

Abating the Weed Parthenium (*Parthenium hysterophorus* L.) Damage in Eastern Africa Using Integrated Cultural and Biological Control Measures

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Summary

Parthenium (Parthenium hysterophorus), a native plant of tropical and sub-tropical South and North America, adversely affects food security, biodiversity, and human as well as livestock health, in eastern Africa. The goal of this project is to develop an integrated weed management system that reduces the adverse impact of parthenium on humans, crops, livestock and plant biodiversity in the East African region. The specific objectives are to: 1) collect accurate information on the distribution and spread of parthenium in Kenya and Tanzania with follow-up surveys in Ethiopia and Uganda, 2) evaluate and demonstrate best management practices for the control of parthenium, 3) evaluate parthenium biocontrol agents for their safety to non-target plant species, and 4) release and evaluate the impact of approved biocontrol agents for the control of parthenium. Under objective 1, a survey result from Uganda has shown the occurrence of parthenium in at least 13 districts. Invasion of new areas has indicated that it is spreading. It was observed in two main localities during a

survey of northern Tanzania with densities ranging from low to high. A survey was also undertaken in central, western and coastal Kenya that has covered 3,700 km. In objective 2, an experiment on the competitiveness of indigenous pasture species against parthenium weed was established in eastern Ethiopia. Among the indigenous species tested, *Chrysopogon aucher* was found to be an effective competitor to parthenium. Under objective 3, a culture of *Zygogramma*, a beetle that feeds on parthenium, is being maintained under quarantine. A successful culturing of *Listronotus*, a stem-boring weevil bioagent has been achieved, and oviposition tests on crops including noog (*Guizotia abyssinica*) and sunflower (*Helianthus annuus*) have been conducted. No eggs were laid on these crops compared to an average of 112.8 eggs per plant on parthenium. In objective 4, an EA application has been submitted to USAID to release *Zygogramma* in Ethiopia. As part of this application, a newspaper notice was placed in one of the Ethiopian newspapers to solicit public comments on the release of *Zygogramma*.

Survey

A parthenium survey, during the year 2010, has been conducted in Uganda, Tanzania, and Kenya, and results are presented below.

Uganda: Parthenium was first detected in Uganda in 2008. A follow-up survey was carried out in Eastern and Western Uganda in July/August 2010 to determine the distribution of parthenium in Uganda. Parthenium was detected in several districts including Busia, Namutumba, Bugiri, Tororo, Mbale, Jinja, Buikwe, Mbarara, Ibanda, Masaka, Kampala,

Kabale, and Kasese, indicating recent spread to new locations. It was found in a radius of approximately 50 – 100 m along the main Eastern entry route to Uganda through Busia-Kenya border. Monitoring and containment activities were conducted after the initial mechanical control efforts were undertaken at Namalemba and Bugembe sites in December 2008. The infestation was cleared by slashing, burning, and digging using hand-hoe. However, some parthenium seedlings still emerged at these sites indicating the need for an integrated management effort. Sites in Namutumba and Jinja Districts where parthenium had been removed in December 2008 were monitored in January 2010. Parthenium density had decreased but some seedlings had germinated. A farm in the Namutumba area previously heavily infested by parthenium had been planted with sweet potato, and no parthenium seedlings were observed in the field although seeds may still be present in the seed bank. Locals were requested to monitor and remove parthenium before seed production. Parthenium inflorescences have also now been observed being used by florists in floral arrangements and some local herbalists are also using parthenium as an herb to treat patients. It is feared that such activities will further spread the weed in Uganda. Countrywide seminars targeting florists, as well as the public, at sites where parthenium is present are planned to improve awareness of the problems associated with this invasive plant.

Tanzania: In Tanzania, surveys were conducted in February and March 2010 by vehicles along selected available road networks, scanning both sides of the road for the weed. Particular emphasis was placed on surveying quarter degree squares (QDS) (25 km x 25 km) immediately surrounding

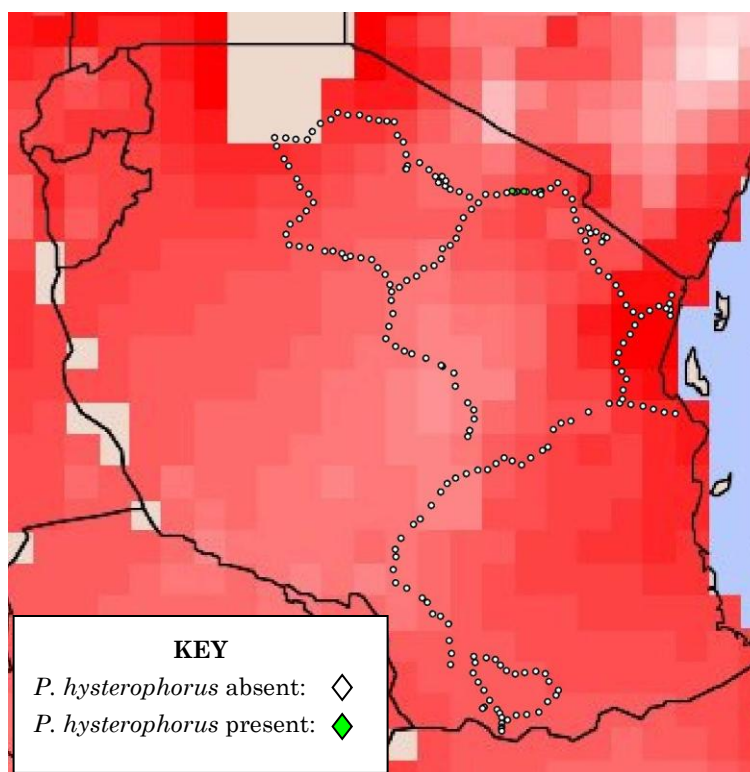


Figure 1. Map illustrating the results of the road side survey, white icons indicate absence of *P. hysterophorus* and green icons represent the presence of *P. hysterophorus*

previous sighting localities and areas which were estimated by the CLIMEX model to be suitable for the growth of parthenium. Parthenium was observed only in two main localities in northern Tanzania. One of them was in and around Kilimanjaro International airport, and the other near Arusha airport, in and around Arusha town (Figure 1). Densities varied from low to high. Further surveys in Tanzania are due to be conducted in February and March 2011. These will cover the north-western sections of Tanzania and the eastern coastline.

Kenya: Field surveys to establish the current status of parthenium in Kenya were undertaken during the last week of April to the first week of May in central and western Kenya. Localities targeted were identified based on the predictions made using CLIMEX software. About 2000 kilometers were covered in seven days of the survey. Data points from

surveyed areas have been entered into an MS spreadsheet in preparation for mapping. Predictions from the CLIMEX analysis prioritized Coastal Kenya for surveys during August 2010. Five days were spent in this survey and a total of 1700 kilometers covered.

Based on the agreement reached during the project planning and training workshop in Ethiopia in December 2009, data points from the parthenium surveys from Kenya, Tanzania, and Uganda have now been received and will be submitted to relevant partners for mapping.

Evaluation and Demonstration of Best Management Practices for the Control of Parthenium

An experiment to determine the competitive effects of indigenous pasture species against parthenium weed was established in July, 2009 in Somali Pastoral and Agro Pastoral Research site, some 30 Km east of Jijiga town in Ethiopia. The experimental field was left to allow the indigenous plant species and parthenium to regenerate naturally from soil seed bank.

The study result revealed the existence of a total of 15 grass and forb species. The indigenous plant species *Botriochloa radicans*, *Chrysopogon aucheri*, *Cenchrus ciliaris* and *Panicum cloratum* dominated the experimental plots both in coverage, dry matter production and growth. *Chrysopogon aucheri* had up to 65% cover and *ca.* 1.25 m growth in height. The parthenium weed had up to 10% coverage and a mean height of 0.75 m. The dry matter biomass for the herbaceous species amounted to a mean value of 270 g/m². Such species as *Chrysopogon aucher* and other herbaceous species that have shown good performance will be considered for displacing parthenium under proper management conditions. This experiment will continue and scaling up of the new technology will be considered based on subsequent outcome of the research activity.

Evaluation of Parthenium Biocontrol Agents for their Safety to Non-Target Plant Species

This objective is being implemented. Cultures of the leaf-feeding beetle, *Zygogramma bicolorata*, and a weevil, *Listronotus setosipennis*, were housed at Ambo Plant Protection Research Center (PPRC) of the Ethiopian Institute of Agricultural Research (EIAR) and host-range evaluation of the latter was conducted at the quarantine facility.

***Zygogramma bicolorata*:** This is the first bioagent introduced to Ethiopia from South Africa in October 2007. Host range tests, under quarantine, on economically important crop species and varieties, and indigenous species have been completed. A permit to release this beetle has been obtained from the Ethiopian government. After completion of the required tests, *Zygogramma* has been maintained for future use in the Ambo quarantine facility. The bioagent has been maintained by supplying vigorously growing and healthy parthenium plants. There were over 2500 adult *Zygogramma* as of September 30, 2010.

***Listronotus setosipennis*:** The second bioagent, stem-boring weevil, was introduced from South Africa in 2009. It has been kept in a separate quarantine facility that was refurbished to meet international standards. It has also been equipped with all the necessary materials that would enable one to conduct host range tests. The weevil lays its eggs on parthenium flowers and feeds inside the stem as opposed to *Zygogramma* which feeds on leaves. This feeding behavior has necessitated the availability of parthenium plants with young flowers and well developed stem for maintaining the culture and also to carry out host range tests. This has been achieved by growing parthenium plants of different age and providing the plants with the necessary nutrients through application of well decomposed manure.

Host range tests: Host range tests consist of collecting oviposition and larval development data. The major task, after maintaining the culture, has been to conduct oviposition tests on major crops and weeds growing in Ethiopia. Synchronizing the flowering of test plants and the proper bioagent stage of growth has been a major challenge. Sexually mature adults need to be released on flowering plants in order to carry out a proper test. Sexually mature bioagents of known age were produced by keeping track of the insect's development, starting from the larval/pupal stage all the way to emergence of adults.

Producing adults of the same age group: A pupation box was used to keep larva/pupa, removed from infested *Parthenium* plants, until adult emergence. Adults that emerged within a week were placed in boxes containing

Parthenium plant and were considered to be of the same age group.

Growing of test plants: Similarly, plants were grown so they reach peak flowering stage at a time when insects of the right stage for tests are available. Beans, peas, sunflower, and niger seed (noog) were grown in plastic pots each with five plants and later thinned to three vigorous and healthy plants.

Testing: Adults of the same age group were used for tests 2-3 weeks later. First, they were removed from the cage early in the morning and kept in a petri dish. Five pairs of mating adults were kept separately in another petri dish and released on each of three plants representing a species of test plant. On the other hand, the same numbers of mating pairs were released on three parthenium plants that

Table 1. Number of eggs laid by *Listronotus* on different test plants and *Parthenium* under quarantine at Ambo PPRC

Test Plant	No. of Eggs			Total No. of eggs	Average No. of eggs/plant
	Plant 1	Plant 2	Plant 3		
Beans	0	0	0	0	0
Control (<i>Parthenium</i>)	146	153	56	355	118.3
Peas	0	0	0	0	0
Control (<i>Parthenium</i>)	46	106	109	261	87
Lathyrus	0	0	0	0	0
Control (<i>Parthenium</i>)	70	66	284	420	140
Noog (Esete)	0	0	0	0	0
control(<i>Parthenium</i>)	136	56	58	250	83.3
Sunflower (S R Black)	0	0	0	0	0
Control (<i>Parthenium</i>)	197	117	92	406	135.3

served as control. Eggs were counted seven days after release. No eggs were laid on any of the test crops, compared to an average of 112.8 eggs per plant on parthenium (Table 1).

Release and Evaluation of the Impact of Approved Biocontrol Agents for the Control of Parthenium

Host range tests, under quarantine, on economically important crop species and varieties, and indigenous species have established that *Zygogramma* is safe for release against parthenium. Based on the test results, the Ethiopian Ministry of Agriculture and Rural Development (MOARD) has issued a permit to release *Zygogramma* for the control of parthenium in Ethiopia. Subsequently, an **initial environmental examination (IEE)** document was prepared in early April, 2010 and submitted to USAID to get a permit to release *Zygogramma*.

Solicitation of public comment: As part of the application, USAID requested a public comment in Ethiopia on the release of *Zygogramma*. Pursuant to this request, an advertisement was placed on one of the widely distributed and read English Newspapers in Ethiopia, The Ethiopian Herald. The solicitation for comments on the application to release *Zygogramma* in Ethiopia was printed in the Newspaper (Vol. LXVI, No. 281, Wednesday, August 4, 2010). The public was asked to review the IEE document and send their comments to either Dr. Kassahun Zewdie of the Ethiopian Institute of Agricultural Research or Mr. Berhanu Gebre Medhin of the Federal Ministry of Agriculture and Rural Development (MOARD). No comment was received after two weeks of advertisement.