Biological control of weeds in Malaysian plantations

Peter A. C. Ooi

International Institute of Biological Control, Malaysian Station, P.O. Box 11872, 50760 Kuala Lumpur, Malaysia

Summary

Weed control in Malaysian plantations has for a long time depended on herbicides. This reflects the interest of weed scientists in Malaysia. For the period 1975-1984, 70% of the publications were on chemical control of weeds. However, in recent years increasing problems have arisen from dependence on chemical control, for example, health effects to operators, herbicide resistance, toxicity to non-target crops and changes in weed flora. These have resulted in a greater interest in biological control of weeds in plantations and other crops.

Eighteen important weeds have been identified in plantation crops, of which 44% are exotic. Tropical weeds from the new world are amenable to classical biological control. However, studies of the ecology of native weeds are necessary to identify safe biological control agents to help in the development of a sustainable weed management with reduced dependence on chemical control. A possible outcome of ecological studies is the development of suitable fungi to augment existing biological control agents.

Classical biological control is reported for three major plantation weeds, namely, *Chromolaena odorata, Cordia curassavica* and *Mikania micrantha.* Of these, successful suppression of *C. curassavica* has been observed. For *C. odorata,* localized defoliation was occasionally observed in Sabah. Difficulties associated with the establishment of the biological control agents of *M. micrantha* are discussed.

Indigenous enemies of native weeds, particularly for *Melastoma malabatrichum* and *Dicranopteris linearis,* are also reviewed.

Introduction

Weed control in Malaysian plantations is dominated by the use of herbicides at the seedling to young plant growth stage of the crop. Chee (2) reported that chemical control could cost up to 24.3% of the cost to replant rubber. However, in mature rubber, weed control costs are lower as herbicides are used mainly to reduce interference with farm operations (15). The preoccupation with chemical control in Malaysia is reflected in the number of publications on this topic. For example, Teoh and Ooi (20) found that for the period 1975-1984, 70% of the publications on weeds were on chemical control. However, in recent years, there has been greater interest in biological control of weeds. This has been given impetus following publicity about the adverse health and environmental effects of herbicides by the local press. Problems associated with crop phytotoxicity when applied to immature plants and drift onto non-target crops and questions about safety to operators have also been highlighted (Chung, personal communication 1991; 8). Herbicide resistance and changes in the flora appear as increasing problems in plantations which regularly use herbicides (2).

As a result, several biological control of weeds projects have been initiated in Malaysia. This paper attempts to review the status of the projects in Malaysian plantation crops. The trend reported may be similar to that reported in neighbouring countries with similar crops.

Major weeds of plantation crops

Weeds in Malaysian plantations are characterized by a mixture of grasses, broadleaves and ferns. A recent review by Rosli Mohamad (15) listed 18 important weed species (Table 1). Of these, six were grasses, eight broadleaves and four ferns. Forty-four percent were exotics.

The weed *Cordia curassavica* (Boraginaceae) is probably not listed in Table 1 because its status has changed following a successful biological control program (16,21).

Prior to the program it was a very important weed in coconut plantations, particularly in Selangor and Johor.

Weeds in plantations are economically important in the establishment stage. For example, *Mikania micrantha* is known to depress early rubber tree growth (23), probably as a result of an allelopathic compound produced by the weed (24).

Biological control attempts

The prospects for classical biological control of exotic weeds in Malaysia was discussed by Ung and Ooi (22). They pointed out that the pest status of the major exotic weeds was due to the lack of effective biological control agents. It was suggested that proven agents be introduced. This strategy worked following the program to control *C. curassavica* with two agents, *Metrogaleruca obscura* DeGeer (Coleoptera: Galerucidae) and *Eurytoma attiva* Burks (Hymenoptera: Eurytomidae). They proved most effective in reducing large populations of the weed throughout the Malaysian peninsular (10,16,21).

Some of the weeds targeted for biological control by Ung and Ooi (22) are listed in Table 1. An example is *Chromolaena odorata*, a plant present both in plantations and vacant land. Both *Pareuchaetes pseudoinsulata* Rego Barros (Lepidoptera: Arctiidae) and *Apion brunneonigrum* Beguin-Billecoq (Coleoptera: Apionidae) were introduced into Sabah between 1970-73 (18). Only the former established, but did not provide control (14). Also, *Acalitus adoratus* fortuitously arrived in Malaysia and neighbouring countries, but has not caused much damage to the weed (see Table 2).

Biological control of *Lantana camara* has been the subject of many projects (Table 2), but still remains a challenge. However, some of the agents released in one country have travelled to others in the region. Two such agents are *Calycomyza lantanae* Frick and *Ophiomyia lantanae* (Froggatt) (Diptera: Agromyzidae) (11). Damage by the former causes severe localized defoliation, but insufficient to control the weed effectively. The role of pathogens should receive more attention now.

Following the success of the control of *C. curassavica* and encouraging results from Cock (3), a program to control *M. micrantha* was initiated (19). This led to the introduction of *Liothrips mikaniae* (Priesner) (Thysanoptera: Phlaeothripidae) from Trinidad. This project continues, despite initial problems with rearing the insect. This was solved, but the insect is proving difficult to establish in the field because of the presence of many general predators (9). Indeed, in the laboratory, predatory thrips, ants and spiders occasionally reduce the breeding populations.

Despite the interest in exotic biological control agents to control weeds, there have been comparatively fewer studies about natural enemies of native weeds. This can be seen in Table 3 compiled from the list prepared by Ahmad and Ho (1). Impressive defoliation of *Melastoma malabathricum* by *Altica cyanea* (Coleoptera: Chrysomelidae) was observed by Kamal and Aziz (5) and Ooi (12). This conspicuous weed has other natural enemies, as two species of moths were introduced into Hawaii from Malaysia (4). There is a need to carefully study the natural enemies of *M. malabathricum* to understand why this weed is still a nuisance in its native range. A possible outcome is the discovery of fungal pathogens.

Recently it was reported that the fern *Dicranopteris linearis* was severely defoliated by *Schlenklingia* ssp. (Coleoptera: Chrysomelidae) (7), but little is known about the biology of this insect.

Based on our experiences, strategies for the biological control of weeds in plantations are suggested. It is hoped that they will prove valuable to those projects in a similar tropical environment.

Strategies for biological control of plantation weeds

The successful biological control of *C. curassavica* was an important milestone for Malaysia, for it showed that it was possible, economically viable, sustainable and safe. This stimulated support for more projects by the National Biological Control Coordinating Committee currently based at the Malaysian Agricultural Research and Development Institute (MARDI). Currently, there are four projects on weeds. Therefore, it is necessary to begin with a proven biological control agent to convince 'negative' administrators of the value of biological control of weeds.

Following the successful *C. curassavica* project, it was possible to embark on a new program using an untested agent for *M. micrantha*. This augurs well for a country where 75% of the total pesticides used are herbicides (15).

An important consequence of running new biological control projects, such as for *M. micrantha*, is that expectations are high. As the biological control agent *L. mikaniae* had not been introduced elsewhere, it was difficult to predict its success. Initially, the thrips were not easy to rear under laboratory conditions. General predators provided problems in field establishment. As studies of rice pests showed that general predators are important in keeping homopteran pests in check (6,13), it should not come as a surprise that general predators would prevent *L. mikaniae* from establishing. Even in the case of the biological control of *Clidemia hirta* using *Liothrips urichi* Karny (Thysanoptera: Phlaeothripidae) in Fiji, it took thousands of thrips and about two years before establishment was reported (17).

The rather poor establishment of *P. pseudoinsulata* in Sabah was also attributed to general predators. As this has not been proven, attempts should be made to discover the factors which prevented it from exerting its potential. Studies of natural enemies of weeds should not only be confined to exotic weeds. Indeed, a knowledge of natural enemies of native weeds may result in more appropriate systems to keep the weeds in check. It is suggested that weed scientists should record all natural enemies found, as this may result in the discovery of weed pathogens. Weed pathology is neglected and efforts should be made to understand its role in native weed populations. The development of mycoherbicides is an important growth area for biological control.

Increased interest in biological control of weeds has also resulted in the need for more efficient quarantine procedures. As a result, Malaysia has constructed a new biological control quarantine facility. This is encouraging to biological control specialists working in Malaysia as it shows the commitment of the country to biological control.

References

1. Ahmad, Y. and Ho, T.H. (1980). List of economic pests, host plants, parasites and predators in West Malaysia (1920-1978). Bulletin No. 153, Ministry of Agriculture, Kuala Lumpur, Malaysia.
2. Chee, Y.K. (1990). Recent weed management development in rubber. *In* 'Proceedings of the symposium on weed management', eds B. A. Auld, et al., pp. 189-197, Biotrop Special Publication, No. 38, Bogor, Indonesia.
3. Cock, M.J.W. (1982). Potential biological control agents for *Mikania micraantha* HBK from the neotropical region. *Tropical Pest Management* 28 (3), 242-54
4. Julien, M.H. (1987). 'Biological control of weeds. A catalogue of agents and their target weeds', 2nd ed CAB International Institute of Biological Control, Ascot, U.K. 150 pp.
5. Kamal, A.K. and Aziz, A.S. (1978). The potential of *Altica cyanea* Weber (Coleoptera: Chrysomelidae) as a biological control agent for *Melastoma malabathricum* Linn. *MARDI Research Bulletin* 6, 15-24.
6. Kenmore, P.E., Carino, F.O., Perez, C.A., Dyck, V.A. and Gutierrez, A.P. (1984). Population regulation of the brown planthopper *(Nilaparvata* lugens Stal) within rice fields in the Philippines. *Journal of Plant Protection in the Tropics* 1, 19-37.
7. Khoo, K.C. and Chung, G.F. (1990). *Schlenklingia* sp. - a prospective biological control agent against bracken. *MAPPS Newsletter* 14 (4), 53.
8. Lee, S.A. and Chung, G.F. (1985). Safety aspects of LV, VLV, ULV and CDA application. *In* 'Recent Developments in Pesticide Application Technology', ed C.H. Teoh, pp. 46-66, Malaysian Plant Protection Society, Kuala Lumpur, Malaysia.
9. Liau, S.S., Ooi, P.A.C., Mohd. Ridzuan Ismail, Tay, B.L., Lee, S.A., Chung, G.F. and Ho, C.T. (1991). *Mikania micrantha:* early experiences on biological control in Malaysia. Presented at the International Conference on Biological Control in Tropical Agriculture, Pahang, Malaysia.
10. Ooi, P.A.C. (1981). *Eurytoma attiva* Burks (Hym., Eurytomidae) attacking *Cordia curassavica* (Jacq.) R. & S. in Kedah and Perlis, Malaysia II. Incidence of *E. attiva*. *Malaysian Agricultural Journal* 53, 1-8.
11. Ooi, P.A.C. (1987). A fortuitous biological control of *Lantana* in Malaysia. *Tropical Pest Management* 33, 233-6.

12. Ooi, P.A.C. (1987). A Melastoma-feeding chrysomelid beetle, *Altica cyanea*. *Malayan Nature Journal* 41, 379-82.
13. Ooi, P.A.C. (1988). Ecology and surveillance of *Nilaparvata lugens* (Stal) - implications for its management in Malaysia. PhD. thesis, University of Malaya, Kuala Lumpur. 275 pp.
14. Ooi, P.A.C., Sim, C.H. and Tay, E.B. (1988). Status of the arctiid moth introduced to control Siam weed in Sabah, Malaysia. *Planter Kuala Lumpur* 64, 298-304.
15. Rosli Mohamad (1990). Country report: Malaysia Weeds and weed management in Malaysian agriculture. *In* 'Proceedings of the symposium on weed management', eds B. A. Auld et al., pp. 41-52, Biotrop Special Publication, No. 38, Bogor, Indonesia.
16. Simmonds, F.J. (1980). Biological control of *Cordia curassavica* (Boraginaceae) in Malaysia. *Entomophaga* 25, 363-4.
17. Simmond, H.W. (1933). The biological control of the weed *Clidemia hirta*, D. Don., in Fiji. *Bulletin of Entomological Research* 24, 345-8.
18. Syed, R.A. (1979). An attempt on biological control of *Eupatorium odoratum* L. f. in Sabah, Malaysia. Proceedings 6th Asian-Pacific Weed Science Society Conference, Vol. II, pp. 459-66.
19. Teoh, C.H., Chung, C.F., Liau, S.S., Ghani Ibrahim, Tan, A.M., Lee, S.A. and Mariati Mohammed (1985). Prospects for biological control of *Mikania micrantha* HBK in Malaysia. *Planter Kuala Lumpur* 61, 515-30.
20. Teoh, C.H. and Ooi, P.A.C. (1986). Towards more effective plant protection in the tropics. *Journal of Plant Protection in the Tropics* 3, 51-72.
21. Ung, S.H., Ahmad, Y. and Chin, W.H. (1979). Biological control of *Cordia curassavica* (Jacq.) R. & S. in Malaysia by *Schematiza cordiae* Barb. (Coleop: Galerucidae). *Malaysian Agricultural Journal* 52, 154-65.
22. Ung, S.H. and Ooi, P.A.C. (1979). Biological control of exotic weeds in Malaysia. Proceedings Plant Protection Seminar 1979 - Strategies in Plant Protection. eds T.K. Lim et al. pp. 49-63.
23. Watson, G.A., Wong, P.W. and Narayanan, R. (1964). Effects of cover plants on soil nutrient status and on growth of Hevea IV. Leguminous creepers compared with grasses, *Mikania cordata* and mixed indigenous covers on four soil types. *Journal of the Rubber Research Institute of Malaya* 18, 123-45.
24. Wong, P.W. (1964). Evidence for the presence of growth inhibitory substance in *Mikania cordata* (Burm. f.) B. L. Robinson. *Journal of the Rubber Research Institute of Malaya* 18, 231-42.

Table 1 *Common weeds in plantation crops (adapted from (15)).*

Name	Family	Origin
Axonopus compressus	Poaceae	new world tropics
Asystasia coromandeliana	Acanthaceae	pan-tropical
Asystasia intrusa	Acanthaceae	pan-tropical
Chromolaena odorata	Asteraceae	new world tropics
Clidemia hirta	Melastomaceae	new world tropics
Cynodon dactylon	Poaceae	pan-tropical
Dicranopteris linearis	Gleicheniaceae	pan-tropical
Imperata cylindrica	Poaceae	pan-tropical
Lantana camara	Verbenaceae	new world tropics
Lygodium flexuosum	Schizaeaceae	pan-tropical
Melastoma malabathricum	Melastomaceae	S. China/Malaysia
Mikania micrantha	Asteraceae	new world tropics
Mimosa pudica	Leguminosae	new world tropics
Nephrolepis biserrata	Nephrolepidaceae	pan-tropical
Ottochloa nodosa	Poaceae	pan-tropical
Paspalum commersonii	Poaceae	Africa
Paspalum conjugatum	Poaceae	new world tropics
Stenochlaena palustris	Blechnaceae	pan-tropical

Table 2 Review of worldwide attempts at classical biological control of major plantation weeds in Malaysia (after (4)).

Weeds	Agents	Countries and degree of control
C. odorata	*Apion brunneonigrum* Beguin-Billecoq (Coleoptera: Apionidae)	Not established in, Ghana, India, Malaysia, Nigeria and Sri Lanka.
	Pareuchaetes pseudo-insulata Rego Barros (Lepidoptera: Arctiidae)	Successful suppression in Guam. Established in India, Malaysia and Sri Lanka. Not established in Ghana and Nigeria. Arrived fortuitously in Brunei and Philippines.
	Acalitus adoratus Keifer (Acari: Eriophyidae)	Arrived fortuitously in China (Hainan), Indonesia, Malaysia, Philippines and Thailand.
C. hirta	*Blepharomastix ebulealis* Guenee (Lepidoptera: Pyralidae)	Established in Hawaii but ineffective.
	Liothrips urichi Karny (Thysanoptera: Phlaeothripidae)	Established in Fiji and good control. Established in Hawaii with partial success. Not established in Solomon Islands Present in Samoa but status unknown.
L. camara	*Aerenicopsis championi* Bates (Coleoptera: Cerambycidae)	Not established in Hawaii.
	Alagoasa parana Samuelson (Coleoptera: Chrysomelidae)	Not established in Australia and South Africa.
	Apion spp. (Coleoptera: Apionidae)	Not established in Hawaii.
	Autoplusia illustrata Guenee (Lepidoptera: Noctuidae)	Not established in Australia.
	Calycomyza lantanae Frick (Diptera: Agromyzidae)	Established in Australia with no control. Established in South Africa. Arrived fortuitously in Indonesia, Malaysia, Papua New Guinea, Philippines, Singapore and Thailand.
	Cremastobombycia lantanella Busck (Lepidoptera: Gracillariidae)	Established with partial control in Hawaii.
	Diastema tigris Guenee (Lepidoptera: Noctuidae)	Not established in Australia, India, Fiji, Ghana, Hawaii, Mauritius, Tanzania, Uganda and Zambia.
	Epinotia lantana (Busck) (Lepidoptera: Tortricidae)	Established and provide some control in Australia, Caroline Islands and Hawaii. Arrived fortuitously in Norfolk Island and India.

Eutreta xanthochaeta Aldrich (Diptera: Tephritidae)	Established in Hawaii but of minor importance. Not established in Australia and S. Africa.
Hepialus sp. (Lepidoptera: Hepialidae)	Not established in Hawaii.
Hypena strigata (F.) (Lepidoptera: Noctuidae)	Established in Australia, Fiji, Hawaii and Norfolk Island. Not established in Guam. Apparently indigenous to S. Africa. Arrived fortuitously in Mauritius.
Lantanaphaga pusillidactyla (Walker) (Lepidoptera: Pterophoridae)	Established in Hawaii. Not established on Caroline Islands and probably S. Africa. Arrived fortuitously in Australia, Hong Kong and India.
Leptobyrsa decora Drake (Hemiptera: Tingidae)	Established in Australia, Hawaii & Norfolk Island. Not established in Fiji, Ghana, Guam and Zambia. Unconfirmed establishment in Cook Islands and South Africa. Arrived fortuitously in Tonga Islands.
Neogalea esula (Druce) (Lepidoptera: Noctuidae)	Established in Australia and Hawaii. Not established in South Africa.
Octotoma championi Baly (Coleoptera: Chrysomelidae)	Ineffective in Australia. Establishment unconfirmed in South Africa.
Octotoma plicatula (F.) (Coleoptera: Chrysomelidae)	Not established in Hawaii.
Octotoma scabripennis Guerin-Meneville (Coeloptera: Chrysomelidae)	Established in Australia, Ghana, Hawaii, India, New Caledonia, Norfolk Island and South Africa. Not established in Cook Islands, Fiji and Guam.
Ophiomyia lantanae (Froggatt) (Diptera: Agromyzidae)	Established in Australia, Cook Islands, Fiji, Guam, Hawaii, Hong Kong, New Caledonia, Norfolk Island and South Africa. Not established in Caroline Islands. Arrived fortuitously in Argentina, Burma, Ghana, India, Kenya, Malaysia, Madagascar, Papua New Guinea, Philippines, Singapore, Sri Lanka, Uganda, Vanuatu, Zanzibar and Zimbabwe.
Orthezia insignis Browne (Hemiptera: Ortheziidae)	Arrived fortuitously in Hawaii and India but ineffective.

Parevander xanthomelas (Guerin-Meneville) (Coleoptera: Cerambycidae)	Not established in Hawaii
Plagiohammus spinipennis (Thomson) (Coleoptera: Cerambycidae)	Limited establishment in Australia, Hawaii and South Africa. Not established in Guam.
Pseudopyrausta acutangulalis (Snellen) (Lepidoptera: Pyralidae)	Not established in Fiji and Hawaii
Salbia haemorrhoidalis Guenee (Lepidoptera: Pyralidae)	Established in Australia, Fiji, Hawaii, Mauritius, South Africa and Uganda. Not established in India, Kenya, Tanzania and Zambia.
Teleonemia elata Drake (Hemiptera: Tingidae)	Not established in Australia, Cook Islands, South Africa, Uganda and Zambia.
Teleonemia harleyi Froeschner (Hemiptera: Tingidae)	Established in Australia.
Teleonemia prolixa Stal (Hemiptera: Tingidae)	Not established in Australia.
Teleonemia scrupulosa Stal (Hemiptera: Tingidae)	Established in Australia, Caroline Islands, Fiji, Ghana, Guam, Hawaii, India, Indonesia, Kenya, Madagascar, New Caledonia, Papua New Guinea, South Africa, Tanzania, Tonga, Uganda, Vanuatu, Western Samoa, Zambia and Zanzibar. Not established in Zimbabwe. Arrived fortuitously in Malaysia (Sabah), Mauritius and Philippines.
Thecla bazochii (Godart) (Lepidoptera: Lycaenidae)	Established in Fiji and Hawaii. Not established in Australia.
Thecla sp. (Lepidoptera: Lycaenidae)	Established in Hawaii.
Uroplata girardi Pic (Coleoptera: Chrysomelidae)	Established in Australia, Cook Island, Fiji, Ghana, Guam, Hawaii, India, Mauritius, New Caledonia, Papua New Guinea, Philippines, South Africa, Tonga, Trinidad, Uganda, Vanuatu, Western Samoa and Zambia.
Uroplata lantanae Buzzi & Winder (Coleoptera: Chrysomelidae)	Not established in Australia. Establishment not confirmed in S. Africa.

	Uroplata sp. nr. *bilineata* Chapuis (Coleoptera: Chrysomelidae)	Established in Australia. Not established in South Africa.
M. malabathricum	*Bocchoris adipalis* (Zeller) (Lepidoptera: Pyralidae)	Established in Hawaii.
	Bocchoris fatualis (Lederer) (Lepidoptera: Pyralidae)	Established in Hawaii.
	Selca brunella Hampson (Lepidoptera: Arctiidae)	Established in Hawaii.

Table 3 *Number of species of arthropods recorded on major weeds of plantations in Malaysia (after (1))*

Weed	No. of species recorded in each Order					
	Coleo	Dipte	Hemip	Isopt	Lepid	Ortho
A. coromandeliana	0	0	1	0	0	0
A. compressus	0	0	2	1	5	0
C. hirta	2	0	0	0	0	0
C. dactylon	1	5	0	1	3	0
D. linearis	2	0	1	0	1	0
I. cylindrica	0	0	13	0	4	3
L. camara	1	0	2	0	1	0
M. malabathricum	6	0	4	0	5	0
M. micrantha	1	0	1	0	2	0
N. biserrata	1	0	0	0	1	0
P. conjugatum	0	0	2	0	0	0

Coleo	Coleoptera
Dipte	Diptera
Hemip	Hemiptera
Isopt	Isoptera
Lepid	Lepidoptera
Ortho	Orthoptera