

Biological control of *Parthenium* by *Zygogramma bicolorata* and *Cassia* spp.

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Introduction

Parthenium hysterophorus Linnaeus (Asteraceae), globally known as feverfew, ragweed or *Parthenium* is a weed of world significance. It is most popularly known as 'congress grass' throughout India while in Hindi speaking belt known by the popular name of 'gajar ghas' (carrot grass). It degrades natural ecosystems by reducing biodiversity (Holm *et al* 1997) and can cause serious allergic reactions in man and animals (Sushilkumar 2012). In India, it has invaded almost all types of crops and has become a serious threat for a gricultural production. Sushilkumar and Varshney (2010) estimated infestation of *Parthenium* in 18.78, 14.25 and 2.0Mha lands in barren, fallow, wasteland including land under non-agricultural uses, crop a rea under cultivation and forest areas, respectively. In India ,History, progress and prospects of classical biological control in India this weed is a serious problem in states like, AndhraPradesh, Bihar, Haryana, Karntaka , Madhya Pradesh, Tamil Nadu and Uttar Pradesh. *Parthenium* is regarded as one of the worst weeds because of its immense capacity of reproduction and ability to thrive in varied climatic conditions. It causes health hazards, like skin allergy (dermatitis), hay fever and asthma in human beings and also toxic to live stock (Lonkar *et al.* 1974, Chippendale and Panetta 1994). It threats native biodiversity besides loss to crop productivity (Holm *et al.* 1997). It is nuisance in public amenity areas like parks, residential colonies and orchards. This weed squeezes grass lands and pastures hence reducing the fodder supply.

The management of *Parthenium* by herbicides was considered only a viable option by Balyan *et al.* (1997) but the effect of herbicide was considered of temporary nature and repeated operations were required. Chemical control of *Parthenium* over avast area like wastelands, rangelands, community land or within forests where the weed commonly found is not cost effective. So biological control seems to bethe

only alternative.

Efficacy of *Zygogramma bicolorata* against *Parthenium* is well established and is capable of causing 5-95% damage to *Parthenium* plants, but infestation varied from place to place (Sushil Kumar,2009). *Cassia tora* and *Cassia occidentalis* nitrogen fixing leguminous plants have been found to more competitive against *Parthenium* which can be recommended for deliberate replacement of *Parthenium* on road side ,community and waste lands in most of three states of India on the basis of low seed rate and spread ability (Sushil Kumar and Bhan 1997). Keeping in view of serious menace by *Parthenium*, experiments were conducted to study the feasibility of *Parthenium* control by *Zygogramma* beetle and competitive plants like *Cassia tora* and *Cassia occidentalis* in various places representing various agroclimatic conditions of Haryana state.

Methods and Materials

Two experiments on feasibility of *Parthenium* control by *Zygogramma bicolorata* beetles and by competitive plants were conducted during Kharif season of 2013 in various parts of state having different agro environments In experiment on biological control of *Parthenium* by *Zygogramma* beetles, beetles collected from established sites in Pinjore area of Panchkula district were released at 3 selected sites which were heavily infested with *Parthenium* (Hisar, Kaithal and Naraingarh) during first week of July 2013. Observations on number of adults, eggs and larvae were recorded at monthly interval. Damage was taken on 0-100 scale based on visual ranking. In another experiment on competitive ability of *Cassia tora* and *Cassia occidentalis* against *Parthenium*, experiment was planned at four locations (Kalka, Karnal, Narwana and Hisar) in different agro climatic zones of Haryana with variation in rainfall, soil type and relative humidity on soils heavily infested with *Parthenium* during last year. Seeds of *Cassia tora* and *Cassia occidentalis*

collected during November-December, 2012 were planted using three seed rates of 10, 15 and 20 kg/ha on these sites upon receipt of rainfall. Density of *Parthenium* and its visual control were recorded at all these sites. At 4th site in Hisar, due to heavy rainfall during August, September and October and water logging, observations on plant stand could not be recorded due to higher mortality of all plants.

Efficacy of Zygotogramma beetles

Visual observations reveal that *Zygotogramma* beetles behaved differentially at different places of release due to difference in rainfall, R.H. and temperature at these sites.

The observations taken at monthly interval revealed that progressive multiplication of beetles along with increase in damage up to 75% at Narain Garh only (Table 1). Beetle population was more during September. At Narain Garh 45% defoliation took place within one month of release. Highest damage was observed in month of September. Number of eggs laid on ventral surface of young and old leaves were more in Narain Garh. Beetles did not multiply at Hisar but at Kaithal only 25% defoliation of mature leaves was observed with little multiplication due to poor rains in the region. At Hisar and Kaithal, only few beetles appeared in nature this year in October month only.

Least damage to *Parthenium* (5%) occurred at Hisar where as it 75% at Narain Garh. This may be due to more rainfall (1050 mm), Low temperature and relative humidity occurred at Narain Garh. Higher temperature of above 40 °C occurred at Hisar during period of July and August detrimental for establishment of *Zygotogramma* beetle may be responsible for poor establishment at Hisar (Virakathmath et al. 2004).

Biological control of Parthenium by competitive replacement through Cassia tora and Cassia occidentalis

Although both *C.tora* and *C.occidentalis* established in the first year at both sites, but at Kalka, in foot hills of Shivalik hills with average rainfall of 1150 mm, *C.tora* was more successful with 90% control of *Parthenium* by using seed rate of 20 kg/ha where as in Karnal and Narwana, *C.occidentalis* with seed rate of 20 kg/ha provided 80-72% replacement of *Parthenium* as against 40-69% by *C.tora* at same seed rate (Table 2, 3 & 4). With increase in seed rate of *Cassia tora* and *Cassia occidentalis*, number of *Parthenium* plants decreased significantly with each successive increase in seed rate of both *C.tora* and *C.occidentalis*. Seed rate of 20 kg/ha of both *C.tora* and *C.occidentalis* was found to give higher competition to *Parthenium* resulting in better control

Table 1: Egg, grub and adult population of Mexican beetles per plant and per cent damage to *Parthenium* in Haryana (2013)

Month	Narain Garh(Ambala)				Kaithal				Hisar			
	Egg	Grub	Adult	Damage(%)	Egg	Grub	Adult	Damage(%)	Egg	Grub	Adult	Damage(%)
August	20	12	15	45	5	3	4	10	0	0	0	0
September	27	14	26	70	3	6	7	22	0	0	0	0
October	15	10	17	75	4	5	3	25	2	0	4	5
November	0	0	4	75	0	0	0	0	0	0	2	5
Over all damage at site (%)	75			25	5							

Table 2: Effect of *C.tora* and *C.occidentalis* on plant stand of *Parthenium hysterophorus* at maturity (Karnal) Rain fall: 600 mm

Treatments	Seed rate (kg/ha)	<i>C.tora</i> (No./m ²)	<i>C.occidentalis</i> (No./m ²)	<i>Parthenium</i> (No./m ²)	<i>Parthenium</i> control (%)
<i>C.tora</i>	10	172	-	156	55
<i>C.tora</i>	15	189	-	125	63.2
<i>C.tora</i>	20	245	-	108	68.2
<i>C.occidentalis</i>	10	-	155	116	65.8
<i>C.occidentalis</i>	20	-	204	92	72.9
Control	-	0	0	340	0
SEm		3.9	3.7	5.8	1.4
CD at 5%		12	10	18	4.3

Table 3: Effect of *C.tora* and *C.occidentalis* on plant stand of *Parthenium hystreophorus* at maturity (Kalka) Rain fall: 1150 mm

Treatments	Seed rate (kg/ha)	<i>C .tora</i> (No./m ²)	<i>C.occidentalis</i> (No./m ²)	<i>Parthenium</i> (No./m ²)	<i>Parthenium</i> control (%)
<i>C.tora</i>	10	98	-	45	69
<i>C.tora</i>	15	121	-	26	82
<i>C.tora</i>	20	128	-	15	89.6
<i>C.occidentalis</i>	10	-	93	52	64.1
<i>C.occidentalis</i>	20	-	101	28	80.6
Control	-	0	0	145	0
SEm		1.8	2.3	2.2	1.8
CD at 5%		5.4	7.2	6.4	5.6

Table 4 : Effect of *C.tora* and *C.occidentalis* on plant stand of *Parthenium hystreophorus* at maturity (Narwana) Rain fall: 400 mm

Treatments	Seed rate (kg/ha)	<i>C .tora</i> (No./m ²)	<i>C.occidentalis</i> (No./m ²)	<i>Parthenium</i> (No./m ²)	<i>Parthenium</i> control (%)
<i>C.tora</i>	10	98	-	45	69
<i>C.tora</i>	15	121	-	26	82
<i>C.tora</i>	20	128	-	15	89.6
<i>C.occidentalis</i>	10	-	93	52	64.1
<i>C.occidentalis</i>	20	-	101	28	80.6
Control	-	0	0	145	0
SEm		2.0	2.5	2.2	1.7
CD at 5%		6.2	7.5	6.7	5.4

*Site 4: CCS HAU Hisar: Experiment failed due to water logging near canal

as compared to 5 and 10 kg seed rates. *Cassia tora* was found more successful as compared to *C.occidentalis* at Kalka but at Narwana and Karnal, *C.occidentalis* was more competitive as compared to *C.tora*. It may be due to intermittent rainfall occurred in Kalka favourable for growth of *C.tora*. In Jabalpur, replacement of *Parthenium* by *Cassia tora* has been well demonstrated along the road side by Sushilkumar (2011).

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