

Review Article

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Parthenium hysterophorus Current Status and Its Possible Effects on Mammalians- A Review

Alka Sahrawat¹, Jyoti Sharma¹, Siddarth Nandan Rahul^{1*},
Snigdha Tiwari¹ and D.V. Rai²

¹Department of Biotechnology, Agriculture and Agri-informatics, Shobhit Institute of Engineering and Technology, Meerut, India

²Shobhit University, Gangoh, Saharanpu, India

*Corresponding author

ABSTRACT

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Parthenium hysterophorus perennial North American weed and known for its harmful effects. It also has the other name like carrot weed, congress grass and one of the ten feared noxious weed species in the world. It is harmful to all the living beings as it causes various serious problems like asthma, bronchitis, dermatitis, and hay fever in human and other mammalians and it has approximately devastated all the main crops and plants by reducing the availability of nutrients and other through competing with the crop. So far, attempts of developing effective control measure have not yielded any success. Not even a single indigenous insect species has proved successful in spite of occurrence and infestation by many species. Management options for *parthenium* include chemical, grazing management, physical and biological methods (Dhileepan, 2009). As it has the high generation and massive seed production capability makes it very hazardous in many ways to the human and other mammalians.

Introduction

Parthenium hysterophorus L. is from class Magnoliopsida and member of Asteraceae family, a noxious weed, inhabits many parts of the world, in addition to its native range in North and South America and the West Indies (Picman and icman, 1984). *Parthenium hysterophorus* L. is originated as a result of natural hybridization between *Parthenium confertum* and *Parthenium bipinnatifidum* (Nath, 1988). It is commonly known as Carrot weed (English), Congress grass (English), False ragweed (English), Korottenkraut

(German), Parthenium weed (English), Bitter weed (English), Starweed (English), Faussecamomille (French-New Caledonia), Feverfew (English), Santa Maria feverfew (English) and White top weed (English) (Kumar 2014). *Parthenium hysterophorus* is found in Australia, Bangladesh, Ethiopia, India, Sri Lanka, Kenya, Madagascar, Nepal, Pakistan, Papua New Guinea, Puerto Rico, South Africa, Swaziland, Taiwan, Vietnam and the United States. In India, it is locally known as 'Gajarghas'. *Parthenium* was introduced to India in seed form as a contaminant of food grains imported from

Mexico. It is regarded as one of the worst weeds because of its invasiveness, potential for spread, and economic and environmental impacts, and it is noxious because it is highly adaptable to almost all type of environmental conditions, can invade all types of land, also causes high losses in the yield of field crops and direct contact with plant (Aneja *et al.*, 1991) and (Auld *et al.*, 1983). In India it has invaded almost all the states with a high level of spreading in Haryana, Punjab and U.P. It was first reported in India in 1880, but recognized as a threat in 1950s.

Parthenium hysterophorus is a prolific weed belonging to Asteraceae family, producing thousands of small white capitula each yielding five seeds on reaching maturity. Within the past century it has found its way to Africa, Australia, Asia and Pacific Islands and has now become one of the world's seven most devastating and hazardous weeds. This noxious weed is often spotted on abandoned lands, developing residential colonies around the towns, railway tracks, roads, drainage and irrigation canals, etc. This weed grows luxuriantly in established gardens, plantations and vegetable crops. Due to its high fecundity a single plant can produce 10,000 to 15,000 viable seeds and these seeds can disperse and germinate to cover large areas. This alien weed is believed to have been introduced into India as contaminants in PL 480 wheat (Public Law 480 passed in 1954 to give food grains to developing countries for eliminating starvation and malnutrition) imported from the USA in the 1950s. Presently, this invasive weed is widely prevalent in India (Singh *et al.*, 2008). Approximately two million hectares of land in India have been infested with this herbaceous menace (Dwivedi *et al.*, 2009).

Parthenium hysterophorus produces an array of secondary metabolites which adds to its aggressive nature in almost all habitats. Parthenin, hymenin, coronopilin,

dihydroisoparthenin, hysterin, hysterothrin and tetraeneurin are the principal constituents of the sesquiterpene lactones along with phytotoxic compounds like hysterin and ambrosin. Some of the flavonoids present are quercelagetin 3, 7-dimethylether, 6-hydroxyl kaempferol and 3-O arabinoglucoside. The weed also produces phenol derivatives like caffeic, vanillic, ferulic, chlorogenic and anisic acids along with some unidentified compounds. Parthenin, hymenin and ambrosin are reported to be responsible for the menacing role of this weed in provoking health hazards (Lata *et al.*, 2008). In humans, they are the causative agents of allergic ailments like bronchitis, dermatitis and hay fever. Parthenin has been reported from almost all the plant parts including trichomes and pollen (Reinhardt *et al.*, 2004; Sharma and Sethuraman, 2007). It also causes dermatitis in cattle and domestic animals. Though it is known for its harmful effects, but some useful properties such as insecticidal, nematicidal and herbicidal and its antimicrobial potential is also documented in literature (Oudhia and Tripathi, 1998a; Oudhia *et al.*, 1997a and b).

Habit and habitat

It is an erect annual herb up to 2 m in height with a deep tap root and an erect stem that becomes woody with age. Leaves are pale green in color, lobed, hairy, alternate, sessile, irregularly dissected and bipinnate. The number of leaves per plant varies from 6 to 55. The flowering starts about a month after germination with creamy white flower heads on the tips of numerous stems. Each flower contains four to five wedged shaped black seeds, two millimeters long with two thin white scales. The plant is a prolific seed producer with single plant producing on an average 2,400–30,000 seeds during its life cycle (Haseler, 1976; Rodriguez and Cepero, 1984; Williams and Groves, 1980). The dispersal of its seed is via different means viz

water currents, movement of vehicles, machinery, livestock, grain, stock feed and wind (Sankaran, 2008). Seeds are capable of germination over a broad range of humidity, pH and temperature but high soil moisture is suitable for seed germination (Ahlawat *et al.*, 1979; Tamado *et al.*, 2002; Singh *et al.*, 2004).

Chemical analysis of *P. hysterothorus*

Isolation and structural elucidation of the active principles of *P. hysterothorus* is required to determine their chemical properties. Chemical analysis of *P. hysterothorus* has indicated that all its parts including trichomes and pollen contain toxins called sesquiterpene lactones (SQL). Maishi *et al.*, (1998) reported that *P. hysterothorus* contains a bitter glycoside parthenin, a major sesquiterpene lactone. Other phytotoxic compounds or allelochemicals are hysterin, ambrosin, flavonoids such as quercelagetin 3, 7-dimethylether, 6-hydroxyl kaempferol, 3-O arabinoglucoside, fumaric acid. P-hydroxy benzoin and vanillic acid, caffeic acid, p coumaric, anisic acid, p-anisic acid, chlorogenic acid, ferulic acid, sitosterol and some unidentified alcohols. Parthenin, hymenin and ambrosin are found to be the culprits behind the menacing role of this weed in provoking health hazards (Lata *et al.*, 2008). *Parthenium hysterothorus* from different geographical regions exhibited parthenin, hymenin, coronopilin, dihydroisoparthenin, hysterin, hysterothorin and tetraeurin A as the principal constituents of their sesquiterpene lactones (De La Fuente *et al.*, 1997). (Gupta *et al.*, 1996) identified a novel hydroxyproline-rich glycoprotein as the major allergen in *P. hysterothorus* pollen. (Das *et al.*, 2007) examined the flowers of *P. hysterothorus* and isolated four acetylated pseudoguaianolides along with several known constituents. A novel sesquiterpenoid, charminarone, the first seco-pseudoguaianolide, has been isolated along

with several known compounds from the whole plant by (Venkataiah *et al.*, 2003). (Chhabra *et al.*, 1999) discovered three ambrosanolides from the chloroform extract of this weed.

Health hazards to humans and livestock

This weed is known to cause many health hazards which have now reached epidemic proportions. Agriculturists are concerned about *P. hysterothorus* affecting food and fodder crops, since the pollen and dust of this weed elicit allergic contact dermatitis in humans (Gunaseelan 1987; Morin *et al.*, 2009). Dermatitis is a T cell-mediated immune injury and the disease manifests as itchy erythematous papules and papulovesicular lesions on exposed areas of the body (Akhtar *et al.*, 2010). These effects have been related to cytotoxicity of the sesquiterpene lactone parthenin (Narasimban *et al.*, 1984). Persons exposed to this plant for prolonged period manifest the symptoms of skin inflammation, eczema, asthma, allergic rhinitis, hay fever, black spots, burning and blisters around eyes. *Parthenium hysterothorus* also causes diarrhoea, severe popular erythematous eruptions, breathlessness and choking (Maishi *et al.*, 1998).

Exposure to *P. hysterothorus* pollens causes allergic bronchitis (Towers and Subba Rao 1992). (Ramos *et al.*, 2001) assessed the mutagenic potential of a crude extract of *P. hysterothorus* in the *Salmonella*/microsome (Ames) assay and the mouse bone marrow micronucleus test. However, it did not show genotoxic potential. (Sharma *et al.*, 2005) observed that the clinical pattern of *Parthenium* dermatitis progresses from airborne contact dermatitis to mixed pattern or chronic actinic dermatitis pattern. Eczema herpeticum is reported to complicate *parthenium* dermatitis. (Sriramarao *et al.*, 1993) worked on the use of murine polyclonal

anti-idiotypic antibodies as surrogate allergens in the diagnosis of *P. hysterothorus* hypersensitivity.

Biological control of *P. hysterothorus* weeds

(Dhileepan 2003a, b) studied the effectiveness of leaf-feeding beetle *Zygotogramma bicolorata*, stem-galling moth *Epiblema strenuana* and stem-boring weevil *Listronotus setosipennis* introduced against *P. hysterothorus* in Australia. The moth *Carmentidactylae* and leaf-rust *Puccinia melampodi* were released to eliminate this weed, but little success has been attained in this regard as the weed has great regenerative potential and moreover the insect consumes only the foliage of the weed which stimulates further leafy proliferation (Dhileepan and Strathie 2009).

Health benefits of *P. hysterothorus*

The decoction of *P. hysterothorus* has been used in traditional medicine to treat fever, diarrhoea, neurologic disorders, urinary tract infections, dysentery, and malaria as emmenagogue (Surib-Fakim *et al.*, 1996). Ethnobotanically, it is used by some tribes as remedy for inflammation, eczema, skin rashes, herpes, rheumatic pain, cold, heart trouble and gynaecological ailments. *Parthenium hysterothorus* has been found to be pharmacologically active as analgesic in muscular rheumatism, therapeutic for neuralgia and as vermifuge (Maishi *et al.*, 1998). This weed is also reported as promising remedy against hepatic amoebiasis. Parthenin, the major constituent of the plant, exhibits significant medicinal attributes including anticancer property (Venkataiah *et al.*, 2003). The methanol extract of the flowers showed significant antitumour activity and parthenin exhibited cytotoxic properties against T cell leukaemia, HL-60 and Hela cancer cell lines (Das *et al.*, 2007). Previously, (Ramos *et al.*,

2002) had established the antitumour potential of *P. hysterothorus* extracts in vitro and in vivo with positive results in terms of tumour size reduction and overall survival of cell lines. Aqueous extract of *P. hysterothorus* has hypoglycaemic activity against alloxan-induced diabetic rats (Patel *et al.*, 2008). So, flower extract of this weed can be used for developing drug for diabetes mellitus.

***P. hysterothorus* as substrate for enzyme production**

Xylanases are hydrolytic enzymes that cleave xylans. The end products of xylan degradation have industrial applications for biofuel, artificial sweetener, animal feed production, baking and textile industry, clarification of fruit juices and coffee extraction. Besides, there has been an increasing interest in using xylanases for ecofriendly bleaching of pulp in paper industries. The potential of *P. hysterothorus* as low-cost raw material for xylanase production was studied by (Dwivedi *et al.*, 2009). They investigated xylanase production from a mutant of *Penicillium oxalicum* in submerged fermentation. Considerably higher level of the enzyme production in medium containing *P. hysterothorus* confirms the feasibility of using this cheap resource as an alternative carbon source to save costs of the enzyme production process (Dwivedi *et al.*, 2009).

***P. hysterothorus* as additive with cattle manure in biogas production**

In the wake of oil crisis, energy generation from biowastes by anaerobic digestion has attracted immense attention. Energy crops are likely to be future sources of digester feed stocks for methane generation. *Parthenium hysterothorus* was mixed with cattle manure at a 10% level and allowed to digest anaerobically at room temperature in 3-l batch digesters. The chemical changes during the

course of digestion and the effect of digested slurry (inoculum) on biogas production were investigated and significant increase in methane content was achieved. The methane content of the gas varied between 60 and 70% (Gunaseelan 1987).

***P. hysterophorus* for welfare of livestock**

Parthenium hysterophorus can be used as a flea-repellent for dogs (Maishi *et al.*, 1998). This weed is a valuable source of potash, oxalic acids and high-quality protein (HQP) which can be used in animal feed (Mane *et al.*, 1986).

Antimicrobial and Wound healing activity

Hydroalcoholic extract of *P. hysterophorus* was in vitro effective against Plasmodium falciparum (Valdes *et al.*, 2010). In vitro, this plant demonstrated antiamoebic activity comparable to the standard drug Metronidazole against axenic and polygenic cultures of *Entamoeba histolytica*, responsible for amoebiasis (Talakai *et al.*, 1995) *Fusarium wilt*, an economically important fungal disease in potato caused by *Fusarium solani* was significantly inhibited by aqueous, methanol and n-hexane extracts (Zaheer *et al.*, 2012). Externally leaf paste application of *P. hysterophorus* showed wound healing activity (Kumar *et al.*, 2011).

Antioxidant activity

The antioxidant phytochemicals protect the cells from oxidative damage caused by free radicals. DPPH (2, 2-diphenyl-1-picrylhydrazyl radical) scavenging assay revealed that Methanolic and ethanolic extract of *Parthenium hysterophorus* showed antioxidant activity 78.25561% and 66.28858% respectively (N *et al.*, 2010). But next time acetone extract was found to have higher anti-oxidant activity than

methanol and chloroform extracts (Priya *et al.*, 2011). 200mg/kg of body weight of fresh leaves ethanolic extract has been showed significant antioxidant activity in rats (Pandey *et al.*, 2012).

Hypoglycemic activity

Administration of aqueous extract of *P. hysterophorus* flower (100 mg/kg of body weight) has been shown significantly decreased the serum glucose level in normal and alloxan induced diabetic rats (Patel 2011). Slightly decreased blood glucose level was found in rats after oral administration of fresh leaves extract (Arya *et al.*, 2012).

Thrombolytic activity

Crude methanolic extract of *P. hysterophorus* has been shown significant thrombolytic effect comparable to standard thrombolytic agent, streptokinase (Al-mamun *et al.*, 2010) Parthenolide and some other metabolites were determined as the inhibitor of human blood platelet function (Hewlett *et al.*, 1996).

Pesticidal activity

Antifeedent bioassay revealed that lactone was found to be about 2.25 times more active than parthenin against sixth-instar larvae of *Spodopteralitura* and pyrazoline adduct was found to be the most effective as an insecticide against the adults of store grain pest *Callosobruchus maculatus* (Datta 2001). Reddy *et al.*, 2017 used parthenium against major insect pest of cruciferous crops *Plutella xylostella* and *Aphis craccivora* Koch

Antifungal activity

Antifungal potential of different extracts of *P. hysterophorus* against human pathogenic fungi were investigated (Rai 1990). The dermatophytes and other fungal pathogens

have been found to be sensitive to sesquiterpene lactones which are present as active agent in asteraceous plant *P.hysterophorus* (Rai 2003).

Heavy metal and dye removal

Sulphuric acid-treated *Parthenium* showed nickel removal and methylene blue dye absorbing efficiency from wastewater or industrial wastes. Ni removal was maximum at pH 5.0 and achieved within 4 h after the start of every experiment. Dye adsorbing ability was also found to be comparable to commercial adsorbents. The cadmium adsorbing ability of *Parthenium* was also explored, which was maximum at pH 3-4 with recovery of 82% with 0.1 M HCl as effluent (Ajmal *et al.*, 2006; Patel, 2011). Activated carbon prepared from *Parthenium* showed cresol (a phenol derivative) adsorbing ability comparable to commercial grade activated carbon (Singh *et al.*, 2008; Patel, 2011).

Impacts of *Parthenium*

Impact on crop production

Due to the invasive capacity and inhibitory role of allelic chemicals, phenolics and sesquiterpene lactones, mainly parthenin, it inhibits the germination and growth of plants including pasture grasses, cereals, vegetables and other plant species (Veena *et al.*, 2012). In India *Parthenium hysterophorus* causes a yield decline of up to 40% in agricultural crops (Khosla and Sobti, 1981). Maharjan *et al.*, 2007 showed that increase in concentration of extract was invariably associated with decrease in germination and seedling characteristics of the crops.

Impact on human and animal health

In India, this weed has been considered as one of the greatest source of dermatitis, asthma,

eye irritation, and sinusitis (hay fever) types of diseases. Pollens in contact with body causes swelling and itching of mouth and nose. Consumption of weed roots causes excessive water loss from the body due to contact of *Parthenium hysterophorus* causes (Oudhia and Tripathy, 1998) acute toxicity in cattle and milk becomes bitter tasting due to the presence of parthenin compound, which is also hepatotoxic in nature. Due to Contact of this weed causes inflamed udder, fever and rushes in cows, allergic inflammation in the mouth of cattle's. If it is present in animal diet then causes dermatitis with pronounced skin lesions and a significant amount (10–50%) of *Parthenium hysterophorus* in the diet can kill cattle and buffalo (Veena *et al.*, 2012) (Ahmed *et al.*, 1988).

It is concluded that, *Parthenium* weed (*Parthenium hysterophorus* L.) is one of the most destructive invasive weeds, intimidating natural ecosystems and agroecosystems in over worldwide. The *Parthenium* is spread in India very fast as it is very fast in growth and produced plenty of seeds. There is the need to encourage the research on the utilization potential of this weed and to evaluate its efficacy on field trials. The target of controlling of *Parthenium* all the aspect of managing should be kept in mind that it does not make any harmful of hazardous to the environment. The various researchers are looking it to control by using it for the benefit to the humans and the environment too an integrated management system is to be developed for the control and eradication of *Parthenium* in India.

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