ROOTSTOCKS

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Economic viability of a tree fruit production enterprise is linked directly to orchard productivity and management efficiency. Optimal levels of productivity and efficiency require tree survival, managed vigor, and good marketable yields over the expected lifespan of the orchard. The grower's choice of rootstock is quite important when peaches, nectarines, or plums are grown on soils having high bulk density, parasitic nematodes, root rot fungal pathogens, or other soil or replant problems. In the southeastern United States, where one or more of these conditions is present in most orchard sites, peach tree survival and growth can be significantly improved by selecting the appropriate rootstock. Peach production efficiency in the Southeast has been limited by the absence of rootstocks that offer moderate vigor or tolerance to undesirable soil properties, site characteristics, and soil-borne pathogens. As good orchard sites become fewer and chemical controls more costly or unavailable, rootstocks that better address these site and vigor problems will become a crucial need.

New rootstocks for peaches [*Prunus persica* (L.) Batsch] are being introduced through commercial nurseries. Many of these rootstocks are complex vegetatively propagated *Prunus* L. hybrids. Experience has shown that extensive testing is critical to avoid commercial failures from rootstocks that prove poorly adapted to local climatic and soil conditions. In addition, putative resistance of new rootstocks to soil diseases and other pathogens has sometimes failed when planted in other production regions.

BIOTIC AND ABIOTIC SOIL FACTORS AFFECTING PEACH ROOTSTOCKS

Parasitic Nematodes

Several nematode species successfully attack peach roots and reduce peach growth and survival. Four nematodes are recognized as injurious to peach trees in the Southeast: ring (*Mesocriconema xenoplax* (Raski) Luc & Raski), root-knot (primarily *Meloidogyne incognita* (Kofoid & White) Chitwood and *M. javanica* (Treub) Chitwood), lesion (*Pratylenchus vulnus* Allen& Jensen), and dagger (*Xiphenema americanum* Cobb).

Rootstock response to nematodes can be categorized as immune, resistant, tolerant, or susceptible. For a specific nematode species, immune or resistant rootstocks are poor or non-hosts for nematode survival and reproduction and are unaffected by nematode feeding. Tolerant rootstocks are fair to good hosts for a specific nematode, but nematode reproduction and feeding does not significantly alter the rootstocks' ability to support scion survival, growth, and productivity. Rootstocks susceptible to a specific nematode are good hosts for nematode reproduction, and nematode feeding impairs tree survival, growth, and fruiting.

Ring nematode has been directly linked to peach tree short life (PTSL) syndrome in the Southeast. Many of the newest rootstocks have not been tested for reaction to ring nematode. However, older (1980s) rootstock introductions such as the French peach seedling rootstocks Montclar, Rubira, GF 305, and Higama, and the plum hybrids Ishtara and Myran are good hosts for ring nematode and are susceptible to PTSL. No peach rootstock has survived better in field tests in South Carolina and Georgia than the regionally developed Guardian™ Brand BY520-9. Guardian is more tolerant to ring nematode and PTSL than Lovell or Halford; whereas Nemaguard and Nemared are highly susceptible to both ring nematode and PTSL. Bailey, another commercial rootstock, is also susceptible to PTSL.

Root-knot nematodes, which cause serious growth reduction in peach trees, are present in sandy soils throughout most of the regions' coastal plains and sandhills production areas. These soils have two species of root-knot nematode (*M. incognita* andthe less common *M. javanica*), as well as a number of races within each species. Several peach rootstocks, including Shalil, Yunnan, and Okinawa, have been introduced for root-knot nematode resistance in the United States in the twentieth century. All of these rootstocks either were not resistant to *M. javanica* or had other problems and eventually were replaced by domestically developed rootstocks such as Nemaguard, Nemared, Flordaguard, and Guardian BY520-9. However, with the exception of Guardian, each of these root-knot resistant rootstocks is susceptible to ring nematode and PTSL (Table 1). In contrast, Lovell and Halford are highly susceptible to both root-knot species and should not be planted on sites having detectable numbers of root-knot nematodes. However, except for Guardian, Lovell and Halford survive better than the root-knot resistant rootstocks on ring nematode sites.

Table 1. Commercial rootstocks planted in the southeastern United States and their tolerance to nematodes, short life, and oak root rot.

Rootstock Cultivar	Ring nematode tolerance	Peach tree short life tolerance	Root-knot nematode resistance	Oak root rot resistance
Lovell	fair	fair-good	susceptible	susceptible
Halford	fair	fair-good	susceptible	susceptible
Nemaguard	poor	poor	resistant	susceptible
Guardian	fair-good	very good-excellent	resistant	susceptible

Lesion (*Pratylenchus vulnus*) and dagger (*Xiphenema americanum*) nematodes are also peach pests in the eastern United States. Lesion nematodes can significantly reduce tree growth and fruit production if not controlled. Rootstocks tolerant to *P. vulnus* in Europe, such as Rubira, Penta, Tetra, Torinel, and P.S.B2, have been evaluated in the eastern United States. These European stocks have shown little promise. In greenhouse studies on resistance to lesion nematode, Bailey and Guardian BY520-9 were less susceptible than many of the European rootstocks tested, though none were resistant. However, little research has been done on the impact of lesion nematode on peach in the Southeast because ring and root-knot nematodes are more serious problems.

The dagger nematode is not common in southeastern peaches but does occur, especially in the piedmont peach production regions. When feeding on peach roots, dagger nematode serves as the vector for tomato ringspot virus (ToRSV), which causes stem pitting. Because many weed species such as dandelions (*Taraxacum officinale* Weber) are hosts for ToRSV, dagger nematode resistance in rootstocks is the only practical way to prevent infection. Peach seedling rootstocks are not resistant to dagger nematodes; therefore, new non-peach rootstocks need to be evaluated as to their susceptibility to the nematode or the virus. Some cherry plum (*P. cerasifera*) selections appear to be less sensitive to ToRSV. Thus, the clonal rootstocks Mr.S. 2/5 and Mr.S. 2/8 (both *P. cerasifera*), Krymsk VVA-1 (*P. cerasifera* x *P. tomentosa* Thunb.) and Krymsk VSV-1 (*P. incana* (Pall.) Batsch x *P. cerasifera*), and Adara (*P. cerasifera*) may offer some tolerance. However, none of these rootstocks have been tested in North America for ToRSV resistance. Buying virus-free trees, tested for ToRSV, is recommended as the best option to help prevent introduction of ToRSV to your orchard site.

Soil Texture and Pathogens

Peach rootstocks are not well adapted to poorly drained or heavy clay soils. On these soils, peach rootstocks are at risk of becoming infected with fungi (*Phytophthora* de Bary) that cause crown rot. Similarly, all peach rootstocks are susceptible to the oak root rot fungus (*Armillaria mellea* (Vahl: Fr.) P. Kumm. and *A. tabescens* (Scop.) Emel) if it is present (Table 1), regardless of soil texture or drainage. Both organisms are difficult to control and eradicate; therefore, genetic resistance to these pathogens would be highly desirable in rootstocks. Research to develop an *Armillaria* (Fr.:Fr.) Staude resistant rootstock at USDA, Byron, Georgia, by hybridizing native plums with other species shows promise, but no rootstocks have yet been released.

Many European rootstocks recently introduced to the United States are listed as tolerant of waterlogging. These rootstocks include Jaspi, Julior, Penta, Tetra, Mr.S. 2/5, Barrier 1, Adesoto 101, Adara, Montizo, and Krymsk VVA-1 and VSV-1. However, because the season of waterlogging is not specified in release notices, it is not known whether these rootstocks are tolerant of dormant or growing season wet soil conditions. Many of these rootstocks were developed in Mediterranean climates that receive their rainfall in the winter. Because waterlogging can also occur during the growing season in the southeastern United States, these rootstocks need further testing before commercial release.

These rootstocks and other European varieties are also listed as tolerant of replant sites and soil diseases. However, specific soil diseases usually are not identified. Ishtara and Myran were reported to be resistant or tolerant to oak root rot (*A. mellea*) in France. Observations in the southeastern United States show that these rootstocks are susceptible to *A. tabescens* and may not be resistant to the endemic fungal soil pathogens. Furthermore, Jaspi has been very susceptible to bacterial canker in South Carolina and Georgia. These preliminary observations underscore the need for thorough, widespread field-testing of new "disease tolerant” rootstocks before they are planted commercially.

Currently, no peach rootstock planted in the Southeast is tolerant to *A. tabescens* or waterlogging. Site selection and cultural practices must be carefully considered when using commercial peach rootstocks on problem soils.

ROOTSTOCKS FOR VIGOR CONTROL

Peach seedling rootstocks, including brachtytic dwarfs, rarely reduce scion vigor more than 10% to 15%. Size control of peaches through rootstocks using other *Prunus* species has not been satisfactorily achieved due to incompatibility or poor tree vigor. Good dwarfing rootstocks for peach would reduce vigor, be graft compatible, and give good fruit production without reduction of fruit size and quality.

Imported European rootstocks listed as mildly dwarfing (approximate percent of peach standard) include Ishtara (70%), Julior (70%), Rubira (90%), Tetra (90%), Mr.S. 2/5 (90%), and Adesoto 101 (80%). Semi-dwarfing rootstocks include PumiSelect (60%), Sirio (60%), and Krymsk VSV-1 (50%) andVVA-1 (40%). The degree of dwarfing with these rootstocks varies with climate, soil type, and site history. Of these new rootstocks, trees on Ishtara have been highly susceptible to bacterial canker in South Carolina, Adesoto 101 root suckers extensively, and PumiSelect has not survived well on heavy soils in South Carolina. Current peach rootstocks used in the southeastern states are all vigorous, with Nemaguard, Flordaguard, and Guardian being more vigorous than Lovell or Halford.

FUTURE COMMERCIAL OUTLOOK

Better peach rootstocks are being developed, but the time from initial testing to commercial production takes a number of years. New rootstocks originating from current breeding programs will probably be complex species hybrids that must be propagated vegetatively, which is a particular likelihood for rootstocks that will be resistant to oak root rot (*Armillaria* sp.), *Phytophthora* sp., waterlogging, and some ectoparasitic nematodes. Micropropagation from tissue culture explants has been employed in western Europe to mass produce unique hybrid rootstocks, and this technology is now being used by a few commercial nurseries in the United States.

Other factors that may delay the release of new rootstocks into the United States are patent laws and licensing agreements that must be negotiated between government agencies, breeders, nurseries, and grower groups. Despite these problems, new rootstocks are being tested through regional and national trials such as the NC-140 regional project, which evaluates new rootstocks for stone and pome fruits across the United States and Canada. This project, in conjunction with new screening methods and extensive cooperation among researchers, is decreasing the time to evaluate future rootstock selections for fruit growers.

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