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PARASITISM POTENTIAL OF *APANTELES OBLIQUAE* WILK. (BRACONIDAE: HYMENOPTERA) AGAINST *SPILOSOMA OBLIQUA* (WALKER)

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ABSTRACT

Apanteles obliquae Wilk. (Braconidae: Hymenoptera) is a solitary larval parasitoid of Spilosoma obliqua (Walker), a notorious and polyphagus pest in India. Nutritional requirement, host age, specificity and density dependent factor play a very crucial role in biocontrol program of parasitoids and further their release in the field for pest control strategies. Attempt has been made to initiate the mass multiplication of parasitoid for successful biocontrol programme. Therefore, present work was conducted to find out the optimum host stage and density for maximum progeny production of the parasitoid under laboratory conditions. The parasitoid caused the highest mortality in the pest larvae of second instars, 4 day old larvae were attacked most with high percent parasitism, 39.00%. Optimum density for maximum progeny production of A. obliquae was 20, which generate maximum parasitism (41.00%). Host specificity by exposing the parasitoids towards different host species and analyse parasitoid preference by S. obliqua > Amsacta mooreii Butler > Olepa ricini (Fabricius) > Olene mendosa Hubner. Nutritional requirement of parasitoid was tested with different foodstuffs and found 50% honey best suited for maximum longevity 8.2 and 11.4 days for males and females respectively. The longevity ratio also female biased, 1: 1.39 (Male: Female). From the results it concludes that A. obliquae fed with 50% honey solution, exposed to 3-5 day old caterpillars of S. obliqua at density of 20 gave maximum progeny production and effectively utilized in the biocontrol programme.

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INTRODUCTION

Agriculture is the backbone of Indian economy. Modern agriculture enhances the status of farmers and their community. Farmers are facing the problem of pests and diseases of crop plants. Earlier pests and diseases could be controlled environmentally but then it shifted to era of chemical control. Due to residual problems, cost of sprays, lack of labor, resistance problem, secondary pest outbreak, pest resurgence and phytotoxicity of insecticides the farmers now deliberately moved towards biological control of agricultural pests. Biological control of different pests with biocontrol agents enhances the crop yield and improves the quality of produce with the least residual problem. The above fact clearly indicates that there is an extreme need to minimize pesticidal use. Therefore, attempts have been made with the use of biocontrol agents for effective control of pests as ecofriendly control measure. *S. obliqua* is the most notorious pest of cereals, pulses, horticultural crops in India. Several management practices were implemented to achieve the control of the pest.

Among biocontrol agents, *A. obliquae* is the most common and potent solitary larval parasitoid scattered in nature and controlling the pest population effectively. Host searching and selection of host density by parasitoid counts the success of biocontrol programme of any pest species (Sathe and Bhosale, 2011). The high rate of parasitism is a desirable characteristic of an ideal parasitoid. In colonization and mass production of parasitoids in biocontrol strategies the shape, size, nutritional suitability, and age of host plays important role (Vinson, 1976; Vinson and Iwantsch, 1980). Leong and Oatman (1968), Lewis and Vinson (1971), Lingren and Nobel (1972), Pawar *et al.* (1989), Romeis and Shanower, (1996), King (1998), Wackers (2001), Eliopoulos (2007), Khatri *et al.* (2012), Sathe *et al.* (2012), Bhosale (2018, 2020), Bhosale and Bhosale (2019), Bhosale and Salunkhe (2022) were made investigations on optimum age, density and specificity of hosts and nutritional requirement of parasitoids. The present study was carried out with *A. obliquae*, a larval parasitoid of *S. obliqua* to find out the optimum age of host for obtaining maximum progeny of parasitoids, which will help in mass rearing and field release for effective biocontrol program.

MATERIALS AND METHODS

Rearing of host species: *S. obliqua* larvae were reared in a small, perforated plastic container (7x8 cm, Diameter x Height). After adult emergence they may transferred in oviposition cage 25x25x25 cm (LxWxH). First instar caterpillars usually hatch after 2 days from oviposition. These larvae were collected and used for further experiments. During the course of study, the host caterpillars were fed with castor leaves. Similarly, the hosts used to conduct the host specificity experiment reared on their natural food like, *Amsacta mooreii*, *Olepa ricini* (Fabricius), *Olene mendosa* Hubner on leaves of castor.

Rearing of parasitoid: Adults of *A. obliquae* were reared in ventilated wooden cage (30x30x30 cm, LxWxH). These are small insects and are negatively geotropic, hence cages must be made with glass walls on three sides and top of the cage while one wall was made up of very fine mesh cloth for proper handling of parasitoids. The *A. obliquae* was fed with 50% honey solution. Adults of parasitoids released for oviposition in the rearing cages for 24 h with different age and density *S. obliqua* caterpillars. After 24 h, adults were removed, and hosts reared for further analysis. The cocoons of parasitoids then transfer into separate containers and adults of *A. obliquae* emerges out that can be used for experimental purpose.

Nutritional requirements and adult longevity of parasitoid on different foodstuffs: Emerged adults of *A. obliquae* are fed with different foodstuffs to analyze the ideal feed for getting the highest longevity. Nutritional supply with natural foods were provided to explore the lifecycle study of parasitoid. Three concentrations of Honey solution *viz.* 100, 50 and 10 percent, however, 50 percent glucose and 50 percent sucrose solution and juice of citrus and apple can also provide as a food.

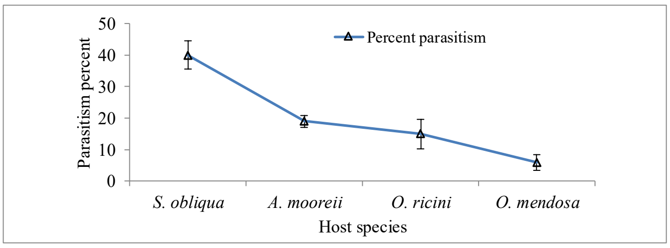
Pest age related parasitism: To determine the effect of host age on parasitism, 20 larvae of *S. obliqua* of known age (ranging from less than 1 day to 13 days old) were exposed to single mated female of *A. obliquae* in a glass cage for 24 hrs. The larvae were removed and placed in separate containers for further observations. Daily records of cocoon construction and parasitoid emergence from each container were neatly observed.

Host density for optimum parasitization: *S. obliqua* caterpillars (4-5 day old) were exposed in densities of 10, 20, 30, and 40 towards mated females of *A. obliquae* for 24 hrs in oviposition cage 25x25x25 cm (LxWxH). The host larvae were reared into plastic containers to record further development or parasitoid emergence.

Host specificity for optimum parasitization: Host specificity was conducted by exposing the mated females of parasitoid towards caterpillars of different host species like *S. obliqua*, *A. mooreii*, *O. ricini* and *O. mendosa*. The hosts were placed in the oviposition cage for 24 h. Hosts were released in 20 densities to record optimum parasitism. Afterwards the hosts were reared on the natural diet and observed the emergence of parasitoid or further lifecycle of host species. The experiments were carried out at 25±2°C, 60±5% RH and 12hr. photoperiod. During the course, castor leaves were provided as food to the caterpillars of *S. obliqua* and other appropriate food for other experimented host species, while the parasitoids were fed with 50% honey solution. Each experiment was repeated 5 times to confirm the results.

RESULTS AND DISCUSSION

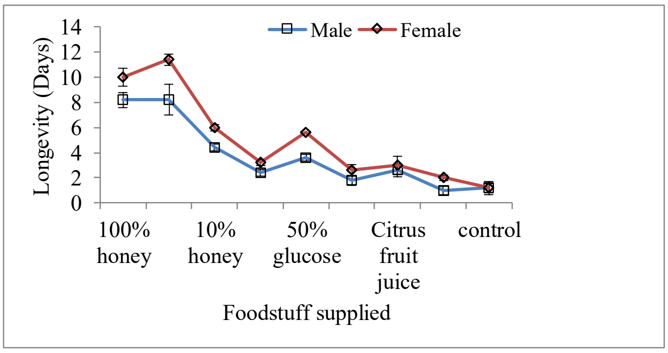
A. obliquae was more effective in controlling the caterpillars of *S. obliqua* than other biocontrol agents associated with the pest. The results of host specificity experiment (Fig. 1) revealed that the parasitoid prefer *S. obliqua* as the primary host with 40.00% parasitism. Among tested hosts, parasitoid showed 19.00 percent parasitism for *A. mooreii*, 15.00 percent parasitism for *O. ricini* and 6.00 percent parasitism for *O. mendosa*. The order of preference for parasitism shown by the parasitoid was *S. obliqua* > *A. mooreii* > *O. ricini* > *O. mendosa*.



*Each value is the mean of five replicates with error bars indicating standard error of mean (SEM).

Fig. 1. Host specificity of *A. obliquae*

Adult longevity of *A. obliquae* with different foodstuff were analyzed and plotted in fig. 2. Parasitoid survived longer with 50% honey solution with maximum male: female longevity ratio (1: 1.39). The maximum longevity of male and female when fed with 50% honey solution was 8.2 and 11.4 days respectively. Hence, it could be best suited for mass rearing of parasitoid in the laboratory.



*Each value is the mean of five replicates with error bars indicating standard error of mean (SEM).

Fig. 2. Adult longevity of *A. obliquae* with different foodstuffs

The results recorded in table 1 indicate that the parasitoid caused the highest mortality in the second instar caterpillars. The caterpillars of 3-6 days old are preferred for parasitism whereas, beyond 11 days old were not attacked by the parasitoid. Four day old caterpillars were attacked most with high percent parasitism (39.00%).

Table 1. Host age parasitism by *A. obliquae*

Host age (days)	% Parasitism	% Mortality	% Moth emergence
1	4.00 (±2.20)^{ef}	6.00 (±3.70)^{a}	90.00 (±2.50)^{ab}
2	8.00 (±3.70)^{de}	8.00 (±1.20)^{a}	84.00 (±3.70)^{abcd}
3	22.00 (±3.70)^{abc}	10.00 (±1.00)^{a}	68.00 (±3.00)^{de}
4	39.00 (±2.50)^{a}	8.00 (±2.90)^{a}	53.00 (±1.90)^{e}
5	25.00 (±3.70)^{ab}	9.00 (±2.50)^{a}	66.00 (±4.60)^{de}
6	20.00 (±3.40)^{abcd}	9.00 (±1.20)^{a}	71.00 (±2.70)^{cde}
7	16.00 (±0.00)^{bcd}	11.00 (±5.10)^{a}	73.00 (±5.10)^{bcd}
8	9.00 (±1.90)^{cde}	4.00 (±3.40)^{a}	87.00 (±1.90)^{abcd}
9	9.00 (±1.90)^{cde}	10.00 (±3.30)^{a}	81.00 (±4.60)^{abcd}
10	4.00 (±1.20)^{ef}	7.00 (±3.30)^{a}	89.00 (±2.40)^{a}
11	3.00 (±2.00)^{ef}	10.00 (±2.70)^{a}	87.00 (±2.50)^{abc}
12	0.00 (±0.00)^{f}	11.00 (±4.00)^{a}	89.00 (±4.00)^{a}
13	0.00 (±0.00)^{f}	10.00 (±3.40)^{a}	90.00 (±3.40)^{ab}
CD (P=0.05)	11.57	17.36	15.63

*The data presented are the mean of five replicates. Different letters indicate the significant difference (One way ANOVA) P<0.05 Tukey's standardized range (HSD) test. Figures in parentheses are standard error of mean (SEM).

The results of optimum host density for maximum progeny production of parasitoid were tabulated in table 2 showed that the number of parasitoids obtained from host density 20 was highest with

41.00 percent parasitism, compared to those produced from other host densities 10, 30 and 40 with 16.00, 32.67, 30.00 and 24.80 mean percentage of parasitism respectively.

Table 2. Host density dependent parasitism by *A. obliquae*

Host density	% parasitism	% Mortality	% Moth emergence
10	19.00 (±1.61)[b]	20.00 (±0.24)[a]	61.00 (±1.61)[a]
20	41.00 (±1.12)[a]	18.00 (±1.47)[a]	40.00 (±2.38)[b]
30	32.67 (±0.84)[a]	14.33 (±0.61)[a]	53.00 (±1.14)[ab]
40	29.00 (±0.87)[ab]	17.50 (±0.30)[a]	53.50 (±1.16)[ab]
50	23.80 (±0.43)[ab]	14.60 (±0.37)[a]	61.60 (±0.64)[ab]
CD (P=0.05)	11.60	7.07	13.68

[*]The data presented are the mean of five replicates. Different letters indicate the significant difference (One way ANOVA) P<0.05 Tukey's standardized range (HSD) test. Figures in parentheses are standard error of mean (SEM).

The statistical analysis was made by one-way ANOVA using the statistical software package SAS 9.3(32) English. The percent values were transformed to arcsine values before analysis. Sathe and Bhosale (2011) reported the host density 100 for obtaining maximum progeny production (38.50%) of the parasitoid *D. insulare*. In present findings 20 host density shows maximum parasitism (41.00%). Likely, Sathe *et al.* (2012), found the optimum host density for maximum parasitism of *Apanteles cretonoti* Viereck on *Amsacta moorei* Butler which was 20 with parasitism of 50 percent. Pawar *et al.* (1989), studied the parasitism of *Campoletis chlorideae* on *Helicoverpa armigera* (Hubner), they found average percentage parasitism of first to third instar larvae, which are only parasitised by parasitoid, parasitism found on associated crop was 44.2 on sorghum, 33.1 on chickpea, 32.6 on pearl millet, 7.1 on groundnut and 4.2 on pigeonpea. Lingren *et al.* (1970) stated the host age preference of *C. chlorideae* towards four lepidopterous host species *Prodenia ridinia* (Craner), *Prodenia praefica* Grote, *Trichopulsia ni* (Hubner) and *Pseudoletia unipuncta* (Hawarth). They reported that caterpillars 1-8 day old of all hosts were susceptible to parasitism, 2-6 day old being most acceptable. In present findings 3-6 day old caterpillars of *S. obliqua* were susceptible and most suitable for parasitism.

Nikam and Basarkar (1981) studied the reproductive potential of *C. chlorideae* and reported maximum parasitization at host density 40. In *Campoplex haywardi* Blanchard, an ichneumonid parasitoid of *Pthorimaea operculella* Zeller, the optimum host density was 75 larvae per tuber for maximum progeny production (Leong and Oatman, 1968). Similarly, Cardona and Oatman (1971), reported 90 host density of *Keiferia lycopersicella* (Walsinghum) as optimum number for maximum parasitism by *Pseudapanteles* (=*Apanteles*) *dignus* Muesebeck. In *P. diguns*, they reported the percentage of parasitization increased with the increase in number of hosts (30, 60 and 90) up to host density 90 per replicate. A decrease in parasitization observed in all replicates when 120 larvae were offered. Han *et al.* (2013) studied the host preference and suitability in *C. chlorideae* and recorded the parasitism against hosts *H. armigera*, *M. separata* and *Spodoptera exigua* (Hubner). They found parasitoid showed maximum parasitism on *H. armigera* followed by *M. separata* and *S. exigua*. In present findings the parasitoid preferred *S. obliqua* followed by *A. mooreii*, *O. ricini* and *O. mendosa*. Dhillon and Sharma (2007) recorded survival and development of *C. chlorideae* on various insect and crop hosts and sound maximum cocoon formation (82.4%) and adult emergence (70.5%) on *H. armigera* than other hosts. Their studies focused on host preference behaviour of *C. chlorideae* on alternate insect hosts like *S. exigua*, *M. separata* and *A. janata*. They noted that the maximum parasitism found on *H. armigera*, followed by *M. separata*, *S. exigua* and *A. janata*. In present findings highest parasitism noted on *S. obliqua* followed by *A. mooreii*, *O. ricini* and *O. mendosa*. *A. obliquae* has been successfully initiating the biocontrol program for managing the *S. obliqua*. Parasitoids can be mass reared in laboratory scale on 50% honey solution. For getting maximum progeny of parasitoid exposed towards second instar *S. obliqua* caterpillars with 20 host density. The research on mass rearing of parasitoid *A. obliquae* to initiate the biocontrol programme for *S. obliqua*.

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