

Parthenium infestation and its estimated cost management in India

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ABSTRACT

Management of risk by a pest in agriculture is one of the major concerns of the decision makers and policy planners. There is always risk of introduction of alien weed seeds along with the imported cereals. This study revealed that how much cost may be involved in management of an alien introduced weed in due course mentioning example of Parthenium which got introduced into India in 1955 along with imported cereals. Initially Parthenium was a problem in waste and vacant land. Reports started to appear about its infestation in field crops after 1980. In general, about 35 million hectare land has been estimated to be infested with Parthenium currently. The increase of Parthenium infestation in crop area in recent past is alarming. For the management of Parthenium, two hand weeding or two chemical sprays are essentially required to get complete relief. It was estimated that 182000 or 18200 crores will be required per year to mitigate the problem by manual labour and Rs 119000 million or 11900 crores are required to manage the weed by Chemical method besides Rs 880 crores for treatment of health and about 10 crores on researchable issues related to biological control in particular and integrated management in general including people awareness programmes. Therefore, since 1955, it would have cost Rs 2067160 million or 206716 crores to manage the parthenium in India by manual labour The losses caused by this weed may be much higher if we take into consideration the cost involved in restoration of biodiversity and aesthetic value already lost due to Parthenium

Key words : *Parthenium hysterophorus*, Infestation in India, Estimated cost of management

In past, many weed species got entry in India inadvertently through the imported cereals due to lack of strict quarantine rules and laws in the country. Such one of the most discussed weed species is *Parthenium hysterophorus* popularly known as "Gajar ghas" which got entry in India in 1950s through the large scale import of wheat and other cereals under PL480 grant from USA. Through public distribution system of these contaminated cereals, Parthenium spread rapidly throughout the country and became noxious. *Parthenium hysterophorus* L., commonly known as carrot weed, white top or congress grass in India, is a herbaceous erect and annual plant belonging to the family "Asteraceae" (compositae). The origin of Parthenium is considered to be from Mexico, America, Trinidad and Argentina. Within last century, it has found its way into Africa, Australia and Asia. Parthenium has now been considered one of the most troublesome weeds in India due to its health causing problems in man and animals besides loss to crop productivity, biodiversity and aesthetic value of land. Earlier Parthenium was considered a weed of wasteland, community land and vacant land but now it has made its way to almost all type of crops, orchards, plantations and forest area. The increasing problem of *P. hysterophorus* is considered as one of the chief causes of reduction of crop productivity in many ecosystems (Patil *et al.*, 1997),

besides health issues in man and animals (Subba Rao *et al.* 1977, Fisher 1996, Sushilkumar 2005) and loss of plant biodiversity in many ecosystems (Rajwar *et al.* 1998; Kumar and Rohatgi 1999, Sushilkumar 2005).

It has been established that growth inhibitors are released from this plant into the soil through leaching, exudation of roots and during decay of residues (Kanchan and Jayachandra, 1980) as a result, Parthenium can be seen in dense, pure stands. Parthenium is reported to cause 15-27% (Mahadevappa 1999) and up to 40% (Khosla and Sobti 1979) yield loss in various crops and reduction in forage production up to 90% in grazing lands in the state of Maharashtra (Vartak 1968). Parthenium has been reported to infest 26-43% area in cereals, 3-44% in pulses and 4-66% in oil seeds crops in Bijapur Districts of Karnataka (Patil *et al.*, 1997). The invasion of Parthenium has threatened the forest biodiversity in sal (*Shorea robusta*) forest (Pandey and Saini 2002) and tea forest of Pench National Park of Madhya Pradesh.

On examination, it was found that 4% of persons were suffering from acute allergic contact dermatitis, however 56% had actually been sensitized by the patch test by Subba Rao *et al.*, (1977). They concluded that chances of getting sensitised to Parthenium are 50% in case of regular exposure by direct contact. A significant

proportion of bronchial asthma patients was sensitised to *P. hysterophorus* (Suresh *et al.* 1994). Pollen grains of *Parthenium* were found to be predominant after its invasion in 1965 in Bangalore (Jayachandra 1971) and an increase in the incidence of nasobronchial allergies reported (Rao and Rao 1985) coincided with the steady and widespread growth of the weed. Random clinical surveys showed that seven per cent of the study population in the area was suffering from allergic rhinitis resulting from exposure to *Parthenium* pollen (Sriramarao *et al.* 1991).

In animals also, *Parthenium* was found to cause clinical signs such as salivation, onset of diarrhoea, anorexia, pruritus, alopecia and dermatitis. *Parthenium* caused itching, alopecia, and dermatitis on the face, muzzle, neck, eyes, thorax, abdomen and brisket region in calves (Fisher 1996). In cattle, due to *Parthenium* contact, there may be loss of hair and marked depigmentation of skin. The bitter and reduced milk yields contaminated with parthenin have been reported in buffaloes and goats, fed on grass mixed with *Parthenium* (Krishnamurthy *et al.* 1977).

Ever since the *Parthenium* became a menace in India, efforts are being made to manage the weed by different methods. Manual method is most effective but it is costly and not practicable. The management of *Parthenium* was also tried in India through the legal act, first in Karnataka state in 1975, declaring *Parthenium* a noxious weed but it could not bring any desirable impact. Under biological control efforts, one insect species *Zygogramma bicolorata* is doing well but this methods also snuffed by some limitations (Sushilkumar 2005, Sushilkumar and Varshney 2007). A large number of chemicals have been recommended to control this weed (Krishnamurthy *et al.* 1977), Herbicides such as 2,4-D, glyphosate, metribuzine *etc.* are effective in controlling *Parthenium* (Brar and Walia 1991, Bhan and Dixit 1997) but not possible to opt this method at large scale owing to environmental contamination.

Management of risk in agriculture is one of the major concerns of the decision makers and policy planners as instability in farm output is considered as the primary cause for low level of farm level investments. In order to develop mechanism and strategies to mitigate risk in agriculture, it is imperative to understand the sources and magnitude of fluctuations involved in agriculture output. The present paper is an effort in this direction. In the present study, an attempt has been made to analyse the cost which would have occurred to manage *Parthenium* by manual or chemical methods. This study will help to understand the decision makers and policy planners the risk involved in importing cereals from other countries as

there is always risk of introducing exotic weed seeds which may cause tremendous loss in future.

MATERIALS AND METHODS

The study uses data on area under different agriculture, forest and wasteland situations for the period from 1955 to 2009. The land use pattern data was collected mainly from a publication of the Directorate of Economics and Statistics, Department of Agriculture and cooperation, Govt. of India (Anon, 1996). For the present analysis, the period was taken into consideration since first record of *Parthenium* in 1955 till 2009 as well as by sub-dividing it into 6 period representing mainly one decade each except first and last. These period classifications will facilitate in some way to know the infestation progress made in each period to increase the area under *Parthenium* infestation.

Recent *Parthenium* infested area (per cent infestation of land) has been estimated on the basis of information collected from about 300 Krishi Vigyan Kendra (KVKs) and 24 centres of All India Coordinated Research Programme Centre on Weed Control (AICRPWC) now renamed as Directorate of Weed Science Research Centre (DWSRC) located throughout the country (Table-1). *Parthenium* infestation in different land used systems like wasteland, crop land, forest *etc* during different period has been estimated on the basis of published literature.

Following criteria were taken into consideration in estimating the *Parthenium* infestation and its cost management :

1. In general, fallow, barren, cultural wasteland, permanent pastures and other grazing land and area under non-agricultural uses exists to the tune of 93.88 million hectares. Such lands were infested by *Parthenium* ranging from 0 to 100% depending on the climatic conditions. On an average 0.5 to 20 % area has been taken under *Parthenium* infestation during different decade based on literature.
2. Area under agricultural uses is about 142.51 million hectare. In crop fields, *Parthenium* problem started after 1965 onwards. It is observed that average infestation has ranged from 0.2 to 15% during 1965 to 2009.
3. Area under forest (68.07 mha) is also increasingly infested with *Parthenium* after 1990s. Around 0.5 to 3% area has been observed to be infested with *Parthenium* during different decade.
4. Estimated cost has been calculated based on the average cost of labour and herbicides during different decades to control this weed in one hectare area basis (Table-2).

5. For calculating manual cost, 40 man days were considered to weed out one hectare severely infested area.
6. For estimating cost of management of Parthenium, minimum two hand weeding or two herbicide sprays were considered essential for its control as it has several flushes in rainy season.
7. Expenditure occurred on biological and other control techniques including funding on research by Govt. of India has been taken in lump sum.

RESULTS AND DISCUSSION

Parthenium infestation in India

Study revealed that Parthenium infestation till 1960 was restricted to Maharashtra and border areas of adjoining states which increased inside of all the nearby states of Maharashtra by 1970. From 1970 onward, it started to spread rapidly throughout the country except a few states. The information collected from Krishi Vigyan Kendra (KVKs) [Agricultural Science Centre] of the country has brought forth the increasing problem of Parthenium in almost all parts of the Country (Fig.1). The record of this weed in Kargil region of Jammu & Kashmir and Port Blair in Andman & Nicobar Islands is a pointer to extraordinary ability of the weed to invade new environments (Yadhuraju *et al.* 2005). The problem is particularly serious in rain-fed ecosystem and in non-crop situations. The spread and infestation of Parthenium are severe in some of the states like Uttar Pradesh, Karnataka, Tamil Nadu, Andhra Pradesh, Bihar and Madhya Pradesh.

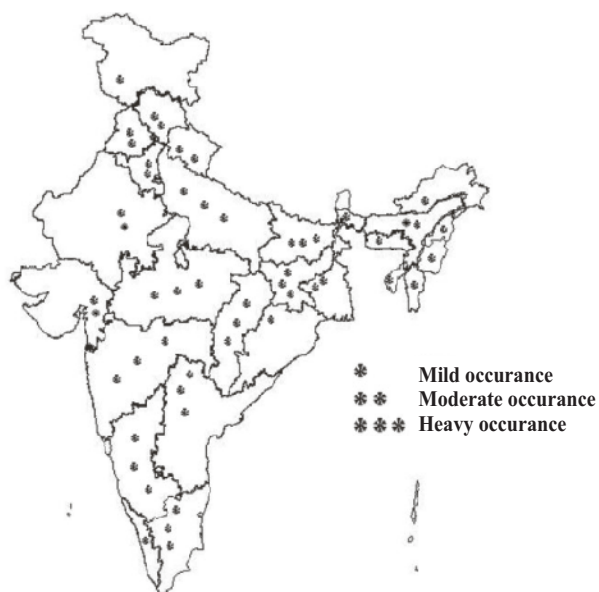


Fig.1. Present status of spread of Parthenium in different states of India

Almost all types of habitates like crops, disturbed habitates, fallow land, road and railway track side, public amenity areas, urban and industrial settlement *etc* this weed thrived well. Orchards, grass and pasture land, open forest, plantation forests are increasingly being infested by the weed.

Mahadevappa (1999) recorded this weed almost from all the states of India except Orissa, north-east region, higher hills of Kashmir and Andman Nicobar Island. But by now, *Parthenium* has spread in almost all the states of north-east region, many parts of Orissa and most of the arid region of Rajasthan except extreme desert area. Yaduraju *et al.* (2005) and Sushilkumar (2005) have also reported its occurrence from Anadman and Kargil region of the country. Andaman represents a island and Kargil represents a cold region.

Estimation of land area infested with Parthenium in India (1955-2009)

Initially Parthenium was a problem in waste and vacant land but reports started to appear about its infestation in field crops after 1980. Although the area infested under crop land is still low keeping in view of its thriving power but its area is increasing day by day. Likewise, reports of Parthenium infestation in forest area also started to appear after 1990. On the basis of these published information, the estimated area infested with Parthenium during different decades is given in Table-1. In general, about 35 million hectare land is estimated to be infested with Parthenium today. The increase of Parthenium infestation in crop area in recent past is alarming.

Table 1. Estimated infested area by Parthenium in India during different decades since 1955

Period	Infestation (in million ha) in different land type			
	Barren, fallow, waste land including land under non - agricultural uses	Crop land	Forest land	Total infested
1955-1960	0.5	0	0	0.5
1961-1970	1.75	0.25	0	2.0
1971-1980	4.5	0.5	0	5.0
1981-1990	6.0	1.0	0	7.0
1991-2000	7.5	2.0	0.5	10.0
2001-2009	18.78	14.25	2.0	35.0

Estimation of cost involved for management of Parthenium (1955-2009)

It has been established that Parthenium problem start increasing after 1960 in India. Increasing infestation in crop fields has compelled farmers to take some manual

Table 2. Estimated cost of control of Parthenium by manual weeding

Period	Average area Infested (mha)	Average Labour cost (Rs/day)	Cost of one hand weeding (Rs/ha)	Cost of two hand weeding (million rupees)	
				Per year	Per decade
1955-1960	0.5	1.5	60	60	360*
1961-1970	2.0	3.0	120	480	4800
1971-1980	5.0	5.0	200	2000	20000
1981-1990	7.0	15.0	600	8400	84000
1991-2000	10.0	40.0	1600	32000	320000
2001-2009	35.0	65.0	2600	182000	1638000**
				Total	2067160

* For six years ** For nine years.

control measures against this weed. It was estimated that in the year 2009, Rs 182000 million or 18200 crores were required per year to manage the weed by manual methods. Therefore, since 1955, it would have cost Rs.2067160 million or 206716 crores to manage the Parthenium in India by manual labour (Table-2).

Likewise, cost involved in herbicidal control has also been calculated on the basis of herbicide cost at the prevailing time (Table-3). It was estimated that in the year 2009, Rs 126000 million or 12600 crores were required per year to manage the weed by chemical methods. Therefore, since 1955, it would have cost Rs 1509480 million or 150948 crores to control the parthenium by chemical methods in India.

Expenditure involved on health problems in human being

On an average about 4% human population has been estimated to suffer with Parthenium related problems which amount to be about 4.4 crores people on the basis of current population in India. On an average if an individual expends currently only Rs 200 in the treatment of Parthenium related problems, it amounts about Rs 880 crores.

Expenditure involved in research in biological control and integrated management of Parthenium

Since 1983, Indian Council of Agricultural Research (ICAR) scientists have made efforts to utilize biological control methods to contain the menace of Parthenium in India. For this purpose ICAR has funded approximately Rs. 20 million in research related issues. DBT, a funding agency of Govt. of India has also contributed about 20 million rupees to fund various projects on Parthenium management in India.

Estimation of current cost in controlling Parthenium in India

Recent survey by Directorate of Weed Science Research (DWSR) has clearly revealed that currently this weed has become a nuisance in agricultural and forest land besides barren, waste land and other nonagricultural lands. It has also been established that this single weed is mainly responsible for health related problems in man and animals besides loss to crop productivity, native biodiversity and environmental degradation. At present about 35 million hectare land is infested by Parthenium for which per year two hand weeding or two chemical sprays are essentially required to get relief. Therefore Rs 182000

Table -3. Estimated herbicidal cost to control Parthenium during different decades

Period	Average Parthenium infested area (mha)	Average cost of one herbicide application (Rs/ha)	Cost of two herbicide spray (million rupees)	
			Per year	Per decade
1951-1960	0.5	80	80	480*
1961-1970	2.0	100	400	4000
1971-1980	5.0	150	1500	15000
1981-1990	7.0	400	5600	56000
1991-2000	10.0	1500	30000	300000
2001-2009	35.0	1800	126000	1134000**
Total				1509480

* For six years ** For nine years.

million or 18200 crores will be required per year to mitigate the problem by manual labour or Rs 126000 million or 12600 crores were required to manage the weed by chemical methods besides Rs 880 crores for treatment of health and about 25 crores on researchable issues related to biological control in particular and integrated management in general including people awareness programmes. The losses caused by this weed may be much higher if we take into consideration the cost involved in restoration of biodiversity and aesthetic value already lost due to Parthenium

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