Macadamia Pollination Research Compendium

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This Research Compendium provides a comprehensive list of all available research in macadamia pollination internationally as of March 2025. This compendium was compiled in tandem with a Literature Review report, which provides synthesis and critical analysis of this body of work. See the Literature Review for detailed methods involved in compiling the references that comprise this Compendium. While this Compendium can be used as a stand-alone document, it is best consulted alongside the accompanying Literature Review. Both the Compendium and Literature Review are structured according to the most salient questions relevant to contemporary Australian macadamia growers, as informed by our research and grower surveys.

The 150 references included in this Research Compendium are numbered and listed in order of appearance in the accompanying Literature Review document. While in some cases references are cited in-text several times in the Literature Review, they are listed in this Research Compendium only once to avoid redundancy, with subsequent mentions included under "References listed elsewhere" subheadings.

For each section, we have provided the 'Summary' from that section in the Literature Review, alongside all references included in that section. Alongside each reference, we have provided information about open-access status, publication format and an access link. In some cases, such as on websites that are subscription based, full access to sources may be restricted by a pay wall. In such cases, the abstract will often still be available via the link provided, and the article author can be contacted to provide a free copy of the article on request. Some older references are not available online, and these are indicated with 'N/A'.

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Is pollination required to maximise macadamia yield?

Summary

Research highlights the critical role of pollinators in maximizing macadamia yields through cross-pollination, as self-pollination results in lower fruit set, nut weight, and kernel quality. Studies demonstrate that cross-pollination significantly improves nut-in-shell yield, kernel yield, and economic returns. Genetic analyses confirm that nearly all macadamia nuts in diverse orchards result from cross-pollination, with additional benefits such as improved mineral profiles observed in some cultivars. While macadamia has a low but non-zero rate of self-compatibility, the degree of self-compatibility varies across cultivars, with most requiring outcrossing for optimal yield and quality. Experimental studies reveal that even partially self-fertile cultivars achieve higher nut set with open pollination, underscoring the importance of pollination. Further research is needed on degree of self-incompatibility for common cultivars, and which specific cross-cultivar combinations are most beneficial.

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What combination of cultivars should be planted to maximize pollination benefits?

Summary

While certain cultivars exhibit partial self-compatibility, all cultivars benefit from pollen outcrossing. Because some cultivar combinations outperform others in nut set and yield, it is important that farm managers select compatible cultivar combinations. Alongside outcrossing compatibility, cultivar selection must also consider additional cultivar-specific traits that have implications for farm management practices, including flowering time and duration, yield potential, market value and disease susceptibility. Though research provides some indication of some suitable pairings, further research is needed to address knowledge gaps in cross-

cultivar compatibility to inform effective planting. There is also little research on how to balance cultivar selection for outcrossing suitability with other farm management considerations that result from cultivar selection. It also may be possible to develop macadamia cultivars with higher selfing rates, as demonstrated in other horticultural crops.

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How should tree plantings be arranged spatially to maximize pollination?

Summary

Research clearly shows that proximity to a cross-pollen source is important for ensuring adequate pollination, with studies showing nut yield and farm-gate value increase with proximity to cross-pollen sources. While guidelines for planting distances are not yet available, pollination services decreased over short distances (24m or 5 rows), showing benefits to close interplanting of cultivars. Further research is needed on how many rows of the same cultivar can be planted before nut yields decline.

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If multiple cultivars are required to maximise pollination, why are single cultivar blocks still setting nuts?

Summary

Although some growers have single-cultivar blocks, studies reveal that outcrossing remains critical for maximizing nut set and yield. Cross-pollination in single-cultivar blocks can be facilitated by factors such as storm-replaced trees, occasional pollen transfer over long distances by bees, or rootstock flowering and it is unclear which of these sources are most important.

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What are the pollinators of macadamia crops?

Summary

Observational studies across multiple countries indicate that European honeybees are the dominant flower visitors in macadamia orchards, often comprising the majority of recorded visits. While honeybees are widely regarded as the primary pollinators due to their abundance, stingless bees are also frequent visitors and are likely to be more efficient pollinators per visit. Honeybees compensate for their lower efficiency through higher visitation rates. Other pollinators, including various beetles, flies, and butterflies likely contribute to macadamia pollination, and in some regions comprise the most abundant pollinators. There is no evidence

to support the idea that nocturnal pollination (e.g. moths) is important. The overall contribution of each species of pollinator to macadamia yield remains uncertain, highlighting the need for further research into their role in macadamia pollination systems.

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How will the spread of the Varroa mite impact the Australian macadamia industry?

Summary

The arrival of the Varroa mite in Australia has raised concerns about the macadamia industry's reliance on honeybees for pollination. While macadamia flowers attract a diverse range of pollinators, the extent to which wild honeybees contribute to pollination remains unclear. Wild honeybee populations are expected to decline significantly, leading to regional differences in resilience, with some areas better positioned to maintain pollination services from other sources. Managed honeybee services may increase in price and decrease in availability. Growers may need to increase their reliance on managed hives or alternative pollinators to compensate for expected honeybee declines. The relative contribution of wild honeybees, managed honeybees and other wild pollinators to macadamia pollination remains a key knowledge gap, and will determine resilience to Varroa.

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How can wild insect numbers be encouraged in macadamia crops?

Summary

Consistent with findings in other crops, preserving remnant vegetation near macadamia orchards has been shown to enhance pollination services by supporting wild pollinators through nesting habitat and year-round floral resources. Studies in Australia and South Africa demonstrate that proximity to natural vegetation increases pollinator visitation rates in orchards, resulting in higher nut set and yield. Conversely, pesticide application negatively affects pollinator abundance, particularly native stingless bees, though honeybees show greater resilience. To enhance wild pollination services, farm management strategies should incorporate pollinator-friendly pesticide application and seek to conserve adjacent natural

habitat. While there are some examples in the research, more studies are required to assess the impact of pesticide use on pollinator health to better inform guidelines for growers.

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How should managed bee hives be used to ensure optimal macadamia pollination?

Summary

Honeybees and stingless bees are key managed pollinators in Australian macadamia orchards, but optimal hive stocking rates remain unclear, with recommendations ranging from 2-8 hives per hectare for honeybees, and no recommendations available for stingless bees. Alongside hive stocking rate, research suggests that the hive introduction timing and hive arrangement is important. Sequential hive introductions during flowering improve pollinator focus on macadamia flowers. Stingless bees have a limited foraging range, and so hives should be placed at 100m intervals. Honeybees are capable of foraging at greater distances, so that hives should be spaced within 250-600m for effective foraging. More research is needed to fill knowledge gaps on adequate honeybee hive stocking rates, and may vary substantially

depending on reliance on managed honeybees in region of interest and orchard layout. There is also no guidance on the use of managed stingless bee hives within macadamia orchards.

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Does wind pollination play a role in macadamia crops?

Summary

Research shows that wind pollination plays a minimal role in macadamia pollination, likely due to the large size of pollen clumps and small stigmatic surfaces on flowers which impede outcrossing by wind. Studies show that while incidental pollen transport by wind may occur, it is insufficient for ensuring effective cross-pollination between cultivars, even in multi-cultivar blocks. Overall, insect pollinators remain essential for achieving sufficient cross-pollination and maximizing yield.

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What role does pollination play in premature nut drop?

Summary

Genetic analyses show that macadamia trees selectively abscise nuts that are not the result of cross-pollination, with nearly all mature nuts being cross-pollinated. While self-pollinated nuts may initially set, they are typically aborted within 10 weeks, highlighting the critical role of outcrossing between cultivars. Other factors, such as resource limitations, predation, and disease, also contribute to early nut abscission, underscoring the complex interactions affecting final nut set. It remains unclear whether macadamia cultivars that exhibit higher rates of self-compatibility may retain more selfed nuts or if farm management practices, such as optimizing soil or water conditions, could improve the retention of selfed nuts.

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