

Green Infrastructure Fact Sheet

Planting for survival

Green Infrastructure Research Group

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Why is survival an issue?

Green roofs are tough places for plants to survive. With the combination of shallow, free-draining substrates, extreme temperatures, and drought with periodic saturation, plant survival is dependent on a range of environmental tolerances.

In most of Europe and North America, green roof plants need to cope with freezing winters. This is rarely a problem in Australian cities, which mostly have Mediterranean or sub-tropical climates. Australian green roof plants, however, require much greater tolerance to water deficit. The plants will experience longer and more extreme periods of low rainfall and, because of restrictions on potable water use, they might have to survive these periods with no or minimal irrigation. While the Australian climate is a challenge, this also brings great opportunity. Areas with constant or seasonal hot and dry climates have the most to gain from using green roofs as a climate change adaptation measure and to mitigate the urban heat island effect.

Which plants make the best survivors?

The plants that are most widely and successfully used on extensive (shallow substrate) green roofs in Europe and North America come from the genus *Sedum*. *Sedums* are succulents. Succulents are specially adapted to retain water using thick and fleshy parts; especially the leaves and stems in the case of *Sedums*. Leaf succulence enables plants to survive drought by providing usable water when no water is available for uptake by roots.

Advantages of succulents

- Shallow rooting
- Tolerant of drought
- Tolerant of cold
- Good surface coverage
- Variety of colours & forms
- Easy to propagate



Sedum pachyphyllum

However, for Australian green roofs, *Sedums* and other plants that are used elsewhere in the world might not be suitable. Apart from issues of plant and substrate availability, this is largely due to the differences in climate. For example, many green roof *Sedum* species have been selected from alpine areas for their frost tolerance and winter survival abilities. These *Sedum* species may not survive in hot and dry climates, where species require greater succulence. Furthermore, at times of water stress, some *Sedums* open their stomata at night to reduce water loss, but this leaves them vulnerable to collapse and death in extended periods of hot weather. It is also important that green roof plants do not invade nearby habitats. No *Sedums* are native to Australia but eight species have naturalized, with two considered to be major weeds.

Fortunately, the native Australian flora has potential for use on green roofs. Many Australian plants are pre-adapted to the dry and low-nutrient conditions typically found on green roofs, owing to the dryness of the continent and its old and highly weathered soils. However, Australia has very few plants that would be considered typical of desert biota worldwide. Stem succulence, leaf succulence, succulent rosette plants and deciduous spiny shrubs are almost absent; Australia's arid zone is largely dominated by sclerophyllous species with deep tap roots. These roots allow plants to access underground aquifers in their natural habitat, but they are unsuitable for the shallow profile of a green roof.

Some native candidates for use on green roofs in Australia

- Drought-adapted herbaceous perennials from grasslands in south-eastern Australia.
- Desert annuals.
- Succulent chenopods and herbaceous plants with soft or fleshy leaves that grow in alkaline and saline soils.

Plant research at Burnley

At Burnley, research has been focused on better decision-making in selecting plants for green roofs for Australia¹². A priority has been evaluating plants from Australian dryland habitats, especially those from shallow soil environments such as rock outcrops and rocky grasslands. A purpose-built experimental green roof with a scoria-based substrate was used to trial 32 different plant species, including Australian species and succulents, some of which are commonly planted on northern hemisphere green roofs. There were four different life-forms; forbs, grasses, upright succulents and spreading succulents. Planted in winter 2008, survival was assessed over the following spring and summer. During summer 2008-09, extreme weather conditions were experienced on the roof, with recorded air temperatures above the roof reaching 69°C. This was coupled with very low rainfall and no irrigation. At the conclusion of the trial in April, only some plants remained alive. Most of the exotic species used widely across European and North American green roofs died. The Australian native forbs and grasses also did not survive, possibly due to their high water use³.



The only plants that survived were succulents; some succulents even showed 100% survival. However, not all exotic succulents performed well, and only two native spreading succulents were able to survive. All of the surviving species had high leaf succulence, which increases the amount of stored water.

Also observed was a capacity for resprouting in plants that have rhizomes and tubers, after rainfall in early autumn. Re-sprouting from underground organs is a common adaptation to drought in Mediterranean-type climates. It can be viewed as a form of succulence, in that water is stored in underground tissues for use when water becomes scarce.

Key traits for plant survival

- High leaf succulence
- Low water use
- Ability to re-sprout after drought

Recommended species list if planting for survival

Upright succulents

- *Lampranthus deltooides* (Exotic)
- *Sedum x rubrotinctum* (Exotic)
- *Sedum pachyphyllum* (Exotic)
- *Sedum acre* (Exotic)

Spreading succulents

- *xSedeveria* (Exotic)
- *Disphyma crassifolium* (Australian)
- *Kleinia mandraliscae* (Exotic)
- *Carpobrotus rossii* (Australian)

Recommendations

For survival in hot and dry climates, species with low water use and high leaf succulence should be chosen. However, if stormwater management is a key objective of a green roof, plants with low water use are not effective (see the “Planting for stormwater management” Fact Sheet). In addition, if Australian species are desired, plants that have re-sprout traits should be selected. These plants can regrow when drought conditions finish and can be particularly useful when combined with plant species with other habits and forms.



¹ Farrell, C., et al., *Hot, high, dry and green? Research supporting green roof plant selection for arid environments*, in *CitiesAlive! 10th Annual Green Roof and Wall Conference*. 2012: Chicago.

² Farrell, C., et al., *Green roofs for hot and dry climates: Interacting effects of plant water use, succulence and substrate*. *Ecological Engineering*, 2012. **49**: p. 270–276.

³ In greenhouse experiments, species with high water use died at least 15 days earlier than *Sedum* species, which are conservative water users.

Our green roof research has been supported by:

