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Integrated Parthenium Management (IPM): Need of the hour

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Parthenium hysterophorus is a species of flowering plant in the aster family, Asteraceae, that is native to the American tropics. It is a common invasive species in India, Australia and parts of Africa. Parthenium weed is a weed of national significance. It is a vigorous colonizer of bare ground, degraded pastures and disturbed sites. It is a fast growing annual plant with prolific seed production. Parthenium weed contains powerful allergens that cause a range of human health problems, including asthma and severe contact dermatitis in sensitized individuals. Parthenium weed is a threat to agriculture because it is unpalatable to livestock and competes with pastures and crop seedlings. Therefore, integrated approach for parthenium management is need of the hour to prevent this forthcoming danger in agriculture.

Common names : (1) Parthenium weed, (2) Bitter weed, (3) Bitter-broom, (4) Carrot grass, (5) Congress grass, (6) False camomile, (7) False ragweed, (8) Feverfew, (9) Parthenium, (10) Santa maria, (11) Santa maria feverfew, (12) White top, (13) White head, (14) Congress weed, (15) Star weed, (16) Carrot weed, (17) Chatak chandani, (18) Ramphool, (19) Garghas, (20) Gazar ghas, (21) Osadi (International common name: Barley flower, Bastard feverfew, Dog flea weed, Mugwort, Wormwood).

Entrance in India : Parthenium probably entered India before 1910 through contaminated cereal grain, but went unrecorded until 1956. It was first introduced due to contaminated PL-480 wheat imported from the United States and is also called as Congress Grass due to the Congress Government which imported the wheat. Since 1956, the weed has spread like wildfire throughout India. It occupies 5 million ha of land in the country. The weed was first sighted in Pune in 1956 as a stray plant on the garbage. But, in a short period, it has spread all over the Pune covering wastelands, railway yards, marshy patches, fallow cultivable lands, grasslands, roadsides, along the canals and other areas. The 1958-59 floods in Pune are believed to have helped the dispersal of this weed initially.

Habitat : Parthenium grows luxuriantly in wastelands and vacant lands, orchards, forestlands, flood plains, agricultural areas, scrub/shrublands, urban areas, overgrazed pastures and along roadsides and railway tracts. Drought and subsequent reduced pasture cover, creates the ideal situation for the parthenium weed to establish itself. It prefers alkaline, clay loam to heavy black clay soils, but tolerates a wide variety of soil types. The weed grows well in areas where the annual rainfall is greater than 500mm and falls dominantly in summer. It can grow upto an elevation of 2200 m above sea level. *Parthenium hysterophorus* is a weed of semi-arid, subtropical, tropical and warmer temperate regions. It is found also in riparian zones (banks of watercourses), seasonal floodplains, grasslands, open woodlands, waste areas, disturbed sites, lawns, gardens and crops. It is particularly aggressive in degraded or disturbed pastures in semi-arid environments.

Mode of infestation : Parthenium colonizes disturbed sites very aggressively, impacting pastures and croplands by outcompeting native species. The allelopathic effect, coupled with the absence of natural enemies like insects and diseases, is responsible for its rapid spread in its introduced ranges. Growth inhibitors like lactones and phenols are released from this plant into the soil through leaching, exudation of roots and decay of residues. These growth inhibitors suppress the growth and yield of native plants.

Toxicity : Contact with this plant causes dermatitis and respiratory malfunction in humans, dermatitis in cattle and domestic animals, due to presence of toxin parthenin. The presence of parthenium pollen grains inhibits fruit set in tomato, brinjal, beans, etc., and is also responsible for bitter milk disease in livestock fed on grass mixed with parthenium leaves. The chemical analysis has indicated that all the plants parts including trichomes and pollen contain toxins called sesquiterpene lactones. The major components of toxic being parthenin and other phenolic acids such as caffeic acid, vanillic acid, anisic acid, p-anisic acid, chlorogenic acid and parahydroxy benzoic acid are lethal to human beings and animals. Despite the fact that parthenium is considered a toxic plant of industrial uses are reported in the literatures. A related species, *Parthenium argentatum* yields rubber which can substitute for Hevea rubber.

Identification of the plant (Taxonomic position) :

(1)Domain- Eukaryota (2) Kingdom- Plantae (3) Phylum-Spermatophyta (4) Subphylum-Angiospermae (5) Class-Dicotyledonae (6) Order-Asterales (7) Family-Asteraceae (8) Genus-Parthenium (9) Species-hysterophorus

Biology : The genus Parthenium consists of about 20 species. *Parthenium hysterophorus* is a result of natural hybridization between *Parthenium confertum* and *Parthenium bipinnatifidium*.

Needs of parthenium management :

– It is a vigorous species, which colonizes in grassy land. It grows rapidly in bare areas along roadsides and water points.

– It is very expensive to control.

– It is a major health hazard to human beings.

– It reduces the production of pasture.

– Its pollens are a major cause of asthma, especially in children and elderly people.

– It emits carbon dioxide and hence, poses a problem to nitrogen fixation and becomes a parasite, dependent on standing crops and animals in its vicinity.

– It is a major cause of allergic, Trinities sinusitis, affecting about 10 per cent of the people who live near it.

– It is a major cause of dermatitis, a skin disease, among animals and human being.

– It causes irritation to eyes.

– It reduces yield of milk and weight of animals.

Parthenium offers a big challenge : Parthenium offers a big challenge to all attempts of control because of its high regeneration capacity, production of huge amount of seeds, high seed germinability and extreme adaptability to a wide range of ecosystem. Parthenium has been declared noxious in America, Australia, India and many other countries especially those having tropical climate. Scientists describe it as a "poisonous, allergic and aggressive weed posing a serious threat to human beings and livestock." It squeezes grasslands and pastures, reducing the fodder supply. The presence of parthenium in cropped lands results in yield reduction upto 40 percent. It is also responsible for bitter milk disease in livestock fed on grass mixed with parthenium. It is a biological pollutant and highly successful in distribution. The reasons for its fast spread are: (1) High germination ability throughout the year, (2) Large seed production ability, (3) High survival rate : Seeds do not have a dormancy period and are capable of germinating anytime when moisture is available. The highest germination rates are at the temperatures ranging from 12^0C to 27^0C. Persistence tests demonstrated that more than 70 per cent of parthenium seeds buried at 5 cm below the soil surface survived for at least 2 years, whereas seeds on the soil surface did not survive for longer than 6 months. Seed viability for 20 years has also been reported, (4) Extreme adaptability in a wide range of habitats, (5) Easy dispersal of seeds, due to its high fecundity. A single plant can produce 10000 to15000 viable seeds and these seeds can disperse and germinate to cover large areas. A large single plant produces upto 100000 seeds in its life cycle. More than 340 million seeds per ha can be present in the surface soil.

Mechanical and cultural control :

– Manual uprooting of parthenium before flowering and seed setting is the most effective method. This is easily done when the soil is wet.

– Ploughing the weed in before the plants reach the flowering stage and establishing pastures or other plants may be effective.

– Competitive replacement of parthenium can be achieved by planting species which will compete with the weed and reduce its population. (Species are-*Cassia sericea, Cassia uniflora, Croton bonplandianus, Croton sparsiflorus, Amaranthus spinosus, Sida acuta, Tephrosia purpurea, Stylosanthes scabra, Cassia auriculata* and *Cassia* tora).

– Planting Cassia species (a non-nitrogen fixing leguminous herb) colonizes more aggressively without giving scope for parthenium to manifest.

– Crop rotation using marigold (Tagetes spp.) during rainy season instead of the usual crop, is found effective in reducing parthenium infestation in cultivated areas.

– There is a high risk of spreading parthenium by the movement of vehicles, livestock and crop produce. Washing down vehicles/machinery before entering into a non-infested region will restrict the spread of seeds.

– Movement of cattle during rainy season will aid in the spreading of seeds in muddy soil. If this is unavoidable, it would be safe to hold cattle in yards or small paddocks to let seeds drop from their bodies and tails before releasing them into larger areas.

– Also, while purchasing cattle feed and crop seeds these need to be checked for contamination by parthenium seeds.

– Fire has been used to control the first flush of emergent weeds at the beginning of the rains, but is only considered to be a short term control measure.

– Physical methods like uprooting, tillage, mowing, flame throwing, burning, hand weeding, etc. are effective in small areas, isolated pockets and agricultural field.

– Growing of competitive crops like maize, sorghum and sunflower to suppress parthenium.

– Making compost –when the weed reaches 50 per cent

– Mulching has smothering effect on weeds by restricting the photosynthesis.

Biological control :

– The leaf feeding beetle, a beetle native to Mexico (*Zygogramma bicolorata*) is capable of defoliating and killing this weed and the stem galling moth (*Epiblema strenuana*) are widely used in several countries to manage parthenium. The moth significantly reduces flower and seed production of the weed, especially at young age.

– Other major bio-control agents used are (a) Stem boring weevil (*Listronotus setosipennis*), (b) Seed feeding weevil (*Semicronyx lutulentus*), (c) Leaf mining moth (*Bucculatrix parthenica*), (d) Stem boring moth (*Platphalonidia mystica*), (e) Stem galling weevil (*Conotrachelus albocinereus*), (f) Root boring moth (*Carmenta ithacae*).

– Use of rust fungus (*Puccinia abrupta* var. *partheniicola*). Uredospore suspensions from 3-week old pustules of the rust have been applied to the foliage of parthenium and a consistent control effect has been achieved.

– Pathogens like *Fusarium pallidoroseum*, *Puccinia melampodii, Sclerotium rolfsii* and *Oidium parthenii* also show good potential as bio-control agents.

– Extract of different plant parts and whole plant of *Cassia tora* caused reduction in germination of parthenium.

Chemical control :

– Use of Glyphosate, Atrazine, Metribuzin, Dicamba, 2,4-D, Picloram has been promising.

– The plants should be treated before flowering and seed setting and when other plants, especially grass are actively growing and can recolonize the infested area.

– In open wasteland, non cropped areas and along railway tracks and roadsides, the spraying of a solution of common salt (Sodium Chloride) at 15-20 per cent concentration has been found effective.

– Paraquat (Gramxone) solution is sometimes applied to plants, when the weeds are young.

– In Australia, spot spraying with Atrazine plus a non-ionic surfactant is recommended as a pre-emergence treatment.

– Post emergence control has been achieved with 2,4-D, often in combination with Picloram.

– Some of the herbicides, such as Imazapyr, Oxadiazon, Oxyfluorfen, Pendimethalin and Thiobencarb have also been reported to be highly effective against parthenium weed.

– Bromoxynil+MCPA were the most effective of a range of post-emergence treatments.

– Glyphosate, Glufosinate, Chlorimuron and Trifloxysulfuron applied at the rosette stage provided greater than 93% control.

– Halosulfuron, MSMA, Bromoxynil, 2,4-D and Flumioxazin gave 58-90 per cent control.

– Norflurazon and Clomazone were also highly effective.

– Atrazine @ 1.25 kg/ha prevented weed emergence completely upto 150 DAS followed by Terbutryne @ 6.0 kg/ha and RH 8817 @2.8kg/ha.

– *Post emergence herbicides viz.,* Diquat @ 0.5kg/ha, Dicamba @2.05kg/ha, *Picloram* @ 1.61kg/ha, 2,4-D (Amine) @5.4 kg/ha, Glyphosate @ 0.9kg/ha; Chlorimuron Ethyl@20g/ha, Metsulfuron@ 3.5g/ha Glufosinate @1% were effective in non-cropped areas.

Bentazon @ 1.5kg/ha at 25 DAS in soybean effectively controlled parthenium.

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Integrated approach : In many locations parthenium weed is able to survive individually applied management measures, and a more effective integrated approach is therefore required in these locations. A holistic approach is propounded in India to achieve sustainable management of parthenium weed and implemented in Australia through improved extension strategies. The following measures are the one of examples of integrated parthenium management-ploughing before flower set + burning when the plants are dry and mature+ application of atrazine or other herbicides like 2,4-D, Paraquat, glyphosate, diuron, dalapon+using *Cassia sericea* to displace parthenium weed+biocontrol using *Zygogramma bicolorata*.

Future strategies:

– There is a need for community efforts in manual removal of weed before it starts flowering.

– Limited use of recommended weedicides can be adopted in suitable areas.

– The role of plant species in competitive displacement of parthenium has to be further evaluated. Particularly the plant species should have some economic value and should not pose health/environmental problems.

– Maximum efforts should be directed towards

Table 1 : Still date generally these chemicals were used to control parthenium

Sr. No.	Name of chemical	Sr. No.	Name of chemical	Sr. No.	Name of chemical
1.	Glyphosate	12.	Imazapyr,	23.	MSMA
2.	Atrazine	13.	Oxadiazon	24.	Bromoxynil,
3.	Metribuzin	14.	Oxyfluorfen	25.	Flumioxazin
4.	Dicamba	15.	Pendimethalin	26.	Norflurazon
5.	2,4-D	16.	Thiobencarb	27.	Clomazone
6.	Picloram	17.	Bromoxynil+MCPA	28.	Terbutryne
7.	Sodium Chloride	18.	Glufosinate	29.	RH 8817
8.	Paraquat (Gramxone)	19.	Chlorimuron	30.	Diquat
9.	Alachlor	20.	Trifloxysulfuron	31.	Metsulfuron
10.	Butachlor	21.	Halosulfuron	32.	Bentazon
11.	Simazine	22.	Diquat		

importation of host specific insects.

– There is a need for interaction between different scientists and laboratories so that an integrated management is evolved.

– The govt. may enact legislation for removal of parthenium in public places.

Awareness :

– Uprooting the weed after seed setting will increase the area of infestation.

– Pulling a plant in flower will aid in the dispersal of pollen grains, resulting in allergic reactions.

– Preventing the spread of parthenium is the most cost effective management strategy.

– Burning is not a useful control strategy for parthenium.

– Cutting or slashing of parthenium enhances its regeneration.

– Uprooting after fruit setting will be a sheer waste of time and money.

– During uprooting, labourers should be equipped with protective measures including ascertaining their parthenium sensitiveness.

– Use lightweight, long sleeved garments and cotton gloves to avoid contact with the skin.

– The seed can stay for years in the soil seed bank and the continuous removal of the weed is required until the seed bank is depleted.

– Fire created open niches in the landscape, into which larger number of parthenium seeds were able to germinate in the absence of vegetation. Therefore, management of parthenium weed in pastures through burning is not considered to be an option.

Conclusion: To feed the ever-increasing population of our country, we are trying to enhance agricultural production overcoming various challenges in agriculture i.e. shrinking cultivable land, lack of irrigation water, labour shortage, problem of farm mechanization, soil salinization, lack of good quality seed, high prices of fertilizers and others. In this respect several promising technologies are coming in the way i.e. good quality seed (enhance production upto 20 percent), drip irrigation (enhance production 15 to 20 percent), SRI technique (higher cost benefit ratio=1:2.5) and others. In this background, parthenium infestation reduces yield upto 40 percent; means it is pulling back our efforts for agricultural progress. Already the weed has occupied over 5 million ha of land in the country. Therefore, the time has come to consider parthenium invasion as a forthcoming danger in agriculture, considering its negative impact on agriculture. Our unawareness about this weed has given it to its' full potential spread. Hence, the extension agency should consider this fact heartily and should take various extension teaching methods (programmes) to aware the farmers especially about this poisonous and harmful weed. Parthenium became a menace due to wide ecological amplitude, profuse growth, fast multiplication, rapid spread, agricultural and health hazards. Several methods have been recommended to suppress its growth. But no method appears to have worked satisfactorily as each method suffers from one or more limitations such as inefficiency, prohibitive cost, impracticability, polluting the environment and only temporary relief etc. However, the integrated parthenium management (IPM) approach recommended recently seems to be promising.

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