Peach Rootstock Issues and Progress for the SE Industry

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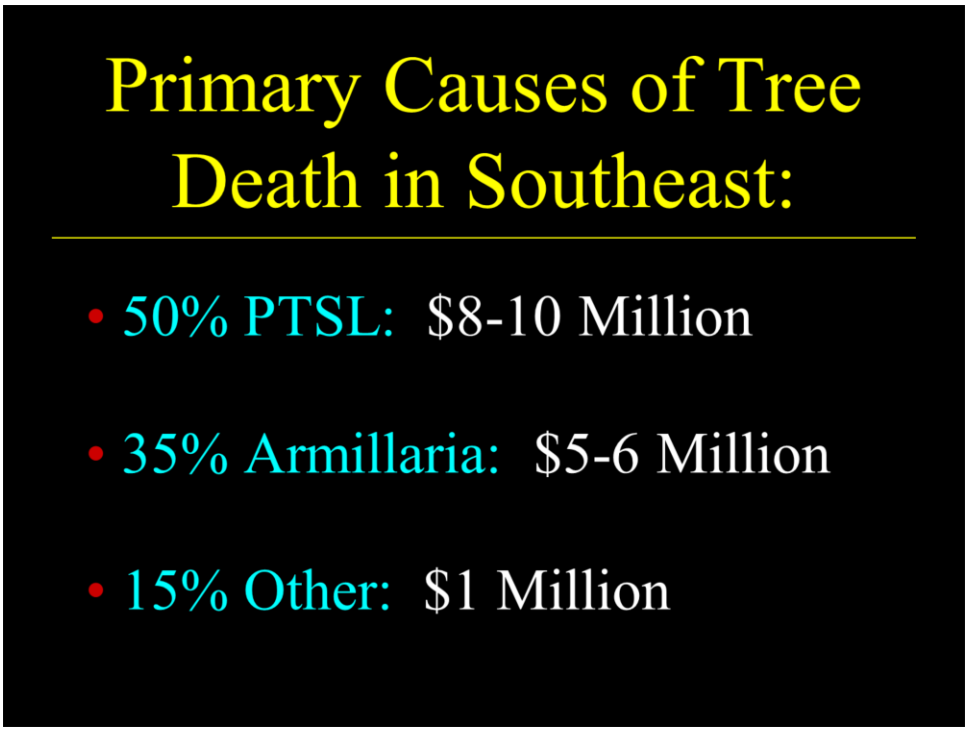
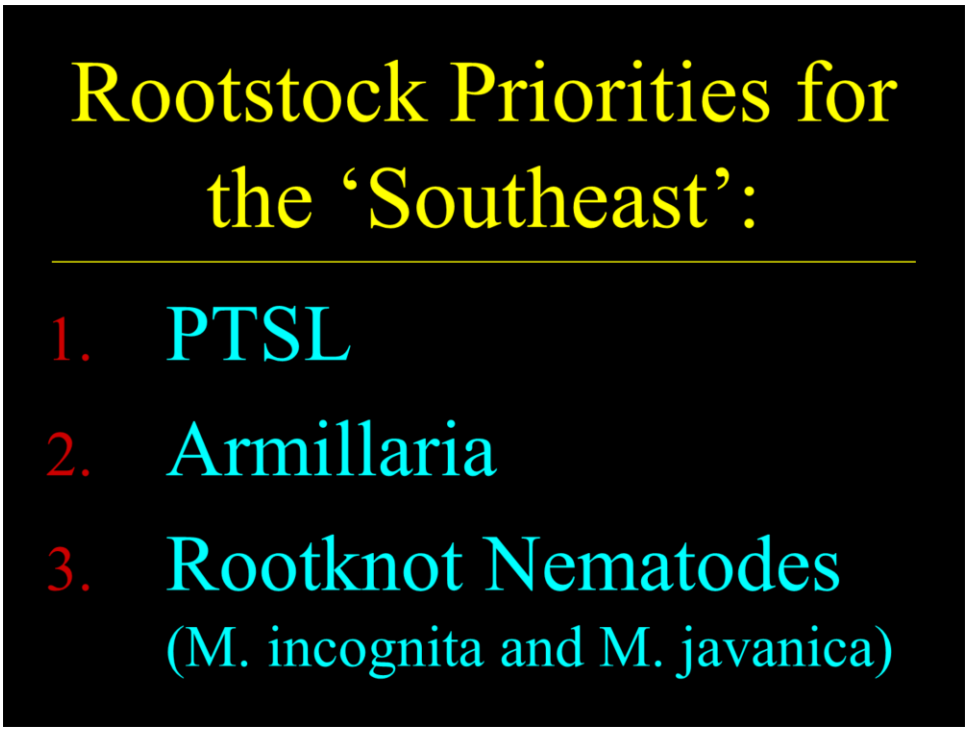
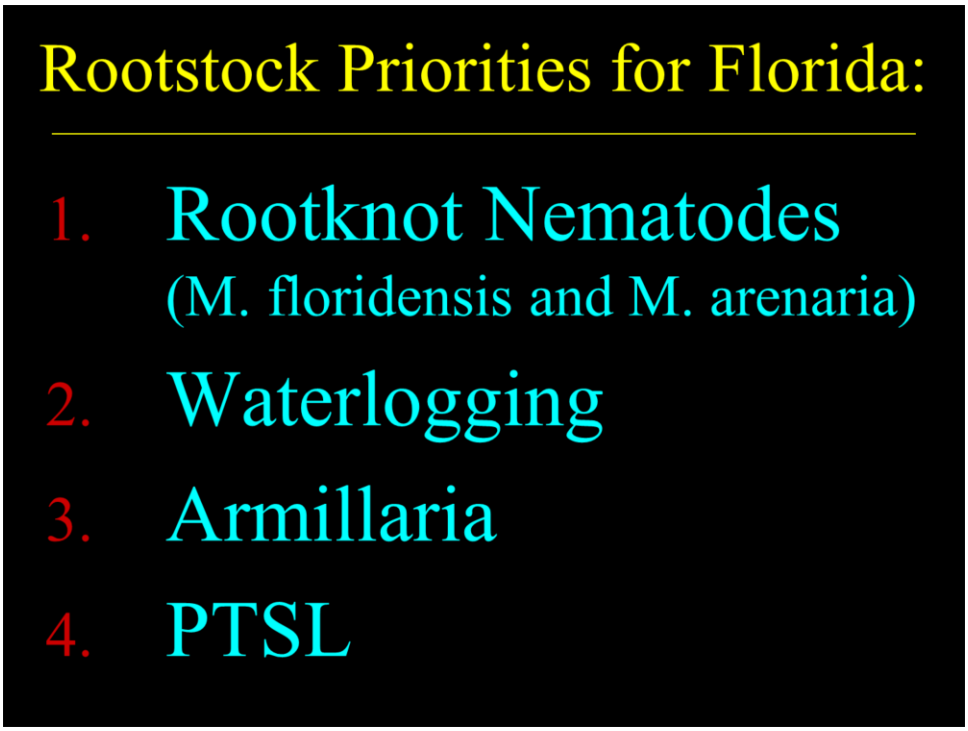


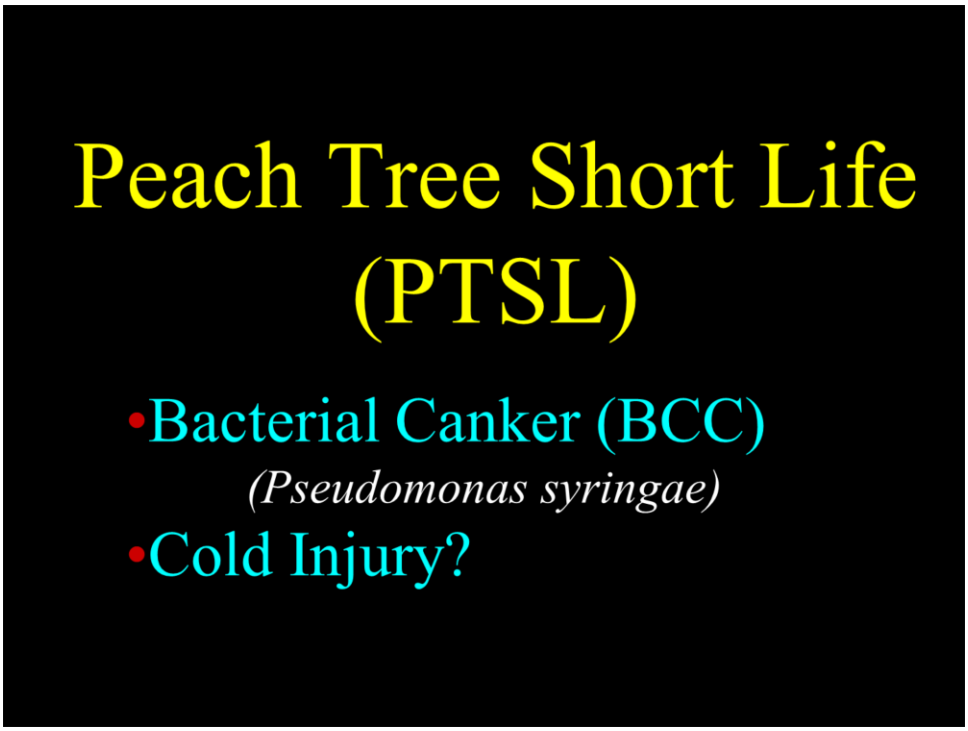
This is how things looked back when I started with the USDA in 1988. There were only 2 rootstock related issues on the radar at the time, peach tree short life (PTSL) and Armillaria (ARR). My how times have changed and justifiably. With progress on both of these issues over time we now have the luxury of considering other possibilities, some of which are coming to the stage now or will shortly. Nonetheless, these 2 issues always have to be on your mind when you look to alternatives for use here in the SE else you risk trading a minor problem for a major one.



For the majority of my career these have been the primary issues I have been breeding and selecting for as they reflect the primary concerns of peach growers in the main production areas of SC and central GA.



However, when you look at Florida everything is turned pretty much on its head. In part this is due to the fact that most of the recent growth in the Florida peach industry has been in central Florida. This area has not been planted to peach before. Problems like PTSL and Armillaria are replant problems, i.e. they become worse as a site is repeatedly planted to peach and the organisms responsible for the problem build up in the soil. Although present in Florida, PTSL and Armillaria have not had the time and opportunity to develop into major issues. However, an issue like waterlogging is site specific, i.e. dependent on the drainage characteristics of the soil being used and is largely unchanging over time. Soils in Florida are very different from those in the main peach production areas in Georgia and South Carolina, often hiding subsoils with low water permeability. When subjected to heavy rainfall a perched water table may form at the boundary between the topsoil and subsoil which in turn drowns the rootsystem of peach trees that has also piled up at this interface. Growers may be unaware that this is happening because the water is 'standing' at the interface and not at the soil surface. The sandier soils of Florida are also very conducive to the buildup of rootknot nematodes which makes this more of an issue there than it is on the heavier soils of Georgia and South Carolina. Additionally, Florida has the dubious honor of also hosting a recently identified RK species, M. floridensis, that is capable of attacking many of the peach rootstocks otherwise resistant to M. incognita or M. javanica.



It is important that growers know what problems they are facing. This is because the management of each problem may differ considerably and the 'solution' to one problem may do nothing for another.

PTSL aka Bacterial Canker Complex (BCC) is often a serious problem especially on old peach land. The coup de grace is inflicted by either bacterial canker or cold injury. PTSL is more widespread than ARR (presumably because of the widespread infestation of peach land with the ring nematode, one of the primary pre-disposing factors for PTSL)

Unlike ARR in which trees can die just about any time of year, most PTSL deaths occur in Spring shortly after bud break.

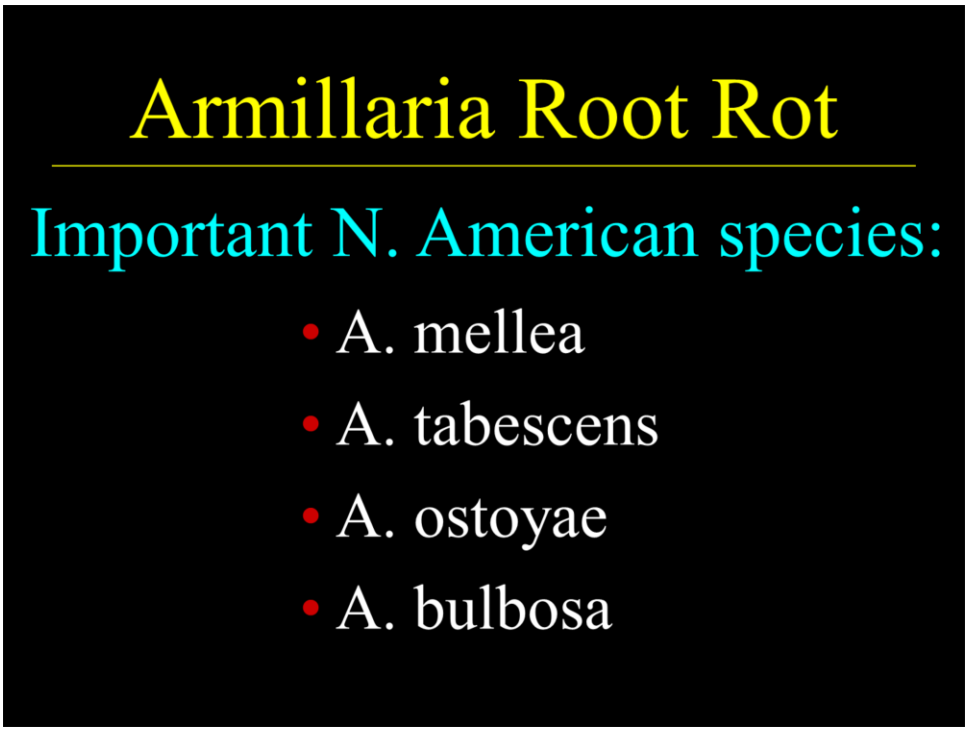
Trunk leakage is often the first indication that something is amiss.

Leaves and flowers will collapse and scorch. They are often delayed in emergence in trees that display PTSL.

Upon closer examination cambial browning/necrosis is evident, particularly on scaffold limbs and trunk.

Interestingly, the cambial browning invariably stops at the ground line. Hence, the roostock is still alive unlike with ARR.

The still living rootstock will often send up profuse suckers but, nevertheless, the tree has been lost.

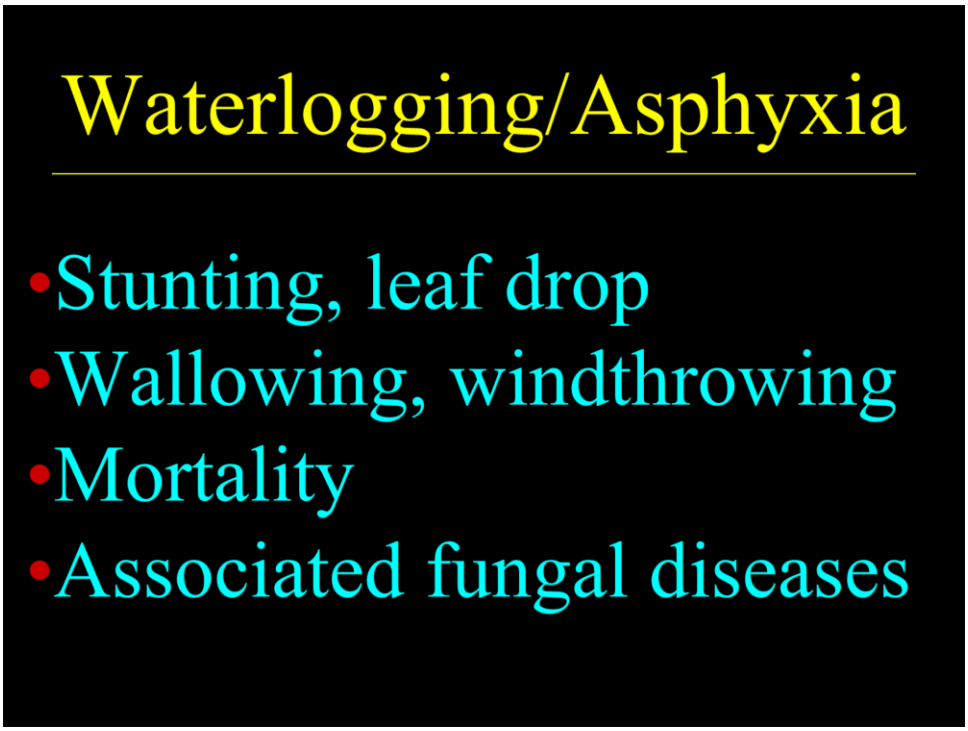


Armillaria is another replant problem in fruit production areas around the world. Relative importance of the different species of Armillaria differs some around the US. A.mellea is probably the most commonly encountered outside the SE but here A. tabescens is the most common species.

Although trees can die in any season, in this case trees died in late summer and the scorched foliage remains attached. Alternatively, trees may fail to come out of dormancy in the Spring and upon inspection will be found to be dead from top to bottom.

Removing soil at the base of the tree will likely reveal a well developed mycelial mat which clearly distinguishes ARR from PTSL, i.e. the time of death is different and the pattern of tissue damage is different. The rootsystem generally remains alive (at least for a while) in PTSL but it is the collapse and death of the rootsystem in ARR that brings the whole tree down.

Clusters of gilled Armillaria mushrooms will usually develop at or close to the base of dead and dying trees. They usually appear after heavy rains, especially in the fall as temperatures decline, but we've occasionally seen them in late spring and even mid-summer. These fruiting bodies are decidedly ephemeral, emerging, developing and either rotting or drying down to an inconspicuous bit of tissue in just a couple of weeks.



Waterlogging can come about several ways. It can be due to a severe inundation that literally floods the landscape such as occurs during hurricanes or it may be more insidious, i.e. a hidden 'perched' water table that occurs when water cannot percolate fast enough through the soil layers and builds up at an interface that slows its progress, such as a plow pan, a cemented layer or even just a sudden textural change from one soil layer to another..

This photo is from a peach orchard near Fort Valley, GA, post Alberto, late July 1994 (ca. 2 weeks after torrential rains). Equipment path?

Post Alberto, late July 1994. Equipment path still with water standing in it.

Post Alberto, late July 1994. Severe leaf drop induced by waterlogging stress.

Post Alberto, late July 1994. Severe leaf drop induced by waterlogging stress. This area is actually a low spot in the orchard that has suffered repeated flooding/waterlogging episodes over time. You can see several trees are long since gone here.

Post Alberto, late July 1994. Water flowed through this orchard in middle Georgia at chest height. If you look closely you can see the bare shoots at the bottom of the canopy, particularly just in front of the observer.

Post Alberto, late July 1994. Water flowed through this orchard in middle Georgia at chest height. Note low branches with no leaves and virtually none on orchard floor. Virtually no tree losses in this orchard, however.

1994 post Alberto. Most tree losses were either where water sat for weeks (on any age tree) or, more commonly, on younger trees less than 4 years old. In my opinion the latter observation has import when it comes to anchorage as well. This is Butch Ferree, peach county extension at the time of Alberto, since retired.

1994 post Alberto. Most tree losses were either where water sat for weeks (on any age tree) or more commonly on younger trees less than 4 years old. Young trees lack the sinker roots that provide real anchorage to a tree. These roots and their elaborations well below the soil surface also temporarily reside in more oxygenated soil during a major flooding event that first saturates the extensive feeder rootsystem near the soil surface. This I believe helps mitigate the stress caused by oxygen displacement as the saturated water front moves down through the soil profile.

Waterlogging Related Pathogens

Oxyporus

Oxporous is an opportunistic pathogen that often attacks trees that have suffered waterlogging stress. It is easily distinguished from ARR since it is a ‘toothed’ fungi. Its mycelium does not form a well developed mat beneath the bark like ARR. Instead it is a ‘diffuse’ grayish mat.

Fruiting body of Oxyporus. Unlike Armillaria mushrooms, this fruiting body will persist after forming.

A notable encounter with Oxyporus occurred in south Georgia in 95, the summer following Alberto. As fruit started to ripen in May a large number of trees went into stress (shoot growth ceased as did final swell of fruit) and started to collapse. It was possible to break trees as large as 4-6" in diameter off at the base simply by grabbing the scaffold limbs and twisting them. The internal wood at and just below the ground line had been broken down by what appeared to be Oxyporus. Most, if not all of these trees also had very dark necrotic areas that was likely a sign of Phytophthora infection. These trees may have been infected by both organisms during the flooding events of Alberto and unusually heavy rainfall that followed in the autumn in this area. Which was responsible for the collapse is probably of more academic importance than practical.

This is a close-up of the broken off trunk at the ground line of the tree in the previous photo. You can see some whitish mycelium at the bark interface and ‘punky’ wood in the core.

1995 Post Alberto tree damage in south Georgia. Note dark lesion, mycelial threads and punky wood. Rapid wood decomposition is, in my experience, typical of Oxyporus (but not Armillaria).

Less than a year after Alberto the wood decomposition from the Oxyporus was such that these trees could be easily broken off by grabbing the scaffold limbs and twisting.

Two years later, Post Alberto result of waterlogging and fungal disease outbreak in south Georgia. Growers tried to nurse some blocks back to health via severe pruning and fertilization but in the end it was ultimately deemed futile. A lesson learned.

Another fungus likely to pop up during a waterlogging event is Phytophthora. This is a likely example of Phytophthora Crown Rot. Note the very dark brown almost black necrosis. This is the color bark and wood typical of waterlogging (with our without the presence of Phytophthora). The soils surrounding the roots will often have grey or black areas or streaks following waterlogging events as well.

A waterlogged tree in Spain. In this case due to a ‘perched’ water table that piled up on a tight subsoil during a heavy rain.

Close up of same tree showing dark necrotic lesion, possibly Phytophthora, down low on trunk. These lesions are invariably associated with waterlogging episodes. Although some progress has been made in identifying Prunus material with some resistance to Phytophthora, most of this effort has been expended towards rootstock development in species other than peach. Regardless, I would expect some relief on this front from some of the plum based materials now becoming available for use with peach. Hopefully, resources can be brought to bear if only to evaluate what's coming into the market place.

Rootknot Nematodes

- Cause significant stunting
- Rootstocks differ significantly as hosts

Rootknot nematodes can be a serious problem in the SE. We have several species that are of concern. Meloidogyne incognita is certainly the most common in the main production areas in Georgia and SC with M. javanica of comparatively minor importance. However, in FL M. floridensis is the primary concern and M. arenaria somewhat less so.

Rootstocks (along with preplant fumigation) is an important and effective tool. We have some good rootstock choices for the main production area but selection is much more limited in Florida. Although Mi and Mj resistance is not uncommon in some of the new rootstocks, my experience has been that Mf resistance is quite rare outside of some of the plum based materials and a select few peach lines.

Typical example of the extreme galling you can see when susceptible peach stocks are attacked by root-knot nematodes (M. incognita on Lovell rootstock in this case).

This is an example of an orchard on Lovell rootstock that was planted on an unfumigated site in central Georgia. Note the extreme variability in tree vigor. As it turned out this site was infested with root-knot nematodes (M. incognita?). These trees will generally not grow out of this stunting. In this case the grower removed this orchard, fumigated and replanted.

Another example from SE Georgia. Tree in front was on Lovell (susceptible) while the ones behind it were budded to Nemaguard (resistant). Trees are all the same age and variety.

Root-knot Nematodes

Important southeastern species:

- Meloidogyne incognita
- M. javanica
- M. floridensis
- M. arenaria

There are a number of species distributed around the US:

Southern RK nematode (Mi) is our most important one generally, especially in the lower coastal plain.

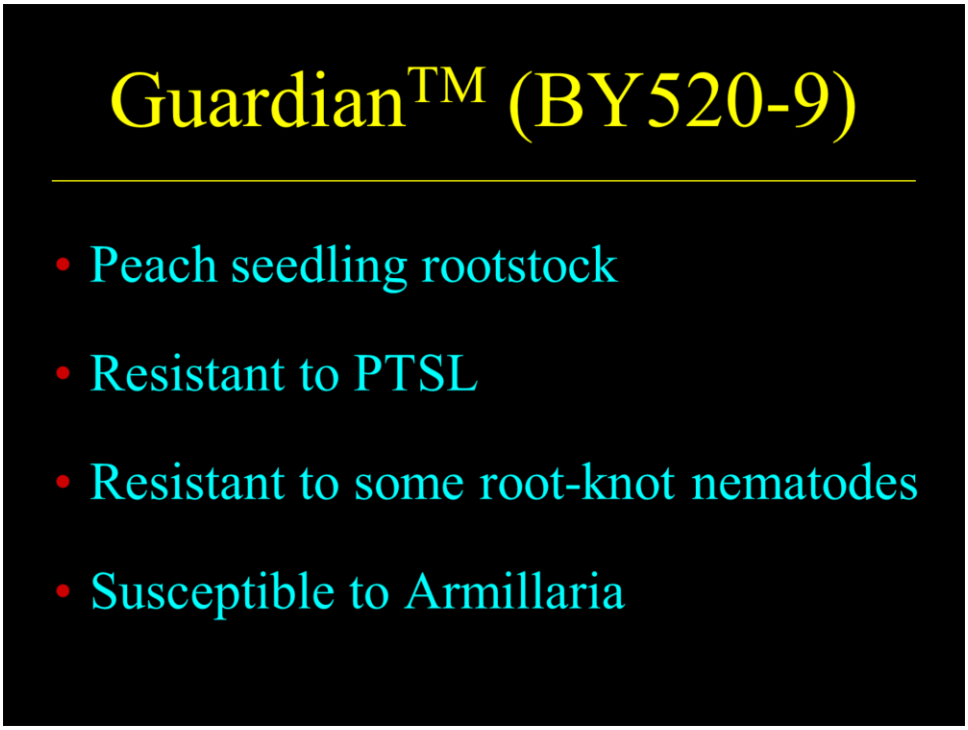
The Javanese (Mj) is occasionally found but is less common (<5% rate of Mi) than Mi

The recently identified 'Peach RK nematode' (Mf) is capable of attacking many of the commercial peach rootstocks resistant to Mi and Mj. Distribution is still somewhat uncertain but it may be common in Florida.

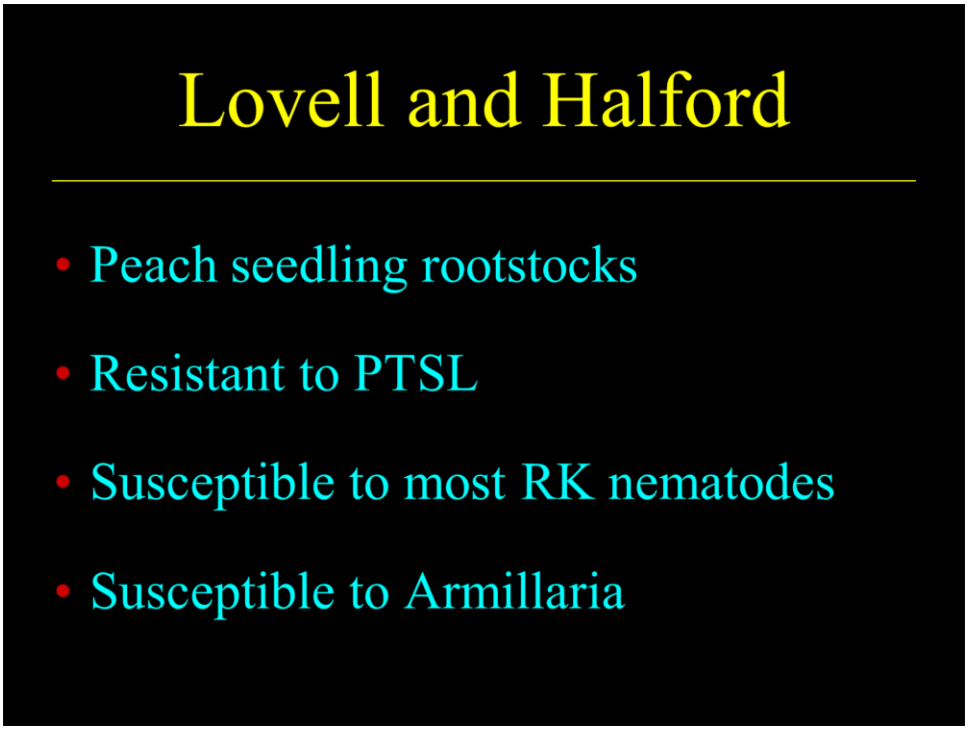
The peanut nematode, M. arenaria, was generally not regarded as particularly common but we are now seeing some instances of damage in FL on Flordaguard where the culprit implicated is possibly a new strain of M. arenaria (or M. floridensis).

Currently Available Rootstocks for Peaches

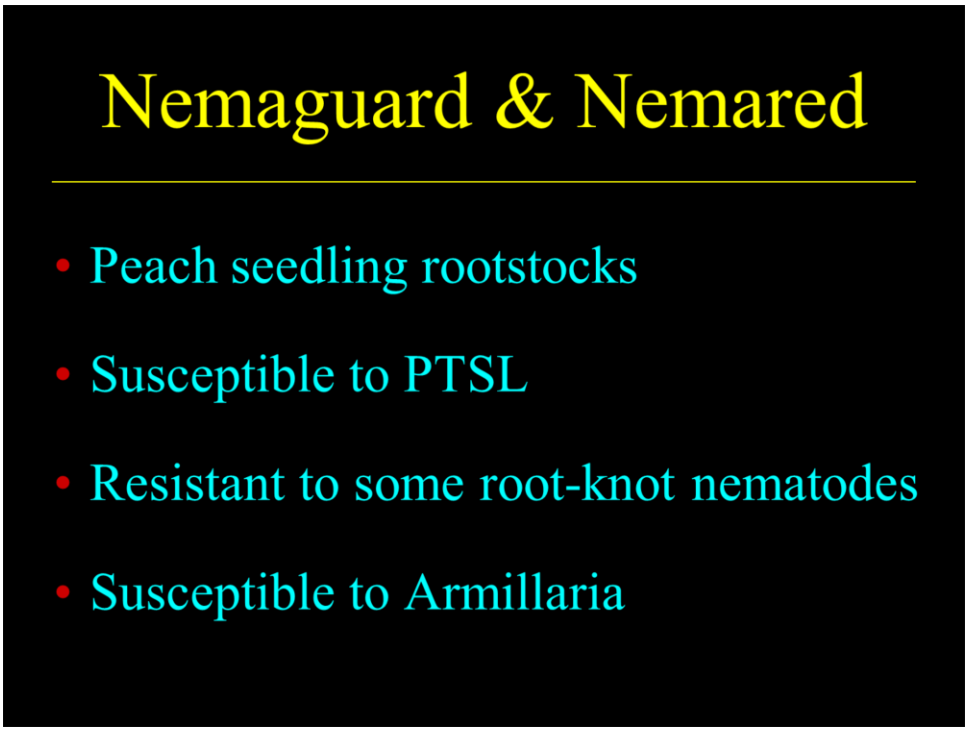
Peaches are propagated on a number of rootstocks. In different parts of the country, i.e. California, vs. the upper Midwest, vs. the Southeast, there are good reasons for preferring one rootstock over another.



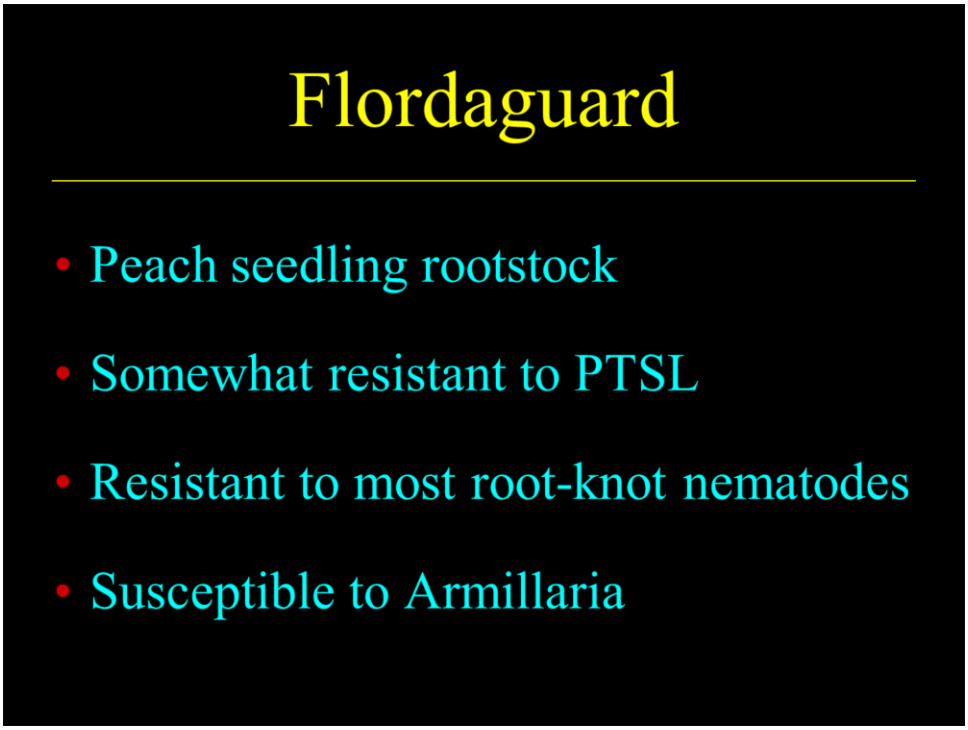
Guardian was released in 1993. To date Guardian's resistance to PTSL has been outstanding and its resistance to RK, appears to be satisfactory for most sites (though it does not appear to be resistant to the Florida nematode). Its one 'Achilles Heel' is its susceptibility to Armillaria root rot, which, with the decline of PTSL losses, has emerged as the number one cause of premature mortality of peach trees in the Southeast. Nevertheless, overall tree life has improved markedly. However, performance downsides include excessive vigor and suckering.



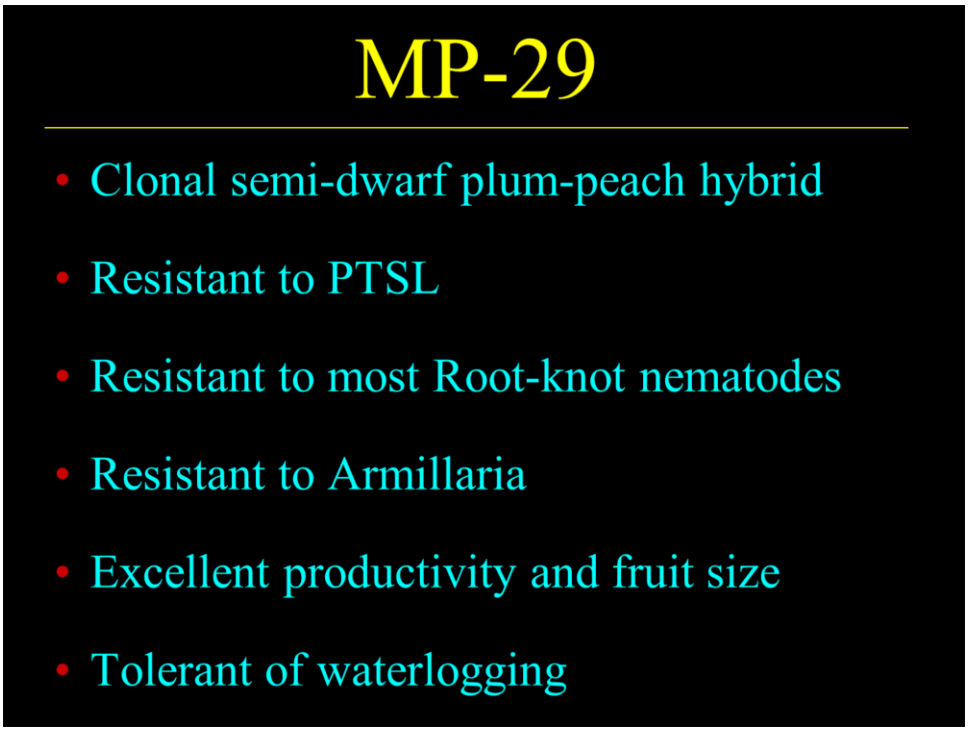
Prior to the release of Guardian, Lovell and Halford were the dominant rootstocks utilized in the Southeast. Halford is probably a seedling of Lovell and behaves much like it. Both have resistance to PTSL (though not as good as Guardian) and lower vigor and suckering than Guardian (ca. 10-15%). Unfortunately, both are susceptible to the common root-knot nematodes found in the SE and, like most peach seedling types, are very susceptible to Armillaria. Lovell has just about disappeared from the market. However, Halford is still available from a few nurseries. Halford is typically being used on sites where PTSL has not been an issue and growers didn't want to deal with Guardian's vigor and suckering.



Nemaguard is still the primary rootstock in California and is available from some of the nurseries supplying trees to the SE US peach industry. Nemared is similar to Nemaguard but red-leaf. Their use on sites prone to PTSL is to be discouraged as both are very susceptible to PTSL. Like Guardian they are resistant to M. incognita and M. javanica but not to M. floridensis. Like most peach seedling types they are very susceptible to Armillaria.



Flordaguard, released in 1991 from the UF program, is a red-leaf rootstock with vigor similar to Lovell and Halford. It is more resistant to PTSL than Nemaguard or Nemared but is clearly not as good as Lovell or Halford, much less Guardian. It has broad root-knot nematode resistance, including M. floridensis. However, it too is very susceptible to Armillaria root rot.

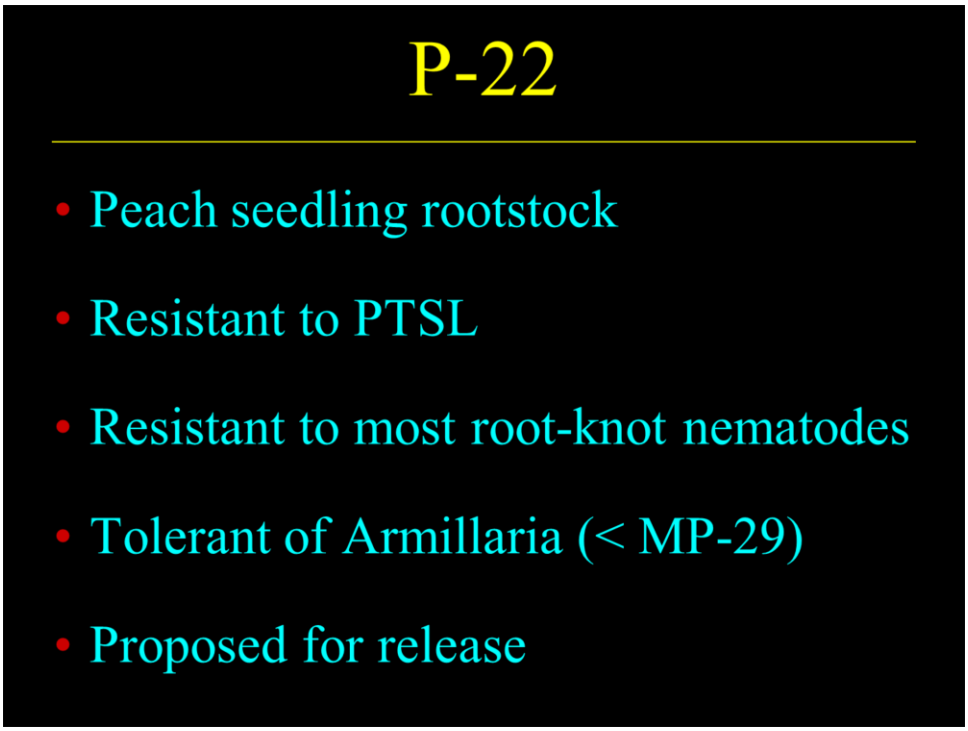


MP-29 was released in 2011.

Its PTSL and Armillaria resistance is second to none at this time. The same appears to be true of its RK resistance. However, remember resistance is NOT immunity. MP-29 displayed excellent productivity during pre-release testing and this is being confirmed in a follow-up horticultural trial. Its excellent fruit size is in stark contrast to that of some of the other complex hybrid Prunus rootstocks recently introduced from other programs. And there now also appears to be good evidence that it has significant tolerance to waterlogging.

So far, testing has yet to reveal any Achilles Heel in MP-29. It has resistance to all the diseases that plague the Southeast (and should have good utility elsewhere, i.e. BCC in California and Armillaria pretty much everywhere). It may yet encounter a RK species that it can't handle but so far so good. Its productivity holds out the possibility of improved per acre yields with no loss in fruit size. And finally its reduced vigor offers significant reductions in excess vegetative growth and the associated labor costs required for its removal. With that said its use outside of the area it was developed and originally tested in should be done so with caution as its adaptation to other areas differing in soil or climate is still unknown at this time.

Biggest issue at this time is its limited availability as it is not as easily propagated as are seedling propagated rootstocks like Guardian and Halford. Nonetheless, nurseries are making progress on this front.



P-22 is being proposed for release as its final testing is wrapping up and seed orchards are coming into bearing. P-22 is a red-leafed rootstock that may be an improvement on Guardian. P-22 has similar vigor and productivity combined with similar resistance to PTSL. Its notable advantages are its broader resistance to rootknot nematodes and better resistance to Armillaria that Guardian can provide (though not as good as MP-29). At best it will be a couple of years before it becomes available.

Rootstock Comparison Guide

Rootstock	*Type*	Vigor	Suckers	Yield	Fruit Size	PTSL	RK-Mi	RK-Mf	ARR
Guardian	P	VH	H	H	Good	R	R	S	S
Lovell Halford	P	H	VL	H	Good	T	S	S	S
Nemaguard Nemared	P	VH	H	H	Good	S VS	R	S	S
Flordaguard	P	H	L	H	Good	T	R	R	S
MP-29	MP	M	M	H	Good	R	R	R	R
P-22 (proposed for release)	P	H	M	H	Good	R	R	R	T

Type: P=peach seedling, M=plum hybrid, MP=plum x peach hybrid
Vigor: H=high, M=medium

Suckers: H=high, M=medium, L=low
Yield: H=high, M=medium

PTSL, RK and ARR: R=resistant, T=tolerant, S=susceptible; Mi=Meloidogyne incognita, Mf=M. floridensis

Comments: For Florida only those rootstocks with known resistance to M. floridensis can be recommended. This rules out most of the rootstocks currently being used in other peach production areas around the country. This leaves Flordaguard as your stock of choice at this time. Although MP-29 has shown resistance to Mf in FL trials its horticultural performance is still under trial and it should be used cautiously if at all until its full performance characteristics have been evaluated. P-22 is being proposed for release and, at best, is at least a couple of years away from availability.

There is now a concerted effort being undertaken to revisit rootstock development for Florida specifically focusing on the rootknot nematode issues that have recently come to the fore. This work includes screening of candidate materials for resistance, the development of markers for resistance to the nematode species of interest and the development of faster, more efficient screening methodologies. In the meantime, on those sites with nematode populations that are capable of attacking Flordaguard your first line of defense would be to use pre-plant fumigation. This approach, though expensive, has proven ability to allow the establishment of new plantings without stunting such that orchards have good profit potential. However, growers need to keep an eye on some of the new fumigants being introduced and tested as well as research on pre-plant rotations of non-host crops to starve out nematodes as they may ultimately offer an attractive option too.