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Parthenium weed as a host of *Tobacco streak virus* in Australia and other countries

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Tobacco streak virus (TSV) has an extensive host range. Surveys in Central Queensland, Australia, have identified at least 18 weed and 10 crop species as field hosts of TSV with sunflower and mung beans being two of the most susceptible crop hosts and evidence indicates that parthenium weed is the major source of the virus moving into crops. Yield losses of approximately 20% have been observed across the sunflower industry in central Queensland since 2004 with localised yield losses of greater than 40% observed in many locations (Fig. 1). In early 2007 up to 70% yield reductions were observed in severely affected mung bean crops.

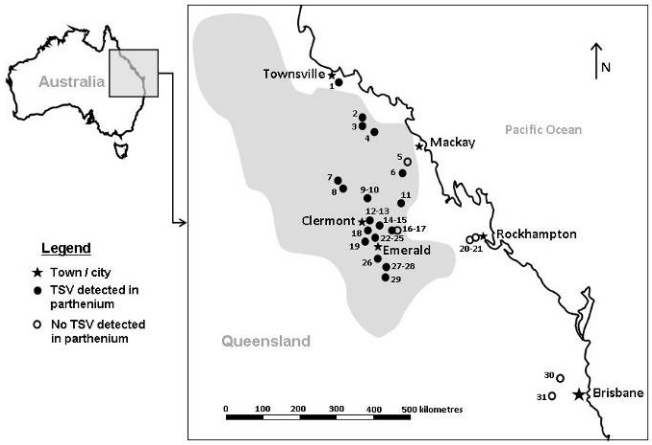
TSV has been found to commonly occur in parthenium weed, as symptomless infections, in central Queensland, Australia across a large area infested with this weed (Fig. 2; Sharman *et al.* 2009). Severe TSV disease outbreaks in affected crops were always associated with the presence of TSV-infected parthenium weed nearby (Sharman *et al.* 2008). Parthenium weed is commonly infected with TSV across the major area of infestation in a range of situations including cropping areas, forest and grazing lands.

Figure 1: TSV infected sunflower growing next to TSV-infected parthenium weed in central Queensland, Australia. Symptoms in crops often include severe necrosis and plant death.

Seed transmission of TSV in parthenium weed was found to occur at rates of c. 7 to 48%. There was almost no change in the rate of TSV seed transmission when parthenium weed seed was stored for up to 24.5 months. Parthenium weed has also been reported as the major source of TSV causing disease epidemics in India in a range of crops (Prasada Rao *et al.* 2003). However, seed transmission of the Indian strain of TSV has not been found to occur in parthenium weed or other hosts. Seed transmission of plant viruses can

form a critical link between generations of host plants which may be temporally separated by adverse seasons, such as winter or drought. It can also enable long distance dispersal of a virus to new locations.

Figure 2: Distribution of TSV-infected parthenium weed in central Queensland, Australia. Shaded area (adapted from Navie *et al.* 1996) contains regions with heavy infestations of the weed.



TSV is pollen-borne and transmission of TSV to healthy plants relies on the virus from infected pollen entering plant cells through the feeding injury caused by thrips. Surveys of pollen diversity and abundance from several Indian cities indicate the potential for large quantities of parthenium weed pollen to become airborne and to move significant distances. Hence, parthenium weed is an ideal alternative host for generating TSV disease epidemics as it produces large amounts of pollen which is easily dispersed by wind or thrips. The high rates of seed transmission and long term viability of TSV in parthenium weed seed demonstrated in Australia, along with the ability of parthenium to often dominate seed banks, remain viable for many years, and produce large amounts of TSV infected pollen indicates that parthenium weed plays a critical role in the life cycle of TSV in central Queensland and the development of disease epidemics in nearby crops.

Results presented here warrant the investigation of TSV infecting parthenium weed, and possible seed transmission, from other regions of the world where parthenium weed and TSV are known to be present, such as India, Pakistan, Brazil and Argentina. As TSV causes no symptoms in parthenium, it may be present but go unnoticed in other countries until it moves into a susceptible crop nearby and causes severe disease outbreaks. Parthenium weed occurs in the state of Parana, Brazil where it is reported to infest soybean crops which are also affected by TSV.

While no mention of parthenium weed has been made in the literature in relation to TSV in Brazil, the results of this study suggest parthenium weed may also be an important host of TSV in that country, particularly considering the Brazilian and central Queensland strains of TSV are very similar by sequence analysis and may share very similar biological characteristics.

Figure 3: Parthenium weed growing next to a sunflower crop. No symptoms are seen in the TSV-infected parthenium weed.

At least two accidental introductions of parthenium weed into Australia have occurred. The second, far more invasive introduction occurred in 1958 into central Queensland and this introduction is believed to have been from Texas, USA, through the importation of contaminated pasture seed. It is possible that TSV was accidently introduced into Australia via TSV-infected parthenium weed seed in the mid 20th century from the USA and it has subsequently been spread with the movement of parthenium weed throughout central Queensland. However the development of severe disease epidemics in crops has only been observed for the last several years whereas parthenium weed has been present at high densities for at least 30 years. It is also possible that TSV was accidently introduced into Australia via seed of another host (possibly a crop) recently and has subsequently become established in parthenium weed.

Parthenium weed on the march; Bhutan, Yemen and Oman invaded!

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Parthenium weed is becoming a weed of global significance and it is expanding its range not only within the already reported countries but it is also invading new ones. Parthenium weed has now been reported in the Dhofar and Wadis regions of Oman where it is becoming a problematic weed in rangelands. According to Dr Annette Patzelt, Senior Director of Oman Botanic Gardens, parthenium weed

is spreading quickly in Dhofar, the southern region of Oman and it is mainly found at lower altitudes along roadsides and on disturbed ground and has invaded many areas which suffer from overgrazing. It is not yet present in central and northern Oman. Similarly the weed has recently been reported in Yemen in the western mountains. The weed is causing allergy problems in humans and many cases of allergy have been reported after the consumption of honey from bees which had feed on the flowers of parthenium weed in the region of Hajah.

Parthenium weed is also present in Bhutan and is distributed in the Punakha, Tongsa, Mongar and Tashigang administrative districts where it is a weed along roadsides, waste lands and in some perennial crops. Parthenium weed is found from 200 to1700 m and probably found in these areas all year long.

Original source of information: Parker C. 1992. Weeds of Bhutan. Thimpu: Royal Government of Bhutan. Published in: Grierson AJC and DG Long. 2001. Flora of Bhutan, Vol 2, Part 3. pp. 1035-1675.

Release of the first biological control agent on *Parthenium hysterophorus* L. in South Africa and continuation of related research activities

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After organising (in collaboration with CABI, IUCN and GEF) the 1st IOBC International Workshop on Biological Control and Management of *Parthenium hysterophorus* (in conjunction with a meeting of the IPM CRSP parthenium project partners) in Nairobi, Kenya in November 2010, research activities on the biological control of *Parthenium hysterophorus* continued at ARC-PPRI at Cedara, in KwaZulu-Natal Province, and at Stellenbosch in Western Cape Province in South Africa. The biocontrol research programme on parthenium weed was initiated in late 2003 and has since imported and evaluated the stem-boring weevil *Listronotus setosipennis* (Coleoptera: Curculionidae), the leaf-feeding beetle *Zygogramma bicolorata* (Coleoptera: Chrysomelidae), and the rust fungus *Puccinia xanthii* var. *parthenii-hysterophorae* (Pucciniales: Pucciniaceae). *Puccinia abrupta* var. *partheniicola* (Pucciniales: Pucciniaceae) is already present in parts of South Africa, and was probably introduced with the plant.

Figure 3: Host testing of a stem-galling moth *Epiblema strenuana* in progress in South Africa.

The rust fungus *P. xanthii* var. *parthenii-hysterophorae* was shown to be suitable for release following host-specificity testing on selected native and economically important plant species, and approval to release this agent in South Africa was obtained in 2010. The first releases of the rust fungus commenced at Kruger National Park in Mpumalanga Province in December 2010. Plants inoculated with the rust fungus were planted out in parthenium weed infestations. This agent is being mass-reared at the PPRI Stellenbosch laboratory as well as the South African Sugar Research Institute, just north of Durban, and further releases in Mpumpalanga and KwaZulu-Natal Provinces particularly, are planned for summer 2011. It is anticipated that this rust fungus will be better suited to the warmer, wetter north-eastern parts of South Africa where dense infestations of parthenium weed occur, than the rust fungus *P. abrupta* var. *partheniicola* that currently has a restricted distribution.

No-choice and multiple-choice tests indicated that most of the 47 native and economically important Asteraceae species tested, including 12 commercial

sunflower cultivars, were unsuitable for *Z. bicolorata*. However, several sunflower cultivars could support feeding and oviposition. After complete development was observed on six sunflower (*Helianthus annuus*) (Asteraceae) cultivars in laboratory testing, a risk analysis was compiled for *Z. bicolorata*. The analysis indicated that the risk of supporting feeding damage or viable populations on these sunflower cultivars in the field in South Africa was very low (<0.2%). Therefore an application for permission to release this agent in South Africa is being compiled. Thermal physiology studies on *Z. bicolorata* and modelling using CLIMEX ver. 3.0 indicates that this agent will be climatically suited to establish throughout much of the range invaded by parthenium weed in South Africa.

Figure 4: Host testing of a seed-feeding weevil *Smicronyx lutulentus* is in progress.

Host-specificity tests on 38 native and economically important species (from 11 tribes) and 13 commercial sunflower cultivars indicated that *L. setosipennis* has a narrow host range. Multiple choice tests resolved oviposition that occurred on eight plant species in no-choice tests, but did not resolve this for all of the sunflower cultivars tested. Due to some oviposition on selected sunflower cultivars, larval development tests are being conducted. An application for permission to release this agent is being compiled. Using data gathered from thermal physiology studies on *L. setosipennis* and modelling using CLIMEX, it has been determined that this agent is likely better suited climatically to the north-eastern parts of South Africa, where parthenium weed infestations are most common.

In March 2010 two additional agents were imported into quarantine at ARC-PPRI Cedara from Queensland, Australia. They are the stem-galling moth *Epiblema strenuana* (Lepidoptera: Tortricidae; Fig. 3) and the small seed-feeding weevil *Smicronyx lutulentus* (Coleoptera: Curculionidae; Fig. 4). Research during 2011 has included no-choice and multiple choice tests of *E. strenuana* on various cultivars of *Guizotia abyssinica*, an important oil-seed crop, commonly known as noog, grown in Ethiopia. Preliminary results indicate that *Xanthium strumarium* is a highly suitable host, but that the *G. abyssinica* varieties tested are less or not acceptable for gall development; tests are not yet conclusive and are still underway. Culturing techniques for *S. lutulentus* have been refined and a large culture has been established in quarantine. Host-specificity trials have been initiated but are in the preliminary stages.

Other activities have included compilation of a review of this research programme for inclusion in a series of reviews on the past decade of research of weed biocontrol programmes in South Africa, due for publication in 2011. Technical capacity has been increased with the appointment of a technician to the project in late 2010. This research programme continues to be funded by the Department of Water and Environmental Affairs' Working for Water Programme, and the KwaZulu-Natal Department of Agriculture, Environment and Rural Development's Invasive Alien Species Programme, and the Agricultural Research Council.

Update from the USAID-IPM CRSP parthenium weed project

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The host-range evaluation of biological agents for the control of parthenium weed has continued in the quarantine facility at the Ambo Plant Protection Research Center of the Ethiopian Institute of Agricultural Research, Ethiopia with funding support from USAID-IPM CRSP. The project is led by Virginia State University and has partners from Ethiopia, Kenya, Tanzania, Uganda, South Africa and Australia.

The safety of the stem-boring weevil (*Listronotus setosipennis*) to non-target plant species was tested under no-choice conditions (Fig. 5). The test plants belonging to the Asteraceae family consisted of five varieties of niger seed (*Guizotia abyssinica*), an oil crop, two varieties of sunflower (*Helianthus annus*), vernonia (*Vernonia galamensis*), *Guizotia scabra, Bidens pilosa, B. pachyloma, Flaveria trinervia* and *Tagetes minuta.* Others tested, not related to

parthenium weed, included tef (*Eragrostis tef*) an important endemic food grain crop in Ethiopia, corn and wheat. No eggs were laid on any of the crops and other non-target plants. Additional host-range testing of *Listronotus* will be conducted in the coming months.

Road side surveys of parthenium weed are being conducted in Kenya, Tanzania and Uganda in an in attempt to improve the understanding of the geographical distribution of this invasive weed in eastern Africa. The surveys are now been undertaken for the second year in a row in the three east African countries. The goal is to collect accurate information on the distribution and spread of parthenium weed in eastern Africa.

Figure 5: The host-range evaluation of *Listronotus* continued in the quarantine facility at Ambo Plant Protection Research Center of the Ethiopian Institute of Agricultural Research, Ethiopia.

Winter rust of parthenium weed in Ethiopia

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One of the pathogens that cause rust on parthenium weed in Ethiopia was identified as *Puccinia abrupta Diet.* Holw. var. *partheniicola (Jackson)* Parmelee in 1967 (Taye *et al*., 2004) it was found infecting leaves, stems and floral parts of parthenium weed plants in cool and humid areas of Ethiopia. The main symptoms seen on the plants were chlorosis, necrosis, and reduction in vegetative growth, and seed production. Host specificity of *P. abrupta* on related crop and weed species showed that its sporulation was observed only on parthenium weed. In Ethiopia it is found widely distributed in an altitudinal range of 1650 to 2650 m.a.s.l.

The rust (*Puccinia abrupta* var. *partheniicola)* is autoecious and a macro cyclic fungus (Evans, 1987a). Studies conducted by Parker *et al*. (1994) and Fauzi (2009) indicated that this pathogen is host specific and completes its life cycle on parthenium weed and the closely related *Parthenium conferatum* causing minor symptoms such as chlorosis and necrosis, but without sporulation on some sunflower cultivars. In Ethiopia it was introduced possibly together with parthenium weed from Kenya and/or Somalia (Taye *et al*., 2004). The presence of *Puccinia abrupta* was reported in Kenya in 1977 (Evans, 1987a). This pathogen has a life cycle of 14 days and its symptom starts to be seen between 8-12 days after inoculation (Evans. 1997a). Evans (1987a) stated that *P. abrupta* reduces both the vegetative growth of young plants and the seed production of older plants in some semi-arid, high-altitude localities (1400 to 1600 m). In these habitats, the rust was found to produce both uredinia and telia in abundance on the leaves, stems and inflorescence. However, in the more humid, low land and coastal situations, infection was generally light and only scattered uredinia occurred on the older rosette leaves (Evans, 1987a).

Figure 6: Winter rust impact studies in Ethiopia.

A photograph taken in the greenhouse by Zelalem Bekeko, 2009, Ethiopia (Fig. 6) shows. inoculated leaves that were subjected to leaf senesence 21 days after inoculation. It has a substantial effect in reducing plant height, leaf area, leaf width, number of seeds per plant and biological age of the parthenium weed plant. Hence, it reduces its competitive ability. Thus, it is a potential pathogen for controlling parthenium weed in the highlands of Ethiopia.

The emerging threat of parthernium weed in Tanzania

Henry Sweddy and Jacqueline Sweddy – Ngorongoro Conservation Area Tanzania

In 2009, Henry Sweedy attended the 10th EMAPI (Ecology and Management Alien Plant Invasions, 22nd to 27th August 2009) meeting with the motto "Effective intervention through enhanced collaboration". EMAPi 10 was the first in the series to be held in Africa. A recent review of geographical biases in invasions ecology (Pysek *et al.*; Trends in Ecology and Evolution 23:237-244) showed a clear under representation of published studies of invasive species from Africa (Although South Africa is reasonably well represented). Poor knowledge of the extent and impacts of plant invasions in Africa undermines the efforts to instigate far-reaching management initiatives functioning across African ecosystems.

As the preceedings continued, it came to the turn for an Ethiopian, Dr Taye Tessema to give his presentation about parthenium weed which has devastated his country in a range of ways including plant biodiversity and yield losses as high as 46 to 97 % for sorghum. The weed has also caused problem to human health through the presence of secondary plant compounds, notably parthenin and vinilic acid which are found in different concentrations in different plant parts, depending on the plant's locality, the plant parts, the plant size and the soil moisture content.

Figure 6: Parthenium weed growing profusely beside a dirt road and in front of a concrete / grill fence.

To Tanzanians, representing the Ngorongoro Conservation Area Authority, this was the first time to hear about this notorious plant. In the report presented to the Board of Directors, it was clearly identified that the most visited conserved area in Northern Tanzania were at threat. This area is highly prone to imminent invasion by parthenium weed and is a major wildlife and livestock dispersal area. Also human interactions among east and central African citizens have increased the possibility of introducing alien plant species across boundaries, whether intentionally or accidentally.

The assumed first sighting of parthenium weed infestation in Tanzania was at Arusha and Kilimanjaro in February 2010. Krissie Clark and Wayne Lotter of the PAMS Foundation helped to develop a document that will act as a code of conduct for the control of alien plant species in the ecological important Ngorongoro Conservation area. Hence invasive alien plants have been identified as one of the main biological threats to biodiversity in the area and the strategic management plan will provide the necessary guidance to effectively manage this problem. Being accredited as a World Heritage Site and a Mans Biosphere Reserve, any environment deterioration would potentially reduce its status it being a Heritage Site. Among other causes would be its deterioration due to the invasive species present.

Figure 7: Road Map of Tanzania- Arusha and Kilimanjaro are in far North, dispatching passenger buses to most parts of the country and beyond every day.

I gave Krissie a copy of our Stellenbosch report and in the following morning she gave me an identification kit

for parthenium weed and told us that she had seen parthenium weed near Arusha and Kilimanjaro international Airport. Using the kit* I continued to reveal more spots having parthenium weed along the main and feeder roads in the Arusha municipality (Fig. 7). The most affected area was the Njiro hill suburb which is a newly growing Arusha sub town with a lot of house construction activities going on, of which construction materials can be one of the sources of pathenium weed infestation. This is the area where flower sellers pick the freely available parthenium weed flowers which are then included in the rose flower bouquets. Such ignorant and unintentional behavior greatly increases the risk of parthenium weed spread as these bouquets may find their way to distant areas and situations such as in weddings, conferences and even on grave yards (Fig. 8 and 9). Another site I found a cluster of pathenium weed was in Moshi Kilimanjaro about 80 km east of Arusha just on the roadside. This signifies that parthenium weed is still localized by roadsides although it has encroached to a small extent into field crop plots next to Moshi - Arusha highway.

PARTHENIUM WEED MAY SPREAD OVER GREAT DISTANCES IN TANZANIA:

As parthenium weed continues to grow along roadsides, it will have a very efficient way of dispersal through transport, hitch hiking great distances. Being a famous tourist and commercial centre, Arusha and Kilimanjaro are the starting point for dozens of buses each morning carrying hundreds of passengers to destinations all over the country and beyond Tanzania boundaries to countries such as Zambia, Malawi, Congo DR, Rwanda, Burundi Uganda and the Kenyan Republic. Such a great road network covering long distances of up to 1500 km to the Zambian border in the south and nearly the same to Rwanda / Burundi in the west, transecting large land masses with various human activities such as subsistence farming and pastoralist, National Parks and large parches of no man's land.

Figure 8: Parthenium weed sold as fillers in bouquets.

NO CONTROL EFFORTS IN PLACE:

Only the Ngorongoro Conservation area authority have tried to apply a code of conduct for alien invasive plant control as the area formerly experienced a threat from alien plants have been identified and some has been categorized to be potentially invasive including parthenium weed which was seen just growing in front of the conference hall door mat and on the old demolished headquarters' slab. Due to several factors seedlings remained very small and flowered at a height of only 7 cm.

AWARENESS:

The general public has little awareness about this weed menace. Last year I tried to communicate the story about partheniun weed to several authorities including the regional agriculture and veterinary officers within the Tanzania Northern regions (Kilimanjaro, Arusha and Mara regions). I tried to inform them about the surge by this dreadful invasive parthenium weed plants and asked if they could in their capacity take some early measures especially informing the public and extension personnel.

After the IOCB conference which was conducted in Nairobi from 30th Nov. to 6th Dec. 2010, the Tanzania Wildlife Research Institute (TAWIRI) representative who attended is now planning to support and conduct research concerning the spread of parthenium weed in the region. In the same move they are looking for a collaborative way to control and minimize spread at this early stage of incursion.

The Ngorongoro Conservation Area management has since 2004, initiated environment education in schools found within the Park and those surrounding it. School children from Primary year five to high school participate and exchange ideas on how the environment is being damaged through human activities. Then the instructors address the issue of alien invasive plants and their harmful effects to the natural environment. From 2004 to 2011 more than 20,000 school children have received this environment education. We are looking forward to initiating the Environment Care Clubs in schools and colleges (Some schools have the Malihai clubs of Tanzania). Such clubs needs continuous support and guidance to make them sustainable.

THE WAY FORWARD:

As an important segment in the East Africa ecosystems, Tanzania have to look for regional collaboration so as to plan together using the available resources to curb the emerging parthenium weed threat and other biological invasions that are cross boundary in nature. Such could be; quick and timely information sharing about detrimental occurrences among regional ecosystem actors. Kenya and Uganda have effectively set objectives (below) to combat the parthenium weed invasion which is profusely spreading in the ecological systems.

*Identification Kits are available from the University of Queensland (asad@uq.edu.au : s.adkins@uq.edu.au

- Designing educational programmes to build capacity, including training courses aimed at agency field staff, managers, specialists and policy makers.
- Building the capacity to formulate and implement educational programmes aimed at community empowerment (e.g. in early detection and control) and at developing school and university curriculum; and creating academic chairs and students fellowships in invasive species biology (Responsibility-educational institutions)
- Building basic border control and quarantine capacity, ensuring all those involved in agricultural quarantine, customs and food inspection are made aware of provisions of the CBD (Convention on Biological Diversity) and the biosafety protocol and implications of these provisions in their work.
- Food aid can preferably be delivered as processed products rather than produce which in many cases are contaminated with weed seeds. The food aid for hunger **relief** in Ethiopia has now turned to be a **grief** due to parthenium weed manifestation.
- The control mission can begin with the highway authorities, in this case the Tanzania National Roads Agency (TANROADS), where the source of infestation always begin due to cargo trafficking and roads construction which obtain unscreened building materials from distant places. These can be key people to alert of any uncommon plant growth along the roads and can take necessary actions to stop spread if found.
- Tanzania National Parks and Ngorongoro Conservation Area Authority (NCAA) can be important icons in the control/awareness mission because of the risk posed for invasion by parthenium weed if it continues to spread.
- Estate owners can also be informed of the threat and be pursued to clean the parthenium weed plants in their vicinity.

CONCLUSION:

In this perspective, the delay in addressing the parthenium issue in the near future may end in great turmoil. A highly prolific plant that is estimated to produce over 20,000 seeds per plant in just four weeks; will increase its population exponentially. In addition, it can grow throughout the year supported with the usual bimodal rains in most parts of Tanzania. Tanzania economy greatly depends on subsistence farming. More than 80% of the country's people live in rural areas engaged in subsistence farming. As we have learnt from the Ethiopian case, there is as high (90%) loss in field crops production where parthenium weed is invaded. Women are the most affected as they do most farm work to earn a living for the family. Parthenium weed is causing a great problem to developing economies if our policy makers will not join hands with scientific advisory teams on combating emerging environment threats like that of parthenium weed. So all sectors should strive to assist in minimizing factors that instigate biological invasions through public awareness and capacity building.

Figure 9: Parthenium weed growing upon a grave at Njiro.

I don't have high premonition, but as Ann Witt noted in his closing speech at the Nairobi conference; 'That if parthenium weed invades the East Africa ecological systems, the loss to biodiversity will be pathetic, hence the trend of the worlds' most famous wildlife migration will remain to be history.'

Let us remove the barriers, come together share and plan for a better world, free from biological invasions that lead us to a fateful enigma.

Parthenium weed in Vietnam

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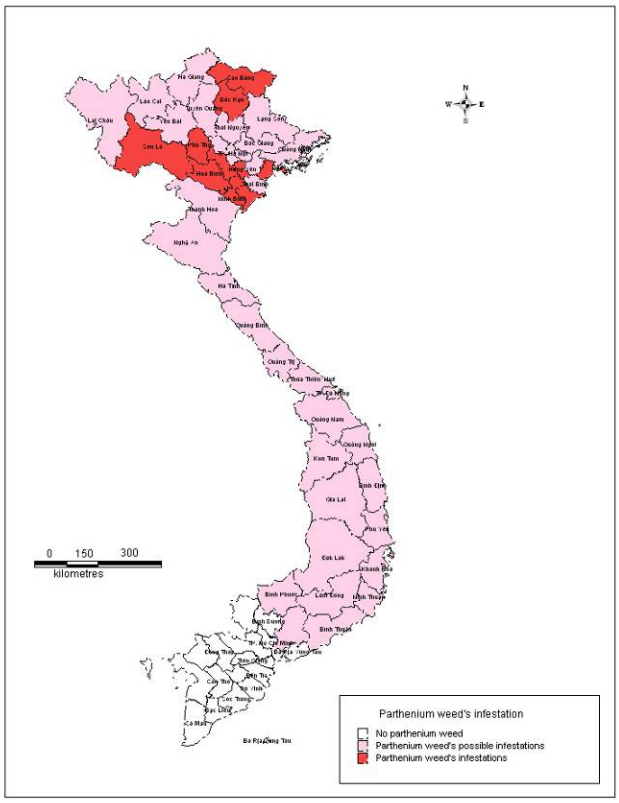
Originating in a region within North, Central or South America, parthenium weed (*Parthenium hysterophorus* L.), an invasive herbaceous Asteraceae weed of tropical and subtropical environments, is responsible for significant losses to rangeland and crop production and has serious effects upon human and animal health. The weed also causes serious impacts upon plant community biodiversity and the cost of its management is often very high. In Vietnam, parthenium weed has been present in the Hanoi and surrounding regions from about 1922 (Arenes *et al.* 1922).

Infestations of parthenium weed were surveyed along roadsides, in fallow land, from the north to the south of

Vietnam and in more detail around the capital city, Hanoi, and in several protected areas (including Ba Be, Cat Ba, Xuan Son, Tam Dao, Cuc Phuong National Parks and Huong Son Protection Forest) in the north of Vietnam, to create a distribution map of the weed in Vietnam. Parthenium weed was present in many provinces in the north such as Cao Bang, Bac Kan, Son La, Thai Nguyen, Phu Tho, Vinh Phuc, Bac Ninh, Hanoi Capital, Hung Yen, Hai Duong, Hai Phong, Ha Nam, Nam Dinh, Hoa Binh and Ninh Binh. No parthenium weed was present from Ho Chi Minh City to the Mekong Delta, the most southerly region of Vietnam. However, parthenium weed was possible present at the rest of the North and the Central region of Vietnam (Figure 10).

Figure 9: The distribution of parthenium weed in Vietnam.



Several biological characteristics of the weed such as plant density and coverage, and height and seed production were measured at Cuc Phuong National Park (Ninh Binh Province) and at the Huong Son Protection Forest Region (Hanoi Capital) (Figure 10). The density of parthenium weed was *ca.* 50 and 70 plants m^{-2} at the Cuc Phuong National Park and the Huong Son Protection Forest, respectively. In addition, the plant height was from 45 to 55 cm at these two locations. From the measurements taken on biological characteristics of the weed, the study also indicated that the biotype present in the two locations were similar but different to the Central Queensland biotype found in Australia.

Figure 11: Parthenium weed at Huong Son Forest Protection Vietnam.

A report on the 3rd International Conference on Parthenium, 8-10 Dec -2010

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Needless to say, invasive alien species are one of the greatest threats to natural biodiversity. This has become one of the most serious environmental concerns of the century worldwide. One such problem is *Parthenium hysterophorus*, which for the last half-century or so, become the killer weed continually affecting our health, livestock, flora, fauna and the environment. Much harnessed by the intense anthropogenic actions, in addition to natural climatic eventualities (floods/cyclones etc.) – this weed has made its indelible treadmill-effects on biodiversity. In an attempt to contain this killer weed, lots much research has been undertaken, and this article sums up the outcome of the **Third International Conference on Parthenium** held at New Delhi, India during 8-10 December 2010. This conference conceptualized on key-theme: **Sustainable conservation of biodiversity in ecosystem vis-a-vis Parthenium.** In addition to this the conference comprised of five sub-themes (1) global views on parthenium, (2) its management strategies, (3) associated human and animal health hazards, diagnosis and management (clinical aspects) (4) utility aspects of parthenium; and (5) awareness & interactive, plenary session with conference recommendations

Symposium: Sustainable conservation of biodiversity in ecosystem vis-a-vis Parthenium

Chairperson: Dr. C. D. Mayee, Chairman, ASRB, New Delhi, India Co-Chairman: Dr. M. Mahadevappa, Ex. Chairman, ASRB, New Delhi Rapporteur : Dr. Ramesh Babu, Professor (Agronomy) & PI, DWSR Centre, UAS, Dharwad

Dr. Steve W. Adkins, Professor of Weed Science, Australia opened elaborately enunciated on the important facts about this weed, reasons for its highly invasive nature, its management strategies and also on work going around the world. So far, no single method has proven effective in its management. Through international collaboration, aspects of biology and ecology of this weed have been investigated to develop sustainable management strategies that can be used now and in future under a changing climate.

Dr. J.S. Pasriche, Consultant, All India Institute of Medical Association (AIIMS), New Delhi, explained the works carried out at AIIMS and through DST funded project on contact dermatitis. Among the plants, *P. hysterophorus* was found to be the commonest agent causing contact dermatitis. He proposed precautionary measures to be taken, application of topical corticosteroids on the affected areas, use of oral corticosteroids whenever the dermatitis is very severe and use of oral azathioprine on continuous basis to get rid of the contact hypersensitivity.

Dr. J G Varshney, Director, DWSR, Jabalpur gave detailed notes on parthenium weed infestation and its effects on agriculture, horticulture, pastures, forests, orchards and on human and animal health. Ever since *Parthenium* became a menace in India and other countries, efforts are being made to manage the weed by different methods. Keeping in view the huge green and dry biomass of parthenium weed available in India, there is need to change this curse to boon by harnessing its various uses. He elucidated how waste can be converted into wealth by way of composting, biogas making, mulching, preparation of biopesticides, feed for silkworm etc.

Dr.T.V.Ramchandra Prasad, University Head (Agronomy), UAS, Bangalore gave the detailed integrated management strategies for its control. He emphasized on the need of developing/importing few more biological agents to contain its infestation, promulgation of Agricultural Pests and Diseases Act and need for the establishment of Alien Invasive Weed Species Authority, similar to that of Rain fed Authority to monitor the invasive alien weeds and advise Government on issues relating to IAWs.

Session 1. Global Spread of Parthenium & Other Invasive Weeds

Chairperson: Dr. Steve W. Adkins, Professor of Weed Science, Australia. Co – Chairperson: Dr.T.V.Ramachandra Prasad, Professor & PI, DWSRC, UAS, Bengaluru. Rapporteur: Dr.C. Chinnusamy, Professor & PI, DWSRC, TNAU, Coimbatore

The first talk was on "Invasion of *Parthenium hysterophorus* in Nepal: current scenario and future challenges by Dr.B.B. Shrestha, Professor of Botany, Nepal. He suggested the weed was introduced from India around 1967 through the road network between two countries. He mentioned that the bio-agent *Zygogramma bicolorata* is doing a good job of weed management in Nepal. Public awareness on its spread and impact on human and animal health and on environment are being organized as observed by him.

Dr. (Ms). K. Dashora, CABI, India presented a paper on "Footprints of CABI in managing invasive alien species globally", with appropriate definition on invasive alien species (IAS) and the environment. She stressed the economic and political impact and consequences of IAS on bio-safety and environment. She described management options for IAS including the use of bio-agents including competitive plants, and the aim is for managing the IAS instead of eradication. A way forward is to create awareness among people and apply strict quarantine rules with a view to monitor cross boundary traffic of IAS were also stressed by her. She concluded her talk with a caution, to remember that a non-native can become an invasive tomorrow so imported food grains and associated plant materials need to be handled carefully.

Session 2. Management Aspects

Chairperson: Dr. Baruch Rubin, President, International Weed Sci. Soc., Israel Co-Chairperson: Dr. T. M. Manjunath, Ex Director, Monsanto Res. Centre.

Rapporteur : Dr.R. Devendra, Professor & DWSRC, UAS, Bengaluru

Some of the eminent speakers of the session were Padmasree M. Mahadevappa, Dr T M Manjunath, Jay J Varshney and N N Angiras, (India), B Rubin (Israel) etc. from different fields and countries. Many contributed papers were also presented; these included a number on biological control. The role of biologicals was clearly presented. The carefully-crafted Integrated Weed Management Programme (IWMP), christened as the Programme on Parthenium Elimination, PROPEL (using weed-competitive *Cassia sericea*, and Mexican beetle, *Z. bicolorata* as major components, 1986-88) was described along with local modification (Pusa Protocol). The path of success from the PROPEL to the PUSA protocol, encourages similar planning's with effective execution in other parts of the world, aiming and attaining the IWMP with biological arsenals.

Session 3. Clinical aspect of Parthenium allergy

Chairperson: Dr. J.S. Pasricha, Consultant, AIIMS, New Delhi. Co-Chairperson: Dr. Sanjeev Handa, Prof. of Dermatology & Venereology PGIMS, Chandigarh Rapporteur: Dr. N.N. Angiras, Professor of Agronomy, HPKV, Himachal Pradesh

Dr. J.S. Pasricha introduced the subject of Parthenium Allergy in India. He reported that ABCD (Air Borne Contact Dermatitis) is caused by a number of weed species belonging to Asteraceae family and informed the house about a patented readymade patch test to diagnose contact dermatitis or air borne dermatitis caused by parthenium weed.

A paper on diagnosis of parthenium allergy was presented by Dr. Sanjeev Handa, Professor of Dermatology and Venereology, PGIMS, Chandigargh. He highlighted the principal source of Contact Dermatitis and airborne dermatitis, the course of the spread of disease, diagnosis and cause of dermatitis by the patch-test (developed by Dr. Pasricha) and prick-test. He cautioned that since avoidance of airborne allergies is not possible preventive measures need to be taken.

A third paper on "Allergic Skin manifestations of Parthenium and skin diseases mimicker parthenium allergy" was presented by Dr.H.K. Kar, Dean PGS, Dr.R.M.L Hospital, New Delhi. He discussed about clinical pattern of ABCD like photosensitive lichnoid, Atopic Dermatitis, hand dermatitis, eyelid dermatitis, exfoloiative dermatitis, phytopho-III dermatitis with illustrations. He reported that out of 156 cases of allergy 36 were due to parthenium and 72.7% were photo-dermatitis. Both male and female are equally sensitive to parthenium allergy.

Dr. Kaushal Verma, Professor Dermatology and Venereology and Dean, AIIMS reported that management of parthenium dermatitis is challenging because of persistence of contact allergy and difficulty in avoidance of the allergens due to ubiquitous distribution. The management consists of pharmaco-therapy and general measures to control the dermatitis and to prevent the relapses. He discussed in detail about the drug therapy like use of corticosteroids, azathioprine, methotrexate and pentoxifyline. Mild to moderate dermatitis can be treated with potent topical corticosterioides. However, moderate to severe disease require treatment with systemic corticosterioides like prednisolone or betamethasone. But long term uses of systemic corticosterioides are known to cause serious and sometime irreversible effects. General measures to minimize the contact with the allergy involve (i) covering all parts of the body (ii) frequent washing of exposed areas of skin with soap (iii) removal of parthenium plant from the immediate environment of patient and (iv) avoidance of oily preparation on the exposed sites of the body which could trap the allergens. Relapses of the dermatitis can be prevented by continuous use of drugs, **remove the patient or remove the parthenium plants from the area.**

Session-4. Utilization of Parthenium & Other Invasive weeds

Chairman: Dr. Jay Varshney, Director, DWSR, Jabalpur, India. Co-Chairman: Dr. Bharat Babu Shrestha, Professor of Botany, Nepal. Rapporteur: Dr.M.V.Chandrakala, Scientist-D, KSSRDI, Bangalore.

Dr. C. Chinnusamy (Professor of Agronomy, TNAU, Tamil Nadu) made a presentation on making parthenium-compost: an approach for Parthenium management. He focused on the result of the study where application of composted parthenium weed recorded highest uptake of nutrients and gave higher yield compared to other organic manure. The application of vermi-compost containing parthenium weed yielded better results.

Dr. R. Devendra, (Professor of Crop Physiology, DWSRC, UAS, Bangalore) in his paper stressed the integrated management through weeding, cultivation of other plants/weeds having allelopathic effect to suppress parthenium weed growth and use of glyphosate. It was felt that the use of botanical agents to suppress the seed-bank of Parthenium may prove to be expensive method and therefore, caution is required.

A paper on allelopathic potential of selected weed species for biocontrol of *P. hysterophorus*, was presented by Dr. G P Satsangi, (Professor of Agric. Operation, Dept. of Botany, DEI, Agra). Contributory oral presentations were made on different utilization aspects of Parthenium like its use as anti-fungal agent, fortificants to increase the silkworm cocoon yield, as a control measure against leaf rust, as a growth promoter for black gram and green gram crops, as a nutrient media for culture of *Bacillus thuringiensis.* One paper described on the attempt to understand the molecular mechanism involved in the stress tolerance capacity of parthenium weed Agra district.

Session 5. Poster, Slide Show and Public awareness:

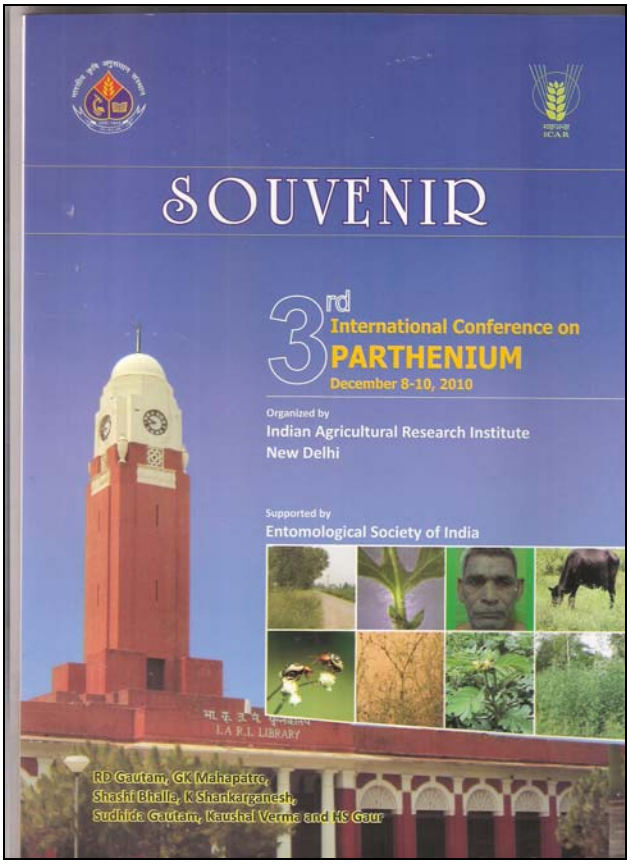
Chairman: Dr. K.R. Koundal, Joint Director (Research), IARI, New Delhi. Co-Chairman: Dr. Nilda R. Burgos, Prof. of Weed Science, Univ. of Arkansas, USA
Rapporteur: Dr. H. Basappa, Principal Scientist (Ent.), DOR, Hyderabad

The session had panelists drawn from each session as well as renowned weed scientists including Dr. S. Singh from HAU, Hissar. The innovative idea of bringing an alternative to the form of poster displays was introduced, wherein display material was digitalized into slides. Each presenter was given 2 minutes for any discussion/queries made by the audiences, and evaluated by the judging Committee. A group of four Junior High School students (2 girls and 2 boys) performed a play on the mass production and field utilization of *Z. bicolorata*, which was appreciated by one and all. The majority felt to have more and more similar plays, and involvement of younger generations to popularize and create awareness on the emerging weed problems. Besides, several posters were screened through power point and the deliberations were conducted.

Session 6. Plenary, and Conference Recommendations:

Chairman : Dr. P.L. Gautam, Chairperson, PPV&FR, and Ex-Chairman, National Biodiversity Authority, Government of India. Conference Chair: Dr. M. Mahadevappa, Former Chairman, ASRB, New Delhi. Co-Chairman: Dr. H.S. Gaur, Dean and Joint Director (Education), IARI, New Delhi. Organizing Secretary: Dr. R.D. Gautam, Professor of Entomology, IARI, New Delhi.

1. Need for National Consultation was felt to be necessary and should stress the need for all Parthenium Weed Management scientists to focus their research work and to get finance for conducting research, awareness program, etc.
2. A National Parthenium Weed Working Group should be set up to provide updated knowledge on all aspects of parthenium with the representatives both from Governmental and non-governmental sectors, SAU's, ICAR Institutes, others and to coordinate with the International Working Group on Parthenium Weed.
3. Documentation of the success stories (such as PROPEL to PUSA PROTOCOL) is required to enthuse and guide others to follow strategies to manage parthenium weed on a large scale.
4. More emphasis should be given to expand activities on testing more bio-agents to contain parthenium, as done in Australia. There is an urgent need to import bio-agents to check the growth of parthenium throughout the year.
5. A road map for managing parthenium weed in a more focused manner needs to be developed for different ecosystems. Legislation to include parthenium weed as an obnoxious weed under the "Agricultural and Pests Diseases Act", GOI may be promulgated in all states and the legislation to be implemented in the right spirit and manner. Similar legislations may be made in other countries as well.



6. Need to document information on spread of parthenium weed in different ecosystems, problems caused on human health, livestock, crop yield losses and soil health, etc. There is an urgent need for impact analysis on a national basis on all aspects of Parthenium.

7. Need to have a National Invasive Weeds Authority / Board in the line with "Rainfed Authority" to monitor the invasive weeds, advise the government on Invasive Alien Weed Species (IAWS), suggesting suitable remedies for managing them based on risk analysis. Strict quarantine is required to restrict the entry of alien invasive species (IAS) of weeds through food, fodder, seeds, etc.
8. An action plan is required to prevent the cross border entry and spread of parthenium weed to non-infested areas in the earl stage itself.
9. New invasive alien species (IAS) such as *Solanum carolinense, Vesbesina encelioides* (wild sunflower) need to followed in some parts of India and there is an urgent need to undertake suitable steps to contain them in the initial stages of invasion.
10. Work on isolation of genes in Parthenium responsible for tolerance to abiotic and biotic stresses may be initiated.
11. There is a need to identify botanicals suppressing Parthenium as relevant to the situations/ ecosystems.
12. Parthenium weed utility, as an alternate strategy to contain the weed, in terms of green manure in transplanted rice and as compost (preparation on scientific way) in various crops could be expanded for adoption. Other uses such as bio-pesticides, energy renewal, etc. could also be explored and expanded.
13. Other utilities namely larvicidal effect and repellent in managing female mosquito, *Aedes aegypti* (main causal agent of Dengue fever), as substrate media for growing *Bacillus thuringiensis*, antifungal activity against rust spores, feed additives to enhance the growth and development of silk worm, could be explored on more scientific ways.
14. Need to educate public about the health problems due to physical contact with parthenium or pollen allergy, availability of ameliorative measures to cure the ailments, ill effect on livestock, yield losses and management options available to contain the weed.
15. There is a need to include weeds in general and Parthenium in particular in Pollution Control Act of India under the sub class of suspended particles in the air as the pollen grains and trichomes suspend in the air and cause allergy to human and animal health.
17. Appropriate administrative-setups, in the form of State-, National- and International-level Working Groups / Management Authorities / Boards coupled with desirable co-ordinations from other Non-Governmental Organizations at global-scale, is the need of hour.

Note: PDF files on publications (Scientific Presentations and Souvenir) may be requested from the senior author and the Organizing Secretary-ICP-2010, Division of Entomology, IARI, New Delhi-110012, India.

Upcoming Conferences on Weed Science and Invasive Species

13th International Symposium on Biological Control of Weeds
Venue: Waikoloa Beach Marriott Resort, Hawaii
Dates: 11-16 September 2011
Website: http://uhhconferencecenter.com/xiii_isbcw.html

23rd Asian Pacific Weed Science Conference
Date: 25-30th September 2011
Venue: Sebel Hotel Cairns, Australia
Website: www.apwss2011.com

The VITH International Weed Science Congress
Date: 17-22nd June 2012
Venue: Hangzhou, China
Website: http://www.iwss.info/Vith_congress.asp

Recent publications on parthenium Weed

Sushilkumar, Ray, P. 2011. Evaluation of augmentative release of *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae) for biological control of *Parthenium hysterophorus* L. *Crop Protection* 30 (6) 587-591.

Timsina, B., Shrestha, B. B., Rokaya, M. B., *et al*. 2011. Impact of *Parthenium hysterophorus* L. invasion on plant species composition and soil properties of grassland communities in Nepal. *Flora* 206 (3) 233-240.

Shafique, S. Bajwa, R Shafique S. 2011. *Tagetes erectus* L. - a potential resolution for management of *Parthenium hysterophorus* L. *Pakistan Journal of Botany* 43 (2) 885-894

Knox, J. Jaggi, D. Paul, M. S. 2011. Population dynamics of *Parthenium hysterophorus* (Asteraceae) and its biological suppression through *Cassia occidentalis* (Caesalpiniaceae). *Turkish Journal of Botany* 35 (2) 111-119.

McConnachie, A. J., Strathie, L. W., Mersie, W., *et al*. 2011. Current and potential geographical distribution of the invasive plant *Parthenium hysterophorus* (Asteraceae) in eastern and southern Africa. *Weed Research* 51(1) 71-84