International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133, Print ISSN: 2664-7125
Received: 15-07-2024, Accepted: 14-08-2024, Published: 29-08-2024
Volume 6, Issue 3, 2024, Page No. 107-112

Study on *Parthenium hysterophorus* a most dangerous weed to ecosystem

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Abstract
Parthenium grows luxuriantly in wastelands, public lawns, orchards, forestlands, flood plains, agricultural areas, urban areas, overgrazed pastures, industrial areas, playgrounds, roadsides, railway tracks and residential plots. Invasive plant species have the potential to damage crops, industries, environment and public health, hence scientists, academicians, leaders of industry and land managers are realizing that invasive species are serious environmental threats for the 21st century. 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 bio-diversity. 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. Parthenium weed is an annual heterophilic herb in the family Asteraceae. It is spreading across the whole country. It gets easily established in almost all the places such as wasteland, roadsides, forests, railway tracks, crop fields, etc. Its high germination ability throughout the year, an enormous seed bank, rapid spread, colonization and extreme adaptability in a wide range of habitats is responsible for its wide spread occurrence. It was reported to be one of the most dangerous weeds of the world. Its flourish in short period due to its fast multiplication, rapid growth and its ability to compete with other native flora. There are many ways like mechanical, chemical, cultural and biological to control it, but it cannot be controlled by using multiple approach. Integrated approach should be the better way to manage this noxious weed. Present review explores the possibility through knowing habitat, distribution, biology, ill effects and properties and management of *Parthenium hysterophorus*.

Keywords: Overgrazed pastures, noxious weed, adaptability, deliberately, environmental threats

Introduction

Parthenium hysterophorus L. is commonly called as congress grass, carrot weed, white cap weed etc. Some of the vernacular names by which Parthenium is known are chatak chandani, broom brush, gajar ghas and safed topi. *Parthenium hysterophorus* is an aggressive annual herbaceous plant. It is among the top ten worst weeds of the world and has been listed in the global invasive species database (Aneja, 1991, 1998) [2]. 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 (Adkins and Shabbir, 2014) [1].

Parthenium is regarded as one of the worst weeds because of its immense capacity of reproduction and ability to thrive in varied climatic conditions, to spread fast due to light and floatable tiny seeds, impact upon human health and environment. These attributes make this plant an invincible weed. Parthenium is an annual herb with a deep tap root and an erect main stem that becomes woody with age having high cellulose content (Kaur *et al*., 2014) [15].

As Parthenium does not reproduce vegetatively from plant parts, hence seeds dispersal is the only method of reproduction. In summer, plants can flower and set seed four weeks after germination because they are stressed and small. Buried seeds have been found to last much longer than seeds on the soil surface. This noxious invasive species is considered to be one of the worst weeds currently known. *P. hysterophorus* L. of the family Asteraceae is fast maturing, erect and much branched annual or ephemeral herb. It shows two distinct phases in life juvenile, rosette or the vegetative stage and adult, mature or the reproductive stage. The juvenile stage exhibits a rosette with large, dark green, simple, radicle, pinnetisect small leaves lacking flowering. The adult stage is erect, much branched with deep tap root system that reaches up to 2 m in height (Lakshmi & Srinivas, 2007) [23]. *Parthenium hysterophorus* is an annual weed plant with a deep taproot and an erect main stem. The weed usually grows to a height of 1-1.5 m, sometimes it can grow as high as 2 m. Its main stem is green when young but becomes woody at maturity, highly branched bearing flowers at the top of each branch. The branching gets highly increased at the time of flowering to bear more flowers and produce large number of seeds. Its leaves are deeply-lobed, pale green and covered with soft and fine hair up to 30 cm in length, close to the soil, alternate, sessile, irregularly dissected having small hair on both the sides. The number of leaves per plant ranges from 6 to55(APFISN). Flowering occurs after one month of germination. The fruit is called cypsela, each flower contains five seeds which are wedge shaped, black, 2mm long with thin white scales. A single plant can produce up to 100000 seeds in its life cycle. Seeds do not have dormancy period and are capable of germinating any time when moisture is available. The highest germination rates are at temperature from 12-27°C (Iqbal *et al*., 2014). The spread of seeds plus their ability to remain viable in the soil for many years pose one of the most complex problems for control (Monaco *et al*., 2001) [25]. Its growth remains less and stunted from November to January due to severe cold (Aneja 1991, 1998) [2]. It has been recorded as viable for up to 6 years and anecdotal evidence suggests even longer period (Gnanavel, 2013) [10].

Parthenium weed is an extremely prolific seed producer, with up to 25,000 seeds per plant (Navie *et al*., 1996) [28] and

with an enormous seed bank, estimated at 2,00,000 seeds/m2 in abandoned fields (Joshi, 1991) [14]. Seeds of Parthenium can germinate any time of the year, given suitable moisture levels, remain viable for a long time and can thrive under very harsh environmental conditions (Williams & Groves, 1980) [42]. Parthenium inhibits the germination and growth of other plants by allelopathy. Kumari *et al*. (1985) [22] showed that cell survival and chlorophyll content were markedly reduced when Parthenium extracts were directly sprayed on the crop plants. All parts of the Parthenium plant at any stage of growth are toxic to humans and animals (Anonymous, 2004) [3]. 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 (Shabbir, 2011).

Phytotoxins of this plant are released from the decomposing biomass and root exudates in the soil. The weed also acts as an alternate host for many diseases, notable being the diseases in Capsicum and tomato. These weeds rapidly invade new surroundings often replace the indigenous species and pose a serious threat to biodiversity. The major component which cause toxicity is 'parthenin' and other phenolic acids such as caffeic acid, vanillic acid, anisic acid, p-anisic acid, chlorogenic acid and para-hydroxy benzoic acid which are lethal to human beings and animals (Mahadevappa, 1997) [24]. It can taint sheep meat and make dairy milk unpalatable due to its irritating odour. When animals eat the Parthenium weed, their milk become bitter and when children drink this milk, it increases the secretion of intestine and decreases the absorption and they develop diarrhoea. If eaten by animals, it is responsible for mouth ulcers with excessive salivation. Significant amount (10-50%) of this weed in the diet can kill cattle (Narasimhan *et al*., 1977) [27]. Parthenium also caused acute illness when it was mixed with cattle fodder (Aneja, 1991). Contact of plant with the body causes dermatitis and the spread of problem all over the body causes great discomfort (Wiesner *et al*., 2007) [41]. Parthenium is spreading at an alarming rate all over India (Kumar *et al*. 2009) [19] and can adopt any climate very easily. Itsbroad-spectrum ovicidal, antimicrobial, larvicidal, nematocidal, herbicidal activities designate the improvement of public health and crop production (Bhatt *et al*., 2012) [5]. It is also used as an additive with cattle manure in biogas production (Patel, 2011) [31].

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 frequent hazard to biodiversity. Exotic weeds reduce farm land, Orchard 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. *Parthenium hysterophorus* is an invasive weed plant of family Asteraceae. This erect, short-lived plant known for its flourishy 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 grasswild feverfew, ragweed, bitter weed, white top, and the "Scourge of India."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 (Prakash *et al*., 2017) [32].

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. *Parthenium hysterophorus* produce a huge quantity of seeds with up to 15-25,000 seeds per plant (Navie, 2003) [29] with a tremendous seed bank, estimated about 2,00,000 seeds/m2 in bare lands and agriculture field (Joshi, 1991) [14]. 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 (Williams, & Groves,1980) [42].

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 complete its life cycle within 4-5 weeks. This noxious weed suppresses 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) [20] 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. *Parthenium hysterophorus* is unpalatable to the animals. Generally, animals do not eat *Parthenium hysterophorus* because of its bitter taste and intense odour (Javaid, & Anjum, 2005) [13].

Earlier investigations in India had revealed its serious health hazards to the livestock in *Parthenium hysterophorus* invaded areas. Being unpalatable, it cannot use as animal fodder and its population is increasing day by day unless mechanically removed 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 complete its life cycle within 4-5 weeks. 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-sensitivity, 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 a local biodiversity

gradually decreases where this plant is pre-sent, 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 some important factor which are the reason of its luxurious growth and spread (Kumar, 2014) [20].

The concentrations of allelochemicals *viz*. Coronopilin, caffeic acid, parthenin, and p-coumaric acid which are present in Parthenium have serious allelopathic effects. The *Parthenium hysterophorus* weed has infested in a large area of india (Kumar, 2009) [19]. This plant contains parthenin, hysterin, hymenin, and ambrosin. Due to the presence of these allelochemicals this weed has strong allelopathic impacts on different crops and human being also (Gunaseelan, 1987). 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 up to 40% in legume crops (Khosla, & Sobti, 1981) [18]. 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 Legheamoglobin content of root nodules by which Rhizobium-legume symbiosis is affected. Leaf and root leachates and their chemical component inhibit nitrate production (Sukhada, & Jaychandra, 1981) [38]. Besides these it can inhibit the growth of algae and mycorhyzzae associated to crop plants because of its fungicidal property (Megharaj *et al*., 1987).

Parthenium weed is noxious for livestock, it can cause dermatitis and skin disorders in animals. 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 reduce the total WBC count in animals which results in the weakening of immune system. 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, tetraneuris, 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.

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 gave proper attention towards the remedy to control Parthenium. Many researches are going on for finding the cheap and best way for its control. Another commonly practiced way of controlling *Parthenium hysterophorus* weed is burning. Mass vegetation of the weed can be destroyed by this practice. But it cannot be considered as safe control strategy for the weed since there is great risk to soil, air and existing plant and animal diversity. 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 livestocks populations decreases the vigor and diversity of grassland that enable the spread of *Parthenium hysterophorus* weed luxriously. So, maintenance of correct stock number might be fruitful in the control of Parthenium weed dispersal (Nigatu *et al*., 2010) [30]. 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.

During winter grazing generally safe since the period has low risk of Parthenium spread. However, Parthenium may grow and germinate in this time also. Another commonly practiced way of controlling *Parthenium hysterophorus* weed is burning. Mass vegetation of the weed can be destroyed by this practice. But it cannot 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 (Kumar, 2014) [20]. Chemical management or herbicidal control is the most widely used to control the growth of *Parthenium hysterophorus*.

The weed can be managed by enhancing its uses for different objectives. It can be extensively used for production of biogas, green manure, herbicide and flea-repellant. 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.

Parthenium hysterophorus accidently entered India in 1910 with the germplasm of cereal grains, and is now considered as an obnoxious weed in our country (Rai *et al*., 2003) [33]. The harmful effects of Parthenium have been well documented not for human health as well as for livestock and native plant species. It causes serious ill effects like asthma, bronchits, dermatitis 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 & Kavathekar, 1990).

The bisque of root used as remedy for amoebic dysentery. The sublethal 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 (Sharma and Bhutani,1988) [35]. 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 (Dominguez & Sierra, 1970) [9]. Parthenium have antifungal effects on different fungal species. This quality of Parthenium can be used to cure the human and animal fungal diseases.

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 inhance its available nutrient content. (Khaket *et al*., 2015) [16]. In Jabalpur, replacement of

Parthenium by *Cassia tora* has been well demonstrated along the road side by Sushil kumar (2011).

Vermicomposting is also a remarkable strategy for the management of *Parthenium*, it has also been enhancing its nutrients and overcome the allelopathic capacity (Yadav & Garg, 2011) [43]. In vermicomposting, phenolic components of Parthenium is remarkably decrease, it also decreases heavy metal percentage and toxic substances. There is significant increase in selected macronutrients and decrease in organic carbon in Parthenium compost, which is suitable for organic farming.

In a nationwide survey under coordinated project sponsored by Department of Biotechnology (DBT), India, plant species namely *Xanthium strumarium*, *Tephrosia purpurea*, *Achyranthes aspera*, *Vitex negundo*, *Cassia sericea*, *Cassia tora*, *Cassia spp*. and *Cannabis sativa* were found to be competitive against the weed. *X. strumarium*, *T. purpurea*, *Cassia sericea* and *Cassia tora* were found most abundant species in wasteland, community land and along the road and railway track sides. Use of fire was tried in Australia to manage the weeds, but it did not prove practicable due to fast germination of Parthenium from the available seed bank in the soil in the niche vacated by the fire in the absence of vegetation (Vogler *et al*. 2000).

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 deferent 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 nematicidal activities (Datta, & Saxena., 2001) [6]. Parthenium can be a better, eco-friendly and cheaper resource of dye and heavy metal absorbent (Khaket *et al*., 2015) [16]. (Dwivedi *et al*., 2009) [8] 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. Production of biogas when Parthenium is digest with cattle manure anaerobically (Gunaseelan, 1998) [11]. *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. The *Parthenium hysterophorus* is a good source of micro- and macro-nutrients and thus can be used as alternative of compost (Khan *et al*., 2011) [17]. Overgrazing due to the explosive increase in livestocks populations decreases the vigor and diversity of grassland that enable the spread of *Parthenium hysterophorus* weed luxriously. So, maintenance of correct stock number might be fruitful in the control of Parthenium weed dispersal (Nigatu *et al*., 2010) [30]. Weed is found in plenty in the nearby agricultural lands, abandoned land and on the bank and the basin of rivers (Murthy *et al*., 1977) [26]. Vermicomposting of *P. hysterophorus* is possible for the management of this invasive weed through polyculture of the earthworm E. foetida and E eugeniae to obtain a value-added organic fertilizer i.e. vermicompost (Devi & Khwairakpam, 2021) [7]. 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 (Singh *et al*., 2005) [36]. The leaf extract of this weed showed remarkable decline in reproductive capacity and lifetime of Lipaphis erysimi (Sohal *et al*., 2002) [37]. These essential oils have no or little effect on the existing vegetation/crops (Isman, 2000) [12].

Result and Discussion

Parthenium hysterophorus, one of the world's most invasive weeds, is known for enormous losses to the biodiversity, agriculture as well as the health of human beings and animals. It is an immensely prolific weed and most awful in crop production which devastated all the useful crops. However, various studies revealed that Parthenium can be used in agriculture in different form. In agriculture, it can be used as biopesticides, green manure, compost, soil amendment values, and vermicomposting. Parthenium in agriculture is used as a green manure. It can be used as bio-pesticides, biochar preparation, mulching, vermicomposting, phytoremediation processes. Addition of Parthenium leaf manure during vegetables cultivation leads to increase in height of plants, yield of grains and straw, with no any appearance of weed during vegetable cultivation. Green leaf manure has shown remarkable increase in number of filled grains in ratoon rice crop. It is a competitive weed, so it consumes more nutrients from the soil hence, the plant is rich in nutrients. During premature stage the plant is uprooted from field and burying it in the soil produces higher quality organic manure. Green manure and compost used improves the physical, chemical and biological properties of soil, increased the yield of agricultural crops. Due to its insecticidal and pesticidal properties it can be used to control several insect pests in agricultural crops. Cuttings of *Parthenium* with the sword enhance its regeneration because large numbers of shoots are emerge out from the cut stems and flowers are produced on such shoots early than the normal plant. Therefore, cutting should be avoided under physical management. If mechanical or manual methods are to be adopted, *Parthenium* should be uprooted completely before flowering.

Parthenium hysterophorus

Conclusion

It can be concluded from the present article that we cannot be abolish the allelopathic and negative effect of *Parthenium hysterophorus* on crop plants and livestock. This weed multiply more rapidly in comparison to other weeds. It covers most of the areas of agricultural and barren lands. Due to population explosion it is necessary to use lands properly for agriculture as well as forestry to use every resource of nature for the improvement. We can control this weed without proper knowledge about the beneficial and harmful effect of Parthenium. Due to high propagative potential, fast growing rate, allelopathic potential, indigestible to animals are main adaptability that made this weed cosmopolitan. Parthenium is a weed although it should be apply for other weeds also. Chemical herbicides can be used in non-cropping area without any problem but it is little bit risky to practicise 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 cannot harm crop plants. 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.

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