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Rusty-leaf Mistletoe (*Scurrula ferruginea*), a Parasitic Plant on Cocoa and Its Management

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The mistletoe (Scurrula ferruginea *), a parasitic plant, is quite widespread in Malaysia.*

A severe infestation of S. ferruginea *was reported on mature hybrid cocoa (9-12-year-old plantings) in a cocoa estate near Merlimau, Malacca in the 1980s. The effect on crop yield was not known, but the vigour, yield and photosynthetic capability had been greatly reduced. The control measures included: (i) removal of infected trees or their infected branches by pruning or poisoning, and (ii) chemical treatments designed to kill the endophytic system. A total of 588 hectares were pruned manually to remove the mistletoes in the cocoa estate near Merlimau, in May/June 1989. The average cost of pruning was estimated at RM 34.50 per hectare. In a poisoning trial using six herbicides (fluroxypyr, triclopyr, dicamba, paraquat, glufosinate-ammonium and 2,4,5-T) the costs was as high as pruning. Manual pruning was therefore the recommended method of controlling cocoa mistletoe. Integrated Weed Management is perhaps the next step towards more effective and more efficient control of mistletoes over very large areas inclusive of cocoa estates, orchards and other agricultural/non-agricultural areas.*

Keywords*:* Scurrula ferruginea*, mistletoe, parasitic plant, cocoa, management.*

Mistletoe is a parasitic flowering plant belonging to the sandalwood order (Santalales) that attaches to the stem of another plant (primarily gymnosperms and angiosperms) (Robert *et al.*, 2008). It belongs to the family, Loranthaceae.

The mistletoe (*Scurrula ferruginea*) is quite widespread in Malaysia. The word "ferruginea" in Latin means rusty red, which refers to the colour of the foliage. *S. ferruginea* is commonly seen infesting road side ornamental flowering trees (*Figure 1*) and some native plants (*Figure 2*). Due to its slender pendulous nature and rusty coloured leaves, the common names of *S. ferruginea* are rusty-leaf mistletoe (see *Figure 3*), slender busy mistletoe and scurfy mistletoe.

In general, mistletoes are obligate hemiparasitic shrubs that grow and attach to the stems and branches of other trees or shrubs. An *obligate parasite* or holoparasite is a parasitic organism that cannot complete its life-cycle without exploiting a suitable host. Hemiparasite is a plant that possesses chlorophyll and typically carries out photosynthesis but is partially parasitic on the roots or shoots of a plant host (e.g. for water and nutrients).

S. ferruginea is an aerial hemiparasite and attaches to the branches/stems of trees through their haustoria. With the penetration of its haustoria into the host plants' tissues, it can draw water and nutrients. Even though this is a parasitic plant, the mistletoe can produce additional food (e.g. sugar) through photosynthesis in the green leaves.

Pollination and dispersion of mistletoes are mainly by birds.

S. ferruginea parasitises on many host

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Figure 1 A roadside ornamental flower tree almost fully covered with several colonies of rusty-leaf mistletoe (Scurrula ferruginea)

Figure 2 A young rusty-leaf mistletoe established on a small tree at the edge of secondary forest. Note the firm attachment of the mistletoe on the main stem of the host plant

Figure 3 *The rusty appearance of the young leaves and flower buds of rusty-leaf mistletoes growing on the branches of a host plant, cocoa (*Theobroma cacao*).* (Note: *The layer of fine brown hair is responsible for the rusty appearance*)

plants including several fruit trees, perennial tree crops, roadside ornamental/shade trees and native forest trees. This mistletoe plant is considered as a serious parasitic weed in rubber (*Hevea brasiliensis* Müll.Arg.) and cocoa (*Theobroma cacao* L.) due to its colonisation on the branches (*Figure 4*). *Tapinanthus bangwensis* (a species of hemiparasitic plant in the family Loranthaceae, which is native to the tropics of western sub-Saharan

Figure 4 *Rusty-leaf mistletoe is a serious parasitic weed of cocoa (*Theobroma cacao*) colonising on the cocoa branches. Note the distinct rusty brown long flower buds*

Africa) is an important mistletoe on cocoa bushes in Africa (Hankworth, 1974). The two most common mistletoes on cocoa in Ghana are *T. bangwensis* and *Phragmanthera incana* (Akrofi & Acheampong, 2016).

A severe infestation of mistletoes was reported on mature hybrid cocoa (9-12-year-old plantings) in a cocoa estate near Merlimau, Malacca in the 1980s. The species of mistletoe was identified as *S. ferruginea* [previously known as *Loranthus ferrugineus* (Roxb)]. The infestation on individual cocoa bush varied from one to many parasitic mistletoes growing on the small and large branches. In very severe advanced infestation, one or two mistletoes could completely cover the cocoa canopy. On cocoa, mistletoe infestation is of considerable economic importance because of the direct effect of reducing yield and the indirect effect of contributing to the general degeneration of trees on farms (Phillips, 1977). The effect on crop yield from *S. ferruginea* is not known, but certainly the vigour and photosynthetic capability was greatly reduced. A total of 588 hectares was pruned manually to remove the mistletoes in May/June 1989. The average cost of pruning amounted to RM 34.50 per hectare.

Incidentally, this plant is considered as a weed; but instead of competing with the soil it grows on the tree/plants and compete directly with the crop.

This paper discusses the biological aspects of rusty-leaf mistletoe, *S. ferruginea*, (with pictorial identifications) and its management.

PLANT DESCRIPTION

S. ferruginea is a semi-woody plant of about 1 m in height with slender, pendulous branches that grow up to 70 cm in length. Being a hemiparasitic plant, it attaches itself to different types of trees that grow in full sunlight and at times, penetrates into the host plant. Pictorial identification guide (showing the parasitic plant, leaves, flowers, haustarium including close-up views) is available in the internet (Jake, 2017).

Scientific name

Scurrula ferruginea (Roxb. ex Jack) Danser.

Synonyms

i. *Cichlanthus ferrugineus* (Roxb. ex Jack) Tiegh.,
ii. *Cichlanthus schultesii* (Blume) Tiegh.,
iii. *Dendrophthoe chrysanthoides* (Korth.) Miq.,
iv. *Dendrophthoe ferruginea* (Roxb. ex Jack) G.Don,
v. *Dendrophthoe schultesii* (Blume ex DC.) G.Don,
vi. *Etubila ferruginea* (Roxb. ex Jack) Raf,
vii. *Loranthus chrysanthoides* Korth.,
viii. *Loranthus ferrugineus* Roxb. ex Jack,
ix. *Loranthus schultesii* Blume ex DC.,
x. *Loranthus sootepensis* Craib,
xi. *Scurrula chrysanthoides* (Korth.) Danser, and
xii. *Scurrula sootepensis* (Craib) Danser.

Classification

Kingdom : Plantae
Phylum : Tracheophyta (Spermatophyta)
Class : Magnoliopsida
Order : Santalales
Family : Loranthaceae
Genus : Scurrula
Species : ferruginea

Common names

Rusty-leaf mistletoe, slender busy mistletoe, and scurfy mistletoe.

Malay names

Jenalu hijau, Benalu teh, Dalu-dalu, Dedalu api, Dedalu api merah, Dedalu api gajah, Menalu asap.

Chinese names

锈毛梨果寄生 (xiu mao li guo ji sheng) – Wu *et al.* (2003).

Distribution

It can be seen in China (China South-Central and Yunnan), India and Southeast Asia [Cambodia, Indonesia (Java, Lesser Sunda Islands, Sulawesi, Sumatra,), Laos, Malaysia (Terengganu, Penang, Perak, Pahang, Selangor, Negeri Sembilan, Melaka), Myanmar, Philippines, Singapore, Thailand, Vietnam].

Habitats

Terrestrial native habitats include forests, mountain slopes, roadside plants, orchards, plantations and secondary forests.

Plant features

The plant is a hemiparasitic shrub, able to grow to about 1 m in height and easily recognisable mistletoe from its rusty brown appearance.

Stem

The stem (grey colour, presence of lenticels and brown hairs) of rusty-leaf mistletoe attaches to the host rather seamlessly producing a few side roots growing along the sides of the branch, including growing many little haustoria into the host plant.

Branches

Brown hairs on the branches are greyish brown or dark brown in colour, smooth and dotted with lenticels (*Figure 5*).

Leaves

The leaves have obvious veins. The upper surface of the leave is smooth and green whereas the lower surface is leathery with short, verticillate hairs (a layer of fine brown

Figure 5 The branches of rusty-leaf mistletoes are grayish brown or dark brown in colour with rusty brown young leaves and the flower buds

hairs) giving it a "rusty" appearance (*Figure 6*). The leaves are arranged opposite and reddish brown in appearance, and ovate in shape, measuring 5-10 cm by 2-6 cm. The leaf stalk is about 2-6 mm.

Flowers

The inflorescences consist of axillary flowers arranged in clusters of four to seven, emerging from the axils (*Figure 7*). Each flower consists of four small petals with brown hairs on its 1.5 cm long tubular corolla with dark brown interior. The flower has the appearance of a little hairy paw, opening on one side (*Figure 8*). The brown hairy ovary is found within the flower.

Figure 6 The leaf of rusty-leaf mistletoes is green on the upper leaf surface but covered with a layer of fine brown hairs on the lower leaf surface, giving it a "rusty" appearance

Figure 7 The inflorescences of rusty-leaf mistletoes are clusters of 4-7 flowers emerging from the axils. Each flower has four small petals and a long tubular corolla. The fruit is a small fleshy hairy ovoid pear-shaped pseudo berry

*Figure 8 The flower of rusty-leaf mistletoes (*S. ferruginea*) has the appearance of a little hairy paw, opening on one side*

Fruit

The fruit is a small fleshy, hairy, ovoid, pear-shaped pseudo berry (*Figure 7*). It is round and blunt at both ends, with granular surface verticillate hairs and measures to about 8-10 mm by 3-4 mm. The stalk is 4-6 mm long and rounded at the apex.

Pollination

Mistletoes are pollinated by biotic agents (primarily birds and insects) as well as wind (Robert *et al.*, 2008). The Dicaeidae (flower-peckers or mistletoe birds) play an important part in the pollination of mistletoes (Gill & Hawksworth, 1961). Devkota and Kunwar (2006) reported four pollinator bird species, namely black-throated sunbird (*Aethopyga saturata*), oriental white-eye (*Zosterops palpebrosus*), fire-breasted flower-pecker (*Dicaeum ignipectus*) and plain flower-pecker (*Dicaeum concolor*) for three *Scurrula* species in Godawari area of Kathmandu Valley, Nepal. Many tropical and subtropical mistletoes in Loranthaceae have large, colourful flowers borne in groups that produce large amounts of sugar-rich nectar that attract avian pollinators. All species in Loranthaceae depend on a biotic agent for pollination (Vidal-Russell & Nickrent, 2008). This dependence is evidenced by their floral morphology distinguished by two main syndromes: entomophily (insect pollination) and ornithophily (bird pollination).

Dispersal

Dispersal of plant is also carried out by biotic agents (mainly birds). The main agents of dispersal/dissemination of mistletoes are the Dicaeidae (flower-peckers or mistletoe birds) (Gill & Hawksworth, 1961). In Godawari area of Kathmandu Valley, Nepal, Devkota and Kunwar (2006) reported dispersal to be mainly carried out by three bird species namely fire-breasted flower-pecker (*Dicaeum ignipectus*), pale-billed flower-pecker (*Dicaeum erythrorynchos*) and plain flower-pecker (*Dicaeum concolor*) for three *Scurrula* species. Flower-peckers have common method of seed dispersal i.e. through defecation of the seeds. Yellow-vented flower-peckers (*Dicaeum chrysorrheum chrysorrheum*) have been seen swallowing the fruits of *S. ferruginea* whole with the seed (Singh-Amar, 2017).

The seeds are coated with a sticky material called viscin (sticky mucilaginous tissue). These sticky seeds can stick onto branches and after germination, the haustoria attach firmly to the host plant and eventually enters the tissues to extract water and non-organic nutrients (Ng & Wee, 2006). Subsequently, the new mistletoe produces basal runners or epicortical roots from the cortex of the stem to form secondary points of attachment to the host plant (*Figure 9*).

Ng and Wee (2006) described in detail how a male scarlet-backed flower-pecker (*Dicaeum cruentatum*) deposited a string of sticky seeds of a mistletoe on sui mei plant (*Wrightia religiosa*) and the seed successfully germinated/grew into a small seedling.

Scurrula ferruginea as butterfly host plant

This species of mistletoe is the caterpillar host plant for several species of butterflies. These butterflies are:

i. Great imperial (*Jacoona anasuja anasuja*) – Tan *et al.* (2013),
ii. White royal (*Pratapa d.eva relata*) – Soon (2015); Karmakar (2021),
iii. Dark blue royal (*Pratapa icetas*) – Karmakar (2021),
iv. Red-spot jezebel (*Delias descombesi*) –

*Figure 9 Close up view showing the basal runners or epicortical roots of rusty-leaf mistletoe growing along the branch of the host plant, pink tecoma (*Tabebuia pallida*). Note the sprouting of several aerial shoots from the basal runner*

Karmakar (2021),

v. Red-base jezebel (*Delias pasithoe)* – Karmakar (2021), and
vi. Gaudy baron (*Euthalia lubentina*) – Karmakar (2021).

Uses

In general, mistletoes are used in medical treatments (Ogunmefun *et al.*, 2013). Briefly, mistletoe has been used in Europe as a treatment for cancer, while American mistletoe in America is said to be toxic. European mistletoe is considered to have medicinal properties for several diseases and has been used to treat a wide variety of physical and mental conditions. It is best known as an additional therapy with other drugs and or radiation for treating cancer. Mistletoe is also useful for the treatment of insomnia, for slowing down the attack of epilepsy and for treating fibroids, arthritis, rheumatism and gout.

The traditional and pharmacological uses of *S. ferruginea* mistletoes include antibacterial, anticancer, antiviral, antihypertensive, antioxidative and cytotoxic effects (Lim *et al.*, 2017). Traditionally, decoctions of this parasitic shrub (*L. ferrugineus*) have been mainly used to treat high blood pressure (BP) and gastrointestinal complaints (Ameer *et al.*, 2015). Phyto-chemicals such as flavonols, alkaloids, tannins, and gallic acid have been reported in mistletoes (Lim *et al.*, 2017). The use of *S. ferruginea* for other medicinal benefits merits further studies.

(*Note*: American mistletoe = *Phoradendron leucarpum*; European mistletoe = *Viscum album*).

Host plants of *Scurrula ferruginea*

S. ferruginea parasitises on many host plants (i.e. host range) as listed below:

1. Wild rose apple (*Syzygium pycnanthum*), Myrtaceae - Anon (2012),
2. Watery rose apple (*Syzygium aqueum*), Myrtaceae - Rahmad *et al.* (2014),
3. Malabar plum or Java plum or Black plum or Jamun or Jambolan (*Syzygium cumini*), Myrtaceae - Rahmad *et al.* (2014),
4. Mountain apple (*Syzygium jambos*), Myrtaceae - Rahmad *et al.* (2014),
5. Wild Eugenia plant or Kelat or kayu kelat (*Syzygium palembanicum*), Myrtaceae - Rohani *et al.* (2019),
6. Straits rhododendron (*Melastoma malabathricum*), Melastomataceae - Anon (2012),
7. Common yellow stem fig (*Ficus fistulosa*), Moraceae – Anon (2012),
8. Indian rubber tree (*Ficus fruiticosa*), Moraceae - Rahmad *et al.* (2014),
9. Hairy fig (*Ficus hispida*), Moraceae - Qiu *et al.* (2003),
10. Rubber (*Hevea brasiliensis*), Euphorbiaceae - Chee and Chung (2014),
11. Cocoa (*Theobroma cacao*), Malvaceae - Chung (2021 - this paper),
12. Yellow elder (*Tecoma stans*), Bignoniaceae - Hong *et al.* (2012),
13. Casuarinas tree or whistling pine tree (*Casuarina equisetifolia*), Casuarinaceae - Hawksworth (1974),
14. Kapok tree or silk cotton tree (*Ceiba pentrandra*), Malvaceae - Hawksworth (1974),
15. Pomelo (*Citrus grandis*), Rutaceae - Hawksworth (1974); Qiu *et al.* (2003),
16. Citron (*Citrus medica*), Rutaceae - Hawksworth (1974),
17. Tapioca (*Manihot esculenta*), Euphorbiaceae - Hawksworth (1974),
18. Avocado (*Persea americana*), Lauraceae - Hawksworth (1974),
19. Guava (*Psidium guajava*), Myrtaceae - Hawksworth (1974),
20. Pomegranate (*Punica granatum*), Punicaceae - Hawksworth (1974); Rahmad *et al.* (2014),
21. Indian gooseberry or Malacca tree (*Phyllanthus emblica*), Phyllanthaceae - Qiu *et al.* (2003),
22. Japanese plum or Chinese plum (*Prunus salicina*), Rosaceae - Qiu *et al.* (2003),
23. Pink trumpet tree or pink tecoma (*Tabebuia pallida*), Bignoniaceae - Rahmad *et al.* (2014); Tang *et al.* (2016),
24. Soapbush wattle or silver wattle (*Acacia holosericea*), Fabaceae - Tang *et al.* (2016); Lim *et al.* (2017),
25. Earleaf acacia or earpod wattle (*Acacia auriculiformis*), Fabaceae - Tang *et al.* (2016),
26. Pride of India (*Langerstroemia speciosa*), Lythraceae - Rahmad *et al.* (2014); Lim *et al.* (2017),
27. Hong Kong orchid tree (*Bauhinia x blakeana*), Fabaceae - Baigi (2016),
28. Butterfly tree or Hawaiian orchid tree. (*Bauhinia purpurea*), Fabaceae - Rahmad *et al.* (2014),
29. Jackfruit (*Artocarpus heterophyllus*), Moraceae - Rahmad *et al.* (2014),

30. Rusty sapindus (*Erioglossum rubiginosum*), Sapindaceae - Rahmad *et al.* (2014),
31. Golden gardenia or cempaka hutan (*Gardenia carinata*), Rubiaceae - Rahmad *et al.* (2014),
32. Mango (*Mangifera indica*), Anacardiaceae - Rahmad *et al.* (2014),
33. Chiku or chicle or sapodilla (*Manilkara zapota*), Sapotaceae - Rahmad *et al.* (2014),
34. Tanjong tree or Bunga tanjung or Spanish cherry (*Mimusops elengi*), Sapotaceae - Rahmad *et al.* (2014),
35. Rambutan (*Nephelium lappaceum*), Sapindaceae - Rahmad *et al.* (2014),
36. Rain tree (*Samanea saman*), Fabaceae - Rahmad *et al.* (2014),
37. Honduras mahogany or big-leaf mahogany or West Indian mahogany (*Swietenia macrophylla*), Meliaceae - Rahmad *et al.* (2014),
38. Philippine almond (*Terminalia calamansanai*), Combretaceae - Rahmad *et al.* (2014),
39. False olive (*Champereia manillana*), Opilliaceae - Rohani *et al.* (2019), and
40. Padang (*Vaccinium littoreum*), Ericaceae - Rohani *et al.* (2019).

Weed status

The mistletoes cause damage by absorbing both water and mineral nutrients from its host trees (Perry, 2006). Healthy trees can tolerate a few mistletoe branch infections, but individual branches may be weakened or sometimes killed. Heavily infested trees may be reduced in vigour, stunted or even killed, especially if they are stressed by other problems such as drought or disease. *S. ferruginea* is considered as a serious parasitic weed in many types of fruit trees, rubber and cocoa due to its colonisation on the branches. On cocoa, mistletoe infestation is of considerable economic importance because of the direct effect of reducing yield and the indirect effect of contributing to the general degeneration of the trees in the farms (Phillips, 1977).

MANAGEMENT

Control of mistletoe has been advocated and frequently practiced throughout the world where the parasites were damaging trees and shrubs of economic or aesthetic value (Gill & Hawksworth, 1961). Control measures include: (i) physically removing infected trees or their parts by pruning, poisoning or burning, and (ii) applying chemical treatments designed to kill the endophytic system. The primary control of mistletoes as parasitic plants in forest, woodland and orchard, remains pruning infected branches and removing infected trees (Robert *et al*, 2008).

Mechanical control by pruning

It has been difficult to eradicate mistletoes in cocoa plantings and more difficult in tall tree crops like rubber. The infestation by mistletoes in sal plantations (sal = *Shorea robusta*) can be controlled by pruning before the ripening of the fruits and their dispersion by birds (De, 1945).

In cocoa, pruning of infected branches is recommended to remove the mistletoes by using long-handled pruning knives (Lass, 1985). The most effective way to control mistletoe in cocoa bushes and prevent its spread is to prune out infected branches, if possible, as soon as the parasite appears. Heavy duty pruning shears can be used to remove infected branches at their point of origin or back to large lateral branches. Infected branches need to be cut at

least 30 cm or one foot below the point of mistletoe attachment in order to completely remove embedded haustoria (Perry, 2006). A disadvantage in pruning is that the cutting tool and other tools used to remove the mistletoes can help in dispersal of mistletoes (including seeds) (Phillips, 1977) consequently, helping in the indirect spreading of the parasitic weed.

At present, in the absence of other more cost-effective control measures, manual pruning using a pair of heavy duty pruning shears for cutting small branches and pruning hand saw for cutting large branches is the control method for *S. ferruginea* in cocoa plantings. Regular attention should be made in routine pruning rounds to remove isolated colonisation as soon as possible.

Biological control

Presently, not much information is available in biological control. Biological control with fungi has been discussed for dwarf mistletoes (Shamoun & Dewald, 2002), but there is no report of leafy mistletoe control with fungi (Parker & Riches, 1993).

Chemical control

Chemical control involving the use of growth regulators applied to aerial shoots was reported by Hawksworth and Wiens (1996), Johnson (1992) and Shamoun and Dewald (2002). The plant growth regulator, ethephon, may be used as indicated on the label to control mistletoe in dormant host trees (Perry, 2006). Dormant host trees refer to the stage in winter when trees lose their leaves. If the chemical solution is sprayed on trees with leaves, the trees may be killed. To be effective, the spray must thoroughly wet the mistletoe foliage.

Chemical control include trunk injection with herbicides (Minko & Fagg, 1989), and application of herbicides to the plant (Graser, 1952). A herbicide poisoning trial was carried out to evaluate the basal stem painting (including the haustorial tissues) to control *S. ferruginea* on cocoa. Six herbicide treatments, namely: i) fluroxypyr (29.6% product) and diesel mixture in 1:39 ratio, ii) triclopyr (32.1% product) and diesel mixture in 1:9 ratio, iii) dicamba (40.8% product) and diesel mixture in 1:14 ratio, iv) paraquat (20% product) and diesel mixture in 1:4 ratio, v) glufosinate-ammonium (20% product) and diesel mixture in 1:4 ratio, and vi) 2,4,5-T (57.5% product) and diesel mixture in 1:19 ratio were evaluated in comparison with an untreated control. Application of herbicide diesel mixture covered the basal stem and the haustorial tissues. Fluroxypyr diesel mixture and glufosinate-ammonium diesel mixture were promising and recorded more than 60 per cent kill. In general, herbicide diesel mixture painting treatments were considered less effective. From observations, some of the mistletoe basal runners escaped chemical effect and produced new aerial shoots of the mistletoes. Cost of herbicide painting could be as high as manual pruning and was found to be an inferior measure.

(*Note*: paraquat, dicamba and 2,4,5-T are no more available in Malaysia)

Integrated weed management

Integrated Weed Management over a larger area, for example the entire cocoa estate or the entire district including plants in housing areas, roadsides, recreation parks, etc. is necessary to cut down the spread and recurrence after a control operation. Integrated management for effective mistletoe control programme requires a combination of methods and the cooperation of planters, agriculturists, park rangers, other government officials and

house/property owners. All parties concerned can reduce mistletoe infestations on susceptible trees in each locality, but without their coordinated actions, infestations will spread and recur. Areas with infested trees left without control treatment, whether estates, parks, riparian reserve areas, small woody lands, orchards, home gardens, etc., can be a continual source of seeds which give rise to further mistletoe infestations. The most drastic and possibly the best control measure are to remove severely infested trees and replace them with less susceptible species. To assist other individual owners in removing mistletoe from less severely infested trees on their property, the governmental agency can provide regular periodic pruning operation in the neighbourhood of the cocoa estates, orchards and other plantations. In severe infestation areas, the Department of Agriculture can gazette the mistletoe as "Dangerous weed"/"Noxious weed". *S. ferruginea* can be placed under quarantine/eradication status and a penalty for failure in its removal should be implemented.

CONCLUSION

The rusty-leaf mistletoe (*S. ferruginea*), a parasitic plant, is quite widespread in Malaysia. It is considered as a serious parasitic weed in many types of fruit trees, rubber and cocoa due to its colonisation on the branches. It has been difficult to eradicate mistletoes in cocoa and more difficult in tall tree crops like rubber. The most effective way to control mistletoe in cocoa and prevent its spread is to prune out infected branches. Manual pruning to remove the mistletoes is the current control in the cocoa estate. Integrated Weed Management would perhaps be a more effective and more efficient control of mistletoes over a very large area inclusive of cocoa estates, orchards and other agricultural/non-agricultural areas. The uses of mistletoes in traditional and pharmacological treatments merit further studies.

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