Eco-friendly *Agapanthus* – myth or reality?

Agapanthus Research Group

LANDCARE RESEARCH
MANAAKI WHENUA

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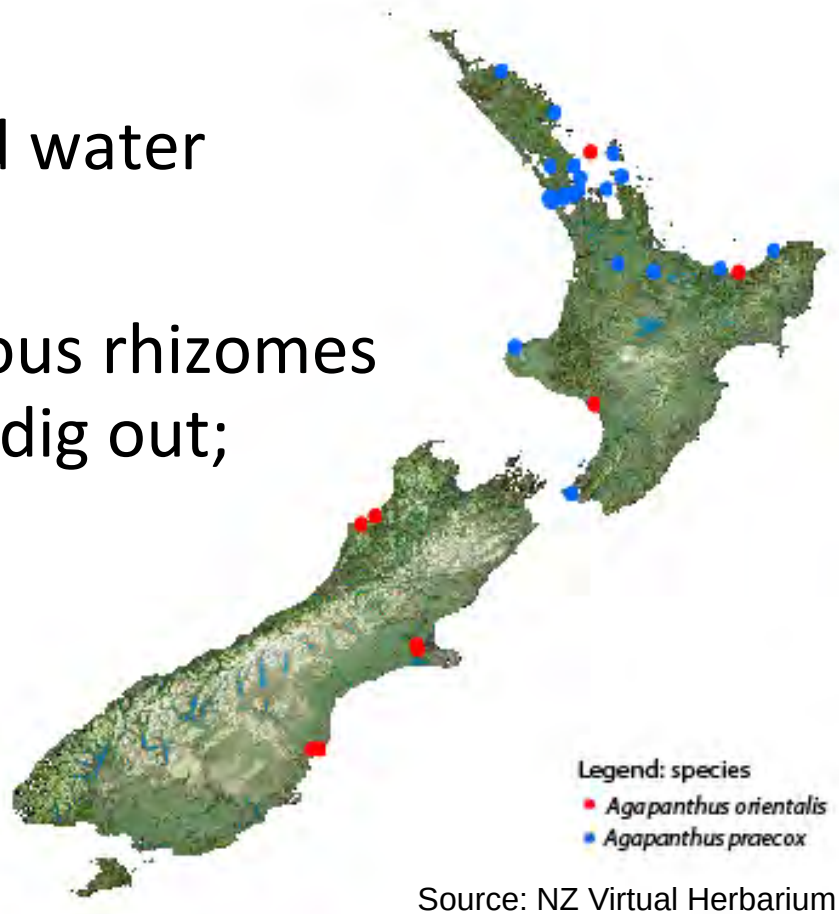
Outline

- Contrast perceptions and values of *Agapanthus*:
  - As a pest plant (weed)
  - As valuable horticultural plants (cultivars)
- Scrutinise various “eco-friendly” claims made by the nursery industry
- Show the way to resolving the environmental and public conflict

Agapanthus as a weed

- First recorded as naturalised in NZ in 1952
- Coastal areas, dune lands, cliffs, roadsides, waste land
- Abundant seed (wind and water dispersed)
- Difficult to control (vigorous rhizomes are extremely difficult to dig out; resistant to herbicides)



Source: NZ Virtual Herbarium

Agapanthus as a weed

- DOC consolidated list of environmental weeds in New Zealand (2008)
- Future NPPA plant?

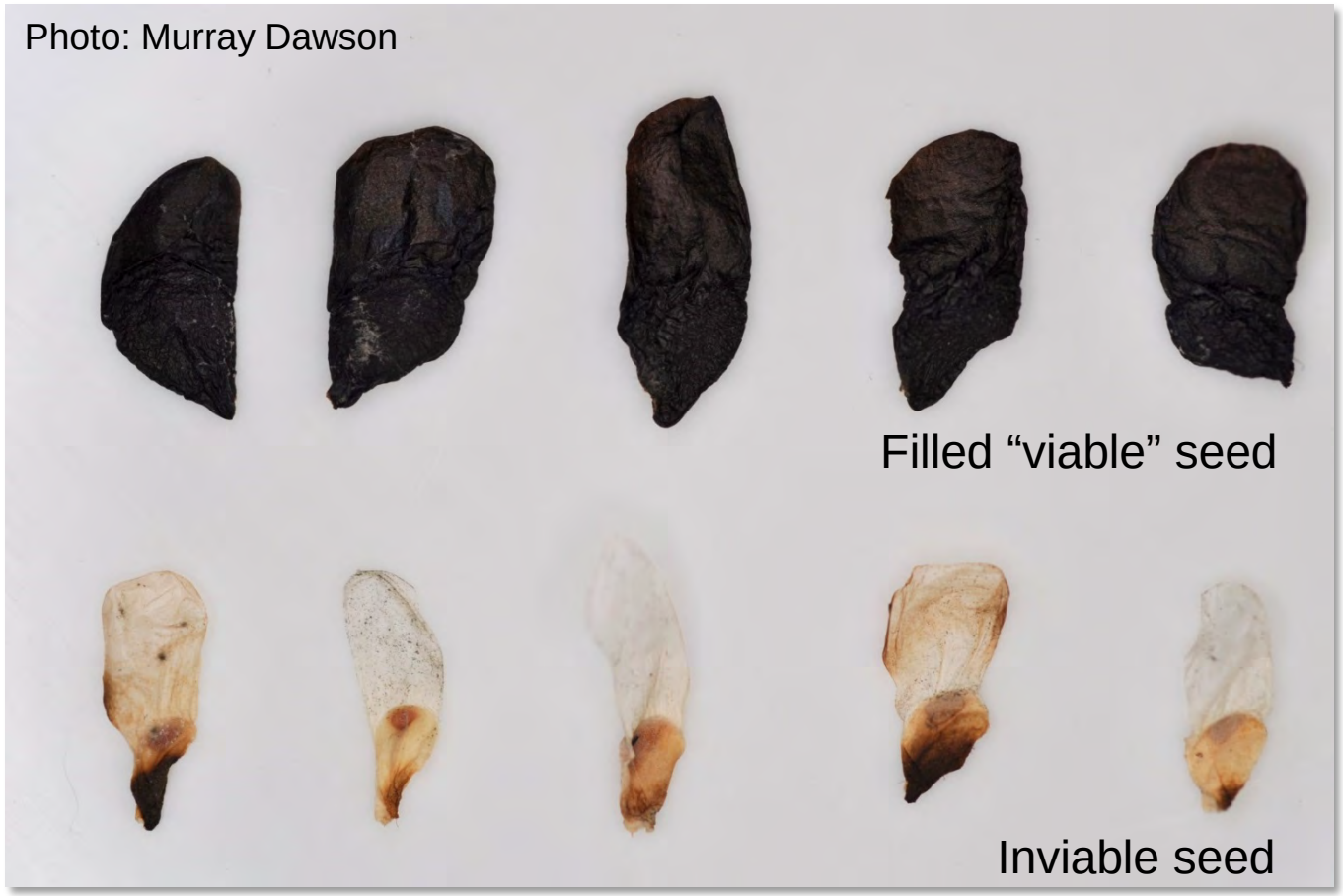
Agapanthus as a weed

- Particularly invasive in the Auckland Region
- RPMS Surveillance Plant (large forms only), Auckland Region (2008)

Photos: Murray Dawson

Agapanthus as a weed

- High seed production
  - Up to 100% seed set and 100% germination rates for tall “wild-type”



Agapanthus as a weed

- High seed production
  - 24 seeds per capsule for tall “wild-type”

Dissected 4-locular capsule.
Photo: Kath Stewart

Agapanthus as a weed

- High seed production
  - 640–4,200 seeds per flower head ("viable" to theoretical maximum) for tall "wild-type"

Mature seed head. Photo: Murray Dawson

Agapanthus as a weed

- High seed production
  - 12,880–70,700 seeds per “wild-type” plant (clump)

Seed heads of fertile cultivar.
Photo: Murray Dawson

Agapanthus in horticulture

- Socio-economic values
- Popular and widely recognised garden plant
- Valuable to nursery industry
  - Peak of >1 million plants pa on domestic market
  - Substantial export market
- Fast growth, abundant flowers, long flowering period, hardy, low maintenance

A. 'Hazy Days'.
Photo: Barrie McKenzie

Agapanthus in horticulture

- Home gardens
- Container planting
- Cut flowers
- Bank stabilisation
- Mass planting
- Traffic island and amenity plantings:

  Glyphosate (Roundup®) resistant so easy to spray edges to kill emerging weeds

Mass planting of white flowered medium-sized cultivar.
Photo: Murray Dawson

Agapanthus in horticulture

- Numerous cultivars
  (c.80 NZ; 625 worldwide)
- Range of statures
  - Low growing “dwarf”: (100–)200 to 500 mm
  - Medium: 600 mm to 1.2 m
  - Tall: up to 1.8(–2) m, including flower stems
- Some have variegated leaves
- Flower colours
  - Blue shades (violets, blues, lavenders & purples)
  - White

Eco-friendly *Agapanthus*?

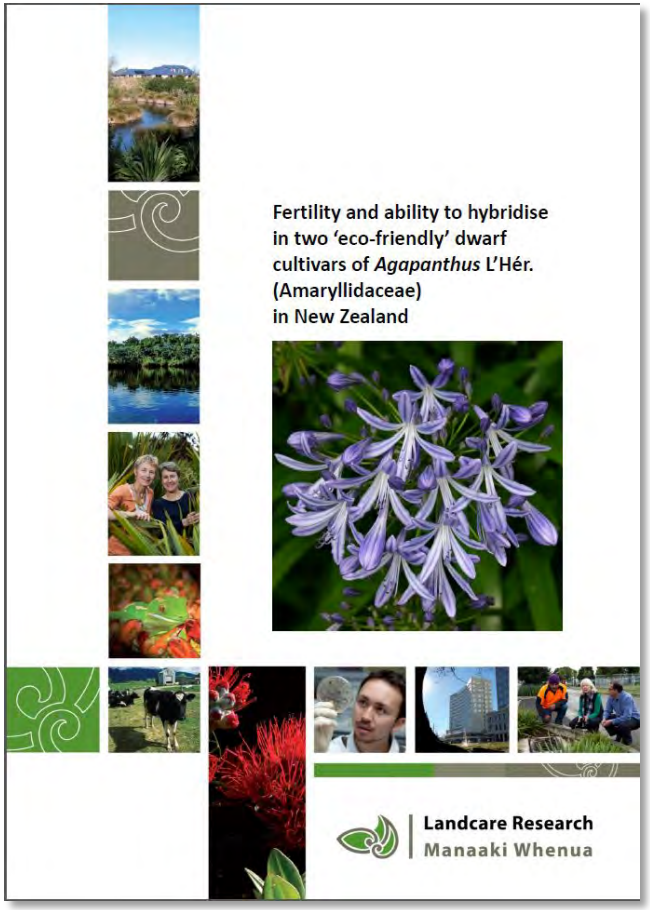
- 2008 Auckland decision to ban tall forms controversial
- Public demanded selections they could still grow
- NZ nursery industry responded by selling <u>existing</u> low-growing selections thought to be less invasive…

Eco-friendly *Agapanthus*?

- Several terms used:
  - “Auckland safe”
  - “eco-friendly”
  - “environment safe”
  - “low-fertility”
  - “sterile”
- Where was the science to support these claims?

Eco-friendly *Agapanthus*?

- Auckland Council (as ARC) funded Landcare Research to investigate eco-friendly claims
- Two “low-fertility” cultivars studied in detail (*A*. ‘Finn’ and *A*. ‘Sarah’)
- Compared against “wild type” and fertile dwarf
- Published report Nov 2010 (Ford & Dawson)



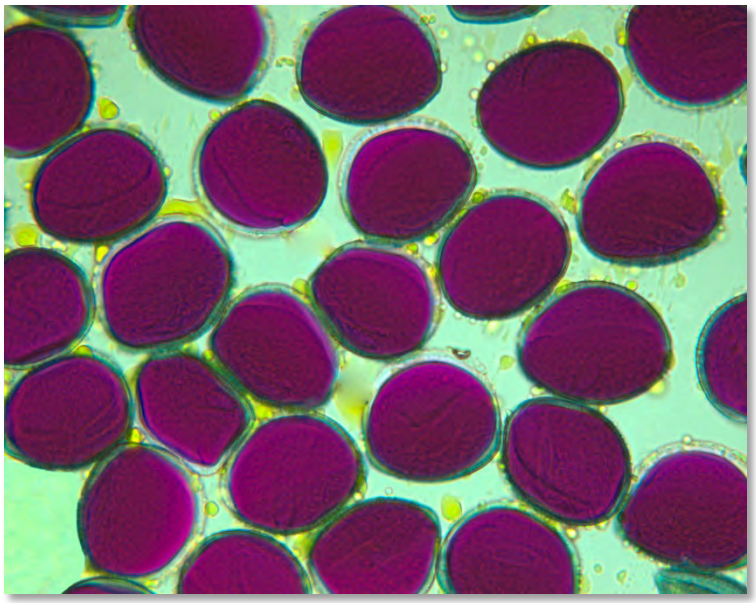
Eco-friendly *Agapanthus*?

- Since 2012, the “Agapanthus Research Group” was established:
  - Auckland Council
  - Nursery industry
  - Landcare Research
- Further funding/resourcing was obtained
- Fertility of additional cultivars have been investigated
- New fully sterile selections are currently being developed

How do you assess fertility?

- Male fertility (pollen):
  - **Pollen stainability**
  - Pollen tube growth (in- and ex-situ)
- Female fertility (seed):
  - Controlled hand-pollinations
    - Selfing
    - Outcrossing
  - **Open pollinated (o.p.) seed set observations**
  - Seed production estimates
  - Seed germination rates

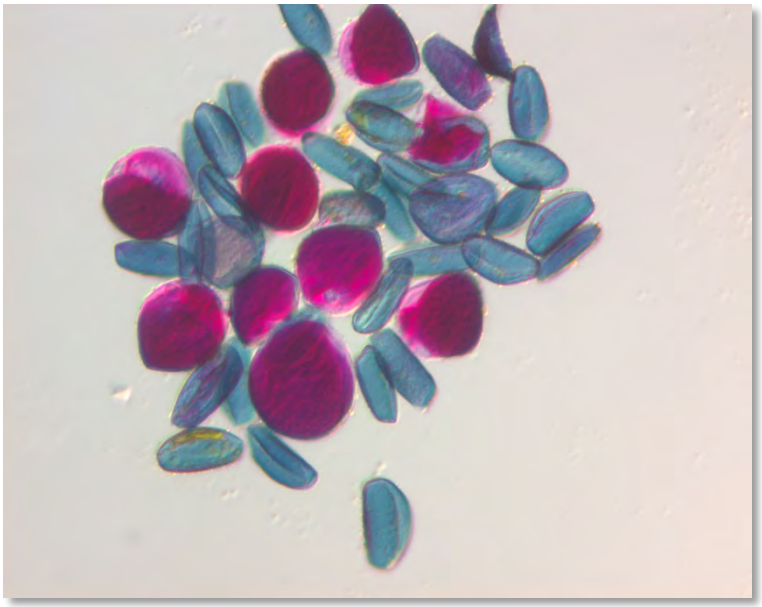
Pollen stainability



“High male fertility”:

High pollen stainability of “wild-type” *Agapanthus*.

Photo: Murray Dawson.



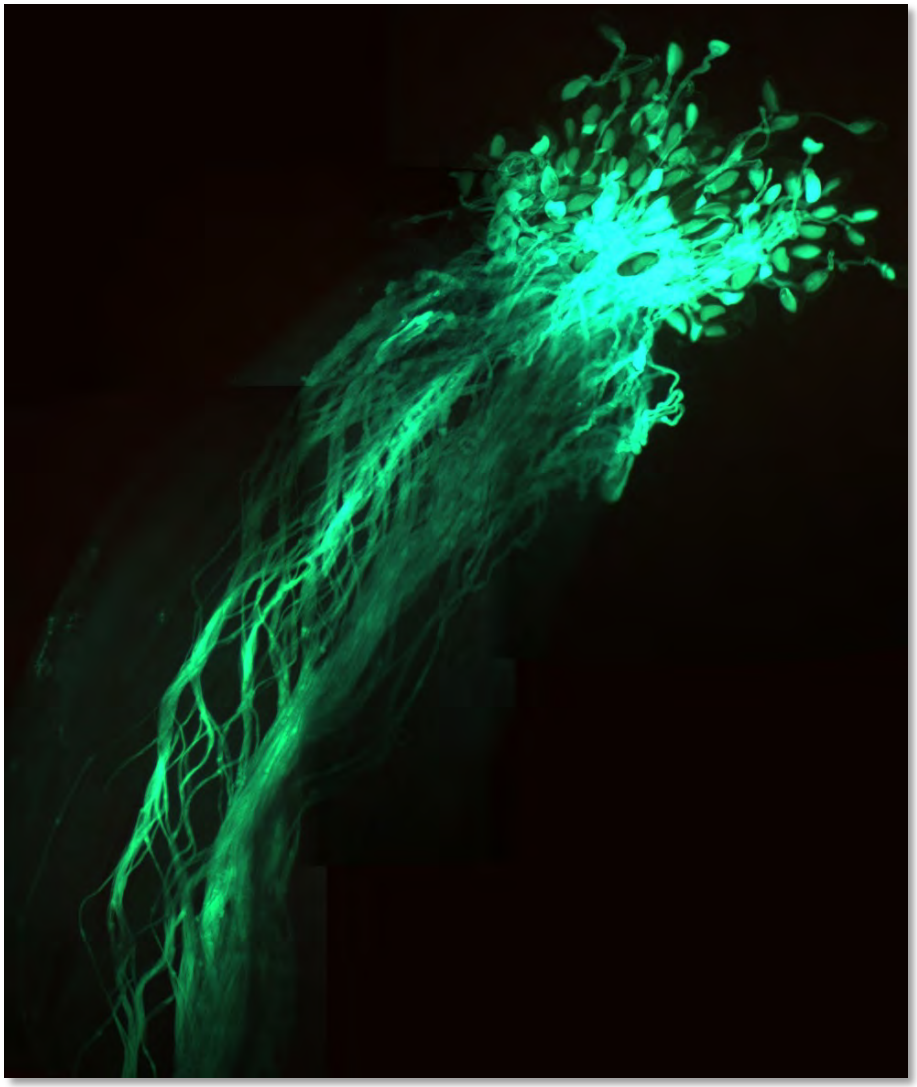
Low male fertility:

Low pollen stainability of *A.* ‘Finn’.

Empty aborted grains are light blue whereas stained (“viable”) pollen is dark red.

Photo: Kerry Ford.

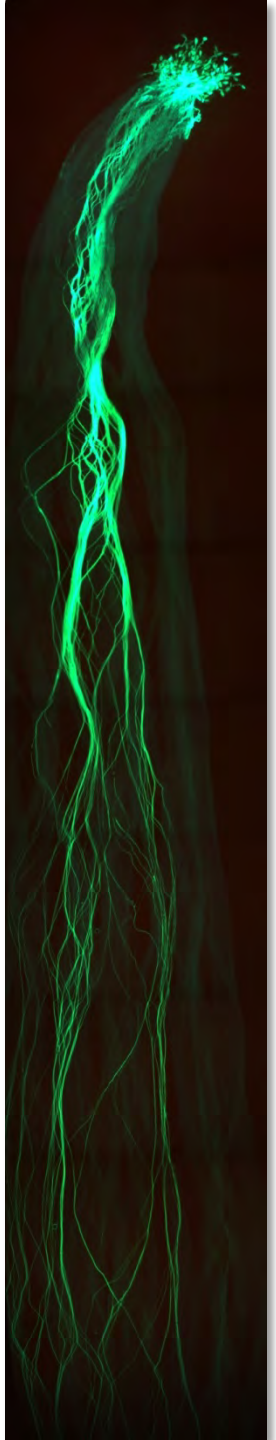
Fluorescence microscopy



Fertile:

Abundant pollen tube growth down the full length of the style of “wild-type” *Agapanthus* using fluorescence microscopy.

Photos: Murray Dawson.



Controlled crosses

Cultivar	Male	Female		
	Pollen fertility	Self fertility (seed set)	Cross fertility (seed set)	Cross fertility (seed germination)
A. 'Finn'	Low (40%)	**Nil**	Low (7.4 %) **As female parent: 9.7%** As male parent: 5.8% (Very low when crossed with *A*. 'Streamline': 3.4%)	High (77%) **As female parent: 74%** As male parent: 80% (Moderate when crossed with *A*. 'Streamline': 52%)
A. 'Sarah'	High (85%)	**Nil**	Moderate (22%) **As female parent: 5.9%** As male parent: 36%	Very high (91.5%) **As female parent: 65%** As male parent: 100%
A. 'Streamline' (Fertile dwarf comparator)	Very high (>95%)	**Moderate (40%)**	Moderate (39%) **As female parent: 31.5%** As male parent: 48%	Very high (96%) **As female parent: 95%** As male parent: 97%
Crosses between individuals of "wild type" tall growing control	Very high (>95%)	**Low (9.5%)**	**High 74% (sib-crosses)**	**Very high (100%)**

Source: Ford & Dawson 2010

Low fertility cultivars

o.p. seed set observations, Auckland & Lincoln, 2012-2016

Confirmed sterile / low fertility

Cultivar	Female fertility	Notes
A. 'Agapetite'	Sterile? Low?	Very dwarf, semi-double white flowers
A. 'Finn'	Very low	Dwarf, white flowers
A. 'Gold Drops' / *A.* 'Golden Drop'	Very low	Dwarf, golden yellow variegated leaves, blue flowers
A. 'Goldstrike'	Very low (/low)	Dwarf, golden-yellow variegation, dark blue flowers
A. 'Sarah'	Very low - low	Dwarf, soft blue flowers
A. 'Thunderstorm'	Sterile? - very low	Dwarf (/medium), variegated leaves, blue flowers

Source: Agapanthus Research Group

- All dwarf
- Three variegated
- No low fertility tall cv's

Other candidates

Cultivar	Female fertility	Notes
A. 'Baby Pete'	Low	Limited testing, dwarf
A. 'Blue Finn'	Sterile?	Limited testing
A. 'Dorothy Edwards'	Sterile?	Limited testing, double flowers
A. 'Pavlova'	Sterile? Low?	Limited testing, dwarf
A. 'Senna'	Sterile?	Limited testing, claimed to be sterile
A. 'Double Diamond'	Not tested	Dwarf, claimed to be sterile, probably because of its semi-double flowers. Re-import?
A. 'Sea Coral'	Low (-medium?)	Too fertile? Dwarf/medium, white flowers that flush coral pink with age
A. 'Snowdrops'	Sterile? (-medium?)	Contradictory results. Dwarf, white flowers
A. 'Timaru'	Low (-medium)	Too fertile? Medium(/tall), blue flowers

Source: Agapanthus Research Group

O.P. seed set observations

- Relatively consistent for each cultivar:
  - Auckland and Lincoln
  - Outside evaluation beds (Auckland); glasshouse and shade house (Lincoln)
  - 2012-2016.
- Some current selections are indeed of low female fertility but most (all?) are not fully sterile.
- Low female fertility (low seed set and viability) is ecologically more important than low male fertility (pollen viability).

Low fertility cultivars

Agapanthus ‘Agapetite’.
Photo: John van der Elst.

Agapanthus ‘Baby Pete’.
Photo: Lyndale Liners.

Low fertility cultivars

Agapanthus ‘Finn’.
Photo: Lyndale Liners.

Agapanthus ‘Gold Strike’.
Photo: Lyndale Liners.

Low fertility cultivars

Agapanthus ‘Pavlova’. Photo: Lyndale Liners.

Low fertility cultivars

Agapanthus ‘Sarah’. Photo: Lyndale Liners.

No/low seed set (o.p.)

Agapanthus ‘Finn’. Photo: Murray Dawson.

No/low seed set (o.p.)

Agapanthus ‘Golden Drop’. Photo: Murray Dawson.

No/low seed set (o.p.)

Agapanthus ‘Snowdrops’. Photo: Murray Dawson.

Low fertility cultivars

Ethical stance to only sell “low fertility” *Agapanthus*

- Most nurseries claims of low fertility have been independently established
- However, some cv’s do set tiny amounts of seed.

Agapanthus 'Baby Pete' (PVR LiNi2010)

Dwarf Agapanthus with masses of eye-catching blue-mauve blooms in Summer. Great for mass planting or for pots and mixed containers. Eco friendly, low fertility variety.
Hardy 0.25 x 0.25m

Agapanthus 'Finn' (PVR)

Dwarf evergreen with neat green foliage and attractive pure white flowerheads that bloom for months on end. An eco friendly, low fertility variety that does not set seed.
Hardy 0.5 x 0.5m

Agapanthus 'Gold Strike' (PVR)

Dwarf Agapanthus with colourful green and yellow-cream variegated foliage, topped with beautiful dark blue blooms. Eco friendly, low fertility variety that does not set seed.
Hardy 0.45 x 0.45m

Agapanthus 'Pavlova' (PVR)

Dwarf Agapanthus with long lasting, white flowers on sturdy stems that make a stunning display in Spring and Summer. Eco friendly, low fertility variety that does not set seed.
Hardy 0.35 x 0.35m

Agapanthus 'Sarah' (PVR)

Dwarf Agapanthus with mid-green foliage and soft lilac blue flowers marked with a deeper blue picotee. Eco friendly, low fertility variety that doesn't set seed. Great for mass planting.
Half ha… 0.4 x 0.4m

Agapanthus 'Tinkerbell'

Colourful sport of 'Peter Pan' is popular for its showy foliage which is neatly banded and edged in white. Shy to bloom and produces few seed. Use in garden borders or pots.
Half hardy 0.3 x 0.3m

Lyndale online catalogue, 2016

Conclusions

- “Low-fertility” is the most accurate term for claims made of most current cultivars.
- If *Agapanthus* is added to the NPPA list (likely) then “sterile” could be defined as “produces less than 2% viable seed” following a US standard.
- Breeding is underway to create fully sterile (“seedless”) cultivars – both dwarf and tall-growing selections.
- Win-win: AC, Nursery Industry and Researchers have come together to solve an environmental problem and public need.

Acknowledgements

Auckland Council: Imogen Bassett, Emma Bodley, Mere Brewer, Jack Hobbs, Rebecca Stanley, Nick Waipara

Landcare Research: Kerry Ford, Peter Heenan, Rachel Innes, Kath Stewart

Nursery industry:
Ian Duncalf, John Liddle, Antony Toledo, Malcolm Woolmore

Funding

Auckland Council

Envirolink Small Advice Grant

KiwiNet Research Commercialisation Award

Landcare Research Investment Funds

Sir Victor Davies Foundation
Research Grant

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