

Crop Protection Compendium - *Mimosa diplotricha* Sauvalle

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NAMES AND TAXONOMY

Preferred scientific name

Mimosa diplotricha Sauvalle

Taxonomic position

Domain: Eukaryota
Kingdom: Viridiplantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledonae
Order: Fabales
Family: Fabaceae
Subfamily: Mimosoideae

Other scientific names

*Mimosa invis*a C. Mart.
Schrankia brachycarpa Benth.
Morongia pilosa Standley
Schrankia pilosa (Standley) Macbr.

BAYER code

MIMIN (*Mimosa diplotricha*)

Common names

English:

giant sensitive plant

French:

grande sensitive
sensitive géante

American Samoa:

vao fefe palagi

Belau:

mechiuaiu

Cambodia:

banla saet (balna sael)

Cook Islands:

pikika'a papa'a

Federated states of

Micronesia:

limemeihr laud

Fiji:

co gadrogadro
wa ngandongandro ni wa
ngalelevu
wagadrogadro levu

India:

anathottavadi

Indonesia:

pis koetjing

Java:

rèmbètè

Northern Mariana Islands:

nila grass

singbiquin sasa

Nusa Tenggara:

boring (borang)

djoekoet borang

puteri malu

Papua New Guinea:

nil grass

Philippines:

makahiang lalake (makahiang
malake)

makahiya

Samoa:

la'au fefe palagi

vao fefe palagi

Thailand:

maiyaaraap thao

Vietnam:

cỗ trinh nu móc

Notes on taxonomy and nomenclature

Mimosa is from the Greek mimikos which means 'to mimic' or 'counterfeit', through the Latin mimus and the feminine suffix -osa which means abounding in, and refers to several flowers masquerading as a single flower. *Invisa* is from the Latin invideo which means 'to hate', referring to the abundant thorns (Parsons and Cuthbertson, 1992).

Mimosa diplotricha was known as *M. invis*a Martius, but the *M. invis*a of Colla is older (Anon., 2001a). However, this taxon is still called *M. invis*a in Africa (i.e. Nigeria) and occasionally in Asia (e.g. Philippines, MacLean et al., 2003). In the neotropics, Barneby (1991) recognised two subspecies (*invis*a and *spiciflora*) each with two varieties.

A thornless form, *Mimosa diplotricha* var. *inermis* (Verdcourt, 1988) arose in Indonesia and Papua New Guinea (Parsons and Cuthbertson, 1992). It was deliberately introduced to the Solomon Islands from Sulawesi in 1931-32 (Waterhouse and Norris, 1987) and was discovered in Java, Indonesia, in 1942 (Soerjani et al., 1987). It is also present in Vanuatu (Waterhouse and Norris, 1987), Papua New Guinea (Henty and Pritchard, 1988), India (Muniappan and Viraktamath, 1993) and Thailand (Gibson and Waring, 1994).

HOST RANGE

Notes on host range

M. diplotricha is the principal weed of rubber and coconut in Papua New Guinea, rubber in Indonesia, sugarcane in Taiwan and the Philippines, lychee in Thailand, and tomato in the Philippines. It is considered a weed of sugarcane in Australia and India; cassava, soyabeans, maize, apple, citrus and tea in Indonesia; coconut in Sri Lanka; rubber in Malaysia; banana and tea in India; and abaca (*Musa textilis*) and pineapple in the Philippines (Wong, 1975; Holm et al., 1977; Tea Research Association, 1977; Aliudin and Kusumo, 1978; Taepongsorut, 1978; Mendoza, 1979; Suwanarak, 1988; Groves, 1991; Muniappan and Viraktamath, 1993). It is considered a major threat to tropical pastures in Australia (Groves, 1991; Willson and Garcia, 1992), the Pacific islands (Swarbrick, 1989; Willson and Garcia, 1992), Papua New Guinea (Henty and Pritchard, 1988) and the Philippines (Holm et al., 1977). It is a weed of lowland rice in Indonesia, the Philippines, Thailand and Vietnam; of dry-seeded rice in the Philippines; and of upland rice in Indonesia, Laos, the Philippines, Thailand and Vietnam (Soerjani et al., 1987; Moody, 1989). It is potentially the worst weed in plantations and arable lands of Fiji and the Philippines (Holm et al., 1977).

Affected Plant Stages: Flowering stage, fruiting stage, post-harvest and vegetative growing stage.

List of hosts plants

Major hosts

Cocos nucifera (coconut), *Hevea brasiliensis* (rubber), *Litchi chinensis* (lichi), *Lycopersicon esculentum* (tomato), *Saccharum officinarum* (sugarcane)

Minor hosts

Ananas comosus (pineapple), *Areca catechu* (betelnut palm), *Camellia sinensis* (tea), *Citrus*, *Coffea arabica* (arabica coffee), *Glycine max* (soyabean), *Malus* (ornamental species apple), *Manihot esculenta* (cassava), *Musa* (banana), *Musa textilis* (manila hemp), *Nicotiana tabacum* (tobacco), *Oryza sativa* (rice), *Zea mays* (maize)

HABITAT

M. diplotricha commonly grows in crops, plantations and pastures, as well as on disturbed moist wastelands and along roadsides, drains and watercourses in tropical and subtropical regions (Holm et al., 1977; Soerjani et al., 1987; Henty and Pritchard, 1988; Swarbrick, 1989; Esguerra, 1991; Parsons and Cuthbertson, 1992; Willson and Garcia, 1992). It grows in light or heavy, moist, often poor soils in areas that are sunny or lightly shaded (Soerjani et al., 1987), from sea level to an altitude of 1500-2000 m (Soerjani et al., 1987;

Henty and Pritchard, 1988). It does not invade closed forests (Muniappan and Viraktamath, 1993).

GEOGRAPHIC DISTRIBUTION

Notes on distribution

M. diplotricha is native to the neotropics, including much of South and Central America, as well as the Caribbean (Barneby, 1991, Holm et al., 1977; Soerjani et al., 1987; Parsons and Cuthbertson, 1992; Willson and Garcia, 1992). However, it is unclear whether it is native to North America and parts of the Caribbean (Barneby, 1991). It has now become widespread throughout the wet tropics and subtropics. Usually a very invasive species wherever introduced.

In Australia, it is confined to the north Queensland coastal region between Ingham and Cooktown, around Mackay, and at Brisbane (Parsons and Cuthbertson, 1992; Anon., 2001b). It has the potential to spread to the Northern Territory and Western Australia (Groves et al., 2003). Indeed, it was found and eradicated in 2004 in Western Australia (Wilson, 2004). In Western Samoa, it is estimated that 85% of the villages on the island of Upolu are infested with the weed (Willson and Garcia, 1992). It commonly forms clumps up to 20 m in diameter in the Markham and Ramu Valleys in Papua New Guinea (Kuniata et al., 1993). In Vanuatu, the thorny form is limited to Malekula, although the thornless variety (*M. diplotricha* var. *inermis*) is used as a cover crop in coffee on Tanna (Waterhouse and Norris, 1987). On Peninsular Malaysia, it occurs in the States of Perlis, Kedah, Seberang Prai, northern Perak, Selangor, Malacca, Negri Sembilan and Johore (Baki and Prakash, 1994). In the Mekong Delta (Vietnam) the plant is viewed only as a minor weed (Triet, 2001).

Distribution List

Asia				
Cambodia	localized	introduced		Holm et al., 1977; Waterhouse & Norris, 1987; Waterhouse, 1993; Wu et al., 2004; EPPO, 2005
[China]				
Guangdong	present	introduced		Wu et al., 2004
Hainan	present	introduced		Wu et al., 2004
Hong Kong	localized	introduced (1995)	invasive	Corlett, 1996
Taiwan	localized	introduced (1965)		Holm et al., 1977; Waterhouse & Norris, 1987; Parsons & Cuthbertson, 1992; Wu et al., 2003; EPPO, 2005
Yunnan	present	introduced		Wu et al., 2003
Christmas Island (Indian Ocean)	widespread	introduced	invasive	PIER, 2004
India	localized	introduced		Holm et al., 1977; Thomas & Shantaram, 1984; Waterhouse & Norris, 1987; Parsons & Cuthbertson, 1992; EPPO, 2005
Assam	present	introduced		Tea Research Association, 1977

Karnataka	present	introduced		Sannamarappa, 1987; Thomas & George, 1990
Kerala	present	introduced		Sannamarappa, 1987; Alex et al., 1991
Uttar Pradesh	present	introduced		Rai & Kanodia, 1980
Indonesia	localized	introduced		Holm et al., 1977; Soerjani et al., 1987; Waterhouse & Norris, 1987; Moody, 1989; Siregar et al., 1990; Waterhouse, 1993; EPPO, 2005
Java	present	introduced		Taepongsorut, 1978; Soerjani et al., 1987
Nusa Tenggara	present	introduced		Parsons & Cuthbertson, 1992; Wilson, 1995a
Papua Barat	present	introduced		Anon., 2001a
Sumatra	present	introduced		Wiersum, 1983
Laos	present	introduced		Moody, 1989; Waterhouse, 1993
Malaysia	localized	introduced		Holm et al., 1977; Waterhouse & Norris, 1987; Parsons & Cuthbertson, 1992; Waterhouse, 1993; EPPO, 2005
Peninsular Malaysia	widespread	introduced		Wong, 1975; Baki & Prakash, 1994
Myanmar	present	introduced		Waterhouse, 1993
Philippines	localized	introduced		Holm et al., 1977; Waterhouse & Norris, 1987; Moody, 1989; Payawal et al., 1991; Parsons & Cuthbertson, 1992; Waterhouse, 1993; EPPO, 2005
Singapore	present	introduced		Waterhouse, 1993
Sri Lanka	localized	introduced		Holm et al., 1977; Yogaratnam et al., 1984; Waterhouse & Norris, 1987; Jayasinghe, 1991; Parsons & Cuthbertson, 1992; EPPO, 2005
Thailand	widespread	introduced		Suwanarak, 1986; Waterhouse & Norris, 1987; Moody, 1989; Napompeth, 1990; Waterhouse, 1993; Noda et al., 1994
Timor-Leste	widespread	introduced	invasive	Wilson, 1995b
Vietnam	localized	introduced		Holm et al., 1977; Waterhouse & Norris, 1987; Moody, 1989; Waterhouse, 1993; EPPO, 2005
Africa				
Burundi	present	introduced		Anon., 2001a
Cameroon	present	introduced		Rivoire, 1982
Congo Democratic Republic	present	introduced		Anon., 2001a
Côte d'Ivoire	present	introduced		Lavabre, 1971
Ethiopia	present	introduced		Anon., 2001a
Ghana	present	introduced		Anon., 2001a
Guinea	widespread	introduced	invasive	Lisowski, 1996
Mauritius	localized	introduced		Waterhouse & Norris, 1987; Parsons & Cuthbertson, 1992; EPPO, 2005
Mozambique	present	introduced		Anon., 2001a
Nigeria	widespread	introduced	invasive	Holm et al., 1977; Waterhouse & Norris, 1987;

Rwanda	present	introduced	Anon., 2001a
Réunion	present	introduced	PIER, 2004
Tanzania	present	introduced	Anon., 2001a
Togo	present	introduced	Anon., 2001a
Zimbabwe	present	introduced	Anon., 2001a
Central America & Caribbean			
Costa Rica	present	native	Barneby, 1991
Cuba	present	native	Barneby, 1991
Guatemala	present	native	Barneby, 1991
Haiti	present	native	Barneby, 1991
Honduras	present	native	Barneby, 1991
Jamaica	present	native	Barneby, 1991
Puerto Rico	present	native	Barneby, 1991
United States Virgin Islands	localized		EPPO, 2005
North America			
Mexico	present	native	Barneby, 1991
USA	localized		EPPO, 2005
Hawaii	present	introduced	Holm et al., 1977; Waterhouse & Norris, 1987; EPPO, 2005
South America			
Argentina	localized	native	Holm et al., 1977; Waterhouse & Norris, 1987; EPPO, 2005
Bolivia	present	native	Smith and Killeen, 1994
Brazil	present	native	Holm et al., 1977; Waterhouse & Norris, 1987; Willson & Garcia, 1992
Alagoas	present	native	Lorenzi, 1982
Amazonas	present	native	Lorenzi, 1982
Bahia	present	native	Lorenzi, 1982
Ceara	present	native	Lorenzi, 1982
Espírito Santo	present	native	Lorenzi, 1982
Fernando de Noronha	present	native	Lorenzi, 1982
Goiás	present	native	Lorenzi, 1982
Maranhão	present	native	Lorenzi, 1982
Matto Grosso do Sul	present	native	Lorenzi, 1982
Minas Gerais	present	native	Lorenzi, 1982
Paraíba	present	native	Lorenzi, 1982
Paraná	present	native	Lorenzi, 1982
Pará	present	native	Lorenzi, 1982
Pernambuco	present	native	Lorenzi, 1982
Piauí	present	native	Lorenzi, 1982

Rio de Janeiro	present	native		Lorenzi, 1982
Santa Catarina	present	native		Lorenzi, 1982
Sao Paulo	present	native		Lorenzi, 1982
Sergipe	present	native		Lorenzi, 1982
Colombia	present	native		Anon., 2001a
Ecuador	present	native		Anon., 2001a
Paraguay	present	native		Anon., 2001a
Peru	present	native		Anon., 2001a
Venezuela	present	native		Anon., 2001a
Oceania				
American Samoa	present	introduced		Swarbrick, 1989
Australia	localized	introduced		EPPO, 2005
Queensland	widespread	introduced		Waterhouse & Norris, 1987; Groves, 1991; Parsons & Cuthbertson, 1992; Willson & Garcia, 1992
Western Australia	eradicated	introduced		Wilson, 2004
Belau	localized	introduced	invasive	Holm and Michaels, 2003; PIER, 2004
Cook Islands	present	introduced		Waterhouse & Norris, 1987; Swarbrick, 1989
Federated states of Micronesia	widespread	introduced		Esguerra, 1991
Fiji	localized	introduced		Holm et al., 1977; Swarbrick, 1989; Waterhouse & Norris, 1989; EPPO, 2005
French Polynesia	present	introduced		Waterhouse & Norris, 1987; Swarbrick, 1989
Guam	present	introduced		Waterhouse & Norris, 1987
New Caledonia	present	introduced		Waterhouse & Norris, 1987; Swarbrick, 1989
Niue	localized	introduced (1990s)	invasive	Konelio, 2003; PIER, 2004
Northern Mariana Islands	present, few occurrences	introduced	invasive	PIER, 2004
Papua New Guinea	localized	introduced		Holm et al., 1977; Waterhouse & Norris, 1987; Henty & Pritchard, 1988; Parsons & Cuthbertson, 1992; Kuniata, 1994; Kuniata & Nagajara, 1994; EPPO, 2005
Samoa	widespread	introduced		Waterhouse & Norris, 1987; Swarbrick, 1989; Willson & Garcia, 1992
Solomon Islands	present	introduced		Smith & Whiteman, 1985; Waterhouse & Norris, 1987; Swarbrick, 1989
Vanuatu	present	introduced		Waterhouse & Norris, 1987; Swarbrick, 1989
Wallis and Futuna	present, few occurrences	introduced	invasive	Orapa, 2003

HISTORY OF INTRODUCTION AND SPREAD

It was first recorded in Indonesia on the island of Java in 1900 (Soerjani et al., 1987). It is known to have been present near Tully in Queensland, Australia since about 1929 (Waterhouse and Norris, 1987; Parsons and Cuthbertson, 1992), was first recorded in Fiji in 1936 (Waterhouse and Norris, 1987), was introduced into Thailand from Indonesia in the 1960s (Napompeth, 1990) and was first reported in Western Samoa in 1972 (Whistler, 1983). *M. diplotricha* was introduced to Taiwan in 1965 as an ornamental and the first herbarium specimen was collected in 1976 (Wu et al., 2003). In Hong Kong, one sterile plant was noted in 1995. Since, further isolated specimens have been discovered as well as a large population and its eradication has been attempted (Corlett, 1996). It was only recently introduced (1990s) to Niue and its eradication is in progress (Konelio, 2003; PIER, 2004) and takes the form of a collaborative project with Wallis and Futuna (Orapa, 2003). Similarly, several small patches present on Guam are subjected to an eradication programme (PIER, 2004).

The timing of introduction of *M. diplotricha* to Nigeria is unknown. Until the 1990s infestations remained limited to roadsides, ditch banks, and wastelands in the southern part of the country but then it became a major weed of cropping systems, including cassava, and is still spreading (Alabi et al., 2001).

BIOLOGY AND ECOLOGY

Physiology and Phenology

In its native range *M. diplotricha* behaves as a perennial (Lorenzi, 1982), but in its introduced range it can be an annual, biennial (Holm et al., 1977; Muniappan and Viraktamath, 1993) or perennial shrub (Parsons and Cuthbertson, 1992; Noda et al., 1994). It is characterized by robust growth, which enables it to scramble over other vegetation, forming spreading, impenetrable, tangled thickets of undergrowth (Holm et al., 1977; Waterhouse and Norris, 1987; Swarbrick, 1989; Parsons and Cuthbertson, 1992). Due to its rapid growth rate, each plant can cover an area of 2-3 m² in one growing season (Parsons and Cuthbertson, 1992). It is extremely invasive, highly competitive, a prolific seed producer and is capable of spreading rapidly (Lockett and Ablin, 1990).

Flowering may occur throughout the year (Holm et al., 1977; Soerjani et al., 1987; Waterhouse and Norris, 1987) but is concentrated late in the wet season (Parsons and Cuthbertson, 1992). In Australia, it usually flowers and seeds from April through to the end of June, but in years when there is little cold weather, plants will seed from April through to December. Some plants can set seeds when only 10 cm high (Anon., 2001b).

Reproductive Biology

Up to 20,000 seeds/m²/year can be produced (Kuniata et al., 1993). Even seedlings a few weeks old can produce viable seed (Holm et al., 1977; Waterhouse and Norris, 1987; Parsons and Cuthbertson, 1992). Although the plant produces copious quantities of flowers, the percentage of floral and/or fruit abortions in Peninsular Malaysia is about 45-50%. Those in the north rarely produce fruits whereas those in the south produce fruits in abundance (Baki and Prakash, 1994).

The plant is extremely persistent because it produces physically and physiologically hard seeds which can survive in the soil for many years (Chadhokar, 1978; Henty and Pritchard, 1988; Parsons and Cuthbertson, 1992; Kuniata et al., 1993; Muniappan and Viraktamath,

1993). Seeds may remain dormant for up to 50 years (Anon., 2001b). The seeds have a long dormancy (Soerjani et al., 1987; Swarbrick, 1989) which can be broken by the heat from grass fires (Kuniata et al., 1993). The spiny seed pods are adapted to dispersal by animals and floodwaters, but seeds can also be distributed in contaminated hay, impure agricultural seed and construction materials, as well as by boats, vehicles and machinery (Holm et al., 1977; Parsons and Cuthbertson, 1992; Kuniata et al., 1993).

Although the seeds may germinate at any time of the year when the right conditions of moisture and temperature are met, most germination occurs at the beginning of the wet season (Parsons and Cuthbertson, 1992). The first true leaf is deeply divided with several pairs of opposite leaflets and subsequent leaves are bipinnate (Parsons and Cuthbertson, 1992).

Environmental Requirements

M. diplotricha is major weed in pastures, plantations and roadsides and can also be serious in crops. It grows best where fertility, soil and air humidity and light are all high and dies away in prolonged dry seasons (Swarbrick, 1997). In its native range, the shrub is often found in disturbed shrub-woodland, at the edge of gallery forest and open rocky places (Barneby, 1991). Low temperatures limit the species but its tolerance limits are unclear. In Australia, reproduction is limited by cold (Anon., 2001b) and Hong Kong winters may be too cold for it to become an important component of the local vegetation (Corlett, 1996). It is a lowland species and in Bolivia, for instance, it has been recorded at an altitude of 270 m (Smith and Killeen, 1994) and up to 1000 m in Sao Paulo, Brazil (Barneby, 1991).

Associations

M. diplotricha has a woody taproot with nitrogen-fixing nodules on the laterals (Swarbrick, 1989).

MEANS OF MOVEMENT AND DISPERSAL

Natural Dispersal (Non-Biotic)

Seeds are transported by running water (Anon., 2001).

Vector Transmission (Biotic)

Barbed seeds are carried by animals or on clothing.

Accidental Introduction

M. diplotricha may be transported on vehicles, machinery and in contaminated earth (Anon., 2001b).

Transport pathways for long distance movement

- Conveyances (transport Vehicles) (Anon. 2001b)
- Soil, Gravel, Water, Etc. (Anon. 2001b)
- Travellers And Baggage: Clothing (Anon. 2001b)

NATURAL ENEMIES

Waterhouse (1994) records that at least 70 species of insect attack *M. diplotricha* in Brazil and lists these and three fungi. *Heteropsylla spinulosa* was collected in Brazil and released in Australia and Western Samoa as a biological control agent against *M. diplotricha*. Nymphs and adults suck sap from leaflets, rachises and growing tips. The tips become thickened and brittle and growth is stunted, distorted and deformed. Adults are pale green, about 2.5 mm long and live for 3-10 days. Females lay about 15 eggs/day and a total of about 50 eggs. The nymphs pass through five instars. The life cycle is completed in 20-28 days. *H. spinulosa* completes up to eight generations per year in its native range. The relatively short life cycle, combined with high egg production makes it possible for populations to increase rapidly. Adults disperse widely with the aid of the wind (Lockett and Ablin, 1990; Willson and Garcia, 1992; Kuniata et al., 1993).

Scamurius sp. was also collected in Brazil and introduced into Australia as a biological control agent. Adults and nymphs feed on the growing tips of the plants or on the leaf rachises. Feeding causes the collapse and death of the tip. The adult is green and brown with red on the abdomen under the wings. It is about 22 mm long. There are five instars prior to maturity, and the adults live for 2-3 months. Females lay up to 300 eggs (Anon., 1988).

Psigidia walkeri, a widespread moth in Brazil which feeds voraciously as a larva on leaves, flower buds, green pods, tender stems and branches of *M. diplotricha* (Waterhouse and Norris, 1987) is undergoing testing in quarantine in Australia as a potential biological control agent (M Vitelli, Tropical Weeds Research Centre, Queensland, Australia, personal communication, 1994). Other natural enemies of *M. diplotricha* in its native range, both insects and fungal pathogens, are listed by Waterhouse and Norris (1987).

In north-east India, where *M. diplotricha* is widely used as a soil rehabilitation crop, looper caterpillars (*Semiothisa* sp.) cause extensive defoliation (Anon., 1974). In Thailand an endemic lymantriid moth *Euproctis fraterna* feeds on the young leaves and flowers (Napompeth, 1990). Kuniata and Nagaraja (1994) recorded 14 species of phytophagous insects feeding on *M. diplotricha* in Papua New Guinea, most of them polyphagous lepidopterans. Most of the insects were also collected on various cultivated crops. The fungal pathogen *Corynespora cassiicola* was recorded killing *M. diplotricha* plants in Queensland, Australia (Waterhouse and Norris, 1987).

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:		
<i>Cercospora canescens</i> (Cercospora leaf spot)	Stems	
<i>Corynespora cassiicola</i> (target leaf spot of tomato)		
<i>Fusarium</i>		

Herbivores:

Balclutha

Euproctis fraterna (coffee hairy caterpillar) Leaves

Heteropsylla cubana (leucaena psyllid) Stems, Leaves

Heteropsylla spinulosa Stems, Leaves Australia; Papua New Guinea; Western Samoa

Scamurius Stems, Leaves

IMPACT

Economic impact

M. diplotricha is regarded by Holm et al. (1977) as being one of the 76 worst weeds of the world. They list it as a weed of 13 crops in 18 countries. Waterhouse and Norris (1987) consider it a serious weed in the Pacific islands, South-East Asia, Mauritius and Nigeria. It rapidly smothers crops and pastures in tropical and subtropical countries, reducing yields. Where hand harvesting of crops is carried out, infested fields are made difficult and dangerous to work; the thorns can cause serious sores on humans (Waterhouse and Norris, 1987). Mechanical harvesters can also be jammed when used in infested crops (Parsons and Cuthbertson, 1992). In Nigerian cassava fields increasing populations of *M. diplotricha* rapidly decrease cassava tuber yields. When *M. diplotricha* density reached 630,000 plants per ha, cassava root yield 12 months after planting was reduced by 80% (Alabi et al., 2001).

Infestations of *M. diplotricha* can be encouraged by overgrazing (Chadhokar, 1978) thus animals are prevented from grazing in heavily infested areas. *M. diplotricha* thickets become a serious fire hazard when dry (Holm et al., 1977; Waterhouse and Norris, 1987). In Papua New Guinea, *M. diplotricha* has a direct negative impact on growth, yield and harvesting of sugarcane, but no direct assessment of the actual economic losses has been made. However, on cattle ranches in the Markham Valley, up to US\$ 130,000 is spent annually on chemical control (Kuniata, 1994).

There is evidence that *M. diplotricha* is toxic to stock (Waterhouse and Norris, 1987; Gibson and Waring, 1994), although Parsons and Cuthbertson (1992) report that a wether fed 60-90 g/day mixed with lucerne chaff did not suffer any adverse symptoms. In Thailand, 22 swamp buffaloes died 18-36 hours after eating *M. diplotricha* var. *inermis* (Tungtrakanpoung and Rhenpanish, 1992). The symptoms were salivation, stiffness, lack of mastication, muscular tremor, dyspnea and recumbency. The toxic elements were found to be cyanide and nitrite. Alex et al. (1991) reported a clinical case of *M. diplotricha* var. *inermis* poisoning of a 2-year-old Jersey-cross heifer in India. The severity of the clinical signs and lesions correlated well with the quantity of the weed consumed. Other animals grazing in the same area did not develop any clinical signs of toxicity, and it appears as if the toxicity is also related to the stage of growth of the plant, and various other animal factors such as the development of tolerance. Tests in Queensland, Australia, show this variety to be toxic to sheep, and a report from Flores, Indonesia, suggests that it is toxic to pigs (Parsons and Cuthbertson, 1992).

Environmental impact

It has the ability to climb over other plants (Schultz, 2000) and probably can shade out light-demanding species and prevent the natural regeneration of other species. It constitutes a wildland fire hazard when dry (PIER, 2004).

Social impact

M. diplotricha has all the characteristics to negatively impact on human activities. The numerous sharp recurved prickles associated with a scrambling habit may give the impression, both visual and tactile, of a sort of 'organic or green barbed wire' (Corlett, 1996, 2001). It does make human movement difficult.

Impact on biodiversity

In Australia it is considered that the plant can exert some intermittent competition and form dense mats to adversely affect the growth of a number of native species (Werren, 2001). It is thought that it would seriously affect the ecology of native plants and animals if allowed to spread in Western Australia (Wilson, 2004).

Summary of impact

Negative impact on: environment; crop production; livestock production; native flora; transport and travel

PHYTOSANITARY SIGNIFICANCE

This species has only relatively recently reached some tropical regions, such as Taiwan, and has become a major weed of agricultural systems in Nigeria where it was previously only known as a weed of roadsides, ditches and wastelands. It has the potential to be introduced, to spread and become a major weed in many tropical areas. It is a declared weed in Australia and, when found, must be eradicated. Recently a plant was found and eradicated in Western Australia, where the local population, and landowners in particular, have been alerted to the threat of its spread (Wilson, 2004). Similarly in Hong Kong the public has been requested to report all new potential sightings (Corlett, 2001).

The species is included as a noxious weed on many country lists including the USA and State of Hawai'i noxious weed lists and is a declared noxious weed in Fiji (PIER, 2004). In Australia's Northern Territory it belongs to the class of Declared Weed: C, i.e. not to be introduced to the Territory (Schultz, 2000). It is also a declared plant under Queensland legislation. This requires landholders to control the pest on the land under their control (Anon., 2001b). In Palau, it was recommended that the species should be excluded from islands where it is not present and eradicated on islands with small populations (Holm and Michaels, 2003).

In Queensland (Australia), machinery passing through infested areas must be washed before moving on to uninfested areas. Sugar cane contaminated with seeds of *M. diplotricha* should not be harvested or transported. Some sand pits have been quarantined and records of all sand/gravel movements from these sites must be kept (Anon., 2001).

SUMMARY OF INVASIVENESS

This small, often scrambling, neotropical shrub has invaded many countries in the old tropics and many oceanic islands. In recent decades it has spread to new regions and has the potential to invade more tropical areas. It forms impenetrable spiny thickets that invade highly disturbed sites, but agricultural systems in particular. The shrub produces

large quantities of seeds at an early age and has a persistent seed bank. It is extremely difficult to control it effectively using mechanical or chemical means. However, biological control programmes have had a large degree of success.

Risk and Impact Factors

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

MORPHOLOGY

Plant type: annual; succulent; woody; seed propagated; biennial.

The following information is distilled from Holm et al. (1977); Soerjani et al. (1987); Waterhouse and Norris (1987); Henty and Pritchard (1988); Parsons and Cuthbertson (1992) and Noda et al. (1994).

M. diplotricha is a scrambling, strongly branched shrub growing 1-2 m tall, woody at the base with age, with stems stretching to about 6 m long, forming low, tangled masses or climbing on other vegetation with the aid of its spiny stems. The green or purplish tinged stems are 4- or 5-angled in cross-section and covered with abundant sharp, recurved, yellowish spines, 3-6 mm long, on the angles and fine, white hairs. According to Henty and Pritchard (1988) the stems do not root above the base, but according to Soerjani et al. (1987) they do. The root system has a robust and branching taproot extending to 1-2 m in depth and often woody at the crown. There are characteristic rhizobial nodules on the root hairs.

The scattered bright-green leaves are finely bipinnate and 10-20 cm long. The leaves consist of 4-9 pairs of pinnae, 3-6 cm long, each with 12-30 pairs of opposite, sessile, lanceolate, acute leaflets, 6-12 mm long and 1.5 mm wide. The leaflet pairs fold together when touched and at nightfall, but they are considered as only moderately sensitive. The rachis is thickened at the base with slender, tapering stipules, and finely hairy with a few prickles along the back.

The flowers are pinkish-violet in colour and occur in globose heads about 12 mm in diameter, singly, in pairs or threes on individual stalks originating in the axils of young leaves. The peduncles are 6-10 mm long and hairy. The corolla is 2 mm long, regular, 4-lobed and green at the tips, with 8 pinkish-violet exerted stamens. The flat, softly spiny, linear, 3-6 seeded pods are 10-35 mm long, 6-10 mm wide, occur in clusters in the leaf axils and break into 1-seeded joints which fall away from unbroken sutures. The seeds are yellow-brown, glossy, flattened, ovate and 2-3.5 mm long. There is a horseshoe-shaped ring on each face. The plant reproduces only by seed.

SIMILARITIES TO OTHER SPECIES

M. diplotricha is similar in appearance to its close relative, the weed *M. pudica* (common sensitive plant). The two are easily separated by the following characteristics. *M. diplotricha* has stems which are angled in cross-section and covered in abundant sharp, recurved prickles along the angles. *M. pudica* has round stems with only scattered prickles on the internodes. The bipinnate leaves of *M. diplotricha* have 4-9 pairs of pinnae, whereas those of *M. pudica* have 1-2 pairs of pinnae. The leaves of *M. pudica* are much more sensitive than those of *M. diplotricha*. When touched, the leaflet pairs of *M. pudica* rapidly fold together and the rachis folds against the stem.

CONTROL

Cultivation, cutting or burning are not generally effective methods of control because plants vigorously regrow from the root crown, and seedling development is rapid and prolific (Waterhouse and Norris, 1987; Parsons and Cuthbertson, 1992). The plant produces copious quantities of seeds which retain their viability in the soil for long periods (Muniappan and Viraktamath, 1993). In any event, waterlogged fields often make mechanical solutions impossible, and seeds can be readily spread on machinery (Holm et al., 1977). Plants can be uprooted by hand when they are very young (Chadhokar, 1978) but the thorns are capable of causing serious sores (Waterhouse and Norris, 1987). In Indonesia, *M. diplotricha* in cropping areas is controlled by hand weeding and tillage cultivation (Suryatna and McIntosh, 1982). Hand weeding is difficult because of the extreme prickliness of the plant (Alabi et al., 2001).

In Queensland, Australia, heavily infested sugarcane fields may need to be quarantined for several years and the crop destroyed to prevent further spread of *M. diplotricha* seed (Parsons and Cuthbertson, 1992). In specific cases cultivation may be effective to control seedlings (Anon., 2001b).

In the Philippines island of Mindanao, the biomass of *M. diplotricha* was significantly reduced at 30 days after crop emergence when upland rice was treated with 5 t/ha of fresh *Gliricidia sepium* green manure plus 5 t/ha of fresh *Senna spectabilis* mulch (MacLean et al., 2003).

Mechanical Control

In Nigeria, Alabi et al. (2004) compared six weeding regimes in cassava infested with 10,000 plants/ha. They concluded that manual removal of the weed, using a traditional hand-held hoe to a depth of 3 to 5 cm, at 4, 7, and 11 weeks after planting consistently gave the highest cassava root yield. After 11 weeks the shrub had no more detrimental effect on cassava.

Slashing in pastures and other non-crop situations on a regular basis to prevent seeding is said to provide effective control (Anon., 2001b).

Chemical Control

M. diplotricha has been successfully controlled in many situations using foliar applications of herbicides such as picloram, clopyralid and fluroxypyr (Parsons and Cuthbertson, 1992). The amount of chemical needed can be reduced by application onto regrowth following slashing or burning (Chadhokar, 1978). Spraying should be carried out after rain when the plants are actively growing, and a thorough wetting of the foliage is necessary (Chadhokar, 1978; Parsons and Cuthbertson, 1992). These foliar herbicides will also affect other pasture legumes and may need to be applied several times during a season to control seedlings before they set further seed of their own (Parsons and Cuthbertson, 1992). Pre-emergence chemicals such as atrazine + 2,4-D mixtures or tebuthiuron can be used in seed beds, but they only remain active for a few months (Waterhouse and Norris, 1987; Parsons and Cuthbertson, 1992) and sometimes follow-up foliar sprays are required 1-3 months after planting (Mendoza, 1979). Seeds of *M. diplotricha* are not killed by short-lived fumigants such as methyl bromide, and only long-lasting soil sterilants are effective (Waterhouse and Norris, 1987). However, chemical controls are frequently considered too expensive to use and are not always effective (Waterhouse and Norris, 1987; Groves, 1991; Muniappan and Viraktamath, 1993; Kuniata and Nagaraja, 1994). Effective herbicides to control the weed in African cassava fields have yet to be identified (Alabi et al., 2001).

In Australia a fact sheet provides practical advice to control *M. diplotricha* in sugar cane (Anon., 2001b). A number of pre- and post-emergence herbicides are listed and include guidelines on rates of application as well as rates and timing for optimal application. For instance, in non-grazed infested areas, fluroxypyr can be effective (Anon., 2001b).

Biological Control

Heteropsylla spinulosa was first collected on *M. diplotricha* in Brazil in 1982. High populations cause stunting and distortion of the leaves and may prevent flowering due to the toxic effects of salivary injections. Approval to release *H. spinulosa* in Australia as a biological control agent against *M. diplotricha* was granted in December 1987 after detailed host-specificity testing under quarantine conditions, and the first field releases occurred in north Queensland in January 1988. During the 1988/89 summer, a dramatic reduction in the vigour of *M. diplotricha* was observed and seed production was suppressed by over 88%. Seedling establishment was reduced and some mature plants killed (Lockett and Ablin, 1990). *H. spinulosa* is now well established (Willson and Garcia, 1992), has spread significantly (Cullen and Delfosse, 1990), and is causing a dramatic reduction in vigour and seed production of *M. diplotricha* in Australia (Parsons and Cuthbertson, 1992; Julien, 1992). It was transferred from Australia to Western Samoa in 1988-89 (Willson and Garcia, 1992) and Papua New Guinea in 1991 (Kuniata, 1994). It is well established in both places. In Papua New Guinea, *H. spinulosa* was adversely affected by drought in 1997, but quickly recovered the following year. The introduction of parasitic wasps, *Psyllaephagus* spp., for the biological control of *Heteropsylla cubana* is a cause for concern (Kuniata and Korowi, 2001).

Scamurius sp. was introduced into Australia from Brazil in 1984, and released into the field at Tully in north Queensland in November 1987 (Anon., 1988). It appeared to establish initially (Anon., 1988) but Julien (1992) records that it failed to establish in the longer term.

Psigidia walkeri, a widespread moth in Brazil which feeds voraciously as a larva on leaves,

flower buds, green pods, tender stems and branches of *M. diplotricha* (Waterhouse and Norris, 1987). It was found to feed on a large number of species, including native Australian *Neptunia* species, and thus was not released in Australia (Vitelli et al., 2001).

An indigenous stem-spot fungus *Corynespora cassiicola*, apparently specific to *M. diplotricha*, has also exercised a degree of control in Queensland, where it is now widespread. It causes defoliation and dieback in very hot humid conditions, and if these conditions prevail late in the season, flowering and seed production can be reduced (Anon., 2001b).

In the Republic of Palau, Holm and Michaels (2003) noted that biological control agents had been released for *M. diplotricha*, and recommended that their status should be checked before reintroducing or introducing new ones as appropriate.

Integrated Control

Although *Heteropsylla spinulosa* can control *M. diplotricha* in north Queensland (Australia) in non-crop areas, pasture and non-crop infestations should be assessed for insect abundance between November and April. The effectiveness of insect control can be predicted by the abundant *H. spinulosa* prior to flowering commencing in early April. When insects are present in large numbers, the growing tips and leaves are curled and stunted, resulting in no or limited flower production. If insect numbers are low then slashing or herbicide application should be carried out before to April for effective control (Anon., 2001b). Grazing by domestic stock tends to control this protein rich legume and prevent it dominating pasture vegetation. Plants stunted by *H. spinulosa* attack are less spiny and more readily grazed by livestock (Anon., 2001b).

The best approach to control the weed is usually to combine different methods. Control may include chemical, mechanical, fire and biological methods combined with land management changes and will be site specific. Early infestations should be treated with herbicide or slashed before seeding occurs; once a plant seeds, infestations will re-occur each year for many years as seeds retain their viability (Anon., 2001b).

USES

In Queensland, Australia, *M. diplotricha* is considered unpalatable to stock (Lockett and Ablin, 1990). However, in a study on Guadalcanal in the Solomon Islands, Smith and Whiteman (1985) found that it could be successfully grazed. They found that large impenetrable thickets developed at moderate animal densities when there was ample alternative browse and no compulsion to graze the *Mimosa* spp., but at higher animal densities, continued trampling and grazing reduced the percentage of *M. diplotricha* and led to an increase in *Mimosa pudica*. While continually heavily grazed, both species of *Mimosa* were kept small.

M. diplotricha has a woody taproot with nitrogen-fixing nodules on the laterals (Swarbrick, 1989). Because of this feature and its tolerance for light shade, it is frequently used as a cover crop and soil renovator in plantations, adding nitrogen and organic matter, reducing erosion (Holm et al., 1977; Allen and Allen, 1981; Henty and Pritchard, 1988) and preventing cattle invading and damaging the estate crops (Alex et al., 1991). The spineless variety *M. diplotricha* var. *inermis* is preferable to the spiny variety, but is less effective as a cover crop (Henty and Pritchard, 1988). In rubber plantations in Indonesia, *M. diplotricha* is valued as it ousts *Imperata cylindrica*, which is considered a more troublesome weed, and it is rolled back with sticks to keep the boles of the rubber trees accessible (Soerjani et al.,

1987). It is also used in coffee plantations in the Côte d'Ivoire as a weed control measure (Lavabre, 1971). In Sri Lanka, the use of *M. diplotricha* as a cover crop in rubber plantations improved the growth and girth of rubber trees more economically than the addition of nitrogen to natural covers (Yogarathnam et al., 1984). It is used as a green manure under coconuts in India (Thomas and Shantaram, 1984; Thomas and George, 1990); tobacco in Sumatra, Indonesia (Wiersum, 1983); arecanut palms in India (Sannamarappa, 1987); tea in Indonesia (Wargadipura, 1973); coffee in the Côte d'Ivoire (Lavabre, 1971); cocoa in Cameroon (Rivoire, 1982); rubber in Sri Lanka (Yogarathnam et al., 1977, 1984; Jayasinghe, 1991) and Indonesia (Soerjani et al., 1987); and maize in Thailand (Sukthumrong et al., 1987).

In coconut plantations in Kerala, India, an experiment was conducted using the area around the base of each palm (1.8 m radius) for raising green manure crops (Thomas and George, 1990). *M. diplotricha* was superior to other species tested in green matter production and nitrogen yield. The green manuring treatment was effective in raising soil fertility parameters. The use of *M. diplotricha* enhanced the yield of coconuts suffering from root wilt disease by over 20%. In Cameroon, *M. diplotricha* is used as an inter-row shade plant in cocoa where its beneficial effects on soil organic matter and biological activity are reflected in increased growth of young cocoa trees (Rivoire, 1982). In tobacco plantations in Sumatra, use of *M. diplotricha* as a cover crop reduced the incidence of slime disease (*Ralstonia solanacearum*) to very low levels, but resulted in a lower quality of tobacco (Wiersum, 1983).

M. diplotricha is also a major source of pollen grains for Italian honeybees (*Apis mellifera*) in the Philippines (Payawal et al., 1991).

PESTS

Pests listed in the database

Major host of:

Hyposidra talaca

Host of (source - data mining):

Eurema hecabe (common grass yellow)

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