Biological control agents of bean fly *Ophiomyia phaseoli* (Tryon) (Diptera:Agromyzidae) on mungbean in Myanmar

Thi Tar Oo
Professor, Department of Entomology and Zoology, Yezin Agricultural University,
Yezin, Nay Pyi Taw, Myanmar
Email: oothitar1@gmail.com

Abstract

Bean fly has recently become a serious pest of economic significance affecting mungbean which is one of the six economically important pulses crops in Myanmar. Two species of parasitoids, i.e. eulophid and braconid, emerged from bean fly pupae in the present study. The number of parasitoids fluctuated at different mungbean growth stages and in different growing seasons. The highest parasitism rate was 58.33 %. The longevity of the eulophid parasitoid was 9.89±0.64 days.

Introduction

The most insect pest species are reasonably well controlled by their own parasitoids under natural condition. Although various parasitoids were reported in different countries, the pests and their natural enemy complexes on legume crops have not been studied in many areas (Greathead 1975). Further effort is thus required to assess the potential for biological control of other legume pests. The braconid, *Opius phaseoli* was reported as the chief biotic factor limiting the population of bean fly on French bean accounting for over 87% of the total parasitisation in East Africa (Greathead 1975, Waterhouse 1998). However, no record was available on the abundance and effectiveness of the braconid, *Opius* spp. on the bean fly population elsewhere in Asia or Southeast Asia, except for the original record of a single of wasp from Manila (Spencer 1973). In Myanmar, no information has been available on the presence and effectiveness of the parasitoids of the bean fly. This study was, therefore, carried out to detect the biology especially longevity and parasitism rate of the existing parasitoids of the bean fly on mungbean in Myanmar.

Materials and Methods

Population dynamics of existing parasitoids of bean fly at different crop growth stages

The experiments were carried out from March to May 2003 (summer season), and from November 2003 to January 2004 (winter season). Field trial was carried out at Yezin Agricultural University Farm

(19º 10´ N, 96º 07´ E, elevation 102 m above sea level). The soil texture was sandy loam and the pH was 5.6.

Experimental design

A Randomized Complete Block (RCB) design with five treatments and four replicates was used in the present experiment. Five treatments were bean fly infestation at different days after emergence (DAE) of crop: 6, 10, 26, 40 and 50 DAE. The individual plot size was 2.5 m x 2.5 m.

Cultural practices

Each plot consisted of 6 rows 45 cm apart and within-row spacing was 10 cm. The tested mungbean cultivar was V 3726 (Yezin-5). All plots received fertilizers at rates of 14.45 N, 53.85 P_2O_5 and 26.92 K_2O kg ha^{-1} using urea, triple-super phosphate and muriate of potash, respectively (AED 2003). The plots were irrigated twice at 30 days after sowing (DAS) and 45 DAS. Hand weeding was also done at weekly interval.

Sampling method

Random sampling method was used to select the sample plants from which natural infestation was recorded at each growth stage, i.e. 6 DAE (unifoliate), 10 DAE (trifoliate), 26 DAE (before flowering), 40 DAE (flowering), and 50 DAE (after flowering). At the time of sampling five random sweepings with insect net (37.5 cm diameter opening) were made in each plot to record adult bean fly and its parasitoids. The number of bean fly adults and parasitoids inside the sweep net were counted and recorded.

Data analysis

The SAS/STAT system software was utilized for analyses. Due to the large variation of variables, data were transformed by using logarithmic transformation method before analysis of variance.

Determination of the existing parasitoids, parasitism rate and longevity

Mungbean plants infested with the bean fly were collected from the field to identify the existing parasitoids in Yezin area. Ten plots were continuously sown at three-day-intervals starting from the third week of February to the third week of March 2005 for the determination of existing parasitoids of *O. phaseoli*. Each plot size was 2.5 m x 2.5 m. One hundred stems infested by bean fly were daily uprooted at random from each plot in the fields. All sample plants were dried in the laboratory under room temperature for one day and leaves from stems were separated. And then 25 infested stems out of 100 plants were kept in each glass jars (8.5cm x 18cm) until adults emerged. Four glass jars were used as replications. The newly emerged adult parasitoids were counted and recorded. The parasitism rate of eulophid was calculated based on the total number of bean fly and the total number of eulophid parasitoid emerged from 100 stems per day collected from the field. The newly emerged adult parasitoids were individually transferred into a test tube plugged with cotton wool. All test tubes and cages were kept on the shelf in a fine mesh cage (60cm x 60cm x 60cm) in the laboratory to prevent the

entry of other insects. Room temperature of laboratory was recorded daily and it was in the range of 25-35°C. Parasitoids were identified according to the keys to the family level outlined by Borror and Delong (1954), Riek (1979) and Konishi (2004). On the other hand, each adult of eulophid parasitoid in a test tube was provided with honey solution to observe its longevity on supplementary food. The cotton wool was daily replaced with a new one to maintain the supply of fresh food. The body length and wingspan of parasitoids were also measured.

Results and Discussion

Mean populations of parasitoids of bean fly, *Ophiomyia phaseoli* (Tryon)

The numbers of parasitoids ranged from 0 to 2.0 at different growth stages in summer season (Figure 1). The parasitoids were firstly noticed at the earliest crop growth stage, 6 DAE. Although the population of parasitoid reached its peak formation at 10 DAE, there was no significant difference among the early mungbean growth stages: 6, 10 and 26 DAE. During the later periods, the mean number of parasitoid decreased with the older crop growth stages. The parasitoid populations at 40 and 50 DAS were significantly lower than that at 10 DAE. It seemed to be due to the effect of high temperature in the summer crop-growing season on the rapid development and the early emergence of the parasitoid from the bean fly pupae.

The fluctuation of parasitoids population varied in accordance with the different periods of crop growth stages of mungbean during winter season 2003-04 (Figure 2). The mean numbers of parasitoid ranged from 0 to 2.25. Although the parasitoid population was quite low and it was almost none at the earliest crop growth stage (6 DAE), the peak in bean fly larva density occurred as early as 6 DAE in winter season. The presence of parasitoids was first noted at 10 DAE. However, as the crop matured, a gradual decrease in the population density of bean fly larvae was found at 10 DAE. There was no parasitoid at 26 DAE and numbers of bean fly larvae decreased down to 1.63 at that stage. It was noticed that the fluctuation pattern was different from that of summer season. Although a little population of parasitoid was found at the beginning of the crop growing season, high parasitoids population was observed at the later crop growth stages (40 and 50 DAE) and consequently the decrease in the density of bean fly larvae.

Classification of the existing parasitoids

Two parasitoids emerged from bean fly pupae were observed in the present study (Plate 1 and 2). The characters of parasitoids were identified according to the key to the families of Eulophidae and Braconidae as described by Borror and Delong (1951), Riek (1979) and Konishi (2004).

It was observed that the fore wings of first parasitoid were not folded longitudinally when at rest and distinct stigmal vein was present in each fore wing. The enlarged hind femurs were observed without tooth below, and tibiae were not distinctly curved, 4 segmented tarsi with long basitarsus, fore tibia without an apical spur, and short and straight fore spur of fore tibia. The adult has a brilliant metallic colour. Based on these characters mentioned by Borror and Delong (1951), Riek (1979) and Konishi (2004), one of the parasitoids observed in the present study could be classified as the eulophid.

Riek (1979) reported that parasitoids of Tribe Hemiptarsenini of Subfamily Eulophinae have one hind tibial spur and long basitarsus, and are often reared from leaf-mining agromyzids. According to key described by Riek (1979), the parasitoid of the present study belongs to Tribe Hemiptarsenini of Subfamily Eulophinae. Another parasitoid shows the key to the family Braconid. It has been outlined that fore wings have no recurrent vein and hind wings with median cell not extending to the base of the marginal vein. The antennae have only 13 segments in female. The ovipositor is very short and stout. Those characters of second parasitoid consent to the key to the family Braconid as described by Borror and Delong (1954). It has been reported that Opiinae, the braconid parasitoids were mostly very small species that parasitize agromyzid and other small Diptera (Reik 1979). Konishi (2004) has reported that there are 26 eulophid and four braconid parasitoids of leaf mining agromyzid pests. The eulophids such as *Hemiptarsenus varicornis* and *Hemiptersenus semialbicornis* are very widespread parasitoids of dipterous leaf miners, including *O. phaseoli* in Australia, New Zealand, New Caledonia, Fiji, Vanuatu, Malaysia, Sri Lanka, India, Pakistan, Saudi Arabia, Senegal, Ghana, Sudan, Ethiopia, Kenya and Tanzania (Bourcek, 1988). The parasitoids of the present study was observed with one hind tibial spur and long basitarsus, and also emerged from pupae of dipterous leaf miner (*O. phaseoli*) as reported by Riek (1979) and Bourcek (1988).Therefore, further effort is required to identify the parasitoids and to assess potential for biological control of bean fly.

The braconid *Opius* spp. was recorded as an important parasitoid in Thailand. Riek (1979) reported that the family Eulophidae is a large family of very diverse forms and habitats. Most of the parasitoids obtained in the present study were eulophids and it seemed to be important parasitoid as a biological control agent for bean fly in Yezin.

Although there may have been the presence of parasitoids in Myanmar, a little information on parasitoids has been documented. The present study tried to find out information regarding parasitoid as biological control agent for controlling the bean fly population of mungbean. In 1966, Abul-Nasr and Assem reported that five parasitoid species emerged from bean fly pupae in the laboratory in Egypt, however, no information was provided on their effectiveness. Spencer (1973) reported a braconid *Opius* spp. from soybean in Taiwan. Greathead (1975) reported that braconids *Opius phaseoli* and *Opius importatus* were introduced from East Africa to Kauai and Maui islands in Hawaii in 1971. It has been reported that one of the major natural enemies of bean fly, the braconid *Opius phaseoli,* in East Africa also occurs in India (Waterhouse 1998).

Longevity of the eulophid parasitoid

Longevity of the eulophid parasitoids was observed as long as 14 days with an average of 9.89 ± 0.64 days (Table 1). It has been reported that longevity of the eurytomid , *Eurytoma poloni* recorded from Indonesia, Malaysia, the Philippines and Java was ranging from 22 to 28 days (Ho 1967). The eurytomid adult males lived 4 to 19 days (average 11.5) and females 10 to 25 days (average 16.9) in Thailand (Burikam 1980). Although the longevity of the eurytomid was recorded in many reports, no information was available on the longevity of the eulophid and braconid. The longevity of the eulophid observed in the present study was much shorter than that of the eurytomid in the previous records (Burikam 1980).

Size of eulophid parasitoid

The body length and the wingspan of the eulophid parasitoids were presented in Table 2. The body length and wingspan of the parasitoids were found in the ranges of 1.08 - 1.59 mm and 1.17 - 2.34 mm with an average of 1.34±0.08 mm and 1.89±0.16 mm, respectively. It has been reported that the eulophid parasitoids were 1 mm in length (Borror and Delong 1954). Riek (1979) revealed that the size of eulophid was as long as 0.6 mm to 4 mm, mostly 1-3 mm in length.

Parasitism rate of eulophid parasitoid on bean fly

Parasitism rate was observed ranging from 0 % to 58.33 % (Table 3). The highest parasitism rate (58.33 %) was in March 2005. The maximum populations of bean fly and its parasitoid was as high as 127 and 31, respectively. In the early period of observation, no parasitoid was found with the maximum number of bean fly (50). After peak population a sharp increase of bean fly population was found to be as high as 127. It may be due to the absence of parasitoids that attack the bean fly host during the previous period. In the mid of the present study (on 15-17 March 2005), it was found that the population of bean fly abruptly decreased with an increase rate of parasitism as high as 42.47 %. Consequently, both the number of bean fly and parasitoid went down to zero. It may be due to the existence of maximum parasitoid number (31) in the previous period. The second peak of bean fly population (43) was observed again when population of parasitoids was as low as 10. Although a small number of bean fly and parasitoids was found, the highest rate of parasitism (58.33%) was observed in the later period of study. The levels of parasitisation rate by *Opius phaseoli* were observed to be as high as 94%, 87%, and 90% in India, East Africa and Ethiopia, respectively (Greathead 1975; Singh 1982; Abate 1991; Waterhouse 1998). In Ethiopia, two eulophids *Chrysonotomyia erythraea* and *C. formosa* were recorded as primary parasitoids attacking bean fly, with the parasitism rate of 0 to 8.7% (Abate 1991). In the present study, the parasitism rate of the eulophid was as high as 53%, which was much higher than that of the eulophid in Ethiopia.

Conclusion

As a component of integrated pest management, biological control has become important to avoid adverse effect of chemicals on environment and non-target organisms. Two kinds of parasitoid were observed in the present study. The two parasitoids belong to the families of Eulophidae and Braconidae. Based on parasitism rate results, eulophid parasitoid could be used as a biological control agent because it was abundant in the ecosystem of study area as compared to braconid parasitoid. To date, there is no published report on the biological control agent of bean fly on mungbean in Yezin and in Myanmar. Therefore, the present observation is considered to be the first one to investigate the biological control agent of bean fly on mungbean.

References

Abate, T. 1991. The bean fly, *Ophiomyia phaseoli* (Tryon) (Diptera: Agromyzidae) and its parasitoids in Ethiopia. Journal of Applied Entomology 111: 278-285.

Abul-Nasr, S. and Assem, M.A.H. 1966. The external morphology of the bean fly, *Melanagromyza phaseoli* (Tryon). Bulletin de la Societe Entomologique d'Egypte 50:61-69

AED (Agricultural Extension Department). 2003. Recommended Technology to set the target yield of the crops. Myanma Agricultural Service, Ministry of Agriculture and Irrigation. pp 21-23.

Borror, D. J. and D. M. DeLong. 1954. An Introduction to the Study of Insects. The Ohio State University, the United State of America. 947 pp.

Bourcek, Z. 1988. Australasian Chalcidoidea (Hymenoptera). CAB International. Institute of Entomology U.K. 832 pp.

Burikam, I. 1980. Ecological investigation on the bean fly, *Ophiomyia phaseoli* (Tryon) (Diptera: Agromyzidae) and its natural enemies in Thailand. M.Sc. (Thesis), Department of Entomology, Kasetsart University, Bangkok, Thailand. 71 pp.

Greathead, D. J. 1975. Biological Control of the bean fly *Ophiomyia phaseoli* (Diptera: Agromyzidae) by *Opius* spp. (Hymenoptera: Braconidae) in the Hawaiian Islands. Entomophaga 20(3): 313-316.

Ho, T. H. 1967. The beanfly (*Melanagromyza phaseoli* Coq.) and experiment on its control. Malaysian Agricultural Journal 46:149-157.

Konishi, K. 2004. An illustrated key to the species of hymenopterous parasitoids of leaf mining agromyzid pests. pp 40-56. *In* Biological Control of Agricultural Pests in Asia. Theory and Practice, 2004 Seminar JASS`04 Fukuoka, Japan 12-22 October 2004.

Riek, E. F. 1979. Hymenoptera (wasps, bees, ants). pp 867-959. *In* The insects of Australia. Index. Bibliography. ISBN 0522 838875. Commonwealth Scientific and Industrial Research Organization. Division of Entomology.

Singh, S. 1982. Ecology of the Agromyzidae associated with Leguminous crop in India. 369 pp.

Spencer, K. A. 1973. Agromyzidae (Diptera) of Economic Importance Series. The Hague Netherlands. Entomologia Vol. 9. 405 pp.

Waterhouse, D. F. 1998. Biological Control of Insect Pests: South East Asia Prospects. Australian Centre for International Agricultural Research 51: 235-255.

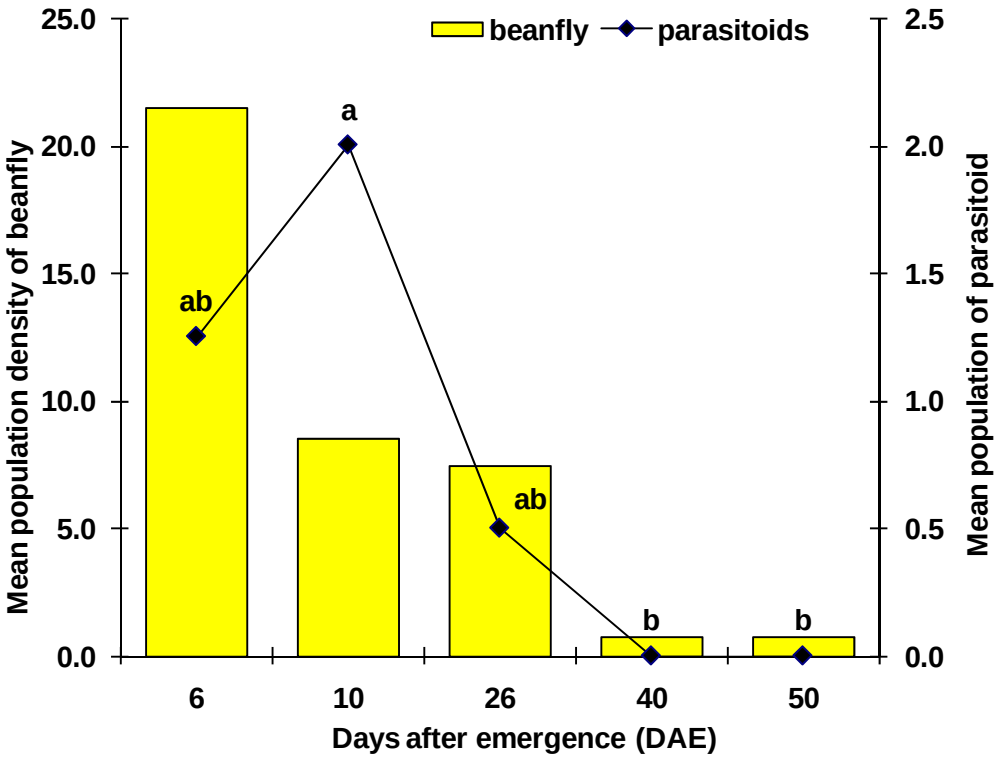

Figure 1. Mean populations of bean fly and its parasitoids at different growth stages of mungbean in summer season, 2003

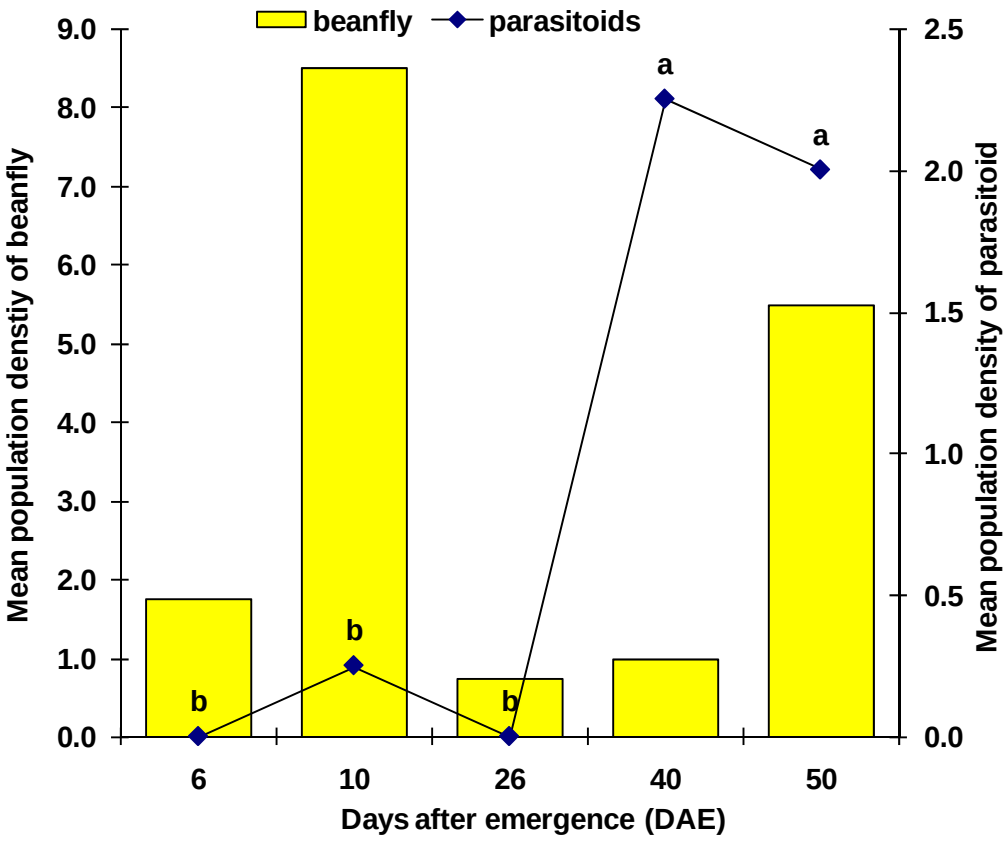

Figure 2. Mean population of bean fly and its parasitoids according to different growth stages of green gram in winter season, 2003-04

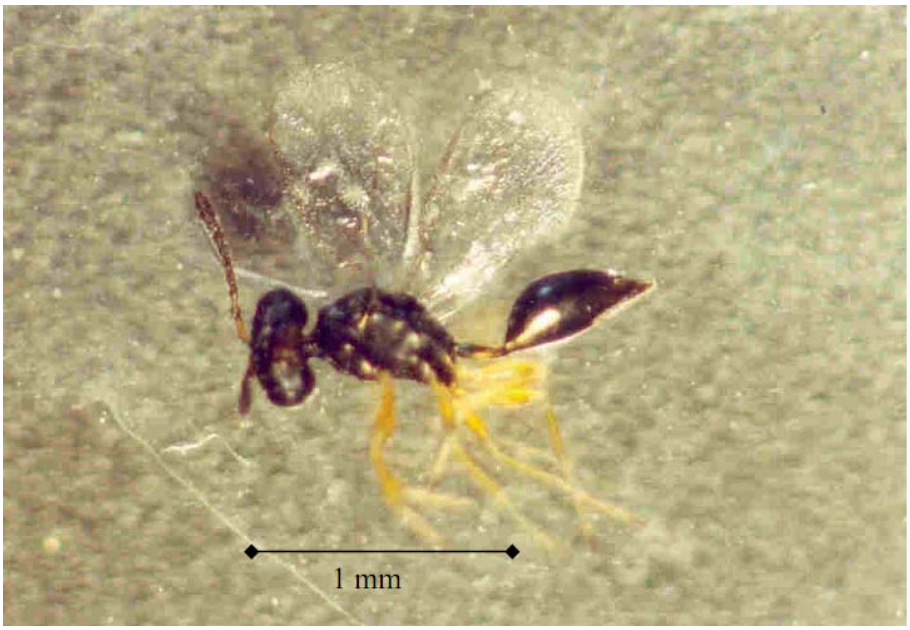

Plate 1. Eulophid parasitoid

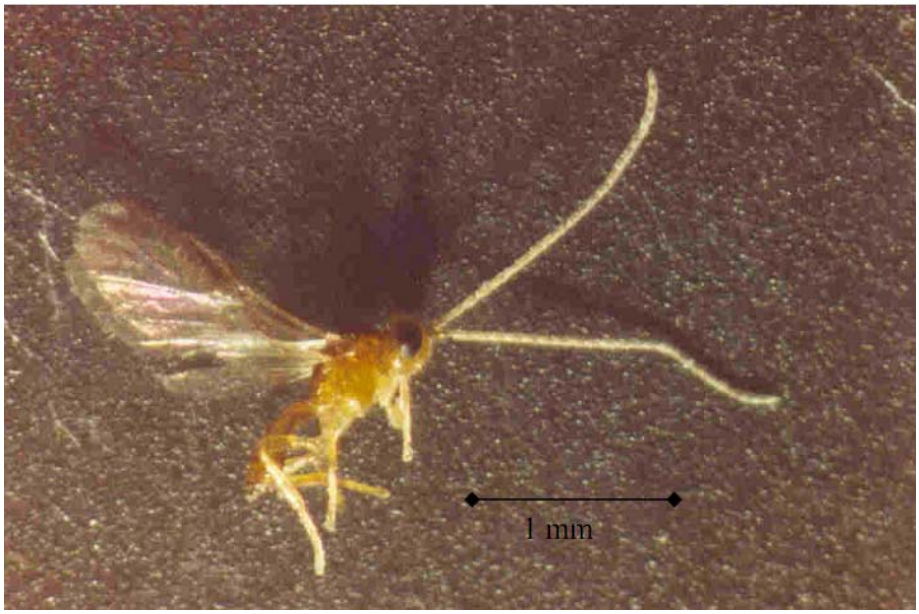

Plate 2. Braconid parasitoid

Table 1. Longevity of the eulophid parasitoids

Parasitoid Number	Days
P1	10
P2	9
P3	9
P4	9
P5	14
P6	10
P7	10
P8	8
Mean	9.88
Standard Error	0.64

Table 2. The size of the eulophid parasitoid

Parasitoid Number	Body Length (mm)	Wingspan (mm)
P1	1.56	1.92
P2	1.08	1.44
P3	1.23	2.22
P4	1.59	2.34
P5	1.44	2.04
P6	1.14	2.1
P7	1.35	1.17
Mean	1.34	1.89
Standard Error	0.08	0.16

Table 3. Parasitism rate of eulophid parasitoid on bean fly

Duration (days)	Number of bean flies emerged	Number of parasitoids emerged	Total	Parasitism (%)
3 - 5.3.2005	50	0	50	0
6 - 8.3.2005	30	0	30	0
9 – 11.3.2005	127	17	144	11.81
12 – 14.3.2005	37	21	58	36.21
15 – 17.3.2005	42	31	73	42.47
18 – 20.3.2005	0	0	0	0
21 – 23.3.2005	43	10	53	18.87
24 - 26.3.2005	21	10	31	32.26
27 - 29.3.2005	5	7	12	58.33