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Biological control of *Parthenium hysterophorus* by insect

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During studies on mycoflora of *Parthenium hysterophorus* an insect was found to devour the plants ferociously. The present study is concerned to know the extent of damage caused to the weed by the insect at the different growth stages. The insects were introduced to the pot plants at healthy vegetative stages when the plants were 4 cm in height with an average of 5 leaves. After one month, it was detected that the maximum impact was on the leaves which were devoured completely by insect expect the mid rib. Also the plant height, shoot length and plant biomass were affected i.e. 65.11%, 56.18% and 71.63% as compared to control ones. The impact on root length, and stem diameter were not significant. Another interesting point was that the plants did not reach the flowering stage.

Therefore, it is concluded that the present insect opens a new dimension for the control of this dangerous weed.

Key words : *Parthenium hysterophorus,* biological control, insect

INTRODUCTION

Parthenium hysterophorus L. (*Heliantheae : Asteracae*) is an obnoxious weed and native of West Indies, Mexico and Tropical America and has now become wide spread in Africa, Australia and Asia. It is commonly known as white top, congress grass, carrot weed, and vernacular name viz. chatak chandani, and gazar ghas (Krishnamurthy *et al.* 1977). In India, it is accidentally introduced in 1955 through food grain and first reported from Pune in 1956 (Rao, 1956). At present it has spread throughout India barring western part of west coast and temperate region of Himalayan range.

In U. P. the weed was first reported by Ellis and Swaminathan in 1969 and now had spread in almost all the districts of U. P. *Parthenium hysterophorus* has originated as a result of natural hybridization between *P. conifertum* and *P. bipinnatifidum* (Nath, 1988). A fully grown plant can produce up to 25,000 seeds in its life time (Navie *et al.,* 1996). Depending upon the frequency and distribution of rain, the plant can complete one, two or even three generations in a year (Singh *et al.* 1993). In India *Parthenium* infest about 5.0 million hectares of land both under cropped and uncropped situation.

It removes major portion of nutrients, destroys natural vegetation and also cause hazards to human beings and animals. Direct contact with plant or plant parts, living or dead, cause allergy, dermatitis, eczema, asthma, pollentosis and hay fever. Animals get rashes on their udders and whole body. Parthenin is responsible for "bitter milk" disease in live stock feeding on grass mixed with *Parthenium.*

The allelopathic potential of *Parthenium* weed results from the release of phytotoxic substance such as ferulic acid, caffeic, P-hydroxybenzoic acids and parthenin.

Because of its prolific cover and hazardous properties, adequate measures are needed for complete eradication. Biological control has received new momentum and is being used successfully because several physical and chemical methods proved uneffective, uneconomical and environmentally unsafe.

Among the numbers of biological control agents, the leaf feeding beetle, *Zygogramma bicolorata* Pallister (Coleoptera, Chrysomelidiae) proved to be most effective. The beetle was imported by Indian Institute of Horticulture Research (IIHR), Bangalore from Mexican substation of Commonwealth Institute

of Biological control (CIBC). The safety to this beetle to the cultivated crop land was confirmed by detailed host specificity test under quarantine measure (Jayanth and Nagarkatti, 1987) and considered as monophagus. But now the insect was also found to feed on Xanthium and Sunflower due to overpopulation and starvation following sudden destruction or disappearance of target weed in Bangalore. Therefore it has been taken as pointer towards expansion of host range.

Zygogramma bicolorata emerges in late spring and active until autumn. The activity of beetle coincides with rainfall and undergoes diapause during winter months within soil and becomes active during the onset of spring. The adult and larvae both feed *Parthenium* leaves. The eggs are laid singly or in groups on undersurface of the leaves, flower heads, stem surface, terminal and axillary buds. The fully grown larvae pupate in soil. The pupal period lasted for two weeks. The whole life cycle takes six to eight weeks. The adult beetle can live up to two years and usually spend six months diapausing in soil during winter.

The beetle was detected in Allahabad for the first time in 2003 and gradually spread to different localities in 2004. But there was sudden outbreak of beetle from April 2005. Similar outbreak was also observed in the adjoining districts and other places of U.P.

Therefore in the present study, biocontrol potential of *Zygogramma bicolorata* has been evaluated on different growth stages of *Parthenium* under caged experiment.

MATERIALS AND METHODS

The experiments were conducted in February to May 2005. Healthy and mature *Parthenium hysterophorus* seeds were collected and sown in pots filled with steam sterilized soil. The emerging seedlings with 2-3 leaves were transplanted to 12 earthen pots (25x27 cm), 20 plants in each pots filled with garden soil. Plants at rosette stage (4 week old) with an average of 5 leaves and 4 cm in height were used in experiment (Fig. 1). Adult *Zygogramma bicolorata* beetles (Fig. 3) were collected from the field and reared on potted *Parthenium hysterophorus* plants within insect proof cages and newly emerged adults were used in the experiments.

When the plants were 4 weeks old, each pot was transferred to the 12 insect proof cages (64x34 cm) (Fig. 2). Among the 12 cages six cages were selected for 15 days experiment and another six cages for 30 days experiment. In both the cases out of six, three were control and three were treated.

In each treated cage newly emerged adult beetles were introduced (10 insect per cage). After the completion of experiment the damage by insect was evaluated by observing the plants under the following parameters i.e., total plant height, shoot length, root length, stem diameter and number of leaves. Biomass of plants was obtained by drying in an oven at 55^{0}C for 72 h and dry weight recorded. For observation 10 plants each were randomly selected from the control and treated series.

For studying the effect of *Z. biocolorata* beetle on flowering of *P. hysterophorus* plants, the insects were introduced to the plants at preflowering stage (8 weeks old) and observed after 15 days.

The percentage of reduction in growth was calculated by following formula (Pant and Mukhopadhyay, 2001). : Q = (a-b/a) x 100 ; Q = % reduction in growth ; a = average growth in healthy plant ; b = average growth in treated plant.

Tests of significance ('t' value) were determined between healthy and treated plants on different parameters i.e. ; plant height, shoot length, stem diameter, root length and plant biomass.

RESULTS AND DISCUSSION

Assessment of reduction on the growth of *P. hysterophorus* plants due to insect *Zygogramma bicolorata* has been presented in Table 1. It is evident that feeding by larvae and adults after 15 days of introduction reduced the plant height by 38.164 %, shoot length by 35.502 %, stem diameter 28.301 % and plant biomass 40.292 % (Fig. 4). In case of 30 days feeding by both adult and larvae the plant height was reduced by 65.116 %, shoot length 56.16 %, stem diameter by 23.636 % and plant biomass by 71.637 % (Fig. 5). However reduction in root length was not significant. Heavy damage was recorded in leaves where the lamina of all the leaves were fed by beetles and only mid rib portion remained in some of the plants.

When such plants were left for another 30 days, plants did not attain flowering which is significant for the control of the weed (Fig. 6). However control plants flowered normally within this period.

Table 1 : Impacts of *Zygogramma bicolorata* on the growth of *Parthenium* after 15 and 30 days of introduction

Criteria	Days of treatment							
	After 15 days				After 30 days			
	Control	Treated	% reduction	Calculated "t" value	Control	Treated	% reduction	Calculated "t" value
Plant height (cm)	10.35	6.4	38.164	8.695	17.2	6.0	65.166	15.651
Shoot length (cm)	8.55	5.6	34.502	12.075	11.59	5.08	56.16	12.638
Stem diameter (mm)	2.65	1.9	28.301	7.398	2.75	2.10	23.636	2.256
Root length (cm)	7.3	6.52	10.684	1.551	8.15	7.14	12.392	2.007
Plant biomass (mg)	479.0	286.0	40.292	42.280	580.0	164.5	71.637	137.442

Fig. 1 : Initial stage at which insects are introduced

Fig. 2 : Insect proof cages

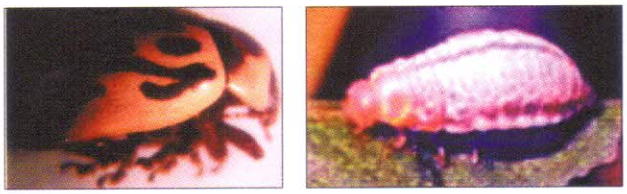

Fig. 3 : Adult and larva of *Zygogramma* beetle

Beetle feed the apical meristem and new emerging leaves. With the continuous feeding shoot lengths, plants height and number of leaves were reduced. Biomass reduction occurred due to heavy foliage damage and loss of photosynthetic tissues. With the increase in duration of feeding, the reduction is also increased. It is due to increased population build up of *Z. bicolorata*. The insect was able to survive and reproduce in cage due to daily irrigation. When the insects were introduced at the preflowering stage

Fig. 4 : Impact on growth after 15 days of introduction of insects

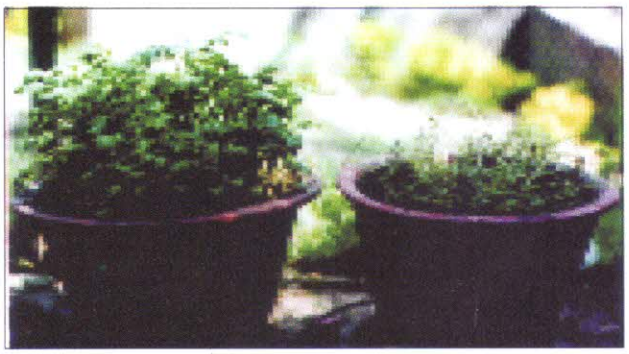

Fig. 5 : Impact on growth after 30 days of introduction of insects

Fig. 6 : Impact on flowering

flowering was not recorded (Fig. 7).

The impacts of other biocontrol agents such as stem galling moth *Epiblema strenuana* and stem boring *Listronotus setosipennis* were not so severe

Fig. 7 : Impact on flowering at preflowering stage

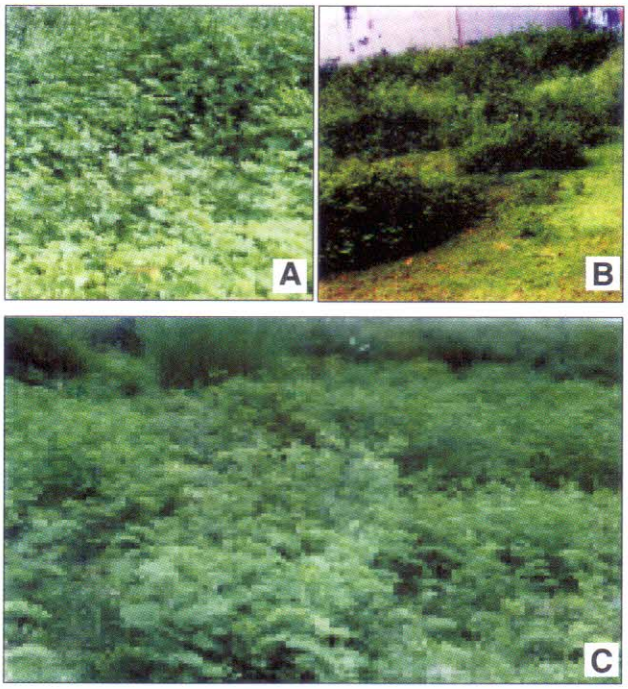

Fig. 8 : Replacement of Parthenium by other weeds–(a) *Cassia tora* (b) *Casia occidentalis* (c) *Tephrosia purpurea*

as that of *Z. bicolorata* at the rosette and preflowering stage. Damage by *E. strenuana* prevented 30% of *Parthenium* from producing any flower at all (Dhileepan and Mc Fadyen, 2001). But in India it could not be considered as a biocontrol agent due to its infestation on other plants also, such as, *Guizotic abysinnica.*

Damage by *Listronotus setosipennis* reduced the number of flower produced to 63% in glass house and 38% in field cage trial. As *P. hysterophorus* has very high reproductive potential, such reduction in flower production is not sufficient for controlling the weed. Whereas damage by *Z. bicolorata* at rosette stage caused total elimination of flowering stage in the present findings. Almost similar observations were recorded in Australia, by Dhileepan *et al.* (2000), where the plant height was reduced by 13-56% and flower production 25-45%. With the 74 days continuous feeding the flowering was reduced by 99%. From our experiment it is clear that with the 30 days of continuous feeding plant height was reduced by 65.116% and reduction in flower production was 100%, which is very significant for the control of weed.

In India initially *Z. bicolorata* became abundant within 3 years after introduction and causing significant reduction in *P. hysterophorus* in localized areas especially around Bangalore where the weed was gradually replaced by other weeds (Jayanth and Bali, 1994. Jayanth and Visalakshy, 1996). But in Northern India it gradually spread to different areas. During our survey of Allahabad district insect infested *P. hysterophorus* were frequently found only in 2004 and onwards. There was sudden outbreak of the insect in 2005. Due to this insect *Z.bicolorata,* the population of *P. hysterophorus* became much reduced as the plant became scanty and scattered in most of the localities. However, when the insect undergoes diapause, parthenium is again growing and flowering normally but their numbers have declined. Also it has been gradually replaced by other weeds wuch as *Achyranthes aspera, Acalypha* sp., *Cassia tora* (Fig. 8a) *Cassia occidentalis* (Fig. 8b), *Croton bonplandianum, Malvastrum* sp. *Sida* sp. and *Tephrosia porpurea* (Fig. 8c).

Although in our finding the insect was found to be effective as a biocontrol agent for Parthenium, it can be concluded that total elimination of the weed can be achieved only by an integrated approach using insect along with mycoherbicide such as *Bipolaris* sp. and *Acremonium* sp. which were found to be inhibitory for seed germination, especially at the time when the insect goes for diapause.

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