Invasive species management summary

Parthenium hysterophorus

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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 weeds 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.

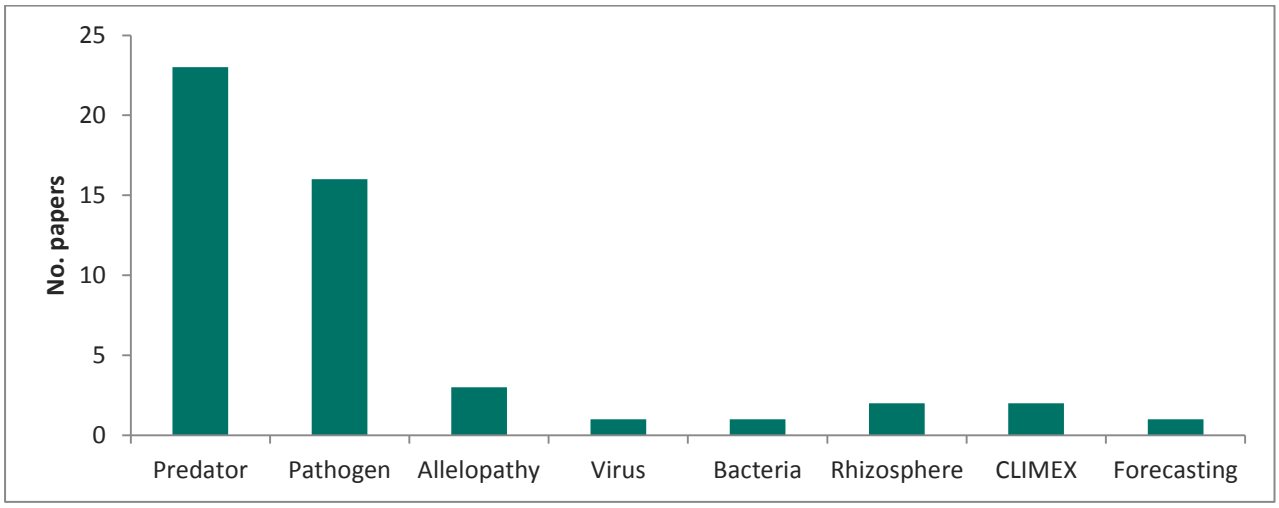

Figure 1 Most common approaches identified using the first 50 CABdirect records returned using the search term "*Parthenium hysterophorus* biocontrol"

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 macroscpora*. 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.

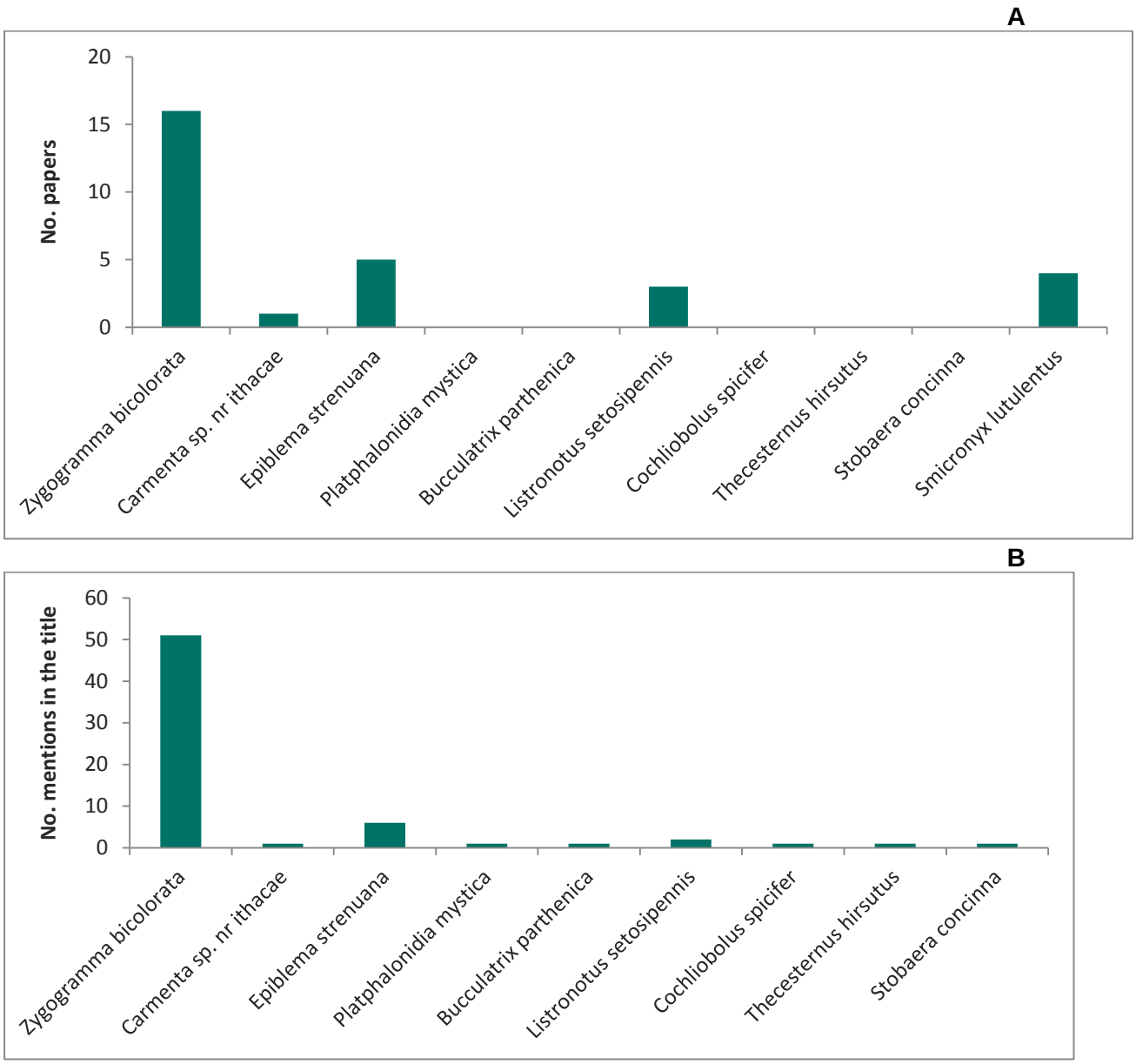

Figure 2 A. Predators most commonly studied based on first 50 records from CAB direct. 18B. Predators in titles of records returned from CABdirect

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. hysteropohrous,* 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.

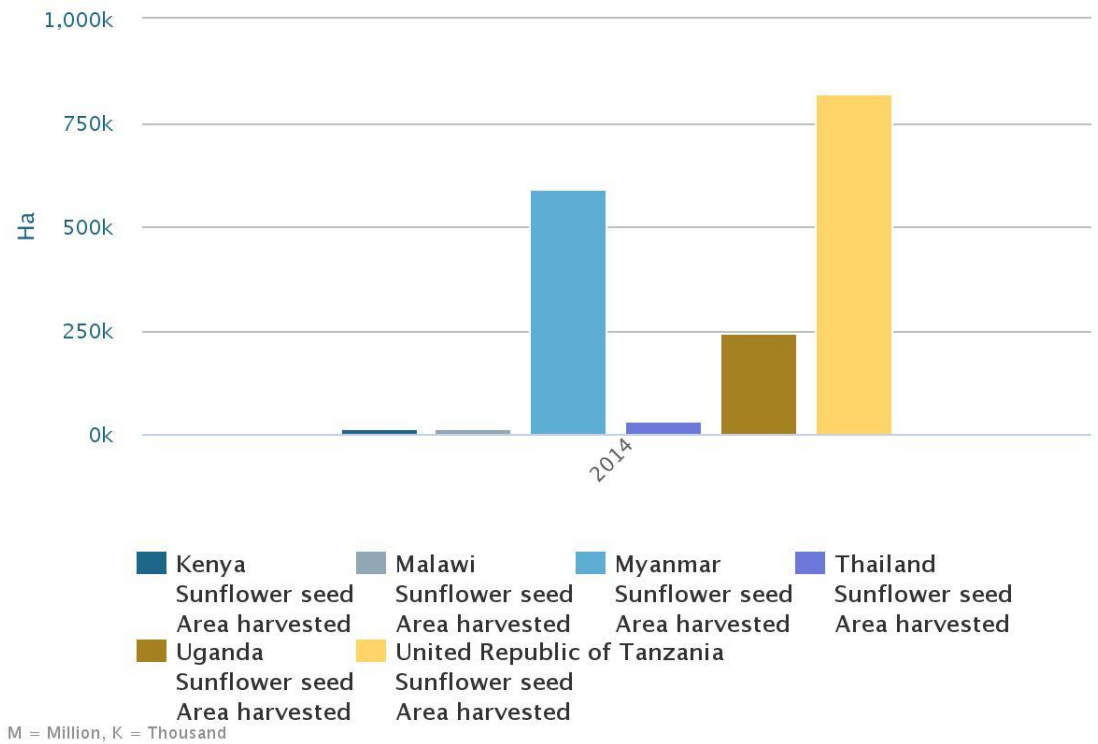

Figure 3 FAO stat data on area of sunflower seeds harvested in big push target countries.

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

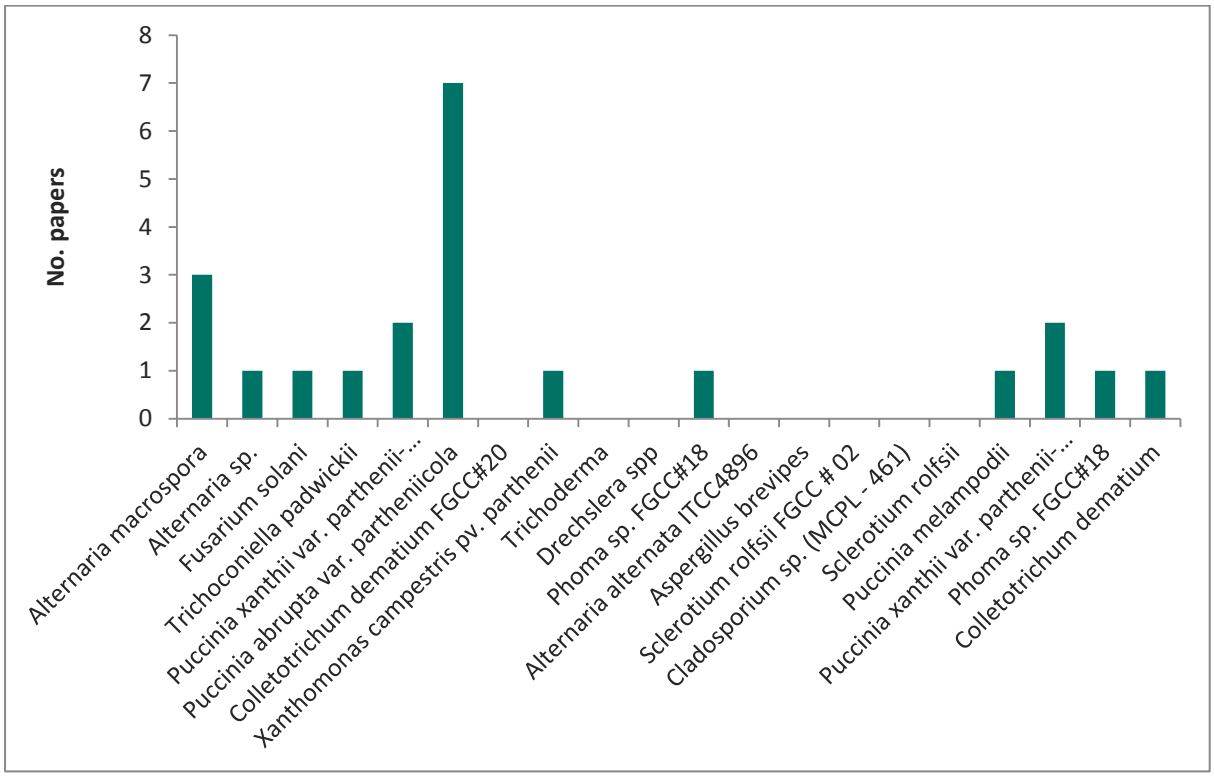

Figure 4 Most commonly studied pathogens to control Parthenium hysterophorus based on first 50 CAB direct records returned using "Parthenium hysterophorus biological control".

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 *Zygogramma bicolorata* (Coleoptera – Chrysomelidae), native to Mexico, was present in Pakistan, entering unintentionally from India.
Hand weeding remains a common control method in Paksitan (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)

Country	Authors of papers associated with this institute (may be from affiliated institute also)	Institution
Australia	Dhileepan, K.; Trevino, M.; Vitelli, M. P.; Senaratne, K. A. D. W.; McClay, A. S.; McFadyen, R. E.	Biosecurity Queensland, Department of Employment, Economic Development and Innovation, Ecosciences Precinct, GPO Box 267, Brisbane, Qld 4001, Australia.
	Sandhya Mishra; Chauhan, P. S.; Goel, A. K.; Upadhyay, R. S.; Nautiyal, C. S, O'Donnell, C	Tropical and SubTropical Weed Research Unit, School of Agriculture & Food Sciences, The University of Queensland, Brisbane, Qld, Australia
India	A. K., D.; Ghosh, R. K.; Bhowmick, M. K.;	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741 252, Nadia, West Bengal, India.
	Sandhya Mishra; Chauhan, P. S.; Goel, A. K.; Upadhyay, R. S.; Nautiyal, C. S	CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow - 226 001, India
India	Bhosle, A. B.; Shetgar, S. S.; Jadhav, M. S.; Gaikwad, B. B.;	Department of Agricultural Entomology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidhyapeeth, Latur - 413 512, Parbhani, Maharashtra, India.
	Maurice, N. G.; Ramteke, P. W.; Shukla, P. K.	Department of Biological Sciences, Sam Higginbottom Institute of Agriculture Technology & Sciences (Deemed-to-be-University) Naini, Allahabad - 211 007, India.
	Kaur, M.; Aggarwal, N. K.;	Department of Microbiology, Kurukshetra University, Kurukshetra 136 119, India.
	Kushwaha, V. B.; Shivani Maurya;	Department of Zoology, D.D.U. Gorakhpur University, Gorakhpur, U.P., India.
	Bilashini, Y.; Lokeshwari, R. K.; Singh, T. K.; Gautam, R. D.;	Entomology Research laboratory, Department of life Sciences, Manipur University, Canchipur - 795 003, Manipur, India.
	Rawat, L. S.; Narwal, S. S.; Kadian, H. S.; Negi, V. S.;	G. B. Pant Institute of Himalayan Environment and Development, Garhwal, Srinagar, Post Box 92, Uttarakhand 246 174, India
	Duary, B.; Mukherjee, A.; Bakar, B. H.; Kurniadie, D.; Tjitrosoedirdjo, S.;	Institute of agriculture, Visva-Bharati, Sriniketan, West Bengal, India.
	Sadaf Quereshi; Ritu Panjwani; Pandey, A. K.; Singh, A. K.;	Mycological Research Laboratory, Department of Biological Sciences, R.D. University, Jabalpur, M.P., India

	Sushilkumar; Puja Ray;	National Research Centre for Weed Science, Maharajpur, Adhartal, Jabalpur (M.P.) - 482 004, India.
Nepal	Shrestha, B. B.; Thapa-Magar, K. B.; Paudel, A.; Shrestha, U. B.; Shrestha, B. B.; Shabbir, A.; Adkins, S. W.;	Central Department of Botany, Tribhuvan University, Kirtipur, GPO Box 5275, Kathmandu, Nepal
Pakistan	Asif Tanveer; Abdul Khaliq; Ali, H. H.; Gulshan Mahajan; Chauhan, B. S.;	Department of Agronomy, University of Agriculture, Faisalabad, Pakistan.
South Africa	Strathie, L.; McConnachie, A.; Wu, Y.; Johnson, T.; Sing, S.; Raghu, S.; Wheeler, G.; Pratt, P.; Warner, K.; Center, T.; Goolsby, J.; Reardon, R. Retief, E.; Ntushelo, K.; Wood, A. R.; E.; Moran, V. C.; Hoffmann, J. H.;	Agricultural Research Council – Plant Protection Research Institute, Private Bag X6006, Hilton, 3245, South Africa StrathieL@arc.agric.za

CABI expertise

Table 12. CABI legacy

Name	Name of project/paper	Link	Comments
Harry Evans	Life-cycle of Puccinia abrupta var. partheniicola, a potential biological control agent of Parthenium hysterophorus (Evans, 1987)	http://www.cabdirect.org/abstracts/19871332812.html?resultNumber=6&start=0&q=Puccinia+abrupta+var.+partheniicola+&rows=10	
Carol Ellison	Expanding classical biological control of weeds with pathogens in India: the way forward (Kumar et al., 2008)	http://www.cabdirect.org/abstracts/20093001846.html?resultNumber=11&start=10&q=Puccinia+abrupta+var.+partheniicola+&rows=10	
Arne Witt	Biological Control of the Invasive Weed Parthenium hysterophorus in East Africa	http://projects.sp.cabi.org/594/SitePages/Home.aspx	No further info on sharepoint site-follow up
Arne Witt	eradicating parthenium in Kenya	http://teams.cabi.org/function/Commercial/Marketing/MarketingMaterial/Parthenium%20eradication.pdf#search=parthenium	CABI has surveyed for weeds across Masai Mara national reserve and has started implementing an eradication programme
? CABI SA	? proposal from CABI south Asia	http://projects.sp.cabi.org/Lists/ProjectDBLegacy/DispForm.aspx?ID=13	Collaboration between CABI SA and FERA to Punjab Agricultural research Board
Harry Evans, Dr.Sabitha Doraiswamy, C.JeyalakshmiP .Jeyasudha	Developing strategies for the control of Parthenium weeds in India using fungal pathogens	http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Legacy_1807.pdf#search=parthenium	
Angel Romero and Marion Seier	Project Report: July - November 1995 Control of Parthenium weed (Parthenium hysterophorus)	http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Legacy_1795.pdf#search=parthenium; http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Legacy_1784.pdf#search=parthenium ; http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Legacy_1788.pdf#search=parthenium	survey work in Mexico
Harry Evans	PROPOSAL FOR THE FIELD RELEASE	http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/Legac	sent Puccinia abrupta to Allan J Tomley in

Name	Name of project/paper	Link	Comments
	OF THE PARTHENIUM RUST FUNGUS PUCCINIA ABRUPTA VAR. PARTHENIICOLA IN AUSTRALIA	yDocs/Legacy_1790.pdf#search=parthenium	Australia from CABI
A.N.G. Holden and H.C. Evans	The biological control of parthenium weed (Parthenium hysterophorusl with the rust Puccinia abrupta var. partheniicola. Host range studies of sunflowers after prior inoculation with Puccinia helianthii	http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Legacy_1513.pdf#search=parthenium	No date
	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)	http://sharepoint.cabi.org/staffcomms/InvasivesLegacy/LegacyDocs/Final%20report_Ethiopia.%20Removing%20barriers%20to%20Invasive%20plant%20management.pdf#search=parthenium	
Arne Witt	building capacity for weed biocontrol in Africa	http://teams.cabi.org/function/Commercial/Marketing/MarketingMaterial/Building%20Capacity%20for%20Weed%20Biocontrol.pdf#search=parthenium	In 2011 CABI held a training workshop in Dar-es-Salaam, Tanzania on the use of biological control for weeds. Largely as a result of this workshop and submissions to the Tanzanian Ministry of Agriculture, Food Security and Cooperatives, we received permission to introduce and release two biocontrol agents in Tanzania: a gall fly, Cecidochares connexa, for chromolaena and a beetle, Zygogramma bicolorata, for parthenium

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