NEW ERA AGRICULTURE MAGAZINE

From Invasion to Impact: *Parthenium hysterophorus* weed as a Major Threat to Agro-Ecosystems

Ajay Kumar Upadhay[1], Bijay Kumar Baidya[2], Nupur Choudhary[3] and Amlanjyoti Khuntia[4]

Abstract: -

Invasive plant species can severely harm agricultural production, industrial activities, ecosystems, and public health. As a result, scientists, academicians, industry leaders, and land managers increasingly recognize invasive species as major environmental challenges of the 21st century. *Parthenium* weed is an annual herb belonging to the family Asteraceae, native to northern Mexico and the southern United States. It forms a large basal rosette and, once established, suppresses the growth of weak or overgrazed pastures through intense competition and allelopathic effects. This weed is widely regarded as one of the most serious threats to biodiversity and causes substantial economic losses in agriculture, forestry, fisheries, wetlands, roadsides, natural ecosystems, and other human-managed environments, while also posing risks to human health. Invasive species impose enormous economic costs globally each year, making *Parthenium* a weed of national importance. Its prolific seed production and high potential for widespread dispersal make effective management particularly challenging. This review highlights the biology of *Parthenium*, its mechanisms of spread and dissemination, and the possible strategies for its management.

Introduction:

An Invasive Alien Species (IAS) refers to a species introduced beyond its native geographical range either from other countries or different regions within a country through

Ajay Kumar Upadhay[1], Bijay Kumar Baidya[2], Nupur Choudhary[3] and Amlanjyoti Khuntia[4]

[1]M.Sc. Scholar, Department of Soil Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar

[2]SMS (Horticulture), Krishi Vigyan Kendra, Nuapada, Odisha University of Agriculture and Technology, Odisha

[3]Subject Matter Specialist, ICAR- CRRI - Krishi Vigyan Kendra, Koderma, Jharkhand

[4]Assistant Manager Livelihood (Agriculture), CBSAE Development Project, Odisha University of Agriculture & Technology, Odisha

intentional or accidental human activities. Such species establish self-sustaining populations in the wild and cause noticeable alterations in local, managed, or natural ecosystems. Biological invasion is regarded as the second most significant threat to biodiversity after habitat loss. *Parthenium hysterophorus* L., a member of the family Asteraceae and commonly known as parthenium weed, congress weed, carrot weed, or white top, is an invasive alien species of global concern. It has emerged as a major weed problem in Australia, Africa, and many other regions worldwide. This invasive weed has been introduced either accidentally or deliberately by humans to meet various needs. Following introduction, it can spread rapidly, forming dense, monospecific stands that severely disrupt native biodiversity in regions such as Argentina, Mexico, the West Indies, and the southern United States. Its presence has also been documented in Bangladesh. *Parthenium hysterophorus* is recognized as a serious health hazard to humans and livestock and poses a substantial threat to the sustainability of natural and agro-ecosystems worldwide. There is concern that, as observed in several countries, this weed may become increasingly widespread in the United States long after its initial introduction. The species was unintentionally introduced into Asia, Australia, and Africa, primarily through contaminated grain consignments, and has since demonstrated highly aggressive invasive behavior. Although first reported in India in 1880, it was not considered a serious threat until the 1950s. Subsequently, it spread rapidly across the region and is now widespread in India, Bhutan, Nepal, Pakistan, Sri Lanka, parts of China, and Bangladesh. By 2005, infestations were estimated to cover more than five million acres of the Indian subcontinent, and the weed was described as one of the most problematic and noxious weeds affecting both urban and rural India.

Botanical Aspects of Parthenium hysterophorus

Parthenium hysterophorus L. (Family: Asteraceae), commonly known as bitter weed, false ragweed, feverfew, parthenium weed, ragweed, or white top, and locally referred to as Kanike ghans, Bethu ghans, or Padke phul, is an annual, erect, and extensively branched herb. The plant typically attains a height of 50–150 cm, with a highly branched stem. Leaves are simple and deeply dissected into numerous leaflets. The flower heads are arranged in corymbose clusters; the phyllaries are ovate, dull white, and arranged in two series of ten, with each flower head measuring about 3–4 mm in diameter. Disc florets are numerous and dull white, bearing four stamens with exerted anthers and a sterile ovary. Ray florets are located opposite the inner

phyllaries, with five ray florets per flower head; these lack a corolla and stamens, but possess a bifid stigma, short style, and an oval, dorsiventrally flattened ovary. The fruit is a cypsela, with each flower head producing five cypselae that are flat and triangular in shape, equipped with thin, white, spoon-shaped appendages. Parthenium weed is an exceptionally prolific seed producer, capable of generating approximately 15,000 to 25,000 seeds per plant

Colonization and spread

Parthenium weed is capable of establishing across a wide range of vegetation types and soil conditions, although it is most commonly associated with alkaline clay loam to clay soils of downs, floodplains, and regions dominated by softwood, brigalow, and gidgee scrub. It is an exceptionally aggressive colonizer and a highly competitive species. The weed readily invades weak or overgrazed pastures with poor ground cover, cultivated fields, and disturbed or bare habitats such as roadsides and tracks, as well as intensively used areas including stockyards and watering points. Its seeds are easily dispersed by water, agricultural and industrial machinery, feral animals, humans, vehicles, livestock, contaminated fodder, and through the movement of grain and seed. Native to subtropical regions of North and South America, parthenium weed can expand rapidly following its introduction into new environments, forming dense, monospecific stands that severely disrupt native biodiversity in areas such as Argentina, Mexico, the West Indies, and the southern United States. The species has since spread to numerous countries across Africa, Asia, and the Pacific, where it has become a major invasive weed, particularly in India and Australia. Its occurrence has also been reported in Bangladesh. While approximately fifteen species of *Parthenium* are found in the Americas and the West Indies, only *Parthenium hysterophorus* L. was introduced into the Indian subcontinent.

The reproductive capacity of parthenium weeds under different climatic conditions

Parthenium hysterophorus can establish on a broad spectrum of soil types, ranging from sandy soils to heavy clays, although it shows a clear preference for clay-rich soils. The species is commonly found in regions receiving more than 500 mm of summer rainfall annually and is well adapted to drought conditions. Seed germination typically occurs at temperatures between 10 °C and 25 °C. However, studies by Williams and Groves (1980) indicate that parthenium weed seeds are capable of germinating across a much wider thermal range, from as low as 10 °C to as high as 36 °C. Seed viability has been reported to exceed 90% within the temperature

range of 12–25 °C. Furthermore, Tamado et al. (2002a) demonstrated that seed viability remains above 50% even after 26 months of burial in soil, with an estimated seed half-life of approximately 3–4 years. Warm environmental conditions further enhance the reproductive potential of parthenium weed by increasing seed output and seed filling, stimulating the production of dormant seeds, and generating seeds with greater longevity in the soil seed bank.

Impact on agricultural viability

Parthenium weed poses a major threat to both pastures and agricultural crops. Numerous studies have demonstrated its strong allelopathic effects on crop establishment and growth. Aqueous extracts prepared from the shoots, leaves, flowers, and roots of parthenium weed significantly reduced seed germination, germination rate, shoot and root growth, and dry matter accumulation in soybean and haricot bean seedlings. Similarly, Maharjan et al. (2007) reported that leaf extracts of *Parthenium hysterophorus* markedly inhibited seed germination and seedling development in a wide range of plant species, including cereal crops such as rice (*Oryza sativa*), wheat (*Triticum aestivum*), and maize (*Zea mays*); cruciferous vegetables such as radish (*Raphanus sativus*), mustard (*Brassica campestris*), and cabbage (*Brassica oleracea*); and members of the Asteraceae including *Ageratina adenophora* and *Artemisia dubia*. Lethal allelopathic effects of parthenium have been documented in crops including chickpea, mustard, and linseed. In Ethiopia, sorghum grain yield losses ranging from 40% to 97% were reported when parthenium remained uncontrolled throughout the growing season. Accumulation of parthenium pollen on maize floral structures has been shown to reduce grain filling by up to 50%. Kumar and Kumar (2010) demonstrated that increasing concentrations of parthenium ash adversely affected seed germination, radicle length, and plumule length in *Phaseolus mungo*, indicating that burning parthenium residues in agricultural fields can further depress crop productivity.

Impact on Biodiversity

Parthenium weed poses a serious threat to national biodiversity by significantly disrupting natural plant communities. Its invasion often leads to the displacement of native species, resulting in ecological imbalance within both natural and agricultural ecosystems. Along with rubber vine, parthenium is regarded as one of the two most serious weed threats to biodiversity in the Einasleigh Uplands bioregion. The species has been reported to cause extensive habitat transformation in native Australian grasslands, open woodlands, riverbanks, and floodplains. Comparable invasions of protected wildlife

areas have also been documented in southern India.

Impact on Human Health

Parthenium weed has been widely associated with a range of human health problems, particularly among individuals who live or work in close proximity to infested areas. Repeated exposure to the plant can lead to the development of hypersensitivity, which may subsequently manifest as allergy-like reactions. Contact with any part of the plant including airborne fragments of dried plant material, pollen, or even roots can induce sensitization and increase the risk of allergic responses. In some cases, individuals with pre-existing allergies may exhibit reactions to parthenium even without prior sensitization to the plant itself. Clinical and epidemiological studies have highlighted the severity of parthenium-related health problems. Wiesner et al. (2007) reported that exposure to the weed causes general illness, asthmatic symptoms, skin irritation, pustules on the palms, cracking and stretching of the skin, and abdominal pain in humans. A survey in Queensland revealed that approximately 10% of workers on properties infested with parthenium had developed visible allergic symptoms ppSerious health risks associated with *P. hysterophorus* were first documented in Pune, India, nearly three decades ago, where several thousand cases of allergic contact dermatitis, including some fatalities, were reported. It has been estimated that after 1–10 years of exposure, 10–20% of the population may develop severe allergic conditions such as hay fever, asthma, or dermatitis, caused by plant dust, debris, or pollen. Beyond direct allergic effects, parthenium may pose more serious long-term health risks. It has been hypothesized that livestock feed contaminated with parthenium may result in tainted milk, and that the hepatotoxic compound parthenin may act synergistically with copper to contribute to Indian childhood cirrhosis (ICC). Although no such cases have yet been reported from Bangladesh, the risk remains significant. Based on earlier findingsm, prolonged exposure of 1–10 years could lead to severe allergic reactions in 10–20% of the exposed population, manifesting as hay fever, asthma, or dermatitis due to contact with pollen, dust, and plant debris.

Biological control

Although chemical herbicides can be effective in suppressing parthenium weed when applied at the appropriate time, their repeated and prolonged use poses serious risks of environmental pollution and ecosystem degradation. Consequently, weed management strategies need to shift away from sole reliance on chemical control toward non-chemical alternatives. Biological weed management is comparatively inexpensive, sustainable, and

environmentally benign. As parthenium predominantly infests waste and fallow lands, biological control represents one of the most economical and practical approaches for keeping this weed under control. Among available options, biological control is regarded as the most cost-effective, environmentally safe, and ecologically sound method for long-term management of parthenium weed. In addition to insects, fungal pathogens have been explored for weed management, including the development of mycoherbicides. *Puccinia abrupta*, a winter rust from Mexico, infects and damages parthenium leaves and stems and is currently established over a wide area from Clermont southwards. Its development requires night temperatures below 16 °C and 5–6 hours of leaf wetness, leading to sporadic outbreaks under favorable climatic conditions. *Puccinia melampodii*, a summer rust also originating from Mexico, weakens plants by damaging foliage during the summer growing season and is spreading across several locations from north of Charters Towers to Injune in the south. Several other disease-causing microorganisms have also been reported on parthenium weed, including *Alternaria alternata*, *A. dianthi*, *A. macrospora*, *Colletotrichum gloeosporioides*, *C. capsici*, *Rhizoctonia solani*, *Fusarium oxysporum*, *F. moniliforme*, *Oidium parthenii*, *Myrothecium roridum*, *Phoma herbarum*, *Sclerotium rolfsii*, *Sclerotinia sclerotiorum*, and phyllody-causing phytoplasma. Collectively, these biological agents highlight the strong potential of integrated biological control strategies for sustainable management of parthenium weed.

Conclusion

Bangladesh, being a subtropical country, is exceptionally rich in biodiversity. Its favorable climate and fertile landscapes support the growth and establishment of a wide range of flora and fauna throughout the year. However, the country's borders and ports remain relatively vulnerable to the entry of exotic plant and animal species. Although parthenium weed is an emerging concern in Bangladesh, it has largely remained unnoticed and inadequately addressed, allowing it ample opportunity to spread across the country. The prevailing climatic and soil conditions are conducive to the growth of numerous weed species, many of which already pose serious threats to the national agricultural system. If the invasive alien species parthenium becomes widely associated with cultivated crops, agricultural productivity would be severely reduced, while human and animal health would face significant risks. As Bangladesh is already a chronically food-deficit country, further infestation of croplands by parthenium similar to the situation observed in other heavily affected countries could drastically

reduce overall crop production and biodiversity. Such impacts would inevitably intensify food insecurity for the country's rapidly growing population. The principal effects of parthenium infestation are on agricultural output, natural ecosystem functioning, biodiversity, and human and livestock health. Therefore, this is no longer merely a timely moment for action; rather, it is already overdue to implement effective management strategies against this noxious weed in Bangladesh. Since no single control method has proven sufficient on its own, an integrated weed management approach combining cultural, mechanical, biological, and judicious chemical methods appears to be the most effective and sustainable strategy for achieving long-term control of parthenium weed.

References

1. Wiesner M, Taye T, Hoffmann A, Wilfried P, Buettner C, Mewis I, Ulrichs C. 2007. Impact of the Pan-Tropical weed Parthenium hysterophorus L. on human health in Ethiopia. Utilisation of diversity in land use systems: Sustainable and organic approaches to meet human needs, Tropentag, October 9-11, Witzenhausen.
2. Kumar M, Kumar S. 2010. Effect of Parthenium hysterophorus ash on growth and biomass of Phaseolus mungo. Academia Arena. 2(1): 98-102.
3. Maharjan S, Shrestha BB, Jha PK. 2007. Allelopathic effects of aqueous extract of leaves of Parthenium hysterophorus L. on seed germination and seedling growth of some cultivated and wild herbaceous species. Sci. World. 5(5): 33-39.
4. Tamado T, Ohlander L, Milberg P. 2002a. Interference by the weed Parthenium hysterophorus L. with grain sorghum: Influence of weed density and duration of competition. Int. J. Pest Manage. 48: 183-188.
5. Williams JD, Groves RH. 1980. The influence of temperature and photoperiod on growth and development of Parthenium hysterophorus L. Weed Res. 20: 47-52.