Invasive species management summary

*Parthenium hysterophorus*

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September 2016
Parthenium weed (*Parthenium hysterophorus*)

A search in CABDirect returned very few relevant references for *Parthenium hysterophorus* IPM, therefore the search term “*Parthenium hysterophorus* Biocontrol” was used instead and this returned 195 records. Of these the first 50 records were used in the analysis of common approaches. In addition to analysis of the first 50 records, a ‘sample’ analysis was also carried out on the titles of all records returned to assess most common predators and pathogens used for biocontrol in the titles. The summary spreadsheet can be found [here](#).

**Geography**

*Parthenium hysterophorus* is native to the southern USA, central and South America. It was reported as a common weed in Southern Africa in the mid 1980s (CPC) and Vietnam around 1922 (Nguyen Thi Lan et al., 2011).

**Most commonly studied approaches**

The most common approach identified from the first 50 records returned using the CAB direct search were using predators to control *P. hysterophorus*, followed by pathogens (Figure 1). What is not apparent from this search is the extent to which rural communities use hand weeding; hand weeding hazardous as the weed is strongly allogenic and affects humans and livestock.

![Bar chart showing the most common approaches identified using the first 50 CABdirect records returned using the search term “*Parthenium hysterophorus* biocontrol”](#)

**Predators (insect herbivores)**

The most commonly studied predator (Figure 18) by far was *Zygogramma bicolorata* followed by *Epiblema strenuana*. The most commonly studied pathogen was *Puccinia abrupta* var. *partheniicola* followed by *Alternaria macrospora*. Analysis of papers showed that the majority of the research work relating to biological control of *P. hysterophorus* has been carried out in India (21 out of 50 records analysed). When the records were examined for work relating to Africa, it was found research has been carried out in South Africa and the potential for biological control has been explored in 3 papers for Ethiopia—using both pathogens and predators.
Epiblema strenuana

McConnachie (2015b) looked at the possibility of using *Epiblema strenuana* as a predator against *P. hysterophorus*. Under no choice tests it was to feed on *Guizotia abyssinica* (a plant used in oil production and as animal fodder which is found in Ethiopia) with larvae causing significant damage during development. Damage was lesser when choice tests were conducted however the decision was made to de-prioritise it as a biological control agent until host range testing had been completed in Australia and field tests conducted.

Zygogramma bicolorata

During analysis of literature, *Zygogramma bicolorata* was found to be the most common biological control agent tested against *P. hysterophorus* globally (Figure 2), with the majority of research originating in India, however there have been recent studies relating the potential of this beetle as a biocontrol agent in Africa. Non target testing has been carried out on 48 species and the agent shows a significant preference for *P. hysterophorus*, however
evidence has shown that *Z. bicolorata* still oviposits on *Helianthus annuus* (sunflower) under multiple choice conditions (Bilashini et al., 2011; McConnachie, 2015a). McConnachie (2015a) tested *Z. bicolorata* against 12 cultivars of *H. annuus* and calculated the risk posed by *Z. bicolorata* for development on sunflowers. It was found that there was a very low risks (<0.2%) of the tested cultivars supporting *Z. bicolorata* feeding and development and <0.16% chance of them supporting viable populations. Given that there is little evidence for the beetle as a pest on sunflowers in its native and introduced ranges (i.e. Mexico and Australia/India). *Z. bicolorata* was released as a control agent against *P. hysterophorus* in 2013 in South Africa. 

In the literature the attacking of sunflower as non-targets has been discussed widely. A cost benefit analysis may need to be carried out in the target countries to see whether the non-target hosts would be affected. Figure 3 shows that Uganda and Tanzania grew 250,000 and >750,000ha of sunflower seeds respectively in 2014 but have agreed to releases which are on-going.

Singh and Negerei (2013) conducted trials in quarantine at the Ambo Plant Protection Research Center (APPRC), Ethiopia to assess the release of this agent against *P. hysterophorus* (see link to document here). They found that the optimal number of beetles required to defoliate the weed were 40 per plant, taking 20 days. Defoliated plants did not regenerate.

Figure 3 FAO stat data on area of sunflower seeds harvested in big push target countries.

From the examination of legacy records at CABI, CABI has applied to the Tanzanian Ministry of Agriculture, Food Security and Cooperatives for permission to release *Z. bicolorata* in Tanzania and permission has been granted.
Pathogens

**Puccinia abrupta var. partheniicola**

_Puccinia abrupta var. partheniicola_ has been studied by many authors (Figure 4) and may represent a candidate agent for the control of _P. hysterophorus_ in Africa. The pathogen has been detected during surveys in Ethiopia commonly at altitudes of 1500-2500m (Taye et al., 2002) and more intensive surveys have been carried out more recently which indicate that this pathogen is exerting a good level of control over _P. hysterophorus_ in Ethiopia (Zelalem et al., 2012). However, performance of the rust can be affected by altitude.

**Potential technology transfer**

CABI has extensive experience with invasive plant control, especially biological control. In the case of parthenium CABI is currently active in introducing, releasing and monitoring the agent _Z. bicolorata_ in Tanzania and Uganda is also interested. However, early assessments suggest that additional agents may need to be considered. The potential to extend biological control to other countries affected by parthenium needs to be considered. Hand weeding should be discouraged because of health risks.

**Current in-country activity (Pakistan)**

As of 2014, only _Zygoraphama bicolorata_ (Coleoptera – Chrysomelidae), native to Mexico, was present in Pakistan, entering unintentionally from India. Hand weeding remains a common control method in Pakistan (EPPO Bulletin 2015, 4(3), 456-461), but should be discouraged because of health risks. Between 2010 and 2012 a CLIMEX model for _P. hysterophorus_ was developed, funded by the University of Queensland (International Parthenium News, July 2010; Shabbir, 2012).
The model predicted that *P. hysterophorus* could spread into northern Pakistan and the Indus river basin in southern Pakistan. There is no PMDG for *P. hysterophorus* in Pakistan.

**Major external researchers**

Table 11. Institutions working with Parthenium hypsterophorus biological control (taken from first 50 returned records in CABDirect)

<table>
<thead>
<tr>
<th>Country</th>
<th>Authors of papers associated with this institute (may be from affiliated institute also)</th>
<th>Institution</th>
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<tbody>
<tr>
<td>India</td>
<td>Sandhya Mishra; Chauhan, P. S.; Goel, A. K.; Upadhyay, R. S.; Nautiyal, C. S, O'Donnell, C</td>
<td>Tropical and SubTropical Weed Research Unit, School of Agriculture &amp; Food Sciences, The University of Queensland, Brisbane, Qld, Australia.</td>
</tr>
<tr>
<td>India</td>
<td>Bhosle, A. B.; Shetgar, S. S.; Jadhav, M. S.; Gaikwad, B. B.; Maurice, N. G.; Ramteke, P. W.; Shukla, P. K.</td>
<td>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow - 226 001, India</td>
</tr>
<tr>
<td>India</td>
<td>Kaur, M.; Aggarwal, N. K.; Kushwaha, V. B.; Shivani Maurya; Bilashini, Y.; Lokeshwari, R. K.; Singh, T. K.; Gautam, R. D.</td>
<td>Department of Agricultural Entomology, College of Agriculture, Vasanthrao Naik Marathwada Krishi Vidhyapeeth, Latur - 413 512, Parbhani, Maharashtra, India.</td>
</tr>
<tr>
<td>India</td>
<td>Rawat, L. S.; Narwal, S. S.; Kadian, H. S.; Negi, V. S.;</td>
<td>Department of Biological Sciences, Sam Higginbottom Institute of Agriculture Technology &amp; Sciences (Deemed-to-be-University) Naini, Allahabad - 211 007, India.</td>
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<tr>
<td>India</td>
<td>Duary, B.; Mukherjee, A.; Bakar, B. H.; Kurniadie, D.; Tjitrosoedirdjo, S.;</td>
<td>G. B. Pant Institute of Himalayan Environment and Development, Garhwal, Srinagar, Post Box 92, Uttarakhand 246 174, India</td>
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<tr>
<td>India</td>
<td>Sadaf Quereshi; Ritu Panjwani; Pandey, A. K.; Singh, A. K.;</td>
<td>Institute of agriculture, Visva-Bharati, Sriniketan, West Bengal, India.</td>
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<tr>
<td>India</td>
<td>Mucological Research Laboratory, Department of Biological Sciences, R.D. University, Jabalpur, M.P., India</td>
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<td>Name</td>
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<tr>
<td>Harry Evans</td>
<td>Life-cycle of Puccinia abrupta var. partheniicola, a potential biological control agent of Parthenium hysterophorus (Evans, 1987)</td>
<td><a href="http://www.cabdirect.org/abstracts/19871332812.html?resultNumber=6&amp;start=0&amp;q=Puccinia+abrupta+var.+partheniicola+&amp;rows=10">http://www.cabdirect.org/abstracts/19871332812.html?resultNumber=6&amp;start=0&amp;q=Puccinia+abrupta+var.+partheniicola+&amp;rows=10</a></td>
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<td>Carol Ellison</td>
<td>Expanding classical biological control of weeds with pathogens in India: the way forward (Kumar et al., 2008)</td>
<td><a href="http://www.cabdirect.org/abstracts/20093001846.html?resultNumber=11&amp;start=10&amp;q=Puccinia+abrupta+var.+partheniicola+&amp;rows=10">http://www.cabdirect.org/abstracts/20093001846.html?resultNumber=11&amp;start=10&amp;q=Puccinia+abrupta+var.+partheniicola+&amp;rows=10</a></td>
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<tr>
<td>Arne Witt</td>
<td>Biological Control of the Invasive Weed Parthenium hysterophorus in East Africa</td>
<td><a href="http://projects.sp.cabi.org/594/SitePages/Home.aspx">http://projects.sp.cabi.org/594/SitePages/Home.aspx</a></td>
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<td>Arne Witt</td>
<td>eradicating parthenium in Kenya</td>
<td><a href="http://teams.cabi.org/function/Commercial/Marketing/MarketingMaterial/Parthenium%20eradication.pdf#search=parthenium">http://teams.cabi.org/function/Commercial/Marketing/MarketingMaterial/Parthenium%20eradication.pdf#search=parthenium</a></td>
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<td>? CABI SA</td>
<td>? proposal from CABI south Asia</td>
<td><a href="http://projects.sp.cabi.org/Lists/ProjectDBLegacy/DispForm.aspx?ID=13">http://projects.sp.cabi.org/Lists/ProjectDBLegacy/DispForm.aspx?ID=13</a></td>
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<tr>
<td>Harry Evans, Dr.Sabitha Doraiswamy, C.JeyalakshmiP.Jeyasudha</td>
<td>Developing strategies for the control of Parthenium weeds in India using fungal pathogens</td>
<td><a href="http://sharepoint.cabi.org/staffcommns/InvasivesLegacy/LegacyDocs/Legacy_1807.pdf#search=parthenium">http://sharepoint.cabi.org/staffcommns/InvasivesLegacy/LegacyDocs/Legacy_1807.pdf#search=parthenium</a></td>
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<tr>
<td>Harry Evans</td>
<td>PROPOSAL FOR THE FIELD RELEASE</td>
<td><a href="http://sharepoint.cabi.org/staffcommns/InvasivesLegacy/LegacyDocs/Legacy_1788.pdf#search=parthenium">http://sharepoint.cabi.org/staffcommns/InvasivesLegacy/LegacyDocs/Legacy_1788.pdf#search=parthenium</a></td>
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<td>OF THE PARTHENIUM RUST FUNGUS Puccinia Abrupta Var. Partheniicola in Australia</td>
<td>yDocs/Legacy_1790.pdf#search=parthenium</td>
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<tr>
<td>A.N.G. Holden and H.C. Evans</td>
<td>The biological control of parthenium weed (Parthenium hysterophorus) with the rust Puccinia abrupta var. partheniicola. Host range studies of sunflowers after prior inoculation with Puccinia helianthii</td>
<td><a href="http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Legacy_1513.pdf#search=parthenium">http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Legacy_1513.pdf#search=parthenium</a></td>
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<td></td>
<td>Ethiopia: Final Report Project Title: Removing Barriers to Invasive Plant Management in Africa: Management plan for Parthenium hysterophorus at Welenchitti Pilot Site in Ethiopia (283)</td>
<td><a href="http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Final%20report_Ethiopia.%20Removing%20barriers%20to%20Invasive%20plant%20management.pdf#search=parthenium">http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Final%20report_Ethiopia.%20Removing%20barriers%20to%20Invasive%20plant%20management.pdf#search=parthenium</a></td>
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<tr>
<td>Arne Witt</td>
<td>building capacity for weed biocontrol in Africa</td>
<td><a href="http://teams.cabi.org/function/Commercial/Marketing/MarketingMaterial/Building%20Capacity%20for%20Weed%20Biocontrol.pdf#search=parthenium">http://teams.cabi.org/function/Commercial/Marketing/MarketingMaterial/Building%20Capacity%20for%20Weed%20Biocontrol.pdf#search=parthenium</a></td>
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