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Diseases of *Desmodium* species — a Review

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Abstract

Fungal pathogens representing 36 genera and over 70 species, one bacterium, mycoplasma-like-organisms, at least six viruses, five races of root-knot nematodes and six other nematodes have been recorded on 18 *Desmodium* species of agronomic interest throughout tropical regions. Although limited information precludes a definitive discussion of the relative importance of many diseases, two fungal diseases — *Synchytrium desmodii* and *Phanerochaeta salmonicolor* — causing wart and pink disease, respectively, of *Desmodium ovalifolium* and several nematode pathogens including races of the root-knot nematodes *Meloidogyne arenaria, M. hapla, M. incognita* and *M. javanica* of *Desmodium* species and stem gall nematode *Pterotylenchus cecidogenus* of *D. ovalifolium* are presently regarded as important pathogens.

Awareness of the range and distribution of fungal pathogens recorded on *Desmodium* species as well as the existence of potentially seed-borne bacteria and potyviruses is regarded as essential for preventing global transmission of these pathogens and serious disease problems in the future. This is the first time that the great diversity of information available on diseases of *Desmodium* species has been summarized. It should provide a useful reference for many tropical pasture scientists.

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Resumen

Hongos patogénicos pertenicentes a 36 géneros y mas de 70 especies, una bacterium, organísmos-como-micoplasmas, por lo menos seis virus, cinco razas de nemátodo de la raiz y seis nemátodos mas han sido registrados en 18 especies de Desmodium *de interés agronómico en regiónes tropicales. Aunque la información escasa impide una discusión definitiva de la importáncia relativa de muchas enfermedades, dos enfermedades fungosas* — Synchytrium desmodii *y* Phanerochaeta salmonicolor — *causando verruga y enfermedad rosada, respectivamente, en* Desmodium ovalifolium *y algunos nemátodos patogénicas que incluyen razas de nematodes de la raiz* Meloidogyne arenaria, M. hapla, M. incognita *and* M. javanica *de especies de* Desmodium *y el nemátodo del tallo* Pterotylenchus cecidogenus *de* D. ovalifolium *son considerados hasta el presente como enfermedades importántes.*

El conocimiento del rango y distribución de patogénos fungosos registrados en especies de Desmodium *y tambien la existencia potencial de la asociación de bacteria y potyvirus con la semilla se considera esencial para prevenir la transmisión global de patogénos y problemas severos en el futuro. Esta es la primera vez que la gran diversidad de información disponible sobre enfermedades de especies de* Desmodium *se ha resumido. Podría suministrar una referencía útil para muchas cientificos de pastos tropicales.*

Introduction

Desmodium is a widespread legume genus of more than 350 species occurring throughout tropical and sub-tropical regions in open woodland and forest clearings (Imrie *et al* 1983). Its centre of origin and most important centre of diversity is South-east Asia (Ohashi 1973; Liu and Chang 1962). Other centres of diversity occur in Mexico and Brazil (Schubert 1980). The genus includes mostly perennial herbaceous plants or

subshrubs (Imrie *et al* 1983). A number of species are successful or have shown potential as pasture and forage plants and cover crops. These include: *D. adscendens* (Sw.) DC.; *D. barbatum* (L.) Benth.; *D. discolor* Vog.; *D. distortum* (Aulb.) Macbr.; *D. heterocarpon* (L.) DC.; *D. heterophyllum* (Willd.) DC.; *D. incanum* DC.; *D. intortum* (Mill.) Urb.; *D. sandwicense* E.Mey. and *D. uncinatum* (Jacq.) DC. (Imrie *et al* 1983); *D. cajanifolium* (H.B.K.) DC. (Schultze-Kraft and Giacometti 1979); *D. ovalifolium* Wall. (Thomas and Grof 1986; Schultze-Kraft and Benavides 1988); *D. strigillosum* Schindl. and *D. velutinum* (Willd.) DC. (CIAT 1987); *D. gangeticum* (L.) DC.; *D. tortuosum* (Sw.) DC. and *D. triflorum* (L.) DC. (Mehra *et al* 1989) and related *Codariocalyx gyroides* (Link) Hassk. (syn. *D. gyroides* (Link) DC.).

The agronomic value of several *Desmodium* species has been well-documented (Imrie *et al* 1983). Greenleaf (*D. intortum*) and Silverleaf (*D. uncinatum*) are widely adapted, highly productive legumes which associate well with stoloniferous grasses (Cameron 1984; Imrie *et al* 1983). *Desmodium heterocarpon* cv. "Florida" is a productive, persistent summer-growing legume in Florida (Kretschmer *et al* 1976) while several *D. ovalifolium* accessions associate well with aggressive stoloniferous grasses such as *Brachiaria* species (Grof 1982) and have produced animal gains of 400 to 700 kg/ha/year in the eastern plains of Columbia (Thomas and Grof 1986; Schultze-Kraft and Benavides 1988).

Although *Desmodium* species have been regarded as free of diseases (Bryan 1969; Skerman 1977; Imrie *et al* 1983), recent more intensive and widespread evaluation, particularly of *D. ovalifolium* throughout the tropical American lowlands by CIAT, has identified several major disease problems which limit the commercial use of this otherwise promising legume (Siddiqi and Lenné 1984; Lenné 1985; Schultze-Kraft and Benavides 1988). As other commercial cultivars, such as Greenleaf and Silverleaf, were selected from very narrow genetic bases distant from associated endemic pathogens, their more widespread use could lead to increased disease problems.

This paper consolidates for the first time the diversity of information from host-disease lists, unpublished records from the International Mycological Institute (IMI) and the authors' personal records of diseases of *Desmodium* species of agronomic interest into a more accessible form for future use by tropical pasture scientists. The importance of these diseases is discussed where information is available.

Diseases caused by fungi

Fungi representing 36 genera and over 70 species have been described on *Desmodium* species of agronomic interest (Table 1). Diseases include leaf spots, leaf blotch, tar spots, sooty moulds, leaf moulds, slime mould, anthracnoses, powdery mildews, foliar blight, pink disease, wilts, diebacks, rusts and false-rusts. The greater diversity of fungal diseases of *Desmodium* species in comparison with other well-known pasture legume genera such as *Stylosanthes* (Lenné and Calderon 1984) reflects the naturally widespread distribution and species diversity of the genus.

Leaf spots caused by Cercospora *species and related genera*

Leaf spots caused by at least seven species of *Cercospora* have been described on more than 11 species of *Desmodium* and *C. gyroides* from many different countries representing most tropical and sub-tropical regions of the world (Table 1). *Cercospora canescens, C. melaleuca, C. desmodiicola* and *C. meibomiae* were the most frequently recorded. It is probable that records of *Cercospora* sp. relate to one of these species. *D. tortuosum* appears to be more predisposed to Cercospora leaf spots than other *Desmodium* species, hosting four different species from Ghana, Jamaica, Papua New Guinea, USA, Venezuela and Zimbabwe (Table 1). Cercospora leaf spot is manifest as small (1–3 mm in diameter), rounded, dark brown to black spots often with chlorotic halos (Lenné *et al* 1983). Fructifications are commonly visible on the under-surface of lesions. Under humid conditions, lesions coalesce causing necrotic patches and occasional defoliation. Cercospora leaf spot is at present regarded as a disease of secondary importance in the tropical American lowlands.

Three species of the related fungus *Pseudocercospora* have also been described on *D. gangeticum, D. incanum* and *D. triflorum* from Asia and the Americas (Table 1). No information could be found on the symptomatology or importance of these pathogens.

Leaf spots caused by other fungi

A number of fungal pathogens commonly causing leaf spots of leguminous hosts in the tropics have been widely reported on *Desmodium* species. These include *Acremonium, Alternaria, Cladosporium, Corynespora, Curvularia, Leptosphaeria, Periconia, Pestalotia, Pestalotiopsis, Phaeoisariopsis, Phoma, Phomopsis, Phyllachora, Phyllosticta* and *Pyrenochaeta* (Table 1). Unfortunately, most records are single entries in host lists and/or single diagnoses of specimens sent to the IMI. Consequently, the incidence, severity and distribution of these diseases has not been documented. Awareness of the range of leaf-spotting fungi capable of infecting *Desmodium* species is worthwhile, as a knowledge of the multiple host ranges of many of these fungal pathogens will be of value in predicting potential problems where *Desmodium* is grown in locations where other leguminous hosts occur.

Sooty, leaf and slime moulds

At least 11 different sooty mould-causing *Meliola* species have been reported on *Desmodium* species throughout South-east Asia, Africa, India, Papua New Guinea, Central and South America and the Caribbean (Table 1). *Meliola bicornis* is the most widespread species with the widest host range. Although sooty moulds are regarded as minor diseases of economic plants, under humid conditions the dark, usually black, fungal mycelium colonizes considerable foliage area, reducing photosynthesis and potentially production, as has been observed on *D. barbatum* in Colombia (Lenné unpublished).

In addition to sooty moulds, leaf moulds caused by more than three species of *Parodiella* have been described on six species of *Desmodium* (Table 1). Like *Meliola*, they are widely distributed throughout the tropics. *P. hedysari* has been recorded on at least six *Desmodium* species including *D. ovalifolium* where it causes light grey to black sooty spots on both leaf surfaces but more commonly on the undersurface (Lenné unpublished). Similar symptoms were described on *D. gangeticum* (Kananjia 1978). It is a secondary disease which may reduce photosynthetic capacity under humid conditions.

The slime mould, *Physarum cinereum*, has been recorded on *D. triflorum* in Papua New Guinea (Shaw 1984). Although common on pasture legumes in the tropics, it causes only localized minor damage (Lenné unpublished).

Anthracnoses

Both *Colletotrichum gloeosporioides* and *C. truncatum* have been recorded as pathogens of several *Desmodium* species, particularly in Florida (Lenné and Sonoda 1978) and South America (Lenné 1981a). Wells and Forbes (1963) found that both *D. intortum* and *D. uncinatum* were susceptible to *C. truncatum* in Georgia. Similar observations were made in Colombia (Table 1). Anthracnose has not been recorded in the field on either of the above species in Australia or South-east Asia. In a host range study with Type A and B *C. gloeosporioides* isolates from Australia, *Desmodium barbatum* CPI 40091 was susceptible to the two fungal strains whereas *D. heterocarpon* P 11928 was only susceptible to the Type A fungus. P 11928 was also highly susceptible to a *C. gloeosporioides* isolate from *Aeschynomene falcata* (Vinijsanum *et al* 1987). In Florida and several South American countries, anthracnose is manifest in small (1–5 mm in diameter), mid to dark brown lesions on leaves and dark lesions (up to 4 mm in length) on stems and petioles of *D. barbatum, D. heterocarpon, D. intortum, D. ovalifolium* and *C. gyroides* (Lenné 1981a, Lenné and Sonoda 1978). Damage is usually slight to moderate. Defoliation may occur under humid conditions. Severe anthracnose has been observed only on mature plants of *D. barbatum* in Florida (Lenné and Sonoda 1978). *C. truncatum* has also been recorded as a seed-borne pathogen of several *Desmodium* species (Richardson 1979).

Powdery mildews

Oidium sp. has been noted on more than six different *Desmodium* species and *C. gyroides* in South America and the Caribbean (Table 1). In addition, Chardon and Toro (1930) found *O. crysiphoides* on *D. tortuosum* in Colombia. Records of *Oidium* sp. on *Desmodium* species in Colombia may also relate to this species. Powdery mildew is manifest as white patches of spores and mycelium on the upper surface of leaflets. In severe infections, mildew totally covers leaf surfaces causing necrosis and defoliation (Lenné *et al* 1983).

Table 1. Diseases of Desmodium species of agronomic interest

Diseases	Causal agent	Host range	Distribution[1]	Source
Fungal Diseases				
Leaf spot	*Acremonium zonatum* (Saw.) W. Gams	*D. velutinum* (Willd.) DC.	Ia	IMI (per. comm.)
	Alternaria sp.	*Desmodium* sp.	ES	Stevenson & Wellman (1944), Crandall et al. (1951)
	Cercospora canescens Ell. & Mart.	*D. incanum* DC.	Ba	Norse (1974)
		D. intortum (Mill.) Urb.	A, G	Alcorn (1972)
		D. tortuosum (Sw.) DC.	Zi, PNG	IMI (per. comm.), Shaw (1984)
		D. uncinatum (Jacq.) DC	K	IMI (per. comm.)
		Desmodium sp.	Ba, Ia	Norse (1974), IMI (per. comm.)
	C. daviesiae Cke. & Mass.	*Desmodium* sp.	A	Simmons (1966)
	C. desmodii Ell. & Mart.	*Desmodium* sp.	ES	Stevenson & Wellman (1944), Crandall et al. (1951)
	C. desmodiicola Atk.	*D. intortum* (Mill.) Urb.	J, USA	Chupp (1953)
		D. tortuosum (Sw.) DC.	J, USA	Chupp (1953)
	C. desmiodiicola Atk. var. *leiocarpa* Ell. & Kell.	*D. tortuosum* (Sw.) DC. *Desmodium* sp.	V	Standen (1952)
	C. meibomiae Chupp	*D. incanum* DC.	V	Standen (1952), Chupp (1953)
		Desmodium sp.	V	Standen (1952)
	C. melaleuca Ell. & Ev.	*D. distortum* (Aubl.) Macbr.	J	Leather (1967), IMI (per. comm.)
		D. gangeticum (L.) DC.	Ia	IMI (per. comm.)
		D. intortum (Mill.) Urb.	J	Leather (1967)
		D. tortuosum (Sw.) DC.	J, Zi	IMI (per. comm.)
		Desmodium sp.	Ta	IMI (per. comm.)
	Cercospora sp.	*D. barbatum* (L.) Benth.	Br, Co	Lenné et al. (1983)
		D. cajanifolium (H.B.K.) DC.	V	Standen (1952)
		D. incanum DC.	J	Leather (1967)
		D. gangeticum (L.) DC.	Ia	IMI (per. comm.)
		D. heterocarpon (L.) DC.	Br, Co	Lenné et al. (1983)
		D. heterophyllum (Willd.) DC.	Co	Lenné et al. (1983)
		D. ovalifolium Wall.	Co	Lenné et al. (1983)
		Codariocalyx gyroides (Link) Hassk.	Br, Co, E, Pe, V, CA	Lenné (unpubl.)
	Corynespora cassiicola (Berk. & Curt.) Wei	*Desmodium* sp.	PR	IMI (per. comm.)
	Curvularia trifolii (Kauffm.) Boedijn	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
	Leptosphaeria ogilviensis (Berk. & Br.) Ces. & De Not.	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
	Periconia byssoides Pers.	*D. uncinatum* (Jacq.) DC.	K	IMI (per. comm.)
	Pestalotia sp.	*D. ovalifolium* Wall.	Co	Lenné (unpubl.)
	Pestalotiopsis adusta (Ell. & Ev.) Steyaert	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
	P. disseminata (Thum) Speg.	*D. ovalifolium* Wall.	Ma	Sing (1973)
	P. versicolor (Speg.) Steyaert	*D. heterocarpon* (L.) DC.	HK	IMI (per. comm.)
	Pestalotiopsis sp.	*Desmodium* sp.	Ma	IMI (per. comm.)
	Phaeoisariopsis caespitosa Petr. & Cif.	*Desmodium* sp.	ES	Crandall et al. (1951)
	P. griseola (Sacc.) Ferraris	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
	Phoma sp.	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
		D. uncinatum (Jacq.) DC	K	IMI (per. comm.)
	Phomopsis sp.	*D. incanum* DC.	Cu	IMI (per. comm.)
	Phyllosticta desmodii Ell. & Ev.	*Desmodium* sp.	Cu, Ia, S	IMI (per. comm.), Tarr (1955)
	P. desmodiicola Died.	*Desmodium* sp.	S	Tarr (1955)
	Phyllosticta sp.	*D. gangeticum* (L.) DC	Ia	IMI (per. comm.)
		D. velutinum (L.) DC.	Ta	IMI (per. comm.)
	Pseudocercospora bhopalensis Deighton	*D. triflorum* (L.) DC.	Ia	IMI (per. comm.)
	P. meibomiae (Chupp) Deighton	*D. incanum* DC.	Cu	IMI (per. comm.)
	P. mulleri Deighton	*Desmodium* sp.	V	IMI (per. comm.)

Table 1. Continued

Diseases	Causal agent	Host range	Distribution[1]	Source
	Pyrenochaeta sp.	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
		Desmodium sp.	V	IMI (per. comm.)
Leaf blotch	*Cladosporium oxysporum* Berk. & Curt.	*D. incanum* DC.	Cu	IMI (per. comm.)
Tar spot	*Phyllachora desmodii*	*Desmodium* sp.	Bu	IMI (per. comm.)
	Phyllachora sp.	*Desmodium* sp.	J	Leather (1967)
Sooty mould	*Meliola bantamensis* Hansf.	*D. gangeticum* (L.) DC.	Ph, Is	IMI (per. comm.)
		Desmodium sp.	DR, V	IMI (per. comm.), Standen (1952)
	M. bicornis Wint.	*D. adscendens* (Sw.) DC.	J, SL, Tr, V	Chardon & Toro (1934), Baker & Dale (1951), Standen (1952), Leather (1967), IMI (per. comm.)
		D. barbatum (L.) Benth.	Co, Tr	Lenné (unpubl.), Baker & Dale (1951), IMI (per. comm.)
		D. incanum DC.	Br, Cu, V	IMI (per. comm.), Chandon & Toro (1934), Standen (1952)
		D. gangeticum (L.) DC.	DEI, Ph, SL	IMI (per. comm.)
		Desmodium sp.	Bu, Ia, PNG, S, Tr, U, V	Chardon & Toro (1934), Baker & Dale (1948–1951), Standen (1952), IMI (per. comm.), Shaw (1984)
	M. bicornis Wint. var. *tephrosiae* Beeli	*Desmodium* sp.	U	IMI (per. comm.)
	M. denticulata Wint.	*D. incanum* DC.	V	Chardon & Toro (1934), Standen (1952)
	M. desmodii Kars. & Roum.	*D. incanum* DC.	V	Standen (1952)
	M. heterocephala Syd.	*Desmodium* sp.	Ph	IMI (per. comm.)
	M. kawandensis Hansf.	*Desmodium* sp.	G	IMI (per. comm.)
	M. scabriseta var. *integra* Deighton ined.	*D. gangeticum* (L.) DC.	Ph	IMI (per. comm.)
		Desmodium sp.		
	M. stizolobi Hansf. & Deighton	*Desmodium* sp.	V	IMI (per. comm.)
	M. stizolobi var. *desmodii-salicifolii* Hansf. & Deighton	*Desmodium* sp.	J	Leather (1967)
	M. trinidadensis (Berk. & Curt.) Speg.	*Desmodium* sp.	Tr	Baker & Dale (1951)
	M. vignae-gracilis Hansf. & Deighton var. *panamensis* Hansf.	*Desmodium* sp.	Pa	IMI (per. comm.)
	Meliola sp.	*Desmodium* sp	J, Ma, S	Tarr (1955), Turner (1971), IMI (per. comm.)
Leaf mould	*Paradiella hedysari* (Schw.) Hughes	*D. adscendens* (Sw.) DC.	J, SL, Tr	IMI (per. comm.)
		D. barbatum (L.) Benth.	Tr, Za, V	IMI (per. comm.) Standen (1952)
		D. gangeticum (L.) DC.	Ia	Kananjia (1978)
		D. ovalifolium Wall.	Co	Lenné (unpubl.)
		D. triflorum (L.) DC.	Ph	IMI (per. comm.)
		Desmodium sp.	Cm, Ia	IMI (per. comm.)
	P. paraguayensis Speg.	*D. tortuosum* (Sw.) DC.	Tr	Baker & Dale (1951)
		Desmodium sp.	V	Chardon & Toro (1934), Standen (1952)
		D. barbatum (L.) Benth.	Tr, V	Baker & Dale (1951), Standen (1952)
	P. perisporioides (Berk. & Curt) Speg.	*Desmodium* sp.	Co, ES, J, V	Chardon & Toro (1930), Stevenson & Wellman (1944), Standen (1952), Leather (1967)
	Parodiella sp.	*D. triflorum* (L.) DC.	PNG	Shaw (1984)

Table 1. Continued

Diseases	Causal agent	Host range	Distribution[1]	Source
Slime mould	*Physarum cinereum* (Batsch) Pers.	*D. triflorum* (L.) DC.	PNG	Shaw (1984)
Anthracnose	*Colletotrichum gloeosporioides* Penz. & Sacc.	*D. barbatum* (L.) Benth.	A, Br, Co, CA	Vinijsanum et al. (1987) Lenné (1981a), Lenné & Sonoda (1978)
		D. gangeticum (L.) DC.	Ia	Lenné (1981a), Lenné & Sonoda (1978)
		D. heterocarpon (L.) DC.	A, Bo, Br, Co	Vinijsanum et al. (1987) Lenné & Sonoda (1978)
		D. intortum (Mill.) Urb.	Co	Lenné (unpubl.)
		D. ovalifolium Wall.	Bo, Br, Co, E, Pe, V	Lenné (unpubl.)
		D. triflorum (L.) DC.	Ia	CMI (per. comm.)
		Codariocalyx gyroides (Link) Hassk.	Co	Lenné (unpubl.)
	C. truncatum (Schw.) Andrus & Moore	*D. barbatum* (L.) Benth.	Br, Co, CA	Lenné (1981a) Lenné & Sonoda (1978)
		D. heterocarpon (L.) DC.	Br, Co	Lenné (unpubl.)
		D. intortum (Mill.) Urb.	Co, USA	Lenné (unpubl.), Wells & Forbes (1963)
		D. ovalifolium Wall.	Br, Co, CA, USA	Lenné (1981), Lenné & Sonoda (1978)
		D. uncinatum (Jacq.) DC.	USA	Wells & Forbes (1963)
		Desmodium sp.	USA[2]	Richardson (1979)
	Colletotrichum sp.	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
Powdery mildew	*Oidium crysiphoides* Fr.	*D. tortuosum* (Sw.) DC.	Co	Chardon & Toro (1930)
	Oidium sp.	*D. cajanifolium* (H.B.K.) DC.	Co	Lenné et al. (1983)
		D. incanum DC.	Ba, Cu	Norse (1974), IMI (per. comm.)
		D. heterocarpon (L.) DC.	Br, Co	Lenné (unpubl.)
		D. intortum (Mill.) Urb.	Co	Lenné et al. (1983)
		D. tortuosum (Sw.) DC.	Ba	Norse (1974)
		Desmodium sp.	Ba, V	Norse (1974), Standen (1952)
		Codariocalyx gyroides (Link) Hassk.	Co	Lenné et al. (1983)
Foliar blight	*Rhizoctonia solani* Kuhn	*D. heterophyllum* (Willd.) DC.	Br, Co Pe, CA	Lenné (unpubl.)
		D. ovalifolium Wall.	Br, Co, Cu, Ma, Pe	Lenné (unpubl.), Tang et al. (1984), Sing (1973)
		D. uncinatum (Jacq.) DC.	Ma	IMI (per. comm.)
Pink disease	*Phanerochaete salmonicolor* (Berk. & Br.) Julich	*Desmodium* sp.	Ma	Turner (1971), William & Liu (1976)
		D. ovalifolium Wall.	Ma	Thompson & Johnson (1953)
Seedling wilt	*Pythium middletonii* Sparrow	*D. intortum* (Mill.) Urb.	A	IMI (per. comm.)
Wilt	*Fusarium moniliforme* Sheldon	*Desmodium* sp.	F	IMI (per. comm.)
	F. semitectum Berk. & Rav.	*D. uncinatum* (Jacq.) DC.	K	IMI (per. comm.)
	Fusarium sp.	*D. ovalifolium* Wall.	Co	Lenné (unpubl.)
		Desmodium sp.	J	IMI (per. comm.)
	Sclerotium rolfsii Sacc.	*D. barbatum* (L.) Benth. *D. incanum* DC. *D. distortum* (Aubl.) Macbr. *D. heterocarpon* (L.) DC. *D. heterophyllum* (Willd.) DC. *D. ovalifolium* Wall	Co	Lenné (1979)
		Desmodium sp	Co	Chardon & Toro (1930)
		Codariocalyx gyroides (Link) Hassk.	Co	Lenné (1979)
Dieback	*Diaporthe phaseolorum* (Cke. & Ell.) Sacc.	*Desmodium* sp.	DR	IMI (per. comm.)
	Nectria ochroleuca (Schw.) Berk.	*Desmodium* sp.	Ta	IMI (per. comm.)

Table 1. Continued

Diseases	Causal agent	Host range	Distribution[1]	Source
Rust	*Aecidium* sp.	*D. incanum* DC.	V	IMI (per. comm.)
		D. intortum (Mill.) Urb.	J	IMI (per. comm.)
	Phakopsora meibomiae (Arth.) Trotter	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
		D. triflorum (L.) DC.	Tr	IMI (per. comm.)
		Desmodium sp.	PNG	Shaw (1984)
	P. pachyrhizi H. Syd. & P. Syd.	*Desmodium* sp.	CA	Deslandes (1979)
	Puccinia sp.	*D. cajanifolium* (H.B.K.) DC.	V	Standen (1952)
	Uredo sp.	*Desmodium* sp.	V	IMI (per. comm.)
	Uromyces hedysaripaniculati (Schw.) Ellis	*D. incanum* DC.	Co	Lenné (unpubl.)
		D. distortum (Aubl.) Macbr.	Tr	Baker & Dale (1951)
		D. intortum (Mill.) Urb.	J, Co	Leather (1967), Lenné (unpubl.)
		D. tortuosum (Sw.) DC.	Co, V	Chardon & Toro (1930), Standen (1952)
		Desmodium sp.	ES, USA[2]	Stevenson & Wellman (1944), Cummins (1981)
		Codariocalyx gyroides (Link) Hassk.	ES	Crandall et al. (1951)
	U. mexicanus Diet. & Holw.	*Desmodium* sp.	SA, CA[2]	Cummins (1978)
	U. tenuistipes Diet. & Holw.	*D. uncinatum* (Jacq.) DC.	Bo	Farr & Stevenson (1963)
		Desmodium sp.	SA, CA[2]	Cummins (1978)
False-rust/wart	*Synchytrium citrinum* (Pat. & Lagerh.) Gaumann	*D. intortum* (Mill.) Urb.	Co, J, V	Chardon & Toro (1930), Standen (1952), Leather (1967)
	S. desmodii Munasinghe	*D. adscendens* (Sw.) DC.	Ta	IMI (per. comm.)
		D. barbatum (L.) Benth.	Co	Lenné (unpubl.)
		D. ovalifolium Wall.	Co, E, Sr, Ch	Lenné (1985), Munasinghe (1955), Schultze-Kraft (per. comm.)
	Woroninella amagense Mayor	*D. cajanifolium* (H.B.K.) DC.	Co	Chardon & Toro (1930)
		D. tortuosum (Sw.) DC.		
Bacterial diseases				
Leaf spot	*Xanthomonas campestris* pv. *desmodiigangetici* (Patel & Moniz) Dye	*D. gangeticum* (L.) DC.	Ia	IMI (per. comm.)
Mycoplasmas				
Little leaf	Mycoplasma-like-organisms (MLO's)	*D. barbatum* (L.) Benth.	Co	Lenné (unpubl.)
		D. incanum DC.	A, Co	Simmonds (1966), Lenné (unpubl.)
		D. gangeticum (L.) DC.	A	Simmonds (1966)
		D. heterocarpon (L.) DC.	SA, CA	Lenné et al. (1983)
		D. heterophyllum (Willd.) DC.		
		D. intortum (Mill.) Urb.	A	Simmonds (1966)
		D. ovalifolium Wall.	SA, CA, Ch	Lenné et al. (1983), Chen et al. (1982)
		D. sandwicense E. Mey.	A	Lenné (unpubl.)
		D. strigillosum Schindl.	Co	Lenné (unpubl.)
		D. tortuosum (Sw.) DC.		
		D. triflorum (L.) DC.	A	Simmonds (1966)
		D. uncinatum (Jacq.) DC.		
		Desmodium sp.	A, CA, SA	Simmonds (1966), Lenné (unpubl.)
		Codariocalyx gyroides (Link) Hassk.	SA, CA	Lenné (unpubl.)
Viruses				
	Centrosema Mosaic Virus (potexvirus)	*D. distortum* (Aubl.)	PNG	Shaw (1984)
	Desmodium Mosaic Virus (potyvirus)	*D. incanum* DC.	USA	Edwardson et al. (1970)

Table 1. Continued

Diseases	Causal agent	Host range	Distribution[1]	Source
	Desmodium Yellow Mottle Virus (tymovirus)	*D. tortuosum* (Sw.) DC.	USA	Scott (1979)
	Peanut Mottle Virus (potyvirus)	*D. incanum* DC.	USA	Demski et al. (1981)
	Mottle Virus	*D. ovalifolium* Wall.	Co	Lenné (unpubl.)
		D. tortuosum (Sw.) DC.	PNG	Shaw (1984)
		D. triflorum (L.) DC.	Ia	Joshi et al. (1976)
		Desmodium sp.	PNG	Shaw (1984)
	Virus	*D. triflorum* (L.) DC.	Mr	Wiehe (1948)
Nematodes				
Root-knot	*Meloidogyne arenaria* (Neal) Chitwood	*D. heterocarpon* (L.) DC.	USA	Kretschmer et al. (1976), IMP[3]
		D. heterophyllum (Willd.) DC.		
		D. intortum (Mill.) Urb.	A	Minton et al. (1967), IMP[3]
		D. ovalifolium Wall.		
		D. strigillosum Schindl.		
		D. tortuosum (Sw.) DC.	A	Minton et al. (1967)
		D. uncinatum (Jacq.) DC.		
		D. heterophyllum (Will.) DC.		IMP[3]
	M. hapla Chitwood	*D. intortum* (Mill.) Urb.	A	Minton et al. (1967),
		D. strigillosum Schindl.		IMP[3]
		D. tortuosum (Sw.) DC.	A	Minton et al. (1987)
		D. uncinatum (Jacq.) DC.		
	M. incognita (Kofoid & White) Chitwood	*D. adscendens* (Sw.) DC.		Stanton & Rizo (1988)
		D. heterocarpon (L.) DC.	USA	Kretschmer et al. (1976), IMP[3]
		D. heterophyllum (Willd.) DC.		IMP[3]
		D. ovalifolium Wall.		IMP[3]
		D. strigillosum Schindl.		IMP[3]
		D. tortuosum (Sw.) DC.	A	Minton et al. (1967)
		D. uncinatum (Jacq.) DC.		
	M. javanica (Treub.) Chitwood	*D. barbatum* (L.) Benth.	Co	Lenné (1981b)
		D. discolor Vog.	Br	Stanton & Rizo (1988)
		D. heterocarpon (L.) DC.	Co, USA	Lenné (1981b), Krestchmer et al. (1976), IMP[3]
		D. heterophyllum (Willd.) DC		IMP[3]
		D. ovalifolium Wall.	Co	Lenné (1981b)
		D. triflorum (L.) DC.	A	Stanton & Rizo (1988)
		Codariocalyx gyroides (Link) Hassk.	A	
		D. uncinatum (Jacq.) DC.	A	Colbran (1964)
	Meloidogyne sp.	*D. tortuosum* (Sw.) DC.	USA	Stanton & Rizo (1988)
		D. triflorum (L.) DC.	A	Stanton & Rizo (1988)
		Desmodium sp.	Ia	
Stem-gall	*Pterotylenchus cecidogenus* Siddiqi & Lenné	*D. ovalifolium* Wall.	Co	Siddiqi & Lenné (1984)
		D. strigillosum Schindl.		Lenné (unpubl.)
		D. velutinum (Willd.) DC.		
		D. barbatum (L.) Benth.	Co	CIAT (1986)
Cyst	*Heterodera glycines* Ichnohe	*D. barbatum* (L.) Benth.	USA	Riggs & Hamblen (1962), Stanton & Rizo (1988)
		D. ovalifolium Wall.	USA	
	H. trifolii Goffart	*D. incanum*	USA	Holtzmann & Aragaki (1963), Stanton & Rizo (1988)
		D. uncinatum (Jacq.) DC.	USA	
Lesion	*Pratylenchus loosi* Loof	*D. ovalifolium* Wall.	Co	Loof (1960), Stanton & Rizo (1988)
		Codariocalyx gyroides (Link) Hassk.		
Other nematodes	*Radopholus similis* (Cobb) Thorne	*D. tortuosum* (Sw.) DC.	A	Stanton & Rizo (1988)
		D. uncinatum (Jacq.) DC.	A	Colbran (1964)
		Codariocalyx gyroides (Link) Hassk.	Ia	Stanton & Rizo (1988)

Table 1. Continued

Diseases	Causal agent	Host range	Distribution[1]	Source
	Rotylenchulus reniformis Linford & Oliveira	*D. tortuosum* (Sw.) DC.	USA	Holdeman & Graham (1953), Stanton & Rizo (1988)
	Belonolaimus gracilis Steiner	*D. tortuosum* (Sw.) DC.	USA	Holdeman & Graham (1953), Stanton & Rizo (1988)

[1] A = Australia, Ba = Barbados, Bo = Bolivia, Br = Brazil, Bu = Burma, CA = Central America, Ch = China, Cm = Cameroon, Co = Colombia, Cu = Cuba, DEI = Dutch East Indies, DR = Dominican Republic, E = Ecuador, ES = El Salvador, F = Fiji, G = Ghana, HK = Hong Kong, Ia = India, Is = Indonesia, J = Jamaica, K = Kenya, M = Malaysia, Mr = Mauritius, Pa = Panama, Pe = Peru, Ph = Philippines, PNG = Papua New Guinea, PR = Puerto Rico, S = Sudan, Sr = Sri Lanka, SA = South America, SL = Sierra Leone, Ta = Tanzania, Tr = Trinidad, U = Uganda, USA = United States of America, V = Venezuela, Za = Zambia, Zi = Zimbabwe.
[2] Isolated from seed.
[3] IMP = International Meloidogyne Project (Sasser et al. 1987).

Foliar blight and pink disease

Foliar blight caused by *Rhizoctonia solani* AG-1 is often observed on *D. heterophyllum* and *D. ovalifolium* in humid regions of the tropical American lowlands (Table 1). Blight generally occurs in patches in the sward usually involving small areas of the pasture. Initial symptoms are water-soaked lesions which develop into tan-coloured necrotic areas. Under humid conditions, the fungal mycelium grows profusely over leaf surfaces causing rotting and defoliation. Stems of affected plants usually regrow new leaves after the peak of the wet season.

Foliar blight has also been recorded on *D. ovalifolium, D. uncinatum* and *Desmodium* sp. in Malaysia (Table 1). However, pink disease caused by *Phanerochaeta salmonicolor* (syn. *Corticium salmonicolor*) is the most serious disease of *D. ovalifolium* in Malaysia (Thompson and Johnson 1953; Wan Zainun Nik personal communication). *P. salmonicolor*, a common pathogen of rubber in Malaysia, affects *D. ovalifolium* due to its common utilization as a cover crop in rubber plantations in Malaysia. Prolonged high humidity particularly favours disease development. Pink disease has not been recorded on *D. ovalifolium* outside Malaysia although this legume is used as a cover crop in rubber plantations throughout South-east Asia and Brazil.

Wilt and diebacks

Seedling wilt of *D. intortum* caused by *Pythium middletonii* has been recorded in Australia (Table 1). Several *Fusarium* species have caused wilts of *Desmodium* species in Colombia, Fiji, Jamaica and Kenya (Table 1). Isolated occurrences of dieback due to *Diaporthe phaseolorum* and *Nectria ochroleuca* have also been noted, but no information on the importance of these diseases could be found.

Sclerotium rolfsii caused high seedling mortality of six *Desmodium* species and *C. gyroides* in glasshouse inoculation studies in Colombia (Lenné 1979). It had previously been recorded on *Desmodium* species in Colombia (Chardon and Toro 1930). To date, however, serious field losses due to *S. rolfsii* have not been observed.

Rusts

Species of *Aecidium, Phakopsora, Puccinia, Uredo* and *Uromyces* have been recorded on *Desmodium* species, mostly in Central and South America and the Caribbean (Table 1). *Uromyces* species are the most commonly observed rusts and *U. hedysari-paniculati* has been recorded on five *Desmodium* species and *C. gyroides*. Severe rusting of lower mature leaves only has been observed in native populations of *D. incanum* and *D. intortum* in South America. Young actively growing leaves are rarely affected. *U. hedysari-paniculata* forms dark brown pustules on lower leaf surfaces. Small (1–2 mm in diameter) chlorotic spots on upper leaf surfaces usually denote rust presence on the lower surfaces. Occurrence of soyabean rust, *Phakopsora pachyrhizi*, on perennial *Desmodium* species in Brazil is regarded as a potential inoculum risk to soyabean production in Minas Gerais, Brazil (Deslandes 1979). The importance of other rusts of *Desmodium* species has not been documented.

False rusts

False rust or wart, caused by *Synchytrium desmodii*, is a serious disease of *D. ovalifolium* in Colombia and Ecuador (Lenné 1985, Lenné *et al* 1990). First recorded in Sri Lanka (Munasinghe 1953), it was introduced on several occasions to South America on infected debris associated with seed produced in South-east Asia (Lenné 1985). It has also been recorded on *D. ovalifolium* in China, *D. barbatum* in Colombia and *D. adscendens* in Tanzania (Table 1). The disease is manifest as galls, shortened internodes and leaf deformation giving plants a rosetted appearance. Free water and high humidity are essential for infection (Price and Lenné 1988). False rust severely reduces seedling survival. Under intermittently flooded conditions, adult plant yield of *D. ovalifolium* is reduced thereby affecting the productivity and persistence of *D. ovalifolium*-based pastures (Lenné *et al* 1990). Although useful resistance has not been identified in seedlings, *D. ovalifolium* CIAT 13089 from Thailand has valuable adult plant resistance. *Synchytrium citrinum* is common in native populations of *D. intortum* in Colombia and is also known from Jamaica and Venezuela (Table 1). However, it has not yet been recorded in pastures of this legume. Being a similar pathogen to *S. desmodii, S. citrinum* has potential to cause severe disease. In regions where *D. intortum* is an important pasture legume such as Australia and South-east Asia, strict quarantine should be practised to avoid chance introduction of *S. citrinum*. Another chytrid, *Woroninella amagense*, has been observed on *D. cajanifolium* and *D. tortuosum* in Colombia (Table 1).

Diseases caused by bacteria

The only bacterial disease recorded on agronomically important *Desmodium* species is leaf spot caused by *Xanthomonas campestris* pv. *desmodii-gangetici* on *D. gangeticum* in India (Table 1). Bacterial leaf spot is manifest as water-soaked lesions with yellow halos which become nectrotic and may coalesce affecting most of the leaflet. Several other pathovars of *X. campestris* have also been recorded on non-agronomic *Desmodium* species in India (Desai and Shah 1960; Pant and Kulkarni 1977; Bradbury 1986). A comparative study to define how many different bacterial pathogens of *Desmodium* species actually exist and their host ranges would be worthwhile.

Diseases caused by mycoplasma-like-organisms

Little leaf, caused by mycoplasma-like organisms (MLO's) and transmitted by leaf hoppers, commonly affects tropical legumes including many *Desmodium* species in Australia and Central and South America (Table 1). Confirmed presence of MLO's in the sieve tubes of the phloem in little leaf-affected *D. ovalifolium* plants has been documented by Chen *et al* (1982) in Hainan Island, China. Definitive symptoms of shortened internodes and proliferation of small leaves have been described on at least 13 *Desmodium* species and *C. gyroides* (Table 1).

Observations on the reaction of different species to little leaf are contradictory. Hutton and Grylls (1956) reported that *D. uncinatum* was highly susceptible while *D. intortum* was highly resistant in Australia. In a later Australian study, however, Imrie (1973) found all 34 tested accessions of *D. intortum* susceptible to little leaf. Lenné (unpublished) has observed slight to severe little leaf in accessions of *D. barbatum, D. heterocarpon, D. heterophyllum, D. incanum, D. ovalifolium, D. strigillosum* and *C. gyroides* throughout Central and South America during periodic disease evaluations from 1978 to 1988. Little leaf incidence and severity varied greatly from site to site and from season to season. Spatial and temporal variation in the incidence and severity of little leaf could be due to variable leaf hopper activity and different species of leaf hoppers. There is general agreement that little leaf is a disease of small evaluation plots and is rarely observed in well-managed, grazed pastures (Harding and Cameron 1972, Imrie 1973, Lenné unpublished).

Diseases caused by viruses

Four characterized and at least two uncharacterized viruses have been reported on *Desmodium* species. These include potyviruses — Desmodium Mosaic and Peanut Mottle; the potexvirus — Centrosema Mosaic; and the tymovirus — Desmodium Yellow Mottle (Table 1). Mottle symptoms on several *Desmodium* species have been attributed to one or more uncharacterized

viruses from Colombia, India, Mauritius and Papua New Guinea (Table 1).

Desmodium Mosaic Virus (DMV), a mechanically-, aphid- and seed-transmitted potyvirus causes leaf distortion, stunting and mosaic of *D. incanum* in Florida (Edwardson *et al* 1970). It is readily distinguished from other *Desmodium* viruses. Peanut Mottle Virus (PMV) has also been recorded on *D. incanum* and other forage legumes in southern Georgia (Demski *et al* 1981) causing moderately severe leaf mottle. Concern is expressed that *D. incanum* may act as a source of PMV for cultivated peanuts.

Desmodium Yellow Mottle Virus (DYMV) is a tymovirus causing yellow mottling of *D. tortuosum* in southern USA (Walters and Scott 1972; Scott 1976). It can be transmitted to *Phaseolus vulgaris* and *Vigna unguiculata*. No information on the economic importance of these viruses was found.

Several viruses described on cowpea and pea number non-agronomically important *Desmodium* species among their hosts. As many legume viruses have wide host ranges, competition for land between crops and pastures may lead to increased virus problems in *Desmodium*-based pastures due to movement of viruses from closely associated crops.

Diseases caused by nematodes

At least 11 species of *Desmodium* and *C. gyroides* are susceptible to at least one of four species of *Meloidogyne* root-knot nematodes, including *M. arenaria, M. hapla, M. incognita* and *M. javanica*, in Australia, USA and South America and through glasshouse studies (Table 1: Lenné 1981b; Sasser *et al* 1987; Stanton and Rizo 1988). Only *D. uncinatum* is susceptible to all four *Meloidogyne* species while *D. heterocarpon, D. heterophyllum, D. ovalifolium* and *D. strigillosum* are susceptible to three species (Table 1).

Root-knot nematodes are described as the worst pests of *D. heterocarpon* cv. Florida in southern Florida (Kretschmer *et al* 1976). *Desmodium ovalifolium* has failed as a cover crop in Malaysia because of infestation with root-knot nematodes (Beeley 1939) while, in Colombia, *M. javanica* caused stunting, chlorosis and wilting of stands of *D. heterocarpon, D. ovalifolium* and *C. gyroides* which later defoliated and died (Lenné 1981b).

Some genotypes of *D. adscendens, D. heterocarpon* and *D. intortum* are apparently resistant to root-knot nematodes (Kretschmer *et al* 1980). *Desmodium intortum* is considered to be more resistant than *D. uncinatum* (Kretschmer *et al* 1980; Cameron 1984). In a collection of 59 accessions of *D. heterocarpon*, 43 had useful resistance to *M. javanica* in Carimagua, Colombia (Stanton and Mere 1986). As above-ground symptoms of chlorosis, stunting and dieback were not reliable for determining resistance, direct assessment of root-galling was necessary.

The International *Meloidogyne* Project screened 70 accessions of *D. ovalifolium* and 42 accessions of other *Desmodium* species and related genera for reaction to Race 1 and 3 of *M. incognita* and Race 1 of *M. arenaria, M. hapla* and *M. javanica* during 1984 to 1986 (Sasser *et al* 1987). Twenty-seven accessions of *D. ovalifolium* and several accessions of *D. velutinum* and *Phyllodium* species were resistant and/or tolerant to the five races. Most accessions of *D. heterophyllum* and *D. strigillosum* were susceptible to two or more races.

Resistance to various races and species of *Meloidogyne* identified in accessions of *Desmodium* species could be of value in breeding programs. *Desmodium ovalifolium* CIAT 350, which is susceptible to *M. javanica*, was less affected by this nematode when grown in association with pasture grasses such as *Brachiaria* species than in monoculture (Lenné 1981c). Root exudates of these grasses may be toxic to *M. javanica*. Both resistance and strategic association hold potential for controlling root-knot nematodes of *Desmodium*.

Stem gall nematode, *Pterotylenchus cecidogenus*, is a major constraint to *D. ovalifolium*-based pastures in the eastern plains of Colombia (Lenné 1983; Siddiqi and Lenné 1984; Stanton 1986). Stem gall nematode also affects Asiatic species *D. strigillosum* and *D. velutinum*. Its most important native Colombian host is *D. barbatum* (CIAT 1984). The nematode produces galls, mostly on lower stems of *D. ovalifolium*, which enlarge and coalesce causing major disruption of the vascular system with resulting chlorosis, wilting and plant death (Lenné 1983; Stanton 1986). *P. cecidogenus* reduces seedling survival and root and stem growth

(Stanton 1986). Screening of a collection of more than 60 accessions of *D. ovalifolium* found none completely resistant, although several accessions including CIAT 13089 were highly resistant (CIAT 1986). CIAT 13089 is now showing promise on farms in Colombia (CIAT 1988). As resistance was not related to attraction of the nematode to the stem, vertical movement on the stem or penetration of the stem (Stanton 1989a), direct nematode counts are necessary to assess resistance. Some control of this nematode has been achieved in pots using benomyl, thiabendazole and thiophanate (Stanton 1989b), but these have not been tested in the field.

Pratylenchus loosi, a lesion nematode, is recorded as a parasite of *D. ovalifolium* and *C. gyroides* (Loof 1960; Stanton and Rizo 1988). *Heterodera trifolii*, a cyst nematode, reproduces on and damages *D. incanum* and *D. uncinatum* in Hawaii (Holtzmann and Aragaki 1963) and *H. glycines* is a pest of *D. barbatum* and *D. ovalifolium* (Riggs and Hamblen 1962; Stanton and Rizo 1988). *Radpholus similis* was reported on *D. tortuosum, D. uncinatum* and *C. gyroides* (Anonymous 1956; Colbran 1964; Stanton and Rizo 1988) while *Belonolaimus gracilis* and *Rotylenchulus reniformis* have been reported on *D. tortuosum* (Holdeman and Graham 1953; Stanton and Rizo 1988). No detailed studies of these parasites have been reported in the literature.

Relative importance of diseases of *Desmodium* species

Although available information on the importance of diseases of *Desmodium* species is limited, several diseases emerge as important. These include wart and pink disease of *D. ovalifolium* caused by the fungi *S. desmodii* and *P. salmonicolor*, respectively; root-knot nematodes (*Meloidogyne* species) of *Desmodium* species; and stem gall nematode (*P. cecidogenus*) of *D. ovalifolium*.

The two fungal diseases are restricted geographically and with respect to host range. Cross-inoculation studies have confirmed the specificity of *S. desmodii* to *D. ovalifolium*. The importance of pink disease on this host may be related to the use of *D. ovalifolium* in preference to other *Desmodium* species as a cover crop in rubber plantations. Although wart was originally restricted to Sri Lanka, introductions of contaminated seed of *D. ovalifolium* have established *S. desmodii* in various locations in South America (Lenné *et al* 1990).

Insufficient information is available to determine whether wart is more important in South-east Asia or South America. Its increased severity associated with humid and flooded conditions has been proven (Lenné *et al* 1990). Wart has considerable potential to reduce legume persistence through reduction in seedling stands and soil seed reserves (Lenné *et al* 1990). Extreme care should be taken with seed from South-East Asia. If *D. ovalifolium* is proven to be a productive pasture legume in a given region, seed should be produced *in situ*.

Pink disease is apparently very serious in *D. ovalifolium* in Malaysia where the legume is used as a cover crop in rubber plantations (Thompson and Johnson 1953; Williams and Liu 1976), but has not been recorded elsewhere. Unfortunately, no information is available on the effect of pink disease on cover crop productivity and persistence. Specific environmental conditions may predispose *D. ovalifolium* to pink disease in Malaysia. Further investigation on this disease would be worthwhile.

In contrast to the most important fungal diseases, root-knot nematode species are widespread pathogens with wide host ranges among *Desmodium* species and related *C. gyroides*. No reports were found, however, on the importance of root-knot nematodes on the long-term productivity and persistence of *Desmodium*-based pastures. Sources of resistance to several root-knot nematodes have been identified among *Desmodium* species (Stanton and Mere 1986; Sasser *et al* 1987) and cultural control through strategic association offers further management possibilities (Lenné 1981c).

Stem gall nematode, *P. cecidogenus*, a native Colombian nematode, is a major constraint to *D. ovalifolium*-based pastures in the eastern plains of Colombia (Stanton 1986). Other Asiatic hosts such as *D. strigillosum* and *D. velutinum* are also susceptible. Although stem gall nematode is a new encounter disease for *D. ovalifolium*, high levels of resistance have been identified in several accessions (CIAT 1986). Chemical seed treatment may have a further role in an integrated management programme.

Although presently available information is not sufficient to evaluate the relative importance of

the many other pathogens recorded on *Desmodium* species in Table 1, the potential importance of some may be assessed. The large range of foliar pathogens recorded is impressive and awareness of them may help in the early detection of potentially damaging species and preempt major research efforts on control. Due to the difficulties of eliminating them from seed, bacteria and potyviruses such as DMV and PMV are potentially very dangerous. Methodology to detect their presence as well as that of seed-borne fungi should be developed in order to avoid introduction to new areas where these pathogens may cause serious damage to other legumes and *Desmodium* species.

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