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Navelina Orange Rootstock Incompatibility

Revisiting a citrus rootstock trial planted in 1997 at the Loxton Research Centre has revealed issues which were not apparent in the early life of the trees. In particular there is strong evidence of incompatibility of Navelina orange scion on three rootstocks.

Tree deaths within the patch since 2006 suggest incompatibility of Navelina 7.5 with C35 citrange, and F80-5 and F80-7 citrumelo (same parentage as Swingle citrumelo) rootstocks. All 24 scion/rootstock combinations performed adequately as young trees (up to 10 years), but since then 20 of the 27 trees of Navelina 7.5 on these three rootstocks (randomly replicated throughout the trial) have died, with no deaths in any other scion/rootstock combination.

It is recommended that Navelina 7.5, and closely related varieties Navelina 315, M7 and FJ Navel should not be budded to C35 citrange, or on F80-5 or F80-7 citrumelo.

BACKGROUND

In 1997 SARDI citrus researcher Peter Gallasch planted a rootstock trial at Loxton Research Centre to compare the performance of three different Navel orange scions on eight rootstocks. The scions chosen were Navelina 7.5 (early-season), Hockney Navel (mid-season) and Summer Gold Navel (late-season). These were budded onto Cleopatra and Sunki Mandarin, Philippine and Santa Barbara Red Lime, Troyer 341 and C35 citrange, and F80-5 and F80-7 citrumelo rootstocks.

The trial was evaluated over the first 10 years of tree growth, with comparisons made of tree size and yield up to 2007. After this date funding was no longer available to monitor the development of the trees, but the trees were maintained as a commercial planting. The Citrus Research program at Loxton Research Centre was subsequently shut down.

In 2015 SARDI developed a project to revisit a range of vine and citrus rootstock trials, which was funded by the Australian Government under the Industry-led Research Sub Program (IRSP) of the South Australian River Murray Sustainability (SARMS) program. In consultation with industry this trial site was one of four selected to be revisited, with the aim of comparing relative performance of scion/rootstock combinations in early life with that of mature plantings.



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NAVELINA TREE DEATHS

The first observation made at this trial site was that many trees were dead. Closer inspection indicated that the dead trees all fell into one of three scion/rootstock combinations. All dead trees had Navelina 7.5 as the scion, and in all cases this was budded onto F80-5 citrumelo, F80-7 citrumelo or C35 citrange.

Historical satellite images of the planting were used to identify living and dead/missing trees at specific dates, with results shown in Figure 1. The graph indicates that the first deaths occurred in trees budded to F80-5 citrumelo, with F80-7 being the next to decline, and C35 citrange holding out the longest. However, the rate of death in C35 trees has been very rapid since 2013, and in all combinations there are only two or three trees remaining alive out of the original nine replicates.

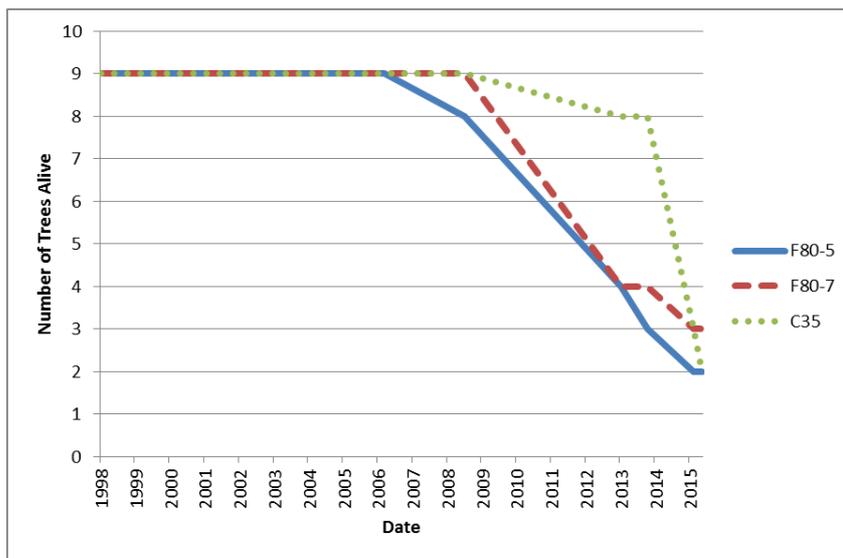


Figure 1: Decline in Navelina tree number over time

TRUNK SYMPTOMS

The pattern of tree death at this site is very strongly suggestive of rootstock/scion incompatibility, given that just three combinations out of 24 in the trial are affected, the dead trees are distributed randomly throughout the trial site, and close to 75% of trees in those specific combinations have died. In order to confirm this, the bud unions of all remaining trees of these combinations were inspected.

Incompatibility often expresses initially as problems at the bud union, not always leading to tree death. Indications of incompatibility include dramatic differences in the diameter of the scion and rootstock trunks (Castle, 1987), often leading to overgrowth by either the scion or rootstock (Castle, 1987; Owen-Turner, 1995). A crease may develop at the bud union, even without significant difference in trunk size (Castle, 1987). Another symptom is excessive suckering of the rootstock (Hardy, 2004).

The trunks and bud unions of the surviving Navelina trees on F80-5, F80-7 and C35 were inspected and photographed to identify any signs of incompatibility. Each of these combinations presents different symptoms at the bud union, as illustrated below.

C35 CITRANGE

While Navelina trees on C-35 citrange survived well for longer than those on F80-5 and F80-7 citrumelo, a sudden collapse in a number of trees at age 16 meant that this rootstock/scion combination quickly caught up to the others in total number of dead trees (Figure 1).

The bud union of Navelina trees on C35 citrange (Figure 2) shows very little external evidence of any problem. The rootstock is smooth and shows little evidence of suckering. The only external clue lies in the slight folding of the trunk at the union (Castle, 1987), evident on the right hand side of the image.



Figure 2: Bud union of Navelina 7.5 on C35 citrange



Figure 3: Exposed bud union of Navelina 7.5 and C35 citrange, showing gap in tissue

A strip of bark was removed from one of the surviving trees of Navelina 7.5 on C35 citrange, across the bud union in the area of the crease, to expose the underlying woody tissue (Figure 3). This revealed that the underlying wood was not connected across the union, but there was a clear break between tissues of the scion and the rootstock.

This is further evidence of incompatibility in this combination. This specific tree is in reasonable health, but already shows some signs of twig dieback, and the ongoing development of tissue separation around the trunk can be expected to lead to further disruption in the flow of carbohydrates manufactured by the scion down to the roots, resulting in root death and eventual tree decline and death.

F80-5 CITRUMELO

Bud unions of Navelina on F80-5 at the trial site show external symptoms of bark death similar to those of phytophthora or sunburn damage, typically on the western side of the trunk, but only below the bud union (Figure 4). Dissection of the union of a dead tree (Figure 5) reveals that the dead tissue below the union reaches deep into the trunk (right hand side of image), with a clear demarcation between scion and rootstock tissue.

There is evidence of a crease above the area of dead bark in Figure 4 (Castle, 1987), and on the left of Figure 5 there is a clear discontinuity between the scion and rootstock tissue near the outer edge of the trunk. This suggests that the woody tissue of the trunk has developed independently in the scion and rootstock, with no connection between the two. This clearly disrupts the flow of carbohydrates from the scion down to the roots, resulting in the death of a portion of the rootstock. This ongoing process ultimately leads to the death of the whole tree.



Figure 4: Bud union of Navelina 7.5 on F80-5 citrusmelo



Figure 5: Dissected bud union of dead Navelina 7.5 on F80-5 citrusmelo

Figure 4 also shows evidence of suckering by the rootstock, noted by Hardy (2004) as a symptom of incompatibility. Borer damage is evident in Figure 5, but this is assumed to be a secondary problem, resulting from poor tree health due to the incompatibility.

F80-7 CITRUMELO

The bud unions of Navelina trees on F80-7 citrumelo (Figure 6) are quite different to those on F80-5 and C35. The rootstock portion of the trunk is much larger than the scion, with evidence of creasing at the union. The rootstock shows extensive nodulation as the result of frequent and persistent suckering (Castle, 1987; Hardy, 2004).



Figure 6: Bud union of Navelina 7.5 on F80-7 citrumelo

RESPONSE OF OTHER SCIONS ON THESE ROOTSTOCKS

As mentioned above, the trial site also contains trees budded to two other varieties, Hockney Navel and Summer Gold Navel. Although no tree deaths have occurred in trees with either of these scions, the bud unions of these trees were also examined to check for the development of symptoms of incompatibility.

C35 CITRANGE

Few Hockney or Summer Gold trees on C35 citrange show the same degree of folding as found in Navelina on C35. However, most trees have a significant reduction in trunk size from rootstock to scion, and many of the trees demonstrate sharp benching at the bud union, a possible precursor to overgrowth by the rootstock. No excessive suckering is evident in either rootstock.

Tree size is consistently small amongst Hockney on C35. It is possible that the smaller tree size under Hockney is caused by the three viroids carried by this selection (Graeme Sanderson, pers. comm.), as well as the slight dwarfing character of C35 citrange (Lacey, 2014), but the presence of large Hockney trees on other rootstocks indicates that there is some interaction between viroids and rootstock. Summer Gold trees on C35 are of medium height, consistent with a slight dwarfing effect of the rootstock.

F80-5 CITRUMELO

The bark death encountered in F80-5 under Navelina (Figure 4) is not evident under either Hockney or Summer Gold navel scions, and the bud union is smooth and shows no signs of incompatibility at this stage.

Tree size relative to other trees in the trial is small to medium under Hockney, and medium to large under Summer Gold.

F80-7 CITRUMELO

The rootstock portions of all trees on F80-7 show size disparity between the scion and rootstock and excessive suckering, making them look very similar to Figure 6.

However, all Hockney and Summer Gold trees on F80-7 are medium-large to large, and appear quite healthy at this point. It is unclear whether tree death due to incompatibility is likely in the future, or whether the bud union has reached equilibrium and the trees will survive and thrive.

RECOMMENDATIONS

Based on the evidence found at this trial site, it is recommended that the rootstocks C35 citrange, F80-5 citrumelo and F80-7 citrumelo should not be used in combination with Navelina 7.5 scion. In addition, due to the close genetic similarity, caution is advised in budding other varieties such as M7, Navelina 315 and FJ Navel (a recent Navelina sport) onto these rootstocks, as similar problems are possible.

For growers who have plantings of Navelina trees budded to these rootstocks, there is little that can be done to prevent incompatibility developing over time. It is likely that trees on C35 citrange will begin to die from about 15 years of age, but individual orchard conditions may hasten or delay the development of symptoms and tree death.

If trees are still healthy, reworking to another variety may be possible (Sanderson et al., 2007), but the new stick-grafts must be inserted below the existing bud union, or the tree chain-sawed below the union and allowed to reshoot from the rootstock before rebudding. The trunk would require whitewashing in either case. Alternatively, inarching may be considered, to develop a new root system to support the existing Navelina scions. These options will be expensive and carry significant risk of failure, so professional advice should be sought.

Alternatively, once trees begin to decline and die they will need to be replaced, so yield from the orchard should be monitored, and replacement trees ordered once trees begin to die, or production from the orchard begins to decline.

Given that incompatibility problems take many years to surface, it is recommended that follow up research similar to the project which funded this work should be undertaken regularly, to revisit older rootstock comparison trial plantings and look for emerging issues. It is not practical to continue full trial assessment over multiple decades, but periodic revisits will identify issues which only emerge over the course of many years.

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