APFISN

INVASIVES

Newsletter of the Asia-Pacific Forest Invasive Species Network (APFISN)

Volume 9 March 2007

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New publications

- Invasive non-native plants alter the occurrence of arbuscular mycorrhizal fungi and benefit from this association.
- Potential selection in native grass populations by exotic invasion.
- Optimal eradication: when to stop looking for an invasive plant.
- Advanced engineering approach to weed management.

Recent books

- Native alternatives to invasive plants.
- Measuring plant diversity- lessons from the field.

Forthcoming Symposia/Workshops

- 22-25 May 2007. The First International Pacific Invasive Ant Conference (IPIAC) 2007, Sheraton Keauhou Bay Resort and Spa Kailua-Kona on the Big Island of Hawaii.
- 22 May 2007. 59th International Symposium on Crop Protection, Ghent University, Belgium.
- 6-12 July 2008. XXIII International Congress of Entomology, Durban, South Africa.

The Asia-Pacific Forest Invasive Species Network (APFISN) has been established as a response to the immense costs and dangers posed by invasive species to the sustainable management of forests in the Asia-Pacific region. APFISN is a cooperative alliance of the 32 member countries in the Asia-Pacific Forestry Commission (APFC) - a statutory body of the Food and Agricultural Organization of the United Nations (FAO). The network focuses on inter-country cooperation that helps to detect, prevent, monitor, eradicate and/or control forest invasive species in the Asia-Pacific region. Specific objectives of the network are: 1) raise awareness of invasive species throughout the Asia-Pacific region; 2) define and develop organizational structures; 3) build capacity within member countries and 4) develop and share databases and information.

Threats

Carrot weed (*Parthenium hysterophorus*)

Carrot weed (parthenium), a member of the family Asteraceae, is one of the world's worst weeds. It is native to North and South America. Parthenium is currently distributed in Argentina, Australia, Bangladesh, China, Cuba, Dominican Republic, Ethiopia, Haiti, Honduras, India, Jamaica, Madagascar, Mauritius, Mexico, Mozambique, Nepal, New Caledonia, Pakistan, Papua New Guinea, Puerto Rico, South Africa, Sri Lanka, Swaziland, Trinidad, United States of America, Venezuela, Vietnam and West Indies.

Parthenium is an annual herb, erect and up to 2 m in height. The stem is branched and covered with trichomes. Leaves are pale green, lobed, hairy,

Parthenium- habit

INVASIVES, monthly newsletter of the Asia-Pacific Forest Invasive Species Network (AFPISN) is intended to share information among countries in the Asia-Pacific region on Forest Invasive Species(FIS) and the threats they pose in the region. If you have any items of news value on FIS to share between national focal points of APFISN and more widely among foresters, agriculturists, quarantine personnel and policy makers, please pass them on to the editor - Dr. K. V. Sankaran, APFISN Coordinator, Kerala Forest Research Institute, Peechi-680 653, Kerala , India (sankaran@kfri.org). The newsletter is supported by the Food and Agriculture Organization of the United Nations (FAO) and USDA Forest Service.

initially forming a basal rosette of strongly dissected leaves that are up to 30 cm in length, close to the soil, alternate, sessile, irregularly dissected and bipinnate having small hairs on both sides, resembling leaves of carrot. The number of leaves per plant ranges from 6 to 55. Flower heads are creamy white, about 4 mm across, arising from the leaf forks. Flowering occurs about a month after germination. Each flower contains five seeds, which are wedge shaped, black, 2 mm long and with thin white scales. Root system is with one main branched taproot and many finer roots. A large single plant produces up to 100,000 seeds in its lifecycle. It is estimated that more than 340 million seeds per hectare can be found on the soil surface in worst affected areas. Seeds do not have a

A field infested by parthenium- Queensland, Australia

dormancy period and are capable of germinating anytime when moisture is available. Dispersal of seeds is mainly through water currents, animals and movement of vehicles, machinery, livestock, grain, stock feed and other produce and to a lesser extent by wind. Most long distance spread is through vehicles, farm machinery and flooding. Germination of seeds occurs between 8 to 30° C - optimum temperature for germination being 22 to 25° C. Persistence tests demonstrated that more than 70% of parthenium seeds buried at 5 cm below the soil surface survived for at least 2 years whereas seeds on the soil surface did not survive for longer than 6 months. Seed viability for 20 years has also been reported.

The common habitats of parthenium are wastelands and vacant lands, orchards, forestlands, flood plains, agricultural areas, scrub/shrublands, urban areas, overgrazed pastures and along roadsides and railway tracks. Drought, and subsequent reduced pasture cover, creates ideal situations for parthenium weed to establish. It prefers alkaline, clay loam to heavy black clay soils but tolerates a wide variety of soil types. The weed grows well in areas where annual rainfall is greater than 500 mm and fall dominantly in summer. It can grow to an elevation of 2200 m above sea level.

Parthenium colonizes disturbed sites very aggressively impacting pastures and croplands out competing native species and degrading natural ecosystems. It aggressively colonizes disturbed sites and reduces pasture growth and depresses forage production. Allelopathic effects coupled with the absence of natural enemies like insects and diseases are responsible for its rapid spread in its introduced ranges. Growth inhibitors like lactones and phenols are released from this plant to soil through leaching, exudation of roots and decay of residues. These growth inhibitors suppress growth and yield of native plants. Parthenium pollen is known to inhibit fruit set in many crops. Germination and growth of indigenous plants are inhibited by its allelopathic effect. In man, pollen grains, air borne pieces of dried plant materials and roots of parthenium can cause allergy type responses like hay fever, photodermatitis, asthma, skin rashes, peeling skin, puffy eyes, excessive water loss, swelling and itching of mouth and nose, constant cough, running nose and eczema. In animals, the plant can cause anorexia, pruritus, alopecia, dermatitis and diarrhea. Parthenium can taint sheep meat and make dairy milk unpalatable due to its irritating odour. In Queensland, Australia, losses to the cattle industry due to parthenium have been estimated to be Au$ 16 million per year in terms of control costs and loss of pasture.

Parthenium is reported to have insecticidal, nematicidal and herbicidal properties. It is used for mulching, composting and production of biogas and paper. The sub-lethal doses of parthenin, a toxin recovered from parthenium, exhibited antitumor activity in mice and the drug can either cure mice completely or increase their survival time after they had been injected with cancer cells. Parthenin is also found pharmacologically active against neuralgia and certain types of rheumatism.

Damage caused by *Z. bicolorata* in parthenium
Z. bicolorata-adult (inset)

In the Caribbean and Central America, parthenium is applied externally on skin disorders and decoction of the plant is often taken internally as a remedy for a wide variety of ailments. In Jamaica, the decoction is used as a flea-repellent both for dogs and other animals.

Manual uprooting of parthenium before flowering and seed setting is the most effective mechanical control method. This is easily done when the soil is wet. Uprooting the weed after seed setting will increase the area of infestation. And, pulling a plant in flower will aid in dispersal of pollen grains resulting in allergic reactions. Ploughing the weed

in before plants reach flowering stage and establishing pasture or other plants at the site may be effective in controlling the weed. Competitive replacement of parthenium can be achieved by planting species like *Cassia sericea, C. tora, Croton bonplandianus , C. sparsiflorus, Amaranthus spinosus, Sida acuta, Tephrosia purpurea, Stylosanthes scabra* and *Cassia auriculata* which will compete with the weed and reduce its population. In certain parts of India, crop rotation using marigold during rainy season is found to be effective in reducing parthenium infestation in cultivated areas.

Seeds of parthenium

Preventing the spread of parthenium is the most cost-effective management strategy. There is a high risk of spreading parthenium by the movement of vehicles, livestock and crop produce. Washing down vehicles/machinery before entering in to a non-infested region will restrict spread of seeds. Movement of cattle during rainy season will aid in spreading of seeds in muddy soil. In this situation, it is recommended to hold cattle in yards or small paddocks to let seeds drop from their body before releasing them into larger areas. Also, cattle feed and crop seeds purchased from infested areas should be checked thoroughly for contamination by parthenium seeds. Burning is not a useful control strategy for parthenium. However, burning for other purposes (to control woody weeds) may not result in an increased infestation so long as the burned area is allowed to recover before other activities are carried out. The large-scale utilization of parthenium may be one of the effective methods to control the weed.

A large number of herbicides have been tried to control parthenium. Of these, use of glyphosate, atrazine, and metribuzin has been promising. Timing of herbicidal application is critical. The plants should be treated before flowering and seed setting and when other plants especially grass are actively growing to recolonize the infested area. In open wastelands, non-cropped areas and along railway tracks and roadsides, spraying of a solution of common salt (sodium chloride) at 15-20% concentration is found effective in controlling the weed.

Several biocontrol agents (insects and pathogens) have been released from time to time to manage the weed biologically. The leaf feeding beetle *Zygograma bicolorata* and the stem galling moth *Epiblema strenuana* are widely used in several countries to manage parthenium. *Z. bicolorata* is now widely used in India to control parthenium. It has spread to about 2 million ha in the country with different status of establishment and spread. In Australia, both the insects have been tried successfully. The moth significantly reduces flower and seed production of the weed especially at young age. It has a relatively high reproduction in a short period of time and its effectiveness has been validated in the central highlands of Queensland. Other major biocontrol agents used are *Listronotus setosipennis* (stem boring weevil), *Semicronyx lutulentus* (seed feeding weevil), *Bucculatrix parthenica* (leaf mining moth), *Platphalonidia mystica* (stem boring moth), *Conotrachelus albocinereus* (stem galling weevil) and *Carmenta ithacae* (root boring moth). Another on-going development on biological control of parthenium is the use of a rust fungus *Puccinia abrupta* var. *partheniicola.* Uredospore suspensions from 3-week old pustules of the rust have been applied to the foliage of Parthenium and a consistent control effect has been achieved. This fungus is now being evaluated for development as a mycoherbicide. Pathogens like *Fusarium pallidoroseum, Puccinia melampodii* and *Oidium parthenii* have also showed good potential as biocontrol agents.

Epiblema strenuana-adult

Leaf rust caused by *Puccinia abrupta* var. *partheniicola.*

Parthenium offers a major challenge to all attempts at control because of its high regeneration capacity, production of huge amount of seeds, high seed germinability and extreme adaptability to a wide range of ecosystems. A single biocontrol agent like *Z. bicolorata* may not be sufficient to manage the weed since its population build up is restricted to July-September where as parthenium can germinate through out the year. Therefore, insects, which remain active during most time of the year, would be more helpful in managing the weed. Attempts need be made to assess the potentials of indigenous insects. Competitive replacement by plants, especially *Cassia tora*, could be treated as one of the avenues for further studies and implementation. Use of herbicides, side by side with other methods of control need also be developed and standardized. Development of new cost-effective and persistent herbicides with less residual effects is the need of the day. Also, development of resistance against commonly used herbicides need be attended to. In general, the management of parthenium may be possible only through an integrated approach involving mechanical, chemical and biological methods.

Manual weeding of parthenium - India

Golden apple snail (*Pomacea canaliculata*)

Golden apple snail is a fresh water snail with a voracious appetite for water plants including lotus, water chestnut (*Trapa natans*), taro (*Colocasia esculenta*), and most importantly, rice. Introduced widely from its native South America for aquarium trade and as a source of human food, it is now a major crop pest in south east Asia (primarily in rice) and Hawaii (taro), and poses a serious threat to many wetlands around the world through potential habitat modification and competition with

Golden apple snail - adult

native species. The snail was introduced from Argentina to Taiwan in the 1980's for commercial production and was distributed widely in Asia as a dietary protein supplement and income earner for rural poor. Unfortunately, the introduction was done in haste without prior studies on its ecological impacts or market information. When demand for the snails became poor, the snail-farming projects were abandoned and in many instances the snails escaped and subsequently became a pest of crops.

Golden apple snail is more or less globular in shape (up to 10 cm in size) with a generally brownish or greenish shell often with spiral banding patterns around the whorls. Its succulent flesh is creamy white to golden pinkish or orange-yellow. The male has a convex operculum that curves out or away from the shell, whereas the female lid curves into the shell. The newly hatched snails will have a soft shell. The shell height ranges from 1.5 to 3 cm in most snails. The eggs are bright pink or strawberry pink. With age, they turn light pink when about to hatch. The presence of the snail is often noted by the sight of the bright pink egg masses laid on solid surfaces (on leaves, twigs, stones) up to about 50 cm above the water surface. The snail lives for 2-6 years with high fertility. Its size usually depends on availability of food. The most destructive stage is when the length of the shell is between 10-40 mm. Golden apple snail reproduces rapidly. Adults mate for 3-4 hours anytime of the day among crowded plants where there is continuous water supply. They can lay 1,000 to 1,200 eggs in a month. The eggs hatch in 7-14 days. Hatchlings grow and mature in about 30-35 days. The whole life cycle is completed in 60 days.

Golden apple snail lives in ponds, lakes, swamps, irrigated fields, canals and water-logged areas. It remains submerged during the day, hidden in vegetation near the water surface. It becomes active during the night and leaves the water in search of fresh vegetation. The snail buries itself in moist soil during dry season. It can also aestivate for 6 months and then become active when the soil is flooded. The snail can survive harsh environmental conditions such as pollutants in water and low oxygen levels.

The snail feeds on a wide range of plants such as algae, azolla, duckweed, water hyacinth, lotus, rice, maize, parsley, pearl barley, rush, taro, water chestnut, water oats and other succulent leafy plants. It prefers young and soft plant parts since feeding is by scraping plant surface with its rough tongue. The snail can also feed on decomposing organic matter. It is a serious pest of young rice seedlings since it consumes the base of the seedlings and kill them. It also consumes the aerial leaves and stems of rice. In the Philippines, over half of the rice fields (1.2-1.6 million hectares) are reported to be infested by golden apple snail. The snail can spread rapidly from agricultural areas into wetlands and other freshwater systems where it may have a serious impact. These impacts involve destruction of aquatic vegetation leading to serious habitat modification, as well as competitive interactions with the native aquatic fauna including native snails. Human health threats are also associated with the species. The snail may be a vector for disease and parasites such

Eggs of golden apple snail

as the lungworm, which can cause eosinophilic meningoencephalitis disease in humans.

Introduced ranges of the snail include most parts of Asia including the Philippines, Japan, Taiwan, Vietnam, Cambodia, Thailand, Laos, Korea, Sri Lanka, parts of Indonesia and Malaysia, southern China and Singapore. Other areas of infestation are Hawaii, Guam, Papua New Guinea, the Dominican Republic and parts of USA (Florida, Texas, and California). The invasion pathways to new areas include legal or illegal import for development of aquaculture projects for human food, through eggs or small juveniles attached to aquatic plants distributed through nurseries or as domestic aquarium snail sold in pet stores. One of the main pathways of spread is through water currents.

Prevention of incursions is the most suitable option for management of golden apple snail. Strict quarantine must be enforced to prevent introduction and spread to countries, which are not yet infested. Climatic modeling has shown that the snail has the potential to spread to yet uninfested parts of the world including India and Australia, which would suffer hugely. To ensure safety, any incipient invasions must be eradicated rapidly. For rice and other crops, it is preferable to use seedlings obtained from snail free areas. Otherwise, examine the plants to ensure that the snails or snail eggs are not transported along with plants. Use of a screen (5 mm mesh) on water inlets will prevent easy spread. Placing a copper wire or strip above the water level on the border of the field will slow the spread since copper is toxic to snails.

Eggs of golden apple snail on rice foliage

Rice field infested by golden apple snail - Philippines

Handpicking of the snail and its eggs on a regular basis is the most successful method to control golden apple snail. Baited traps filled with lettuce, cassava and taro leaves and rotten jackfruit can be used to attract snails to facilitate collection. The handpicked snails can be used for human consumption or crushed to serve as a food source for fish or duck. Use of pesticides could be successful but this method may invite serious environmental and human health consequences. Biological control methods using fish, duck and red ants (which feed on eggs) have not been effective in managing the snail. In Indonesia, application of lime (CaO) at the rate of 50 kg h^{-1} was moderately effective in controlling the snail population. An integrated management program in Vietnam, supported by FAO, involving fish farming in rice fields was successful in controlling the snail. Through this program, while the common carp ate the smaller snails (shell height less than 1 cm), the larger snails were handpicked by local farmers and ground up to feed the fish.

New publications

Greipsson, S. and A. Di Tommaso. 2006. Invasive non-native plants alter the occurrence of arbuscular mycorrhizal fungi and benefit from this association. Ecological Restoration, 24: 236-241.

Mealor, B.A. and A. L. Hild. 2006. Potential selection in native grass populations by exotic invasion. Molecular Ecology, 15: 2291-2300.

Regan, T. J., McCarthy, M. A., Baxter, P.W.J., Dane, P. F. and H.P. Possingham 2006. Optimal eradication: when to stop looking for an invasive plant. Ecology Letters, 9: 759-766.

Sakai, K. and S. Upadhyaya.2007. Advanced engineering approach to weed management. Weed Biology and Management, 7: 1-2.

Recent Books

Native alternatives to invasive plants: By C.Colston Burrell, published by Brooklyn Botanic Garden, 2006. The biggest enemy of any garden is not a pest, disease, or poison-it's any plant with tougher survival skills than the plants it competes with. A good way to weed out the invaders is with this fiendishly clever guide to native plants that can seek and destroy the top 100 most unwelcome perennials, grasses, vines, shrubs, and trees. While replacing the invaders, the beautiful, hardy native plants described here also attract native birds and butterflies, while turning away their own enemy invaders. Word-and-picture guides provide tips on care and maintenance, while helpful "at a glance" boxes depict shapes, sizes, best locations, and most attractive features of each native alternative.

Measuring plant diversity- lessons from the field: By Thomas J. Stohlgren, published by Oxford University Press, 2006. There are compelling, urgent reasons for plant ecologists to do a far better job measuring plant diversity in this new century. Rapidly invading plant species from other countries are affecting rangeland condition and wildlife habitat, forcing more plant species onto threatened and endangered species lists, and increasing the chances of wild fires. This book empowers the reader to take an experimental approach in the science of plant diversity to better understand the distributions of common and rare species, native and non-native species, and long-lived and short-lived species. Case studies from actual field investigations demonstrate how to test and assess various field techniques.

Forthcoming Symposia / Workshops

22-25 May 2007. The First International Pacific Invasive Ant Conference (IPIAC) 2007, Sheraton Keauhou Bay Resort and Spa Kailua-Kona on the Big Island of Hawaii. International experts will gather in Hawai`i to present the latest research and information on invasive ants. In addition to oral presentations, poster sessions and exhibits, time has been planned for important networking and information sharing. Contact: Carol Russell (carol.e.russell@aphis.usda.gov)

22 May 2007. 59th International Symposium on Crop Protection, Ghent University, Belgium. The Symposium will focus on new developments in all aspects of crop protection. The program will include oral presentations, poster presentations, a plenary session with two invited papers and parallel sessions with submitted papers related to the following subjects: Phytopathology, Agricultural Entomology, Nematology and Acarology, Herbology, Pesticide residues, Toxicology and Ecotoxicology, Application Technology, Biological and integrated control of pests, diseases and weeds and a special session on formulation of pesticides. Contact: Dr. ir. P. Spanoghe (iscp@ugent.be)

6-12 July 2008. XXIII International Congress of Entomology, Durban, South Africa. The scientific programmes include: Pest management of annual and perennial crops, Pesticides residues and toxicology, Transgenics, Forest entomology, Stored product and post harvest entomology, Ecology, Genetics and evolutionary biology, Insect pathology, Medical and veterinary entomology, Reproduction and development, Physiology and biochemistry, Behaviour and neurobiology, Social insects, Systematics, Phylogeny and zoogeography, Conservation, Biodiversity and climate change, Insect plant interactions and Invasive species. Contact: Dr. G.L. Prinsloo (PrinslooGL@arc.agric.za)

Compiled and edited by Dr. K. V. Sankaran, APFISN Co-ordinator on behalf of the Asia-Pacific Forest Invasive Species Network. For more information on the APFISN, please contact your national focal point or the APFISN Co-ordinator or Mr. Patrick Durst, Senior Forestry Officer, FAO Regional Office for Asia and the Pacific, 39 Phra Atit Road, Bangkok. Email: patrick.durst@fao.org