Enhancing Biodiversity

The role of native insectary plants and their contribution to conservation biological control in vineyards

Ways to build resilience and stability into vineyard agroecosystems using native insectary plants

Mary Retallack, from The University of Adelaide and Retallack Viticulture, highlights the preferred attributes of native insectary plants for use in Australian vineyards. This is the second in a series of articles that will provide practical insights for growers.

Introduction

In my previous article (October 2018 issue, 'The importance of biodiversity and ecosystem services in production landscapes') I explored the benefits of biodiversity enhancement, the role it can play in enhancing resilience and stability in production landscapes, and the contribution ecosystem services make towards 'provisioning' and 'regulating' services. Insectary plants are valued for their capacity to provide 'provisioning' services such as shelter, nectar, alternative prey/hosts and pollen to nourish and extend the presence of predatory arthropods, which in turn provide 'regulating' services via the biocontrol of vineyard pests.

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Conservation biological control involves the implementation of practices that maintain and enhance the reproduction, survival, and efficacy of natural enemies of pests (Barbosa 1998, Begg *et al.* 2017, Fiedler *et al.* 2008). Relatively little work has been done on the use of specific native plant species in the field of conservation biological control within Australia. However, the body of knowledge is steadily increasing to provide innovative and practical solutions for wine growers.

A recent study identified associations between three native insectary plants and predatory arthropods in and

AT A GLANCE

- Insectary plants provide 'SNAP', an acronym that refers to shelter, nectar, alternative prey/hosts and pollen which is needed to nourish predatory arthropods and parasitoids and enhance their presence in vineyards. In turn, they provide free biological control of pests.
- Native plants are naturally adapted to Australia's dry climate and are consistently reported as having a low occurrence of pests and high occurrence of natural enemies.
- The majority of predators that attack crop pests are native species and an increase in predators is reported where there are stands of native vegetation adjacent to crops.
- It is anticipated that biological pest control can be enhanced in vineyards by planting native insectary plants, which would reduce insecticide inputs, and enhance biodiversity and resilience.

around vineyards. In this article we will introduce these insectary plants and highlight the preferred attributes sought to maximise the likelihood they will contribute towards conservation biological control. In latter articles I will present case studies of the ways growers have incorporated native insectary plants and the types of predatory arthropods observed in association with these plants.

Preferred attributes of insectary plants

Careful screening of insectary plants is important to ensure success. Insectary plants need to be attractive to predators and be easy to establish and maintain, without actively competing with grapevines or providing breeding sites for pests. A range of attributes is important. For example, flower colour may impact on attractiveness to different predators and parasitoids. A parasitoid wasp, *Trichogramma carverae*, is reported to associate with white flowers of alyssum to a greater extent than other colours of the same cultivar (Begum *et al.* 2004). As a general rule, it is suggested that growers focus their efforts on selecting insectary plants that provide multiple benefits (Fiedler *et al.* 2008).

Attributes to consider are:

1. Plant species that are native to the local area, naturally adapted and suitable for use in and around vineyards, with little or no additional inputs (irrigation or fertiliser) required:
   - select plants that are commercially available, or easy to propagate from seed, cutting or by division
   - easy to manage
   - overlap in their flowering times to collectively provide SNAP resources throughout the year.
2. A diversity of plants types, representing different functional groups, morphology and strata. Considerations for flowers include:
   - size — an abundance of smaller flowers is preferred, otherwise bees may deplete the available resources if only larger flowers are present
   - shape and accessibility of floral resources — depth and width; some flowers are 'buzz pollinated' and their resources can only be accessed by native bees, or the nectar from long, narrow flowers may only be accessed via species with long mouthparts i.e. butterflies
   - Seasonality — a long flowering period is preferred.
3. Plants that are attractive to natural enemies:
   - that provide provisioning services for beneficial arthropods at key times in their lifecycle
   - the timing of pollen and nectar production coincides with the needs of predators and parasitoids and especially during spring/summer when biocontrol is critical
   - plants that prolifically produce pollen and/or nectar.
4. Plants that do not harbour herbivorous pests.

Why choose native plant species?

Exotic insectary plants

Exotic insectary plants such as buckwheat (*Fagopyrum esculentum*), a native to Asia; alyssum (*Lobularia maritima*), a native to the Mediterranean and Southern Europe; and phacelia (*Phacelia tanacetifolia*), a native to California, have come to dominate the literature (Fiedler and Landis 2007a). They are frequently used outside their natural ranges. Even though these plants are recognised for their superior provisioning services elsewhere, their performance when used locally has been variable due to Australia's dry conditions (Thomson and Penfold 2012). Similarly, it has been reported that the presence and longevity of light brown apple moth (LBAM), *Epiphyas postvittana*, may be boosted in the presence of buckwheat (Begum *et al.* 2006), so its use may be counterproductive in some situations.

Native insectary plants

We have sought to broaden the suite of insectary plants available for use in Australian conditions. In addition to their capacity to provide 'SNAP', native plants are preferred for the following reasons:

Figure 1. Australian native insectary plants (a) Christmas bush, *B. spinosa*, (b) prickly tea-tree, *L. continentale* and (c) Wallaby grass, *Rytidosperma ssp.*

Figure 2. Rose bushes have been traditionally used at the end of strainer posts and offer no intrinsic benefit (a) C.A. Henschke and Co. have incorporated Christmas bush at the end of their strainer posts (b,c) and it is suggested that the use of native plants may be a better alternative.

- they are naturally adapted to Australia's climatic conditions and have a lower requirement for water and nutrients (Pandey *et al.* 2018)
- the majority of predators that attack crop pests are native and are associated with native plants (Gagic *et al.* 2018)
- an increase in predators is reported where there are stands of native vegetation adjacent to production landscapes (Landis *et al.* 2005, Landis et al. 2000, Parry *et al.* 2015)
- native evergreen woody plants provide resources throughout the year and help to fill a 'resource gap' when deciduous plants such as grapevines enter dormancy over winter
- they have minimal recurring costs once they are established and many species will persist for many years, in contrast to annuals or biennials which require regular re-seeding (Fiedler *et al.* 2008).

- they provide a range of additional ecosystem service benefits such as biodiversity enhancement, weed suppression, soil stabilisation, incorporation of organic matter, improvement of soil structure and water infiltration (Penfold 2010).

Moreover, native perennial woody plants and ground covers may be more compatible with crop management than exotic annuals (Daane *et al.* 2018, Pandey *et al.* 2018). It is anticipated that enhanced biodiversity should increase the overall resilience of the system and also buffer against the possibility of exotic plant and arthropod species invading and dominating the localised area.

Native insectary plants

Three candidate insectary plants — Christmas bush (*Bursaria spinose);* prickly tea-tree (*Leptospermum continentale);* and wallaby grass (*Rytidosperma* ssp.) — were selected for assessment based on their attributes and the availability of established plants adjacent to or in vineyards located in the Barossa and Adelaide Hills wine regions.

Perennial evergreen woody native plants

Christmas bush (Figure 1a, page 32) and prickly tea-tree (Figure 1b) are both erect, evergreen native shrubs that grow from one to four metres tall and are commonly found throughout southern and eastern Australia. They have an abundance of small white flowers, which provide both pollen and nectar and attract a wide range of predators. Christmas bush typically flowers from late spring until late summer and the prickly tea-tree flowers from early spring to late summer.

Perennial native wallaby grass

Wallaby grasses are erect, perennial grasses with fine leaves and distinctive white, fluffy seed heads when mature (Figure 1c). They grow from 30 to 80cm depending on the species and flowering occurs in late spring and early summer. Wallaby grasses grow actively during the spring and enter dormancy when conditions dry out in summer (Penfold and McCarthy 2010). *Rytidosperma* ssp. have a similar distribution to Christmas bush and prickly tea-tree, and are known to support the presence of a range of predatory arthropods including brown lacewings, wolf spiders, ground beetles and parasitoids (Danne *et al.* 2010, Penfold and McCarthy 2010, Wood *et al.* 2011).

Different *Rytidosperma* ssp. can be selected in response to specific tolerance to wet sites, drought, heat, frost, acid soils, or low growing habit for use under perennial crops (Prescott 2016). Six species of wallaby grasses were assessed comprising common wallaby grass (*R. caespitosum*), brown-back wallaby grass (*R. duttonianum*), copper-awned wallaby grass (*R. fulvum*), hairy wallaby grass (*R. pilosum*), slender wallaby grass (*R. racemosum*), and small-flowered wallaby grass (*R. setaceum*). Other plants that may provide insectary benefits.

A number of candidate plants suited for use in the Adelaide Hills and/or Barossa were also identified via a desktop review as having the capacity to provide insectary benefits and may hold widespread appeal including wild rosemary (*Dampiera rosmarinifolia*), dryland tea tree 'Moonah' (*Melaleuca lanceolate*), clasping goodenia (*Goodenia amplexans*), hop goodenia (*Goodenia ovata*), cut-leaf goodenia (*Goodenia pinnatifida*), common boobialla, desert hakea (*Hakea mitchellii, Myoporum insulare*), creeping boobialla (*Myoporum parvifolium*), sticky boobialla (*Myoporum petiolatum*), long-leaved bush-pea (*Pultenaea daphnoides*), twiggy bush-pea (*Pultenaea largiflorens*), blue-rod (*Stemodia florulenta*), fairy fan flower (*Scaevola aemula*), as well as *Acacia* ssp., *Eucalyptus* ssp., *Lomandra* ssp.

It is also reported that the longevity of parasitoids which predominantly feed on nectar (Gillespie *et al.* 2016, Gurr *et al.* 2017) are significantly enhanced by Australian natives including coastal rosemary (*Westringia fruticose*), creeping mint (*Mentha satureioides*), crimson bottlebrush (*Callistemon citrinus*), tea-tree (*Leptospermum* cv. 'Rudolph'), grevillea (*Grevillea* cv. 'Bronze Rambler'), creeping boobialla (*Myoporum parvifolium*), and austral trefoil (*Lotus australis*) (Pandey *et al.* 2018).

Other plants identified for their insectary benefits in vineyards include straw wallaby grass (*Rytidosperma richardsonii*), windmill grass (*Chloris*

truncate), creeping saltbush (*Atriplex semibaccata*) and lagoon saltbush (*Atriplex suberecta*) (Danne *et al.* 2010). A broad range of native plants selected from local ecological vegetation communities have also been recently utilised in on-ground trials in Victoria (Thomas 2017). All species should be matched to the site requirements and trialled prior to broader scale use. A diversity of appropriate insectary plants is encouraged.

Manipulating the structure and habit of insectary plantings

It may be possible to manipulate the flowering time, structure and habit of insectary plants. For example, some woody plant species can be pruned or hedged to manipulate the density of flower clusters or encourage a compact habit. In the case of Christmas bush this may provide a suitable alternative to roses and other introduced plants that are often planted at the end of strainer posts in Australian vineyards and offer no intrinsic benefit. Moreover, the incorporation of native plants is a fantastic way to tell our unique Australian story to international consumers by utilising our natural assets to stand out in a crowded marketplace.

Similarly, the mowing of grass swards can be used to manipulate the timing of flowering and the provision of pollen for predators such as predatory mites (Smith and Papacek 1991). Mowing of alternative rows in preference to all rows can be used to retain habitat and shelter for predatory insects and spiders that live and reproduce in long grass (Bernard *et al.* 2006, Wood *et al.* 2011). Similarly, grasses can be slashed to a minimum height of 10cm to preserve habitat. Kneed wallaby grass (*Rytidosperma geniculatum)* will grow to a height of 30cm (Chivers 2018) and may be suitable for use under vine and in mid rows, without the need for slashing. A mix of *Rytidosperma* ssp. can be selected to suit the local conditions, based on the performance required.

Conclusion

The native insectary plants assessed in this study were not found to be breeding sites for economically damaging vineyard herbivores and are not considered a threat when planting them in or around mature vineyards. They supported populations of predatory arthropods throughout the year. Vineyard managers are encouraged to explore the use of Christmas bush, prickly tea-tree and wallaby grass as insectary plants, as well as other local species, in their vineyards. The use of insectary plants should help winegrape growers produce grapes with lower insecticide inputs, while enhancing the biodiversity and resilience of their vineyards. The featured insectary plants can be planted virtually wherever winegrapes are grown. In addition, the results of this study may be applicable to a range of Australian crop production landscapes.

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Acknowledgements

This research was made possible through scholarships to Mary Retallack awarded by the Australian Government Research Training Program Scholarship, The University of Adelaide C.J. Everard Supplementary Scholarship, SARDI Women's Suffrage Centenary Bursary, Wine Australia PhD Supplementary Scholarship. Project operating support was provided via Wine Australia and the Adelaide Hills Wine Region Post Graduate Biodiversity Study Grant.

I thank managers who allowed me to collect data in their vineyards: Prue Henschke, Craig Markby, and

Dan Falkenberg. I also thank Professor Michael Keller, Associate Professor Duncan Mackay, Dr Linda Thomson, Dr Michael Nash and Dr Maarten van Helden who provided feedback on the research manuscript and Glenys Wood who assisted with arthropod identification.

For more information on this article contact Mary Retallack: mary@viti.com.au

References

Barbosa, P. (1998) Agroecosystems and conservation biological control. (Academic Press: San Diego).

Begg, G.S.; Cook, S.M.; Dye, R.; Ferrante, M.; Franck, P.; Lavigne, C.; Lovei, G.L.; Mansion-Vaquie, A.; Pell, J.K.; Petit, S.; Quesada, N.; Ricci, B.; Wratten, S.D.and Birch, A.N.E. (2017) A functional overview of conservation biological control. Crop Protection 97, 145-158. doi: 10.1016/j.cropro.2016.11.008.

Begum, M.; Gurr, G.M.; Wratten, S.D.; Hedberg, P.R. and Nicol, H.I. (2006) Using selective food plants to maximize biological control of vineyard pests. Journal of Applied Ecology 43:547-554. doi: 10.1111/j.1365-2664.2006.01168.x.

Begum, M.; Gurr, G.M.; Wratten, S.D.and Nicol, H.I. (2004) Flower color affects tri-trophic-level biocontrol interactions. Biological Control 30:584-590. doi: 10.1016/j.biocontrol.2004.03.005.

Bernard, M.; Semerato, L.; Carter, V. and Wratten, S.D. (2006) Beneficial insects in vineyards: Parasitoids of LBAM and grapevine moth in south-east Australia. The Australian & New Zealand Grapegrower & Winemaker 513, 21-28.

Chivers, I., 'Wallaby grass Oxley, Rytidosperma geniculatum', (Native Seeds, www.nativeseeds.com.au/product/oxley-wallaby-grass/, 2018).

Danne, A.; Thomson, L.J.; Sharley, D.J.; Penfold, C.M.and Hoffmann, A.A. (2010) Effects of native grass cover crops on beneficial and pest invertebrates in Australian vineyards. Environmental Entomology 39:970-978. doi: 10.1603/en09144.

Fiedler, A.K. and Landis, D.A. (2007a) Attractiveness of Michigan native plants to arthropod natural enemies and herbivores. Environmental Entomology, 751-765.

Fiedler, A.K.; Landis, D.A.and Wratten, S.D. (2008) Maximizing ecosystem services from conservation biological control: The role of habitat management. Biological Control 45:254-271. doi: 10.1016/j.biocontrol.2007.12.009.

Gagic, V.; Paull, C. and Schellhorn, N.A. (2018) Ecosystem service of biological pest control in Australia: the role of non-crop habitats within landscapes. Austral Entomology, n/a-n/a. doi: 10.1111/aen.12328.

Gillespie, M.A.K.; Gurr, G.M.and Wratten, S.D. (2016) Beyond nectar provision: the other resource requirements of parasitoid biological control agents. Entomologia Experimentalis Et Applicata 159: 207-221. doi: 10.1111/eea.12424.

Gurr, G.M.; Wratten, S.D.; Landis, D.A. and You, M.S. (2017) Habitat management to suppress pest populations: progress and prospects. In: Annual Review of Entomology, Vol 62, Ed. M.R. Berenbaum pp. 91-109.

Landis, D.A.; Menalled, F.D.; Costamagna, A.C. and Wilkinson, T.K. (2005) Manipulating plant resources to enhance beneficial arthropods in agricultural landscapes. Weed Science 53:902-908. doi: 10.1614/ws-04-050r1.1.

Landis, D.A.; Wratten, S.D.and Gurr, G.M. (2000) Habitat management to conserve natural enemies of arthropod pests in agriculture. Annual review of entomology 45:175-201. doi: 10.1146/annurev.ento.45.1.175.

Pandey, S.; Rahman, A.and Gurr, G.M. (2018) Australian native flowering plants enhance the longevity of three parasitoids of brassica pests. Entomologia Experimentalis Et Applicata 166, 265-276. doi: 10.1111/eea.12668.

Parry, H.R., S. Macfadyen, J.E. Hopkinson, F. Bianchi, M.P. Zalucki, A. Bourne, and N.A. Schellhorn (2015) Plant composition modulates arthropod pest and predator abundance: Evidence for culling exotics and planting natives. Basic and Applied Ecology 16, 531-543. doi: 10.1016/j.baae.2015.05.005.

Penfold, C.M. (2010) Native grass cover crops. Australian & New Zealand Grapegrower & Winemaker 554: 48-50.

Penfold, C.M. and McCarthy, M. (2010) 'Soil Management for Yield and Quality' - Sub-project 'Pursuing Sustainability – the role of native ground cover species'", (Grape and Wine Research and Development Corporation, Adelaide).

Prescott, A. (2016) 'Native grasses: a regional guide', Natural Resources, Adelaide and Mount Lofty Ranges. Licensed under Creative Commons Attribution 3.0 Australia License www.creativecommons.org/licenses/by/3.0/au Copyright owner: Crown in right of the State of South Australia 2016. Revised 2017., Adelaide).

Smith, D. and Papacek, D.F. (1991) Studies of the predatory mite Amblyseius victoriensis (Acarina: Phytoseiidae) in citrus orchards in south-east Queensland: control of Tegolophus australis and Phyllocoptruta oleivora (Acarina: Eriophyidae), effect of pesticides, alternative host plants and augmentative release. Experimental and Applied Acarology 12:195-217. doi: 10.1007/bf01193467.

Thomas, K. (2018) 'Planting native vegetation for beneficial insects and improving farm integrated pest management through biodiversity', (Port Phillip and Westernport CMA, Victoria, http://www.ppwcma.vic.gov.au/wp-content/uploads/2017/09/Insectariums-Case-study-AUGUST-2018.pdf).

Thomson, L.J. and Penfold, C.M. (20112) 'Cover crops and vineyard biodiversity', (Grape and Wine Research and Development Corporation, Adelaide).

Wood, G.; Glatz, R.; DeGraaf, H.; Siekmann, G. and Stephens, C. (20111) 'Revegetation by design - Promoting the 'on farm' use of native vegetation as agents of 'natural pest control'", (RIRDC, Canberra). GW