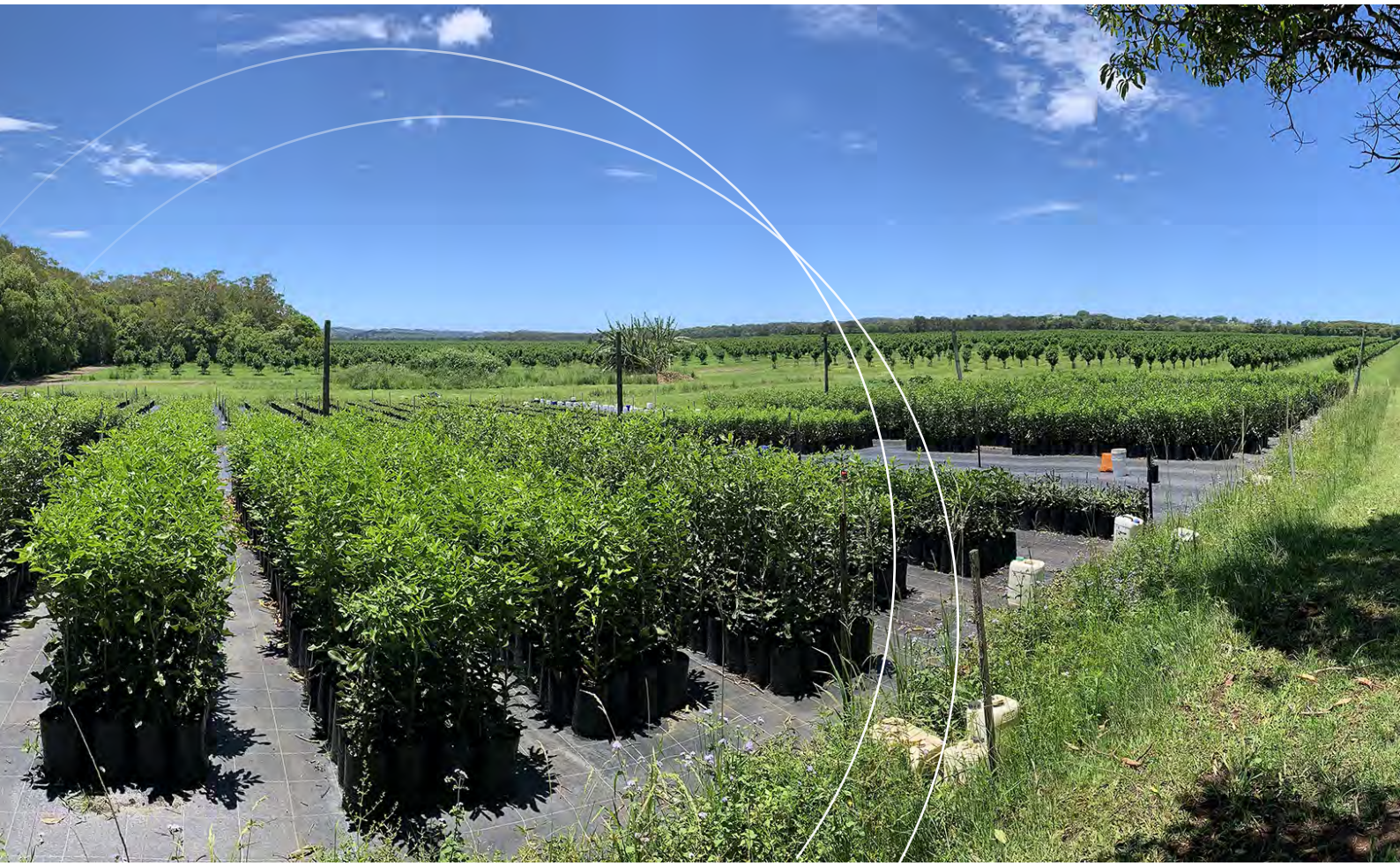
Department of Primary Industries
Department of Regional NSW

Macadamia grower's guide 2024

CULTIVARS



Jeremy Bright and Stephanie Alt

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Macadamia grower's guide: cultivars

Jeremy Bright
Development Officer – Macadamia
NSW Department of Primary Industries
1243 Bruxner Highway
Wollongbar NSW 2477

M 0427 213 059
E jeremy.bright@dpi.nsw.gov.au
W www.dpi.nsw.gov.au

Stephanie Alt
Principal Consultant
Give Soil a Chance
Koonorigan NSW 2480

M 0427 331 440
E givesoilachance@gmail.com
W www.givesoilachance.com.au

About this guide

Cultivars are plants that have been bred to have favourable traits. Varieties are wild plants. Macadamia cultivars produce more saleable nuts than their wild counterparts. Plant breeders continue to develop new cultivars to outperform their predecessors and meet the emerging challenges of commercial production.

Selecting macadamia cultivars for new orchards or upgrading existing orchards is challenging. Many factors influence the performance of mature trees in an orchard. Cultivars differ, as do sites and management systems.

There is no 'always best' answer for which cultivar or combination of cultivars is best for a region. All cultivars have their advantages and disadvantages. Selecting cultivars is easier once you identify the tree characteristics that suit your management intentions.

Cultivars combines information from published sources and numerous growers' experience to help with cultivar selection in the Australian regions.

The Macadamia grower's guide project (2022–24) provides up-to-date resources for macadamia growers. The online resources allow for timely updates incorporating new research findings and evolving macadamia management practices.

NSW DPI maintains up-to-date resources for macadamia growers on the Nuts webpage (https://www.dpi.nsw.gov.au/agriculture/horticulture/nuts).

The *Macadamia grower's guide: new orchards* has information on site selection, tree spacings and cultivar arrangements for cross-pollination and harvest ease. considering soil types, spacings, and combinations of cultivars for cross-pollination and harvest ease.

The Macadamia grower's guide: young trees describes the management of young trees, including pruning.

The *Macadamia grower's guide: nutrition and soil health the foundations* and *the next level* covers soil, nutrient additions and managing the orchard floor.

The *Macadamia integrated orchard management guides* bring together managing the canopy, orchard floor and drainage to promote and sustain high productivity.

The *Macadamia plant protection guide* provides up to date recommendations for pest and disease IPDM.

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High producing orchards

Since 2016, the Australian macadamia industry has used the integrated orchard management (IOM) framework to manage orchards. The IOM framework describes the stages of development and potential decline of macadamia orchards (Figure 1, green line). Growers using IOM aim to have their orchard blocks achieve and remain in IOM stage 2 – peak production for as long as possible (Figure 1, brown line). In stage 2 orchards:

- performance is reaching the maximum production for the site
- branches are touching or inter-woven within the row
- there is open space in the canopy between rows, allowing sunlight to reach the orchard floor
- tree height is less than or equal to the row width
- there is a mix of living and non-living ground cover on the orchard floor
- the drainage system works as planned, and there is minimal soil erosion.

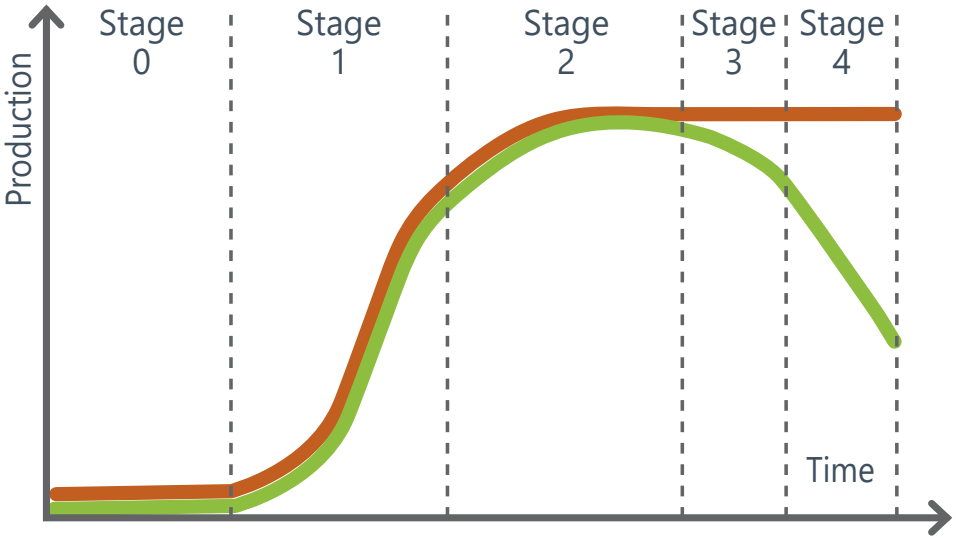

Figure 1. The ideal performance of a macadamia orchard, plateauing at Stage 2 (brown line).

The ideal scenario is for a new orchard or block to reach IOM stage 2 quickly and remain in peak production for many years or decades (Figure 2). Eventually, especially in fertile conditions, it becomes difficult to manage tree size and features of IOM stage 3, such as trees taller than row width and low ground cover percentage can appear before yield declines. Some people call this era 'mining the farm' because, for a while, the orchard can continue producing while running down its resources. Early in IOM stage 3, intervention (see the *Integrated orchard management practice guide*) can more easily bring the orchard back to IOM stage 2. Later in IOM stage 3 and into IOM stage 4, replanting blocks can become a viable strategy.

Growers can steadily replant a proportion of older blocks to add advantageous new cultivars, improve earlier block design, avoid a descent into IOM stage 4 (poor performance), and reset some blocks back to earlier IOM stages.

Cultivar selection influences yield potential, the time to achieve IOM stage 2, and some ongoing management costs. To stay in peak production, growers must maintain a suitably sized and structured canopy. Pruning operations are a significant management cost over the life of the orchard. Cultivar differences will influence the pruning strategy and frequency.

Figure 2. The objective is to get to integrated orchard management (IOM) stage 2 as quickly as possible, and to stay there for as long as possible.

New and old cultivars

Newer cultivars are bred to outperform their predecessors and most promise higher yield potential than older cultivars. While older cultivars have demonstrated their performance over decades in some regions, there is less information available on how the newer cultivars perform in mature orchards. Growers should strike a balance of risk and reward in favouring new or established cultivars.

Cultivars are identified with numbers, sometimes with a letter prefix that indicates its origin. Many of the early commercial cultivars were developed in Hawaii at the Hawaii Agricultural Experiment Station (HAES). Sometimes these are referred to with the prefix H for Hawaii, but most often, they are identified by the number only with no prefix (e.g. 660, 741, 816). Cultivars developed in Australia at Hidden Valley Plantations were also named with numbers but with the added prefix A (e.g. A4, A29) for Australia. More recently developed Australian cultivars have longer prefixes such as MCT for Macadamia Conservation Trust or MIV, an abbreviation of Macadamia Improvement Variety.

Management intentions

What approaches and practices will you use, and how intensively do you plan to manage the canopy, orchard floor and drainage to maintain the orchard? The answers to these questions and many more heavily influence cultivar selection.

There are trade-offs between cultivars regarding management costs, potential yields, and sound kernel recovery. Different cultivars might do better with varied pruning strategies and frequency. Either select cultivars that suit your canopy management style or adapt your canopy management to the cultivar. Large trees with dense canopies

generally require more pruning than smaller trees with open canopies.

For all cultivars, maximise yields by pruning to:

- avoid too much height and excessive woody growth
- maximise the amount of fruiting wood in each season
- maintain light penetration into the canopy and to the orchard floor
- prevent unproductive dead centres within the tree canopy.

Selecting cultivars

Growers should look to maximise profit per hectare by choosing cultivars that:

- provide high saleable kernel/hectare yield in their region
- have lower risks of losses from the effects of pests, diseases and environmental stress
- suit their management approach.

There is no perfect macadamia cultivar. The challenge is identifying which traits and performance factors are desirable or most problematic in a specific orchard system. Then, choose the cultivars with the most positive attributes for your region, orchard design and management style. Aim to avoid having any of the negative features. Shifting the balance in favour of one attribute will likely result in a compromise somewhere else. Once you clarify the importance of different factors for your situation, you can make better trade-off decisions. Table 1 shows an example of how a grower's preference can guide cultivar selection.

Table 1. An example of how grower preferences can influence cultivar selection.

Grower preference	Region	Essential	Desirable	Trade-off	Undesirable	Unacceptable
Low crop protection chemical use	Northern Rivers	Low pest damage risk, such as thicker shelled, without sticktights	Open canopy	Lower kernel recovery	Mid or late-season flowering and nut drop	Extended flowering

Grower preferences often include:

- tree size and shape that fits the orchard spacing (i.e. large spreading trees do not produce to their full potential in close in-row spacings, while small–medium upright trees in wide row widths do not fully use the land in production)
- high yield potential (kg/ha)
- nut production at a young age (precocity) for early income
- prolonged production (25-plus years of solid productivity)
- a nut drop pattern that avoids having nuts on the ground during the area's highest annual rainfall period
- nut drop completed before the next season's flower set (to allow time for critical integrated orchard management operations)
- trees free of sticktights

- low disease susceptibility
- low susceptibility to insect damage
- self-pollinating trees for uniform, larger blocks
- strong branches that are not prone to wind breakage
- trees that are heat tolerant and have a low water demand
- an open canopy (for optimal light, air movement and spray penetration)
- trees that are not prone to abnormal vertical growth (AVG) disorder
- 3 or more cultivars to minimise the risk of crop failure.

Performance ratings

Some cultivars perform consistently better than others in different regions. Knowing what other growers have planted and are planting now is also relevant. A valuable way to investigate cultivar options is to identify knowledgeable growers within the region that achieve high, long-term productivity.

Cultivars are given a rating for each region (Table 2 and Table 3), guided by research and the perspectives of experienced commercial growers and advisors in 2024. These ratings are expected to change as further information becomes available on the newer cultivars.

Developing regions have fewer orchards and years in production. For these regions, less information exists and fewer cultivars are rated. There are no ratings available for Western Australia yet.

The performance ratings are:

- **Workhorse**: widely planted, proven performance, still being planted.
- **Rookie**: recently widely planted, promising but not yet proven in the long term (a minimum of 20 years).
- **Newbie**: newly developed, promising in trials, not yet widely planted in commercial orchards.
- **Pensioner**: historically widely planted, still in production, but with few new plantings as it does not consistently perform as well as other cultivars.
- **Specialist**: planted for site-specific limitations, e.g. soil constraint; however, it is not widely planted.
- **Non-starter**: never much planted in the region and not expected to be.

For example, in NSW, especially on the coastal floodplains, cultivar 344 is still popular (**workhorse**). In Qld, this same cultivar is less used in new plantings but is still in production in older orchards (**pensioner**). Cultivars such as A203 and MCT1 are newer cultivars that are becoming established commercially (**rookies**) in Qld, while these are not yet much explored in NSW (**newbie**).

The research-based information comes from regional variety trials (RVTs). The RVTs analyse how well cultivars perform in the regions and which cultivars suit specific environments. Regional variety trials now cover most macadamia-growing regions of Australia. The RVTs comparing elite new cultivars with standard cultivars are now in their fourth iteration. The RVT results are good indicators of cultivar performance but have limitations; there might not be many of each cultivar, and they could be growing among other cultivars rather than in blocks of the same cultivar.

Table 2. Performance ratings for cultivars in the NSW regions.

Region/ rating	NSW Mid North Coast	NSW Northern Rivers: plateau	NSW Northern Rivers: coastal floodplain
Workhorse	246, 849, A4, A16, A29, A38	246, 741, 816, 842, 849, A16, A38	344, 741, 849, A38
Rookie	–	A29, A203, MCT1	A29, A203
Newbie	A376, A447, A538, MCT1	A376, A447, A538	MCT1, A376, A447, A538
Specialist	–	A4, Daddow	816, 842, 246
Pensioner	344, 741, 660, 816, H2, Daddow	344, 660, A268, H2	A4, A268
Non-starter	842, A268, A203, A403, A422,	A403	A16, A403, A422

Table 3. Performance ratings for cultivars in Queensland regions.

Region/ rating	SE Qld: Glasshouse, Peachester	SE Qld: Gympie, Kin Kin	Central Qld: Bundaberg, Maryborough, Childers, Gin Gin	North Qld coastal: Mackay, Rockhampton	North Qld inland: Emerald	Far North Qld: Tolga, Mutchilba, Kennedy
Workhorse	344, 741, 849, A16, A38, A203	741, 344, 246, Daddow, 849, 842, A16, A203	741, A4, A16	741, A16, 816, 842	A16	A16, A268, 741
Rookie	–	–	MCT1, A203	MCT1, A203	MCT1	–
Newbie	A376, A447, A538	A376, A447, A538	MIV1-P, MIV1-G, MIV1-J, MIV1-R, A376, A447, A538	P, G, J	–	–
Specialist	816, 246 pollinator	816, H2, A403, A422	Daddow, A4, H2, A403, A422	A203	–	–
Pensioner	A4, A29, A268	A4, A29, A268, 660	344, 849, 842, 816, 246, A268, 814, A29, A38, A268	344	246, 344	–
Non-starter	A403, A422	–	660, 788, Beaumont		741	344, 849

Australian macadamia growing regions

Australia has 5 established macadamia regions, 4 on the east coast (Figure 3) and 1 on the west. There are 3 emerging regions in northern Queensland. Unsurprisingly, there is more information on regional differences for the established regions than the emerging regions.

Average farm size (ha)	Average tree age (years)	Average cost/ha	NIS t/ha	SK t/ha	%SKR
Central Queensland					
86	15	10,039	3.1	1.0	35.0
South-eastern Queensland					
29	26	10,404	2.9	0.9	33.3
Northern Rivers NSW					
24	26	8,130	2.6	0.8	33.4
Mid-north Coast NSW					
19	22	8,895	2.3	0.8	38.0

Figure 3. Regional average yields per hectare and cost of production per tonne nut-in-shell. NIS/ha is nut-in-shell at 10% moisture content per hectare. SK t/ha is sound kernel/hectare. %SKR is per cent sound kernel recovery. Data: Mulo and Bignell (2022).

New South Wales Mid North Coast

This region centres around the Valla/Macksville area, extending to Corindi in the north, Yarrahappinni to the south, and Bowraville in the west. Most orchards are on moderate to steep slopes and are smaller scale than in other regions. The annual rainfall is 1,486 mm (Smoky Cape weather station), and the wettest period of the year is from January to June. The average maximum and minimum temperatures are 23.5 °C and 15.7 °C, respectively. Frosts can occur. Soil types vary widely from sandy loam on the coast to heavier black–grey soil further inland. Flowering and nut drop are generally a few weeks later than in the Northern Rivers.

New South Wales Northern Rivers

Coastal floodplain

Orchards in this region are on floodplain land close to the coast. The planted area is expanding rapidly and extends from Byron Bay down to Maclean. The average rainfall for the area is approximately 1,469 mm (Yamba weather station). The average maximum and minimum temperatures are 23.2 °C and 15.4 °C, respectively. Soil type is highly variable as they have formed in multiple floods, but are mainly vertosols (clays with shrink–swell properties that crack when dry).

Some land is flood-prone and the intensity and duration of possible flooding can be severe constraints. Areas of acid sulfate soil (ASS) or potential ASS can affect sites as management must comply with the *NSW acid sulfate soils manual*. Trees on the floodplain require mounds at least 600 mm high to allow the roots to be out of the water table. The tree roots are limited to mainly growing within the mound, so trees on the coastal flats are typically more compact than those grown on the nearby Alstonville plateau. Commonly, the prior land use was cattle, vegetable or sugar cane production.

The Plateau

Centred around the Alstonville Plateau, orchards extend from Dalwood in the south to Tweed in the north and west to the Hogarth range. The soil on the plateau is typically deep and well-drained ferrosols (well-structured soil high in iron). The average rainfall in the area is 1825.2 mm (Alstonville weather station), and weather conditions are mild due to the proximity to the sea and elevation. The average maximum and minimum temperatures are 26.5 °C and 15.0 °C, respectively. The highest average rainfall months are March and June, making harvesting difficult at these times. There is little recent expansion of the area under macadamia. The terrain is highly variable on the plateau, ranging from gentle to steep slopes.

South-east Queensland

Glasshouse Mountains and Peachester

The Glasshouse Mountains growing area, centred around the Sunshine Coast hinterland, extends from Eumundi to the north and Burpengary to the south. The volcanic geology surrounding the Glasshouse Mountains region makes some soil rich and fertile. There are also areas of poor soil. Due to the large area, the soil types vary from ferrosols to podosols (soil with a B horizon rich in organic matter, iron or aluminium) and some hydrosols (wet soil, saturated for at least 2–3 months a year). The average rainfall in the Glasshouse region is 1,414.1 mm (Beerburrum weather station), and average maximum and minimum temperatures are 26.5 °C and 14.8 °C, respectively.

Gympie and Kin Kin

The Gympie region includes the iconic Bauple township, where Europeans first identified the macadamia (Bauple nut). The Gympie region extends from Bauple to the north, Kin Kin to the south and west to Lower Wonga. The average maximum and minimum temperatures are 27.1 °C and 13.9 °C, respectively. Rainfall is less than in the Glasshouse region, with an annual average of 1,105.9 mm (Gympie weather station). Irrigation is desirable due to lower summer rainfall.

Central Queensland

Bundaberg, Maryborough, Childers and Gin Gin

Bundaberg is Australia's largest macadamia production region and is still expanding. The area extends from Baffle Creek in the north, as far south as Maryborough and west to Gin Gin. Central Qld features large holdings on flat land, previously growing small crops or sugar cane, with long tree rows. The average rainfall in Bundaberg is 998.7 mm (Bundaberg weather station), and average maximum and minimum temperatures are 26.8 °C and 16.4 °C, respectively. Irrigation is necessary. The soil types vary from red ferrosols and hydrosols to sandy loams. The wettest months are December to March.

Abnormal vertical growth (AVG) has been a problem in macadamia trees around Bundaberg. The red soil in this region presents a high risk for AVG, so selecting cultivars at a lower risk of AVG is essential. Many growers prefer cultivars with a spreading rather than an upright shape.

North Queensland

This relatively new region for macadamia spreads from as far north as Mackay, down to Rockhampton in the south, and as far west as Emerald. Hotter temperatures are a challenge for macadamia growers in this region. Irrigation is essential, with some growers using sprinklers to increase local humidity and supply water to roots. Rainfall is predominantly in the summer, with a very dry winter and spring.

Mackay, Rockhampton

Mackay has mostly fertile clay and loam soil, with some less fertile loam and sand. The average rainfall in Mackay is 1,526.6 mm (Mackay weather station), and the average maximum and minimum temperatures are 27.3 °C and 17.9 °C, respectively.

Rockhampton soil is mostly ferrosol, well-drained red or yellow-brown soil with a clay-loam to clay texture. The average annual rainfall (mostly falling in summer) is 805.4 mm (Rockhampton weather station), and average maximum and minimum temperatures are 28.4 °C and 16.8 °C, respectively.

Emerald

In Emerald, the average rainfall is 560.5 mm (Emerald weather station), and average maximum and minimum temperatures are 29.9 °C and 16.4 °C, respectively. Emerald mostly has tenosols (soil with distinct A and poorly developed B horizons).

Far North Queensland

Mareeba, Burdekin

The far north Queensland region extends from Mareeba to the north and Dimbulah to the west, with scattered smaller farms as far south as Kennedy. The area has a long history of macadamia production and is making a revival after being destroyed by cyclones in the 1990s. A typical agricultural soil in the Mareeba/Dimbulah area is derived from granite and has low fertility. Soil is predominantly dermosol (well-structured soil) and ferrosols. Soil profiles often reveal a sandy loam/sandy clay loam over a red, structured, coarse sandy clay soil with a slightly acidic pH. The average rainfall is 836.1 mm (Mareeba weather station), and average maximum and minimum temperatures are 29.0 °C and 18.0 °C, respectively. Irrigation is essential as rainfall is confined to the summer wet season from November to March.

South Western Australia

The Western Australian production region comprises small farms scattered from the north of Perth, south to Margaret River, and Albany to the east. Orchards are generally on hills with well-drained tenosol, kandosol (poorly structured loams) and rudosol (sand and gravel) soil (van Gool et al. 2018), overlaying granite (ferricrete). These poor soil types constrain tree size, with an old tree in WA (>35 years) rarely taller than 4 m. Western Australia has the benefit of minimal pests (such as fruit spotting bug and macadamia nut borer) and disease issues due to the dry climate. The average rainfall is 726 mm (Lower west weather station), and average maximum and minimum temperatures are 23.2 °C and 11.1 °C, respectively. Irrigation is essential.

Cultivar differences

The differences between cultivars are **tree traits** and **performance factors**. Traits tend to be consistent wherever the trees grow to maturity, whereas performance factors vary with management, site characteristics and seasonal conditions.

Neither traits nor performance factors are good or bad, but maintaining high production relies on matching cultivars with conditions, orchard design and management practices that suit them.

Tree traits

Traits define the consistent qualities of cultivars. This section uses the terminology of the *Agrilink macadamia variety identifier system* by Vock et al. (1998).

Base decisions on an appropriate planting density or the cultivars to select for a planned spacing on a combination of shape, canopy density and size.

- Wide spacings (9 × 5 or 10 × 5 m or <222 trees/ha) suit spreading, large trees.
- Medium spacings (8 × 4 m or 250–312 trees/ha) suit round or upright, open canopies and small or medium size trees.
- Close spacings (7 × 4 m or >357 trees/ha) suit upright, open canopies and small or medium size trees.

Shape

The shape is the general, natural appearance of the canopy. Within cultivars, shape can vary with environment, age and management. Some cultivars are more variable than others (Table 4).

Most trees start from the nursery as a single leader, with the scion grafted onto the rootstock. After planting, the tree develops a more complex branch structure. Pruning maintains an obvious lead branch that supports the highest foliage, regulating the growth of lower branches. The leader does not need to be in the absolute centre like a pine tree.

The tree shape categories are:

- **spreading**: branches tend to extend laterally and occupy more space (Figure 4)
- **upright**: branches tend to grow upwards (Figure 5)
- **round**: tending to form a somewhat ball-shaped canopy (Figure 6)
- **upright with a turkey neck**: tending to have a leader with a bulge of foliage above the main canopy (Figure 7).

Figure 4. Spreading tree shape in young (left) and mature (right) trees.

Figure 5. Upright tree shape in young (left) and mature (right) trees.

Figure 6. Round tree shape in young (left) and mature (right) trees.

Figure 7. Turkey neck (red circle) in mature trees.

For decision-making, spreading vs upright is the main issue. Upright cultivars tend to work with closer spacings, while spreading cultivars are favoured for wider spacings. Round or turkey neck shapes are visually distinctive but do not have much influence on management.

Table 4. Shape of macadamia cultivars. Source: Vock et al. (1998).

Round	Spreading	Upright	Upright with turkey neck
A4*	A4*	A16*	660
A16*	A203	A29	741
A403	A268	A38	814*
A422	A447*	A376	–
A447*	246	344	–
A538	333*	741	–
333	508*	791	–
508*	783	814*	–
781	800	816	–
P	849	842	–
H2	MCT1	–	–
Daddow	G	–	–
–	J	–	–
–	R	–	–
–	Beaumont	–	–

*cultivar with variable shape that appears in more than one category.

Size

Size is the likely natural height and width of the tree without pruning or crowding. Tree size strongly influences row width and tree spacing (within the row). Generally, small, upright trees require less work to manage in most block designs. The tree size categories are small, medium, and large (Table 5).

Table 5. The typical tree size of different macadamia cultivars.

Small	A16, P, 814, A447, A538
Medium	A4, A38, A203, A268, 660, 783, Beaumont (791), 842, 849, MCT1, A376, R
Large	H2, 246, 333, 344, 508, 741, 781, 800, 816, Daddow, J, G, A403, A422

Canopy density

The canopy density can be dense or open (Table 6). In some cultivars, such as 842, the growing habit starts with an open canopy when young and later becomes a dense canopy.

With a dense canopy, it might be difficult to see into the centre of the tree when standing back from it. With an open canopy, it is possible to see through the centre of a tree or even into the next tree row (Figure 8). Within cultivars, density varies by region and micro-climate.

Figure 8. Left: a dense canopy; notice that you cannot see through the outer layer of leaf to the trunk. Right: an open canopy that you can see through to the next row.

Dense canopies can increase the risk of some problems in the orchard, such as:

- unproductive centres, only fruiting on the outer edge of the canopy
- low levels of living ground cover on the orchard floor and soil erosion
- spray treatments for pests being less effective because of difficulties in achieving coverage.

Pruning systems can manage canopy density to some extent. Cultivars with dense canopies might need more severe or more frequent pruning.

Table 6. The typical canopy density of macadamia cultivars.

Dense	A16, A447, 246, 333, 344, 508, 660, 781, 783, 800, 816, 849, H2, Beaumont, J, P, R, and G
Open	MCT1, G, A4, A38, A203, A268, NG8, 791, 814, A376, A403, A422
Open when young and dense when older	Daddow, 741, 842

Precocity

Precocity is how long the cultivar takes to start bearing commercially viable yields. Precocious (early-yielding) cultivars, such as MCT1, A203 and A4, bear harvestable nut yields at around 3 years after planting. Non-precocious (late-yielding) cultivars bear at 5–6 years of age. There might be a trade-off, with earlier-producing cultivars reported as less productive later. However, this could be due to management rather than the cultivar. For example, earlier-producing cultivars might not be receiving sufficient nutrition because they are being managed the same as late-producing cultivars despite having a higher nutrient demand.

Growers working with a mix of cultivars usually vary their management practices for cultivars with different precocity. Pruning and training can start earlier and be more frequent in the precocious cultivars. With nutrition, a precocious cultivar yielding several tonnes of nut-in-shell needs, at the very least, the nutritional value of the nuts replaced (see NIS replacement values in *Macadamia growers guide: nutrition and soil health – the foundations*). Non-precocious trees of the same age that are not yet producing will require less nutrients.

Bearing wood age

Bearing wood age is the age of the wood that produces most flowers and nuts. This trait significantly affects the management and pruning of the tree in peak production (IOM stage 2), as one of the aims of pruning is to maximise bearing wood in the canopy.

Cultivars with younger bearing wood age usually respond to well-timed mechanical hedging by developing more bearing wood at the edges of the canopy. Cultivars with older bearing wood do better with selective pruning that opens the tree centres to light.

Sometimes, trees can flower soon after planting. This can happen because the scion for the graft has been taken from the hardened flush of the source tree, grafted onto the rootstock, and then been in the nursery for approximately 18 months. Consequently, the flowering is from wood older than the young tree itself (Figure 9).

Flowering location with respect to light intensity also needs to be considered. A cultivar such as A38 will produce flowers within the canopy in dappled light, so this should be encouraged. Other cultivars will flower in stronger light, positioned on the outer canopy. Different strategies will apply to encourage flowering on those cultivars.

Figure 9. Flowering from wood that is older than the tree.

Flowering

Cultivars that do not flower simultaneously cannot cross-pollinate (Figure 10). Macadamia trees hold and develop more nuts from cross-pollinated flowers than self-pollinated flowers when both are on the tree. Having at least 3 cultivars that usually flower at the same time, including at least one that flowers over an extended period, helps cross-pollination.

Figure 10. Cultivars must have flowers present at the same time to cross-pollinate.

Extended flowering periods provide more opportunities for cross-pollination. Short flowering periods increase the potential for crop failure if heavy rain or long spells of rainy days coincide with flowering (Figure 11). Late flowering carries more potential for insect damage as flower pest populations build up throughout the season. Early flowering can compromise the timing of chemical sprays to protect the flowers because harvest operations are still in progress.

Figure 11. Rain-damaged macadamia flowers.

Nut drop

Nut drop dictates harvesting. Prolonged or multiple nut drops can spread the farm's workload over a longer harvest season. The region's wettest time of the year is the least favourable for harvesting. Avoid selecting cultivars that drop nuts in the wet season and favour cultivars that drop nuts in the drier months. Crop quality depends on the capacity to harvest fallen nuts as soon as possible. Fallen nuts left too long on the ground can:

- germinate in the shell, becoming unsaleable (Figure 12)
- degrade with the kernel discoloring, becoming mouldy through discolouration (Figure 13) and suffering from other disorders
- wash away in rain
- be eaten by animals (such as rats, pigs, and cockatoos) (Figure 14).

A late season nut drop carries more risk of affecting the next season's crop. Continuing harvest operations can restrict opportunities for other work, such as pruning, applying organic materials, and making drainage adjustments.

Figure 12. A nut germinated in the shell.

Figure 13. A mouldy nut.

Figure 14. Nuts damaged by rats.

Performance factors

Yield

These terms describe specific aspects of commercial macadamia yields:

- **Nut-in-shell** (NIS) is the macadamia kernel encased in the shell; the total NIS weight is made up of the kernel and the shell.
- **Kernel recovery** (%) is the proportion of kernel as a percentage of NIS; there are 3 components of kernel recovery:
  - **premium KR%** is the fully mature kernel that is plump (not shrivelled), round and firm with even white or cream colouring, with no off-odour or rancidity
  - **commercial KR%** has minor defects on kernel, i.e. light discolouration, light discoloured crest, and light shrivelled; these are still acceptable for human consumption
  - **reject (unsound) KR%** is affected by a defect and not suitable for human consumption.
- **Total kernel recovery** (TKR%) is the sum of premium, commercial and unsound KR%.
- **Saleable kernel recovery** (SKR%) is the amount of kernel the processor pays for, i.e. the sum of premium KR% and commercial KR%; growers are paid on SKR not TKR.

Management strongly influences NIS t/ha and SKR%. The most important yield metric to compare across cultivars and orchards is saleable kernel yield in tonnes per hectare (t/ha), determined by:

$$\text{kernel yield (t/ha)} = \text{NIS (t/ha)} \times \text{Saleable kernel recovery (SKR\%)}$$

The average SKR is 33% and differs between cultivars and regions. High SKR cultivars attract a higher price/kg for NIS because they deliver more saleable kernel per kg of NIS. High percentages of insect damage, mould, internal discolouration, heavy discolouration, shrivelled and germinated nuts reduce SKR%.

The grower's revenue is determined by the weight of nuts delivered and the price per tonne for the nuts. While a higher sound kernel recovery will attract a higher price per kilogram, there is little return on a small amount of NIS, even with excellent SKR%.

Dehusking ease

Any difficulties with dehusking contribute to harvest and handling costs, nut quality and disease risk. Easy dehusking cultivars can be dehusked at harvest. Cultivars that are difficult to dehusk will probably need to go through the dehusker several times, which can cost time and money. It also raises the risk of the kernel being damaged.

Germination risk

Kernels that germinate before processing are deemed unsound. Germination risk can be influenced by shell thickness and climatic conditions. Thinner shell cultivars can have a higher risk of pre-germination.

Disease risk

Dense canopies can be more conducive to disease if not managed correctly to allow enough airflow and light into the canopy. Consider the pruning requirements of cultivars with dense canopies before committing to growing them. The risks of phytophthora, husk spot and other diseases for each cultivar are included in the following sections. Some cultivars do not drop all their nuts, and the husk (sometimes with the nut) remains in the tree as 'sticktights', which increases disease risk as the husk can harbour the husk spot pathogen (*Pseudocercospora macadamiae*). It can also lead to old nuts being included in the next season's harvest.

Pest damage risk

Many pests, such as fruit spotting bug (FSB), prefer some macadamia cultivars over others. Generally, the thicker the husk and shell, the less likely pests will infest the tree and damage the nuts. Cultivars that produce bunches of nuts are more prone to pests such as macadamia nut borer.

Cultivars with open micropyles (an opening in the shell that helps respiration and gas exchange for the kernel) can present increased risks for pest damage and storage of NIS. Carpophilus beetle and kernel grub can use an open micropyle to access the kernel without leaving a mark on the shell, making it difficult to notice the pest. If infestation in the field goes unnoticed, these pests will:

- mature and feed on the kernels
- breed
- possibly spread other opportunistic diseases in the silo, rendering more of the stored nuts unsaleable.

Abnormal vertical growth risk

Abnormal vertical growth (AVG) (Figure 15) is a disorder that creates:

- excessive upright growth
- few lateral branches
- reduced flowering
- poor nut set
- yield reduction (O'Farrell 2011).

The AVG disorder has been most severe in Central Qld but occasionally occurs in Northern NSW. The risk classes for AVG are low, tolerant, or susceptible.

In Central Qld, deep, well-drained ferrosol soil increases the potential for AVG. Growers can select cultivars based on the risk of AVG. Those in Bundaberg should have AVG tolerance high on their list of desirable characteristics. Most of the new release cultivars claim to be AVG tolerant.

Figure 15. A macadamia tree with abnormal vertical growth. Photo: Simon Andreoli, Marquis Macadamias.

Other differences

Other performance factors where little is known about the differences between cultivars include:

- how the cultivar establishes in each region, i.e. is it easy to grow?
- response to ethephon (Ethrel®, a synthetic version of a plant hormone that causes fruits to ripen) to hasten nut drop
- sensory quality (taste, texture)
- shelf life
- uniformity in colour and absence of discolouration in both raw and roasted nuts
- kernel size
- style spread.

In South Africa, processors are starting to measure the 'style spread' as the percentage of whole nuts, halves, large pieces, small pieces, and fine particles created in cracking the nuts (Figure 16). Style spread varies, with some cultivars producing considerably more whole nuts than others. Whole nuts are more valuable than half nuts, and half nuts are more valuable than pieces.

Figure 16. Styles of processed macadamia nuts.

Cultivars

A4

Table 7. Cultivar A4 description.

Traits	
Shape	Spreading to rounded
Size	Medium
Canopy density	Moderate to open
Precocity	Very precocious
Bearing wood age	6 months
Flowering	Short, profuse, mid to late season with second summer flowering when crop set is poor
Nut drop	Mid-season
Variable characteristics	
Total kernel recovery (%)	45
Whole kernel (%)	40–50
Dehusking ease	–
Germination risk	–
Disease risk	Susceptible to husk spot, phytophthora and botryosphaeria.
Pest damage risk	High, susceptible to late season spotting bug and nut-borer.
Abnormal vertical growth (AVG) risk	Tolerant; is used as a replacement tree where AVG has occurred.
Other features	
Nutrition	A4 might need higher fertiliser rates, especially young bearing trees. The leaves can look paler, but this is not necessarily a sign it needs more fertiliser.
Pruning	Needs limb removal every 3–4 years once mature to avoid unproductive centres. Pruning stimulates vigour.
Cross-pollinators	A16, 246, 741, Daddow, 344, 660, 849
Notes	Produces well when young but needs more attention with age. Older trees might decline on shallow soil. Nuts can be difficult to pick up with finger-wheel harvesters. A thin-shelled cultivar with a moderately large NIS size. Very sticky, sappy husk. When green, NIS is hard to dehusk.
Origin	Hidden Valley Plantations first generation 1987.

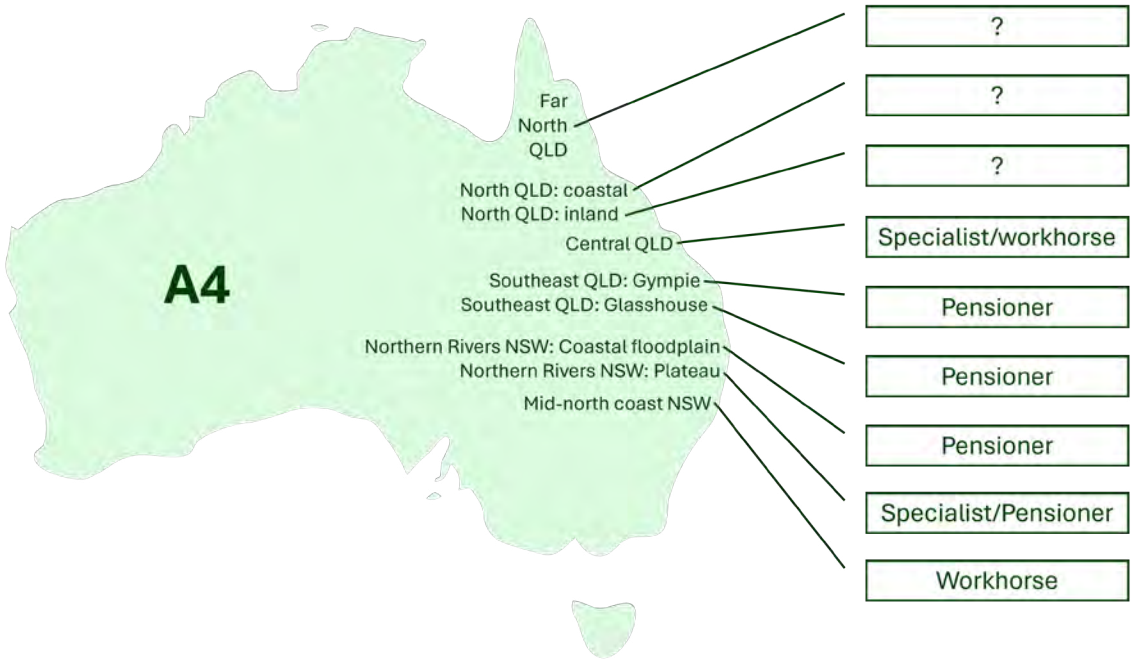

Figure 17. Regional ratings for the A4 cultivar.

A16

Table 8. Cultivar A16 description.

Traits	
Shape	Upright
Size	Small
Canopy density	Moderate to dense with willowing branches
Precocity	Non-precocious
Bearing wood age	2 years
Flowering	Mid to late season
Nut drop	Very late season
Variable characteristics	
Total kernel recovery (%)	40–45
Whole kernel (%)	40–50
Dehusking ease	Low, prone to sticktights. Tree shakers shorten harvest.
Germination risk	–
Disease risk	Susceptible to husk spot due to sticktights. Susceptible to phytophthora.
Pest damage risk	–
Abnormal vertical growth (AVG) risk	–
Other features	
Nutrition	–
Pruning	Benefits from periodic limb removal to open up the canopy centre.
Cross-pollinators	246, 344, 660, 741, Daddow, 814, 849
Notes	A consistent performer in the NSW Mid North Coast, although sticktights extend the harvest period. Good performer in Bundaberg. Thinner shell. Sticky husk when green. Reported as growing well in Mackay with regular pruning and has less requirement for staking.
Origin	Hidden Valley Plantations first generation 1987.

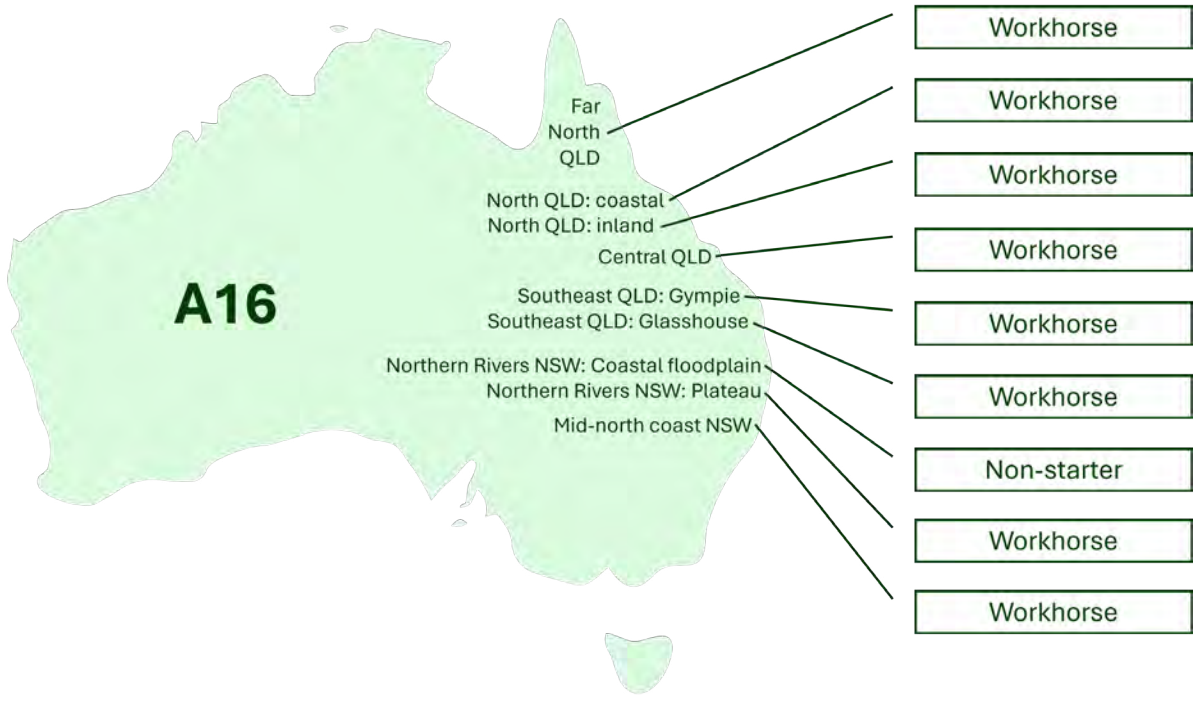

Figure 18. Regional ratings for the A16 cultivar.

A29

Table 9. Cultivar A29 description.

Traits	
Shape	Very upright
Size	Large
Canopy density	Very open
Precocity	Non-precocious
Bearing wood age	2 years
Flowering	Short, mid-season
Nut drop	Mid-season
Variable characteristics	
Total kernel recovery (%)	38
Whole kernel (%)	35
Dehusking ease	Low risk of sticktights.
Germination risk	–
Disease risk	Partially tolerant to husk spot. Moderately susceptible to phytophthora.
Pest damage risk	–
Abnormal vertical growth (AVG) risk	–
Other features	
Nutrition	–
Pruning	–
Cross-pollinators	–
Notes	Most used in southern NSW. Susceptible to wind damage. Poor yield in dry conditions. The kernel is slightly dark.
Origin	Hidden Valley Plantations 1991.

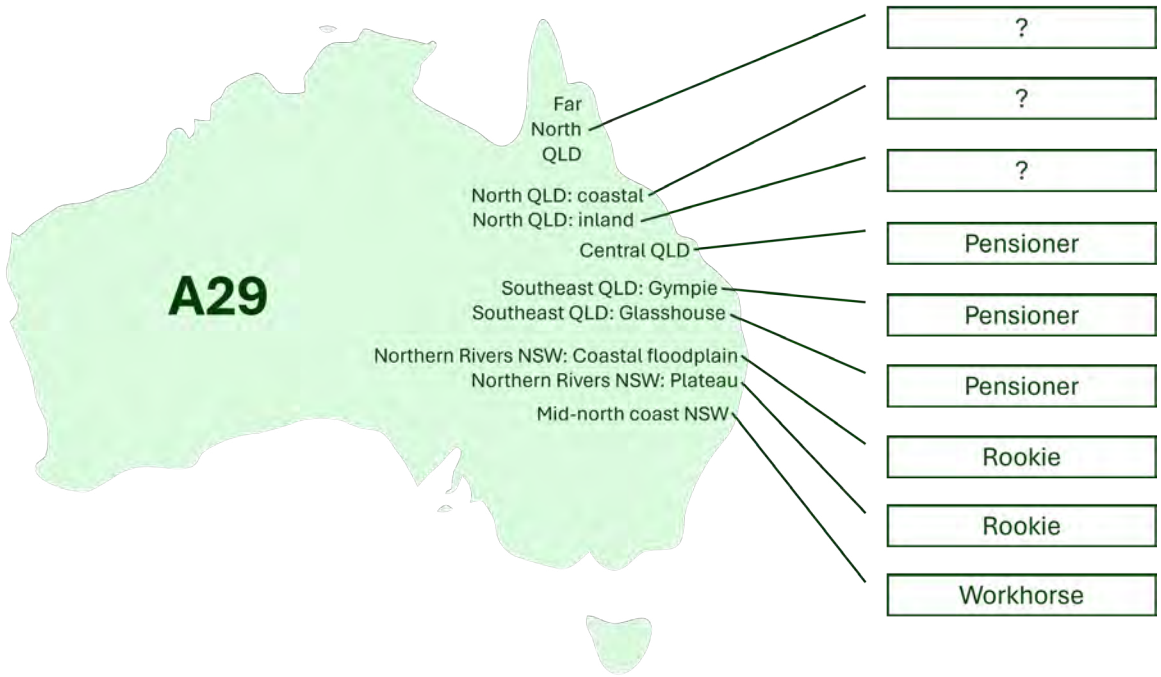

Figure 19. Regional ratings for the A29 cultivar.

A38

Table 10. Cultivar A38 description.

Traits	
Shape	Upright
Size	Medium
Canopy density	Open; grows long, leggy branches
Precocity	Precocious
Bearing wood age	2 years
Flowering	Short, mid to late season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	36–40
Whole kernel (%)	60–90
Dehusking ease	Prone to sticktights, responds to ethephon to hasten nut drop.
Germination risk	–
Disease risk	Susceptible to husk spot. Moderately susceptible to phytophthora.
Pest damage risk	Susceptible to nut borer, highly susceptible to scale.
Abnormal vertical growth (AVG) risk	–
Other features	
Nutrition	–
Pruning	Necessary for wind resistance when young, later needs pruning for size.
Cross-pollinators	741, Daddow, A203 (moderate self-pollination).
Notes	Susceptible to wind damage when young. Can suffer moisture stress on lighter soil. Needs extra care in poor sites. Yields well with light leaf cover. Kernel quality is variable. Discolouration can be an issue. Bunched nuts create issues with insect control. Husk splits easily on hot days. Most of the nuts are borne close to the trunk.
Origin	Hidden Valley Plantations first generation 1981.

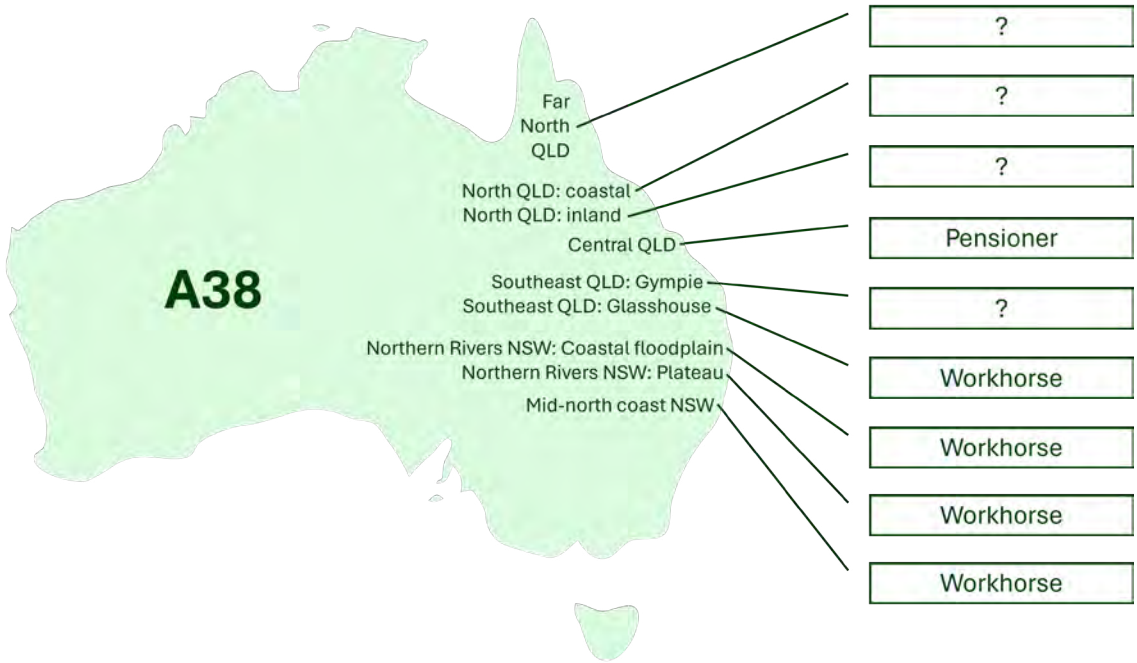

Figure 20. Regional ratings for the A38 cultivar.

A203

Table 11. Cultivar A203 description.

Traits	
Shape	Slightly upright
Size	Small to medium
Canopy density	Moderately open with distinctive sinuous branches that allow good spray penetration and coverage.
Precocity	Precocious – can bear in year 2 and have a harvestable yield in year 3.
Bearing wood age	1 year
Flowering	Short, mid to late season
Nut drop	Early to mid-season
Variable characteristics	
Total kernel recovery (%)	32–37: lower in the tree's younger years and when nuts are small.
Whole kernel (%)	40–50
Dehusking ease	Low risk of sticktights.
Germination risk	–
Disease risk	Highly susceptible to Botrysphaeria, branch dieback and yellow halo leaf disease
Pest damage risk	Late flowers face a higher risk of insect attack. Thick husk and shell provide some protection from pests.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	Drops immature and nubbins (unpollinated, teardrop-shaped) nuts when nutrition is inadequate.
Pruning	Necessary for wind resistance up to 3 years after planting. It is hard to train to a central leader.
Cross-pollinators	344, 741, 816, 842, A4, A16, A38 (limited self-pollination)
Notes	Widely planted in Central Qld. Very susceptible to wind damage. Moisture stress can lead to trees dropping more immature nuts. Less productive on marginal soil, including vertosols, needs good drainage.
Origin	Hidden Valley Plantations second generation 1984.

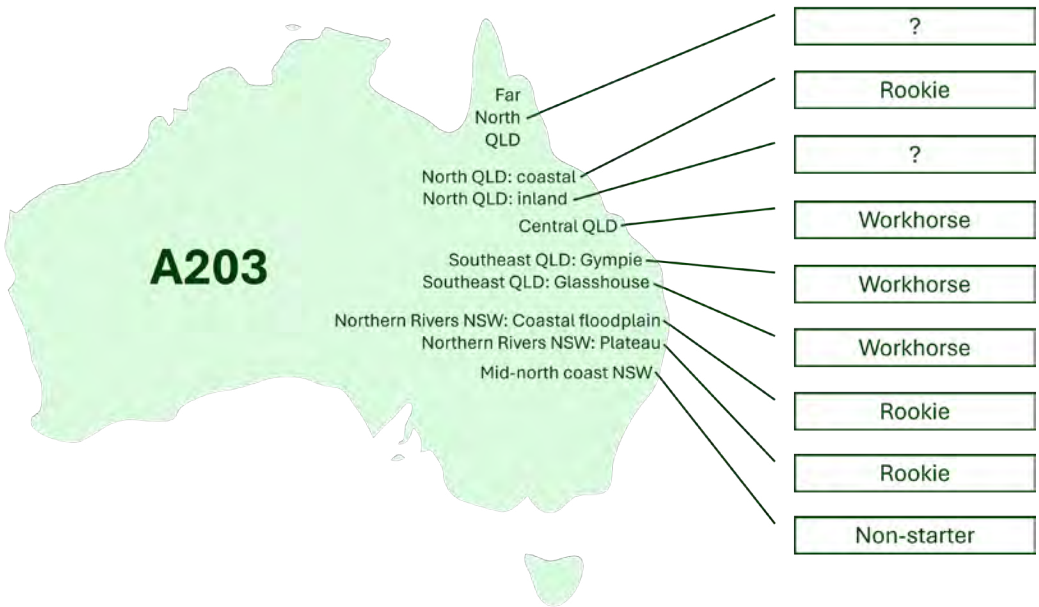

Figure 21. Regional ratings for the A203 cultivar.

A268

Table 12. Cultivar A268 description.

Traits	
Shape	Spreading
Size	Medium to large
Canopy density	Moderately open
Precocity	Precocious
Bearing wood age	2 years
Flowering	Short, mid-season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	35–40
Whole kernel (%)	50–55
Dehusking ease	Low risk of sticktights.
Germination risk	High: nuts are prone to quality loss if left on the ground for any time.
Disease risk	Susceptible to husk spot and botryosphaeria.
Pest damage risk	Its thick shell plus husk (>10 mm) might reduce FSB damage.
Abnormal vertical growth (AVG) risk	Tolerant, sometimes used as a replant where AVG has occurred, usually higher producing trees are preferred.
Other features	
Nutrition	–
Pruning	–
Cross-pollinators	Often planted as a polliniser (rarely self-pollinates).
Notes	Susceptible to wind damage, especially in coastal areas. NIS can have a poor appearance. Can have kernel quality problems in hotter, drier regions.
Origin	Hidden Valley Plantations second generation.

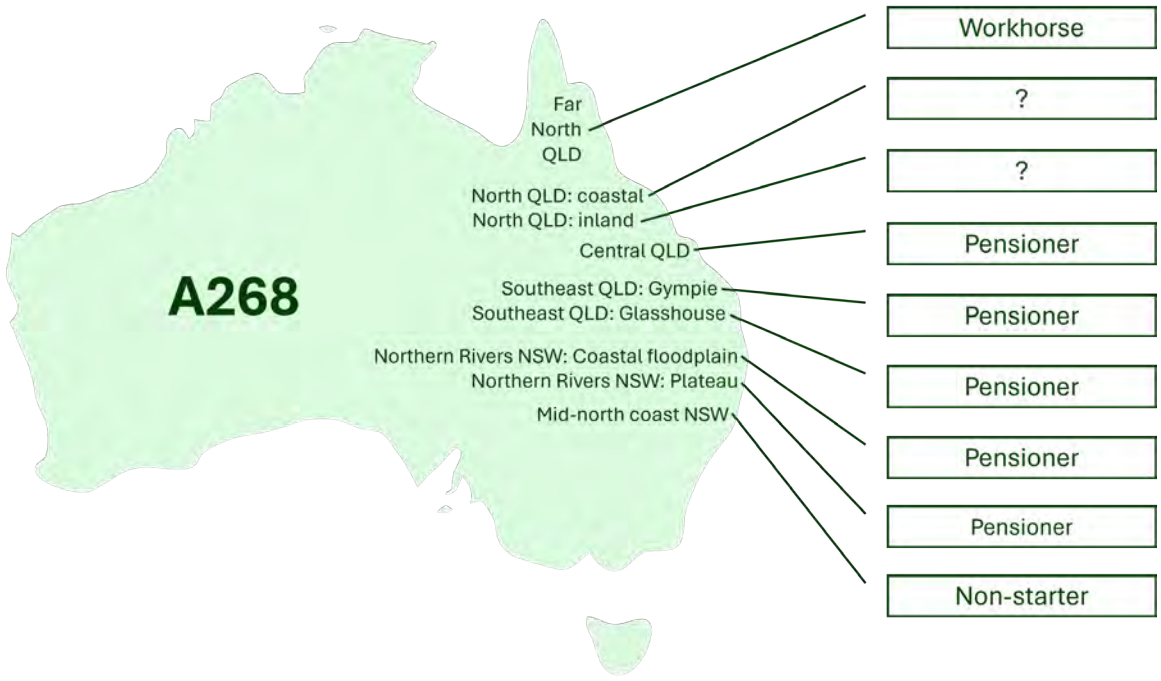

Figure 22. Regional ratings for the A268 cultivar.

A376

Table 13. Cultivar A376 description.

Traits	
Shape	Upright
Size	Medium
Canopy density	Moderately open
Precocity	Precocious
Bearing wood age	2 years
Flowering	Short, mid-season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	35–40
Whole kernel (%)	50–65
Dehusking ease	Low risk of sticktights, responds to ethephon.
Germination risk	Low
Disease risk	Susceptible to husk spot and botryosphaeria.
Pest damage risk	Insect damage was low at Hidden Valley Plantations.
Abnormal vertical growth (AVG) risk	–
Other features	
Nutrition	–
Pruning	–
Cross-pollinators	–
Notes	Performed well at most RVT Series 3 sites. It is in the early stages of industry adoption with no obvious faults observed.
Origin	Hidden Valley Plantations third generation.

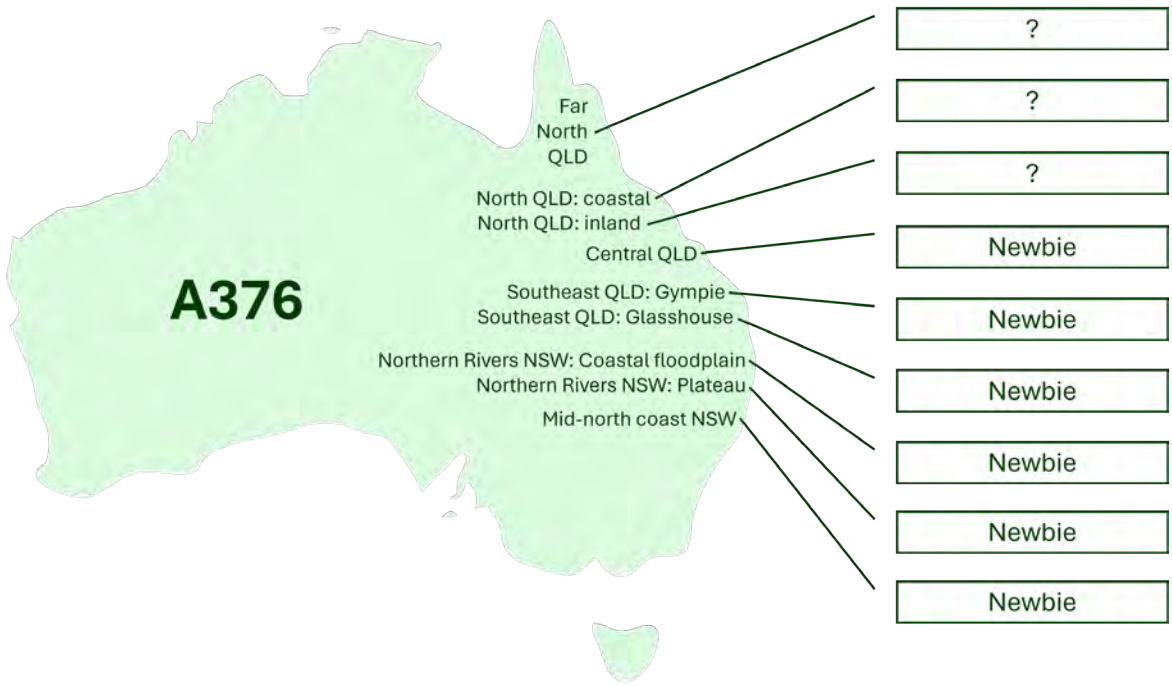

Figure 23. Regional ratings for the A376 cultivar.

A403

Table 14. Cultivar A403 description.

Traits	
Shape	Round
Size	Large
Canopy density	Moderately open
Precocity	Precocious
Bearing wood age	2–3 years
Flowering	Mid-season
Nut drop	Late season, clean dropping
Variable characteristics	
Total kernel recovery (%)	38–43
Whole kernel (%)	30–55
Dehusking ease	Low risk of sticktights, low response to ethephon.
Germination risk	Low at Hidden Valley Plantations.
Disease risk	–
Pest damage risk	Late flowers face a higher risk of insect attack. Thick husk and shell provide some protection from pests.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	–
Pruning	–
Cross-pollinators	–
Notes	Performed well at most RVT Series 3 sites. The late harvest period suits Central Qld sites.
Origin	Hidden Valley Plantations third generation.

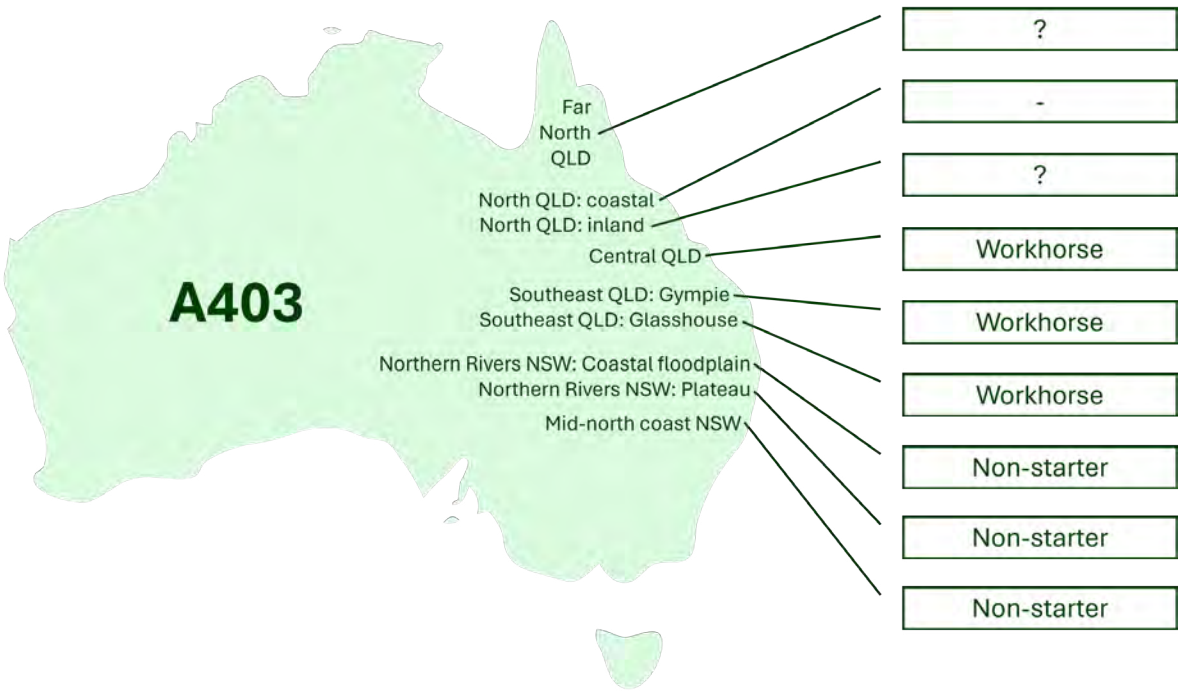

Figure 24. Regional ratings for the A403 cultivar.

A422

Table 15. Cultivar A422 description.

Traits	
Shape	Round
Size	Large
Canopy density	Moderately open
Precocity	Precocious
Bearing wood age	2–3 years
Flowering	Mid-season
Nut drop	Late season, clean dropping
Variable characteristics	
Total kernel recovery (%)	39–43
Whole kernel (%)	50–60
Dehusking ease	Low risk of sticktights, low response to ethephon.
Germination risk	–
Disease risk	–
Pest damage risk	Late flowers face a higher risk of insect attack. Thick husk and shell provide some protection from pests.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	–
Pruning	–
Cross-pollinators	–
Notes	Average to good performance at most RVT Series 3 sites. The late harvest period suits Central Qld sites.
Origin	Hidden Valley Plantations third generation.

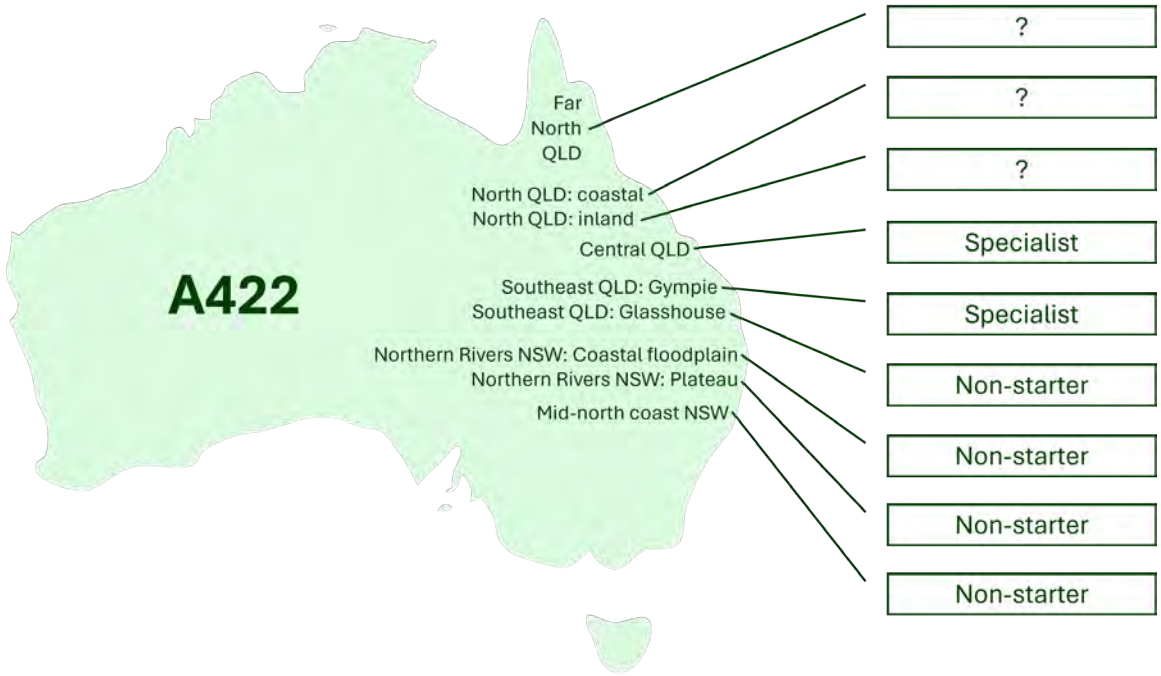

Figure 25. Regional ratings for the A422 cultivar.

A447

Table 16. Cultivar A447 description.

Traits	
Shape	Round to spreading
Size	Small
Canopy density	Moderate to dense
Precocity	Precocious
Bearing wood age	2–3 years
Flowering	Mid-season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	38–43
Whole kernel (%)	30–55
Dehusking ease	Low risk of sticktights, moderate response to ethephon.
Germination risk	Low at Hidden Valley Plantations.
Disease risk	Susceptible to trunk canker.
Pest damage risk	–
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	–
Pruning	–
Cross-pollinators	–
Notes	Performed well at most RVT Series 3 sites despite its petite size.
Origin	Hidden Valley Plantations third generation.

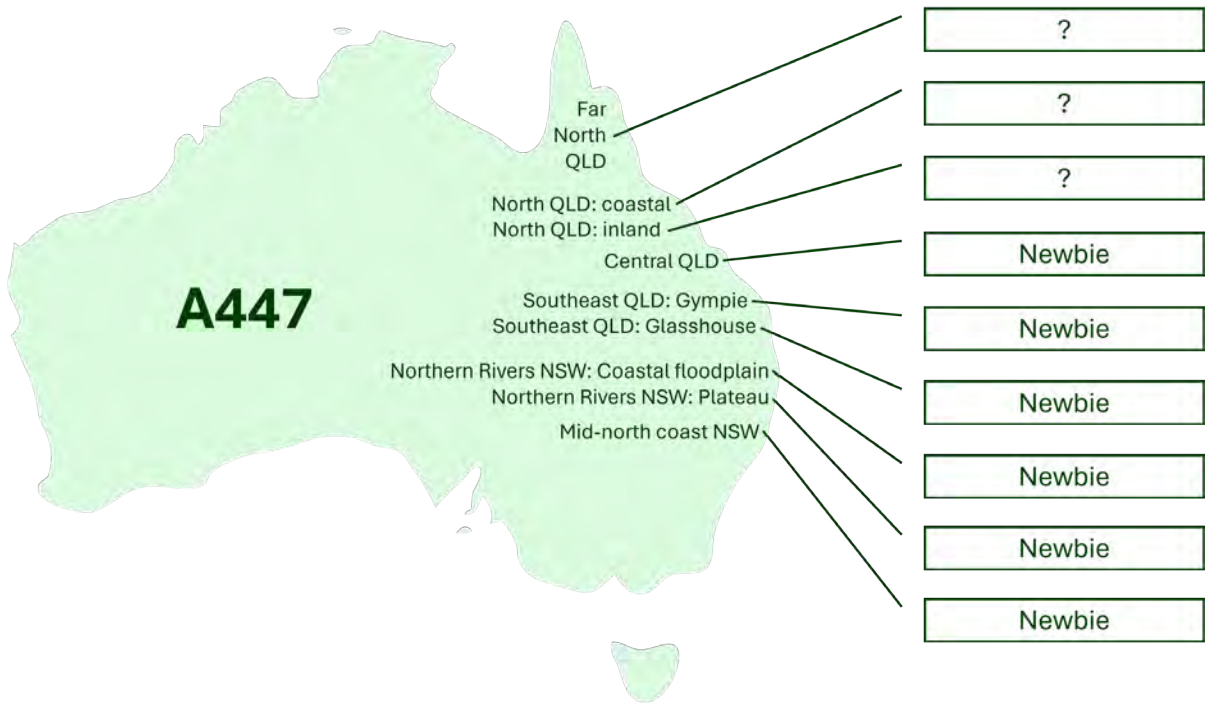

Figure 26. Regional ratings for the A447 cultivar.

A538

Table 17. Cultivar A538 description.

Traits	
Shape	Round
Size	Small
Canopy density	Moderate to dense
Precocity	Very precocious
Bearing wood age	2 years
Flowering	Late season
Nut drop	Early to mid-season
Variable characteristics	
Total kernel recovery (%)	43–46
Whole kernel (%)	50–60
Dehusking ease	Low risk of sticktights, responds to ethephon.
Germination risk	–
Disease risk	–
Pest damage risk	–
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	–
Pruning	–
Cross-pollinators	–
Notes	Performed well at most RVT Series 3 sites despite its small size.
Origin	Hidden Valley Plantations third generation.

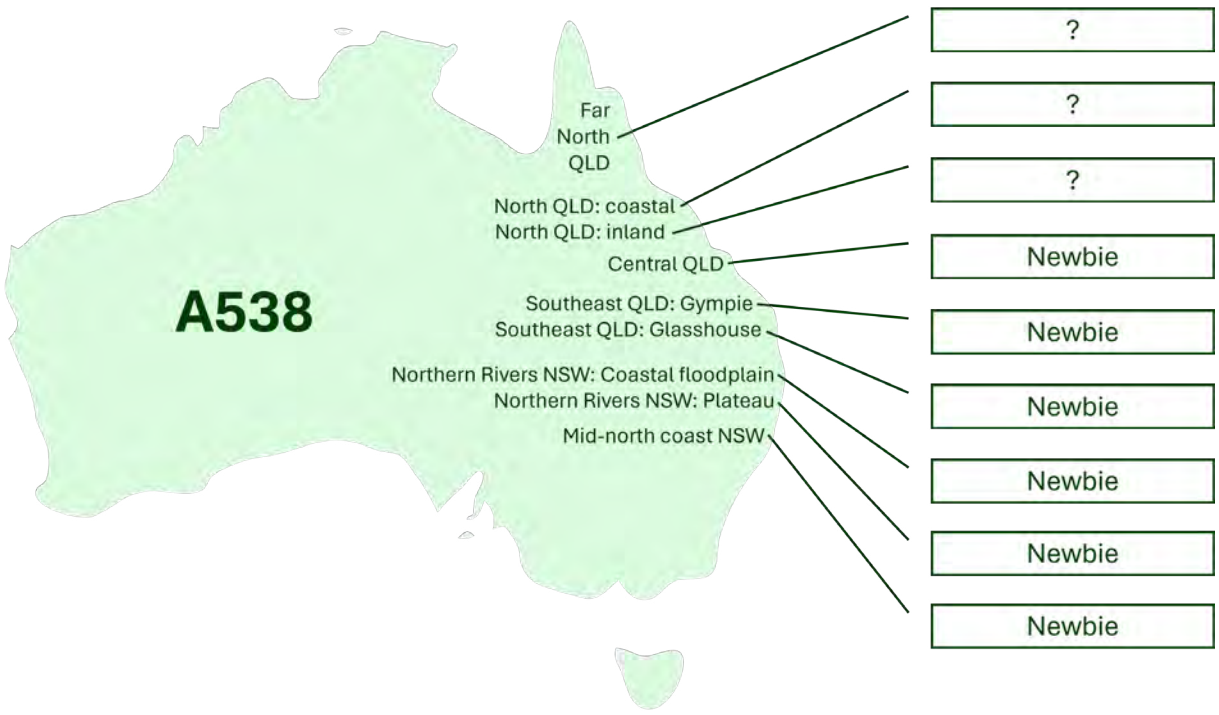

Figure 27. Regional ratings for the A538 cultivar.

246

Table 18. Cultivar 246 description.

Traits	
Shape	Spreading
Size	Large
Canopy density	Moderately dense
Precocity	Non-precocious
Bearing wood age	3–4 years
Flowering	Early season, extended
Nut drop	Early to mid-season
Variable characteristics	
Total kernel recovery (%)	31–41, tending to the low end of the range in hotter environments.
Whole kernel (%)	Low
Dehusking ease	Drops well naturally and has a moderate response to ethephon.
Germination risk	–
Disease risk	Highly susceptible to husk spot.
Pest damage risk	High due to an open micropyle, especially nut borer and kernel grub.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	Needs good drainage and soil management. Does not perform well on vertosols.
Pruning	Needs limb removal every 3–4 years once mature to avoid unproductive centres. Pruning stimulates vigour.
Cross-pollinators	A16, Daddow, A4 (low self-pollination). Often planted as a polliniser.
Notes	Planted widely in NSW and south-east Qld. Unpopular in Bundaberg. Susceptible to wind damage. Heavy leaf drop can hamper harvest. Shell thickness can vary.
Origin	Hawaii Agricultural Experiment Station first generation, known as 'Keauhou'.

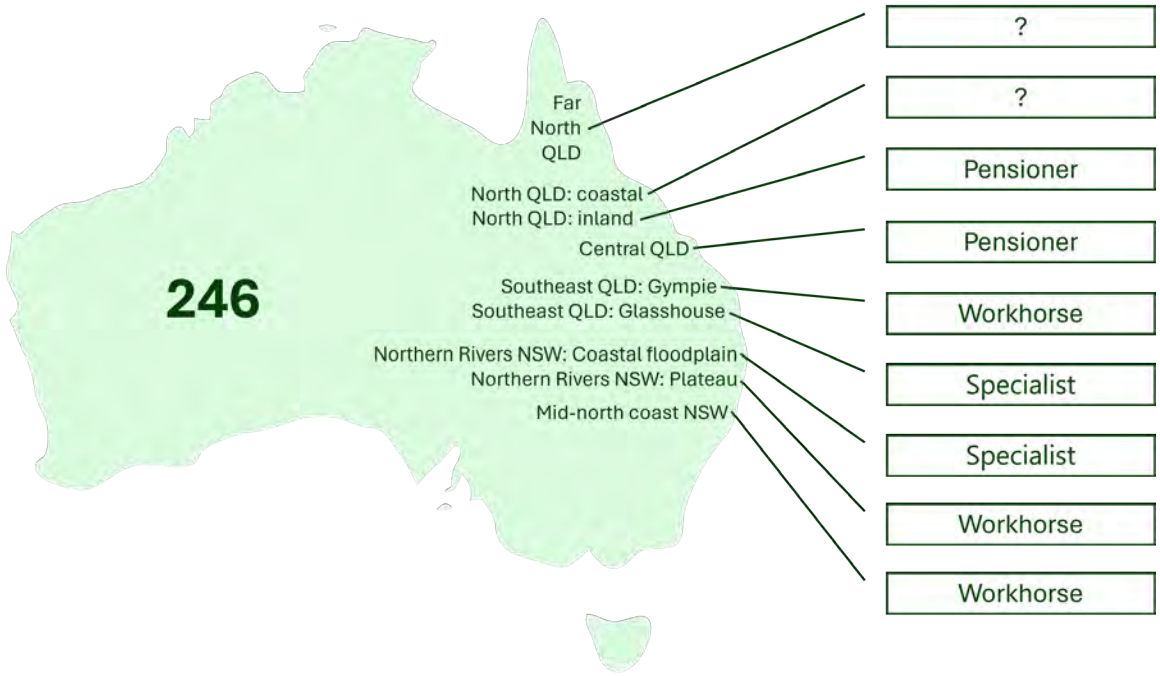

Figure 28. Regional ratings for the 246 cultivar.

344

Table 19. Cultivar 344 description.

Traits	
Shape	Upright, becoming more rounded if given sufficient space.
Size	Medium to large
Canopy density	Dense to very dense
Precocity	Precocious
Bearing wood age	3–4 years
Flowering	Light, mid to late season.
Nut drop	Early (Qld) to mid-season (NSW).
Variable characteristics	
Total kernel recovery (%)	34–39
Whole kernel (%)	Low
Dehusking ease	Clean dropping, moderate response to ethephon.
Germination risk	–
Disease risk	Susceptible to botryosphaeria.
Pest damage risk	Susceptible to nut borer.
Abnormal vertical growth (AVG) risk	Susceptible
Other features	
Nutrition	–
Pruning	Prune to open the canopy as yields drop with decreasing light levels. Does not respond well to regular hedging.
Cross-pollinators	Daddow, 814, 246, 849 (very low self-pollination)
Notes	Hardy tree, performing well in a range of climates and soil types. Widely planted in the 1980s and 1990s, it is still favoured on coastal floodplains and in areas with marginal soil. Trees are smaller and more rounded on the coastal flats. A consistent performer in Qld, however, is susceptible to AVG and no longer favoured in North Qld. More vulnerable to heat stress than other cultivars. Branches are wind tolerant, but whole trees can blow over.
Origin	Hawaii Agricultural Experiment Station first generation, known as 'Kau'.

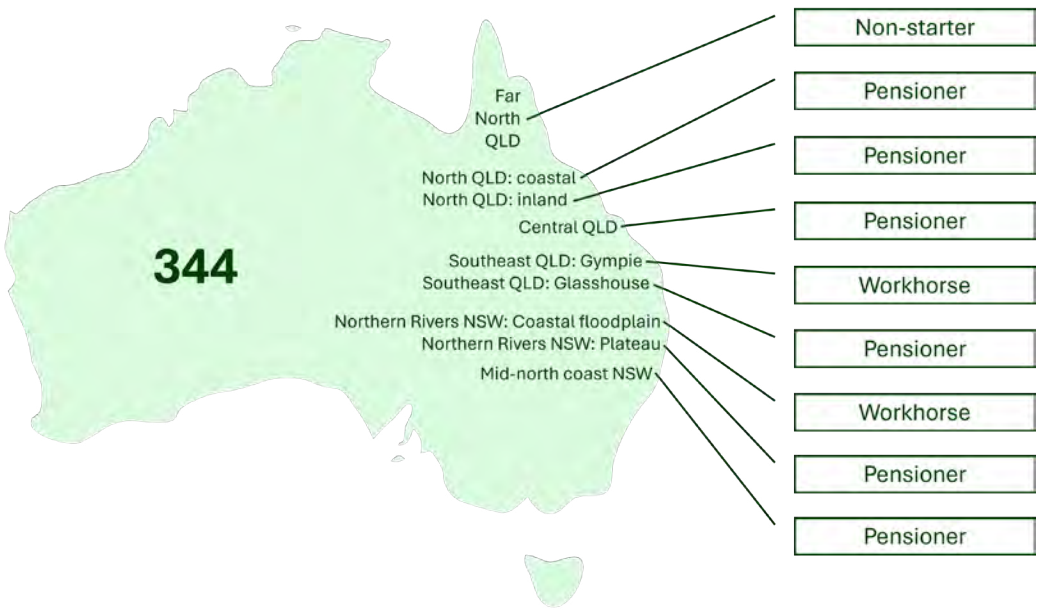

Figure 29. Regional ratings for the 344 cultivar.

660

Table 20. Cultivar 660 description.

Traits	
Shape	Upright with a turkey neck
Size	Medium to large
Canopy density	Moderately dense
Precocity	Precocious
Bearing wood age	3–4 years
Flowering	Variable
Nut drop	Very early season
Variable characteristics	
Total kernel recovery (%)	35–39
Whole kernel (%)	High
Dehusking ease	Tends to naturally dehusk on the orchard floor, impairing harvest by finger wheels.
Germination risk	High; nuts can germinate on trees in wet conditions.
Disease risk	Slightly susceptible to husk spot.
Pest damage risk	Thin-shell increases the risk of pest damage.
Abnormal vertical growth (AVG) risk	Highly susceptible
Other features	
Nutrition	It has lower baseline leaf nitrogen levels compared with other cultivars.
Pruning	–
Cross-pollinators	Self pollinates
Notes	Produces consistent yields, but stress on the tree can reduce nut size below commercial acceptance. Small nut size has made it unpopular in hot, dry regions. Relatively wind tolerant. Looks very similar to cultivar 741.
Origin	Hawaii Agricultural Experiment Station first generation, known as 'Keaau'.

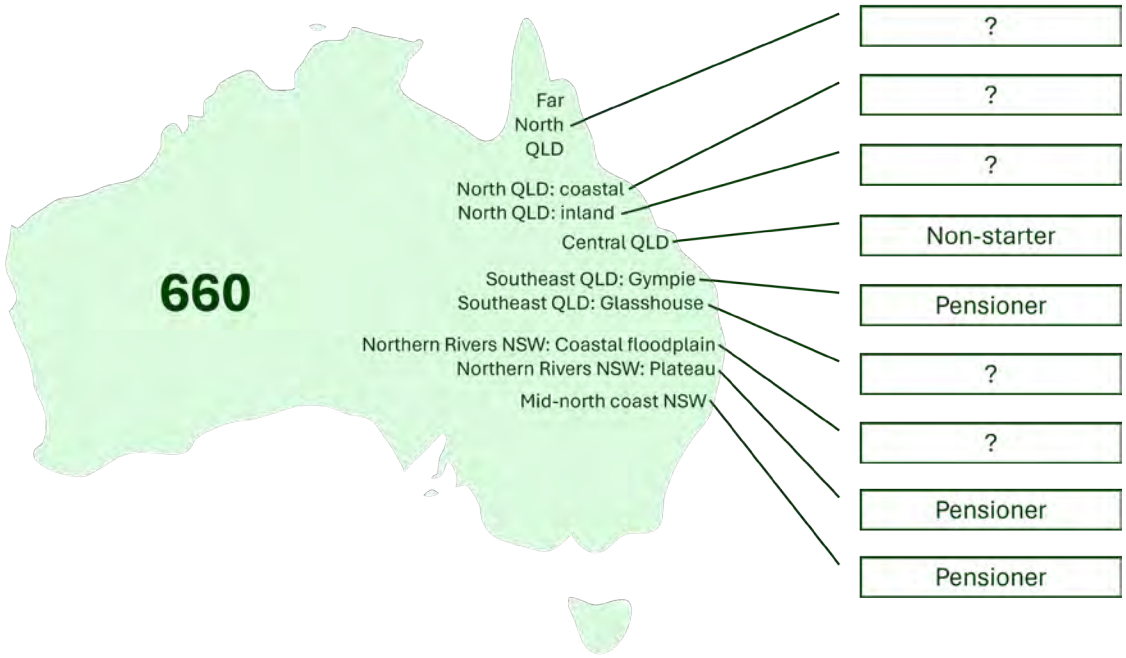

Figure 30. Regional ratings for the 660 cultivar.

741

Table 21. Cultivar 741 description.

Traits	
Shape	Upright with a turkey neck
Size	Large
Canopy density	Moderately open
Precocity	Non-precocious
Bearing wood age	3–4 years
Flowering	Late season, usually concentrated, sometimes light.
Nut drop	Early season
Variable characteristics	
Total kernel recovery (%)	33–43
Whole kernel (%)	Low–moderate
Dehusking ease	Usually easy, it can have a high level of sticktight nuts if the irrigation program is not correctly adjusted to provide adequate water.
Germination risk	–
Disease risk	Susceptible to botryosphaeria and husk spot (although early nut drop limits the effect).
Pest damage risk	–
Abnormal vertical growth (AVG) risk	Highly susceptible
Other features	
Nutrition	Optimal yield might not be reached without adequate nutrition and drainage.
Pruning	–
Cross-pollinators	814, A16, 849, A4 (self-pollinates). Associated with reduced nut size and TKR% as a polliniser.
Notes	Generally, is a reliable, hardy tree suited to a wide range of soil types. Moisture stress can cause smaller nuts and lower TKR%. Relatively wind tolerant, but trees can blow over. Heat tolerant and performs well in northern sites, but premature nut drop can be problematic in hotter climates. Has performed very well on the Alstonville Plateau, where mature orchards consistently crop well. Has shown inconsistent flowering (tending to biennial bearing) in Bundaberg. Might be more frost-tolerant than other cultivars. Looks similar to cultivar 660.
Origin	Hawaii Agricultural Experiment Station first generation, known as 'Mauka'.

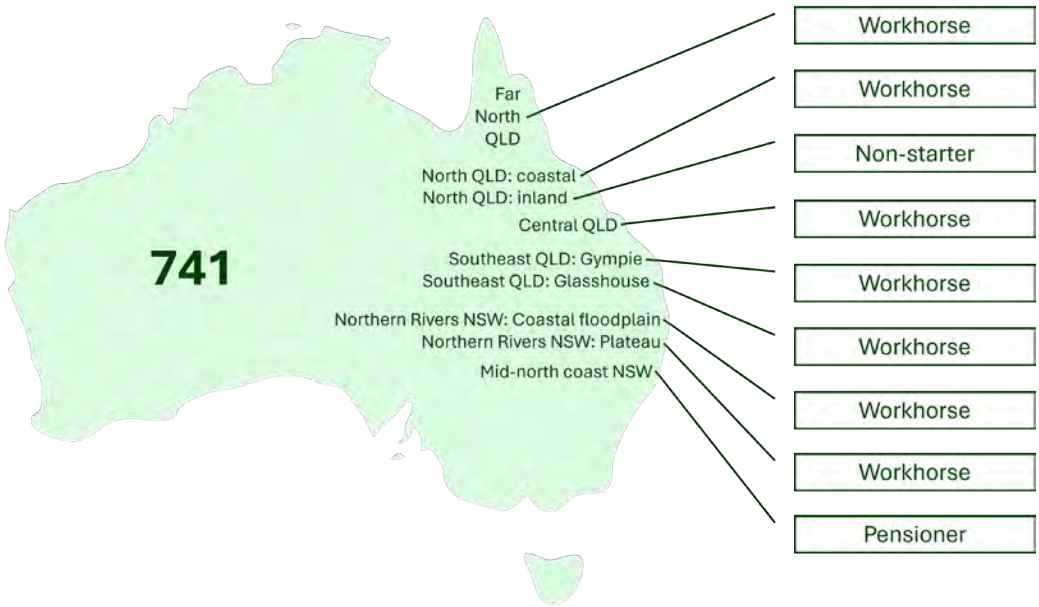

Figure 31. Regional ratings for the 741 cultivar.

816

Table 22. Cultivar 816 description.

Traits	
Shape	Moderately upright
Size	Medium to large
Canopy density	Moderately dense
Precocity	Non-precocious
Bearing wood age	3–4 years
Flowering	Late season, light.
Nut drop	Early to mid season, extended.
Variable characteristics	
Total kernel recovery (%)	42–47
Whole kernel (%)	High
Dehusking ease	Prone to sticktights
Germination risk	–
Disease risk	Highly susceptible to phytophthora, susceptible to husk spot.
Pest damage risk	–
Abnormal vertical growth (AVG) risk	–
Other features	
Nutrition	Responds very well to increased organic matter on the orchard floor. Requires higher nutrition and very good drainage management. Can look paler but this is not necessarily a sign it needs more fertiliser.
Pruning	Needs pruning to control size and avoid unproductive centres.
Cross-pollinators	Poor self-pollination
Notes	A great early performer that tends to decline through disease later in its life.
Origin	Hawaii Agricultural Experiment Station second generation.

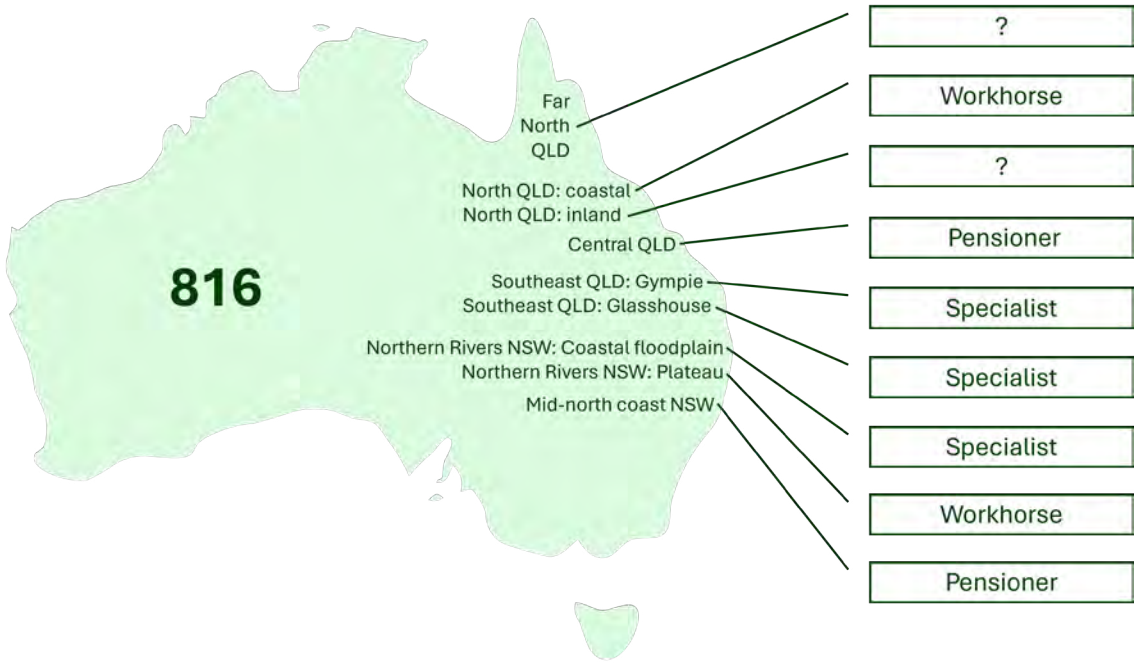

Figure 32. Regional ratings for the 816 cultivar.

842

Table 23. Cultivar 842 description.

Traits	
Shape	Moderately upright to spreading
Size	Medium to large
Canopy density	Open, becoming denser with age.
Precocity	Precocious
Bearing wood age	3–4 years
Flowering	Early season, intense, extended.
Nut drop	Mid to late season, extended.
Variable characteristics	
Total kernel recovery (%)	36–41
Whole kernel (%)	High
Dehusking ease	Mite damage to the husk can impair dehusking.
Germination risk	–
Disease risk	Susceptible to phytophthora, slightly susceptible to husk spot.
Pest damage risk	–
Abnormal vertical growth (AVG) risk	Susceptible
Other features	
Nutrition	–
Pruning	Responds well to different canopy management strategies as trees age.
Cross-pollinators	Daddow, 814, 344, 246 and 849 (self-pollinates)
Notes	Hardy and grows well in a range of soil types. Suited to warm areas, tolerant of hotter climates. It grows too quickly on the NSW Northern Rivers plateau and has more potential on the NSW Northern Rivers floodplain, where trees are compact. Very susceptible to wind damage. The kernel is beige-brown (some growers harvest separately from whiter kernel cultivars).
Origin	Hawaii Agricultural Experiment Station second generation.

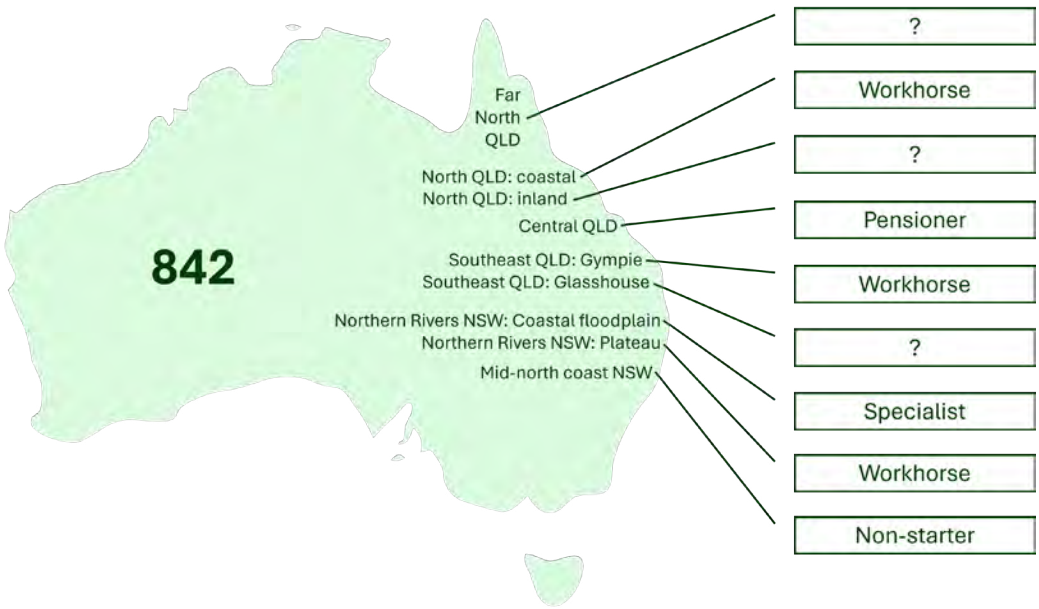

Figure 33. Regional ratings for the 842 cultivar.

849

Table 24. Cultivar 849 description.

Traits	
Shape	Spreading
Size	Medium to large
Canopy density	Moderately open to dense.
Precocity	Non-precocious
Bearing wood age	3–4 years
Flowering	Late season, light, short.
Nut drop	Mid to late season, extended.
Variable characteristics	
Total kernel recovery (%)	40–46
Whole kernel (%)	High
Dehusking ease	–
Germination risk	Pre-germination can be a significant defect in conducive seasons.
Disease risk	Susceptible to phytophthora, botryosphaeria, husk spot and flower blight.
Pest damage risk	Thin shell makes it more prone to insect damage, e.g. lace bug.
Abnormal vertical growth (AVG) risk	–
Other features	
Nutrition	–
Pruning	Does well with limb removal to keep the centre productive.
Cross-pollinators	741, Daddow, A4 (some self-pollination).
Notes	A consistent producer that continues to perform when older. Widely planted in NSW, it is used predominantly as a polliniser on the coastal flats. It is prone to wind damage. Kernel can show basal (at the bottom of the nut) discolouration and be affected by internal discolouration in rings.
Origin	Hawaii Agricultural Experiment Station second generation.

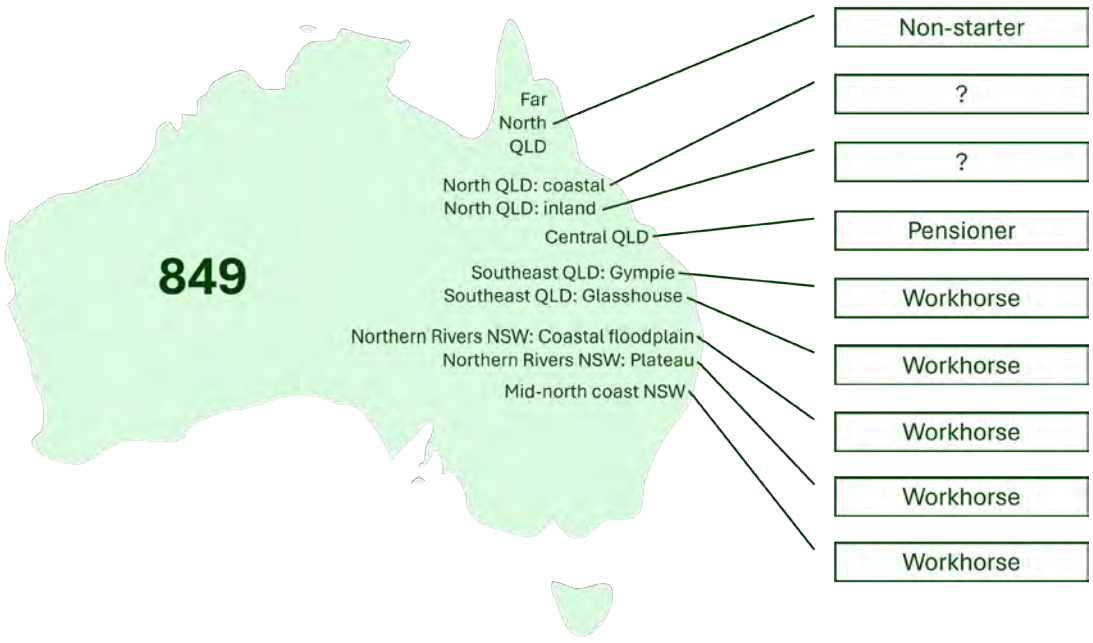

Figure 34. Regional ratings for the 849 cultivar.

H2 (rootstock)

Table 25. Cultivar H2 description.

Traits	
Shape	–
Size	Large
Canopy density	–
Precocity	–
Bearing wood age	3–4 years
Flowering	Late season, short.
Nut drop	Mid-season.
Variable characteristics	
Total kernel recovery (%)	31–35, lower in hot, dry seasons. It can produce many nuts that are too small to be commercially viable.
Whole kernel (%)	High
Dehusking ease	–
Germination risk	–
Disease risk	Very susceptible to phytophthora.
Pest damage risk	Open micropyle increases insect damage risk.
Abnormal vertical growth (AVG) risk	Susceptible
Other features	
Nutrition	Might show excessive vegetative growth if over fertilised.
Pruning	–
Cross-pollinators	–
Notes	It is not widely planted now, mainly used for rootstock seed nuts, not commercial cropping.
Origin	Early Australian selection in the 1950s from the Gold Coast, known as 'Hinde'.

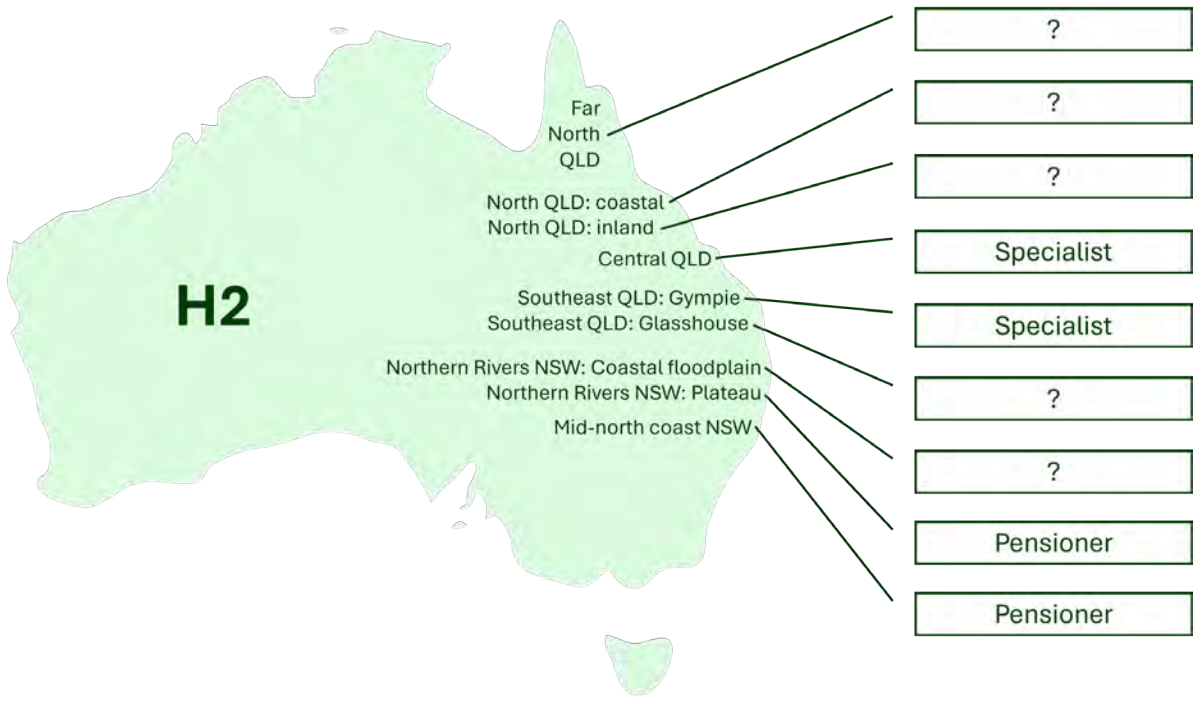

Figure 35. Regional ratings for the H2 cultivar.

Beaumont

Table 26. Cultivar Beaumont description.

Traits	
Shape	Spreading
Size	Medium to large
Canopy density	Very dense
Precocity	Non-precocious
Bearing wood age	3–4 years
Flowering	Late season
Nut drop	Late season
Variable characteristics	
Total kernel recovery (%)	32–38 (possibly higher in some coastal regions), good quality. Kernel sometimes adheres to shell and might discolour.
Whole kernel (%)	Low
Dehusking ease	Very prone to sticktights.
Germination risk	High; nuts can germinate on trees in wet conditions.
Disease risk	Susceptible to leaf diseases such as yellow halo disease, tolerant of husk rot.
Pest damage risk	Sensitive to scale insects and mealybugs. Will tolerate some thrips.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	High nitrogen inhibits fruiting.
Pruning	–
Cross-pollinators	Very little self-pollination.
Notes	High yielding. Has higher water requirement than other cultivars and suffers in drought conditions. Intolerant to salt spray. Wind tolerant. Growing in popularity as a rootstock, but it is only used as a rootstock in Australia.
Origin	Early Australian selection in the 1950s from Casino called NSW44. Later, it was also named 695 in Hawaii and Beaumont after being introduced to California in 1965 by Dr JH Beaumont.

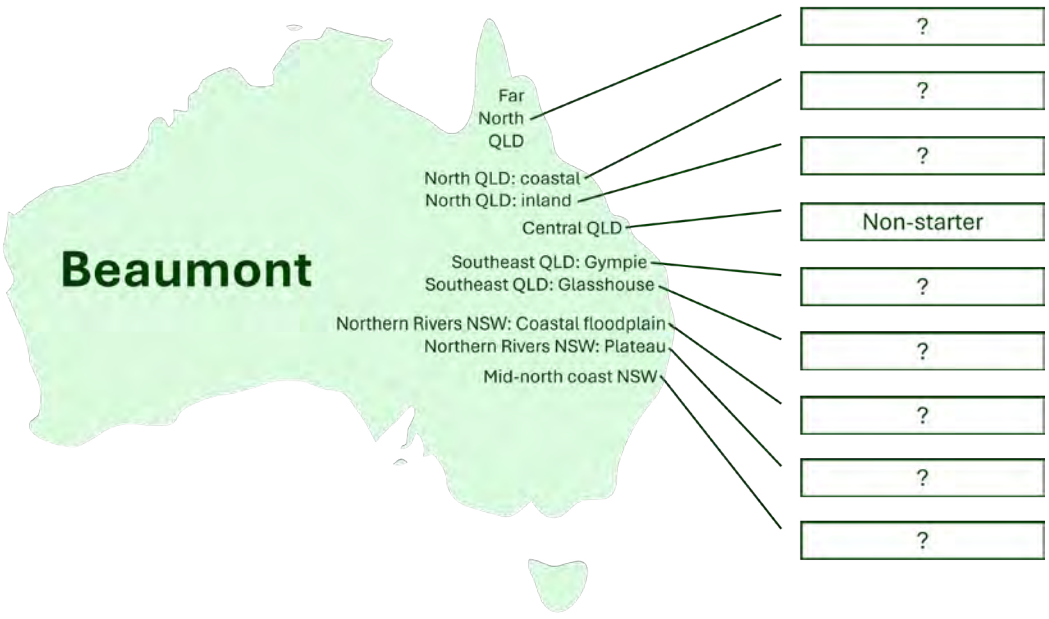

Figure 36. Regional ratings for the Beaumont cultivar.

MCT1

Table 27. Cultivar MCT1 description.

Traits	
Shape	Slightly spreading
Size	Small to medium
Canopy density	Open
Precocity	Very precocious
Bearing wood age	2–3 years
Flowering	Mid to late season, can flower out of season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	42–50
Whole kernel (%)	43
Dehusking ease	Not prone to sticktights.
Germination risk	–
Disease risk	–
Pest damage risk	High because of thin shells, but the thick husk offers some protection.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	Needs good management and nutritional inputs to bear high yields consistently.
Pruning	Requires regular pruning.
Cross-pollinators	A16 (very little self-pollination)
Notes	High-yielding with good canopy efficiency. Moderately susceptible to some wind damage because of branch length, requiring staking or supports. Performance in hotter, drier seasons is good because of large kernels and high TKR%. Trial results are from Bundaberg and unproven in NSW.
Origin	An Australian selection by Ian McConachie in the 1980s, now owned by the Macadamia Conservation Trust, derived from the A4 cultivar. MCT1 is protected by Plant Breeders Rights and royalties are payable to the Macadamia Conservation Trust via the commercialisation agent, ANFIC, and are only available from licensed nurseries.

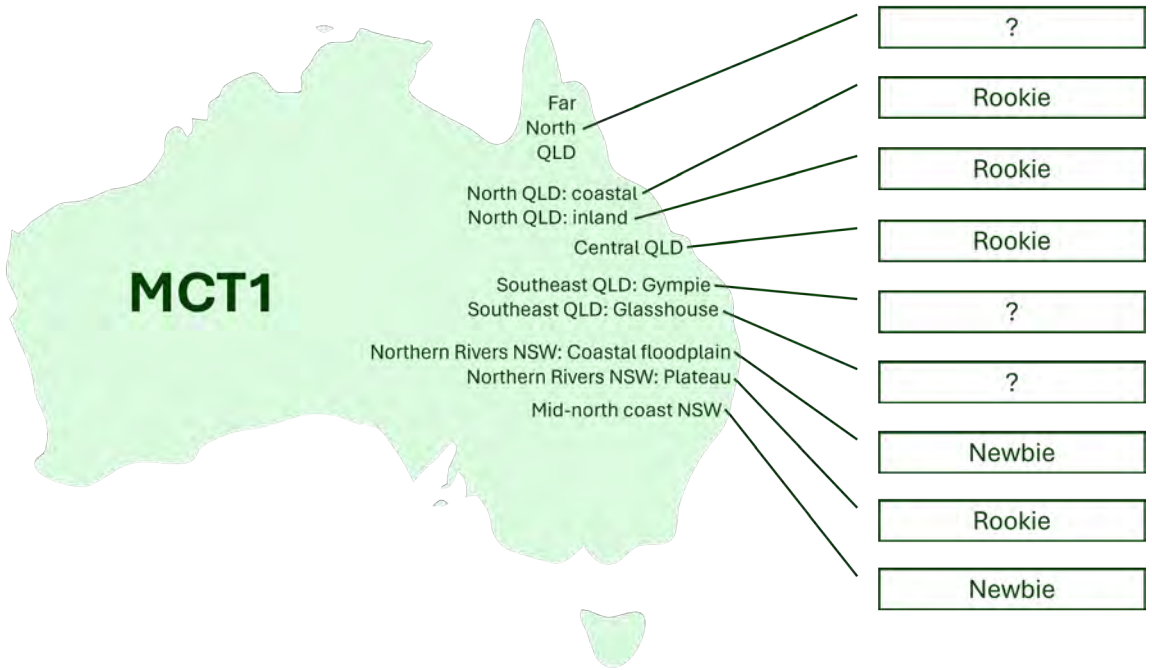

Figure 37. Regional ratings for the MCT1 cultivar.

MIV1-G

Table 28. Cultivar MIV1-G description.

Traits	
Shape	Spreading; can be more upright when young.
Size	Medium to large
Canopy density	Moderately open when mature, but young trees can be dense.
Precocity	Precocious
Bearing wood age	2–3 years
Flowering	Mid to late season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	42.6 based on varietal trials average
Whole kernel (%)	44.35
Dehusking ease	Moderate to low rating for sticktights in the RVTs
Germination risk	Pre-germination not observed
Disease risk	Not susceptible to husk spot.
Pest damage risk	Thin husks can increase insect damage risk.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	–
Pruning	Young trees might need minimal pruning and thinning due to tight branching.
Cross-pollinators	Unknown
Notes	An interesting new cultivar with attractive results reported for production and SKR. Unproven in orchard conditions, it is potentially a good all-rounder and suitable for poorer soil.
Origin	Australian Macadamia Industry Cultivar Generation 1, released in 2019. Plant Breeders Rights and royalties protect this cultivar and are payable to Hort Innovation and the Queensland Department of Agriculture and Fisheries via the commercialisation agent, QSGA. The cultivar is only available from licensed nurseries.

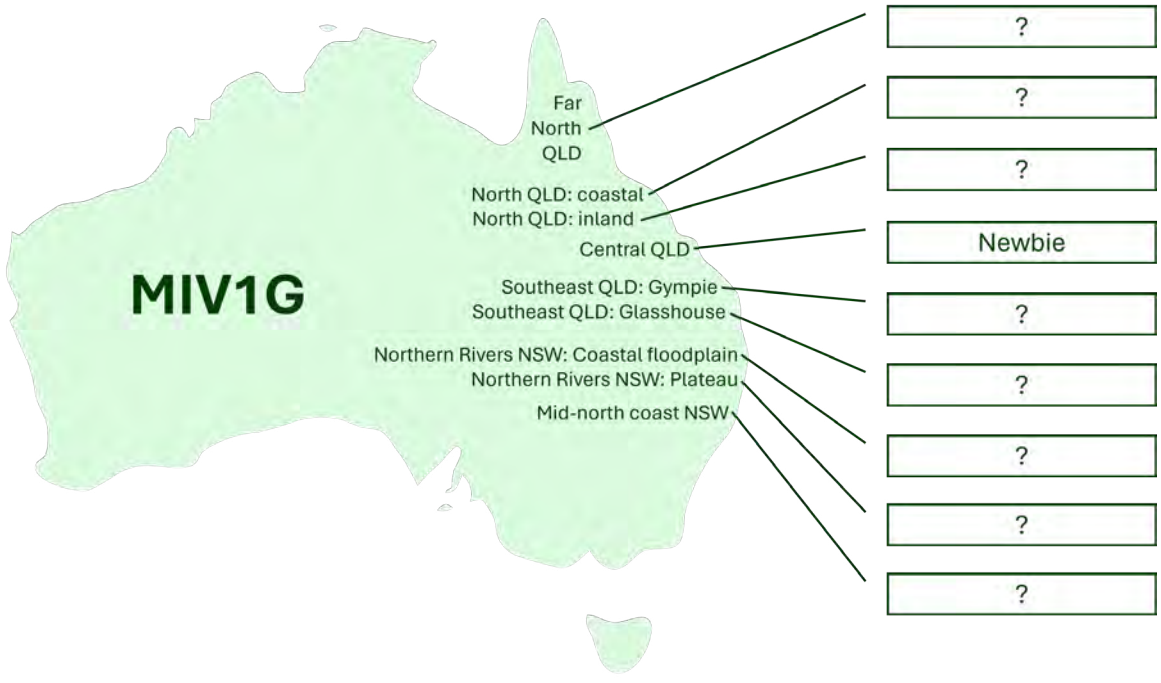

Figure 38. Regional ratings for the MIV1-G cultivar.

MIV1-J

Table 29. Cultivar MIV1-J description.

Traits	
Shape	Slightly spreading
Size	Small to medium
Canopy density	Moderately dense
Precocity	Precocious (reported as non-precocious in North Qld coastal region)
Bearing wood age	–
Flowering	Mid to late season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	44.8 in cultivar trial, very large kernels.
Whole kernel (%)	Low
Dehusking ease	Moderate possibility of sticktights.
Germination risk	Pre-germination not observed
Disease risk	Not susceptible to husk spot.
Pest damage risk	High because of thin shells, although the thick husk offers some protection.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	–
Pruning	Needs minimal pruning in the early years.
Cross-pollinators	Unknown (unknown self-pollination)
Notes	–
Origin	Australian Macadamia Industry Cultivar generation 1, released in 2019, parentage A16 and 781. This cultivar is protected by Plant Breeders Rights and royalties are payable to Hort Innovation and the Queensland Department of Agriculture and Fisheries via the commercialisation agent, QSGA. The cultivar is only available from licensed nurseries.

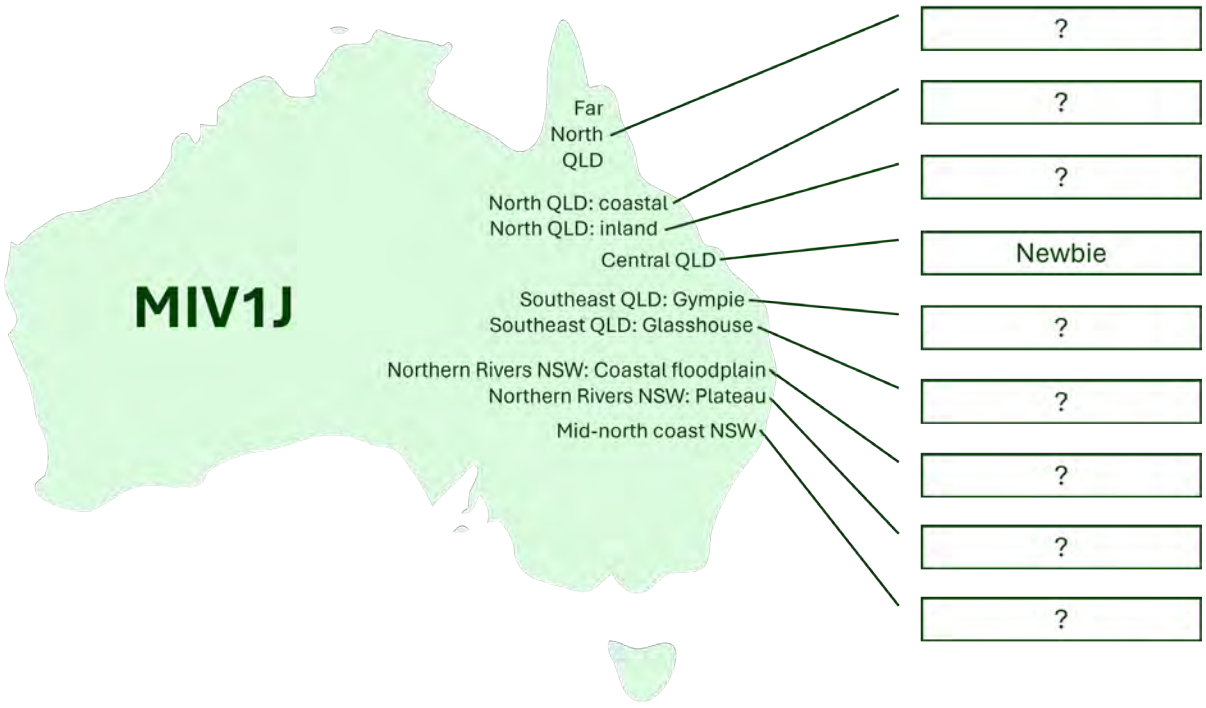

Figure 39. Regional ratings for the MIV1-J cultivar.

MIV1-P

Table 30. Cultivar MIV1-P description.

Traits	
Shape	Round
Size	Small
Canopy density	Moderately dense in NSW, more open in north Qld.
Precocity	Precocious
Bearing wood age	–
Flowering	Mid to late season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	34.8
Whole kernel (%)	Low
Dehusking ease	Susceptible to sticktights.
Germination risk	Pre-germination not observed
Disease risk	Can be susceptible to husk spot
Pest damage risk	Small micropyle and thin husk can increase the risk of pest damage.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	–
Pruning	Requires less pruning than MCT1 and A16
Cross-pollinators	Unknown (unknown self-pollination)
Notes	Promising in Central Qld on poorer country. Not frost tolerant. Yielding less than MCT1 and A16 in North Qld coastal region.
Origin	Australian Macadamia Industry Cultivar generation 1, released in 2019, parentage A16 and 814. This cultivar is protected by Plant Breeders Rights and royalties are payable to Hort Innovation and Queensland Department of Agriculture and Fisheries via the commercialisation agent, Queensland Strawberry Growers' Association (QSGA). The cultivar is only available from licensed nurseries.

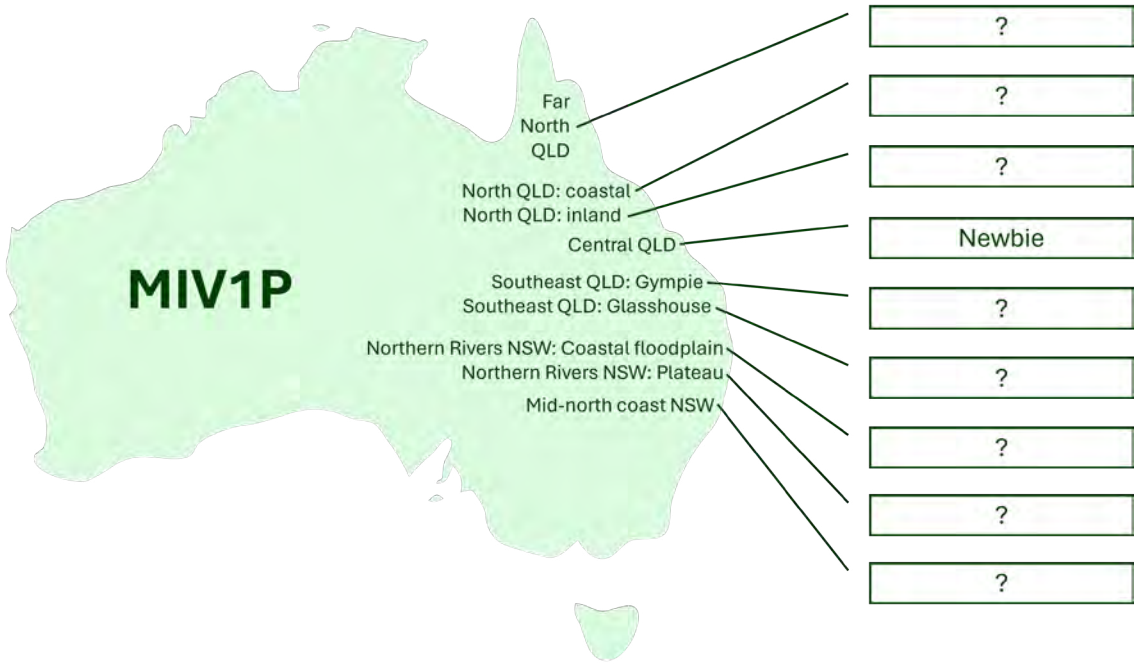

Figure 40. Regional ratings for the MIV1-P cultivar.

MIV1-R

Table 31. Cultivar MIV1-R description.

Traits	
Shape	Spreading to round
Size	Medium to large, smaller in Bundaberg
Canopy density	Moderately dense
Precocity	Precocious
Bearing wood age	–
Flowering	Mid to late season
Nut drop	Mid to late season
Variable characteristics	
Total kernel recovery (%)	37.8 in cultivar trials
Whole kernel (%)	Moderate
Dehusking ease	Low susceptibility to sticktights
Germination risk	Pre-germination not observed
Disease risk	Low susceptibility to husk spot and husk rot.
Pest damage risk	Moderately thick-shelled, offering some protection against pest damage.
Abnormal vertical growth (AVG) risk	Tolerant
Other features	
Nutrition	–
Pruning	–
Cross-pollinators	Unknown (unknown self-pollination)
Notes	–
Origin	Australian Macadamia Industry Cultivar generation 1, released in 2019, parentage Daddow and 842. This cultivar is protected by Plant Breeders Rights and royalties are payable to Hort Innovation and Queensland Department of Agriculture and Fisheries via the commercialisation agent, QSGA. The cultivar is only available from licensed nurseries.

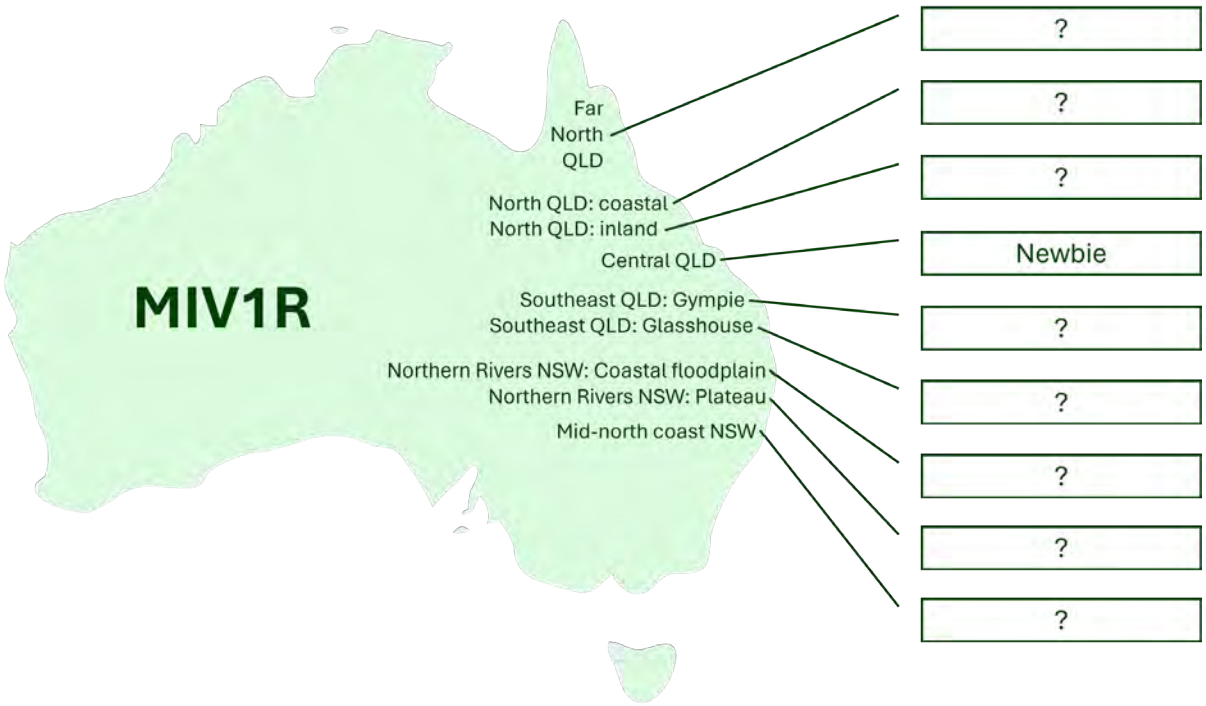

Figure 41. Regional ratings for the MIV1-R cultivar.

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Introducing: regional performance ratings

Individual cultivars are rated by consensus of advisors and experienced growers

Workhorse
Widely planted, proven performance, still being planted.

Specialist
Planted for site-specific limitations, e.g. soil constraint; however, it is not widely planted.

Rookie
Recently widely planted, promising but not yet proven in the long term (a minimum of 20 years).

Newbie
Newly developed, promising in trials, not yet widely planted in commercial orchards.

Pensioner
Historically widely planted, it is still in production but with few new plantings as it does not consistently perform as well as other cultivars.

Non-starter
Never much planted in the region and not expected to be.