

## An Overview on *Parthenium* as a New Menace for Indian Agro-Ecosystems and its Management

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### Abstract

*Parthenium hysterophorus* L. commonly known as Congress grass is an aggressive and noxious weed among top worst weeds in the world. Now, it is widely distributed in all the crops of almost all the states of the India threatening natural agro-ecosystems and biodiversity. It a great menace due to causing skin allergy, asthma in human being and animals too. *Parthenium* has got major weed status in India. This weed alone may lowered the average yield of crop up to 40% and forage production about 90%. Sustainable crop production of many crops, grasslands and orchard ecosystems are being greatly affected by invasion of this noxious weed in the country. Various approaches viz., physical, mechanical, agronomical, chemical and biological have been employed for *Parthenium* management but most of them are not so effective due to invading characteristics of this weed as well as other limitations. Integrated weed management practices have been found effective to minimize this noxious weed. An attempt has been made to review its impact on various crops production, human and animal health and its effective management.

**Keywords:** Noxious; Agro-Ecosystem; Forage.

### Introduction

*Parthenium hysterophorus* L., popularly known as carrot weed or gajar grass because of its appearance like carrot plants, white top or congress grass in India. It belongs to family Asteraceae or Compositae. This weed was introduced to India in seed form as a contaminant of food grains imported from Mexico. First time *Parthenium* reported as waste land weed in Pune (Maharashtra) during 1956. It is now widely distributed in all the crops of almost all the states of the country threatening natural agro-ecosystems and biodiversity. It has also been considered as a one of the most noxious and problematic weed due to poisonous, pernicious, causing skin allergy, asthma in human being and animals. It has great potential of invasiveness, for quick spread and environmental impacts. In Australia, this weed has been considered as one of the greatest source of dermatitis, asthma, nasal-dermal and naso-bronchial types of diseases. Besides, it also reduced the yield and quality of field crops and animal products (Aneja *et al.*, 1991).

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*Parthenium* has occupied almost all the states and areas of our country in arable lands, crops, orchards, pastures and waste lands like railway tracts, canals, roadsides, industrial areas, forest areas and even national parks and residential colonies. Within few decades it widely spread in the plains of India and became the country's "worst weed".

It is bushy and leafy herb and attains an average height of 1 to 1.30 m. The stem becomes comparatively hardy at maturity stage. *Parthenium* bears head of capitulum type flowers surrounded by bracts around flower and appears a flower cluster (Warshaw and Zug, 1996). It has capability

to produce millions of pollen grains per plant and easily be transported and spread new areas by wind and has a great seed production potential which can produce average 10,000 to 25,000 seeds per plant. Due to its photo-thermo insensitivity and wide adaptability of soils it grows round the year except in severe winters. However, it grows in almost all types of ecosystems except where soil is not saline because salinity is harmful for its flowering (Chembolli and Srinivas, 2007).

### **Harmful effects of *Parthenium hysterophorus* L. on Agriculture and Ecosystems**

*Parthenium* weed can complete its vegetative and reproductive phases only in four weeks. This weed has invaded about 35 million hectares of land in our country today. Its infestation in crop area in recent past years is alarming. (Sushilkumar, 2009). In India, it reduces about 40% of crop yield (Khosla and Sobti, 1981). *Parthenium* plant contains harmful biochemicals, like parthenin, hymenin, hysterin and ambrosin etc. The weed exerts strong allelopathic effects on different crops by releasing these exudates in rhizosphere (Gunaseelan, 1998). *Parthenium* badly affects root nodulation and activities of rhizobium in leguminous crops. It also affects the free living microorganisms viz. *Actinomyces*, *Azotobacter*, and *Azospirillum* in the soil. It is prolific in nature and produce a huge number of pollens i.e. on an average 624 million/plant, which are transported for shorter distance and in clusters of 600-800 grains. These pollen grains settle on the vegetative and floral parts inhibits fruit setting in some crops like maize, brinjal, capsicum, tomato, and sunflower.

*Parthenium* has the potential to damage the natural ecosystems. This menace totally changed Australian grasslands, open woodlands and flood plains river banks, (Chembolli and Srinivas, 2007). This weed has great capability to invade new surroundings rapidly and can dominate the native indigenous species and pose a serious threat to local biodiversity (Seema Patel, 2011). It colonizes in roadsides, railway tracts, water resources and crop lands. Reports disclosed that this aggressive weed occupied about 14.25 million hectares of cultivated land during 2001-2007 compared to 2 million hectares in 1991-2000 (Javaid and Adrees, 2009). A survey conducted in Bangladesh on various invasive alien species and indicates that *Parthenium* can easily flourish on different types of land viz., fallow land, road sides, waste land, low land, railway tracks and even in colonies. Reports further said that *Parthenium* easily established in new habitats and replace the number of local indigenous species (Akter and Zuberi, 2009). It is also well known

fact that *Parthenium* primarily exerts severe detrimental effect on human being and livestock by causing many skin and respiratory problems. The dermatitis caused by this weed affects the face, neck, eyelids, chest and other exposed organs (Warshaw and Zug, 1996). It also affects other exposed organs shows as scattered scaly papules over the mainly forehead, ears, cheeks, nape of neck, forearms, hands and under surface of chin etc. through chronic actinic dermatitis reported by Kaur *et al.*, 2014. In *Parthenium* dermatitis extracts of *Parthenium* responded with positive skin reaction to mAb2 and also involves TH type cytokines (Akhtar *et al.*, 2010).

The *Parthenium* also acts as a host for various pests and pathogens which caused diseases in crops. This weed also caused severe dermatitis problems in livestock including horses and cattle and scattered lesions appeared on their skin. Grazing animals, fed on grass mixed with this weed produce bitter milk and low quality of meat from goats, cows and buffaloes (Aneja, 1991). If it is eaten in small amount, it is responsible for mouth ulcers with excessive salivation. However, significant amount (10 to 50%) of *Parthenium* weed in the diet can kill cattle (Narasimhan *et al.*, 1977). Besides, it causes itching, eye irritation, anorexia, diarrhea, pruritus, alopecia, in dogs.

### **Management of *Parthenium hysterophorus* L.**

For the management of *Parthenium* various methods viz., preventive, physical, mechanical, agronomical, chemical, biological, legal and integrated approaches are in practice. Singh *et al.*, 2004 reported that use of biological tools like using insects, microorganisms and competitive plants have been found the most economic ways of managing this problematic weed. The use of botanical extracts as germination and growth inhibitors is a new emerging concept for effective management of *P. hysterophorus*. Several studies on plants extract and their active ingredients have also been attempted to control this weed. (Sushilkumar and Saraswat, 2001).

### **Preventive measures for management**

Sunilkumar *et al.*, 2017 advocated that no any weed control programme is successful if adequate preventive measures are not taken to reduce weed infestation. Prevention comprised of all possible measures taken to prevent the introduction and or establishment and distribution of weeds in new local, regional or national level. It included use of *Parthenium* free clean and certified seeds, creation of weed free good tilth, clean cultivation, feeding

of *Parthenium* seed free material to the farm animals, incorporation of well rotten organic manures, cleaning of farm machinery and irrigation channels before use to avoid adding the *Parthenium* are some effective measures. Successful management of *Parthenium* is based on integration of all the available techniques and their implementation round the years are as under:

#### 1. Physical management

Hand pulling and burning are most effective methods to reduce the weed seed bank. Hand pulling should be done during rainy season or in moist soil. Before flowering is the best time to uproot the plants regarding its management because it is less effective after flowering. In other seasons especially in summer, it is difficult to uproot the plant and if tried, plants are broken, from which further regeneration takes place. Burning is more effective in wastelands and isolated areas. In small areas and isolated pockets such as flower beds, lawns, kitchen garden and in intensively cultivated agricultural fields, hand weeding may be really effective and should be preferred. Persons should wear hand gloves and full sleeve shirts, mask and goggles to avoid direct body contact with the weed during uprooting programmes. According to researchers about 4% human population is sensitive to *Parthenium*. If any symptoms like itching, swelling of skin etc. reflected such person should not be employed for *Parthenium* removal programme.

#### 2. Mechanical management

Mechanical deep ploughing before flowering is good and economical in crop fields where *Parthenium* germinate profusely. The weed is incorporated into the soil as green manure. Precaution should be taken to give spot chemical treatment over those plants which remain on surface as such plants not buried completely may rejuvenate. Weeding with small tools in early stage is also effective in newly introduced cropped area.

#### 3. Agronomical/Cultural management

Selection of competitive crop and adoption of suitable crop rotation may be a good tool to manage *Parthenium* in crop fields. Farmers are advised for quick growing crop like sorghum and *Sesbania* (daincha) to suppress the growth of *Parthenium* in their crop field, particularly when fields are supposed to keep as fallow. This method may be employed in colonies

and gardens. Several cultural practices like thorough land preparation, growing of suitable varieties which have smothering effect, maintaining optimum plant population, mulching, soil solarisation, stale seed bed technique, balance fertilizer application, proper fertilizer placement and water management are some other important factors in controlling this weed (Ray and Gour, 2012 and Javaid, 2007).

#### 4. Legal management

The government of India and state governments should declare *Parthenium* as noxious weed and also a weed of national significance and constitute and implement law to hold responsible the owner of a vacant field or land. Municipalities in towns or cities, ministry of transport on road side, railway ministry on railway tracks side; irrigation departments on the bunds of irrigation canals should take appropriate step to control the weed by available methods.

#### 5. By use of chemicals

Hand pulling of *Parthenium* is labour and cost intensive while manual control method become ineffective in some cases or conditions. Khan *et al.*, 2012 reported that it can be controlled by the use of chemicals like use of Glyphosate (2.5 kg a.i./ha) or Paraquat (0.51 kg a.i./ha), Metribuzin (0.3 to 0.5%) or 2,4-D (2-2.6 kg a.i./ha) or Hexazinone (3.5 kg a.i./ha). The similar results were obtained by Ramamoorthy *et al.*, 2004; Reddy *et al.*, 2007; Singh *et al.*, 2003; Mishra and Bhan, 1994).

The use of herbicides for different crops should be done only after consulting weed scientists because chemicals are highly specific and alteration in time, dose or method may cause severe injury if applied in crop or efficacy may be lower. Alachlor (2.0 kg a.i./ha) can be applied as pre-emergence to control *Parthenium* in soybean, rajmash, banana and tomato crop. Metribuzin (0.50 to 0.75 a.i./ha) can be used as pre-emergence just after sowing to control *Parthenium* in potato, tomato and soybean crop. Atrazine is effective to control *Parthenium* in maize. There are some limitations using chemicals like herbicidal effect of chemicals which persist for a longer time. Sometimes the plants so suppressed by chemicals have regenerated after remaining dormant for a shorter time. Also chemical treatment repeatedly can kill the existing plants but cannot prevent the entry of seeds getting deposited from outside. The remaining seeds as well as newly deposited seeds are always ready for germination with a slight moisture available to them in the soil. Because of

continuous seed production without any interval in the entire calendar year, reinvasion of the areas can hardly be avoided unless the seed source itself is checked (Mahadevappa, 1999).

#### 6. By use of biological control agent

##### • Maintenance of natural biodiversity

Biological control is an effective measure by intentional manipulation of natural enemies for the purpose of controlling harmful weeds. Biological control is less expensive and not poses any threat to non-target organisms, environment and biodiversity if systematically applied. Different types of bio-control agents like competitive plants, insects, fungi, nematodes, viruses etc. are used to manage the weed (Shushilkumar, 2009; Singh *et al.*, 2004). Insects have received maximum attention in biological control of *Parthenium* followed by competitive plants and pathogens. It is self-perpetuating and can spread on its own while other control measures require inputs periodically. It is easy to integrate with other control measures (Jayaramaiah *et al.*, 2017).

A botanical survey in relation to *Parthenium* control across the country has revealed an interesting factor that the *Parthenium* cannot penetrate into areas where the natural flora have not been disturbed. Wherever there is indiscriminate destruction of naturally existing plant species, the chances of *Parthenium* proliferation are more. In Maharashtra, *Stylosanthes scabra* has been found to compete with *Parthenium* through allelopathic effect. This has been confirmed by the field observation made by the officers of the Department of Forests, Karnataka. Several other plant species were also identified as having similar impact but with varying degrees. The strongest species effective for *Parthenium* control listed in the order are

- i. *Cassia sericea*
- ii. *Tephrosia purpurea*
- iii. *Stylosanthes scabra*
- iv. *Croton sparsiflorus*
- v. *Hyptis spp.*
- vi. *Cassia tora*
- vii. *Amaranthus spinosus*.

Further, *Parthenium* growth is very intensive in places where new constructions like extensions in cities and towns are going on. All these observations lead to the conclusion that maintenance of biodiversity, that is natural flora wherever possible,

is important to check *Parthenium* entry or invasion and its growth as weed (Mahadevappa, 1999).

##### • Use of Insects

A good number of insect and non-insect pests may be used to control *Parthenium* under bio-control approach. In India, use of more than 50 insects have been reported against *P. hysterophorus* but none of the insect has been found to be host specific yet. The classical approach was started by Jayanth in 1987 from Mexico with the introduction of host specific leaf feeding *Zygogramma abicolorata pallister* (Coleoptera: Chrysomelidae) and the stem galling moth *Epiblema strenuana*. These two insects have showed good potential to manage this weed (Jayanth, 1987). Both adult and larvae of *Zygogramma abicolorata* feed on leaves. In early stage, larvae feed on the axillary and on the terminal buds and move on to the leaf blades as they grow and the fully-grown larvae enter the soil and pupate. The density of insect's one adult per plant caused skeletonization of leaves within 4-8 weeks. But findings of other scientists disclosed that little successful was made due to very high germination of weed and moreover the insect is not a host specific and found that this insect can attack to other crops like sunflower in India (Dhileepan, 2001; Jayaramaiah *et al.*, 2017). In our country, insect species have been reported on *Parthenium*, but none of the indigenous insects was found host-specific yet. Based on well documented success by Mexican beetle, *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae), in other countries where they were introduced, beetle were imported from Mexico to India. After intensive laboratory and field studies, it was found host specific, which can eat only *Parthenium*, hence, its use was permitted by Government of India. Therefore, Mexican beetles may be multiplied and released anywhere in India for *Parthenium* suppression.

##### • Use of Viruses

A joint view of several scientists is that few viruses can be used for biological control of *Parthenium*. *Parthenium* phyllody disease is very common on *Parthenium* weed in India. The incidence varies from 10% in February-June to 100% in August-December. The leafhopper (*Orosius albicinctus*) population in the field is positively correlated with the incidence of this disease. The phyllody disease of *Parthenium* is transmitted by *O. albicinctus* and the active transmission is found to be 55%. The minimum acquisition access period is found to be 20 minutes and the inoculation access period is 15 minutes. Incubation

period in the vector varies from 15 to 20 days. The pathogen persists throughout the life of the *O. albicinctus*. *Parthenium* phyllody was transmitted by *O. albicinctus* to cowpea, urdbean, moongbean, horsegram, pigeonpea, sunhemp, fieldbean and soybean. Scientists researching on this area feel that there is no hope of using this as a bio-control method in the near future, but their efforts continue work with the hope of positive results in future.

### 7. Other methods

Growing competitive crops is also not practicable because *Parthenium* is not such a big problem in cultivated lands where regular weeding operation is done. Further, cropping pattern has to be decided based on the suitability, cropping sequence, crop compatibility and changing the crop for the sake of *Parthenium* control is not going to become practicable. One possibility of using a plant enemy in intensively cultivated land to control *Parthenium* is only growing of *Stylosanthus scabra* and *Tephrosea spp.* in lands exclusively devoted to forage production. An experiment conducted by National Research Centre for Weed Science, Jabalpur, India and found that marigold can easily suppress the *Parthenium* weed by both shade and also by allelopathic effects. Some information of relevance to this aspect may also be found relating to biological control of *Parthenium* through plants (Mahadevappan, 1999).

### 8. Awareness programmes

Since *Parthenium* is a noxious weed of national significance having characteristics of high allergy, disturbing indigenous flora and endangering biodiversity. Therefore, a campaign of awareness programmes should be organized for the public welfare. Besides, "*Parthenim Day*" should also be celebrated especially in affected areas.

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