

Biological Management of Allelopathic Plant *Parthenium* Sp.

Rinzim Rinzim, Anupam Tiwari

**School of Bioengineering and Bioscience, Lovely Professional University,
Phagwara-Punjab-India**

Abstract

Globally, weeds have been figured as a major threat and act as an obstacle for crop production, even though the farmers put tremendous effort to eliminate the weeds to get a better yield. Weeds stayed as a steady threat to productivity and manageability for soil and environment, regardless of many years of research and advances in management practices. *Parthenium hysterophorous* is widely viewed all around the world including India as a serious and unsafe weed. It is responsible for many health risks in human and animal. It gives problems to the human respiratory system and also causes allergies to some people. Experts tried with a different biological method like insects, beetle, microorganism and many pathogens which caused broad disperse damage to *Parthenium*. Biorational weed control is also offered by allelopathy by the production and quality of allelochemical from the leaf, blossoms, grains, nuts, bud, berry, trunk and organization of living or decaying plant substance. The allelochemical may be released in different quantities under suitable condition, inhibits the developing seedling. Allelochemical is selective in nature, much like synthetic herbicides.

1. Introduction

A basic definition for a weed from a human point of view would be ‘an undesirable plant’, and this normally implies that a weed in one place may not be a weed in another. Weeds are not constantly accommodated into a similar classification of ‘pest’ as insects and other invertebrate or vertebrate pests. Most weeds do not affect humans directly and their threat to

humans is not severe but some weeds like *Parthenium* have a great health effect in human [1].

Any organism that is harmful to human is known as a pest. In line with it, weeds are essential pests since they occupy open-air spaces in the community environment, for example, gardens, parks, yards, lawn, scenes, and landscapes. Generally, weeds have the capability to invade, proliferate, and survive among the incorporating desired plants [2]. Numerous weeds can likewise survive in stressful environment conditions [3].

In about last few decades, the elimination of invasive plants was done with the application of synthetic (chemical) herbicides. Such kind of herbicides can cause environmental damage and also it also harms living organisms including human. The resistance of invasive herbs grew stronger with the misuse of the chemical herbicides. Hence, we can consider the use of bioherbicides a positive, environmentally and economically sustainable alternative [4].

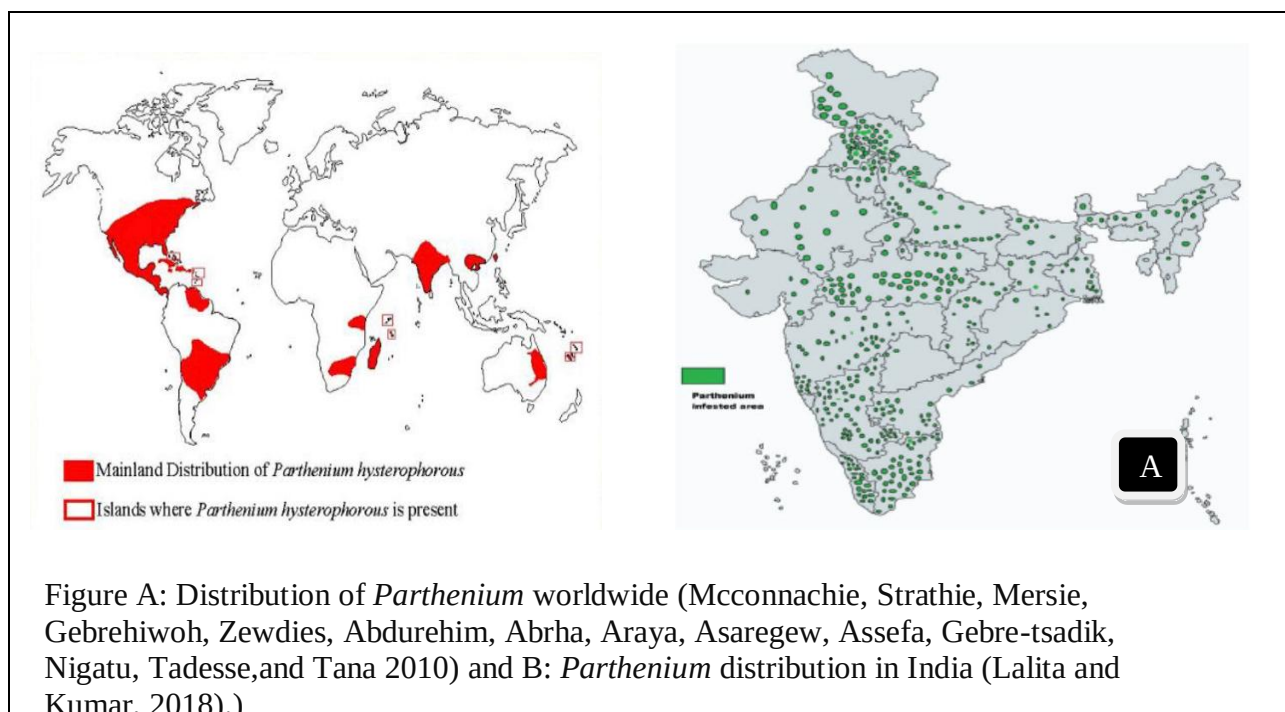
Generally, the weeds are of three types based on the morphology of the plant such as grasses, sedges, and weeds. Based on their life cycle they are annual, biennial and perennial. *Parthenium hysterophorus* is an annual herb that takes over the weak pastures with thin vegetation. Empty places near roadsides and around play area are readily colonized and disturbed by *Parthenium*. It can also colonize with some trees like brigalow, gidgee and softwood scrub soil. The existence of *Parthenium* decreases the stability of improved grazing land establishment which also reduces pasture production [5]. *P. hysterophorus* is the product of natural hybridization between *P. confertum* and *P. bipinnatifidum*. *P. hysterophorus* can thrive in a hostile environment and suppress the growth of other native species due to its allelopathic effect [6]. This review tries to report on the current status of the weed and to analyse the findings of both the published and unpublished researches on biological control.

2. Status of Weed

Parthenium is a weed of worldwide presence, considerably found in Asia (India, Taiwan Bangladesh, Pakistan, Vietnam Israel, Nepal, Bhutan, Sri Lanka, and southern China), Africa (Mozambique, Ethiopia, Kenya, South Africa, Swaziland, Somalia, etc...), Pacific and Australia [7].

Parthenium is usually known as congress grass and carrot weed in India and in the USA it is commonly known as feverfew and false ragweed. Aside from the drop in crop yield and plant biodiversity, it is considered the worst weed that makes human and animals vulnerable to the diseases associated with it [8].

Parthenium weed infestation is increasing rapidly over India and may be more serious than reported here. It was in 1951 that the *Parthenium* weed was first discovered in Poona (Maharashtra State). At around 1972, it reached as far as Kerala in the south and Kashmir in the north. Later, in 1979 it expanded and advanced till Assam. Currently, it can be found all over the subcontinent. Infact, it infests about 5 million hectares in Karnataka state making it the most dominant weed in the area [9]. Particular in India, *Parthenium* weed has managed to penetrate and thrive in regions of severe climatic conditions. Its presence is seen re-occurring in the coastal regions of Tamil Nadu. Presently, *Parthenium* have not spared single state in India. It has managed to accomplish prime stature among the weeds in India and Australia within short span of time due to its rapid multiplication, fast growth and its ability to rival with other native flora [10].



3. Morphology of *Parthenium* weeds.

Parthenium hysterophorus belongs to Asteraceae family and is a fast-growing, upright and much stretched annual herb. It has the potential to grow rapidly till the height of 0.50-1.50 m. It can grow up to 2m in great soils [11]. Throughout its life, *Parthenium* exhibits two particular stages everyday, vegetative stage (juvenile) and the reproductive stage (adult). The vegetative stage shows a rosette, pinnatisect radical and dark green leaves without flowering [12]. The lower leaves are extensive which spreads on the floor and covers all the vegetation which is situated below. The reproductive stage is upright, stretched with profound tap root system [11].

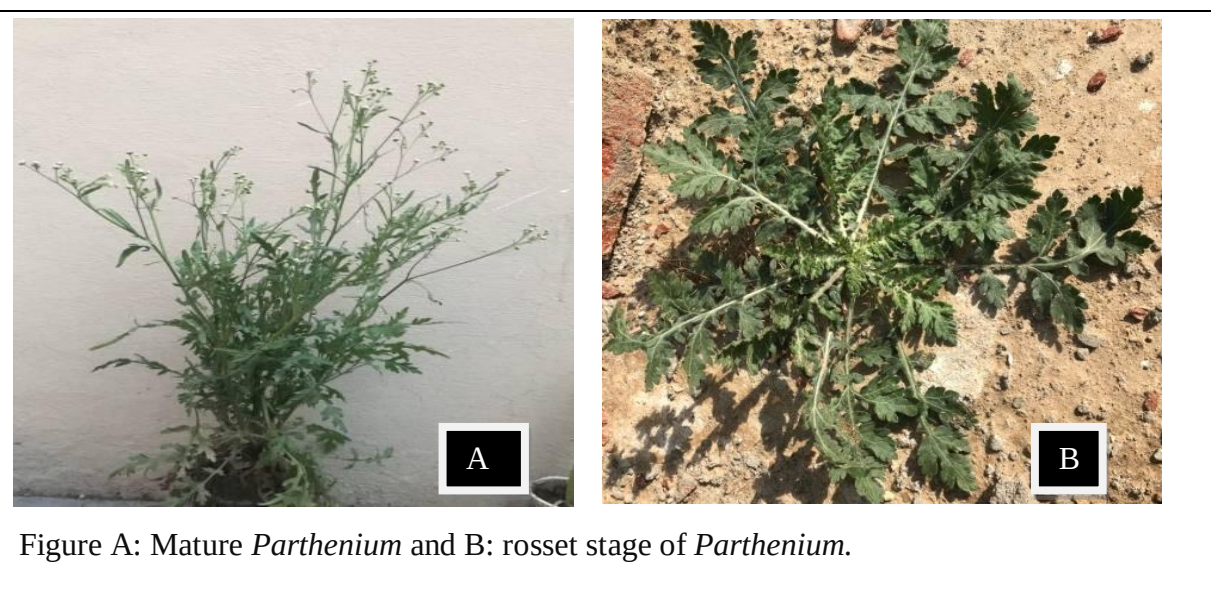


Figure A: Mature *Parthenium* and B: rosette stage of *Parthenium*.

The stems are usually hairy, octangular, branched and woody as the plant matures. The leaf is usually simple and alternate and it is little smaller small near the pinnacle of the limb (branches). The blooms are rich white, around 4mm, emerging from leaf forks. The huge amount of pollen grains is created which are winds pollinated. Seeds are black and wedge-shaped produced by each bloom [13]. The fruit of *Parthenium* is known as cypsela which is light brown in colour in its young days and later turns dark brown (mature). The fruit takes up the obvate and ellipsoid shape [14].



Figure A: showing flower (capitula) of *Parthenium hysterophorus* and B: showing seeds of *Parthenium hysterophorus*.

The seeds are mostly disseminated by water, animals, winds even the movement of vehicles and farm machinery helps in the dispersal of seeds. Vehicles and farm machinery are responsible for long-distance dispersal [5] [15]. The capability of the seed to remain viable for many years and the dispersal of seed has been one of the complex problems to control [16]. Seeds do not undergo dormancy period, it can germinate any time when available moisture is present [17].

4. Harmful effects of *Parthenium*

Parthenium is widely regarded as the most vicious weed due to its toxic effects both to humans and to biodiversity that are discussed below.

4.1. Effect of *Parthenium* on Ecosystem: *P. Hysterophorus* can disturb the natural ecosystems. There has been an incident where *Parthenium* has altered total habitat change in native Australian grasslands, open river banks, woodlands, and flood plains [18]. *Parthenium*

conquered 2 million hectares of farmlands in 1991-2000 whereas it conquered 14.25 million hectares during 2001-2007. *Parthenium* prefers wastelands, gardens, playgrounds, flood plains, woodlands, agricultural field urban areas, overgrazed pastures, industrial areas, roadsides, railway side, and residential plots to develop itself [19]. Further, the minimised pasture cover and the drought create the ideal situation for the *Parthenium* weed to form itself. *Parthenium* weed is dominant in clay loam, alkaline soils despite having the potential to grow in any types of soil [20].

4.2. Effect of *Parthenium* on crops: The presence of the chemicals like parthenin, hysterin, hymenin and ambrosin in *P.hysterophorus* enforces strong allelopathic effects on various crops. In most dicot and monocot plants, the parthenin inhibits germination and radicle growth. Later, it enters the soil through the decaying leaf debris [21].

The nodulation in legumes is also affected by *Parthenium*, mainly due to the hindrance of activity of nitrifying bacteria and nitrogen bacteria, such as *Azospirillum*, *Azotobacter*, *Actinomycetes* and *Rhizobium* [20].

Parthenium generates huge numbers of pollens (624 million per plant). These pollens in groups of 600-800 grains are transported away to short distance. It suppresses fruit growth in tomato, brinjal and beans after it lands on the vegetative and stigmatic surface in the floral part of the plant. In India, it has been reported that *Parthenium* is responsible for a 40% decrease in the yield of agricultural crops [22]. The survey in Bangladesh indicated that *P.hysterophorus* can be found in different types of lands like farmstead, fallow land, orchard, low land, and railway track [23].

The loss in sorghum grain yield was reported to be 40-97%, when the *P. hysterothorus* was not considered all over the season [24]. Its allelopathic conditions hampered the germination and growth of agricultural crops such as wheat, rice, maize, pigeonpea, sorghum, blackgram etc. [22].

4.3. Effect of *Parthenium* on animals and human: *Parthenium hysterothorus* is responsible for causing inflammation (dermatitis) on horses and cattle. It can also cause mouth ulcers and 10 to 50% of these weeds in the diet can even kill the cattle [25].

There has been report of the deaths of buffalo, cross bred calves, bull, and calves when *Parthenium hysterophorus* L. was fed to them. Additionally, these animals were noted to develop severe dermatitis [26]. Furthermore, it is responsible for diseases like anorexia, diarrhea, alopecia, and eye irritation and hay fever [27]. In human beings, swelling and itching in mouth and nose were observed when body was exposed to pollens. Further, it was also observed to cause asthma (allergic bronchitis) in the later stages [26]. If the human body is exposed to the plant, it can lead to dermatitis often causing pain in all part of the body [20].

5. Chemical constituents of *P. Hysterophorus*

Parthenium hysterophorus contains large amount of terpenoids, flavonoids, proteins, volatile oils, carbohydrate, saponins, tannins, glycosides, steroids lignins, organic acid, sugars, amino acid, and other phenolic compounds [28]. A bitter glycoside parthenin and Sesquiterpene lacton are the major chemical constituents of *P. hysterophorus*. All the parts of *Parthenium hysterophorus* including pollen and trichomes contains SQL (sesquiterpene lactones) [29]. Parthenin, ambrosin and hymenin are observed to be the offender behind the threatening role of this weed in inciting health hazard. A report from various examinations showed the presence of trace, minor and the major volatile oils (essential oils) extraction from various plant parts of *Parthenium* [30] which are shown in following table;

Table No. 1. Showing various chemical constituents in *P. Hysterophorus*.

Sl.no.	Main Compounds	Constituents	References
1	Amino acids	Glycine, proline, alanine and lysine	[30]
2	Essential oils	p-cymene, tricylene, bornyl acetate, α -pinene, β -pinene, α -thujene, β -elemene, camphene, tetradecane, oxo- α -ylangene, dodecane, α -phellandrene, benzothiazole, α -terpinene, nerol, γ -terpinene, chrysanthone, α -humulene, sesquiterpenes, Sabinene, Linalool, Limonene,	[30]

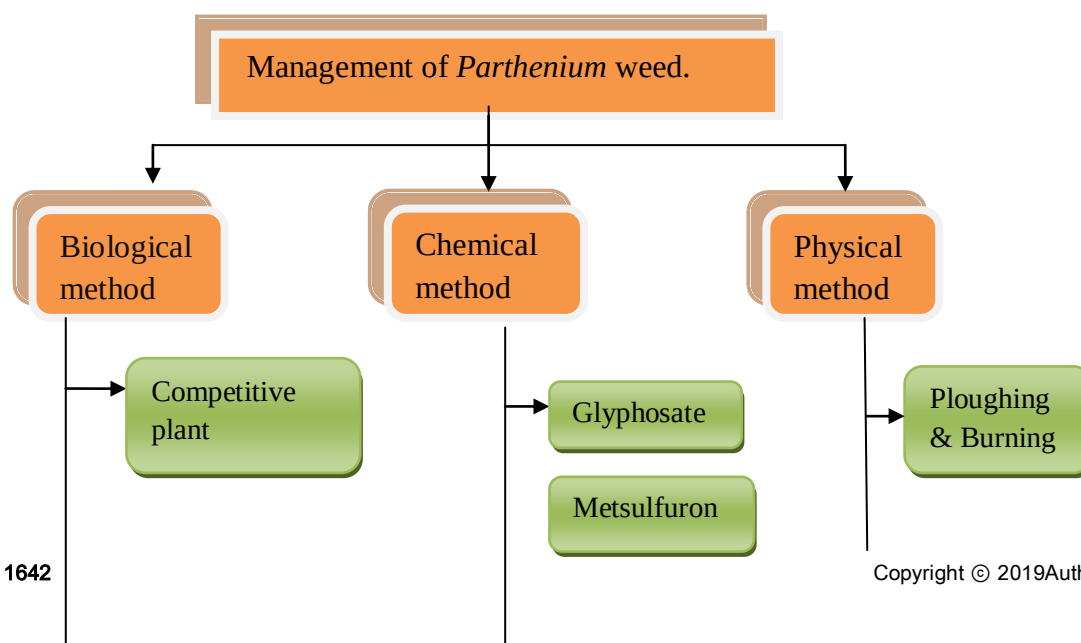
3	Terpenoids	Sesquiterpene lactones: Ferulic acid, parthenin, epoxyartemisin, Quercetin, Caffeic acid, P-hydroxybenzoic, cinnopolin, balchinin, costunolide, P-anisic acid, and artemisinin.	[30]
4.	Flavonoids	Luteolin, jaceidin Quercetin 3,7-dimethylether, apigenin, santin, 6-hydroxy kaempferol, quercetin chrysoeriol, and centaureidin.	[29] [30]
5.	Allelochemicals or phytotoxic compounds	Hysterin and ambrosin, hymenin, Fumaric acid, Vanillic acid, Chlorogenic acid, anisic acid, gallic acid, p-caumaric acids.	[29]
6.	Other compounds	Canin, Parthenolide, Pathenolide, Reynosin, Santamarin, tannins, Pyrethrin, Hysterone, etc.	[30]

6. Management of Weed.

We can control *Parthenium* weeds in several different ways. Some of the methods are discussed below:

6.1. Biological methods

The control of weeds by the biological method is the deliberate maneuver of the natural foes by the man to control harmful weeds. Biological control does not aim to completely eradicate the harmful weeds but rather aims to maintain its number less than the average that would occur, when the bio-control agent is absent [31].



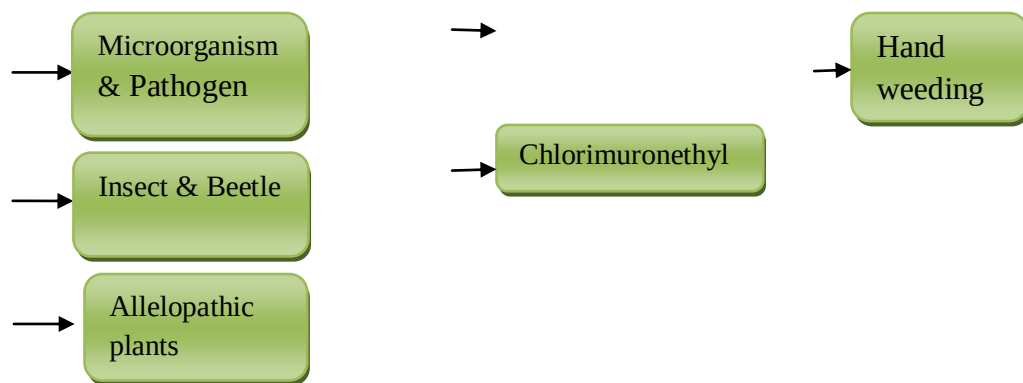


Figure: Showing schematic representation of management of *Parthenium* weed.

6.1.1. Control by Competitive Plants

The competitive plants like *cassia sericea*, *Amaranthus spinosus*, *Cassia tora*, *Tagetes spp* can conquer its environment and suppress the growth of other plants in the vicinity. Hence, this technique can be applied to control *Parthenium* [32] [28].

India has been pioneer in carrying out the research. By using the competitive plants, not many countries have been able to bring about significant improvement to the biological method [33]. Nevertheless, in Australia, the plants like bluegrass, Floren bluegrass, buffelgrass, and butterfly peagrass were found to control the growth and development of *Parthenium* weed [34]. In the USA, Johnsongrass, Cogan grass, barnyard grass, *Ipomoea* species, *Senna obtusifolia*, and other grasses were found extensively on barren land and agriculture land instead of *Parthenium*. [5]. Some plant species from South Africa and Pakistan (*Panicum maximum*, *Digitaria eriantha*, *Imperata cylindrica*, *Cenchrus pennisetiformis*, and *Sorghum halepense*) have been recorded to rival or challenge with the *Parthenium* [5].

In India (Madhya Pradesh), some plant species have been known to replace the *Parthenium* by diverse methods. Example: *Parthenium* was naturally replaced by *Cassia tora*, commonly called “Chakoda” in Madhya Pradesh. This method involves dissemination of *Cassia tora* seeds in *Parthenium* infested area. Plenty of seeds of *C.tora* can be found during the month of March-April [35]. In the protected area of Madhya Pradesh, the application of marigold was recommend for controlling the growth of *Parthenium* weed [36]. By using this method, numerous *Parthenium* plagued sites have been controlled [5].

6.1.2. Control by microorganisms and Pathogen.

Biological Control through Pathogens is the practice in which the weeds can be controlled using the pathogens. The organisms like fungi, bacteria, and viruses are capable of producing toxins strong enough to kill weeds [9].

The toxins produced by a group of fungi are termed as mycoherbicides and the toxin produced by these microorganisms are termed as bioherbicides [37] [5]. Most research works have been focused on fungi comparing to other different microorganisms. In some countries like Mexico, Argentina, Trinidad, and Cuba, the experts from International Institute of Biological Control (IIBC) carried out an extensive survey and ended up recording 26 species of fungi on *Parthenium* [38]. The experts also realized some species preferable for biological control purposes like *P.melampodi* and *Entyloma compositarum* [5].

It was observed that the *Parthenium* was attacked by two kinds of bacteria i.e *Ralstonia solanacearum* and *Xanthomonas campestris*. Using the roots as the route, these bacteria infest seeds. Apart from *Parthenium*, the crops like tomato, brinjal and potato were also infested by *Ralstonia solanacearum*. It can survive as long as six months in the soil [5].

The occurrence of *Alternaria* sp. *PMK2* in the world was reported for the first time by Kaur and Aggarwal (2016) [39]. The species was chosen for an experiment to monitor the growth of *Parthenium* with the help of bio-control agents. Fortunately, the experiment proved to be worth as the results were encouraging. However, the assigned experts for this particular experiment could not justify the result. At last, they settled the trial by assuming the cultural filtrate to be toxic or homogenous substance. They stated that the contagious cultural filtrates requires further studies to find the constituents present on them (Kaur and Aggarwal, 2016) [39].

Some kinds of Pathogen have two sides (Pathogen attacking both *Parthenium* and Crops) (Kalidas, 1981). The same pathogen attacks *Parthenium* and was also reported to harm or damage the crops plant. We can only conclude that until now none of the pathogens has demonstrated promising outcomes to diminish the effects of *Parthenium* in the natural field conditions [5].

6.1.3. Control by Insects.

The leaf-feeding beetle (*Zygogramma bicolorata*), stem-galling moth (*Epiblema strenuana*) and stem-boring weevil (*Listronotus setosipennis*) were introduced to tackle *P. hysterophorus* in Australia [40]. Numerous insects were identified on *Parthenium* however, not a single one of them had potential of being host-specific.

The experts after analysis concluded that most of the insects on this weed in India to be polyphagous pests of agricultural crops. A handful of it occurred in the significant portion which often led to the death of the plant while many occurred in small portion causing slight damage only [33].

In order to control *Parthenium hysterophorus*, *Zygogramma bicolorata* (beetle) was imported into India in 1983 [3]. This beetle thrived till now in north, south and central of India. The combat against *Parthenium* has been greatly aided by the beetle especially in large areas. The beetles also indirectly prevented the extinction of indigenous species which impeded the loss of biodiversity [5].

The adults defoliate the plants. When the beetles chew soft tissues beneath the flowers, the young flowers are cut by the beetles. Totally defoliated plants begin to show dieback symptoms and eventually get killed [33].

There are mainly four types of scale creepy crawlies that attacks the stems and parts of the plant. Out of them, *Paraissetia nigra* and *Saissetia coffeae* are known to trigger the shrivelling of *Parthenium* plants in the glasshouse. Likewise, stems of the weed are attacked by *Orthezia insignis*. It forms dense colonies on the leaves and blossoms of the weed in summer, which ultimately brought about the withering and drying of few plants [33].

The larvae and adults species of bark beetle *Hypothenemus eruditus* and the larvae of *Oberea* sp. (beetle) swarmed into the stems which ultimately causing shrinking and death of the plants. The adult of some species like flea beetle *Leperomorpha vittata* cause spots on the leaves by scratching the epidermis. They additionally benefited from stems by scratching the epidermis and scooping the cortex portion [33].

6.1.4. Control of *Parthenium* by allelopathic grass

Allelopathy is a biological phenomenon in which the organism generates biochemicals that can cause a damaging effect on the germination, growth, survival, and reproduction of the organism [41]. The allelochemicals such as flavonoids, terpenoids, pentanoids and arsenoides can be used as herbicides, fungicides, and growth regulators. Many plants have been found to possess the ability to cause allelopathy [42]. Hence, the experts have experimented with the hope to control the weed.

Dicanthium annulatum, *Cenchrus pennisetiformis*, and *Sorghum halepense* are the allelopathic grasses whose, both the shoots and the roots extract decreases the germination and control premature seedling growth of tropical weed *Parthenium hysterophorus* [41][43].

Some plants like *Cassia sericea*, *Croton bonplandianum*, *Mirabilis jalapa*, *C.tora*, *Sida spinosa*, *C.auriculata*, and *Amaranthus spinosus*, which have the ability to cause allelopathy which ultimately smothers the natural habitat of *Parthenium* [44]. *C. sericea* was reported to minimize the assembly of *Parthenium* by 70% and its populace by 52.5% in India [45].

Similarly, the aqueous leave extracts of *Azadirachta indica*, *Eucalyptus tereticornis*, and

Sl.no.	Botanical name	Common name	Family	Part used	References
1.	<i>Dicanthium annulatum</i>	Sheda grass	Poaceae	Shoot and Root.	[41]
2.	<i>Cenchrus pennisetiformis</i>	Slender buffelgrass	Poaceae	Shoot and Root	[41]
3.	<i>Sorghum halepense</i>	Johnson grass	Poaceae	Shoot and Root	[41]
4.	<i>Imperata cylindrical</i>	Cotton wool grass	Poaceae	Root and shoot	[43]
5.	<i>Desmostachya bipinnata</i>	Halfa grass	Poaceae	Root and shoot	[43]
6.	<i>Cassia tora</i>	Tora	Fabaceae	Leaves and stem	[34]
7.	<i>Cassia sericea</i>	Silver Cassia	Fabaceae	Leaves and stem	[34]
8.	<i>Mimosa pudica</i>	Touch me not	Fabaceae	Leaves and stem	[34]
9.	<i>Azadirachta indica</i> ,	Neem	Meliaceae	Leaves	[46]
10.	<i>Ficus benghalensis</i>	Indian banyan	Moraceae	Leaves	[46]
11.	<i>Melia azadarach</i>	Chinaberry tree	Meliaceae	Leaves	[46]
12.	<i>Mangifera indica</i>	Mango	Anacardiaceae	Leaves	[46]
13.	<i>Syzygium cumin</i>	Black Plum	Myrtaceae	Leaves	[46]

14.	<i>Cassia occidentalis</i>	Coffee senna	Fabaceae	Shoot	[47]
15.	<i>Tephrosia purpurea</i>	Wasteland weed	Fabaceae	stem, root and leaves	[48]
16.	<i>Eucalyptus</i>	Gum tree	Myrtaceae	leaves	[29]
17.	<i>Helianthus annuus</i> L	sunflower	Asteraceae	root and stem.	[41]
18.	<i>Sorghum bicolor</i> L. <i>Oryza sativa</i> L	Sorghum & Rice	Poaceae	root and stem.	[49]

Aegle marmelos completely hindered the seed germination of *Parthenium* and it may be used to control the weed [20]. The experts developed that the aqueous concentrates of the allelopathic grass like *Desmostachya bipinnata* and *Imperata cylindrical* not just smothered the germination and development of the *Parthenium hysterophorus* yet additionally limited the spread of poisonous weed [32]. So, therefore, the *I. cylindrica* and *D.bipinnata* is used as a natural effective product mainly to control the population of the noxious weed (*Parthenium hysterophorus*) [43].

In 1966, it was reported that, *Xanthium strumarium* (wastelands weed) was able to compete with *P. hysterophorus* in India [37]. It was reported that, the aqueous shoot extracts of *Cassia occidentalis* have a remarkable effect against *Parthenium hysterophorus* and gives encouraging substitute tool to control [47].

Table 1: Showing the list of the plant (allelopathic) used for suppressing growth and germination of the Weed (*Parthenium hysterophorus*).

The aqueous extracts of *Tephrosia purpurea* (root, leaves and stem) was tested under the laboratory conditions to measure its inhibitory potential on seedling growth and seed germination of *Parthenium hysterophorus* L. It was found that the radicle was more suppressed than the plumule. It was also noticed that the inhibitory effect increases with increase in the concentration of aqueous extracts. Considering the results of the experiment, more studies need to be carried out under green house and field conditions [48].

In an attempt to impede the growth and germination of *Parthenium hysterophorus* L, the root and shoot extracts of three allelopathic plants, namely sunflower (*Helianthus annuus* L.), sorghum (*Sorghum bicolor* L.) and rice (*Oryza sativa* L.) were evaluated against it. After the

experiment, it was concluded that there was no effect on seedling biomass and shoot length. However, the root length and germination were reduced by all the extracts [49].

Researchers found out that, the five allelopathic trees (leaves) such as *Azadirachta indica*, *Ficus benghalensis*, *Melia azadarach*, *Syzygium cumini*, and *Mangifera indica* can also control the noxious weed, *Parthenium hysterophorus*. Out of these five allelopathic trees, *Ficus benghalensis* and *Mangifera indica* were proved to be inhibitory than rest [46].

Cassia Uniflora belonging to Leguminosae family, a native of Tropical America, was found in parts of Karnataka and has slowly spread to the neighboring states of Karnataka. Young seedlings of *Parthenium* are even smaller than *Cassia uniflora*. Additionally, *Cassia Uniflora* has superior shoot and root systems. So, this feature equips them to defer flowering, minimize the number of capitula as well as seeds and smother the vegetative growth of *Parthenium*, [50].

6.2. Physical Controls.

Before flowering and seed setting, the *Parthenium* can be uprooted manually. This has been often considered to be one of the most effective methods [3]. *Parthenium* weed was successfully plowed during the rosette stage before it produces seeds. Another way of mechanical control is the hand weeding which takes lots of time [51].

Burning can also be considered another method to control the weed. However, this burning method has also been proved to be quite ineffective. This is so because firstly, it consumes a huge quantity of fuel and other, burning damages other productive plants growing in the locality [52].

6.3. Chemical Controls.

Chemical control comes in the scene when the natural enemies of *Parthenium* are absent. The most popular and effective chemical herbicides are glyphosate, bromoxynil chlorimuron-ethyl, ametryn, bromoxynil+MCPA, atrazine, and metsulfuron.[41]. To control the *Parthenium*, 2,4-D EE (0.2%) and metribuzin (0.25 and 0.50%) were reported to be more effective [53].

In the areas like barren land, along railway tracks, roadsides and water channels it was reported that the weed can be effectively controlled at the rosette stage. Of all the methods spraying the solution of common salt at 15-20% to manage *P. hystrophorus*, have been considered to be the easiest way [37].

Though glyphosate and isoproturon are both effective in eliminating *P. Hysterophorus*, glyphosate is better than isoproturon [54]. Extensive chemical utilization has escalated the user's concern in the present years. Furthermore, the toxic effects like carcinogenic, residual toxicity problems and environmental pollution has put limit to its utilization [53].

7. Integrated management of weed.

There should be always more than one approach to minimize *P. hystrophorus* successfully. Some of the approaches are biological, mechanical and chemical which can constantly monitor the weeds and make sure it does not exceed the minimum economic threshold level [37]. Integrated management of *Parthenium* is a technique to manage weeds with the help of diverse technologies. Under the given agro-ecosystem, it aims to improve the productivity of crop at minimal cost possible and considering ecological and socio-economic constraints [37].

The Integrated weed management technique was implemented in Australia complementary to biological control technique with other management technique to control *P. Hysterphorus* where the suppressive plants like *Astrella squarosa* and the introduced legume, butterfly pea (*Clitoria ternatea*) along with two biological control agents, *Zygogramma bicolorata* and *Epiblema strenuana* were used. It successfully did its job of suppressing the weed in the absence of biological control agents. Additionally, its potential to suppress could be increased when any one of the aforementioned biological agents were present. These profound experiments proved that the best way to weed control is when complemented by biological control techniques with suppressive plants [20].

8. Conclusion.

All these informations reflected in this review suggests possibility of health hazards due to *Parthenium hystrophorus* especially to the urban residents of India & Australia.

Furthermore, this review also emphasize on agricultural and natural ecosystems. Distinct specialists around the world have decided to focus on weed management strategies due to its rapid growth.

Some of the allelopathic plants have tremendous ability to control weed in problematic urban places. One such plant is Marigold which is highly traditional and abundant in Indian market. Marigold can be used in urban places where it can mitigate the weed growth. It is most marketable product which has high aesthetic value. In Bangalore, a booming city in India, Zygomma beetle has produced remarkable result in eliminating parthenium weed.

References:

- [1] V. S. G. R. Naidu, *Handbook on weed identification*. . Directorate of Weed Science Research, Jabalpur, 2012.
- [2] R. Matusova, T. van Mourik, and H. J. Bouwmeester, “Changes in the sensitivity of parasitic weed seeds to germination stimulants,” *Seed Sci. Res.*, 2004.
- [3] S. Jayanth, K. P., & Nagarkatti, “Investigations on the host-specificity and damage potential of *Zygomma bicolorata* Pallister (Coleoptera: Chrysomelidae) introduced into India for the biological control of *Parthenium hysterophorus*,” *Entomon*, vol. 12, no. 2, pp. 141–145, 1987.
- [4] C. A. S. F. de Miranda *et al.*, “Chemical Composition and Allelopathic Activity of *Parthenium hysterophorus* and *Ambrosia polystachya* Weeds Essential Oils,” *Am. J. Plant Sci.*, 2014.
- [5] Sushilkumar, “Biological control of *Parthenium* in India: status and prospects,” *Indian J. Weed Sci.* , 2009.
- [6] P. Msafiri, C. J., Tarimo, M. T., & Ndakidemi, “Allelopathic effects of *Parthenium hysterophorus* on seed germination, seedling growth, fresh and dry mass production of *Alysicarpus glumaceae* and *Chloris gayana*,” *Am. J. Res. Commun.*, vol. 1, no. 11, pp. 190–205, 2013.
- [7] T. S. Kumar, S., Jayaraj, S., & Muthukrishnan, “Natural enemies of *Parthenium hysterophorus* Linn.,” *J. Entomol. Res.*, vol. 3, no. 1, pp. 32–35, 1979.
- [8] V. Kumar, “Weeds in tropics: problems and prospects,” *Van Sangyan*, vol. 3, no. 2, pp. 1–6, 2016.

- [9] H. C. Evans, "Parthenium hysterophorus: a review of its weed status and the possibilities for biological control," *BiocontrolNews Inf.*, 1997.
- [10] A. Kumar, "Parthenium hysterophorous L. and its impact on living world," *Indian J Sci Res*, vol. 4, no. 1, pp. 8–14, 2014.
- [11] J. Picman and A. K. Picman, "Autotoxicity in Parthenium hysterophorus and its possible role in control of germination," *Biochem. Syst. Ecol.*, 1984.
- [12] M. Van Der Laan, C. F. Reinhardt, R. G. Belz, W. F. Truter, L. C. Foxcroft, and K. Hurle, "Interference potential of the perennial grasses *Eragrostis curvula*, *Panicum maximum* and *Digitaria eriantha* with *Parthenium hysterophorus*," *Trop. Grasslands*, 2008.
- [13] R. Schmid, L. Holm, J. Doll, E. Holm, J. Pancho, and J. Herberger, "World Weeds: Natural Histories and Distribution," *Taxon*, 1998.
- [14] S. Guyana, P., & Paraguay, "Parthenium hysterophorus L. Asteraceae–Parthenium weed.," *Bull. OEPP/EPPO Bull.*, vol. 44, no. 3, pp. 474–478, 2014.
- [15] and N. S. B. Debalina Saha, Chris Marble, Robert H. Stamps, Shawn Steed, "Biology and management of Ragweed parthenium (*Parthenium hysterophorous* L.) in ornamental crop production.," 2018.
- [16] V. Singh, S.K., and Chandra, "Asteraceae of Azamgarh.," in *Proceedings of the National Academy of Sciences of India.*, 1982, pp. 29–41.
- [17] C. Jeyalakshmi and V. Valluvaparidasan, "Distribution of microorganisms in the parthenium weed infested soil of Tamil Nadu," *J. Biopestic.*, 2010.
- [18] C. Lakshmi and C. Srinivas, "Parthenium: A wide angle view," in *Indian Journal of Dermatology, Venereology and Leprology*, 2007.
- [19] A. Javaid and H. Adrees, "Parthenium management by cultural filtrates of phytopathogenic fungi," *Nat. Prod. Res.*, 2009.
- [20] M. Kaur, N. K. Aggarwal, V. Kumar, and R. Dhiman, " Effects and Management of Parthenium hysterophorus: A Weed of Global Significance ," *Int. Sch. Res. Not.*, 2014.
- [21] V. Nallathambi Gunaseelan, "Impact of anaerobic digestion on inhibition potential of Parthenium solids," *Biomass and Bioenergy*, 1998.

- [22] R. K. Meena, R.K., Verma, V.K., Tiwari, A., Shukla, S., Verma, S.K., and Singh, "Impact and management of *Parthenium hysterophorus*," *Glob. J. Bio-Science Biotevhnology*, vol. 6, no. 1, pp. 15–18, 2017.
- [23] T. P. Khaket, H. Aggarwal, D. Jodha, S. Dhanda, and J. Singh, "Parthenium hysterophorus in current scenario: A toxic weed with industrial, agricultural and medicinal applications," *J. Plant Sci.*, 2015.
- [24] T. Tamado, L. Ohlander, and P. Milberg, "Interference by the weed *Parthenium hysterophorus* L. with grain sorghum: Influence of weed density and duration of competition," *Int. J. Pest Manag.*, 2002.
- [25] L. A. Weston, "Utilization of allelopathy for weed management in agroecosystems," in *Agronomy Journal*, 1996.
- [26] T. R. Narasimhan, M. Ananth, M. N. Swamy, M. R. Babu, A. Mangala, and P. V. S. Rao, "Toxicity of *Parthenium hysterophorus* L. to cattle and buffaloes," *Experientia*, 1977.
- [27] G. Maishi, A. I., Ali, P. S., Chaghtai, S. A., & Khan, "A proving of *Parthenium hysterophorus*, L," *Br. Homeopath. Journal*, vol. 87, no. 1, pp. 17–21, 1998.
- [28] T. T. Bezuneh, "Phytochemistry and antimicrobial activity of *Parthenium hysterophorus* L.:a review," *Sci. J. Anal. Chem.*, vol. 3, no. 3, pp. 30–38, 2015.
- [29] S. Patel, "Harmful and beneficial aspects of *Parthenium hysterophorus*: an update," *3 Biotech*, 2011.
- [30] M. M. S. Dipankar Chandra Roy, "Toxicology , Phytochemistry , Bioactive compounds and Pharmacology of *Parthenium hysterophorus*," *J. Med. Plants Stud. Toxicol.*, 2013.
- [31] V. B. Kushwaha and S. Maurya, "Biological utilities of *Parthenium hysterophorus*," *J. Appl. Nat. Sci.*, 2012.
- [32] R. Javaid, A., Anjum, T., & Bajwa, "Biological control of *Parthenium* II: Allelopathic effect of *Desmostachya bipinnata* on distribution and early seedling growth of *Parthenium hysterophorus* L.," *Int. J. Biol. Biotechnol.*, vol. 2, no. 2, pp. 459–463, 2005.
- [33] J. Srikanth and N. A. Pushpalatha, "Status of biological control of *Parthenium hysterophorus* L. in India: A review," *Int. J. Trop. Insect Sci.*, 1991.

- [34] N. I. Devi, Y.N., Ghanapyari, K., Dutta, B.K., Ray, D.C., and Singh, "Parthenium infestation and evaluation of botanicals and bioagents for its management.," *Indian J. Weed Sci.*, vol. 45, no. 1, pp. 62–67, 2013.
- [35] J. G. Kumar, S., and Varshney, *Gajarghas ka jaivik niyantrana: vartman stathiavamn sambhavnain (in Hindi), Biological control of Parthenium: present and future.* 2007.
- [36] V. M. Kauraw, L.P., Chile, A., Bhan, "Evaluation of *Fusarium pallidroseum*(Cooke) Sacc., for the biocontrol of *Parthenium hysterophorus* L.," in *First International Conference on Parthenium Management.*, 1997, pp. 70–74.
- [37] R. B.N., S. K. R., P. R., and J. R., "Harmful Effects of *Parthenium hysterophorus* and Management Through Different Approaches"- A review," *Ann. Plant Sci.*, 2017.
- [38] R. P. Seier, M. K., Harvey, J. L., Romero, A., & Kinnersley, "Safety testing of the rust *Puccinia melampodii* as a potential biocontrol agent of *Parthenium hysterophorus* L.," in *First international conference on parthenium management*, 1997, pp. 63–69.
- [39] M. Kaur and N. K. Aggarwal, "Biocontrol potential of *Alternaria* sp. PMK2, against a devastating weed: *Parthenium hysterophorus* L.," *Int. J. Pest Manag.*, 2017.
- [40] K. Dhileepan, "Current Status of the Stem-boring Weevil *Listronotus setosipennis* (Coleoptera: Curculionidae) Introduced Against the Weed *Parthenium hysterophorus* (Asteraceae) in Australia," *Biocontrol Sci. Technol.*, 2003.
- [41] A. Javaid and T. Anjum, "Control of *Parthenium hysterophorus* L., by aqueous extracts of allelopathic grasses," *Pakistan J. Bot.*, 2006.
- [42] N. A. J. M. A. Hussain, F., & Abidi, "Allelopathy exhibited by *Imperata cylindrica* (L.) P. Beauv.," *Pakistan J. Bot.*, vol. 23, pp. 15–25, 1991.
- [43] R. B. A. A. J. TEHMINA ANJUM, "Biological Control of *Parthenium* I : Effect of *Imperata cylindrica* on Distribution , Germination and Seedling Growth of *Parthenium hysterophorus* L .," *Int. J. Agric. Biol.*, 2005.
- [44] S. Wahab, "Management of *Parthenium* through an integrated approach initiative, achievements and research opportunities in India," in *Proceedings of the 2nd International Conference on Parthenium*

Management. Bangalore, India. University of Agricultural Sciences, 2005.

- [45] S. Kandasamy, O. S., and Sankaran, “Biological suppression of Parthenium weed using competitive crops and plants.,” in *1st International Conference on Parthenium Management.*, 1997, pp. 33–36.
- [46] S. Javaid, A., Bajwa, R., & Shafique, “Management of Parthenium hysterophorus L. in Pakistan.,” in *21st Asian Pacific Weed Science Society (APWSS) Conference*, 2007, pp. 186–191.
- [47] J. Knox, D. Jaggi, and M. S. Paul, “Allelopathic Effect of Selected Weeds on Biochemical Activity of Parthenium hysterophorus,” *Acs Symp. Ser.*, 2010.
- [48] M. P. Bhatnagar, “Allelopathic effect of Tephrosia purpurea on Parthenium hysterophorus L.,” *J. Environ. Sci. Technol.*, vol. 4, no. 2, pp. 18–22, 2018.
- [49] A. Javaid, S. Shafique, R. Bajwa, and S. Shafique, “Effect of aqueous extracts of allelopathic crops on germination and growth of Parthenium hysterophorus L.,” *South African J. Bot.*, 2006.
- [50] J. Srikanth, S. Joshi, and C. A. Viraktamath, “Luperomorpha-Vittata Duvivier a New Association with Parthenium-Hysterophorus L. And Other Weeds,” *Curr. Sci. Bangalore*, 1991.
- [51] D. Kalidas, “Phytopathogens as weed control agents.,” in *8th Asian-Pacific WeedScience Society Conference.*, 1981, pp. 157–159.
- [52] H. N. Ray, P. and Gour, “Integrated management of Parthenium hysterophorus L.(Asteraceae): a weed of worldwide significance.,” *India J. Mycol Plant Pathol*, vol. 5, pp. 605–632, 2012.
- [53] A. Javaid, “Herbicidal potential of allelopathic plants and fungi against Parthenium hysterophorus - A review,” *Allelopathy Journal*. 2010.
- [54] A. Shabbir, “Chemical control of Parthenium hysterophorus L.,” *Pakistan J. Weed Sci. Res.*, vol. 20, no. 1, 2014.