of tissues, remains to be seen. This might seem more an intellectual curiosity, but as markers are developed for important traits, it may become feasible to incorporate important rootstock traits into scion cultivars for use as own-rooted cuttings. Even with current breeding and screening techniques, it should be possible to incorporate resistance to root-knot nematodes into scion cultivars at this time. Not having to bud or graft finished trees offers both cost and 539 time savings to offset part of the cost of clonal propagation. Efficient protocols have been developed for peach (Couvillon and Erez, 1980; Coston *et al.,* 1983) and should be feasible for the relatively easy to root plums, though cherries remain quite difficult (W. Proebsting, pers. commun.). Own-rooted trees of 'Stanley' plum have been recommended for avoidance of stem-pitting, which develops in grafted 'Stanley' trees that are infected subsequently with TmRSV (Cummins and Gonsalves, 1986). Own-rooted trees of several peach varieties appeared to be less susceptible to stem-pitting than conventional grafted trees (Byers and Yoder, 1994) and have exhibited higher levels of nutrients (Couvillon, 1982). However, own-rooted trees were shown to be more susceptible to PTSL (Reighard *et al.,* 1990). 6. Fruit Quality. Rootstocks capable of improving the fruit quality attributes of the scion variety would be of great interest. There appear to be some possibilities in this area, though many of the effects reported to date have been relatively subtle, negative, or inconsistent, particularly for fruit size. It is often difficult to separate apparently negative effects on fruit size from the combination of the positive traits of reduced vigor and increased productivity that can lead to imbalanced crop loads if not managed properly (Lang, 2000). Potentially useful rootstock influences on fruit maturity have been described for some stone fruits (Beckman and Cummins, 1991a; Beckman *et al.,* 1992; Moreno *et al.,* 1995). The development of an understanding of the physiological basis of these effects will be important. Interstems Some mention of interstems is appropriate here. While obviously incapable of directly affecting below ground issues such as soilborne diseases, insects, waterlogging, low fertility, etc., interstems have been shown to provide hardier trunks (Crossa-Raynaud and Aduergon, 1987; Grzyb and Rozpara, 1994), control vigor (Roberts and Westwood, 1981; Grzyb and Rozpara, 1994; Rozpara *et al.,* 1998), delay bloom and fruit maturation of peach (Reighard, 1998); improve fruit quality, vigor control and yield for sweet cherry (Larsen, 1970; Larsen and Patterson, 1981; Larsen *et al.,* 1987), and influence foliar nutrient content in cherry (Rozpara *et al.,* 1990). However, an unavoidable yet significant limitation to their utilization is the added time and cost associated with their production. Furthermore, issues such as graft incompatibility and virus sensitivity/ hypersensitivity remain the same for interstocks as for rootstocks.

THE NEW PROSPECTIVE

A new rootstock, *Prunus persica* Japan (syn. *Prunus japonica*) which is compatible to all the stone fruits has been studied at the IARI, Regional station, Shimla and successful results have been recorded. It is mainly cultivated for ornamental use (figure 1). It is a shrub species in the genus *Prunus*. The shrub reaches 1.5 m by 1.5 m. Its flowers are hermaphrodite and are pollinated by insects. The plant blossoms in May. Its fruit reaches about 14 mm in size and has an agreeably sweet flavor.

All the stone fruits like peach, plum, apricot, almond and cherry of genus *Prunus* have been successfully grafted on *Prunus persica* Japan. These have shown complete graft compatibility, precocity and fruit set. The rootstock is very dwarfing in nature thus can be successfully used for high density plantation. Based on the performance of this rootstock on plant architecture (dwarfing), graft/ budding compatibility, productivity, fruit size, fruit colour and quality, abiotic stress resistance (cold), it has been recommended to use this promising rootstock for stone fruit cultivation in high density orcharding and low chilling areas. Even it can be

Precocity and graft compatibility in peach and nectarine

Left: Precocity in cherry

Right: Prunus japonica (dwarf rootstock for stone fruits)

Precocity and graft compatibility in Plum

Precocity and graft compatibility in Almond

grown in pots, kitchen garden where little space is available for any kind of cultivation.

SUMMARY

This rootstock has shown graft compatibility, precocity and smaller in size than the standard rootstock. Based on the performance of this rootstock on plant architecture (dwarfing), graft / budding compatibility, precocity, productivity, fruit size, fruit colour and quality, abiotic stress resistance (cold), it has been recommended to use this promising rootstock for stone fruits cultivation in high density orcharding and low chilling areas. Even it can be grown in pots, kitchen garden where little space is available for any kind of cultivation.

References

Balmer, M. (2001), Sweet cherry tree densities and tree training. Compact Fruit Tree 34: 74–77.

Beckman, T.G., Okie, W.R. and Myers, S.C. (1992), Rootstocks affect bloom date and fruit maturation of 'Redhaven' peach. *J. Amer. Soc. Sci.* 117:377–379.

Boyhan, G.E., Norton, J.D., Pitts, J.A. and Himelrick, D.G. (1998), Growth, yield, survival, and leaf nutrient concentrations of plums on various rootstocks. Fruit Var. J. 52:71– 79.

Brown, S.K. (1989), Rootstock effect on foliar nutrient concentrations of 'Redhaven' peach trees. HortScience 24:769–771.

Callesen, O. (1998), Recent developments in cherry rootstock research. Acta Hort. 468:219–228.

Caruso, T., Giovannini, D. and Liverani, A. (1996), Rootstock influences the fruit mineral, sugar and organic acid content of a very early ripening peach cultivar. J. Hort. Sci. 71:931–937.

Choi, C. and Andersen, R.L. (2001), 'Hedelfingen' sweet cherry fruit and tree growth responses to thinning and five rootstocks. J. Amer. Pomol. Soc. 55:114–119.

Coston, D.C., Krewer, G.W., Owings, R.C. and Denny, E.G. (1983), Air rooting of peach semihardwood cuttings. HortScience 18: 323–324.

Couvillon, G.A. (1982), Leaf elemental content comparisons of own-rooted peach cultivars to the same cultivars on several peach seedling rootstocks. J. Amer. Soc. Hort. Sci. 107:555–558.

Crossa-Raynaud, P. and Audergon, J.M. (1987), Apricot rootstocks. p. 295–320. In: R.C. Rom and R.F. Carlson (eds.), Rootstocks for fruit crops. Wiley, New York.

Cummins, J.N. and Gonsalves, D. (1986), Constriction and decline of 'Stanley' prune associated with Tomato Ringspot Virus. J. Amer. Soc. Hort. Sci. 111:315–318. 545

Fideghelli, C., Della Strada, G., Grassi, F. and Morico, G. (1998), The peach industry in the world: Present situation and trend. Acta Hort. 465: 29–40.

Gryzb, Z.S. and Roxpara, E. (1994), The influence of different interstems on the growth and yield of Ruth Gerstetter plum cv. trees. Acta Hort. 359: 256–259.

Hanson, E.J. and Perry, R.L. (1989), Rootstocks influence mineral nutrition of 'Montmorency' sour cherry. Hort Science 24: 916–918.

Lang, G., Howell, W., Ophardt, D. and Mink, G. (1997), Biotic and abiotic stress responses of interspecific hybrid cherry rootstocks. Acta Hort. 451: 217–224.

Lang, G.A. (2000), Precocious, dwarfing, and productive—how will new cherry rootstocks impact the sweet cherry industry? HortTechnology 10: 719–725.

Lang, G.A. and Ophardt, D. (2000), Intensive crop regulation strategies in sweet cherries. Acta Hort. 514:227–234.

Lang, G.A. (2001), Critical concepts for sweet cherry training systems. Compact Fruit Tree 34:70–73.

Layne, R.E.C. (1974), Breeding peach rootstocks for Canada and the northern United States. HortScience 9:364–366.

Layne, R.E.C. (1987), Peach rootstocks. p. 185–216. In: R.C. Rom and R.F. Carlson (eds.), Rootstocks for Fruit Crops. Wiley, New York.

Long, L. (2001), Sweet cherry training systems. Compact Fruit Tree 34:66–69.

Malcolm, P., Holford, B., McGlasson, B., Newman, S., Richards, G. and Topp, B. (1999), Growing low chill peaches and nectarines on high chill rootstocks causes spring shock syndrome. Austral. Fresh Stone Fruit Quart. 1(1):11–12.

Neilsen, G. and Kappel, F. (1996), 'Bing' sweet cherry leaf nutrition is affected by rootstock. HortScience 31:1169–1172.

Reighard, G.L. (1998), Manipulation of peach phenology, growth, and fruit maturity using interstems. Acta Hort. 465:567–572.

Reighard, G.L. and NC-140 Cooperators. (2001), Five-year performance of 19 peach rootstocks at 20 sites in North America. Acta Hort. 557:97–102.

Rozpara, E., Grzyb, Z.S. and Olszewski, T. (1990), The mineral nutrient content in the leaves of two sweet cherry cvs. with interstem. Acta Hort. 274:405–411.

Rozpara, E., Grzyb, Z.S. and Zdyb, H. (1998), Growth and fruiting of two sweet cherry cultivars with different interstems. Acta Hort. 468:345–352.

Webster, A.D. (1996), Rootstocks for sweet and sour cherries, p. 127–163. In: A.D. Webster and N.E. Looney (eds.), Cherries: Crop Physiology, Productions and Uses, CAB Intl., Oxon, UK.

Werner, D.J. and Young, E. (1987), Effect of 'Siberian C' rootstock, interstem, and scion on foliar calcium content in peach. Fruit Var. J. 41:140–141.

Wertheim, S.J. (1998), Rootstock guide: Apple, pear, cherry, European plum. Fruit Research Station Publ. 25, Wilhelminadorp, The Netherlands, p. 85–114.

Wertheim, S.J., Balkhoven, J.M.T., Callesen, O., Claverie, J., Vercammen, J., Ystaas, J. and Vestrheim, S. (1998), Results of two international cherry rootstock trials. Acta Hort. 468:249–264.

Young, E. and Olcott-Reid, B. (1979), Siberian C rootstock delays bloom of peach. J. Amer. Soc. Hort. Sci. 104:178–181.

Young, E. and Houser, J. (1980), Influence of Siberian C rootstock on peach bloom delay, water potential, and pollen meiosis. J. Amer. Soc. Hort. Sci. 105:242–245.

Zavalloni, C. and Flore, J. (2002), Nitrogen- and water-use efficiency of sweet cherry (Prunus avium L.) cv. 'Rainier' grown on 'Mazzard' and on 'Gisela' dwarfing rootstocks. Prog, XXVIth Intl. Hort. Congr., p. 346.