Determining the temporal interaction of *Camellia* cultivar flowering periods and camellia petal blight disease presence in Auckland, New Zealand

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Abstract

Botanic gardens hold diverse and valuable living collections that provide a number of research, conservation and education opportunities. Auckland Botanic Gardens (ABG) has an internationally significant collection of species and cultivar camellias that have been used for scientific research into understanding which species are susceptible to camellia petal blight. ABG has surveyed all cultivars and species in its collection over multiple years to identify which camellias are affected by petal blight and which avoid it, based on their flowering period. A total of 363 camellias were assessed for petal blight over 6 years of surveying. It was found that 245 cultivars and 6 species were susceptible to the disease, while 68 cultivars and 32 species did not display any visual symptoms. These are important findings, as enthusiasts and breeders alike may use them to inform their respective interests.

Introduction

Botanic gardens play a key role in supporting and facilitating research. They hold diverse and important plant collections that provide researchers with convenient access to plants which are well documented on databases. Horticultural and botanical experts are available to make daily observations on growth, maintenance, and pests and diseases. Information that staff acquire through regular observations is captured on the databases; this provides an important life history of the plants, revealing information about them over time, such as their susceptibility to pests or diseases.

Camellias have been grown in New Zealand as a common garden plant for decades. They provide autumn and winter interest in gardens as specimen trees and are also used as hedging (Fig. 1). They attract insect pollinators and birds to gardens at a time of year when there are fewer flowers around for foraging.

Since the introduction to New Zealand in the early 1990s of the fungus *Ciborinia camelliae*, the causal agent of camellia petal blight, many *Camellia* cultivars have no longer been useful amenity plants because this disease infects the blooms, causing them to turn brown and fall early (Fig. 2). The fungus can be confirmed by removing a flower from the plant and looking on the back side for a grey ring of fungal hyphae at the base of the petals (Fig. 3). *C. camelliae* only infects the floral parts of a plant and is not known to infect any other genera

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Fig. 1 Camellias are commonly used as hedging in New Zealand. Photo: Rebecca Stanley.

Fig. 2 Brown flowers of *Camellia japonica* 'Kate Sheppard'. Photo: Rebecca Stanley.

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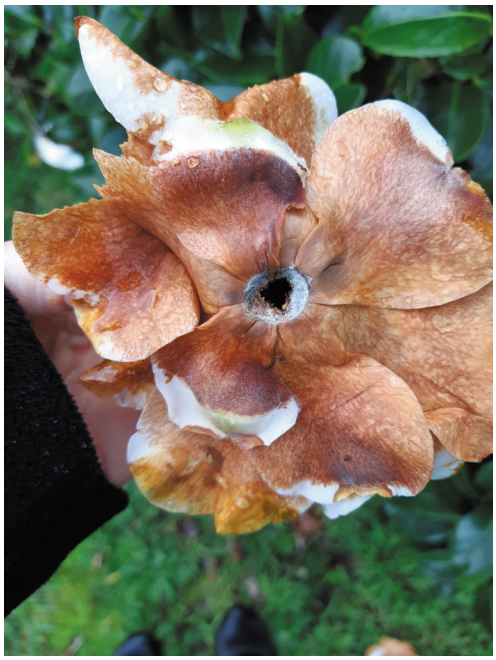

Fig. 3 Grey ring on mould around the base of a *Camellia japonica* 'Kate Sheppard' flower. Photo: Rebecca Stanley.

(Taylor & Long, 2000). Since as far back as 1919, *C. camelliae* has been found in other countries, including Japan, France, England, Spain, Italy, Germany, Switzerland, Portugal and the United States, but it did not become widespread until the 1970s (Taylor & Long, 2000). In the late 1990s, a survey undertaken throughout New Zealand found it to be widespread and likely to be dispersed by wind and the transfer of infected material (Taylor, 1999).

Ciborinia camelliae is a host-specialist pathogen that only affects plants in the genus *Camellia*. Apothecia develop on sclerotia in spring and are dispersed by wind. These ascospores infect camellia petals quickly, causing the flowers to fall from the plant onto the ground (Taylor & Long, 2000). When the flowers are on the ground, the sclerotia develop on the petals and overwinter on the rotting flowers (Taylor & Long, 2000) until environmental conditions are suitable for starting the cycle of infection again. This means the fungus does not require a second species to complete its reproductive cycle.

There are no strategies that prevent or control the annual reincursion of this fungus despite testing in various stages of the *Ciborinia camelliae* lifecycle with fungicides (Couselo *et al.*, 2014). The disease affects larger-flowered, spring-blooming cultivars (*japonica* types) more frequently, partly because they flower later when the fungus is more active. The fungus is most active after a period of cool temperature followed by warming temperatures and moisture (American Camellia Society, 2020). However, spores can remain dormant for approximately four years until favourable conditions are met (Taylor, 2004). The disease is also more visible on larger and paler-flowered blooms.

Auckland Botanic Gardens (ABG) has had a significant collection of *Camellia* species and cultivars – a total of 521 varieties since the gardens opened in 1982 (Fig. 4). The collection was planted in 1985 with the help of the late Neville Haydon, the former owner of Camellia Haven nursery. There are few studies of camellia petal blight's impact in gardens; however, some work has gone into testing a range of 39 *Camellia* for petal blight resistance. These range from *C. pitardii* × *japonica* 'Nicky Crisp' (Fig. 5), which has no resistance to the fungus, to *C. lutchuensis* (Fig. 6), which has high resistance (Denton-Giles *et al.*, 2013). A breeding programme at ABG applies the knowledge from genetic work carried out by Denton-Giles *et al.* (2013) to select larger-flowered cultivars resistant to petal blight. The aim of this breeding programme is to develop a beautiful,

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Fig. 4 Auckland Botanic Gardens' Camellia Garden contains a range of species and cultivars. Photo: Emma Bodley.

large-flowered camellia with an attractive habit, suitable for a small home garden and that is petal blight resistant. The breeding programme began in 2014 and it will take several more years before results are seen. Regular updates about the breeding programmes are published on the ABG website (Auckland Botanic Gardens, 2020). Denton-Giles *et al.* (2013) used the ABG *Camellia* collection to sample species; it was an easy task to sample 43 species in the Camellia Garden where all species camellias are planted together across two beds, a task that in the wild would be more costly and time-consuming.

Methods

Staff and students surveyed the ABG *Camellia* collection (1769794.95, 5902489.15 NZTM) during the flowering season in 2006, 2007, 2010, 2016, 2017 and 2018. A list of camellias in the collection was exported from the Plant Management Database with their locations to make surveying easier. A total of 363 camellias were surveyed between April and October over the six flowering seasons. For each camellia the presence or absence of petal blight was recorded. Five to ten flowers were assessed. If there was any doubt regarding a camellia's susceptibility to

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Fig. 5 *Camellia pitardii* × *japonica* 'Nicky Crisp' is susceptible to petal blight. Photo: Jack Hobbs.

petal blight during the initial assessment, cultivars were reassessed later in the flowering season. Detailed phenology records were not recorded during these surveys. Notes on phenology were, however, made on specific cultivars to help inform when to recheck flowers for petal blight.

Results

From the multiple surveys, we compiled a list of 245 cultivars which are susceptible to petal blight (Table 1) and a list of 68 cultivars on which we have not yet observed natural petal blight infections (Tables 2 & 4). Of these 68 that show no visual symptoms of petal blight, 48 are autumn-flowering cultivars, and 18 begin flowering in winter or spring. Six species are susceptible to petal blight, and 32 species show no visual symptoms of the disease. Many of the cultivars that have no visual symptoms of petal blight have a resistant species in their parentage, such as *Camellia lutchuensis* (Fig. 6). Although only the presence or absence of petal blight was recorded, we noted that some cultivars displayed symptoms differently. Dark-coloured flowers are less impacted aesthetically by petal blight because the brown petals are not as obvious in comparison to lighter flower colours. White and light pink flowers are aesthetically less attractive when infected with petal blight because the contrast between the light petals and the brown rot is greater.

Fig. 6 Petal blight resistant *Camellia lutchuensis.* Photo: Jack Hobbs.

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Table 1 List of *Camellia* cultivars (total = 245) that are susceptible to petal blight in the Camellia Garden at ABG.

Camellia 'Apple Blossom Sun'	*Camellia japonica* 'Dorothy James'
Camellia 'Bett's Supreme'	*Camellia japonica* 'Dr Lilyan Hanchey'
Camellia 'Conquettii'	*Camellia japonica* 'Dryade'
Camellia 'Court Jester'	*Camellia japonica* 'Easter Morn'
Camellia 'Lin Ryu'	*Camellia japonica* 'Ecclefield'
Camellia 'Mudan Cha'	*Camellia japonica* 'Ed Combatalade'
Camellia complex *granthamiana* hybrid 'Parisienne'	*Camellia japonica* 'Elaine's Betty'
Camellia complex *japonica* hybrid 'Superscent'	*Camellia japonica* 'Eleanor Martin Supreme'
Camellia complex *reticulata* hybrid 'Anzac'	*Camellia japonica* 'Elegans'
Camellia complex *saluenensis* hybrid 'Fairy Wand'	*Camellia japonica* 'Elegans Champagne'
Camellia cuspidata hybrid 'Spring Festival'	*Camellia japonica* 'Elegans Splendor'
Camellia cuspidata × *saluenensis* 'Bellbird'	*Camellia japonica* 'Elegans Supreme'
Camellia cuspidata × *saluenensis* 'Cornish Snow'	*Camellia japonica* 'Elsie Ruth Marshall'
Camellia japonica 'Alfred Upson'	*Camellia japonica* 'Firedance'
Camellia japonica 'Amazing Graces'	*Camellia japonica* 'Fragrant Boutonniere'
Camellia japonica 'Angel'	*Camellia japonica* 'Gayle Walden'
Camellia japonica 'Aquarius'	*Camellia japonica* 'Grace Albritton'
Camellia japonica 'Ave Maria'	*Camellia japonica* 'Grand Slam'
Camellia japonica 'Baby Pearl'	*Camellia japonica* 'Gwenneth Morey'
Camellia japonica 'Berenice Boddy'	*Camellia japonica* 'Hakuhan-kujaku'
Camellia japonica 'Betty Sheffield Supreme'	*Camellia japonica* 'Hanafuki'
Camellia japonica 'Black Pearl'	*Camellia japonica* 'Harriet Bisbee'
Camellia japonica 'Black Tie'	*Camellia japonica* 'Harry Cave'
Camellia japonica 'Black Velvet'	*Camellia japonica* 'Hishikaraito'
Camellia japonica 'Blaze of Glory'	*Camellia japonica* 'Holly Bright'
Camellia japonica 'Bonbon Red'	*Camellia japonica* 'Honeyglow'
Camellia japonica 'Can Can'	*Camellia japonica* 'Hopkin's Pink'
Camellia japonica 'Canterbury'	*Camellia japonica* 'In the Pink'
Camellia japonica 'Carter's Sunburst Blush'	*Camellia japonica* 'James Lockington'
Camellia japonica 'China Doll'	*Camellia japonica* 'Jerry Donnan'
Camellia japonica 'Clarise Carleton'	*Camellia japonica* 'Kate Sheppard'
Camellia japonica 'C. M. Hovey'	*Camellia japonica* 'Katie'
Camellia japonica 'C. M. Wilson'	*Camellia japonica* 'Kick Off'
Camellia japonica 'Commander Mulroy'	*Camellia japonica* 'Kramer's Beauty'
Camellia japonica 'Coronation'	*Camellia japonica* 'K. Sawada'
Camellia japonica 'Dark of the Moon'	*Camellia japonica* 'Lady Clare'
Camellia japonica 'Debutante'	*Camellia japonica* 'Lady Loch'
Camellia japonica 'Desire'	*Camellia japonica* 'Lady Macon'
Camellia japonica 'Diddy's Pink Organdie'	*Camellia japonica* 'Lady Vansittart Pink'
Camellia japonica 'Dolly Dyer'	*Camellia japonica* 'Laurie Bray'
Camellia japonica 'Dona Herzilia de Freitas Magalhaes'	*Camellia japonica* 'Leah Homeyer'

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Camellia japonica 'Lemon Drop'	*Camellia japonica* 'Prince Frederick William'
Camellia japonica 'Little Bit Red'	*Camellia japonica* 'Queen Diana'
Camellia japonica 'Little Bit Striped'	*Camellia japonica* 'R. L. Wheeler'
Camellia japonica 'Little Ginger'	*Camellia japonica* 'Roger Hall'
Camellia japonica 'Little Man'	*Camellia japonica* 'Royal Velvet'
Camellia japonica 'Little Michael'	*Camellia japonica* 'Rudolph'
Camellia japonica 'Look Away'	*Camellia japonica* 'Ruffian'
Camellia japonica 'Lovelight'	*Camellia japonica* 'San Dimas'
Camellia japonica 'Lover Boy'	*Camellia japonica* 'Sanpei-tsukbaki'
Camellia japonica 'L. T. Dees'	*Camellia japonica* 'Scentsation'
Camellia japonica 'Lulu Belle'	*Camellia japonica* 'Show Time'
Camellia japonica 'Mahogany Glow'	*Camellia japonica* 'Silver Anniversary'
Camellia japonica 'Man Size'	*Camellia japonica* 'Silver Chalice'
Camellia japonica 'Manuroa Road'	*Camellia japonica* 'Silver Tower'
Camellia japonica 'Margaret Davis'	*Camellia japonica* 'Silver Waves'
Camellia japonica 'Mark Alan'	*Camellia japonica* 'Something Beautiful'
Camellia japonica 'Maroon and Gold'	*Camellia japonica* 'Stacy Susan'
Camellia japonica 'Mary J. Wheeler'	*Camellia japonica* 'Sundae'
Camellia japonica 'Mary Paige'	*Camellia japonica* 'Sunset Oaks'
Camellia japonica 'Maui'	*Camellia japonica* 'Swan Lake'
Camellia japonica 'Michael's Joy'	*Camellia japonica* 'Taba Meibi'
Camellia japonica 'Midnight'	*Camellia japonica* 'Takanini'
Camellia japonica 'Midnight Variegated'	*Camellia japonica* 'The Czar'
Camellia japonica 'Mini Pink'	*Camellia japonica* 'Thomasville Beauty'
Camellia japonica 'Moonlight Bay'	*Camellia japonica* 'Tiffany'
Camellia japonica 'Moshio'	*Camellia japonica* 'Tinsie'
Camellia japonica 'Mrs D. W. Davis'	*Camellia japonica* 'Tom Thumb'
Camellia japonica 'Mrs D. W. Davis Descanso'	*Camellia japonica* 'Tootsie'
Camellia japonica 'Mrs Swan'	*Camellia japonica* 'Twilight'
Camellia japonica 'Nanbanko'	*Camellia japonica* 'Ville De Nantes'
Camellia japonica 'Nick Carter'	*Camellia japonica* 'Violet Bouquet'
Camellia japonica 'Nuccio's Cameo'	*Camellia japonica* 'Virginia Franco Rosea'
Camellia japonica 'Nuccio's Carousel'	*Camellia japonica* 'Volcano'
Camellia japonica 'Nuccio's Gem'	*Camellia japonica* 'Volunteer'
Camellia japonica 'Nuccio's Jewel'	*Camellia japonica* 'Wendy'
Camellia japonica 'Nuccio's Pink Lace'	*Camellia japonica* 'Wilamina'
Camellia japonica 'Onetia Holland'	*Camellia japonica* 'Wildfire'
Camellia japonica 'Pilida'	*Camellia japonica* 'William Jackson'
Camellia japonica 'Pink Smoke'	*Camellia japonica* 'Yukimiguruma'
Camellia japonica 'Pirate's Gold'	*Camellia japonica* × *fraterna* 'Christmas Daffodil'
Camellia japonica 'Pride of California'	*Camellia japonica* × *fraterna* 'Paddy's Perfumed'
Camellia japonica 'Prima Ballerina'	*Camellia japonica* × *lutchuensis* 'Cinnamon Cindy'

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Table 1 List of *Camellia* cultivars (total = 245) that are susceptible to petal blight in the Camellia Garden at ABG (*cont.*).

Camellia japonica × *reticulata* 'Fire Chief Variegated'	*Camellia saluenensis* hybrid 'Ole'
Camellia japonica × *reticulata* 'Harold L. Paige'	*Camellia saluenensis* × *reticulata* 'Barbara Clark'
Camellia pitardii 'Snippet'	*Camellia saluenensis* × *reticulata* 'Brian'
Camellia pitardii hybrid 'Annette Carol'	*Camellia saluenensis* × *reticulata* 'Fair Lass'
Camellia pitardii hybrid 'Autumn Herald'	*Camellia saluenensis* × *reticulata* 'Francie L'
Camellia pitardii hybrid 'Festival of Lights'	*Camellia saluenensis* × *reticulata* 'Innovation'
Camellia pitardii hybrid 'Gay Pixie'	*Camellia sasanqua* 'Moon Moth'
Camellia pitardii hybrid 'Hilda Jaggs'	*Camellia williamsii* × *reticulata* 'Blissful Dawn'
Camellia pitardii hybrid 'Nonie Haydon'	*Camellia* × *pitardii* hybrid 'Adorable'
Camellia pitardii hybrid 'Pearly Cascade'	*Camellia* × *williamsii* 'Angel Wings'
Camellia pitardii hybrid 'Pink Cameo'	*Camellia* × *williamsii* 'Anticipation'
Camellia pitardii hybrid 'Pink Ruffles'	*Camellia* × *williamsii* 'Ballet Queen'
Camellia pitardii hybrid 'Purple Fire'	*Camellia* × *williamsii* 'Buttons 'n Bows'
Camellia pitardii hybrid 'Rhonda Elizabeth'	*Camellia* × *williamsii* 'Daintiness'
Camellia pitardii hybrid 'Sprite'	*Camellia* × *williamsii* 'Debbie'
Camellia pitardii hybrid 'Vonnie Cave'	*Camellia* × *williamsii* 'Delores Edwards'
Camellia pitardii × *japonica* 'Contemplation'	*Camellia* × *williamsii* 'Donation'
Camellia pitardii × *japonica* 'Dr Colin Crisp'	*Camellia* × *williamsii* 'Dreamboat'
Camellia pitardii × *japonica* 'Garnet Gleam'	*Camellia* × *williamsii* 'Dresden China'
Camellia pitardii × *japonica* 'Jury's Pearl'	*Camellia* × *williamsii* 'E. G. Waterhouse'
Camellia pitardii × *japonica* 'Nicky Crisp'	*Camellia* × *williamsii* 'Elsie Jury'
Camellia reticulata 'Chrysanthemum Petal'	*Camellia* × *williamsii* 'Hari Withers'
Camellia reticulata 'Moutancha'	*Camellia* × *williamsii* 'Joe Nuccio'
Camellia reticulata 'Tom Durrant'	*Camellia* × *williamsii* 'Jury's Sunglow'
Camellia reticulata 'Tongzimian'	*Camellia* × *williamsii* 'Jury's Yellow'
Camellia reticulata × *granthamiana* 'Lois Shinault'	*Camellia* × *williamsii* 'Les Jury'
Camellia reticulata × *japonica* 'Beth Dean'	*Camellia* × *williamsii* 'Little Lavender'
Camellia reticulata × *japonica* 'Den Burton'	*Camellia* × *williamsii* 'Marjory Ramsey'
Camellia reticulata × *japonica* 'Dr Clifford Parks'	*Camellia* × *williamsii* 'Mary Phoebe Taylor'
Camellia reticulata × *japonica* 'Lasca Beauty'	*Camellia* × *williamsii* 'Mirage'
Camellia reticulata × *japonica* 'Lovely Lady'	*Camellia* × *williamsii* 'Moonsong'
Camellia reticulata × *japonica* 'Red Crystal'	*Camellia* × *williamsii* 'Our Betty Variegated'
Camellia reticulata × *japonica* 'Ruta Hagman'	*Camellia* × *williamsii* 'Rendezvous'
Camellia reticulata × *japonica* 'Valentine's Day'	*Camellia* × *williamsii* 'Rose Bouquet'
Camellia reticulata × *saluenensis* 'Massee Lane'	*Camellia* × *williamsii* 'Rose Holland'
Camellia reticulata × *sasanqua* 'Gael's Dream'	*Camellia* × *williamsii* 'Softly'
Camellia rusticana 'Botanyuki'	*Camellia* × *williamsii* 'Sun Song'
Camellia rusticana 'Himatsuri'	*Camellia* × *williamsii* 'Twinkle Star'
Camellia rusticana × *lutchuensis* 'Fragrant Joy'	*Camellia* (× *williamsii*) × *japonica* 'Night Rider'
Camellia saluenensis hybrid 'Itty Bit'	

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Table 2 List of *Camellia* cultivars (total = 48) in the Camellia Garden at ABG that have no observed petal blight infections and are autumn-flowering.

Camellia 'Bett's Surprise'	*Camellia sasanqua* 'Paradise Belinda'
Camellia chekiangoleosa 'Earlybright'	*Camellia sasanqua* 'Paradise Gillian'
Camellia complex *rosiflora* hybrid 'Wirlinga Gem'	*Camellia sasanqua* 'Paradise Hilda'
Camellia complex *tsaii* hybrid 'Wirlinga Bride' (PBR)	*Camellia sasanqua* 'Paradise Joan'
Camellia japonica 'Cho-cho-san'	*Camellia sasanqua* 'Paradise Little Liane'
Camellia japonica 'Lily Pons'	*Camellia sasanqua* 'Paradise Pearl'
Camellia japonica 'Luana's Angel'	*Camellia sasanqua* 'Paradise Vanessa'
Camellia japonica 'Steve Blount'	*Camellia sasanqua* 'Plantation Pink'
Camellia japonica 'Tama-no-ura'	*Camellia sasanqua* 'Rosette Blush'
Camellia japonica × *lutchuensis* 'Cinnamon Scentsation'	*Camellia sasanqua* 'Setsugekka'
Camellia japonica × *lutchuensis* 'Koto-no-kaori'	*Camellia sasanqua* 'Taishuhai'
Camellia kissii hybrid 'Buttermint'	*Camellia sasanqua* 'Weeping Maiden'
Camellia lutchuensis hybrid 'Fairy Blush'	*Camellia sasanqua* × *fraterna* 'Yoimachi'
Camellia oleifera 'Jaune'	*Camellia williamsii* × *lutchuensis* 'Sugar and Spice'
Camellia oleifera × (× *hiemalis* 'Snow Flurry')	*Camellia* × *hiemalis* 'Bonanza'
Camellia sasanqua 'Double Rainbow'	*Camellia* × *hiemalis* 'Chansonette'
Camellia sasanqua 'Dwarf Shishi'	*Camellia* × *hiemalis* 'Dazzler'
Camellia sasanqua 'Early Pearly'	*Camellia* × *hiemalis* 'Kanjiro'
Camellia sasanqua 'Exquisite'	*Camellia* × *hiemalis* 'Shishigashira'
Camellia sasanqua 'Gay Border'	*Camellia* × *hiemalis* 'Winsome'
Camellia sasanqua 'Jennifer Susan'	*Camellia* × *vernalis* 'Yuletide'
Camellia sasanqua 'Marie Steiner'	*Camellia* × *williamsii* 'Angel Wings'
Camellia sasanqua 'Midnight Lover'	*Camellia* × *williamsii* 'Mini Mint'
Camellia sasanqua 'Mine-no-yuki'	*Camellia* × *williamsii* 'Red Dragon'

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Table 3 List of *Camellia* species infected (petal blight present) or not visibly affected (petal blight absent) in the field at ABG.

Name	Petal blight present	Petal blight absent	Previous research that supports our findings
Camellia bailinschanica	1		
Camellia caudata		1	Denton-Giles, 2013
Camellia chekiangoleosa		1	
Camellia crassipes		1	Denton-Giles, 2013
Camellia cuspidata		1	Taylor, 2004
Camellia euryoides		1	
Camellia flava		1	
Camellia fluviatilis		1	
Camellia forrestii		1	Taylor, 2004
Camellia fraterna		1	Taylor, 2004; Denton-Giles, 2013
Camellia granthamiana		1	
Camellia grijsii		1	Taylor, 2004
Camellia handelii		1	
Camellia henryana		1	Denton-Giles, 2013
Camellia huiliensis		1	
Camellia impressinervis		1	
Camellia irrawadiensis		1	
Camellia jinshajiangica		1	
Camellia lutchuensis		1	Taylor, 2004; Denton-Giles, 2013
Camellia minutiflora		1	
Camellia miyagii		1	Denton-Giles, 2013
Camellia nitidissima var. *nitidissima*		1	
Camellia oleifera		1	
Camellia pitardii var. *pitardii*	1		
Camellia polyodonta	1		
Camellia puniceiflora		1	
Camellia reticulata f. *simplex*	1		
Camellia rosiflora		1	Taylor, 2004
Camellia salicifolia		1	
Camellia saluenensis	1		
Camellia sinensis		1	
Camellia sinensis var. *sinensis* f. *rosea*		1	
Camellia subintegra	1		
Camellia transarisanensis		1	Denton-Giles, 2013
Camellia transnokoensis		1	Taylor, 2004; Denton-Giles, 2013
Camellia trichocarpa		1	Taylor, 2004
Camellia trichoclada		1	
Camellia tsaii		1	Taylor, 2004

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Table 4 Winter- or spring-flowering camellias (total = 18) with no observed petal blight infections at ABG.

Camellia complex *saluenensis* hybrid 'Gay Baby'	*Camellia japonica* 'Yuri-tsubaki'
Camellia fraterna × *tsaii* 'Ariel's Song'	*Camellia japonica* × *fraterna* 'Tiny Princess'
Camellia japonica 'Bob's Tinsie'	*Camellia japonica* × *lutchuensis* 'Sweet Emily Kate'
Camellia japonica 'Demi-Tasse'	*Camellia lutchuensis* × *japonica* 'Scented Gem'
Camellia japonica 'Kumagai Nagoya'	*Camellia rosiflora* × *tsaii* 'Baby Bear'
Camellia japonica 'Nokogiriba-tsubaki'	*Camellia rosiflora* × *tsaii* 'Baby Brother'
Camellia japonica 'Nuccio's Pearl'	*Camellia rosiflora* × *tsaii* 'Baby Willow'
Camellia japonica 'Sir Victor Davies'	*Camellia* × *williamsii* 'Wynne Rayner'
Camellia japonica 'Sweet Olive'	*Camellia* × *williamsii* 'Mimosa Jury'

Conclusion

There are at least ten cultivars where susceptibility is unclear from field observations because flowering times have not been recorded; these will be confirmed in subsequent years (Appendix). This requires not only observing the presence or absence of petal blight, but also recording phenology to gain an understanding of whether resistance or avoidance is the mechanism for the lack of petal blight. Although camellias are not commonly grown by gardeners, we have compiled a list of *Camellia* species and our observations of the impact on them of petal blight (Table 3).

Until there is more success in breeding for resistance to camellia petal blight, we recommend that gardeners choose autumn-flowering (*sasanqua* type) cultivars (Table 2) to avoid the unsightly effects of the disease. However, there are some late-flowering camellias that display no visual symptoms of petal blight which could be a result of their parentage providing some resistance (Table 4). These *Camellia* cultivars flower before *Ciborinia camelliae* releases its spores but some also have a certain resistance thanks to their parentage.

We provide an extensive list of petal blight free camellias and are happy to share this information with gardens, nurseries and other breeders. At ABG, we have gradually removed plants that have petal blight and so when people visit our garden, they will see healthy, petal blight free plants which will provide them with inspiration for planting at home. At ABG, we display plants that grow well in Auckland conditions, are free from pests or diseases and have spectacular flowering. We hope that this will help gardeners make choices about which cultivars to avoid planting and, in addition, will inform the ABG cultivar breeding programme with regard to the selection of resistant parents.

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Appendix

The following is a list of camellias (total = 10) in ABG's collection that have been recorded as having no petal blight. This is either because no record of flowering times has been documented to determine if they are autumn flowering or not, or because they are no longer held in the ABG collection. It cannot therefore be determined whether they are petal blight resistant or avoid petal blight by early flowering. This will be investigated in subsequent years.

Camellia japonica 'Grape Soda'
Camellia japonica 'Kikarako'
Camellia japonica 'Prince Eugene Napoleon'
Camellia japonica 'Red Ensign'
Camellia pitardii × *fraterna* 'Alpen Glo'
Camellia pitardii × *japonica* 'Persuasion'
Camellia rosiflora 'Cascade'
Camellia rosiflora hybrid 'Standard Bearer'
Camellia rosiflora × *fraterna* 'Captured Enriches'
Camellia × *williamsii* 'Water Lily'

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