



# Review on a weed *Parthenium hysterophorus* (L.)

Lalita<sup>1</sup>, Ashok Kumar<sup>2</sup>

<sup>1</sup>Ph.D scholar, Department of Botany, CCS University, Meerut, U.P., India; <sup>2</sup>Assistant Professor, Department of Botany, CCS University, Meerut, U.P., India.

## ABSTRACT

In the present time we are facing the infestation of *Parthenium hysterophorus* everywhere. It is available in stocks around the railway tracks, in bare lands, in agriculture fields, in orchards and forests, it invade major portion of Indian continental. We are familiar with *Parthenium hysterophorus* noxious properties and want to control its infestation. However, only controlling its growth is not a solution to remove it but it can be managed via its utilization for different purposes. Recently a lot of research has been going on to explore the utilization properties of *Parthenium*. This review article presents some properties and utility potential of *Parthenium* concluded by various researchers.

**Key Words:** Weed management, Allelopathy, Invasion, Herbicides

## INTRODUCTION

Weeds in routine are known to be unwanted in a given situation and these are harmful, dangerous or economically detrimental having serious threat to primary production and biodiversity. Invasive Alien Species are known to be the species which are introduced from outside from its origin place to other countries either by deliberately or unintentional human activities. They have established self-reproducing populations in the wild and have caused evident changes in nearby, simulated as well as biological systems.. Invasion is known as very important hazard to biodiversity (2). They reduce farm and forest productivity. *Parthenium hysterophorus* is the main invasive alien weed which dominates over the native species and adversely affects the biodiversity. The word *Parthenium* is taken from the Latin word parthenice which means for medicinal uses (4)

*Parthenium hysterophorus* is an invasive weed plant of family Asteraceae. This erect, short-lived plant known for its flourisly growth and its abundance notably in hot climates. *Parthenium* is native plant of north-east Mexico and was endemic to America but now it is widely distributed in all countries of Asia and Europe. *Parthenium* (*Parthenium hysterophorus* L.) is known with different names in different countries such as carrot weed, star weed, congress grass,

wild feverfew, ragweed, bitter weed, white top, and the “Scourge of India”. This weed with productive seed generation has high allelopathic impact on neighboring plants and competitiveness with economically important crops.

Spread of *Parthenium hysterophorus* has been documented to cause enormous loss to the biodiversity by replacing native species in the natural ecosystems, sometimes causing total habitat alteration. To know about *Parthenium hysterophorus* effects, habitat and its biology have immense significance in agriculture. Only with detailed knowledge of this noxious weed, it will be possible to controlled and manage the weed in different ways. Present review explores the possibility through knowing habitat, distribution, biology and chemical properties of *Parthenium hysterophorus*.

### (1) Origin and Distribution of *Parthenium*

*Parthenium hysterophorus* is native to the region encompassing the Central America, Southern North America, Gulf of Mexico, West Indies, and Central South America. The weed has now spread all around the globe including mainland as well as island. In India and other countries of Asian continent such as China, Bangladesh, Nepal, Pakistan, etc, it has spread on alarming rate. Its spread and infestation are severe in some of the countries like Australia, South Africa, Ethiopia, India and Pakistan. It was introduced into Asia,

#### Corresponding Author:

Dr. Lalita, (Ph.D scholar), Department of Botany, CCS University, Meerut, U.P., India.  
Email: [lalita.khari@gmail.com](mailto:lalita.khari@gmail.com)

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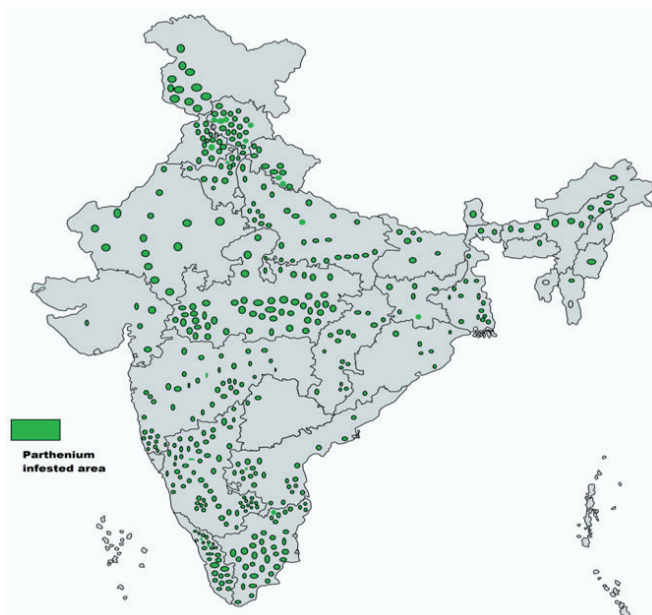
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Africa and Oceania with cereal and grass seed shipment from America during the 1950s (5).

### (i) IN INDIA:

*Parthenium hysterophorus* possibly entered India in 1910 (with infected cereals germplasm) however, went unrecorded until 1956. The weed was first revealed in India in 1955 (38) and now happens everywhere the (48) in around 35 million hectares of land (23). In India, this weed has serious problem in approximate all states like Karnataka, Andhra Pradesh, Haryana, Bihar, and Madhya Pradesh and Uttar-pradesh (22). *Parthenium hysterophorus* occurred in all states of country and presenting a serious threat in many states those have large areas of agriculture land, non cropping areas and grazing land (25). At present time India has becomes one of the most infested countries of world.



**Figure 1:** Map showing sites known to be infested with *Parthenium hysterophorus* in different states of India.

The spread of *Parthenium hysterophorus* has been reported from all states of India with different intensity. Generally, overall spread in terms of *Parthenium* density and dispersion level is maximum in Andhra Pradesh, Maharashtra, Bihar, Punjab, Chhattisgarh, Delhi, Haryana, Karnataka, Madhya Pradesh, Tamil Nadu and Uttar Pradesh; medium in Jharkhand, Assam, Gujarat, Rajasthan, Himachal Pradesh, Jammu & Kashmir, Uttarakhand, Orissa, and West Bengal; low in Andaman & Nicobar, Arunachal Pradesh, Goa, Kerala, Lakshadweep, Manipur, Mizoram, Meghalaya, Nagaland, Sikkim and Pondicherry. However its infestation varied in different states and different regions of states (Table 1).

**Table 1: Status of *Parthenium hysterophorus* in different states of India.**

Name of states	Over all spread and infestation level
Andaman & Nicobar islands	Low
Kerala	Low
Andhra Pradesh	High
Madhya Pradesh	High
Arunachal Pradesh	Low
Maharashtra	High
Assam	Medium
Manipur	Low
Bihar	High
Meghalaya	Low
Chattishgarh	Medium
Mizoram	Low
Chandigarh	Medium
Nagaland	Low
Pondicherry	Medium
Gujarat	Low
Punjab	High
Haryana	High
Rajasthan	Medium
Himachal Pradesh	Medium
Sikkim	Low
Jammu & Kashmir	Medium
Tamil Nadu	High
Jharkhand	Medium
Uttar Pradesh	High
Karnataka	High
Uttarakhand	Medium
Orissa	Medium
Goa	Low
Delhi	High

In U.P. earlier this weed was noticed at Pantnagar opposite to the railway station and has spread to a few agricultural lands and also in Rae-Bareilly district and Jhansi areas (10). It grows most luxuriously in some districts especially around western U.P. Weed is found in plenty in the nearby agricultural lands, abandoned land and on the bank and the basin of rivers (29).

It is very well reported to occur in Western U.P. like Pilibhit, Puranpur Tehsil, Bisalpur Tehsil, Shahjahanpur, Mala and Deoria forest (Pilibhit) Badaun, Bareilly, Etah, Aligarh, Hathras, Firozabad, Mainpuri, Mathura, Moradabad, Meerut, Bijnor, Rampur, Jyotiba-Phule Nagar, Baghpat, Muzaffarnagar, Saharanpur, and other parts of the state (32).

There are less data available on the abundance of *Parthenium hysterophorus* in Meerut district due to less research, but there are plenty of *Parthenium* found grown in the bare areas, railway platforms and in agriculture lands.

## (2) HABITAT

This exotic weed is generally spotted on bare lands, industrial areas, developing residential colonies, railway tracks, roads, drainage and around the ditch etc. This weed also grows vigorously in gardens, forests and agricultural fields. Due to its high luxuriance growth, it can produce about 15,000 seeds/plant, which can disperse and germinate to different area in a large amount. It has potentiality to adjust to a variety of habitat conditions. It infest woodland, open spaces of urban regions, overgrazed pastures, developed terrains, irrigated and uncovered zones, for example, roadsides, tracks, and intensely loaded regions, for example, stockyards and watering areas such as irrigation canal, water channels and ditch(43). It grows better in hot climates. High temperature is favorable for the development of this noxious weed production. Low temperature represses the development of the plant and the seed productivity (33). Under favorable climatic conditions like more than 500 mm average rainfall and 30°C mean temperature *Parthenium hysterophorus* can reach heights of 1.5 to 2.0 m. Under dry conditions, the plants may mature and set seed at even heights of only 10 cm.

This weed is characterized by its density and biomass varying with soil type. It prefers alkaline clay, loam soil to heavy black clay soils to grow luxuriously (3). *Parthenium* invaded sites mostly have sandy loam soil with pH ranging from 5.4 to 7.4, water holding capacity 16.8 to 63%, total nitrogen 0.055 to 0.206%, organic matter 1.134 to 4.24%, phosphorus 31.86 to 69.93 kg/ha, potassium 74.72 to 746.5 kg/ha(15). *Parthenium* has ability to can grow over a wide range of moisture, pH and temperature conditions however it requires high soil moisture for its seed germination. Reportedly it is a photoperiod and thermo-period insensitive and can flower year-round. Seed germination can happen over an extensive range of temperature and soil pH. Further, it is very competitive to compete with a number of crops including legumes & cereals.

## (3) INFESTATION OF PARTHENIUM HYSTEROPHORUS

### (a) Agriculture and pastures ecosystems:

Before 1980 this weed was seldom noticed growing in crop lands but now it has spread too much extent into almost all types of agriculture crops, forests and plantation ecosystems. In Uttar-pradesh, Uttarakhand, Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, etc., *Parthenium* is known as harmful weed of agriculture lands. In crop fields, where only one crop is grown in a year, it grows abundantly in the fallow

period following the occurrence of mild rains. Its infestation is severe in the field where irrigation canals are used. On the bank of narrow, human-made waterway systems(water canal or ditch), *Parthenium hysterophorus* weed grows abundantly due to the good availability of moisture and its seeds being carried by irrigation water canal.

### (b) Orchards and forests ecosystems:

Earlier, it was not known for its infestation in gardens and forests but at present time it spread vigorously into these areas. This weed grows luxuriantly in orchards because of low weeding practices in such ecosystems. Mango orchards in Uttar Pradesh, Madhya Pradesh and Maharashtra are frequently invaded by *Parthenium* weed causing a nuisance to growers. In Himachal Pradesh, this weed has spread in the majority of apple orchards grown in the lower elevations. Similarly in Maharashtra, orange orchards have been invaded with *Parthenium* weed causing problems to growers. *Parthenium* can grow luxuriously in bare lands/wastelands and in forests, it inhibits the growth of other plants by which local bio-diversity being threatened. *Parthenium* weed has invaded numerous National Parks of India including Pench, Rajaji, Kanha, Bandhavgarh etc. (25).

### (c) Bare lands

*Parthenium hysterophorus* vigorously grows in bare lands. It can be seen growing everywhere either on roadside, around the factories or mills, platforms and even the lands which are not suitable for crop production due to their high metal toxicity or scarcity of the mineral nutrients. It is the important feature of *Parthenium* weed that it has a wide range of habitat and it can be survive in harsh conditions in which other normal plants cannot survive. It is an important reason of the rapid infestation of *Parthenium* in India and other countries as alien weed.

## (4) MORPHOLOGY

*Parthenium hysterophorus* is highly branched, short lived (annual), upright (erect) herbaceous plant that form a rosette habitat during the early stage of life. At maturity, but occasionally can reach up to 2m or even more in height.

### STEM

Stem is cylindrical, solid, more or less fluted with longitudinal lines corresponding to the extension of the midrib of the leaves. Mature stems are greenish and covered with small soft hairs which are known as hirsuties, stems become much harder as reach to maturity.

### LEAVES

The leaves are alternately arranged and stalked (petioles) upto 2 cm long founds in two different forms. During the early stages of life it forms rosette habitat. Leaves are alter-

nate, simple and deeply pinnatifid. The blade is 11 to 15 cm long and 6-10 cm wide, the blade of lower leaves are broad and intensely divided in comparison to upper leaves. Abaxial surface of leaves are covered with short, stiff hairs that lie close to the surface.

## FLOWERS

Numerous small flower- heads generally known as capitulum are organized in clusters at the top of the branches (in terminal panicles). Each flower-head (capitulum) is borne on a stalk (pedicel). Capitulum (3-5 mm across) are off-white or white in color containing ray florets (0.3-1 mm long). They also have various (15-60) small flowers (tubular florets) in the centre surrounded by two rows of small green bracts (an involucre). It can flowered at any time of the year, but commonly occur during raining season.

## SEED

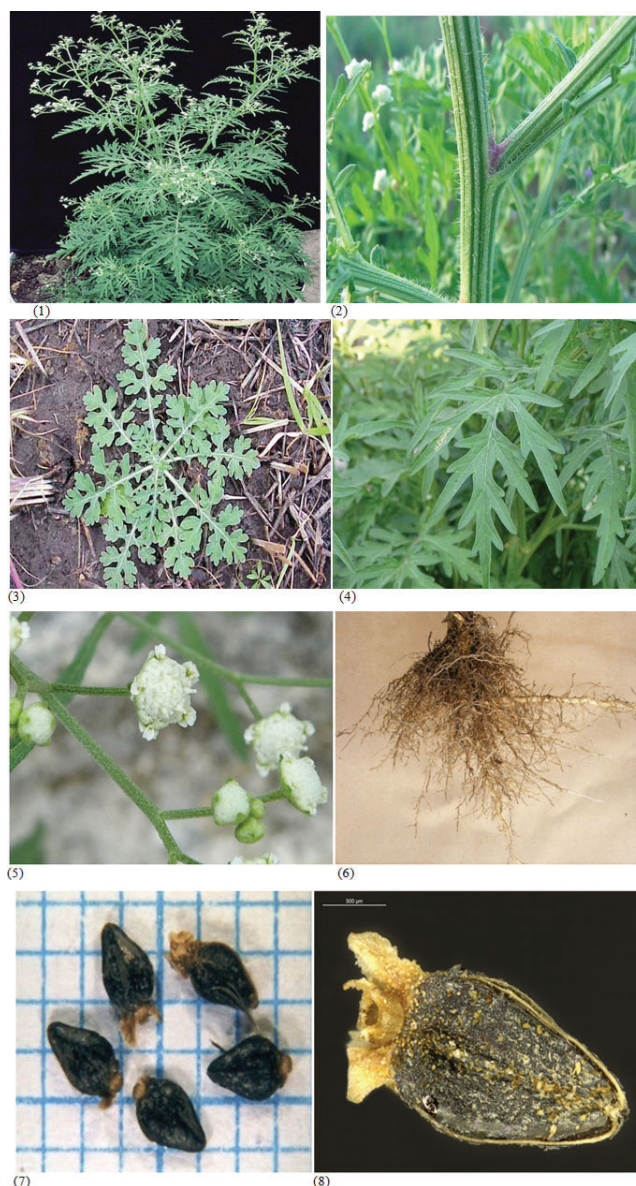
Five small 'seeds' generally known as achenes are produced in each flower-head. Seeds are black obovoid, 2 mm long and 1.5 mm wide consisting two or three small scales known as pappus about 0.5-1 mm in height, two straw-colored papery structures (actually dead tubular florets), and a flat bract.

## (E) Seed biology, germination and longevity

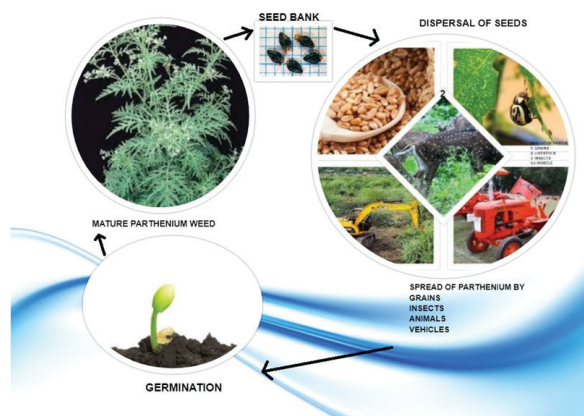
After 24-48 days of germination flowering takes place in *Parthenium*. This can happen at any time of the year. The best alternating temperature regime for its weed seed germination is 21/16 °C (day/night). Further its seeds can live for between 4-6 years in the soil as seed bank. Studies have also shown their buried seeds to live much longer than seeds on the soil surface (1).

## (5) HOW IT IS SPREADS

*Parthenium hysterophorus* retain an extraordinary capability to spread grow and established well in wide range of environmental conditions (Monika, 2014). It completes life cycle 90-120 days which helps in quick spreading (20). Its seeds can be dispersed through various methods such as water current, animals, movement of vehicles, machinery, livestock and the grains or seeds of crops. Further *Parthenium* has a relatively short life cycle, grows very quickly and survives under different habitats. Generally for long distances it spread through vehicle, agricultural instruments and with water flow. *Parthenium* produced enormous number of tiny seeds which are light weight and can survive as seed bank in soil for long time (7). These some abilities of *Parthenium hysterophorus* helps to spread rapidly resulted in infestation of *Parthenium* everywhere.



**Figure 2:** *Parthenium hysterophorus* (L.) plant and its Parts: (1) whole plant at maturity (2) Stem of plant (3) rosette habitat of young plant (4) leaves (5) a flowering twig (6) plant root (7) seeds (8) enclosure of seed respectively.



**Figure 3:** Life cycle of *Parthenium hysterophorus*.

**(5) Causes of rapid spread**

- High reproductive potential
- Fast growth rate
- Allelopathic potential
- Unpalatable to animals

**(i) High reproductive potential:**

*Parthenium hysterophorus* produce a huge quantity of seeds with up to 15-25,000 seeds per plant (30) with an tremendous seed bank, estimated about 2,00,000 seeds/m<sup>2</sup> in bare lands and agriculture field (15). Seeds of *Parthenium* can survive under harsh conditions and remain viable for a long time period. These qualities of this weed help in its fast spreading. Seeds of *Parthenium* can germinate any time of the year, when suitable moisture is available (46).

**(ii) Fast growth rate:**

It is vigorously growing annual herbaceous weed. Generally, *Parthenium* flowered when it is only 4-8 week old and can flower for several months. Under unfavorable conditions like salt and drought stress, the weed can completes its life cycle within 4-5 weeks.

**(iii) Allelopathic potential:**

This noxious weed suppress the development of nearby plants by allelopathy. Leachate and extract of leaves and inflorescence prevent the germination and growth of associated economically important crops. Kumari *et al.* (2014) observed that physiological and biochemical parameters remarkably reduced when aqueous extract of *Parthenium* were directly sprayed on the crop plants. *Parthenium* has strong allelopathic effects on other plants even it can cause 40-80% yield loss in agricultural crops.

**(iv) Unpalatable to animals:**

*Parthenium hysterophorus* is unpalatable to the animals. Generally animals do not eat *Parthenium hysterophorus* because of its bitter taste and intense odour (14). Earlier investigations in India had revealed its serious health hazards to the livestock in *Parthenium hysterophorus* invaded areas. Being unpalatable, it can not use as animal fodder and its population is increasing day by day unless mechanically removed.

**Table 2: Chemical constitution of *Parthenium***

Chemicals class	Major constituents	Plant parts	References
Sesquiterpene lactones	Parthenin, caffeic acid, <i>p</i> -coumeric acid	Stem, leaves and pollen	Kanchan and Jayachandra
Phenolic acids	Ferulic acid, vanicillic acid, anicic acid, fumaric acid	Root and leaves	Valliappan and Towers
Sesquiterpene lactones	Coronopilin	Stem, flowers and trichomes	Picman <i>et al.</i>
Minor sesquiterpenes	Ambrosionalides, 2B-hydroxycoronopilin, 1,3-hydroyparthenin	Flowers	Sethi <i>et al.</i>
Sesquiterpene lactones	Pseudoguananolides	Stem and leaves	Fuente <i>et al.</i>
Sesquiterpene lactones	Hystrin	Stem	Vivar <i>et al.</i>
Secopseudoguananolides	Charminarone	All plant parts	Venkataiah <i>et al.</i>
Flavonoids	Aglycone	Aerial parts	Shen <i>et al.</i>
Pseudoguananolides	flavanols Hysterones A to D	Flower	Ramesh <i>et al.</i>
Sesquiterpene lactones	Acetylated pseudoguananolides	Flower	Biswanath <i>et al.</i>

Source: Adkins et al., 2013

**(7) IMPACT OF PARTHENIUM****(a) Impact on Biodiversity**

This weed has the potential to disturb the natural ecosystem, as it can grow throughout the year in almost all drastic conditions suppressing native vegetation. Owing the absence of effective natural enemies, its allelopathic effect as well as photo insensitivity and thermo insensitivity, it is a threat for natural diversity. Rapid spread of *Parthenium* can disturb natural ecosystem because it has very fast infestation capacity and allelopathic potential which have the ability to disrupt any type of natural ecosystem. Species richness, evenness and local biodiversity gradually decrease where this plant is present, this situation clearly indicates the native biodiversity loss of weeds and other crop plants due to *Parthenium* infestation. Its infestation is coupled with its allelopathic potential

and the absence of its natural inhibitors such as pathogen, insects and their larvae, these are the some important factor which are the reason of its luxurious growth and spread (22). The concentrations of allelochemicals viz. Coronopilin, caffeic acid, parthenin, and *p*-coumaric acid which are present in *Parthenium* have serious allelopathic effects.

**(b) Impact on Crop production**

The *Parthenium hysterophorus* weed has infested in a large area of india (24). This plant contains parthenin, hysterin, hymenin, and ambrosin. Due to the presenence of these allelochemicals this weed has strong allelopathic impacts on different crops and human being also (11). This weed have adverse impacts on legumes by disturbing their symbiosis with Nitrogen fixing bacteria such as *Rhizobium*, *Azotobacter*, *Azospirillum* and Actinomycetes. It produces huge

numbers of pollens (Approx. 700 million), which travels a long distance from source plant to other crop plants and inhibits the fruit setting in these crop plants such as tomato, brinjal, beans, and cereals. *Parthenium* can cause yield loss upto 40% in legume crops (19).

#### (c) Impact on Soil Microflora

*Parthenium* is known to its inhibitory effect on growth and activity potential of different bacterial species related to Nitrogen assimilation such as *Rhizobium* and *Azotobacter* and nitrifying bacteria like *Nitrosomonas*. Aqueous extract of *Parthenium* has detrimental effects on the growth of *Rhizobium*, *Nitrosomonas* and *Azotobacter*. It reduced the Leghaemoglobin content of root nodules by which *Rhizobium*-legume symbiosis is affected. Leaf and root leachates and their chemical component inhibit nitrate production (45). Besides these it can inhibit the growth of algae and mycorrhizae associated to crop plants because of its fungicidal property (Megharaj et al., 1987).

#### (d) Effects on Animals

*Parthenium* weed is noxious for livestock, it can cause dermatitis and skin disorders in animals (12). Loss of skin pigmentation, dermatitis, mouth ulcers with extreme salivation and diarrhoea has been observed in animals. If excess amount of this weed is eaten by the animals it can cause death. The *Parthenium* extract reduces the total WBC count in animals which results in the weakening of immune system.

#### (e) Effects on Human Beings

*Parthenium* plant parts can be toxic to some people it is estimated up to 73% of people living with the weed are sensitive to it. Females are twice more likely to be sensitive than males. Dermatitis, hay fever, asthma, and bronchitis are the major health problems found in human beings caused by the pollen grains and other plant parts of *Parthenium*. The major allergens found in this plant are parthenin, coronopilin, tetraeneurins, and ambrosin. Its pollen grains are well known to causing asthma in human beings. Direct contact of this plant can cause dermatitis not only site specific but can spread all over the body. Clinically the *Parthenium* dermatitis can be divided into five types which are-

1. The classical pattern
2. The chronic actinic dermatitis (CAD)
3. The mixed pattern (classical and chronic actinic dermatitis pattern combination)
4. The photosensitive lichenoid eruption
5. The prurigo nodularis like pattern (4).

### (8) CONTROL OF PARTHENIUM

The control of *Parthenium* weed is a serious challenge due to its vigorously spreading nature. Immediate actions are being quite necessary to eradicate the plant since it has more hazardous impact on environment as well as to public health.

India has great risk of rapid invasion of the weed in agricultural lands, for which it might give proper attention towards the remedy to control *Parthenium*. Many researches are going on for finding the cheap and best way for its control. Some of the control measures that can be undertaken in India are as follows-

#### (a) GRASSLAND MANAGEMENT

Grazing management is the most useful method for the control and manage the *Parthenium* spread on a large scale. However, this practice has not been implemented effectively in India. Meadow land can be sustain with growing grasses and herbs in them. This may however, requires rehabilitation of poor meadow followed by sound grazing maintenance programs. Such a practice, however, has a lot of challenges in our country due to socioeconomic and cultural factors.

#### (b) CONTROLLING OVERGRAZING

Overgrazing may increase the *Parthenium hysterophorus* infestation. Control of overgrazing therefore can minimize its infestation to some extent. Overgrazing due to the explosive increase in livestock populations decreases the vigor and diversity of grassland that enable the spread of *Parthenium hysterophorus* weed luxuriously. So maintenance of correct stock number might be fruitful in the control of *Parthenium* weed dispersal (31). Alternatively, pasture spreading can be helpful for rehabilitation of pasture lands which might be more effective than simply reducing the weed. However, overgrazing must be avoided Spring-summer period is found to be quite suitable for pasture sapling with first 6-8 weeks being quite important. Grazing during winter is generally safe since the period has low risk of *Parthenium* spread. However, *Parthenium* may grow and germinate in this time also.

#### (c) BURNING

Another commonly practiced way of controlling *Parthenium hysterophorus* weed is burning. Mass vegetation of the weed can be destroyed by this practice. But it can not be considered as safe control strategy for the weed since there is great risk to soil, air and existing plant and animal diversity. *Parthenium hysterophorus* ash also has allelopathic effect on crop yield but yield loss is low in comparison to the leachate and dry mass of this weed (22).

#### (d) MANUAL CONTROL

Manually, *Parthenium* weed can be controlled by simple hand plucking. But this is not recommended since it might cause serious health hazard. Further, the seeds may drop off and increase the area of infestation.

#### (e) HERBICIDE CONTROL/CHEMICAL MANAGEMENT

Chemical management or herbicidal control is the most widely used to control the growth of *Parthenium hysterophorus*. However, now we focus on bioherbicides but it is not effective as chemical herbicides till now. Chemical herbicides which are commonly used are glyphosate @ 2.5 kg/ha-1, atrazine @ 2.6 kg/ha-1, bromoxynil @ 0.56 kg/ha-1,

common salt @ 20%, 2,4-D amine @ 3 l/ ha-1, 2,4-D ester @ 4 l/ ha-1, Floumeturon @ 2.24 kg/ ha-1, Hexazinone @ 3.5 kg/ ha-1, Metribuzin @ 0.7 kg/ha-1, Norflurazon @ 2.24 kg /ha-1 and Paraquat 0.5 l/ ha-1. These herbicides are well known for their ability to control this weed. (16, 39,41,27).

The stage and time of the rosette stage is the right time to apply post emergent herbicides in wasteland, non-cropped areas, along railway tracks, water canals and roadsides (Khan et al., 2012). Very effective treatments for *P. hysterophorus* control were noticed glyphosate and metribuzin, having higher effect at 28 after the herbicide application. Applications of herbicides further divided into two branches which are as follows-

### (1) Non-cropping areas

*Parthenium* should be eradicated by herbicide treatment early before it can set seed. Small and isolated areas of infestations can be treated immediately. Repeated spraying is necessary to prevent seed production. Spraying should be done before the flowering when the plants are small. Active growth of other grasses could be prompted for simultaneous control of the weed. Some of registered herbicides to control *Parthenium* weed are: atrazine, 2, 4-D+picloram (trodon 75-D) 2,4-D ester, glyphosate, metasulfuron methyl (for seedlings only), hexazinone, dicamba, etc (CRC 2003). These herbicides in different concentrations are effective for spot spray or boom spray or both.

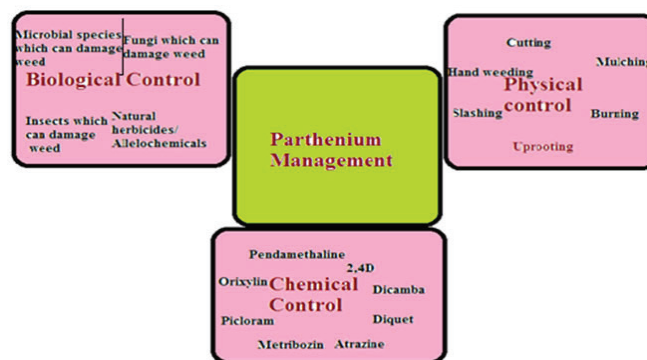
### (2) Cropping areas

Chemical herbicides can be used in non-cropping area without any problem but it is little bit risky to practise these herbicides in cropping areas because these can harm crop plants. So use of chemical fertilizers in agriculture land requires precautions to choose the herbicides so that it can not harm crop plants. The biological or natural herbicides, like the volatile oils from aromatic plants in very low concentration are quite helpful on such areas to abort *Parthenium* seeds (42). These essential oils have no or little effect on the existing vegetation/crops (13). Observations have revealed that essential oils from different plants such as *Eucalyptus* sp., *Ageratum*, *Lantana camara* etc. can be used for the control of *Parthenium*.

#### (f) BIOLOGICAL CONTROL

Biological control might be one of the best methods for controlling the *Parthenium* weed dispersal. It can be done by the use of insects which can feed on *Parthenium* hysterophorus and we can also used fungi, bacteria and plants which have adverse effects on *Parthenium*. The moth *Epiblema strenuana* (introduced from Mexico) has been established in all *Parthenium* dominated areas. The moth's larvae feed on the stem of the weed and forms ball which inhibit the plant growth. Some other released insects which are found to be beneficial

in controlling the weed.



**Figure 4:** Management of *Parthenium hysterophorus* by Chemical, Physical and Biological methods.

#### (g) CONTROL BY OVER USE OF THE WEED

This weed can be managed by enhancing its utility for different purposes. It can be extensively used for biogas production, as green manure and flea-repellant and herbicide. Over-exploitation of *Parthenium* for its beneficial use thus should be prompted in the developing countries like India where implementation of other alternative and expensive control measures is difficult.

### (9) UTILIZATION OF PARTHENIUM

#### (a) Use as a Traditional Medicinal plant

*Parthenium hysterophorus* accidentally entered India in 1910 with the germplasm of cereal grains, and is now considered as an obnoxious weed in our country (37). The noxious impacts of *Parthenium* have been well documented not for human health but also for livestock and native plant species. It causes serious effects like asthma, bronchitis, dermatitis (allergic reaction), and hay fever in human being. Despite this problem it has also been used in industry for its noxious, insecticidal, nematicidal and herbicidal properties as well as for composting (Sastri and Kavathekar 1990). The bisque of root used as remedy for amoebic dysentery. The sub-lethal doses of parthenin extract help in reducing cancerous activity in the cells of mice. Investigations also revealed that *Parthenium* can be used to cure the hepatic amoebiasis, neuralgia and certain types of rheumatism (40). In America, it is applied externally on skin as remedy for a wide variety of diseases. In Jamaica, the elixation is used to kill the flea in animals (8).

#### (b) Antifungal:

As mentioned earlier *Parthenium* have antifungal effects on different fungal species. This quality of *Parthenium* can be used to cure the human and animal fungal diseases. Antifungal potential of different extracts of *Parthenium hysterophorus* against human pathogenic fungi were investigated by Rai (36) and Rai (35). Fungi related to dermatitis found sensitive

to sequester terpenoid lactone found in *Parthenium hysterophorus* and it can be used for the remedy of skin diseases (37).

#### (c) Antioxidant:

*Parthenium hysterophorus* methanolic extracts showed high antioxidant effect. Therefore, it can be utilized as natural antioxidants. It is naturally available antioxidant, if it will be commercially available it can replace synthetic antioxidant which have harmful impacts on human health (18). It is more valuable to produce antioxidant naturally after the research that synthetic antioxidants have high carcinogenicity in comparison to naturally produced antioxidant.

#### (d) Antitumor:

*Parthenium hysterophorus*'s methanolic extract obtained from flower revealed antitumor activity in mice having transplantable lymphocytic leukemia. Level of neoplastic markers like glutathione, cytochrome P-450, glutathione transferase and UDP-glucuronyl transferase adjusted significant consequently backing off the advancement of tumors and expanded survival of animals (28).

#### (e) Antimicrobial:

*Parthenium hysterophorus* exhibits strong antimicrobial and antifungal activity. It inhibits the growth of rhizosphere flora such as *Rhizobium*, *azotobacter*, *Rhizospirillum* as well as it can inhibit bacterial and fungal growth such as those of *A. niger*, *F. oxysporum*, *C. albicans*, *S. aureus*, and *E. coli* etc..

#### (f) Larvicidal:

Use of synthetic insecticides to control insects and their larvae are extensively used but these are not eco-friendly source to kill the insects and their larvae because these are not safe for humans, having detrimental impacts on effects on environment as non bio-degradable and hazardous effect on livestock. It can cause biomagnification which results in loss of biodiversity. Investigations on *Parthenium* revealed its larvicidal properties which can be used to control larvae of different insects such as mosquitos and aphids which harm human health and crop plants respectively. Larvicidal potency of *Parthenium* aqueous extract against *Aedes aegypti* larvae and other mosquito larvae. (21). The leaf extract of this weed showed remarkable decline in reproductive capacity and lifetime of *Lipaphis erysimi* (44). However more research is needed to explore the larvicidal components of *Parthenium* and their commercialization.

#### (g) *Parthenium*'s compost:

The *Parthenium hysterophorus* is a good source of micro- and macro-nutrients and thus can be used as alternative of compost (18). These macro and micro elements are present in this weed in excessive amount, so due to this property, it can be utilized to furnish crop plants. However, this plant have high quantity of essential oils and phenolics which have

detrimental impacts on the growth, yield and reproduction capacity of crop plants it cannot be used directly. Although, *Parthenium* can be used as compost and biofertilizers, it gives better results when applied with *Eichhornia crassipes*. Observation revealed that *Parthenium* with *Eichhornia* not only decrease the harmful effect of *Parthenium* but also enhance its available nutrient content. (17).

Vermicomposting is also a remarkable strategy for the management of *Parthenium*, it has also been enhance its nutrients and overcome the allelopathic capacity (47). In vermicomposting, phenolic components of *Parthenium* is remarkably decrease, it also decrease heavy metal percentage and toxic substances. There is significant increase in selected macronutrients (N,P,K) and decrease in organic carbon in *Parthenium* compost, which is suitable for organic farming.

#### (h) Pesticidal effects:

*Parthenium* have insecticidal activity due to the presence of phenolic compounds such as Parthenin. Parthenin is the major volatile compound of *Parthenium* having phytotoxic and insecticidal activity against different insects such as *Spodoptera litura*, *Callosobruchus aculatus*, *Cassia tora* and *Meloidogyne incognita*, and their larvae. Pyrazoline adduct, saturated lactone, and propenyl derivatives of parthenin showed remarkable phytotoxic and nematocidal activities. (6).

#### (i) Heavy metal and dye removal:

*Parthenium hysterophorus* can be used in phytoextraction or removal of heavy metals. *Parthenium* treated with HCl noticed for the removal of Ni and dye absorbing efficiency from industrial wastes. Although it is depend upon the pH for example Nickel removal was significant at pH 5.0 and its dye absorbing capability can replace the commercially available adsorbents. Heavy metals which can experimentally absorbed by *Parthenium* are Ni, Cd, Cu, Co and Zn etc. Activated carbon prepared from *Parthenium* showed cresol (a phenol derivative) adsorbing ability comparable to commercial grade activated carbon (34). As, heavy metals and dyes have carcinogenic properties these are harmful for human health so their removal is necessary. *Parthenium* can be a better, eco-friendly and cheaper resource of dye and heavy metal absorbent. (17).

#### (j) *P. hysterophorus* as substrate for enzyme production

Xylans are almost as ubiquitous as cellulose in plant cell walls and contain predominantly  $\beta$ -D-xylose units linked as in cellulose. Xylans are cleaved by the hydrolytic enzyme Xylanases. The end products of xylan degradation can be used as a source of energy (biofuel), as a sugar alternative, textile industry, bakery products and in the clarification of fruit extracts. It can be used in paper industries also. Dwivedi et al. (2009) observed that *Parthenium hysterophorus* can be used as raw material for the xylanase production. High level of the enzyme production with *Parthenium hysterophorus* as

a raw material confirms the feasibility of using this weed as an alternative carbon source for cost effective enzyme production process (9).

#### (k) *P. hysterophorus* as substrate for biogas production

At this time when we face the oil crisis there are requirement of alternative source of energy generation, bio-wastes can be a good example of these source and has attracted immense attention. Plants which can be used as alternate energy source(ex.- *Jatropha*) likely to be future sources of digester feed stocks for methane generation. *Parthenium hysterophorus* can be used for the production of biogas. It can be used with cattle manure and apply to anaerobically digest at room temperature in batch digesters. Production of biogas when *Parthenium* is digest with cattle manure anaerobically (12). *Parthenium hysterophorus* can be used as a substrate for the production of biogas, it will not only control this weed but can be useful and eco-friendly alternate of limited energy sources.

**Table 3: Utility potential of *Parthenium hysterophorus***

Parthenium hysterophorus source (as used)	Uses
Whole plant	Source of dye
	In phytoremediation
	Bioadsorption
	Plant enzyme extraction for dye degradation
	Oxalic acid preparation
	Folk remedies
	Source of edible protein
	vermicomposting
	composting
	As green manure
Plant extract	Biochar preparation
	Weed control
	Nanoparticles synthesis
	Corrosion inhibition
	Growth promotion in some crops
	In a limited amount
Plant lignocellulose	Feed additive for silkworm
	Substrate for xylanase production
	Lignin extraction
	Biogas production
	Biofuel production
	Pulp and paper marketing
	Production of cellulose and its derivatives

## CONCLUSION

It can be concluded from the present review article that we cannot decline the allelopathic and negative impacts of *Parthenium hysterophorus* on crop plants and livestock. This weed spread more rapidly in compare to other weeds. It covers many areas of agriculture lands as well as bare lands. At the present time of population explosion in India, it is necessary to use lands properly for agriculture as well as forestry. It is necessary that we can use every resource of nature for the improvement. We can control this weed through its management and it would be happen when we have the proper knowledge about the beneficial and harmful effect of *Parthenium*. When we have proper knowledge of we can use it in different prospective which we have discussed above. This is not about the *Parthenium* although it should be apply for other weeds also.

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## REFERENCES

- Adkins, S and Shabbir, A., 2014. Biology, ecology and management of the invasive parthenium weed (*Parthenium hysterophorus* L.). *Pest Manag. Sci.*; 70(7): 1023-1029.
- Akter A and Zuberi, MI., 2009. Invasive alien species in Northern Bangladesh: Identification, Inventory and Impacts. *Intl. J. Biodivers Conserv*; 1(5): 129-134.
- Annapurna, C, and Singh, J S.,2003. Variation of *Parthenium hysterophorus* in Response to Soil Quality: Implications for Invasiveness. *Weed Research*; 43 (3): 190–198.
- Bailey LH.,1960. *Manual of cultivated plants*, Macmillan, New-York.
- Bhowmik, PC and Sarkar, D., 2005. *Parthenium hysterophorus* L.: Its World Status and Potential Management. *International Conference on Parthenium Management, Bangalore*; 1-6.
- Datta, S and Saxena, DB.,2001. Pesticidal properties of parthenin (from *Parthenium hysterophorus*) and related compounds. *Pest Manage. Sci*; 57: 95-101.
- Dogra et al.,2011. Distribution, Biology and Ecology of *Parthenium hysterophorus* L. (Congress Grass) an invasive species in the North-Western Indian Himalaya (Himachal Pradesh). *African Journal of Plant Science*; 5(11): 682-687.
- Dominguez, XA and Sierra, A.,1970. Isolation of a new diterpene Alcohol and parthenin from *Parthenium hysterophorus*. *Planta Medica*; 18:275-277.
- Dwivedi et al., 2009. *Parthenium* sp. as a plant biomass for the production of alkali tolerant xylanase from mutant *Penicillium oxalicum* SAU- 3.510 in submerged fermentation. *Biomass Energy*; 33:581-588.

10. Ellis, JL, Swaminathan, MS.,1969. Notes on some interesting plants from south India. *Journal of the Bombay Natural History Society*; 66: 233-234.
11. Gunaseelan, V N., 1987. Parthenium as an additive with cattle manure in biogas production. *Biol. Wastes*;21: 195–202.
12. Gunaseelan, VN., 1998. Impact of anaerobic digestion of inhibition potential of *Parthenium* soils. *Biomass Bioenergy*; 14:179–184.
13. Isman, MB.,2000. Plant essential oils for pest and disease management. *Crop Protection*; 19:603- 608.
14. Javaid, A and Anjum, T, 2005. *Parthenium hysterophorus* L. — a noxious alien weed. *Pakistan Journal of Weed Science Research*;11:1–6.
15. Joshi, S.,1991. Biological control of *Parthenium hysterophorus* L. (Asteraceae) by *Cassia uniflora* Mill (Leguminosae) in Bangalore, India. *Tropical Pest Management*; 37: 182-186.
16. Kathiresan et al.,2005. Ecology and control of *Parthenium* invasion in command area. *Conference on Parthenium Management. Bangalore, India*: 77-80.
17. Khaket et al., 2015. *Parthenium hysterophorus* in current scenario: A toxic weed with industrial, agricultural and medicinal applications. *J. Plant Sci*; (10): 42-53.
18. Khan et al., 2011 Nutritional investigation and biological activities of *Parthenium hysterophorus*. *Af. J. Pharm. & Pharmacol*; 5 (18): 2073-2078.
19. Khosla, S N and Sobti, S N.,1981, Effective control of *Parthenium hysterophorus* L. *Pesticides*;15:18-19.
20. Kohli et al., 2006. Status, invasiveness and environmental threats of three tropical American invasive weeds (*Parthenium hysterophorus* L., *Ageratum conyzoides* L., *Lantana camara* L.) in India. *Biological Invasions*; 8:1501– 1510.
21. Kumar et al., 2011. Impact of *Parthenium hysterophorus* leaf extracts on the fecundity, fertility and behavioral response of *Aedes aegypti* L. *Parasitol. Res*; 108: 853-859.
22. Kumar, S. 2014. Spread, maintenance and management of *Parthenium*. *Indian Journal of Weed Science*; 46(3):205–219.
23. Kumar, S. and Varshney J G., 2007. Biological control of *Parthenium* : present and future, *National Research Centre for Weed Science*, Jabalpur, India; pp-157.
24. Kumar,S 2009. Biological control of *Parthenium* in India: status and prospects. *Indian Journal of Weed Science* ;41(1&2) : 1-18.
25. Kumar,S., 2012. Current spread, impact and management of *Parthenium* weed in India. *International Parthenium News*;5: 1-6.
26. Kumari et al., 2014. Impact of *Parthenium hysterophorus* L. invasion on species diversity of cultivated fields of Bilaspur (C.G.) India. *Agricultural Sciences*; 5: 754-764.
27. Mishra, JS and Bhan, VM., 1994. Efficacy of sulfonyl urea herbicides against *Parthenium hysterophorus*. *Weed News*; 1: 16.
28. Mukherjee, B and Chatterjee, M., 1993. Antitumour activity of *Parthenium hysterophorus* and its effect in the modulation of biotransforming enzymes in transplanted murine leukaemia. *Planta Medica*; 59(6): 513-516.
29. Murthy et al., 1977. *Parthenium*, a new pernicious weed in India. *University of Agricultural Sciences, Technical Series*;17: pp- 66.
30. Navie S, 2003. *The biology of Parthenium hysterophorus* L. in Australia. PhD Thesis, The University of Queensland, Brisbane, Australia.
31. Nigatu et al., 2010. Impact of *Parthenium hysterophorus* on grazing land communities in North-Eastern Ethiopia. *Weed Biol. Manage*;10: 143-152.
32. Prakash et al., 2017. Medicinal Plant Resources of Western Uttar Pradesh State of India. *IOSR Journal of Environmental Science, Toxicology and Food Technology*; 11( 1): 01-12.
33. Pandey et al., 2003. Growth, reproduction, and photosynthesis of ragweed parthenium (*Parthenium hysterophorus*). *Weed Sci.*; 51:191–201.
34. Patel, S., 2011. Harmful and beneficial aspects of parthenium hysterophorus: an update. *Biotech*;(1): 1-9.
35. Rai MK., 1995. Comparative antimycotic activity of different parts of *Parthenium hysterophorus* L. *World Weeds*; 2 : 53-57.
36. Rai MK and Upadhyay SK., 1990. In vitro efficacy of different extract of *Parthenium hysterophorus* Linn. Against human pathogenic fungi using different techniques. *Indian J. Pathol. And Microbiol.*; 33(2): 179-181.
37. Rai et al., 2003. Plant derived antimycotics: Potential of Asteraeous plants. In *Plant derived antimycotics: Current Trends and Future prospects* : *Howorth Press, N-York, London, Oxford*: pp. 165-185.
38. Rao, R S., 1956. *Parthenium*, a new record for India. *Journal of Bombay Natural History Society*; 54 : 218-220.
39. Reddy, K N and Bryson, CT., 2005. Why ragweed parthenium is not a pernicious weed in the continental USA. *Conference on Parthenium Management. Bangalore, India*: 61–64.
40. Sharma GL and Bhutani KK., 1988. Plant based Antiamoebic drugs part ii :Amoebicidal activity of parthenin isolated from *Parthenium hysterophorus*. *Planta Medica*; 54(2):120-122.
41. Singh et al., 2003.Assessment of allelopathic properties of *Parthenium hysterophorus* residues. *Agric Ecosys Environ*; 9:537–541.
42. Singh et al., 2005. Herbicidal activity of volatile oils from *Eucalyptus citriodora* against *Parthenium hysterophorus* L. *Annal. App. Biol.*;146: 89-94.
43. Singh et al., 2004. Control of Ragweed *Parthenium (Parthenium hysterophorus)* and Associated Weeds. *Weed Technology* ;18 (3): 658–664.
44. Sohal et al., 2002. Evaluation of the pesticidal potential of the congress grass, *Parthenium hysterophorus* Linn. on the mustard aphid, *Lipaphis erysimi* (Kalt.). *J. Environ. Biol*; 23: 15-18.
45. Sukhada, KD and Jaychandra 1981. Effect of *Parthenium hysterophorus* on nitrogen fixing and nitrifying bacteria. *Canad. Journ of Bot.*; 59: 199-202.
46. Williams, JD, and Groves, RH., 1980. The Influence of Temperature and Photoperiod on Growth and Development of *Parthenium hysterophorus*. *Weed Research* ;20 (1): 47–52.
47. Yadav, A and Garg, VK., 2011. Recycling of organic wastes by employing *Eisenia fetida*. *Bioresour. Technol*; 102: 2874-2880.
48. Yaduraju et al., 2005. *Parthenium hysterophorus* L. distribution, problems and management strategy in India. *International Conference on Parthenium Management Bangalore, India*; 6-10.