

intentional manipulation of natural enemies by man for the purpose of controlling harmful weeds. *Parthenium* can be managed by its natural enemies like insects and fungi. 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. Under the biological control programme, host-specific bio agents from the native home of the weed are imported into other countries, where the weed had entered and became invasive.



Post-emergence application of herbicide for the control of *Parthenium* in non-cropped area

Based on well-documented success by the Mexican beetle (*Zygogramma bicolorata*), in other countries where they were introduced, beetle was imported in 1982 from Mexico to India. Detailed host-specificity tests under quarantine conditions confirmed the safety of *Z. bicolorata* to cultivated crops in the country. This beetle has been found effective to control *Parthenium* in different parts of the country. Beetles are of white or light reddish in colour with dark brown longitudinal markings on the elytra, measuring about 6 mm in length. Light yellow eggs are laid generally on ventral side of the leaves and hatch in 4-7 days. The beetle completes its life-cycle in 22-32 days. Insect completes 5- 6 generations under field conditions in a year. Both adults and larvae are capable of feeding on *Parthenium*. By continuously feeding on *Parthenium*, it gradually kills the weed. Newly-emerged plants after first flush are very vulnerable to the attack of grubs and adults.



Zygogramma bicolorata and its attack on *Parthenium* leaves

6. Management by effective utilization: *Parthenium* can be most effectively used in compost and vermicomposting. The compost should only be prepared by pit system. The *Parthenium* biomass should be buried in the pit in layers. On each layer, 5 kg dung slurry and 500 g urea should be used. After filling the pit, it should be closed by the mixture of soil and dung. The compost prepared by *Parthenium* contains more nutrients than the compost prepared by dung only. Precautions should be taken that for compost making only those *Parthenium* plants should be selected which has not reached to flowering stage.

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Integrated management of *Parthenium hysterophorus*



Parthenium hysterophorus (Family: Asteraceae), is also well known as gajar ghas, safed topi, chatak chandni and is native to Mexico, America, Trinidad, Argentina. It is one of the most problematic alien invasive weeds in the tropical and subtropical world and popularly known as Gajar ghas due to its appearance like a carrot plant. Its strong allelopathic, potential prolific seed production and phenotypic plasticity in growth enables this species to invade a wide range of habitats in areas where natural ecosystems are disturbed to varying scales by anthropogenic activities. After the noticeable occurrence of *Parthenium* in Pune (Maharashtra) in 1956, it has spread like a wild fire throughout India. At present, it has invaded about 35 million hectares of land in India. It is a nuisance on road sides and railway tracks, vacant lands, wastelands, industrial areas, on the sides of open drainage systems and irrigation canals besides invading agricultural crops.



Parthenium infestation

How to identify ?

Parthenium leaves look like carrot leaves and attains height of 1.5-2.0 meter. It is heavily branched especially when reaches to the flowering stage. Stem and leaves covered with fine hairs whereas flowers are white in colour.

How does *Parthenium* spread ?

It mainly spreads through seeds. A single plant can produce about 5,000-25,000 seeds. The seeds are very light in weight and easily carried or transported by wind, water or through various human activities. *Parthenium* has the capacity to re-grow from the cut or broken parts. Its allelopathic effects coupled with the absence of efficient natural enemies are two important factors responsible for its rapid spread in India.

Harmful effects of *Parthenium*

In general, *Parthenium* is a poisonous, pernicious, problematic aggressive weed posing a serious threat to biodiversity, human

beings and livestock. *Parthenium* is partly responsible for allergic eczematous dermatitis, allergic rhinitis, fever, sinusitis and asthma in urban populations of humans. Besides ill-effects, it also causes several other problems like blockage of common pathways and reduces the aesthetic value of parks, gardens and residential colonies. *Parthenium* also infests field crops, orchards, plantations and forests. It severely reduces crop productivity besides loss to biodiversity and environment.



Harmful impact of *Parthenium* on human health and livestock

Integrated management of *Parthenium*

Ever since the weed became a menace in India and other countries, efforts have been made to manage the weed by different methods. But so far, no single method has proved satisfactory as each method suffers from one or more limitations such as impracticability, temporary control, environmental safety, high cost etc. Therefore, there is an urgent need to adopt an integrated *Parthenium* management approach by amalgamating two or more methods together as and when applicable.

1. Legal and extension management: The management of *Parthenium* was also tried in India through the legal act, first in Karnataka. This act can be complemented at the municipality or stated to prevent the spread of *Parthenium*

2. Mechanical and manual methods: Uproot the *Parthenium* before flowering during monsoon when soil is wet. Gloves and masks should be worn while uprooting as it causes allergy to

sensitive person. Skin should not be touched while uprooting. People may be sensitise on community basis for uprooting.

3. Cultural management: Farmers should adopt fast growing crops like sorghum, berseem and Dhaincha/sesbania to suppress the growth of *Parthenium* in their field. *Parthenium* can also be managed by competitive plants like *Cassia tora*, *Cassia sericea*, marigold, *Tephrosia purpurea*, *Achyranthes aspera* etc. But among these *C. tora* or *C. sericea* are widely used to replace *Parthenium*. Its strong allelopathic effects does not allows *Parthenium* to grow in its surroundings. The seeds of *Cassia* can be collected during October-November and should be broadcasted in March-April before monsoon on the pre-identified areas to be replaced.

4. Use of chemicals:

Parthenium in non-cropped areas can be controlled by use of glyphosate (1.0-1.5%) for total vegetation control but if grasses are to be saved, Metribuzin (0.3-0.5%) or 2,4-D (1.0-1.5%) can be used. In different crops, the use of herbicides should be done only after consulting weed scientists/ experts as different herbicides are recommended to different crops. Alachlor (2.0 kg/ha) can be used as pre-emergence to control *Parthenium* in soybean, rajma and tomato. Metribuzin (0.50 to 0.75 kg/ha) can be used as pre-emergence just after sowing to control *Parthenium* in potato, tomato and soybean. In crops like sugarcane sorghum, maize, pearl millet etc. 2, 4-D (0.5 kg/ha) can be applied as post emergence.

5. Use of biological control agent: Among several components of integrated management, biological control has been considered the most important approach due to its cost-effectiveness, environmental safety, and sustainability in controlling *Parthenium*. Biological control of weeds is the



Use of *Cassia tora* as a management option for *Parthenium*