INTERNATIONAL PARTHENIUM NEWS

Number 8, July 2013

First insect agents released for the management of parthenium weed in South Africa

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After several years of research under quarantine conditions in South Africa, applications for permission to release the leaf-feeding beetle *Zygogramma bicolorata* (Coleoptera: Chrysomelidae) and the stem-boring weevil *Listronotus setosipennis* (Coleoptera: Curculionidae), that were submitted to the relevant government authorities (Department of Agriculture, Forestry and Fisheries; DAFF) in July 2012 and December 2012 respectively, were successful in 2013. Permission to release *L. setosipennis* in South Africa was granted in late June 2013 and in early August 2013 for *Z. bicolorata*. Host-specificity testing of both insect agents was protracted due to the need to demonstrate that, other than selected closely related native and economically important Asteraceae, that various *Helianthus annuus* (sunflower) cultivars of local economic importance were not at considerable risk of damage. Sunflower is the major oil producing crop cultivated in South Africa and some feeding, egg-laying and development by both biological control agents was observed on some sunflower cultivars in various laboratory tests. After no-choice, multiple-choice and larval development tests were conducted, risk analyses were finally undertaken on each agent to quantify the risk of their release to non-target species. These risks were ultimately determined to be extremely low for both agents, results of which also concurred with field evidence from Australia and the native range where these agents are not a threat to sunflower production. On the basis of these results, permission for the release of *L. setosipennis* and *Z. bicolorata* in South Africa was granted by DAFF.

Adult weevils and plants containing developing larvae were used to make the initial releases of *L. setosipennis* at three sites around Hluhluwe town (KwaZulu-Natal Province; KZN) on 3rd July 2013. Initial releases of larvae and adult beetles of *Z. bicolorata* were conducted at another three sites around Hluhluwe town, and on the margin of a rural community area bordering the Isimangaliso Wetland Park (KZN), a UNESCO World Heritage Site, on 7th August 2013.

Fig. 1: First releases of the stem-boring weevil *Listronotus setosipennis* on 3rd July 2013 in Hluhluwe town, South Africa, with staff of the ARC-PPRI parthenium biocontrol project.

Despite these releases being conducted during the dry season, small stands of actively growing parthenium weed plants were located due to the unseasonal rainfall received by this region during the recent winter season. Although not an ideal period in terms of activity of the insect agents, these releases were intended only to initiate the process, with further extensive releases planned for spring and summer when plant and insect activity peaks within the summer rainfall period. These releases represent the first releases of *L. setosipennis* and of *Z. bicolorata* in Africa.

Fig. 2: The stem-boring weevil *Listronotus setosipennis*

Mass-rearing of both *L. setosipennis* and *Z. bicolorata* is being undertaken at ARC-PPRI Cedara, and an experienced insectary at the South African Sugarcane Research Institute's Weed Biological Control Unit near Durban will also assist with the mass production of *L. setosipennis*. The insect agents will be released at selected sites as widely as possible through the invasive range of parthenium weed in South Africa, namely in KZN, Mpumalanga and North-West Provinces. Areas that are of higher climatic suitability as determined by earlier research on the thermal physiology and climatic modeling of *Z. bicolorata* and *L. setosipennis*, will be prioritized for releases to maximize successful establishment.

Fig. 3: The first releases of the leaf-feeding beetle *Zygogramma bicolorata* on 8th August 2013 in Hluhluwe town, South Africa, with staff of the ARC-PPRI parthenium weed biocontrol project.

It is likely that in time, these biological control agents will also spread into the neighbouring countries of Swaziland and Mozambique, benefitting these countries which are severely affected in parts by parthenium. This will particularly benefit Swaziland which is heavily infested with parthenium weed and where much of the population relies on subsistence agriculture. Biological control will contribute to the sustainable, long-term management of parthenium weed and benefit small-scale and commercial agricultural production (crop and animal), conservation of biodiversity, and resource-poor communities in southern Africa. At a strategic planning workshop for the management of parthenium in protected areas (priorities for biodiversity conservation) in KZN Province, held in August 2013, it was concluded that biological control could benefit protected areas by focusing on establishing biological control agents in zones surrounding the reserves. Many of these zones house resource-poor communities and provide a significant seed source for invasion of parthenium weed into the protected areas due to the heavy infestation in these areas. This will supplement the benefit of any active chemical control program on parthenium weed being undertaken within reserve boundaries.

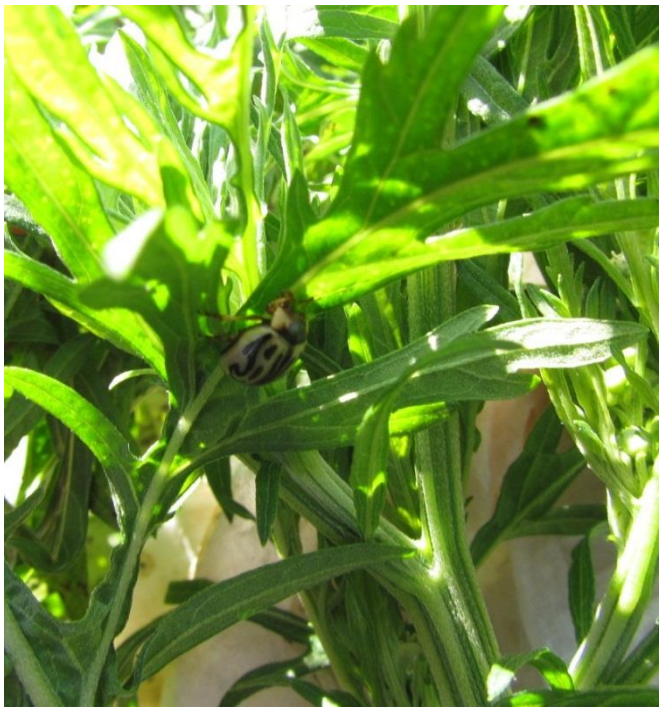

Fig. 4: Adults of the leaf-feeding beetle *Zygogramma bicolorata*

As parthenium weed is problematic in many other African countries the South African biological control project has also been assisting more widely on the continent. Since 2005 the South African project has provided guidance and assistance to the USAID-funded Integrated Pest Management Collaborative Research Support Program's (IPM CRSP) project on the management of *Parthenium hysterophorus* in East Africa, resulting in the importation of *Z. bicolorata* and *L. setosipennis* into Ethiopia from South Africa and the evaluation in quarantine by the Ethiopian Institute of Agricultural Research, for which permission to release both agents has now been granted, currently on a restricted basis while further field trials to demonstrate host specificity are conducted. The South African project, in collaboration with CABI Africa, has also provided a starter culture of *Z. bicolorata* to Tanzania in late September 2013 and guidance for the first releases there. The South African parthenium weed biological control project has benefitted immensely from the successful Australian biological control program on parthenium weed that has been conducted during recent decades. In the initial stages, agents were prioritized for introduction into South Africa based on their impact on the weed in Australia and their likely suitability for the local conditions where the plant invades. Other agents in the suite of natural enemies that may be used against parthenium weed in South Africa include *Puccinia abrupta* var. *partheniicola* (Pucciniales: Pucciniaceae) which is already established on parthenium weed, likely having been introduced with the plant as it was not a deliberate introduction, and the rust fungus *Puccinia xanthii* var. *parthenii-hysterophorae* (Pucciniales: Pucciniaceae), more recently deliberately released and which is deemed more suitable for warmer, wetter conditions where parthenium weed is more prevalent in South Africa. Research on the seed-feeding weevil *Smicronyx lutulentus* (Coleoptera: Curculionidae), which has proved to be extremely host specific in laboratory tests, in concurrence with Australian results, will be concluded in 2013 and an application for permission to release this agent in South Africa is to be submitted to the relevant government authorities in the coming months. Due to the damage caused to parthenium weed, the root crown-boring moth *Carmenta* sp. nr. *ithacae* (Lepidoptera: Sesiidae) is intended for importation from its introduced range in Australia in 2014, for evaluation in quarantine of its suitability for release in South Africa. As parthenium weed continues to spread in South Africa, with growing concern of the need for various control activities, biological control is increasingly recognized as a key control option for the sustainable management of parthenium weed.

Ms M. Gareeb, Mr S. Sambo, Ms L. Khumalo, Mr D. Nkala and Mr S. Mqolombeni, of ARC-PPRI Cedara, are thanked for their technical support to the parthenium project. Financial support from the Agricultural Research Council, the Department of Environmental Affairs Natural Resource Management Programmes' Working for Water Programme and previous support from the KZNthe Department of Agriculture and Environmental Affairs' Invasive Alien Species Programme is gratefully acknowledged. We thank Dr R. McFadyen, Dr K. Dhileepan and Mr M. Trevino in Australia for their advice and support.

Rust fungi for the management of parthenium weed in South Africa

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The rust fungi, *Puccinia abrupta* var. *partheniicola* and *Puccinia xanthii* var. *parthenii-hysterophorae* (formerly known as *P. melampodii*) form the fungal part of a suite of fungal and insect biological control agents that are to be used against parthenium weed in South Africa.

In 1995, the winter rust fungus *P. abrupta* was observed for the first time on parthenium weed plants in South Africa. As no deliberate introductions had been made, so it was presumably introduced together with its host plant as early as 1880. Due to the fact that *P. abrupta* is more damaging on parthenium weed in arid, cooler regions it was thought that it would have little impact on the weed in the wetter, high temperature areas in which the weed is currently spreading in South Africa. For this reason, research focused mainly on the summer rust fungus, *P. xanthii*, collected from the humid lowland areas in Mexico (Parker 1989). Successfully implemented as a biocontrol agent against parthenium since 2000 (Tomley 2000), *P. xanthii* has played an important role in an integrated approach to manage parthenium weed in Australia. In 2007, *P. xanthii* was imported into South Africa from Australia and established in the quarantine laboratories at ARC-PPRI Stellenbosch. Following approval for release in the summer of 2010/2011, mass production and release of the rust were undertaken to establish this agent more widely in South Africa.

Maintenance of the rust culture and mass production of *P. xanthii* on whole plants is primarily undertaken at ARC-PPRI Stellenbosch. Infected plants are regularly shipped to mass production facilities established at the Lowveld Pest, Disease & Variety Control Offices in Mpumalanga and the South African Sugar Research Institute in KwaZulu-Natal, for production and release of the fungus. Releases undertaken in KwaZulu-Natal during spring 2011 and summer 2012 proved unsuccessful and no further releases were made in 2012. Additional releases are continuing in Mpumalanga as parthenium remains verdant in this region throughout the year. The summer rust will be re-released in KwaZulu-Natal in spring and summer 2013/2014.

Interestingly, the winter rust *Puccinia abrupta* emerged in KwaZulu-Natal and Mpumalanga during the 2013 winter season at higher incidences than previously observed. The cold, wetter winter season could possibly account for the increased prevalence of this rust. An implementation program will be developed for winter 2014 to augment the natural winter rust populations with additional releases. Development of an optimal release strategy for the summer rust is underway and will be implemented with field trials this coming season.

Fig. 1: The winter rust *Puccinia abrupta* var. *partheniicola*. Notice the sporangia on the upper leaf surface

Whole, heavily rust infected potted plants are placed in the field at 1 to 2 m intervals with an average of nine pots per site. High ambient temperatures and low rainfall will negatively impact on the success of this agent and releases will be prioritized when conditions are optimal for rust infection and successful establishment.

Fig. 2: The summer rust *Puccinia xanthii* var. *parthenii-hysterophorae.* Notice the sporangia on the upper leaf surface

Fig. 3: Mass production facility established at the Lowveld Pest, Disease & Variety Control Offices in Mpumalanga

Implementation of a suite of biological control agents is the key to the long term sustainable management of parthenium weed in South Africa. Thanks to Ms Gwen Samuels and Mrs Lea Orien for their technical support. Thanks to Ms Karlien Trumpelmann Lowveld Pest, Disease & Variety Control Officer, Malelane, Mpumalanga and the South African Sugarcane Research Institute's Weed Biological Control Unit, Mount Edgecombe, KwaZulu-Natal for their assistance in mass production and releases. Financial support from the Agricultural Research Council, and the Department of Environmental Affairs Natural Resource Management Programme's Working for Water Programme, is gratefully acknowledged.

Fig. 4: Field infection of parthenium weed by *Puccinia abrupta*

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Update of action taken against *Parthenium hysterophorus* in KwaZulu-Natal (KZN), South Africa during 2013

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One of the most anticipated benefits of Early Detection and Rapid Response (EDRR) to invasive alien species is a reduction in long-term management costs, but identifying and controlling species with relatively small/localized population sizes is also likely to be more successful than dealing with established invaders occupying large areas. *Parthenium hysterophorus* is known to occur in at least four of the nine South African Provinces located on the eastern part of the country. One of these is KwaZulu-Natal (KZN), a coastal Province sharing its borders with Swaziland and Mozambique. Even though the first South African record stems from KZN and dates back to 1880, *P. hysterophorus* was only considered invasive in the country a century later in the 1980's (McConnachie et al., 2010).

The term "Famine Weed," has recently been coined as a common name for *P. hysterophorus* in South Africa, in the hope that this will assist with relaying the seriousness of its impacts to a much broader audience, especially to people who do not have a scientific background. Many South African stakeholders have since started to adopt this common name, hence Famine Weed will be used in this article. Surveys conducted in KZN during 2007 illustrate a sporadic rather than continuous distribution of Famine Weed. However, results from a recent CLIMEX model (McConnachie et al., 2010) indicate that there are many climatically suitable areas in South Africa where *P. hysterophorus* could occur, so it is likely that this species has not yet reached the full extent of its distribution.

This information, coupled with the inherent invasive characteristics of this species, as well as evidence of invasive behaviour displayed in other countries, has resulted in a proactive approach by KZN stakeholders in tackling Famine Weed. Here we discuss the efforts of two organizations which aim primarily at: a) preventing spread from dense infestations and taking Rapid Response action to control satellite (new) populations and b) protection of biodiversity hotspot areas against Famine Weed invasions. It should be noted that these do not reflect the only efforts in the Province, and in most cases these are collaborative efforts with many partner organizations in KZN.

1) Reduction of Famine Weed spread from dense infestations – taking Rapid Response action to tackle outlier populations

The South African National Biodiversity Institute's Invasive Species Programme (SANBI ISP) was tasked with treating Famine Weed populations in the south eastern parts of the Province, to prevent spread southwards and westwards of dense infestations.

SANBI ISP clearing activities on Famine Weed began during the 2010/11 flowering season, and has continued since then. During the 2012/13 period, two clearing teams comprising 12 people each were employed to systematically survey major and minor roads leading from the dense infestations, and tackle satellite populations reported by keen spotters following awareness raising efforts. The clearing teams managed to treat all populations along regional, national and local transport routes as well as all towns and communities en-route and all other reported sites. Plants were treated from January 2013 until May 2013 using a Picloram and Fluroxypyr herbicide mix. From data collected during this clearing effort, key focus areas for the next clearing season have been identified as priorities. (i.e. localities of the satellite populations).

Fig. 1: SANBI ISP clearing teams treating Famine Weed.

2) Towards an integrated strategy for the management of Famine Weed (*Parthenium hysterophorus)* in South African protected areas

Famine Weed represents a significant direct threat to protected areas in eastern South Africa through *inter alia* impacts on biodiversity, ecological carrying capacity, staff and visitor health, and the overall tourism experience. Of particular concern, Famine Weed will have a negative effect upon the number of rhino in key protected areas (in India the carrying capacity has in some instances has been reduced by 90%), and will reduce the productivity of the population (with poaching the overall population growth is currently just above zero), thereby making the populations significantly more susceptible to the impacts of poaching. Indirect impacts of Famine Weed include increased rural poverty and reduced grazing capacity of communal rangelands, both

of which will increase pressure for access to resources within protected areas. As the invasion process is relatively recent, there is still a good opportunity of successful management and even, in some cases, eradication, but the need for action is urgent. As such, Ezemvelo KZN Wildlife, South African National Parks and the iSimangaliso Wetland Park Authority are developing strategies to manage Famine Weed in their protected areas.

A recent systematic survey of Famine Weed in north-eastern KZN (Macdonald & Lee 2013) has identified the extent of invasion in all protected areas and within a 5 km buffer zone along all access roads. Every 100 m section of all tourist and management tracks was surveyed, with density quantified firstly in the first 20 m either side of the road (to account for disturbance effect of the road), and secondly within 200 m either side.

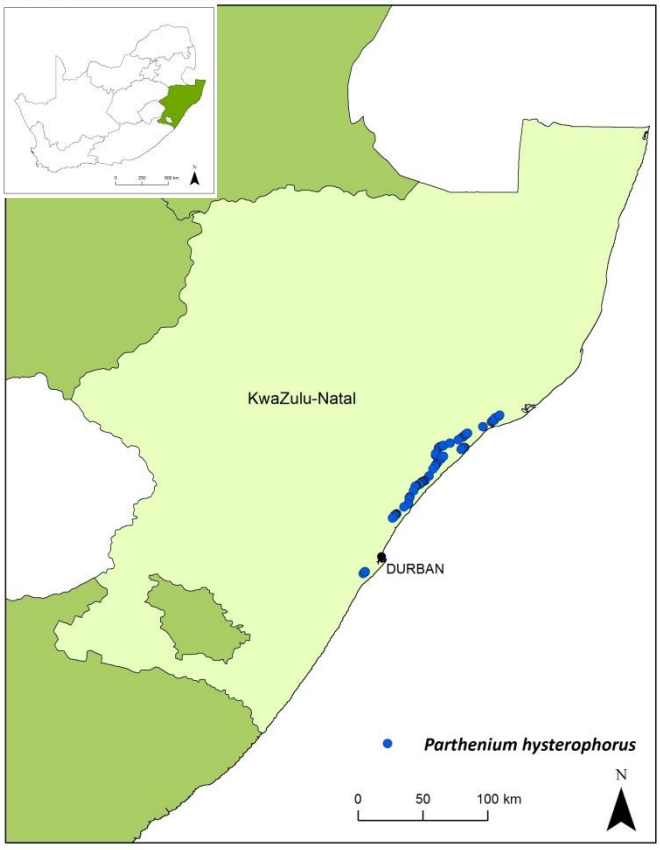

Fig. 2: Populations of Famine Weed treated by SANBI ISP teams during 2012/3 are shown by blue dots on the left, and the relative position of the KZN province in SA is shown in the inset. Map credits: Haylee Kaplan

The descending order of infestation of KZN protected areas is: Phongolo Nature Reserve, Ndumo Game Reserve, Tembe Elephant Park, Imfolozi Game Reserve, Hluhluwe Game Reserve, Umkhuze Game Reserve (the only part of iSimangaliso Wetland Park World Heritage Site surveyed), and Ithala Game Reserve. Other north-eastern protected areas appear free at this stage, but have Famine Weed infestations on or close to their boundaries. It is particularly worrying that communal rangelands almost completely surrounding these protected areas are very heavily infested.

A stakeholder workshop was held in August, and from this workshop six pillars of the protected area strategy were identified : 1) managing vectors of spread/invasion pathways so as to minimize the introduction of seed into the protected areas, 2) early detection and rapid response to the establishment of plants, 3) good planning and implementation of best practice to minimize opportunities for establishment, maximize resilience of the habitats, and maximize efficacy of any response measures, 4) adopting an integrated control approach that incorporates buffer zones and maximizes the benefits of biological control, 5) ensuring effective coordination and partnerships with other role players, and 6) ensuring appropriate levels of awareness, especially amongst staff.

Time-bound targets for management of Famine Weed have been defined, and these targets will define the fundamental approach, range of interventions and resource requirements, and also provide a performance indicator against which progress can be measured. The targets for KZN protected areas were determined to be to: 1) prevent Famine Weed from establishing in PAs where it does not currently occur, and 2) eradicate the species rapidly from those protected areas where it has established, except for heavily-infested areas where the medium term target is substantial control with a growing-season aerial cover not exceeding 0.5%

It was identified that a number of changes to management and tourism operations are necessary, some of which are relatively inexpensive and/or require minor changes to standard operating procedures; however, other changes will require significant resource allocation. Two key interventions are 1) the establishment of wash-down facilities at high risk entrances to protected areas, with selective washing of high risk vehicles, and 2) establishment of Parthenium-specific buffer zones around protected areas to reduce the amount of seed entering the protected areas. Game capture and Invasive Alien Species operations (ironically!) have been demonstrated to be important vectors of seed dispersal, particularly to remote areas away from the main road networks.

Ad hoc and systematic monitoring programm will be implemented to enable detection of changes to distribution and abundance patterns, providing information that can be rapidly assimilated into the control programs, and which will allow for evaluation of success of the strategy. Given the economic, biodiversity and rhino conservation implications, provincial Treasury in KZN has been approached to assist in making funds available to tackle the problem of parthenium weed invasion in protected areas.

Fig 3: Participants of the KZN Protected Areas Famine Weed (parthenium weed) Strategy workshop – August 2013

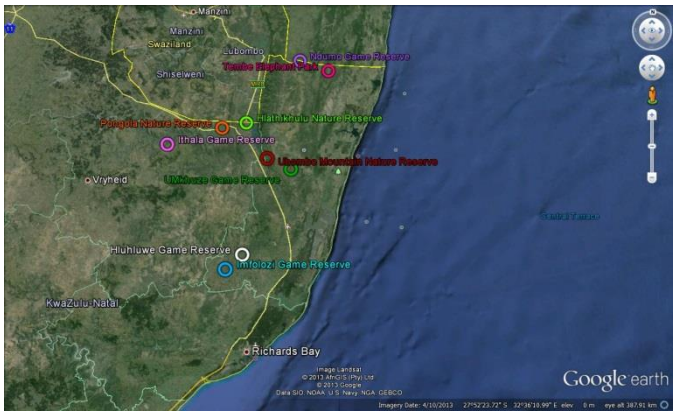

Fig 4: Google image showing localities of several protected areas in KZN.

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* Sponsored by the Working for Water Programme, Natural Resource Management, Department of Environmental Affairs

Addition to EPPO Alert List & Expert Working Group Meeting for performing a PRA on Parthenium weed

Reported by **Asad Shabbir**

Parthenium weed was added to the European and Mediterranean Plant Protection Organization (EPPO) Alert List in 2011 (https://www.eppo.int/QUARANTINE/Alert_List/invasive_plants/Parthenium_hysterophorus.htm). Within the EPPO region, the species is so far only officially recorded in Israel.

The Working Party on Phytosanitary Regulations decided in June 2012 that a Pest Risk Analysis (PRA) should be performed for this species. An Expert Working Group on *P. hysterophorus* met in Paris in 2-5 July 2013 to perform a PRA, on the basis of the hundreds of scientific publications available on the species. The overall conclusion of the PRA was that, if the pest spreads further in the EPPO region, it would be likely to establish in the EPPO Mediterranean countries and result in economic damage.

The Expert Working Group was composed of:

Guillaume Fried, Anses, France
Darren Kriticos, CSIRO Ecosystem Sciences, Australia
Alfons Oude Lansink, Wageningen University, the Netherlands
Dane Panetta, Australia
Hathwar Ramachandra Prasad, University of Agricultural Sciences, Bengaluru, India
Asad Shabbir, University of the Punjab, Lahore, Pakistan
Tuvia Yaacoby, Plant Protection and Inspection Services, Israel
Sarah Brunel EPPO Secretariat. Paris France.

Source:
(https://www.eppo.int/MEETINGS/2013_meetings/EWG_PTNHY.htm)

Modeling parthenium weed early canopy architecture and the impacts on biological control activity

(A poster presented at 7th International Conference on Functional—Structural Plant Models 9 -14th June 2013 Saariselka, Finland)

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Parthenium weed (*Parthenium hysterophorus* L., Asteraceae) is an annual invasive species that affects agro- and natural ecosystems, and human and animal health. Management is most effective if undertaken prior to flowering and an integrated strategy involving biological control agents is considered environmentally friendly and thereby recommended. However, this strategy is affected by environmental changes as well as parthenium weed itself. Research into the interaction between parthenium weed, biological control agents and the environment has been undertaken for certain insect agents but not for fungal agents specifically the summer rust (*Puccinia xanthii* var. *parthenii-hysterophorae* Seier, H.C. Evans & Á. Romero). This study creates a three-dimensional (3D) Lindenmayer-systems (L-systems) based canopy architecture model to study the impact of a number of abiotic (temperature, CO_2, and soil moisture) and biotic (plant density) factors on parthenium weed early development and the summer rust distribution

Phase 1. Parthenium weed model (Fig 1)

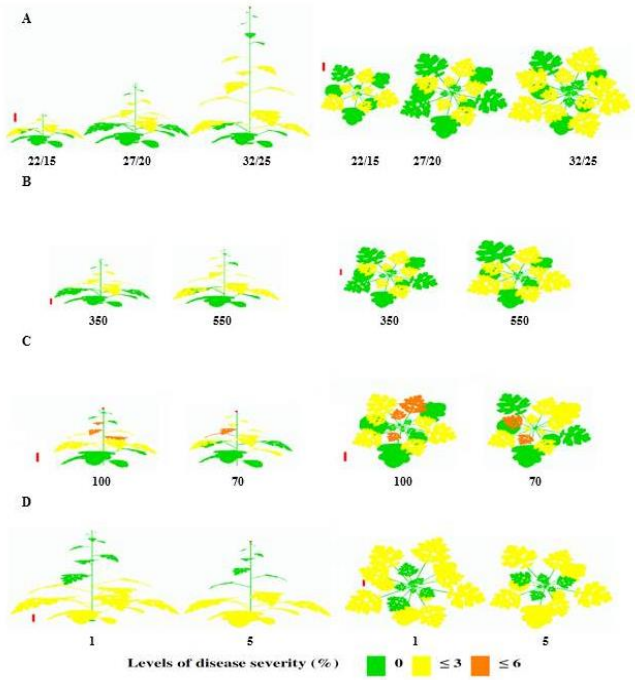

Fig 1. Side- and top- views of the summer rust distribution and disease severity on early parthenium weed plant canopy grown under various environmental factors of temperature regimes (°C, A), CO_2 concentration (ppm, B), soil moisture level (%, C) and plant density (plants pot^{-1}, D). Different levels of disease severity are illustrated in different colours from green to orange. The red dot indicates the first flower formed on the plant. Red scale bar = 1 cm. The red dot indicates the first flower formed on that plant

T**ested factors**: temperature regime (day/night 22/15, 27/20, and 32/25 ± 1 °C), CO_2 concentration (350 and 550 ppm), soil moisture level (100 and 75 % of field capacity), and plant density (one and five plants pot^{-1})

Simulation period: 28 days of plant growth

Parameter inputs: leaf length and width, petiole length, and internode length.

Leaf visualization: leaf image digitization and texture mapping

Plant development: thermal time concept and decomposition rule in L-systems

Phase 2. Incorporation with the summer rust

Inoculation of the summer rust: spray of spore suspension (10^5 spores/mL) onto parthenium weed plants

Parameter inputs: disease severity per leaf. Fifteen days after inoculation, leaves were harvested for image digitization processing and disease severity calculation as follows:

i) disease severity = (disease area/leaf area) x 100 %

ii) disease area = (captured $pixels_{DA}$/pixels of the image file) x dimensions of the image file

iii) leaf area = (captured $pixels_{LA}$/pixels of the image file) x dimensions of the image file

where 'captured $pixels_{DA}$' defined the brownish colour of pustule-like telia of the summer rust (colour threshold: hue 10 - 25 and saturation 0 – 100) and 'captured $pixels_{LA}$' defined the green colour of parthenium weed leaves (colour threshold: hue 40 - 110 and saturation 0 – 100)

Disease severity visualization: leaves with disease (disease severity > 0 %) were filled with colours according to the level of disease severity in contrast to the green (disease severity = 0 %), see Fig. 1.

DWSR organized "*Parthenium* Awareness Week' throughout India

Reported by Sushilkumar, Program Coordinator, Parthenium Awareness Week. Directorate of Weed Science Research,

Parthenium hysterophorus (Family: Asteraceae), locally called *gajar ghas* or congress grass, is an alien weed which entered into India along with wheat imported from USA in the mid 1950s. Since then it has spread alarmingly and invaded about 35 million ha of land through the country. The weed is responsible for causing many diseases like skin allergy, hay fever, breathing problems in human beings and animals besides reducing agricultural productivity and causing loss of biodiversity. This dreaded weed is spreading at an alarming rate that all efforts for its management are falling short. In view of the seriousness as well as the magnitude of the threat posed by this weed, the Directorate of Weed Science Research (DWSR), Jabalpur has been organizing mass awareness programm since 2004 to educate the farmers and general public about the ill effects of *Parthenium* and ways to manage it.

Fig 1. Awareness programme at Jabalpur (Madhya Pradesh)

In 2013 also, DWSR organized a country-wide program "***Parthenium* Awareness Week**" from 16-22 August, 2013 by involving State Agricultural Universities (SAUs), Krishi Vigyan Kendra (KVKs), State Agricultural Departments, institutes of ICAR, AICRP Centres of Weed Control, many NGOs, municipalities, schools and colleges. To facilitate the organizers, posters and extension materials, especially developed for this occasion, were distributed to about 1100 stakeholders with the appeal to multiply and develop more such material in regional languages for further distribution among people.

Fig 2. Uprooting of Parthenium in Ludhiana (Punjab)

Activities like awareness, lectures, photo exhibitions, farmers' meetings, students' rallies, uprooting, demonstrations on *Parthenium* management were done throughout India. These events were covered by print and electronic media, which resulted in creating awareness among people about this dreaded weed. This programme was found highly successful in creating awareness and educating the people about the ill effects of *Parthenium* and the techniques of its management.

Fig 3. Uprooting by people at Sriniketan (West Bengal)

At DWSR, Jabalpur, the awareness programs were organized in Panagar, Majholi, Gosalpur, Kundam, Bankhedi and Shahpura localities on different days of the week. A training-cum-awareness program was conducted at the Directorate on 19th August, in which about 56 people from the city and adjoining districts participated. The scientists of the Directorate participated in the Parthenium weed awareness prgramm in collaboration with State agriculture Department at Rewa, Dindori and Jhansi.

In the north-eastern region of the country, programs were organized by Assam Agricultural University, Jorhat; Central Agricultural University, Manipur; Bidhan Chandra Krishi Vishwavidhyalya, Mohanpur; Vishwa Bharti, Shrineketan; Orissa University of Agricultural and Technology, Bhubaneswar; Rajendra Agricultural University, Pusa; and Birsa Agricultural University, Ranchi in collaboration with KVKs, schools and colleges in the region.

In northern region of the country, Universities like SKUAST, Jammu; GBPUAT, Pantnagar; CSKHPKV, Palampur; NDUAT, Faizabad; CSAUAT, Kanpur; CCSHAU, Haryana; and PAU, Ludhiana did numerous awareness programs in collaboration with Krishi Vigyan Kendras, colleges and schools. Many ICAR institutes also created awareness among the people by organizing various events.

In southern India, all the agricultural universities and KVKs organized many events in urban and rural areas to create awareness among people. The prominent universities were: ANGRAU, Hyderabad; TNAU, Coimbatore; KAU, Kerala; and University of Agricultural Sciences, Bengaluru and Dharwad.

Fig 4. Awareness meeting at Jhansi (Uttar Pradesh)

From the western part of India, awareness programs were organized by Agricultural universities like AAU, Anand; MPUAT, Udiapur; SKRAU, Bikaner; DBSKKV, Dapoli; PDKV, Akola; and MAU, Parbhani; many KVKs and ICAR institutes.

In central India, agricultural universities like IGKVV, Raipur; RVSKVV, Gwalior; many KVKs, ICAR institutes observed the week in collaboration with schools and colleges. A glimpse of this mega event can be seen by clicking following links:

- Posters and extension folders on Parthenium weed
- Parthenium weed awareness programs organized in different states
- Parthenium weed awareness week in newspapers

International Parthenium Weed Network meeting

Dear members of the International Parthenium Weed Network (iPaWN),

At the APWSS Conference in Bandung 22-25 October 2013, there will be a meeting of the International Parthenium Weed Network Wednesday 23rd at 5pm. We hope many of you will be attending the Conference and

will be able to join the meeting. The meeting is open to anyone interested in parthenium weed including those that may not yet be members of the Network, so if you know of other people who might be interested, feel free to let them know about it.

The Group has been very active over the past couple of years with our Newsletters on the APWSS web site (www.APWSS.org) and under the link iPaWN.

It would good idea if each country could select one representative to provide a brief update on the latest situation within their country with respect to weed spread, impacts and management. These reports will then be presented by the chair at the meeting

Steve Adkins &
Asad Shabbir

Upcoming Conferences on Weed Science and Invasive Species

The 24th Asian-Pacific Weed Science Society Conference
Dates: October 22-25, 2013
Venue: Bandung, Indonesia
http://apwss2013.com/

XIV International Symposium on Biological Control of weeds
Dates: 2-7 March 2014
Venue: Kruger National Park, RSA
http://www.isbcw2014.uct.ac.za/

4th International Symposium on Weeds and Invasive Plants
Dates: 18-23 May 2014
Venue: Montpellier, France
http://invasive.weeds.montpellier.ewrs.org/default.asp

Special International Workshop on Weeds and Invasive Plants: The 2nd Science Incubator
Dates: 24-28 June 2014
Venue: Spain
http://andinallanos.weebly.com/index.html

8th Neobiota Conference
Dates: 3-8 November 2014
Venue: Antalya, Turkey
http://www.oekosys.tu-berlin.de/menue/neobiota/

Recent Publications

Kumar, S., Masto, R.E., Ram, L.C., Sarkar, P., George, J.Selvi, V.A. 2013. Biochar preparation from *Parthenium hysterophorus* and its potential use in soil application. Ecological Engineering 55 (0), 67-72.

Retief, E., Ntushelo, K.Wood, A.R. 2013. Host-specificity testing of *Puccinia xanthii* var. parthenii-hysterophorae, a potential biocontrol agent for *Parthenium hysterophorus* in South Africa. South African Journal of Plant and Soil 30 (1), 7-12.

Shashie Ayele, Lisanework Nigatu, Tamado Tanaand Steve W. Adkins, 2013. Impact of parthenium weed (*Parthenium hysterophorus* L.) on the above-ground and soil seed bank communities of rangelands in Southeast Ethiopia. International Research Journal of Agricultural Science and Soil Science. 3 (7), 262-274

Haroon Khan, Khan Bahadar Marwat, Gul Hassan and Muhammad, Azim Khan, 2013. Socio - economic impacts of Parthenium (*Parthenium hysterophorus* L.) In Peshawar valley, Pakistan. Pak. J. Weed Sci. Res., 19 (3): 275-293,

Talemos Seta, Abreham Assefa, Fisseha Mesfin and Alemayehu Balcha, 2013. Distribution status and the impact of parthenium weed (*Parthenium hysterophorus* L.) at Gedeo Zone (Southern Ethiopia) African Journal of Agricultural Research. 8(4), 386 -397