Crop Protection Compendium - *Morella faya* (Ait.) Wilbur

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NAMES AND TAXONOMY

Preferred scientific name

Morella faya (Ait.) Wilbur

Taxonomic position

Domain: Eukaryota
Kingdom: Viridiplantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledonae
Order: Myricales
Family: Myricaceae

Other scientific names

Myrica faya Ait.

BAYER code

MYRFA (*Myrica faya*)

Common names

English:
firetree
fire tree
fayatree
firebush

Spanish:
faya

French:
gale faya

Hawaii:
candleberry myrtle

Portugal:
faia das ilhas
faia
samouco

Notes on taxonomy and nomenclature

Throughout the literature Morella faya has been, and still often is, referred to as *Myrica faya*. Only recently has the nomenclature change made by Wilbur (1994) been highlighted (Staples et al., 2002). This change had been easily overlooked as the new combination for *M. faya* was made in a footnote and resulted from Wilbur's recognition of the genus *Morella* Lour as a segregate from *Myrica*. However, it must be noted that the division of the Myricaceae into three genera might not be definitive and may still be revised (Griffin and Blazich, 2001).

HOST RANGE

Notes on host range

This tree is primarily associated with primary succession, such as colonization of old lava flows. However, it is also common on pasture lands in Hawaii where the weedy nature of the tree was first recognized.

HABITAT

In its native range, *M. faya* is a frequent component of forest canopies. In many stands it is co-dominant, whereas it is generally absent from the shrub layer. In open areas, *M. faya* is a pioneer species on old lava flows and spreads readily into pasture lands. It is also found on sea cliffs, rocky hillsides and along roadsides. Habitats invaded in Hawaii reflect those occupied by the species in its native range (Lutzow-Felling et al., 1995; Arévalo and Fernández-Palacios, 2000). In its native Azores, stands dominated by *M. faya* are invaded by the Australian tree *Pittosporum undulatum* (Marler and Boatman, 1952).

GEOGRAPHIC DISTRIBUTION

Notes on distribution

M. faya is native to the Macaronesian islands of the Azores, Madeira and the Canary Islands but not Cape Verde. It is also found on mainland Portugal but it is unclear whether the species is native or has been introduced (Press and Short, 1994). This species has not been widely introduced around the world but it is known to be present in the Hawaiian Islands, Florida, Australia and New Zealand. On all the main Hawaiian islands the species has become a major environmental weed. In New Zealand it is cultivated but has only been reported as naturalized from the Chatham Islands (Owen, 1997).

Distribution List

Europe				
Portugal	localized			Press & Short, 1994
Azores	widespread	native		Marler & Boatman, 1952
Madeira	widespread	native		Press & Short, 1994
[Spain]				
Canary Islands	widespread	native		Bramwell & Bramwell, 1984
North America				
[USA]				
Florida	present	introduced (late 1800s)		Hodges & Gardner, 1985
Hawaii	widespread	introduced	invasive	Vitousek & Walker, 1989
Oceania				
Australia	present	introduced	not invasive	Csurhes & Edwards, 1998
Queensland	present, few occurrences	introduced	not invasive	Anon., 2003
New Zealand	present	introduced	not invasive	Owen, 1997

HISTORY OF INTRODUCTION AND SPREAD

M. faya was introduced into Hawaii probably by immigrants from the Azores or Madeira in the late 1800s, either as an ornamental or a medicinal plant. During the 1920s and 1930s the species was extensively planted for watershed reclamation. The weedy tendencies of *M. faya* were first recognised by the mid-1920s and by 1944 the Territorial Board of Agriculture and Forestry began an attempt to eradicate the species (Neal, 1965). By the 1990s, Whiteaker and Gardner (1992) reported that *M. faya* was a problem on all the major Hawaiian islands and covered around 35,000 ha. Over 80% species cover was found to occur on the island of Hawaii, including over 12,200 ha in the Hawaii Volcanoes National Park where only one tree existed in 1962, and it is considered to be one of the main noxious weed species. They considered that the species had yet to reach the limits of its potential distribution and a decade later its cover in Hawaii Volcanoes National Park had increased to over 15,900 ha, although much dieback has occurred since 1990 (Lenz and Taylor, 2001).

BIOLOGY AND ECOLOGY

Physiology and Phenology

This tree is adapted to xeric conditions and exhibits attributes such as a relatively low transpiration rate. Broadly similar phenological patterns have been observed in the native and invaded ranges with flowering in late spring and fruiting towards the end of the year. In Hawaii, peak flowering time occurs in June with a minimum in December-January. Fruits may be observed all year round but in Hawaii, fruits ripen primarily between August and November. Peaks of immature fruiting have been recorded in August-September and a minimum in February-March. Maximum mature fruiting has observed in November and a minimum in May. Leaf flushing peaks in June but some differences in leaf flushing and leaf fall between the three Hawaiian sites investigated have been observed (Kraus, 1964; Whiteaker and Gardner, 1992).

Reproductive Biology

M. faya is considered to be a dioecious species; however, male plants often produce some fruits and female individuals may bear a few male inflorescences. It appears to be a wind-pollinated species although in Hawaii it is visited by the introduced *Apis mellifera*. Up to 20,000 seeds per tree are produced every year. The fruit is bird-dispersed in its native range, whereas in Hawaii it is dispersed by birds (mainly introduced species) and feral pigs. Seed germination decreases from 80% at 10 weeks to 30% after 78 weeks of dry storage. Passage of seeds through birds has no effect on germination whereas the species own leaf litter reduces seed germination. Germination occurs at all light levels but is highest under 55-63% of shade (Walker, 1990). In its native range, *M. faya* contribute little to the seed bank of forests where the tree is a canopy co-dominant (Arévalo and Fernández-Palacios, 2000).

Environmental Requirements

In its native range, the distribution of *M. faya* is very much determined by rainfall and temperature. Frost appears to be a major limiting factor as the tree has not been recorded more than 100 m above the frost line. The minimum amount of annual rainfall necessary for the occurrence of the tree is about 500 mm. In some forests, fog drips are a significant source of water and the tree is therefore rarely encountered above the high moisture cloud zone. In the Macaronesian islands the altitudinal range is 400-1500 m, however, this can

vary greatly between islands, with the upper altitudinal limit for example ranging from 600 to 1500 m. In Hawaii, *M. faya* occurs between 150 and 2000 m altitude, but does not regenerate naturally at either altitudinal extreme. The mean annual rainfall range is 1270-2540 mm and mean annual temperature may be as high as 22°C. In Hawaii, *M. faya* has been found in 11 soil types and with soil pH of 5-6 in forest soil in Tenerife, Canary Islands (Whiteaker and Gardner, 1992; Fernández-Palacios and Arévalo, 1998). Being a light-demanding species it does not regenerate under its own canopy light (Fernández-Palacios and Arévalo, 1998), and typically natural regeneration takes place on old lava flows or in open vegetation.

Associations

M. faya forms a symbiotic association with the nitrogen-fixing actinomycete *Frankia* sp. (Turner and Vitousek, 1987).

Climatic amplitude (estimates)
- Mean annual rainfall: 500 - 2500 mm
- Rainfall regime: winter
- Mean annual temperature: 13 - 22ºC

Soil descriptors
- Soil texture:
- Soil drainage: free
- Soil reaction: acid
- Special soil tolerances: infertile
- Soil types: acid soils; sandy soils; volcanic soils; mountain soils; grassland soils

MEANS OF MOVEMENT AND DISPERSAL

Natural Dispersal (Non-Biotic)

The fruit is bird-dispersed in its native range, whereas in Hawaii it is dispersed by birds (mainly introduced species) and feral pigs. Eleven species of birds are known to visit *M. faya*, four are natives and seven exotics (LaRosa et al., 1985; Woodward et al., 1990). The two studies, both carried out in the Hawaii Volcanoes National Park, came to different conclusions although they both view the species as bird-dispersed. LaRosa et al. (1985) concluded that the exotic finch, *Carpodacus mexicanus*, and the native *Myadestes obscurus* were the most important dispersal agent. Woodward et al. (1990) found that the four species of native birds that visit the tree rarely feed on the fruits whereas out of the seven exotic birds visiting the species, five were observed ingesting the fruit. The Japanese White eye (*Zosterops japonicus*) was the most frequent visitor and consumer and is the primary dispersal agent according to Woodward et al. (1990), whereas LaRosa et al. (1985) found that it rarely consumed the fruit. Over a third of the *Zosterops japonicus* captured by Woodward et al. (1990) produced faecal samples containing seeds. These seeds were just as viable as those obtained from *M. faya* trees or collected below their canopies.

Agricultural Practices

This species does not appear to be currently used or promoted for land rehabilitation.

Accidental Introduction

There is a low risk of accidental introductions.

Intentional Introduction

Introduction for ornamental purposes is the most likely pathway for the species to spread into new regions.

NATURAL ENEMIES

M. faya suffers from a number of diseases resulting in canker, dieback and root rot. *Nectria galligena*, common throughout its native range, causes severe canker and galls. The dieback disease, *Ramularia destructiva*, may be especially severe on the shoots of young plants or stump coppice. It may also cause premature shedding of flowers and fruits (Gardner and Hodges, 1990). In Hawaii, *Botrytis cinerea* causes fruit rot and up to half of the fruits have been reported as infected (Duffy and Gardner, 1994). The leafhopper *Sophonia rufofascia* Kuoh and Kuoh (Homoptera: Cicadellidae) was first reported in the state of Hawaii in 1987 probably resulting from an accidental introduction from Asia. It feeds on the leaf phloem of a wide host plant range. The insect has a major impact on tree health including a reduction in leaf size, constriction of leaf xylem diameters, leaf chlorosis and necrosis, and is probably the main or sole cause of the dieback exhibited by *M. faya* since the late 1990s (Lenz and Taylor, 2001).

Natural enemies listed in the database

The list of natural enemies has been reviewed by a biocontrol specialist and is limited to those that have a major impact on pest numbers or have been used in biological control attempts; generalists and crop pests are excluded. For further information and reference sources, see About the data. Additional natural enemy records derived from data mining are presented as a separate list.

Natural enemies reviewed by biocontrol specialist		
Natural enemy	**Pest stage attacked**	**Biological control in:**
Pathogens:		
Botryotinia fuckeliana (grey mould-rot)	Fruits/pods	
Septoria hodgesii	Leaves	
Herbivores:		
Caloptilia sp. nr. schinella	Leaves	

Additional natural enemies (source - data mining)		
Natural enemy	**Pest stage attacked**	**Biological control in:**
Herbivores:		
Caloptilia schinella		Hawaii

IMPACT

Economic impact

As *M. faya* facilitates an increase in the polyphagous *Sophonia rufofascia* abundance, this could cause some economic impact on fruit crops where *M. faya* is present. There are, however, no quantitative assessments of economic damage caused by *M. faya*.

Environmental impact

M. faya has many deleterious impacts but it primarily changes ecosystem function by altering the nitrogen cycle. It also forms monospecific stands that have virtually no understorey and its litter inhibits germination and seedling establishment of the native tree *Metrosideros polymorpha*. In Hawaii, during primary succession on lava flows, invasion by *M. faya* increases nitrogen inputs to this system by at least fourfold and in native forest the tree alters both the quality and quantity of litter entering the decomposition process. These changes favour the abundance of exotic earthworms and their biomass under the canopy of *M. faya* is four to nearly eight times greater than under the canopy of the native *Metrosideros polymorpha*. In turn, this increase in the number of earthworms which are actively sought by feral pigs causes widespread disturbance and damage to native vegetation from pig feeding. It also increases the abundance of harmful insect herbivores (Aplet, 1990; Vitousek et al., 1987; Vitousek and Walker, 1989; Lenz and Taylor, 2001).

Impact on biodiversity

M. faya facilitates the spread of introduced species and animals, exotic earthworms in particular. In the Hawaii Volcanoes National Park, *M. faya* is recognized as one of the most important environmental weeds.

Summary of impact

Negative impact on: native flora; biodiversity; environment; livestock production

PHYTOSANITARY SIGNIFICANCE

The State of Hawaii, USA restricts the import of *M. faya* seeds (Friday, 2000). In Queensland, Australia *M. faya* has been declared a Class 1 pest, i.e. a species that is not commonly present in Queensland and, if introduced, would cause an adverse economic, environmental or social impact. If established the species is subject to eradication from the state and landowners must take reasonable steps to keep the land free of the pest (Anon., 2003). There is a low risk of accidental introductions and introduction for ornamental purposes is the most likely pathway for the species to spread into new regions.

SUMMARY OF INVASIVENESS

This Macaronesian endemic has so far proved to be invasive only in the Hawaiian islands. Introduced in the 1800s and widely used subsequently in reclamation planting, it has spread into a variety of habitats including natural forest, lava flows, roadsides and abandoned pasture. It has a variety of impacts on native and exotic fauna and flora especially as a result of the changes this nitrogen-fixing species induces on nutrient cycling. Since the mid-1900s, various control programmes have been initiated, including biological control programmes, but these have had limited success and the species has yet to be brought under control, although natural dieback has been observed in recent decades.

Risk and Impact Factors

- invasive in its native range: no
- proved to be invasive outside its native range: yes
- highly adaptable to different environments: no
- high reproductive potential: yes

- highly mobile locally: no
- its propagules remain viable for more than one year: no
- tolerates cultivation, browsing pressure, mutilation, fire etc.: no
- competitive in crops or pasture: no
- affects ecosystem: yes
- adversely affects natural communities: yes
- adversely affects community structure: yes
- adversely affect human health: no
- has sociological impacts on recreational patterns, aesthetics, property values: no
- harmful to animals: no
- produces spines, thorns or burrs: no
- host or vector of pests or diseases: no
- likely to be accidentally transported internationally: no
- likely to be deliberately transported internationally: yes
- difficult to identify or detect as a commodity contaminant: no
- difficult to identify or detect in the field: no
- difficult or costly to control: yes

MORPHOLOGY

Plant type: tree; shrub; woody; seed propagated.

M. faya is an evergreen tree growing up to 12 m tall in its native range, but is usually much smaller where introduced, e.g. no more than 8 m tall in Hawaii and in windy and exposed sites it may only reach a height of 2 to 3 m. It is often multi-stemmed and branches have reddish peltate hairs. The leaves are alternate, coriaceous, oblanceolate, glabrous, and their size varies, being 4-11 cm long by 1-2.5 cm wide. Leaf margins are somewhat revolute, remotely serrulate or serrate in upper half with a rounded to acute apex. Flowers are unisexual and generally born on separate trees. Each inflorescence is a spike or catkin bearing yellow flowers with no perianth. These are borne among leaves of the current year's growth. The fruit is a slightly fleshy edible drupe ca 6 mm in diameter and dark red or blackish when mature, containing 1-5 seeds.

SIMILARITIES TO OTHER SPECIES

There is no confusion with other species and no particular difficulties in identifying this tree.

CONTROL

Cultural Control

M. faya is not a preferred fodder for livestock, thus herbivory is of very limited value in controlling the species (Lutzow-Felling et al., 1995). The grass *Schizachyrium condensatum* reduces recruitment of *M. faya* as it substantially reduces light at the soil surface and is thought to then reduce germination and early seedling growth of the *M. faya* (D'Antonio and Mack, 2001) though management strategies involving reseeding have not been developed.

Chemical Control

Use of herbicides has proved to be the only effective means of controlling the species to date. However, due to the high costs of chemicals and labour requirements the original aim of eradicating the species was never achieved. Glyphosate is very effective when applied by the notching method or to drilled holes. The species is susceptible to foliar sprays of picloram resulting in complete canopy kill and 99% control of resprouting. Control of *M. faya* by soil application in open vegetation with tebuthiuron has been poor. The species is moderately sensitive to drizzle applications of triclopyr in water or oil and repeat applications may provide adequate suppression as the canopy density is reduced by previous treatments (Whiteaker and Gardner, 1992; Matooka, 2000).

Biological Control

The biological control of *M. faya* has been attempted since the 1950s. In 1956, *Strepsicrates smithiana* Walsingham (Tortricidae) was introduced to Hawaii but it failed to become established on *M. faya*. Instead, at low elevation it became established on *M. cerifera*. By the early 1960s, insects associated with *M. faya* in its native range had been extensively documented (e.g. Kraus, 1964) and later efforts included the use of pathogens (Hodges and Gardner, 1985). A number of diseases causing cankers, dieback and root rot were identified as potential biocontrol agents (Gardner and Hodges, 1990). The first agent to become established on *M. faya* is a leaf miner, *Caloptilia* nr. *schinella* Walsingham (Gracillariidae) which was released in Hawaii in 1991 (Leen and Markin, 1996). By 1995, this leaf miner had spread widely from the four release sites; however, its impact on the trees was negligible. In 1998, the leaf spot fungus *Septoria hodgesii* Gardner was released but this agent has had no significant impact (Smith, 2002). In view of the limited success achieved with introduced biological control agents, an alternative approach has been suggested. It entails the introduction of more aggressive or ecologically fit strains of already established insect pests and pathogens and Duffy and Gardner (1994) suggested that this approach should be envisaged for the fruit rot *Botrytis cinerea*. Due to the poor results so far achieved and the lack of potential biological control agents from the native range, the biological control programme of *M. faya* has been greatly reduced since 1995 (Smith, 2002).

Integrated Control

There is little hope that a single biological control agent will be discovered that will effectively control *M. faya*. It is likely that a variety of agents in conjunction with the use of traditional control methods will keep the species under control.

USES

This species has a limited potential. It is an ornamental with a good degree of wind tolerance. It was formerly viewed as species to be used in land reclamation as was the case in Hawaii during the early 1900s, and Portuguese labourers used to make wine from the fruits. In its native range it is viewed as a valued fuelwood and other minor uses have been reported (Lutzow-Felling et al., 1995).

PESTS

Pests listed in the database

Minor host of:
Trichodorus (stubby root nematodes)

Wild host of:
Sophonia rufofascia (two-spotted leafhopper), *Xyleborinus saxesenii* (fruit-tree pinhole borer)

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