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Field release and impact of *Cecidochares connexa* (Macquart) (Diptera: Tephritidae) on *Chromolaena odorata* (L.) King and Robinson

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ABSTRACT: **Field release of the gall fly, *Cecidochares connexa* (Macquart) (Diptera: Tephritidae) introduced from Indonesia into India in 2002 was made on naturally growing *C. odorata* (L.) King and Robinson at two locations in Bangalore during July-October, 2005 using different field release methods. Following establishment, the gall fly was observed to spread to a distance of one kilometer at GKVK and two kilometer at Tataguni village in northeastern direction by the end of second year after release. The gall numbers encountered by an individual in ten minutes, search steadily increased from 2.5 to 98.3 at GKVK and from 1.6 to 156 at Tataguni village. There was 11.61 and 16.72 per cent reduction in plant height, 30 and 60 days after oviposition in galled plants over control. There was significant reduction in number of branches per plant (35.62%), number of panicles per plant (45.43%), number of capitula per panicle (12.07%) and number of seeds per head (10.89%) in galled plants over control in individual oviposition method. In mass cage method, 40.84, 36.48 and 55.42 per cent reduction in plant height, 30, 60 and 120 days after oviposition in galled plants over control was recorded. There was significant reduction in number of branches per plant (65.56%), number of panicles per plant (48.44%) and number of capitula per panicle (58.98%) in galled plants over control.**

KEY WORKDS: *Cecidochares connexa*, *Chromolaena odorata*, establishment, field release, impact

INTRODUCTION

Chromolaena odorata (L.) King and Robinson invaded India in 1914 and has become a serious invasive weed in the wet/dry tropics of Western India (Muniappan and Viraktamath, 1993). Classical Biological Control attempts were made in India through the introduction of the arctiid defoliator, *Pareuchaetes pseudoinsulata* Rego Barros in 1970s and the seed-feeding weevil, *Apion brunneonigrum* Beguin-Billecocq in 1982; the former established in some areas with limited impact and the latter did not establish (Singh, 1998). The hairy caterpillar and the seed weevil failed to produce the desired suppression of the weed (Bhumannavar *et al.*, 2004), hence there was need to introduce additional biocontrol agents against *C. odorata*. Efforts were renewed in 2002 through the

introduction of the tephritid stem gall fly, *Cecidochares connexa* (Macquart). Host-specificity tests carried out under quarantine conditions on 76 host plants belonging to 29 families revealed that the gall fly was capable of feeding and reproducing only on *C. odorata*. A pure culture of the tephritid was established and the biology studied (Bhumannavar *et al.*, 2004). Limited field release permit was issued during 2005 and the field releases were made. The present studies were made to ascertain the establishment and assess the impact of gall fly on the weed at two locations in Bangalore and the results are presented in this paper.

MATERIALS AND METHODS

Naturally growing *C. odorata* of about two hectares area in the University of Agricultural Sciences, GKVK, Bangalore was selected for the initial limited field release studies. Field release was done by individual oviposition method, mass cage method after slashing and open field release method during July-August, 2005.

Individual oviposition method

One litre transparent drinking water bottle with sufficient aeration was utilized for enclosing a single shoot for oviposition. The bottle was supported with an iron rod fixed to the ground when small isolated shoots were enclosed. One mated female along with the male was enclosed from 1000 to 1300 hours for an hour in each shoot. Females were used for oviposition till their death. The oviposited shoot was tagged and observed for gall formation, shoot height and number of branches. Observations on shoot height and number of branches were recorded again 30 and 60 days after oviposition. Observations were also recorded on number of panicles per branch and number of capitula per panicle when the plants flowered. An equal number of control plants were also tagged and similar observations recorded. The galls were left open for emergence of adults and further spread.

Mass cage method

Plants were slashed to ground level on 21.7.2005. Slashed plants with about 70 new sprouts were enclosed in a nylon cage (1 x 1 x 1 m) and ten mated females along with males were released on 16th day after slashing. Two such cages were set up. The nylon cage was removed after the death of all released adults (14 days after release). Slashed plants without caging were maintained as control plants. Observations on shoot height were recorded 30, 60 and 120 days after the release. After flowering, observations on number of branches, number of panicles per branch and number of capitula per panicle were recorded. The plants with galls were left for adults to emerge and spread.

The impact of gall fly on the growth of the weed was measured by estimating the per cent reduction in plant height, number of branches, number of panicles per branch and number of capitula per panicle in plants with gall as compared to control plants without galls.

Open field release

Naturally growing *C. odorata* measuring approximately ten hectares in area at village Tataguni, Anekal taluk, Bangalore was selected for open field release studies. Field release was done by allowing mated females over new shoots for egg laying. In all 86 females were thus released into the open between August-October, 2005.

Gall number and spread

The number of galls in second and subsequent generations was estimated by counting the number of fresh galls encountered by a person in a ten minute search over a rough area 50-70 sq. m. in the released and adjoining field.

The spread of gall fly in second and subsequent generations was recorded by closely examining all the plants for the presence of galls at 25, 50, 75 and 100 metres away from the released spot in the east, west, north and south directions.

RESULTS AND DISCUSSION

Individual oviposition method

By utilizing 23 females, 371 shoots were got oviposited within 20 days. Females survived from

Table 1. Impact of stem gall fly on *Chromolaena odorata* plant growth in individual oviposition method on grown up plants

Sl. no.	Growth parameter	Control plants	Plants with gall (s)	Per cent decrease over control
1.	Plant height 30 days after oviposition (cms)	173.72	154.26	11.61*
2.	Plant height 60 days after oviposition (cms)	207.89	173.14	16.72*
3.	Mean number of branches per plant	25.55	16.45	35.62
4.	Mean number of panicles per plant	32.25	17.60	45.43
5.	Mean number of capitula per panicle	17.40	15.30	12.07
6.	Mean number of seeds per head	32.81	29.24	10.89*

* Students 't' test significant between two means at P≥ 0.001

1-14 days (x = 7.43 ± 4.47 days). The maximum number of galls produced by a single female was 50 with an average of 19.60. The females produced 173 terminal and 278 axillary galls. On a single shoot maximum of six galls (one terminal and five axillary) were produced.

Mass cage method

Ten mated females produced 76 terminal and 5 axillary galls on 55 newly sprouted shoots in one cage and 75 terminal and 2 axillary galls on 75 shoots in another cage. Mean gall number per female was 7.9 in the two cages, which was much less (19.6) than individual oviposition method.

Impact assessment

Individual oviposition method

There was a significant reduction in plant height 30 days after oviposition (11.61%) and 60 days after oviposition (16.72%) in galled plants as compared to control plants (Table 1). There was significant reduction in number of branches per plant (35.62%), number of panicles per plant (45.43%), number of capitula per panicle (12.07%) and number of seeds per head (10.89%) in galled plants over control plants (Table 1).

Mass cage method

The height of control plant was 64.85cm whereas it was 38.37 cm in galled plant 30 days after oviposition, recording a reduction of 40.84 per cent over control (Table 2). The height of control plant was 101.4 cm, whereas it was 64.41 cm in galled plant 60 days after oviposition, recording a reduction of 36.48 per cent over control. A reduction of 55.42 per cent in height in galled plant over control plant was recorded 120 days after oviposition.

There was a significant reduction in number of branches per plant (65.56%) in galled plants over control. Significant reduction in number of panicles per plant (48.44%) and number of capitula per panicle (58.98%) was seen in plants with galls as compared to control (Table 2).

There was a reduction of 55.42 per cent in plant height of galled plant over control, three months after oviposition in mass caging method while Desmier de Chenon *et al.* (2000) reported 65.17 per cent reduction in plant height of galled plant over control plant in Indonesia.

Number of galls

At GKVK, Bangalore in a ten minute

intensive search one could count 9.1 fresh galls 45 days after oviposition in the released plot by the second generation. The gall number was less than one, 50 m away from the released spot in south, east and west directions in a similar ten minute search. The count had gone up to 5.55 galls in a ten minute search by the fourth generation around the release spot. Field observations at GKVK, Bangalore revealed that the gall number increased from 2.5 galls (April, 2006) to 98.3 (November, 2006) confirming its establishment (Fig.1.).

At Tataguni village the gall number in second generation around release spot was 3.6 galls/10 minutes. It was 9.6 galls/10 minutes, 100 m away and one gall/10 minutes, 200 m away from the release spot. The gall number improved by the fourth generation (12 months after the release) and one could encounter 16.9 fresh galls in ten minutes

Table 2. Impact of stem gall fly on *C. odorata* plant growth in slashed plants

Sl. no.	Growth parameter	Control plants	Plants with gall (s)	Per cent decrease over control
1.	Plant height 30 days after oviposition (cm)	64.85	38.37	40.84*
2.	Plant height 60 days after oviposition (cm)	101.40	64.41	36.48*
3.	Plant height 120 days after oviposition	167.7	74.77	55.42*
4.	Mean number of branches per plant	11.35	3.91	65.56*
5.	Mean number of panicles per plant	14.70	7.58	48.44
6.	Mean number of capitula per panicle	19.60	8.04	58.98*

* Student's 't' test significant between two means at P= 0.001.

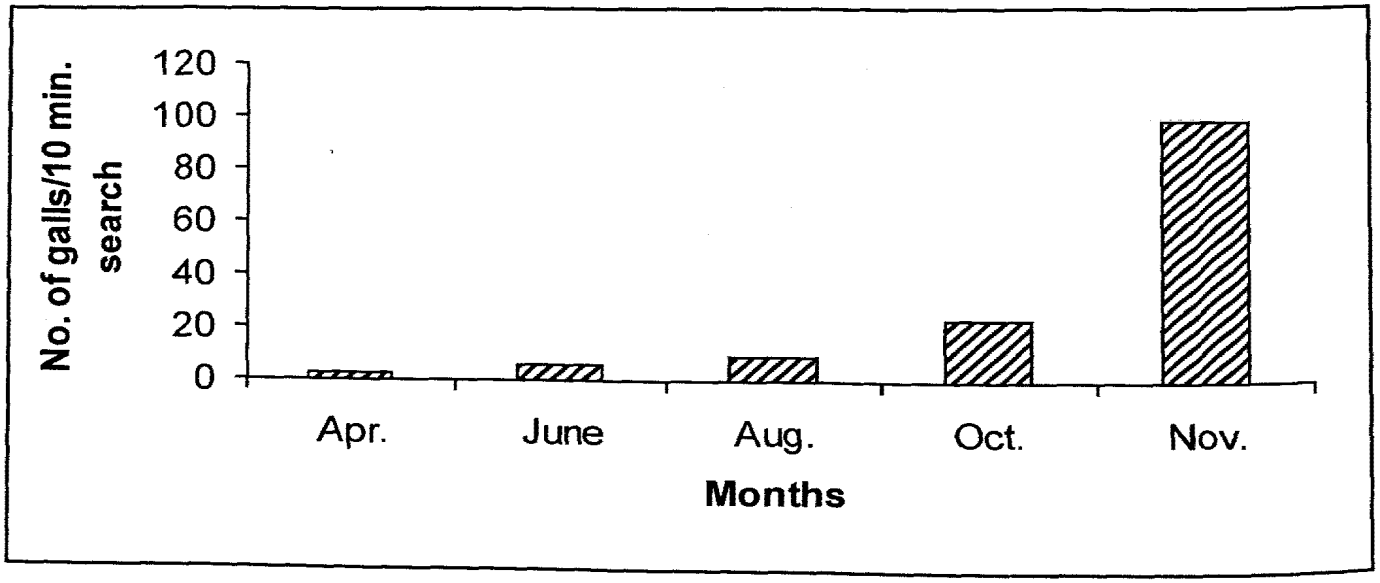

Fig. 1. Gall numbers at GKVK, Bangalore during 2006

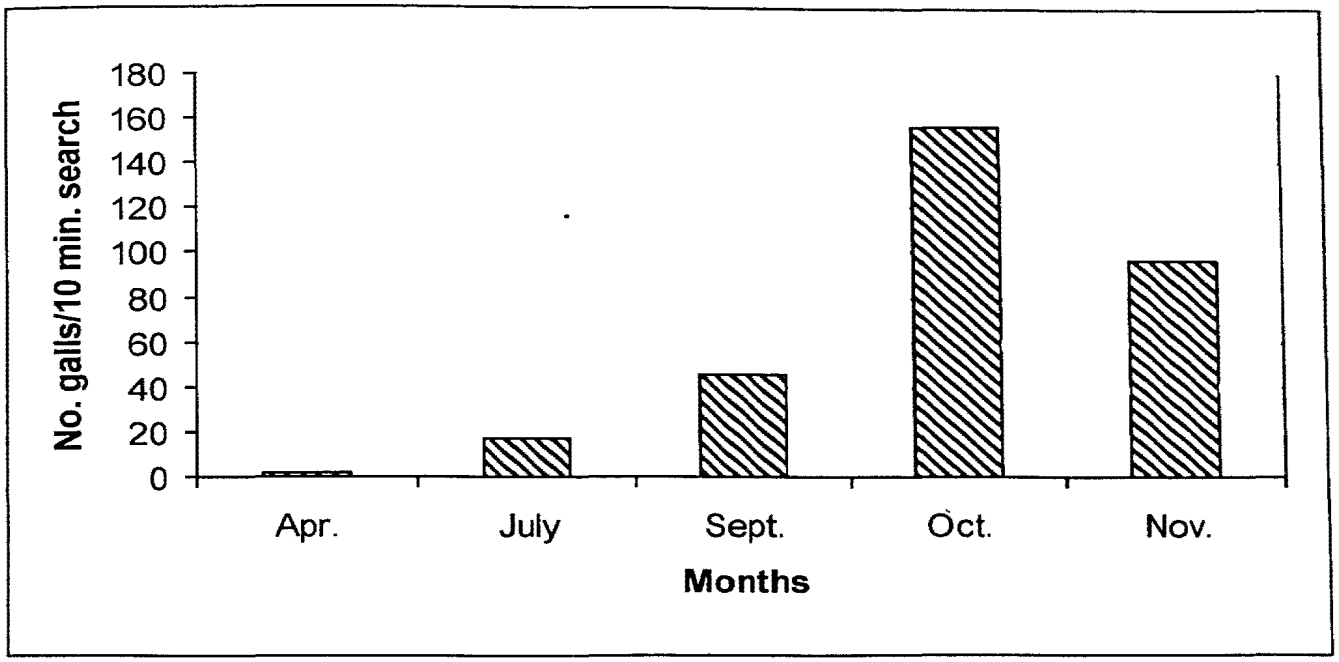

Fig. 2. Gall numbers at Tataguni Village, Bangalore during 2006

search. Observations during 2006-07 revealed an increase in gall number from 1.6 galls (April, 2006) to 156 (October, 2006) (Fig.2.). Similar gall numbers were recorded by Desmier de Chenon *et al.* (2000) in Indonesia.

Spread of the gall fly

Adult emergence was observed 90 days after oviposition. Close examination of shoots 60 days after adult emergence revealed presence of second-generation galls, which confirmed the field establishment of the gall fly. Fresh galls were observed at 25 m distance in north and at 50 m distance in south, east and west directions indicating the spread of this gall fly in its second generation, whereas Desmier de Chenon *et al.* (2000) recorded the fly movement up to 90 m in the second generation. The galls were observed at 50 m distance in the north and at 25 m in south, east and west directions by the third generation. However, in the fourth generation, the galls were observed beyond 100 m distance in the north, east, west and south directions from the release spot. During 2006-07, the gall fly could spread to a distance of one kilometer in northeastern direction at GKVK, Bangalore.

At Tataguni village, 12 months after the release, multiple generations were observed which could be confirmed by the presence of fresh as well as fully matured galls. The galls were observed beyond 500 m distance from the release spot, indicating better spread of the gall fly through the open release method. The differences in spreading rate could be because of prevailing environmental conditions like wind speed and direction as well as the phenology of the host plant in the two countries. The gall fly could spread to a distance of two kilometers in northeastern direction.

In the present studies, the gall fly was released at the fag end of the growing season of *C. odorata*, its spread in first and second generation got affected due to low winter temperatures and absence of rain. The gall fly could successfully overcome the dry period from January to April in larval stage and fresh galls were observed during May, 2006 indicating its establishment. Similar observations were recorded in Java and Indonesia

where the gall flies had successfully overcome the prolonged dry weather conditions (Desmier de Chenon *et al.*, 2000; Tjitrosemito, 2000; Wilson and Widayanto, 2004).

Two years of field observations confirmed the establishment of the gall fly in the field. The gall numbers are increasing in the release spots and the gall fly is spreading to adjoining areas.

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