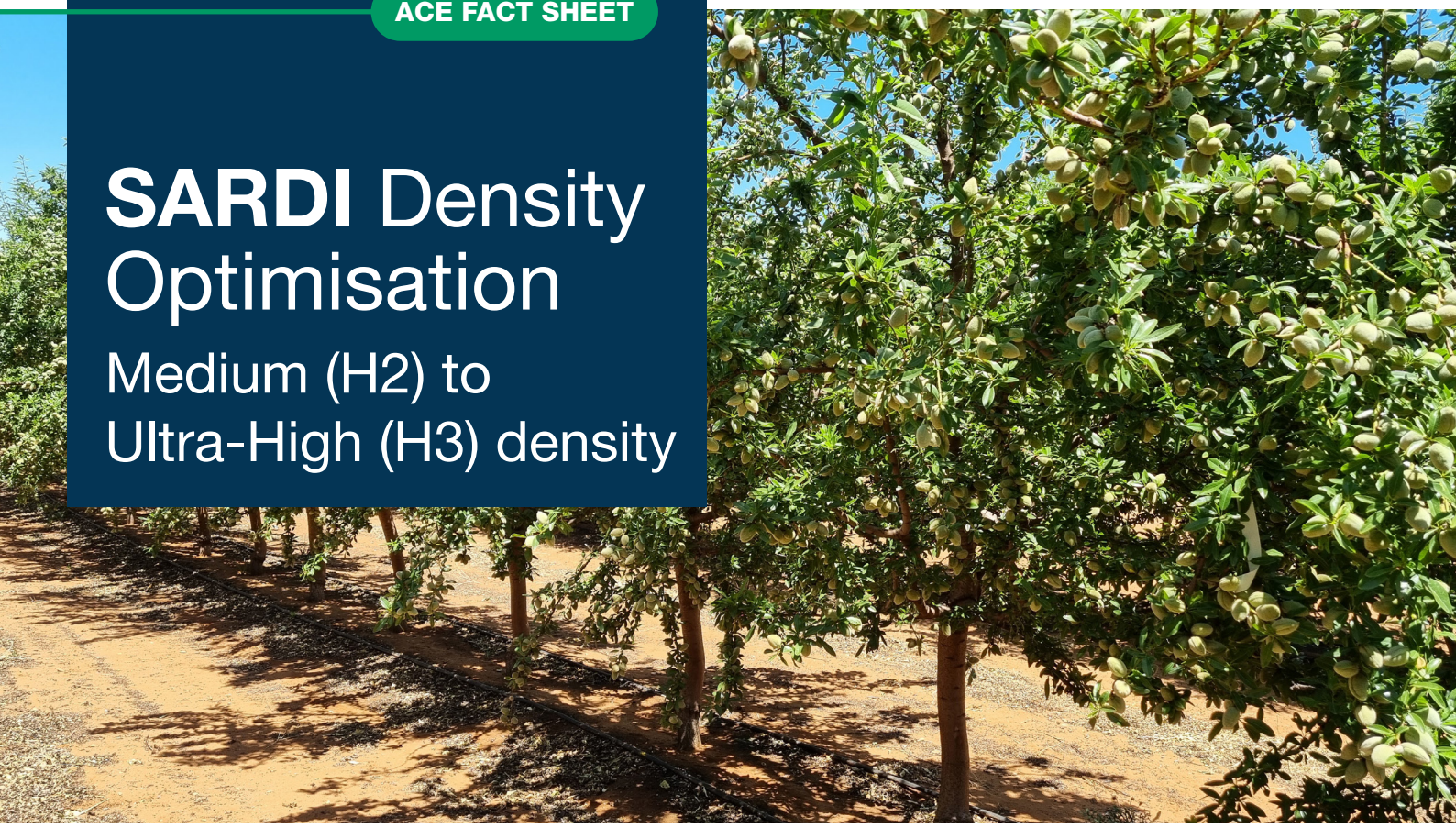
Government of South Australia
Department of Primary Industries and Regions

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

ACE FACT SHEET

SARDI Density Optimisation

Medium (H2) to Ultra-High (H3) density



Background

SARDI's second density optimisation trial is an ambitious investigation of an ultra-high-density, narrow production system using size controlling rootstocks and new self-fertile varieties. Tree densities range from 635 to 1481 trees/ha at within row distances of 1.5, 2.5 and 3.5 m at a reduced row width of 4.5 m. This experiment contributes to SARDI's collaboration with Plant and Food Research (PFR) and is part of a multi-crop, orchard intensification project (AS18000) that is supported through Hort Innovation and the Hort Frontiers Advanced Production Systems Fund.

Whilst this orchard design is not currently practical for commercial application, SARDI expects to test and demonstrate some of the almond industry's longer-term goals. These include increased early yields, improved resource use efficiencies, single pass shake and catch harvesting, alternate mid-row management strategies and improved hygiene for both kernel and trees.

Aim

To test the performance of two self-fertile varieties grafted to each of three low vigour rootstocks across a three-step density transition from Horizon 2 (635 trees/ha) to Horizon 3 (1481 trees/ha)

Trial design

Four replicates of 18 treatments
1,520 trees / 1.6 ha

Two varieties	Shasta, Vela
Three rootstocks	Controller-6, Controller-7, Rootpac-40
Three densities (4.5 m rows)	635, 889, 1481 trees/ha
Planted	2019

Results so far

One of the earliest learnings from this orchard has been the value of planting advanced nursery stock. Whilst the health of the young planting material used in this experiment was exceptional, nursery trees were delivered as very small potted plants. Given their small size, much of the first two seasons was spent developing canopy, which limited the opportunity for high early yields. Had the planting material been more advanced, such as traditional un-headed field grown nursery trees, commercial yields may have been achieved in the second season.

All trees were trained as a modified central leader using a temporary trellis structure which was removed after the 3rd leaf. Tree training targeted a hedgerow form of approximately 1.2 m wide and 3.5 m tall.

Commercially harvestable yields were first achieved in 2021/22 (3rd leaf). In both season 2022 and 2023, the yield of trees grafted to Rootpac-40 and Controller-6 rootstocks exceeded that of trees grafted to Controller-7 (Figure 1). Yield differences were driven by Controller-7's intolerance to mildly alkaline soils (particularly evident in shallower soils at one end of the trial orchard). While trees grafted to this rootstock were clearly the least productive combination being tested, they did show signs of improved growth in 2023 and had encouraging yields that year.

To date, within each variety by rootstock combination, trees planted at 1481 trees/ha outperformed those at the lower densities. Kernel size averaged 1.3 g for Shasta and 1.6 g for Vela. Shasta showed signs of pinched tips in 2023 and both Shasta and Vela expressed minor pepper spotting, common for both varieties that season. There is yet to be any interaction between kernel quality and the density by genotype treatments.

As experimental trees matured into their 5th leaf (2023/24) and carried heavier crops, the spread of nut laden laterals into the mid-row introduced the risk of crop removal during early summer hedging operations. In this year, rather than sacrificing crop with early summer hedging, trees were allowed to spread further into the mid-row. The goal being to dampen canopy vigour by retaining crop and exploit the increased light penetration offered by heavily laden limbs laying-over. Mechanical canopy maintenance (hedging) will then be applied immediately postharvest 2024, encouraging crop inside the canopy.

Early assessments of the 2024 crop suggest that Vela has a moderate crop, in response to higher yields in 2023. Shasta trees appear to be carrying a heavy crop apart from Controller-7 grafted trees in the shallower soils.

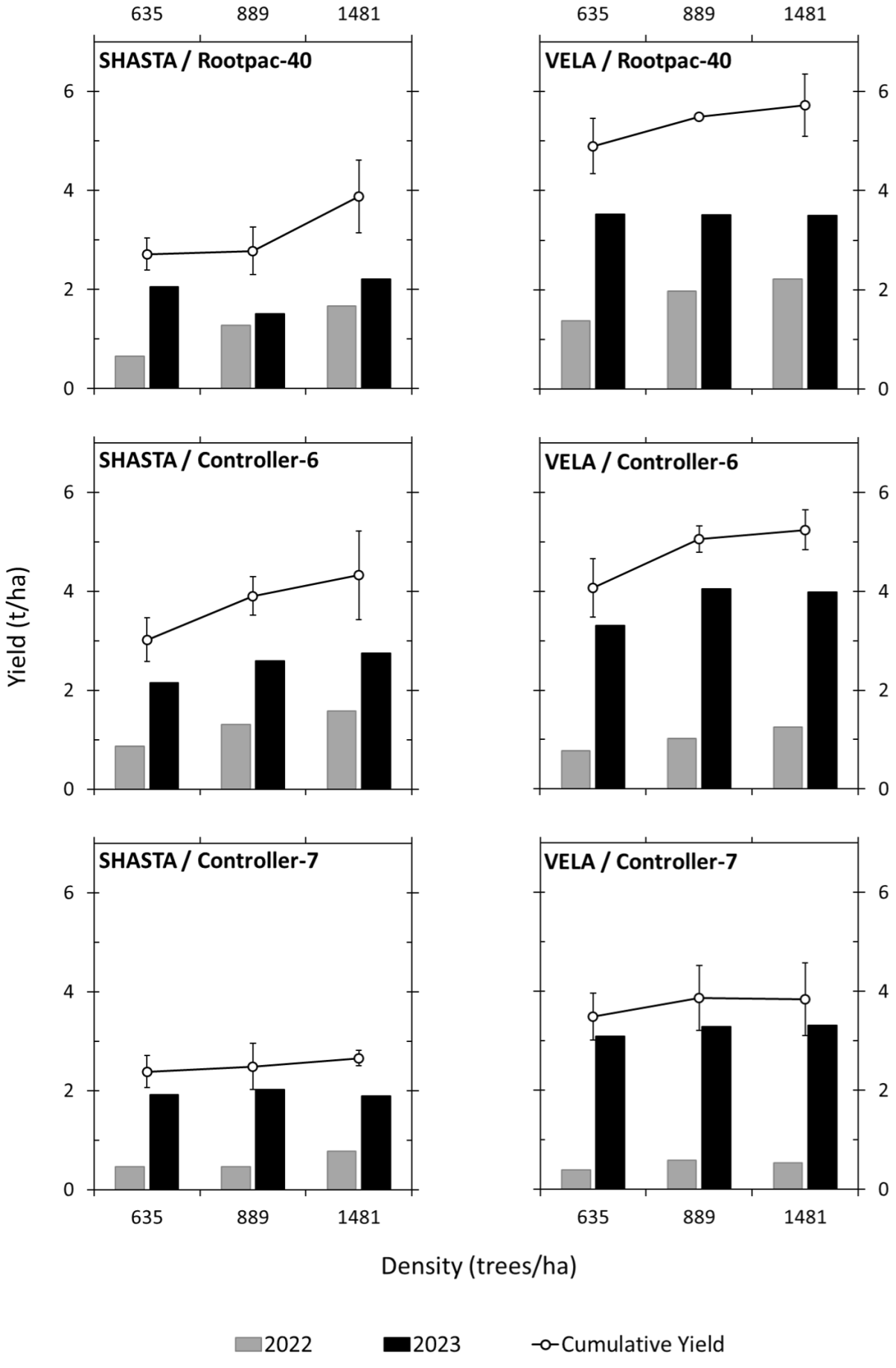


Figure 1 Kernel yields (t/ha) in 2022 and 2023 (3rd to 4th leaf) and the cumulative total yields for Shasta and Vela grafted to three rootstock genotypes (Rootpac-40, Controller-6, Controller-7). Trees were planted at densities ranging from 635 trees/ha to 1481 trees/ha. Established in 2019 at the ACE Orchard, South Australia. Bars indicate Standard Error of the Mean.

Suitability for ultra-high-density hedge

Early results suggest Vela may be more suited than Shasta to this ultra-high-density hedge system due to weeping growth habit and internal bearing.

Vela – presents as a more spreading and heavily leafed tree than Shasta. The variety crops well internally (if not overly shaded) and can have extension growth hedged mid-season without excessive crop loss.

Vela / Controller-6 / 1481 trees/ha

Shasta – presents as an upright canopy with lower branch density and greater tip bearing than Vela. However, crop laden limbs tend to lay into the inter-row space, meaning that mid-season hedging can result in crop loss. Leaving hedging until postharvest makes the removal of some structural wood inevitable.

Shasta / Controller-6 / 1481 trees/ha

Ongoing investigations

- Annual yield and kernel quality metrics.
- Canopy development and architecture studies using ground and aerial based remote sensing.
- Cost benefit analysis of high-density production systems.

Further information

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