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Biological parameters of *Cotesia flavipes* reared on different larval instars of *Chilo partellus* under laboratory conditions

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Abstract
The present study was conducted on biological parameters of parasitoid *Cotesia flavipes* reared on *Chilo partellus* larvae under laboratory condition of 25±1 °C and 60±5% relative humidity at Insect pest Management program, National Agricultural Research Centre, Islamabad. The parasitoid could not survive on first and second instar larvae of *C. partellus*, while it successfully completed its life cycle on 3rd, 4th and 5th instar larvae. No significant difference was observed in the mean developmental duration 16.26 ± 0.37, 16.86 ± 0.36, 16.78 ± 0.27 from parasitism to adult parasitoid emergence on 3rd, 4th and 5th instar larvae of *C. partellus*, respectively. The duration of pupae reared on 3rd instar larvae was the longest (6.46 ± 0.13 days) and significantly different from mean pupal duration on 4th (5.06 ± 0.21) and 5th (5.12 ± 0.31) larval instar larvae. Mean Adult duration was 48.46 ± 0.27, 42.53 ± 0.23 and 42.34 ± 0.21 hours when reread on 3rd, 4th and 5th instar larvae, respectively. Similarly, the rate of parasitism was 66.46± 0.48, 80.4± 0.51 and 71.7± 0.41% and the mean number of pupae (cocoons) was 32.66± 0.23, 44.60.32 and 39.6± 0.37, respectively thus showing significant difference, when reared on three larval instar. The most preferable stage by *C. flavipes* was 4th instar larvae of *C. partellus*.

Keywords: *Cotesia. flavipes*, biology, parasitism, host insect, *C. partellus* larvae

1. Introduction

Maize stem borer (*Chilo partellus*) (Swinhoe) is the most devastating pest of maize and is responsible for its poor yield. It is one of the major limiting factors in successful maize production worldwide and the pest predominantly found in Subcontinent, Asia and Africa [1]. It damages the maize plant by feeding on leaves initially then it bores into the stem and makes tunnel within the stem thus disrupting the nutrient flow to the ear heads and subsequently forms the dead hearts [2]. Its damage symptoms include shot holes in the whorl of leaves and dead hearts and if plant survives then it becomes weak with less fruit with holes and tunnels in the stem. The economic importance of the parasitoid is tremendous and can reduce 32-55% population of maize stem borer larvae [3]. In Pakistan it is found to cause 10-50% damage in maize fields [4].

Mostly the farmers used chemical insecticides for the control of Maize stem borer Worldwide. As the pesticides are not environmentally friendly and created a number of problems including resistance in insects, degradation of natural ecosystem, abolition of natural enemies and environmental pollution and as well as dangerous for health are some of the major problems caused by arbitrary use of pesticides. Therefore alternate control measures are highly important for the management of this destructive pest [5, 6].

Biological control agents of Maize stem borer not only help in improving yield but also help to lower the frequent use of pesticides. Among bio control agents of Maize stem borer *Cotesia flavipes* (Cameron) has been found to be highly successful against *Chilo partellus* [7]. The parasitoid is indigenous to Asia and has been introduced successfully into more than 40 countries for biological control programs, primarily those related to genera *Chilo* and *Diatraea* [8]. It is the gregarious larval parasitoid of stem borers [9]. The parasitoid attacks the medium and large larval instars of stem borer more preferably. *C. flavipes* reared on different stem borer's species showed different performance at different temperatures [10]. [11] Concluded that fecundity and longevity are the most important biological parameters that determine the potential of biological control agents to be used in biological control programs.

Keeping in view the importance of the parasitoid the present study was initiated to study the biological parameters and to find hot the most preferred stage for successful rearing of the parasitoid and evaluate their potential as bio control agent against *Chilo partellus*. It will be helpful for utilization of this parasitoid in successful IPM programs against Maize stem borer in the field.

2. Materials and Methods

2.1 Rearing of *C. partellus*

The present study was conducted in April, 2015 on biological parameters of parasitoid *Cotesia flavipes* reared on *Chilo partellus* larvae under laboratory condition of 25 ±1 °C and 60 ±5% relative humidity at Department of Plant and Environmental Protection, Insect pest Management program, National Agricultural Research Centre, Islamabad. Maize stem borer was initially collected from infested plants in the field and brought to laboratory for rearing. The colony was established on maize stem. The larvae were shifted to plastic jars daily and fresh piece of maize stem was provided inside the jars. Each jar contained 10-15 larvae with 4-5 stem pieces. Jars were examined daily and diet was changed after 2 days. The process was continued till pupal formation in jars. The pupae were kept in separate plastic jars for adult emergence. Upon adult emergence, they were provided fresh leaves of maize arranged longitudinally, tapped with walls of containers and as well as paper was fixed at the bottom. Eggs were collected daily from the leaves by dispatching the leaves from bottle and cutting the eggs deposited on leaf pieces. The eggs were kept for hatching and newly hatched larvae were then shifted to new jars with fresh natural diet and the process was continued.

2.2 Rearing of *Cotesia flavipes*

The stock culture of *C. flavipes* was maintained under the same laboratory in plastic rearing jars on *C. partellus* larvae. The larvae were provided inside the jars for 24 hours and then replaced and kept in another plastic containers provided with fresh maize stem for feeding. The larvae were daily check for parasitism and the diet was replaced with fresh diet. The process was continued till the formation of white cocoons outside the body of larvae. The cocoons were collected daily and kept in other plastic containers for adult emergence. Upon adult emergence the parasitoid was provided fresh larvae for further propagation and maintenance of the culture

2.3 Experiments

Experiment was conducted on the biological parameters of *Cotesia sp*. reared on *C. partellus* larvae under controlled conditions in Laboratory. Counted number of 1st, 2nd, 3rd and 4th instar larvae of *C. partellus* were released in separate jars containing *C. flavipes* adults. A total of 15 larvae of each instar were released in the respective jars containing 20-25 adults of *Cotesia sp.* The larvae were exposed for 12 hours to *C. flavipes* adults and were then replaced and transferred to other jar. The parasitized larvae were provided maize stem for further feeding until the *Cotesia* cocoons formed.

The following parameters were observed regularly:

- Mean developmental duration of *Cotesia* from parasitism till adult emergence.
- Mean adult duration.
- Mean pupal duration.
- Mean number of pupal cocoons of *Cotesia* formed per larvae of maize borer.
- Mean rate of parasitism

2.4 Statistical Analysis

The data collected was statistically analyzed by using Computer Software i.e. Statistics 8.1 and the means were compared by using LSD test.

3. Results and Discussion

The results obtained are presented in the Table 1. First and second instar larvae of *C. partellus* were parasitized but the larvae of *C. flavipes* could not complete their development on 1st and 2nd instar of *C. partellus* and as a result no cocoon formation occurred as the larvae of *C. partellus* died immediately after parasitism. [12] Depicted the same results that no cocoon formation of *C. flavipes* occurred in 2nd instar larvae of *C. partellus*. They also observed that no parasitization occurred in 5 days old larvae of *C. partellus*, while the parasitization percentage increased from 34.79 to 82.61 percent with the increase in the age of larvae.

3.1 Mean developmental duration

Data regarding the comparison of the means of different biological parameters of *Cotesia* on 3rd and 4th instar of maize borer is given in Table 1. According to the data, mean developmental duration from parasitism to adult emergence was 16.26 days in 3rd instar larvae of *C. partellus*. While developmental duration from parasitism to adult emergence on 4th and 5th instar of *C. partellus* was 16.86 days and 16.78 respectively, this is statistically similar to mean developmental duration in 3rd instar. These results are well in agreement with those of [13] who recorded developmental period of 18.8 days and [14] who observed developmental duration of 17.9 days. Short developmental period is very helpful for the rapid increase of a parasitoid as it can multiply quickly in a short period of time.

3.2 Mean pupal duration

Mean pupal duration of *Cotesia sp.* was 6.46 days in 3rd larval instar of maize borer, which was found to be significantly different from the mean pupal duration (5.06 days) in 4th larval instar and (5.12 days) in 5th larval instar (Table 1). This difference is may be due to differences in size of the instars leading to slow development in 3rd instar.

3.3 Mean adult duration

Mean adult duration of *Cotesia sp.* emerged from 3rd instar of *C. partellus* was 48.46 hours, which was found to be significantly different from mean adult duration (42.53 hours) on 4th and (42.34 hours) 5th larval instars of *C. partellus* (Table 1). Many researchers have reported the similar results. [15] observed that, when heavier larvae of *Diatraea saccharalis* Fab. Were exposed, the number of offspring of *C. flavipes* was greater. Results of the present study demonstrated that the host stage is an important factor that affects the growth, survival and development duration of *C. flavipes*. These results are in accordance with the findings of [16]. The parasitoid also takes shorter time to develop from egg to cocoon in parasitized 4th instar larvae than in 3rd instar. This could be due to a slower development rate in smaller host as a result of lack of adequate food supply [17]. Fast development of a parasitoid on small hosts may result in the death of host which in turn will also be harmful to the parasitoid. Therefore, to ensure successful development *C. flavipes* may adjust its rate development according to the host. As a result of which, larger food supply in 4th larval instar may lead to a faster growth and development.

3.4 Mean number of pupal cocoons

Mean number of pupal cocoons of *Cotesia sp*. formed per larvae were 32.66 in 3rd instar of *C. partellus*, while Mean number of cocoons of *Cotesia* formed per larvae in 4th and 5th larval instars of *C. partellus* were 44.6 and 39.6 respectively, which are significantly different from each other (Table 1). The increase in the number of cocoons with increasing larval age would be due to the size and capacity of larvae to favour development of parasitoid. These results are in similarity to those of [10] who reported that significantly more number of cocoons emerged, when 4th instar larvae was the host than 3rd instar larvae.

Table 1: Biological parameters of *C. flavipes* reared on *C. partellus* larvae under laboratory conditions.

Biological parameters	Host stage			
	3rd instar larvae	4th instar larvae	5th instar larvae	LSD
Duration from parasitism up to adult emergence (Days)±S.E	16.26a ±0.37	16.86a± 0.36	16.78a±0.27	1.06
Pupal (Cocoon) duration (Days)± S.E	6.46a± 0.13	5.06b± 0.21	5.12b±0.31	0.50
Adult parasitoid duration (Hours)± S.E	48.46a± 0.27	42.53 b±0.23	42.34b±0.21	0.74
No. of Pupae (Cocoons) per larvae ± S.E	32.66a ±0.23	44.6b ±0.32	39.6c±0.37	0.81

Mean followed by the same lower case letter was non-significantly different at P value ≤ 0.05 (One-way ANOVA) using LSD test

3.5 Mean rate of parasitism

According to the data on comparison of mean rate of parasitism on different instars of *C. partellus* there was a significant difference in 3rd and 4th instar with minimum parasitism 66.46% on 3rd instar larvae of *C. partellus* and maximum parasitism 80.4% on 4th instar larvae of *C. partellus*. While parasitism on 5th instar larvae was 71.7 (Fig. 1). This is in accordance to the results of [18], who indicated that the rate of parasitism was 80% on 4th instar larvae of *C. partellus* but are in contradiction with the results of [19], who found out that 3rd instar stage of *C. partellus* was the most suitable for parasitization by *C. flavipes*.

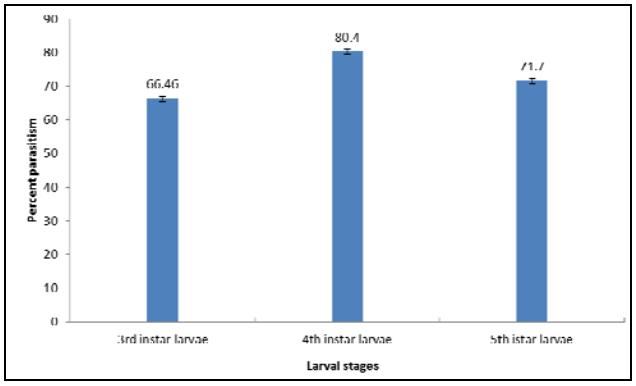

Fig 1: Percent parasitism of *C. flevipes* reared on different larval instars of *C. partellus*

The biological parameters of the parasitoid are highly influenced by individual factors and their interaction. The biotic and abiotic factors such as fecundity and longevity affect the biological activities of the parasitoid [20, 21]. Among other factors that affect the potential of parasitoid, host age is highly important [22]. The development of Parasitoid within the host is affected by environmental factors such as temperature [23] as well as factors depending on the host itself such as host stage and quality [24].

4. Conclusion

The results suggested successful development of *C. flavipes* on *C. partellus* larval instars thus showing that it has the ability to overcome the immune system of this pest. While laying eggs, *Cotesia flavipes* injects substances into the body of the stem borer, which then interfere with the immune mechanism of the host [25, 26, 27]. This shows show that this parasitoid can be established successfully for the control of *C. partellus* because there is a physiological compatibility between them.

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