

**Evaluating prospects for biological control of
invasive weeds in Melanesia:
A report on the ACIAR-funded workshop
held at the Novotel Hotel, Nadi, Fiji,
25-27th November 2013**

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A workshop was held at the Novotel Hotel, Nadi, Fiji from 25-27th November 2013 to prioritise weeds that could be included in a possible future ACIAR-funded regional biocontrol project (Appendix 1). It was attended by 18 people, representing 12 organisations in eight countries. Caress Whippy and Joeli Uluinayau, Secretariat of the Pacific Community (SPC) provided valuable logistical support (Appendix 2).

Day 1 Wednesday, 25th November 2013

The meeting was opened by Tony Gunua, SPC, followed by an address by Richard Markham, ACIAR Program Manager, Pacific Crops.

Participants were asked what they can contribute to the workshop, as well as what they hoped they could gain from the workshop. Most thought they appreciated the opportunity to get together with researchers from other countries and organisations in the region and have the opportunity to provide input into developing a regional biocontrol program.

Dick Watling, Nature Fiji Mareqeti Viti, gave a presentation on the perceptions of *Spathodea campanulata*. He presented a case that the species was not invasive and not having any impact on biodiversity, forestry or agriculture. He said that there has not been any research conducted to quantify impacts of this species, positive or negative. Therefore, before a decision on biocontrol of African tulip tree is made, research should be conducted to understand the role of this species in the landscape. Moreover, there needs to be full consultation with a broad range of stakeholders to clarify perceptions and take different perspectives into account.

David Moverley, SPREP, gave a presentation on SPREP's activities in the Pacific and how they could provide assistance or link in with future biocontrol projects in the Pacific. SPREP currently has a Global Environment Fund project on weed management, involving eight countries, including PNG and Vanuatu, which includes determining the presence and distribution of invasive species. Up to now SPREP has had little experience in weed biocontrol activities. There is the possibility of strong linkages with the AusAID weed management projects in PNG and Vanuatu which are recording the presence of invasive weeds, as part of their biocontrol monitoring activities.

Darcy Oishi, Department of Agriculture, Hawaii gave an overview of biocontrol activities in Hawaii. Some weeds that Hawaii is currently researching, such as *Miconia calvescens* and *Clidemia hirta* may be of interest to the Melanesian countries. Darcy emphasized the importance of building public awareness of and stakeholder support for weed biocontrol efforts.

Sarah Dodd, NZ Landcare gave an overview of biocontrol activities that may be undertaken in a new project in the Cook Is. Some weeds such as *Spathodea campanulata*, *Merremia peltata*, *Mikania micrantha* and *Xanthium strumarium* may be of interest to the Melanesian countries. Landcare has already established links with Iain Patterson, Rhodes University, South Africa to conduct field surveys and host specificity testing of possible agents for African tulip tree.

Michael Day, QDAFF gave a presentation on the status of weed biocontrol in the Melanesian countries to date. All countries have introduced biocontrol agents, with mixed success (Appendix 3).

Michael then presented a matrix of priority weed lists for each country developed from several regional workshops spanning back to 2002. The matrix also included a pre-workshop exercise, where participants were asked to submit what they or their organisation thought were their country's 'top 10' weeds. While some plant species were included in almost every list for a particular country, there was still a bit of variation in the composition of the lists, suggesting that priorities change over the years. However, it also suggests that weed priority lists are subjective, depending on who compiles the list. For the current workshop, most countries had three separate lists submitted from different organisations (Fiji had two lists submitted) (Appendix 4). Even among these current lists, there was considerable variation as to what was viewed as the most important weeds for each country, with up to 24 different species cited in the three lists for some countries (Appendix 4).

All weed lists for each workshop for each country since 2002 were compiled into one large list for each country (Appendix 5). The total number of species listed as being a priority for each country since 2002 were: Fiji (34), PNG (32), Solomon Islands (28) and Vanuatu (44).

Participants broke into groups by country and were asked to prioritise their combined weed list from Appendix 5 into the top 10 most important weeds. Most countries were represented by several organisations which helped with addressing perceptions etc. Warea Orapa and Tony Gunua, as past and present employees of SPC, also provided assistance to Maclean Vaqalo to prioritise a list for the Solomon Is (Appendix 6).

Tuesday, 26th November

Field trip. The participants spent the day in the field, travelling along the Coral Coast Road, towards Suva and stopping off at various places to look at weeds. Warea and Apaitia Macanawai acted as guides.

About 2-3 km east of Nadi towards Sigatoka at Yako Village, we viewed a large pond covered entirely with *Pistia stratiotes* (water lettuce). The beetle *Neohydronomus affinis* has not been introduced into Fiji. Water lettuce does not appear to be a major problem in Fiji as it has not been included in any weed priority list. However, Warea later reported that it is also present at several other sites (Nawaka, Navua and Ba), and is sold in markets, while

Tony Gunua reported that water lettuce is also on Vanua Levu. So, it has the potential to spread further.

At Cuvu, we inspected *Spathodea campanulata* scattered along the roadsides and in forests. Along the creek, there were quite a few trees scattered along the banks and in the forests. There was much discussion about its presence and impact and the group believed it is hard to imagine that it is not having some impact. Its mere presence must be displacing some other species in the forest.

Also present at the site was *Mikania micrantha*, scattered in small patches along the roadside. The rust *Puccinia spegazzinii* which was released nearby in 2009 and 2010 but was thought not to have established, was found at a low rate of incidence.

Further east at Pacific Green, Yadua, we inspected several patches of pink-flowering lantana, growing in exposed areas beside the road. The agents *Calycomyza lantanae*, *Crocidosema lantana*, *Hypena laceratalis*, *Ophiomyia lantanae*, *Teleonemia scrupulosa* and *Uroplata girardi* were found in low numbers and were not having a significant impact on the weed.

At Naviti, we inspected a small patch of *Mimosa diplotricha* and found the psyllid *Heteropsylla spinulosa* in low numbers. Also present was *M. micrantha* and the rust *P. spegazzinii*.

Lunch was at Natadola Beach, on the way home from the last site visited.

All the length of the road travelled, scattered trees of *S. campanulata* were present. In some cases, it was growing beside land cleared for farming while in many other situations, it was growing within forests or its edges.

Wednesday, 27th November

Quentin Paynter, NZ Landcare gave a presentation on the future work on *Merremia peltata* that will be conducted by NZ Landcare. *M. peltata* is considered a major weed in many countries within the Pacific and there have been numerous requests for a biocontrol program to be implemented. However, there is a debate on whether or not it is a native species of the region or individual country or where it has been introduced. Moreover, there does not appear to be a consensus or even a pattern to its perceived status across the region. The work proposed by Quentin will try to determine its origin prior to any biocontrol research being undertaken. Quentin will invite countries to submit plant samples for testing once the project is underway.

Stefan Naser, a weed biocontrol consultant from South Africa gave a presentation on the initial exploration for biocontrol agents for *Spathodea campanulata* in West Africa. Of the possible candidates found to date, Stefan believes an eriophyid mite *Colomerus spathodeae* would be the most promising and most specific. However, he noted that only a brief survey had been made in West Africa, at a time when neither flowers nor seeds were in evidence, so only leaf-feeding species were observed. Further exploration throughout its native range is required and through all seasons. To accommodate differing perceptions of the tree, Stefan mentioned that insects that reduce flowering and seed set could be introduced, thus leaving the standing plants intact.

The participants then broke into their country groups. Each group was given a table of the complete list of biocontrol agents introduced into their country for each of the weeds listed in Appendix 5. The table also included biocontrol agents (and their status) which have been released against the same species in other countries (Appendix 7).

The participants were asked to produce a list of three species that have been the target for weed biocontrol elsewhere, and for which they would like to implement biocontrol in their country. The participants were also asked to nominate which biocontrol agents they would introduce to control the three weeds listed (Appendix 8).

The participants were also asked to produce a list of three weed species which they think are the most important weeds regardless of whether the weeds are a biocontrol target (Appendix 8). The participants were then asked to present their lists to the group and justify each species' inclusion. The weed species will be included in the preparation of a Phase 1 project proposal to be submitted to ACIAR.

The afternoon session was spent discussing the capacity of organisations to implement a possible biocontrol program and some impediments that may need to be overcome. For some countries such as PNG and Vanuatu, there are already active biocontrol programs in progress and facilities, processes and networks already established. For Fiji and Solomon Islands, there are quarantine and glasshouse facilities available, although technical capacity may be limited.

For the Solomon Islands there can be misunderstandings between the Ministries of Environment, Conservation and Agriculture and it is unclear who should take the lead when importing biocontrol agents. In Fiji, the process involved in importing and releasing biocontrol agents can be confusing, involving many people in different sections. Communication within and between organisations can be lacking and the responsibilities of each organisation relating to importing and releasing biocontrol agents are unclear.

For both countries, there is uncertainty relating to the level of support in implementing weed biocontrol programs and this will need to be addressed early in the project development. One option is to hold meetings or mini-workshops to engage regulators, senior management and scientists so the project gains everyone's support. There will also need to be some public awareness campaigns to engage people and to educate them in weed biocontrol.

The workshop closed with participants offering what they gained from the workshop and how they can help progress weed biocontrol in their country. All thought the workshop was useful and supported the possibility of a weed biocontrol project.

Acknowledgements

Special thanks to Caress Whippy and Joeli Uluinayau who organised the workshop and travel arrangements of most of the participants. They also were responsible for the day to day logistics and support of the workshop, without whose help, the workshop would not have been such a success. Many thanks to Richard Markham and ACIAR who funded the workshop. Thanks also to our collaborators, especially Dr Stefan Naser (South Africa), Darcy Oishi (Hawaii), David Moverly and Posa Skelton (SPREP), Sarah Dodd and Quentin Paynter (NZ Landcare) and Dick Watling (NFMV).

**Appendix 1: Evaluating prospects for biological control of invasive weeds in Melanesia
Novotel Hotel, Nadi, Fiji
25-27 November 2013**

Agenda

Sunday, 24th November

Participants arrive.

Monday, 25th November

Welcome address and introduction (Richard Markham).

Introductions by each participant (include what you can contribute and what you hope to get out of the workshop).

Research conducted by Dick Watling (this will provide context when we start the prioritization exercise)

Discussion on the decision-making process in the prioritization of weeds. What do we need to consider? Stakeholders, environment, expectations, perceived views etc

Talk by David Moverley on the SPREP project and how it may link in with future biocontrol projects.

Weed biocontrol research in Hawaii (Darcy Oishi)

NZ's involvement in weed biocontrol in the Pacific (Sarah Dodd)

Wrap up of morning session

Lunch

Overall view of biocontrol research conducted. This will include providing an update on what weeds have been targeted in each country and what agents are already present in each country (Mike).

Discussions of the weed lists supplied over the years and by different organisations.

Discussions to rationalise weed priority list for each country in view of the morning's discussions.

Tuesday, 26th November

Field trip to view various weeds and biocontrol agents. Look at impacts of weeds in different scenarios etc.

Wednesday, 27th November

Talk by Quentin on *Merremia peltata* research and work in NZ.

Talk by Stefan Naser on prospects for biocontrol of *Spathodea campanulata*.

Discussions on research of *Spathodea campanulata* and *Merremia peltata*. Are there gaps and/or opportunities?

Lunch

Discussions on finalising top three weeds for each country to be targeted for biocontrol in a future project; identification of possible biocontrol agents that could be introduced into each country.

Discussions on research gaps which could be included in the larger project. i.e. are there weeds which are of high importance but not current biocontrol targets?

Identify organisations and individuals that could be involved in future research projects.

Wrap up.

Appendix 2. Workshop participants

Name	Country	Organisation	Email address
Richard Markham	Australia	ACIAR	Richard.Markham@aciar.gov.au
Michael Day	Australia	QDAFF	Michael.Day@daff.qld.gov.au
Miliakere Nawaikula	Fiji	Ministry of Agriculture	miliakere.nawaikula@agriculture.gov.fj
Apaitia Macanawai	Fiji	Ministry of Agriculture	apaitia.macanawai@govnet.gov.fj
Dick Watling	Fiji	NFMV	support@naturefiji.org
Tony Gunua	Fiji	SPC	TonyG@spc.int
Maclea Vaqalo	Fiji	SPC	maclea@spc.int
Emil Adams	Fiji	SPC	emila@spc.int
Darcy Oishi	Hawaii	Hawaii Government	Darcy.E.Oishi@hawaii.gov
Sarah Dodd	NZ	Landcare	DoddS@landcareresearch.co.nz
Quentin Paynter	NZ	Landcare	PaynterQ@landcareresearch.co.nz
Warea Orapa	PNG	NAQIA	worapa@naqia.gov.pg
Sim Sar	PNG	NARI	sim.sar@nari.org.pg
David Moverly	Samoa	SPREP	davidm@sprep.org
Posa Skelton	Samoa	SPREP	posas@sprep.org
Stefan Nesor	South Africa	Consultant	NesorS@arc.agric.za
Merriam Seth	Vanuatu	Vanuatu Biosecurity	mseth@vanuatu.gov.vu
Sylverio Bule	Vanuatu	Vanuatu Biosecurity	bsylverio@vanuatu.gov.vu

Caress Whippy and Joeli Uluinayau, SPC provided logistic support

ACIAR – Australian Centre for International Agricultural Research
QDAFF – Queensland Department of Agriculture, Fisheries and Forestry
NFMV – Nature Fiji Mareqeti Viti
SPC – Secretariat of the Pacific Community
NAQIA – National Agriculture Quarantine Inspection Authority
NARI – National Agricultural Research Institute
SPREP – Secretariat of the Pacific Regional Environment Programme

Appendix 3. The status of weed biocontrol in the four Melanesian countries.

Weed species	Agent	Status
Fiji		
<i>Clidemia hirta</i>	<i>Liothrips urichi</i>	Established, heavy impact in sunny areas
<i>Cyperus rotundus</i>	<i>Athesapeuta cyperi</i>	Established, no impact
<i>Eichhornia crassipes</i>	<i>Neochetina eichhorniae</i>	Established, heavy impact
<i>Elephantopus mollis</i>	<i>Tetraeuaresta obscuriventris</i>	Established, medium impact
<i>Lantana camara</i>	<i>Calycomyza lantanae</i>	Established, unknown impact
	<i>Charidotis pygmaea</i>	No establishment
	<i>Diastema tigris</i>	No establishment
	<i>Hypena laceratalis</i>	Established, slight impact
	<i>Leptobyrsa decora</i>	No establishment
	<i>Octotoma championi</i>	No establishment
	<i>Octotoma scabripennis</i>	No establishment
	<i>Ophiomyia lantanae</i>	Established, slight impact
	<i>Pseudopyrausta santatalis</i>	No establishment
	<i>Salbia haemorrhoidalis</i>	Established, slight impact
	<i>Strymon bazochii</i>	Unknown establishment
	<i>Teleonemia scrupulosa</i>	Established, variable impact
	<i>Tmolus echion</i>	No establishment
	<i>Uroplata fulvopustulata</i>	No establishment
	<i>Uroplata girardi</i>	Established, variable impact
<i>Mikania micrantha</i>	<i>Puccinia spegazzinii</i>	Established, unknown impact
<i>Mimosa diplotricha</i>	<i>Heteropsylla spinulosa</i>	Established, heavy impact
<i>Salvinia molesta</i>	<i>Cyrtobagous salviniae</i>	Established, heavy impact
	<i>Cyrtobagous singularis</i>	Established, no impact
	<i>Paulinia acuminata</i>	Established, no impact
	<i>Samea multiplicalis</i>	Established, no impact
<i>Sida</i> spp.	<i>Calligrapha pantherina</i>	Established, heavy impact
<i>Xanthium strumarium</i>	<i>Euaresta aequalis</i>	No establishment
	<i>Nupserha vexator</i>	No establishment
Papua New Guinea		
<i>Chromolaena odorata</i>	<i>Calycomyza eupatorivora</i>	No establishment
	<i>Cecidochares connexa</i>	Established, heavy impact
	<i>Pareuchaetes pseudoinsulata</i>	Established, variable impact
<i>Eichhornia crassipes</i>	<i>Neochetina bruchi</i>	Established, heavy impact
	<i>Neochetina eichhorniae</i>	Established, heavy impact
	<i>Niphograptus alboguttalis</i>	No establishment
	<i>Xubida infusella</i>	Unknown establishment
<i>Lantana camara</i>	<i>Teleonemia scrupulosa</i>	Established, heavy impact
	<i>Uroplata girardi</i>	Established, slight impact
<i>Mikania micrantha</i>	<i>Puccinia spegazzinii</i>	Established, unknown impact
<i>Mimosa diplotricha</i>	<i>Heteropsylla spinulosa</i>	Established, variable impact
<i>Pistia stratiotes</i>	<i>Neohydronomus affinis</i>	Established, variable impact
<i>Salvinia molesta</i>	<i>Cyrtobagous salviniae</i>	Established, heavy impact
<i>Sida</i> spp.	<i>Calligrapha pantherina</i>	Established, heavy impact
<i>Tribulus cistoides</i>	<i>Microlarinus lareynii</i>	No establishment
	<i>Microlarinus lypriformis</i>	Established, heavy impact
<i>Xanthium strumarium</i>	<i>Epiblema strenuana</i>	No establishment

Solomon Islands		
<i>Clidemia hirta</i>	<i>Liothrips urichi</i>	No establishment
<i>Eichhornia crassipes</i>	<i>Neochetina eichhorniae</i>	Established, slight impact
<i>Lantana camara</i>	<i>Octotoma scabripennis</i>	No establishment
	<i>Teleonemia scrupulosa</i>	Established, heavy impact
	<i>Uroplata girardi</i>	Established, heavy impact
<i>Mikania micrantha</i>	<i>Liothrips mikaniae</i>	No establishment
<i>Mimosa diplotricha</i>	<i>Heteropsylla spinulosa</i>	Established, heavy impact
Vanuatu		
<i>Eichhornia crassipes</i>	<i>Neochatina bruchi</i>	Established, unknown impact
	<i>Neochetina eichhorniae</i>	Established, heavy impact
<i>Lantana camara</i>	<i>Teleonemia scrupulosa</i>	Established, slight impact
	<i>Uroplata girardi</i>	Established, slight impact
<i>Mikania micrantha</i>	<i>Puccinia spegazzinii</i>	Established, unknown impact
<i>Mimosa diplotricha</i>	<i>Heteropsylla spinulosa</i>	Established, slight impact
<i>Pistia stratiotes</i>	<i>Neohydronomus affinis</i>	Established, variable impact
<i>Sida</i> spp.	<i>Calligrapha pantherina</i>	Established, heavy impact

Appendix 4. The most important weed species in each country according to the different workshops held since 2002. A list of the most important weeds for each each country as submitted by the participants or country representatives for this workshop is indicated in the shaded region.

	Meyer 2000	PPP Workshop 2002	PPP Workshop 2004	Julien et al 2007	Auckland Workshop 2009	SPC	ACIAR Workshop 2013 MoA	
Fiji	<i>Annona glabra</i> <i>Clidemia hirta</i> <i>Eichhornia crassipes</i> <i>Hydrilla verticillata</i> <i>Lantana camara</i> <i>Leucaena leucocephala</i> <i>Merremia peltata</i> <i>Mikania micrantha</i> <i>Pennisetum polystachyon</i> <i>Piper aduncum</i> <i>Rubus moluccanus</i> <i>Spathodea campanulata</i> <i>Sphagneticola trilobata</i>	<i>Mikania micrantha</i> <i>Merremia peltata</i> <i>Cyperus rotundus</i> <i>Mimosa diplotricha (M.invisa)</i> <i>Lantana camara</i> <i>Sphagneticola trilobata</i> <i>Eichhornia crassipes</i> <i>Spathodea campanulata</i> <i>Sphagneticola trilobata</i> <i>Kyllingia polyphylla</i> <i>Hyptis pectinata</i>	<i>Kyllingia polyphylla</i> <i>Clerodendrum chinensis</i> <i>Merremia peltata</i> <i>Spathodea campanulata</i> <i>Sphagneticola trilobata</i> <i>Piper auritum</i> <i>Xanthium strumarium</i> <i>Cyperus rotundus</i> <i>Mikania micrantha</i> <i>Sida</i> spp.	<i>Cyperus rotundus</i> <i>Eichhornia crassipes</i> <i>Lantana camara</i> <i>Merremia peltata</i> <i>Xanthium strumarium</i>	<i>Clerodendrum chinensis</i> <i>Coccinia grandis</i> <i>Cyperus rotundus</i> <i>Eichhornia crassipes</i> <i>Hedychium</i> spp. <i>Kyllingia polyphylla</i> <i>Merremia peltata</i> <i>Mimosa pudica</i> <i>Piper aduncum</i> <i>Senna tora</i> <i>Solanum torvum</i> <i>Sphagneticola trilobata</i> <i>Stachytarpheta jamaicensis</i> <i>Stachytarpheta urticifolia</i> <i>Xanthium strumarium</i>	<i>Spathodea campanulata</i> <i>Merremia peltata</i> <i>Convolvulaceae</i> spp. <i>Sphagneticola trilobata</i> <i>Xanthium strumarium</i> <i>Clerodendrum chinensis</i> <i>Senna tora</i> <i>Solanum torvum</i> <i>Piper aduncum</i> <i>Stachytarpheta</i> spp.	<i>Spathodea campanulata</i> <i>Sphagneticola trilobata</i> <i>Merremia peltata</i> <i>Ludwigia</i> spp. <i>Mikania micrantha</i> <i>Ageratum conyzoides</i> <i>Cyperus rotundus</i> <i>Commelina diffusa</i> <i>Cuphea carthagenensis</i> <i>Kyllingia polyphylla</i>	
PNG		<i>Cyperus rotundus</i> <i>Mimosa diplotricha (M.invisa)</i> <i>Mimosa pudica</i> <i>Bidens pilosa</i> <i>Chromolaena odorata</i> <i>Parthenium hysterophorus</i> <i>Piper aduncum</i>	<i>Sorghum halepense</i> <i>Rottboelia cochinchinensis</i> <i>Piper aduncum</i> <i>Mikania micrantha</i> <i>Cyperus rotundus</i> <i>Chromolaena odorata</i> <i>Sida</i> spp. <i>Mimosa diplotricha</i> <i>Mimosa pigra</i> <i>Xanthium strumarium</i> <i>Parthenium hysterophorus</i>	<i>Clidemia hirta</i> <i>Cyperus rotundus</i> <i>Lantana camara</i> <i>Miconia calvescens</i> <i>Xanthium strumarium</i>	<i>Clerodendrum chinensis</i> <i>Clidemia hirta</i> <i>Coccinia grandis</i> <i>Commelina benghalensis</i> <i>Cyperus rotundus</i> <i>Hedychium</i> spp. <i>Merremia peltata</i> <i>Mimosa pigra</i> <i>Mimosa pudica</i> <i>Piper aduncum</i>	<i>Mimosa pigra</i> <i>Spathodea campanulata</i> <i>Limnocharis flava</i> <i>Merremia peltata</i> <i>Piper aduncum</i> <i>Solanum torvum</i> <i>Xanthium strumarium</i> <i>Convolvulaceae</i> spp. <i>Mimosa diplotricha</i>	<i>Piper aduncum</i> <i>Spathodea campanulata</i> <i>Melinis minutiflora</i> <i>Mikania micrantha</i> <i>Pennisetum purpureum</i> <i>Tithonia diversifolia</i> <i>Mimosa pigra</i> <i>Miconia calvescens</i> <i>Thunbergia laurifolia</i> <i>Coccinia grandis</i>	<i>Mikania micrantha</i> <i>Eichhornia crassipes</i> <i>Chromolaena odorata</i> <i>Mimosa pigra</i> <i>Mimosa diplotricha</i> <i>Sida acuta</i> <i>Pistia stratiotes</i> <i>Spathodea campanulata</i> <i>Salvinia molesta</i> <i>Sorghum halepense</i> <i>Cyperus rotundus</i> <i>Piper aduncum</i>
Solomons		<i>Mikania micrantha</i> <i>Merremia peltata</i> <i>Cyperus rotundus</i> <i>Mimosa diplotricha (M.invisa)</i> <i>Mimosa pudica</i> <i>Lantana camara</i> <i>Eichhornia crassipes</i>	<i>Cyperus rotundus</i> <i>Mikania micrantha</i> <i>Broussonetia papyrifera</i> <i>Merremia peltata</i> <i>Mimosa diplotricha</i> <i>Sida</i> spp. <i>Paspalum maximum</i> <i>Elusine indica</i> <i>Solanum torvum</i> <i>Stachytarpheta urticifolia</i>	<i>Cyperus rotundus</i> <i>Eichhornia crassipes</i> <i>Lantana camara</i> <i>Merremia peltata</i> <i>Sida</i> spp.	<i>Clerodendrum chinensis</i> <i>Clidemia hirta</i> <i>Coccinia grandis</i> <i>Commelina benghalensis</i> <i>Mimosa pudica</i> <i>Piper aduncum</i> <i>Sida</i> spp. <i>Sphagneticola trilobata</i> <i>Stachytarpheta jamaicensis</i> <i>Stachytarpheta urticifolia</i> <i>Xanthium strumarium</i>	<i>Broussonetia papyrifera</i> <i>Mikania micrantha</i> <i>Merremia peltata</i> <i>Convolvulaceae</i> spp. <i>Mimosa diplotricha</i> <i>Solanum torvum</i> <i>Senna tora</i> <i>Spathodea campanulata</i> <i>Sida</i> spp. <i>Stachytarpheta</i> spp.	<i>Broussonetia papyrifera</i> <i>Coccinia grandis</i> <i>Piper aduncum</i> <i>Mikania micrantha</i> <i>Merremia peltata</i> <i>Mimosa diplotricha</i> <i>Stachytarpheta</i> spp. <i>Spathodea campanulata</i> <i>Hyptis capitata</i> <i>Clidemia hirta</i>	<i>Merremia peltata</i> <i>Stachytarpheta</i> spp. <i>Mikania micrantha</i> <i>Eichhornia crassipes</i> <i>Broussonetia papyrifera</i> <i>Samanea saman</i> <i>Leucaena leucocephala</i> <i>Spathodea campanulata</i> <i>Mimosa diplotricha</i> <i>Lantana camara</i>
Vanuatu	<i>Cordia alliodora</i> <i>Eichhornia crassipes</i> <i>Heteropogon contortus</i> <i>Imperata cylindrica</i> <i>Lantana camara</i> <i>Leucaena leucocephala</i> <i>Merremia peltata</i> <i>Mikania micrantha</i> <i>Panicum maximum</i> <i>Paspalum conjugatum</i> <i>Salvinia molesta</i>	<i>Mikania micrantha</i> <i>Merremia peltata</i> <i>Cyperus rotundus</i> <i>Senna tora</i> <i>Solanum torvum</i>	<i>Parthenium hysterophorus</i> <i>Merremia peltata</i> <i>Mikania micrantha</i> <i>Spathodea campanulata</i> <i>Sida</i> spp. <i>Lantana camara</i> <i>Solanum torvum</i> <i>Mimosa diplotricha</i> <i>Eichhornia crassipes</i> <i>Pistia stratiotes</i> <i>Amaranthus spinosus</i>	<i>Lantana camara</i> <i>Merremia peltata</i>	<i>Clerodendrum chinensis</i> <i>Coccinia grandis</i> <i>Eichhornia crassipes</i> <i>Merremia peltata</i> <i>Mimosa diplotricha</i> <i>Mimosa pudica</i> <i>Piper aduncum</i> <i>Senna tora</i> <i>Solanum torvum</i> <i>Spathodea campanulata</i> <i>Sphagneticola trilobata</i> <i>Stachytarpheta jamaicensis</i> <i>Stachytarpheta urticifolia</i>	<i>Senna tora</i> <i>Merremia peltata</i> <i>Convolvulaceae</i> spp. <i>Parthenium hysterophorus</i> <i>Solanum torvum</i> <i>Dolichandra unguis-cati</i> <i>Stachytarpheta</i> spp. <i>Spathodea campanulata</i> <i>Leonotis nepetifolia</i> <i>Hyptis capitata</i>	<i>Mimosa diplotricha</i> <i>Merremia peltata</i> <i>Solanum torvum</i> <i>Lantana camara</i> <i>Mikania micrantha</i> <i>Pistia stratiotes</i> <i>Senna tora</i> <i>Hyptis capitata</i> <i>Parthenium hysterophorus</i> <i>Urena lobata</i> <i>Spathodea campanulata</i> <i>Dolichandra unguis-cati</i> <i>Eichhornia crassipes</i> <i>Amaranthus spinosus</i>	<i>Amaranthus spinosus</i> <i>Bidens pilosa</i> <i>Cassia mimosiifolia</i> <i>Imperata cylindrica</i> <i>Panicum maximum</i> <i>Sorghum halepense</i> <i>Eleusine indica</i> <i>Cyperus rotundus</i> <i>Corchorus tridens</i> <i>Euphorbia heterophylla</i> <i>Euphorbia hirta</i> <i>Mimosa pudica</i> <i>Physalis angulata</i> <i>Sida acuta</i> <i>Solanum nigrum</i> <i>Stachytarpheta angustifolia</i> <i>Paspalum conjugatum</i> <i>Bracharia decumbens</i> <i>Mikania micrantha</i> <i>Merremia peltata</i>

Appendix 5. A list of all weeds mentioned in all workshops since 2002. Lists are in alphabetical order

	FIJI	PNG	SOLOMONS	VANUATU
1	<i>Ageratum conyzoides</i>	<i>Bidens pilosa</i>	<i>Broussonetia papyrifera</i>	<i>Amaranthus spinosus</i>
2	<i>Annona glabra</i>	<i>Chromolaena odorata</i>	<i>Clerodendrum chinensis</i>	<i>Bidens pilosa</i>
3	<i>Clerodendrum chinensis</i>	<i>Clerodendrum chinensis</i>	<i>Clidemia hirta</i>	<i>Bracharia decumbens</i>
4	<i>Clidemia hirta</i>	<i>Clidemia hirta</i>	<i>Coccinia grandis</i>	<i>Cassia mimosiifolia</i>
5	<i>Coccinia grandis</i>	<i>Coccinia grandis</i>	<i>Commelina benghalensis</i>	<i>Clerodendrum chinensis</i>
6	<i>Commelina diffusa</i>	<i>Commelina benghalensis</i>	Convolvulaceae spp.	<i>Coccinia grandis</i>
7	Convolvulaceae spp.	Convolvulaceae spp.	<i>Cyperus rotundus</i>	Convolvulaceae spp.
8	<i>Cuphea carthaginensis</i>	<i>Cyperus rotundus</i>	<i>Eichhornia crassipes</i>	<i>Corchorus tridens</i>
9	<i>Cyperus rotundus</i>	<i>Eichhornia crassipes</i>	<i>Elusine indica</i>	<i>Cordia alliodora</i>
10	<i>Eichhornia crassipes</i>	<i>Hedychium</i> spp.	<i>Hyptis capitata</i>	<i>Cyperus rotundus</i>
11	<i>Hedychium</i> spp.	<i>Lantana camara</i>	<i>Lantana camara</i>	<i>Dolichandra unguis-cati</i>
12	<i>Hydrilla verticillata</i>	<i>Limnocharis flava</i>	<i>Leucaena leucocephala</i>	<i>Eichhornia crassipes</i>
13	<i>Hyptis pectinata</i>	<i>Melinis minutiflora</i>	<i>Merremia peltata</i>	<i>Eleusine indica</i>
14	<i>Kyllingia polyphylla</i>	<i>Merremia peltata</i>	<i>Mikania micrantha</i>	<i>Euphorbia heterophylla</i>
15	<i>Lantana camara</i>	<i>Miconia calvescens</i>	<i>Mimosa diplotricha (M.invisa)</i>	<i>Euphorbia hirta</i>
16	<i>Leucaena leucocephala</i>	<i>Mikania micrantha</i>	<i>Mimosa pudica</i>	<i>Heteropogon contortus</i>
17	<i>Ludwigia</i> spp.	<i>Mimosa diplotricha (M.invisa)</i>	<i>Paspalum maximum</i>	<i>Hyptis capitata</i>
18	<i>Merremia peltata</i>	<i>Mimosa pigra</i>	<i>Piper aduncum</i>	<i>Imperata cylindrica</i>
19	<i>Mikania micrantha</i>	<i>Mimosa pudica</i>	<i>Samanea saman</i>	<i>Lantana camara</i>
20	<i>Mimosa diplotricha (M.invisa)</i>	<i>Parthenium hysterophorus</i>	<i>Senna tora</i>	<i>Leonotis nepetifolia</i>
21	<i>Mimosa pudica</i>	<i>Pennisetum purpureum</i>	<i>Sida</i> spp.	<i>Leucaena leucocephala</i>
22	<i>Pennisetum polystachyon</i>	<i>Piper aduncum</i>	<i>Solanum torvum</i>	<i>Merremia peltata</i>
23	<i>Piper aduncum</i>	<i>Pistia stratiotes</i>	<i>Spathodea campanulata</i>	<i>Mikania micrantha</i>
24	<i>Piper auritum</i>	<i>Rottboelia cochinchinensis</i>	<i>Sphagneticola trilobata</i>	<i>Mimosa diplotricha</i>
25	<i>Rubus moluccanus</i>	<i>Salvinia molesta</i>	<i>Stachytarpheta jamaicensis</i>	<i>Mimosa pudica</i>
26	<i>Senna tora</i>	<i>Sida acuta</i>	<i>Stachytarpheta</i> spp.	<i>Panicum maximum</i>
27	<i>Sida</i> spp.	<i>Solanum torvum</i>	<i>Stachytarpheta urticifolia</i>	<i>Parthenium hysterophorus</i>
28	<i>Solanum torvum</i>	<i>Sorghum halepense</i>	<i>Xanthium strumarium</i>	<i>Paspalum conjugatum</i>
29	<i>Spathodea campanulata</i>	<i>Spathodea campanulata</i>		<i>Physalis angulata</i>
30	<i>Sphagneticola trilobata</i>	<i>Thunbergia laurifolia</i>		<i>Piper aduncum</i>
31	<i>Stachytarpheta jamaicensis</i>	<i>Tithonia diversifolia</i>		<i>Pistia stratiotes</i>
32	<i>Stachytarpheta</i> spp.	<i>Xanthium strumarium</i>		<i>Salvinia molesta</i>
33	<i>Stachytarpheta urticifolia</i>			<i>Senna tora</i>
34	<i>Xanthium strumarium</i>			<i>Sida acuta</i>
35				<i>Solanum nigrum</i>
36				<i>Solanum torvum</i>
37				<i>Sorghum halepense</i>
38				<i>Spathodea campanulata</i>
39				<i>Sphagneticola trilobata</i>
40				<i>Stachytarpheta angustifolia</i>
41				<i>Stachytarpheta jamaicensis</i>
42				<i>Stachytarpheta</i> spp.
43				<i>Stachytarpheta urticifolia</i>
44				<i>Urena lobata</i>

Appendix 6. The top ten weeds for each country as perceived by workshop participants. Species marked with an asterisk are those species that have been or are targeted for biocontrol research.

FIJI	PNG	Solomons	Vanuatu
<i>Spathodea campanulata</i> *	<i>Coccinia grandis</i> *	<i>Broussonetia papyrifera</i>	<i>Mimosa diplotricha</i> *
<i>Merremia peltata</i>	<i>Cyperus rotundus</i>	<i>Coccinia grandis</i> *	<i>Merremia peltata</i>
<i>Sphagnediola trilobata</i>	<i>Sorghum halepense</i>	<i>Cyperus rotundus</i>	<i>Lantana camara</i> *
<i>Cyperus rotundus</i>	<i>Melinis minutiflora</i>	<i>Lantana camara</i> *	<i>Mikania micrantha</i> *
<i>Solanum torvum</i>	<i>Merremia peltata</i>	<i>Merremia peltata</i>	<i>Senna tora</i>
<i>Piper aduncum</i>	<i>Mikania micrantha</i> *	<i>Mikania micrantha</i> *	<i>Hyptis capitata</i>
<i>Senna tora</i>	<i>Mimosa pigra</i> *	<i>Piper aduncum</i>	<i>Parthenium hysterophorus</i> *
<i>Kyllingia polyphylla</i>	<i>Piper aduncum</i>	<i>Samanea saman</i>	<i>Spathodea campanulata</i> *
<i>Commelina diffusa</i>	<i>Rothboelia cochinchinensis</i>	<i>Spathodea campanulata</i> *	<i>Dolichandra unguis-cati</i> *
<i>Ludwigia</i> sp.	<i>Spathodea campanulata</i> *	<i>Kyllingia polyphylla</i>	<i>Panicum maximum</i>
	<i>Xanthium strumarium</i> *	<i>Hyptis capitata</i>	

Sida spp.	Calligrapha pantherina	Yes	Heavy impact	Eutinobothrus sp.	Unknown impact in Australia	Re-distribute? Consider
Solanum torvum						
Spathodea campanulata					Preliminary exploration in Africa	Pursue bc options
Sphagneticola trilobata						
Stachytarpheta jamaicensis						
Stachytarpheta urticifolia						
Xanthium strumarium				Epiblema strenuana Puccinia xanthii	Slight impact in Australia Variable impact in Australia	Consider Consider
PNG						
Bidens pilosa						
Chromolaena odorata	Cecidochares connexa	Yes	Heavy impact in most areas		Introduce agents from RSA	Re-distribute? Low priority
Clerodendrum chinensis				Phyllocharis undulata	Established in Thailand. Slowly spreading	Low priority
Clidemia hirta				Liothrips urichi	Established in Fiji, Hawaii. Excellent control in most areas. Little effect in very wet areas under dense shade.	Low priority
				Antiblemma acclinalis	Established in Hawaii but rare, likely from parasitism.	Low priority
				Ategumia matutinalis	Established in Hawaii but heavily parasitized and has little impact.	Low priority
				Colletotrichum clidemiae	Variable outbreaks resulting in frequent defoliation. However impact typically low and infected plants often regenerate quickly. Natural dispersal of this fungus uncommon. A volunteer-assisted redistribution program was initiated to aid spread.	Consider for wet areas
				Lius poseidon	Uncommon in Hawaii. Damage to weed overall appears minimal. Parasitism?	Low priority
				Mompha trithalama	Possible impact on viable seed production but needs formal evaluation. Widespread distribution and high abundance but impact is low. Parasitism recently documented.	Low priority
Coccinia grandis				Acythopeus coccinae Melittia oedipus	Established in Guam, Hawaii, NMI. Defoliation in some areas. Parasitized. Established in Guam, Hawaii, NMI. Substantial control in Hawaii.	Low priority Consider
Commelina benghalensis						
Cyperus rotundus				Athesapeuta cyperi Bactra minima Bactra venosana	Established in Hawaii, Mauritius, Tonga. Little impact anywhere. Established in Tonga. Little impact Established in Hawaii. Little impact.	Low priority Low priority Low priority
Hedychium spp.						
Lantana camara	Calycomyza lantanae Hypena laceratalis Lantanothrips pusillidactyla Ophiomyia lantanae Teleonemia scrupulosa Uroplata girardi	Yes Yes Yes Yes Yes Yes	Slight impact Slight impact Slight impact Unknown Heavy impact Slight impact		Minimal impact in Australia and elsewhere Minimal impact in Australia and elsewhere Minimal impact in Australia and elsewhere Heavy damage to seeds in late season in Australia and elsewhere Heavy damage elsewhere in dry areas Seasonally damaging in Australia and elsewhere	
				Aceria lantanae Ophiomyia camarae Prosopidium tuberculatum	Damaging in South Africa, recently released in Australia Damaging in South Africa and NQ Seasonal defoliation in Australia	Consider Consider Consider
Merremia peltata						
Miconia calvescens				Colletotrichum gloeosporioides	Variable impact in Hawaii & French Polynesia	Consider
Mikania micrantha	Puccinia spegazzinii	Yes	Needs further release efforts	Liothrips mikaniae	Never established	Needs further release efforts Low priority
Mimosa diplotricha	Heteropsylla spinulosa	Yes	Variable impact			Re-distribute?
Mimosa pigra				Acanthoscelides puniceus Carmenta mimosa Chalcodermus serripes Chlamisus mimosae Coelocephalapion pigrae Diabole cubensis Leuciris fimbriaria Macaria pallidata Malacorhinus irregularis Nesaecepeida infuscata Neurostota gunniella	Slight impact in Australia Heavy impact in Australia Heavy impact in Australia Slight impact in Australia Slight impact in Australia Unknown Slight impact in Australia Variable Variable Too early post release Heavy impact in Australia	Consider Consider Consider Consider Low priority Low priority Low priority Low priority Low priority Low priority Consider
Mimosa pudica						

Parthenium hysterophorus Under eradication

Piper aduncum

Rottboelia cochinchinensis

Sida spp. *Calligrapha pantherina* Yes Heavy impact *Eutinobothrus* sp. Unknown impact in Australia Re-distribute? Consider

Sorghum halepense

Xanthium strumarium *Epiblema strenuana* (Walker) Slight impact in Australia Consider
Puccinia xanthii Variable impact in Australia Consider

Solomons *Broussotia* sp

Clerodendrum chinensis *Phyllocharis undulata* Established in Thailand. Slowly spreading Low priority

Clidemia hirta *Liothrips urichi* No Small releases only. Established in Fiji, Hawaii. Excellent control in most areas. Little effect in very wet areas Re-introduce under dense shade. Low priority
Antiblemma acclinalis Established in Hawaii but rare, likely from parasitism. Low priority
Ategumia matutinalis Established in Hawaii but heavily parasitized and has little impact. Low priority
Colletotrichum clidemiae Variable outbreaks resulting in frequent defoliation. However impact typically low and Consider for wet areas infected plants often regenerate quickly. Natural dispersal of this fungus uncommon. A volunteer-assisted redistribution program was initiated to aid spread.
Lius poseidon Uncommon in Hawaii. Damage to weed overall appears minimal. Parasitism? Low priority
Mompha trithalama Possible impact on viable seed production but needs formal evaluation. Widespread Low priority distribution and high abundance but impact is low. Parasitism recently documented.

Coccinia grandis *Acythopeus cocciniae* Established in Guam, Hawaii, NMI. Defoliation in some areas. Parasitized. Low priority
Melittia oedipus Established in Guam, Hawaii, NMI. Substantial control in Hawaii. Consider

Commelina benghalensis

Cyperus rotundus *Athesapeuta cyperi* Established in Hawaii, Mauritius, Tonga. Little impact anywhere. Low priority
Bactra minima Established in Tonga but little impact Low priority
Bactra venosana Established in Hawaii. Little impact. Low priority

Eichhornia crassipes *Neochetina eichhorniae* Yes Slight impact. *Neochetina bruchi* Established in Australia, PNG. Very damaging. Re-distribute? Consider
Niphograptus albiguttalis Established in Australia (slight impact) but failed in PNG. Low priority

Elusine indica

Lantana camara *Octotoma scabripennis* Unknown Unknown
Teleonemia scrupulosa Yes Heavy
Uroplata girardi Yes Heavy
Calycomyza lantanae Yes Slight
Aceria lantanae Damaging in South Africa, recently released in Australia Consider
Ophiomyia camarae Damaging in South Africa and NQ Consider
Prosopodium tuberculatum Seasonal defoliation in Australia Consider

Merremia peltata

Mikania micrantha *Puccinia spegazzinii* Yes Needs further release efforts *Liothrips mikaniae* Never established Needs further release efforts Low priority

Mimosa diplotricha *Heteropsylla spinulosa* Yes Heavy impact May need to be re-distributed

Mimosa pudica

Paspalum maximum

Piper aduncum

Sida spp. *Calligrapha pantherina* Introduce from Fiji, PNG, Vanuatu where it is aiding control Consider
Eutinobothrus sp. Unknown impact in Australia Consider

Solanum torvum

Sphagneticola trilobata

Stachytarpheta jamaicensis

Stachytarpheta urticifolia

Xanthium strumarium *Epiblema strenuana* Slight impact in Australia Consider
Puccinia xanthii Variable impact in Australia Consider

Vanuatu						
Amaranthus spinosus						
Clerodendrum chinensis						
				Phyllocharis undulata	Established in Thailand. Slowly spreading	Low priority
Coccinia grandis						
				Acythopeus cocciniae	Established in Guam, Hawaii, NMI. Defoliation in some areas. Parasitized.	Low priority
				Melittia oedipus	Established in Guam, Hawaii, NMI. Substantial control in Hawaii.	Consider
Cordia alliodora						
Cyperus rotundus						
				Athesapeuta cyperi	Established in Hawaii, Mauritius, Tonga. Little impact anywhere.	Low priority
				Bactra minima	Established in Tonga but little impact	Low priority
				Bactra venosana	Established in Hawaii. Little impact.	Low priority
Eichhornia crassipes	Neochetina eichhorniae	Yes	Heavy impact			Re-distribute?
	Neochetina bruchi		Too early			Needs to be released further
				Niphograpta albiguttalis	Established in Australia, PNG. Very damaging.	Low priority
					Established in Australia (slight impact) but failed in PNG.	
Heteropogon contortus						
Imperata cylindrica						
Lantana camara						
	Teleonemia scrupulosa	Yes	Slight impact			
	Uroplata girardi	Yes	Slight impact			
	Calycomyza lantanae	Yes	Slight impact			
	Crociosema lantana	Yes	Slight impact			
	Hypena laceratalis	Yes	Slight impact			
	Ophiomyia lantanae	Yes	Unknown			
				Aceria lantanae	Damaging in South Africa, recently released in Australia	Consider
				Ophiomyia camarae	Damaging in South Africa and NQ	Consider
				Prospodium tuberculatum	Seasonal defoliation in Australia	Consider
Leucaena leucocephala						
				Acanthoscelides macrophthalmus	Slight impact in South Africa	Low priority
Merremia peltata						
Mikania micrantha						
	Puccinia spegazzinii	Yes	Needs further release efforts			Needs further release efforts
				Liothrips mikaniae	Never established	Low priority
Mimosa diplotricha						
	Heteropsylla spinulosa	Yes	Slight impact			Re-distribute?
Mimosa pudica						
Panicum maximum						
Parthenium hysterophorus						
				Carmenta sp. nr. lthacae	Slight impact in Australia	Consider
				Conotrachelus albocinereus	Slight impact in Australia	Consider
				Epiblema strenuana	Slight impact in Australia	Consider
				Zygogramma bicolorata	Variable impact in Australia	Consider
Paspalum conjugatum						
Piper aduncum						
Pistia stratiotes						
	Neohydronomus affinis	Yes	Needs further release efforts			Re-distribute?
Salvinia molesta						
						Sylvio reports its not present
Senna tora						
Sida spp						
	Calligrapha pantherina	Yes	Heavy impact			Re-distribute?
				Eutinobothrus sp.	Unknown impact in Australia	Consider
Solanum torvum						
					Preliminary exploration in Africa	
Spathodea campanulata						
Sphagneticola trilobata						
Stachytarpheta jamaicensis						
Stachytarpheta urticifolia						

Appendix 8. The list of the top weeds (and the name of the biocontrol agents that could be introduced) for each country in which biocontrol could easily be implemented. A list of three weeds in each country which participants would like to see biocontrol research implemented is also indicated.

FIJI

Xanthium strumarium (*Puccinia xanthii*, *Epiblema strenuana*)

Clerodendrum chinensis (*Phyllocharis undulata*)

Coccinia grandis (*Melittia oedipus*)

Pistia stratiotes (*Neohydronomus affinis*)

Wish list

Sphagneticola trilobata

Cyperus rotundus

Senna tora

PNG

Mimosa pigra (*Carmenta mimosa*, *Chalcodermis serripes*,

Neurostrota gunniella)

Xanthium strumarium (*Puccinia xanthii*, *Epiblema strenuana*)

Coccinia grandis (*Acythopeus cocciniae*, *Melittia oedipus*)

Mikania micrantha (*Puccinia spegazzinii*)

Piper aduncum

Tithonia diversifolia

Sorghum halepense

SOLOMONS

Coccinia grandis (*Acythopeus cocciniae*, *Melittia oedipus*)

Sida acuta (*Calligrapha pantherina*)

Mikania micrantha (*Puccinia spegazzinii*)

Broussonetia papyrifera

Piper aduncum

Sphagneticola trilobata

VANUATU

Mimosa diplotricha (*Heteropsylla spinulosa*)

Dolichandra unguis-cati (*Carvalhotingis visenda*)

Parthenium hysterophorus (*Zygrogramma bicolorata*)

Panicum maximum

Senna tora

Piper aduncum