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Parthenium a Noxious Weed: A Review on the Allelopathic Impact on Crop Plants and Their Management

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ABSTRACT

Allelopathy is a chemical interaction between higher plants in which allelochemicals generated by donor plants can significantly alter – and in some cases, hinder – the development of recipient (test) plants. Allelopathy is thought to have a significant role in their fast spread. This is particularly true of invasive alien species (IAS) such as Ambrosia artemisiifolia and Sorghum halepense. Only a few weed species are known to have an allelopathic inhibitory effect among these dominant weeds. Parthenium hysterophorus L. is world's worst weed. Although it originated in tropical America, it has now spread quickly to Asia, Africa, Australia, and Europe. It can be controlled by herbicides, but their use adversely affects the environment and human health. It has been shown that extracts, residues and essential oils of many allelopathic plant species effectively control the germination and growth of Parthenium.

KEYWORDS: *Allelopathy, Parthenium hysterophorus, weed, inhibitory, environment, human health*

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INTRODUCTION

The weed *Parthenium* is seen as a crop, grazing, and environmental hazard. It has spread to almost 40 nations (Bajwa 2018). The central highlands of Queensland, Australia, contain 8.2 million ha of *Parthenium* weed infestation, with isolated infestations also present in the state's northern and eastern regions. In India, *Parthenium* weed has grown to be a significant issue in every State, from which it has spread to nearby nations via cars or as a contaminant of seeds that have been transported. Additionally, this weed brutally devastates the pasture and agricultural plains of Eastern African Nations, with Ethiopia seeing the worst infestation (Adkins et al., 2014). *Parthenium hysterophorous* L. is one of the ten most dangerous weeds on the planet. It has spread widely throughout Pakistan's Punjab and Khyber Pakhtunkhwa provinces. In an endeavour to find alternatives to chemical herbicides for weed management, *Parthenium* has risen to become the 7th most destructive weed in Asia, Africa, and Australia.

It's thought to have arrived in the Indo-Pak subcontinent via North America (Kaur et al., 2014). *Parthenium hysterophorus* L. belong to Asteraceae; family is an annual or short- lived perennial herbaceous plant (Adkins et al., 2011) that invades disturbed locations, damages natural ecosystems, and can cause major allergic reactions in humans and livestock (Lonkar et al., 1974; Chippendale and Panetta, 1994) and is a major issue in rangelands, agriculture, and forestry (Tamado et al., 2002; Nath et al., 1981). It spread too many more part of the world, and it causes annual ecological and agricultural losses in large amounts. Its widespread spread has been reported in Pakistan's Khyber Pakhtunkhwa and Punjab provinces. It is responsible for severe health issues in humans, causing bronchitis, hay fever, dermatitis, and asthma. Pollens of this weed cause asthma, while contact of a body part with this weed causes dermatitis. Parthenin, ambrosi, tetraneuris, and coronopilin are the common allergens located in different places of this weed (Kaur et al., 2014).

WEED AND CROP PRODUCTION

Weeds and crop plants are spatially adjacent. They deny crop plants of the limited nutrients, space, light, and moisture available to them. As a result, the physiological activities and growth of crops are harmed when weeds are present (Rajcan and Swanton, 2001). Due to weed-crop competition, reduced crop output is the endresult. Crop plants are affected indirectly by weeds. Allelopathic interaction by specific weed species has an impact on crop development. Allelochemicals from allelopathic weeds can harm budding crop seedlings by disrupting root and shoot growth, among other things.

CHALLENGES IN WEED MANAGEMENT

Weed management has become even more vital and difficult as the world's population grows and resources become scarce. In order to ensure food security around the world, precise weed control is required. Herbicide application, mechanical weeding, and hand weeding are currently the most effective weed control methods. However, the long-term viability of chemical weed management faces some difficulties. The emergence of herbicide resistance in weeds is the most significant of these concerns. The harmful effects of herbicides on the environment, human, and animal health are also issues in weed management with herbicides (Chauhan, 2020).

ORIGINS AND SPREAD

According to Navie et al, 1996 *Parthenium* weed is native to the Gulf of Mexico region, which encompasses southern Brazil, northern Argentina, and southern Bolivia in addition to the southern United States of America (Dale et al., 1981). The growth of *Parthenium* weed is an erect and having branching annual as short lived perennial. Plants can grow to be 2.5 meters tall when fully mature, however most individuals are only 1.5 meters tall. The leaves are hairy and divided into a series of thin lobes. On the stem tips, the little white blooms (4 mm diameter) consist of five distinct ray florets (rarely six, seven, or eight).A typical bloom comprises two sterile florets attached laterally to 4 or 5, blackish achene's (Two millimeter diameter) inside of a straw-colored fruit layer. The quick germination and fast growth of the plant (Nguyen et al., 2011), as well as its allelopathic nature, enable it restrict nearby vegetation (Navie et al., 1998), allow it to develop vigorously and, as a result, produce a large quantity of seeds, and expending to its soil seed bank (Belgeri et al., 2012).

The *Parthenium* weed germinates in the spring, produces blooms and seed throughout its life cycle, and dies in the late autumn (Figure 1). It can begin flowering as early as one month after planting and will continue to flower for another 6–8 months. *Parthenium* weed can germinate, grow, and flower in a wide variety of temperatures and photoperiod conditions; hence it can be found growing in the field at any time of year in its introduced range. On the other side, summer is the most crucial season for development because it is warm and has more frequent and abundant rainfall. Most plants die during harsh winters because their aerial portions cannot withstand frost, however certain plants can recover from mild winters and old stem bases by growing from their roots. In Australia, regions with more than 500 mm of

annual summer rainfall are the most favorable for *Parthenium* weed. (Navie et al., 1996**)**. The weed prefers dark, alkaline, crumbling clay soils with high fertility levels, and these conditions are ideal for it to grow. It can also be found in a variety of soil types, such as clay loams and sand loams in naturally disturbed areas with limited vegetation, such as wastelands, plains that have been cleared, and grazed pastures, parthenium weed thrives. (Navie, 1996).

SEED BIOLOGY, GERMINATION AND LONGEVITY

In the conditions all right, flowering start anywhere between 28 to 42 days after seedlings emerge. As a result, it can occur at any time of the year. (Navie et al., 1996). For *Parthenium* weed seed germination, the optimal day/night temperature range was 21/16^{0}C. Additionally, Navneet et al., 2010 found that although both populations studied germinated throughout a wide range of temperatures, the two Australian biotypes' ideal single temperature for germination was between 22 and 25 degrees. According to the same authors, 70% of seed buried at a depth of 5 cm underground would survive for at least two years under field conditions, with a half-life of seven years. This was in line with Dhileepan and McFadyen's 2012 discovery that Parthenium weed seeds might survive for four to six years in the soil seed bank. According to additional studies, buried seeds survive much longer than seeds that are exposed to the soil's surface (Navie et al., 1998).

ALLOPATHIC INTERFERENCE AND TOXICITY

Strong allelopathic tendencies of the *Parthenium* weed have been theorized as a factor in the invasion and persistence of this weed in a range of native and non-native populations. (Kanchan, 1980). The leaves and roots of *Parthenium* weed, which are aerial portions, contain a number of possible allelochemicals. (Table)1. The emergence and development of several plant species, including native plants, crops, and pasture species, have been shown to be hampered by these compounds. *Parthenium* weed remnants have reportedly caused harm to a variety of significant field, horticultural, vegetable, and agroforestry crops. Therefore, more research should focus on identifying and measuring the distinct suppressive elements in order to evaluate the suppressive properties of various weeds, not simply suppressing.

Table 1: Allelochemicals that may exist have been found in several *Parthenium* weed plant sections.

Sr. No	Chemical Family	Chemical Constituent	Plant Parts	References
1.	Sesquiterpene lactones	Cumeric acid and Parthenin	Stem, leaves and pollen grains	Kanchan, 1980
2.	Phenolic acids	Fumaric acid and anicic acid	Leaves and Roots	Valliappan and Towers, 1988
3.	Sesquiterpenes lactones	Coronopilin	Flowers, Stem and trichomes.	Picman and Picman, 1984
4.	Minor sesquiterpene	Ambrosonalides and 2B-hydroxycoronopilin	Flower	Sethi et al., 1987
5.	Sesquiterpene lactones	Pseudoguananolides	Leaves and Stem	De la Fuente et al., 2000
6.	Sesquiterpenes lactones	Hystrin	Stem	De Vivar et al., 1990
7.	Flavonoids	Aglyconeflavanols	Aerial parts	Shen et al., 1976

IMPACTS OF *PARTHENIUM* ON AGRICULTURE

The *Parthenium* weed has significant unintended consequences on agricultural output. Local sale of pasture and agricultural seed lots may be hampered by *Parthenium* weed seed contamination. (Chippendale and Panetta, 1994). By acting as a secondary host to several significant crop pests and diseases, *Parthenium* weed can unintentionally lower crop output. The common hairy caterpillar (Diacrisiaobliqua Walk), Xanthomonas campestris, phaseoli, and tobacco stripe virus are pests that are significant economically. (Sharman et al., 2009).

Parthenium hysterophorus invades disturbed areas vigorously and severely harms meadows and crops. Due to the weed's reduction of the activities of the nitrifying and nitrogen-fixing bacteria Rhizobium, Actinomycetes, Azotobactor, and Azospirillum, nodulation in legumes is affected. Many viral infections that affect crop plants employ the weed as a secondary host. It also acts as a different host for the mealy bug insect. *P. hysterophorus* suppresses yield in infested sorghum, it causes the sale and transit of these produce to be limited (Jamil et al., 2021).

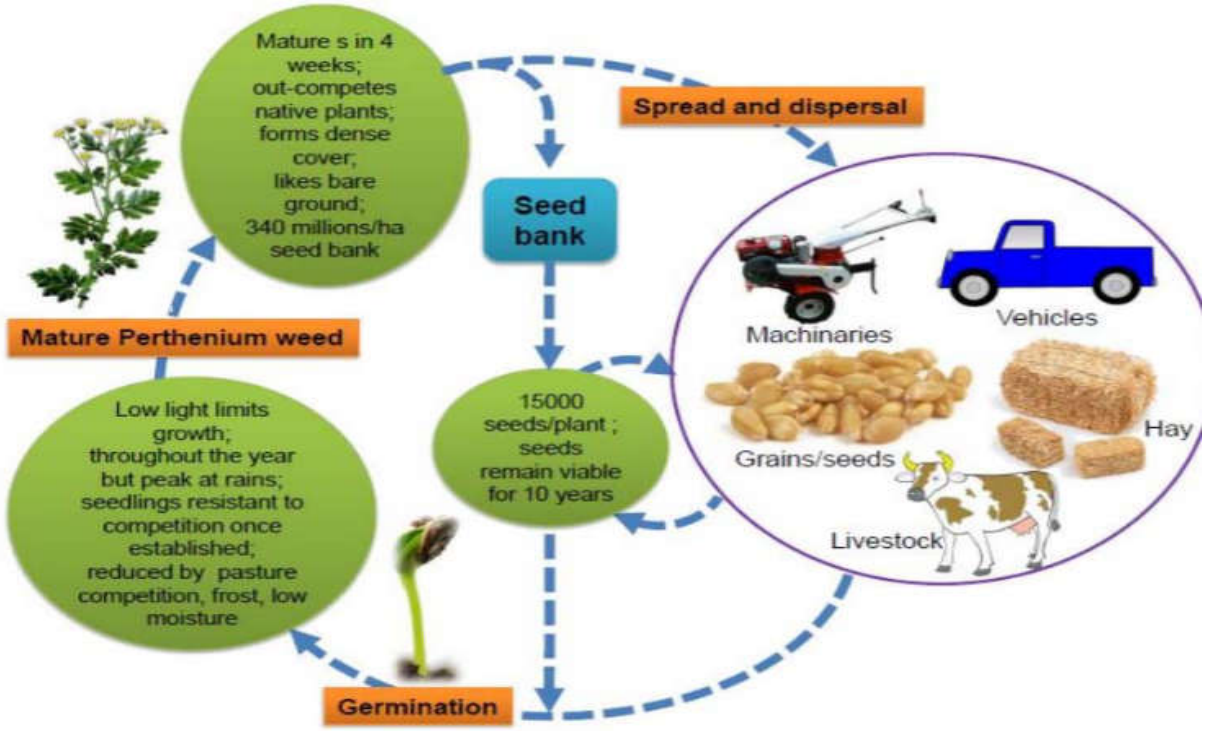

Figure 1: The seed dispersal and life cycle of *Parthenium hysterophorus* (Masum et al., 2013)

INTEGRATED WEED MANAGEMENT

The best strategy for long-term *Parthenium* weed control is integrated weed management, which combines all viable management options. A more efficient integrated approach is required, since *Parthenium* weed can withstand independently applied management strategies in many locations (Tabe Ojong, et al., 2022). These integrated weed control kits must be effective at killing weeds, economical, simple to use, and ecologically safe. One element of a comprehensive *Parthenium* weed management strategy is the incorporation of suppressive plants with biological control agents. The *Parthenium* weed has not yet been extensively eliminated using this strategy (Chacko et al., 2021).

CULTURAL MANAGEMENT

Parthenium weed is an established weed in all States and Territories of Australia, and landowners are required to control it and/or report it to the appropriate State authorities if it is discovered. The *Parthenium* weed has been classified as a class 2 weed in Queensland, which indicates that it is a widespread weed that can have detrimental effects on the economy, the environment, and society. *Parthenium* weed is a noxious weed in New South Wales, and landowners must notify local government control authorities of its existence three days after they spot it. *Parthenium* weed has been designated as noxious in South Australia, Tasmania, Western Australia, and the Northern Territory; it is a prohibited weed in Victoria. (Bashar et al., 2021).

PHYSICAL MANAGEMENT

Due to the scale of the weed infestations and the high cost of labour in some nations, physical *Parthenium* weed removal is not viewed as a cost-effective solution in Australia, where all States have classified the plant as a weed. In addition, it induce contact dermatitis and asthma, this management strategy may have an adverse effect on the health of the personnel hired to undertake this activity **(**Bashar et al., 2021). Additionally, populations of *Parthenium* weed quickly repopulate after human removal and will grow from clipped or partially removed plants that still have roots. In developing nations, where labour is scarce, hand pulling and hoeing techniques are frequently used (Rao et al., 1979).

CONCLUSION

Allelopathy is a difficult problem because various mechanisms co-occur and interact in natural systems. Therefore, more research should focus on isolating and quantifying the distinct suppressive components in order to evaluate the suppressive capacities of many weeds, not just those that suppress *Parthenium*. For instance, while shade is commonly cited as one of the main suppressive variables, its contribution should be properly defined. Since this weed is very effective in nature and has more suppressing power, we believe that special attention should also be made to the distinction between resource competition and allelopathy. This weed can be utilized easily for weed management or for weed suppression.

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