

Effect of Light on the Longevity and Fecundity of *Venturia canescens* (Gravenhorst) (Hymenoptera: Ichneumonidae)

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Abstract.- The effect of light on the longevity and fecundity of *Venturia canescens* (Gravenhorst) (Hymenoptera: Ichneumonidae) was investigated at 25±1°C temperature and 60-70 % relative humidity. In the experiment, *V. canescens* was reared in L0:D24 (continuous darkness) and L16:D8 (2000 and 5000 lux light intensities), and the longevity and fecundity of the parasitoid were defined at these conditions. The results indicated that photoperiod and light intensity significantly affected the longevity and fecundity of the parasitoid. The maximum average longevity was found to be 583.92±43.46 hours in continuous darkness. The average longevity of the parasitoid decreased in L16:D8 (15.17% and 25.35% in 2000 and 5000 lux light intensities, respectively). Similarly, the maximum average fecundity was found as 193.02±4.45 in L0:D24 and average fecundity of the parasitoid decreased in L16:D8 (10.53% and 30.78% in 2000 and 5000 lux light intensity treatments, respectively). The findings of this investigation confirm that photoperiod and light intensity could have potential for improving biological control efficacy of *V. canescens* in grain storage warehouses.

Keywords: *Venturia canescens*, longevity, fecundity, photoperiod, light intensity.

INTRODUCTION

Venturia canescens (Gravenhorst) (Hymenoptera: Ichneumonidae) is an asexual synovigenic solitary koinobiont endoparasitoid that is known to parasitize and successfully develop in the larvae of several lepidopterous pests of stored food products (Salt, 1976). With respect to its efficacy as biological control agent, several laboratory and field studies have examined its potential against pyralids (Ahmad, 1936; Schöller, 2000; Harvey and Thompson, 1995). However, it is known that the parasitoid has not been efficiently used in biological control programs in the past.

When developing biological control programs based on augmentative or inoculative parasitoid release, knowledge of longevity and fecundity of parasitoids are crucial (Godfray, 1994; Jervis and Copland, 1996). Because the longevity and fecundity are affected by a number of factors including photoperiod and light intensity, they may

0030-9923/2007/0005-0315 \$ 8.00/0

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influence many aspects of parasitoid biology and ecology, such as foraging behavior, searching efficiency and motivation to oviposit (Ueno, 1999) which may in turn influence parasitoid and host population processes.

It was found that photoperiod and light intensity are important factors by affecting the biology and behaviour of many insects (Jervis and Copland, 1996). However, limited studies have been restricted on the effects of these factors. Our previous observations also indicated that changes in photoperiod and light intensity affected behaviour of *V. canescens*. Therefore, in the present study, the effects of both photoperiod and light intensity were investigated with the objective of optimizing the longevity and fecundity of *V. canescens* in the context of a biological control program.

MATERIAL AND METHODS

Host rearing

The Mediterranean flour moth *Ephesia kuehniella* Zeller (Lepidoptera: Pyralidae) was

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reared in the laboratory at $25\pm 1^\circ\text{C}$ temperature and 60-70% relative humidity. Culturing was undertaken using clear plastic containers (20x14x7cm) on a 2:1 mixture of wheat flour and rough wheat bran containing approximately 250 g sterilized food and 300 eggs. This allowed host larvae to develop with excess food throughout larval life. The eggs hatch about 4 days, the larval period including five instars completed in approximately 35 days, and pupal period lasts 8 days at the favourable environmental conditions.

Parasitoid rearing

An asexual strain of the parasitoid *Venturia canescens* Gravenhorst (Hymenoptera: Ichneumonidae) was cultured on mature larvae of Mediterranean flour moth in plastic containers (as for *E. kuehniella*, above) at $25\pm 1^\circ\text{C}$ temperature and 60-70 % relative humidity with a 16:8 h light: dark photoperiod. In order to rear the parasitoid, 4-5 days old ten adult parasitoids which had been fed with pure honey were transferred into the container including approximately 250g sterilized food and 300 29-day-old mature larvae. After 24 h parasitization, parasitoids were removed from the container in order to prevent probable superparasitism. This procedure was repeated every two days. Development of the wasps from ovipositing to adult emergence was completed approximately in 25 days under these conditions.

The hosts were parasitized individually in Petri dishes at $25\pm 1^\circ\text{C}$ temperature for experiments. To prevent superparasitism, parasitized hosts were removed from the petri dishes and transferred to the container including enough nutrient for development. Newly emerged adult parasitoids (0-3h old) were transferred into glass tubes (1x16 cm) individually. In the experiment, the longevity of the parasitoid was measured in L0:D24 (continuous darkness) and L16:D8 (2000 and 5000 lux light intensities). All parasitoids were host-deprived from emergence until the day of death. Honey was provided as food source to adult parasitoids daily, until their death. Illumination was provided by fluorescent bulbs mounted 60 cm above. In determination of light intensities, a luxmeter was used. To designate exact death times of parasitoids, countings were made 2 times a day (08:00 and

20:00), and the longevity of the parasitoid was determined in L0:D24 and L16:D8 (2000 and 5000 lux light intensities).

In determination of effects of light (photoperiod and light intensity) on the fecundity of the parasitoid, the same parasitoids which were used in determination of longevity were used. After their natural death, to count egg masses, parasitoids were dissected and their mature eggs in ovarioles were counted. To count stored (mature) eggs, dissection of each parasitoid was conducted following the method of Harvey *et al.* (1996) as modified by Jervis & Copland (1996). Each parasitoid placed in insect saline solution (7.5 g NaCl/L) and restrained from moving in the saline by piercing its thorax with an entomological pin. The insect was then dissected by grasping the metasoma with forceps and pulling the long ovipositor distally with another pair of forceps. This enabled the ovaries and the rest of the reproductive system to be removed. Ovaries were then placed in a drop of saline on a microscope slide. Ovulated (mature) eggs were afterwards counted by cutting the lateral oviducts, where they accumulate, at the calyx gland just below the ovaries. A cover was placed gently over the eggs in suspension so that they could be viewed and counted easily.

All experiments were conducted at $25\pm 1^\circ\text{C}$ temperature and 60-70 % relative humidity in laboratory conditions. In each treatment (continuous darkness, 2000 and 5000 lux in L16:D8), 50 adults and totally 150 adults of *V. canescens* were used for the longevity and fecundity measurements. The effects of photoperiod and light intensity on the longevity and fecundity, data were submitted to one-way analysis of variance (ANOVA) at $P= 0.05$. Means were separated by using Duncan's Multiple Range Test.

RESULTS

The longevity of *V. canescens* was significantly affected by photoperiod and light intensity ($F=5.91$, $df=2$, $P=0.003$) (Fig. 1). The average longevity of the parasitoid was found as 583.92 ± 43.46 , 498.96 ± 43.11 , and 383.52 ± 37.20 hours in continuous darkness, 2000 and 5000 lux, respectively.

Survival curves of *V. canescens*, which consisted of times of death of parasitoids, in different photoperiod and light intensity conditions are shown in Figure 2. The figure showed that longevity of the parasitoid in continuous darkness condition was found longer than those of the parasitoids in 2000 and 5000 lux light density conditions. The initial deaths of the parasitoids began at the 132nd, 36th and 24th hours in L0:D24, 2000 and 5000 lux light, respectively. Thereafter longevities of the parasitoid in all treatments were found to have a linear decrease in time. Maximum longevities were found as 996, 900 and 780 hours in L0:D24, 2000 and 5000 lux light intensity, respectively.

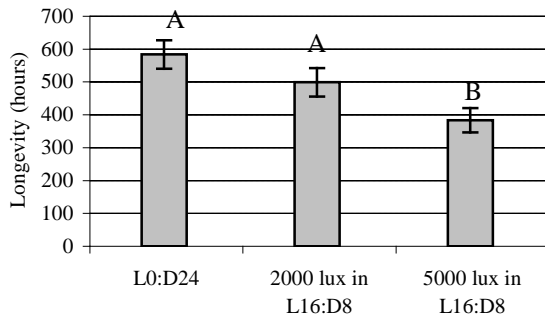


Fig. 1. The effect of photoperiod and light intensity on the longevity of *Venturia canescens* (hour). Bars with the same letter are not significantly different ($P < 0.05$; Duncan). Bars show the standard error of mean. Experiments were conducted with 50 samples for each treatment.

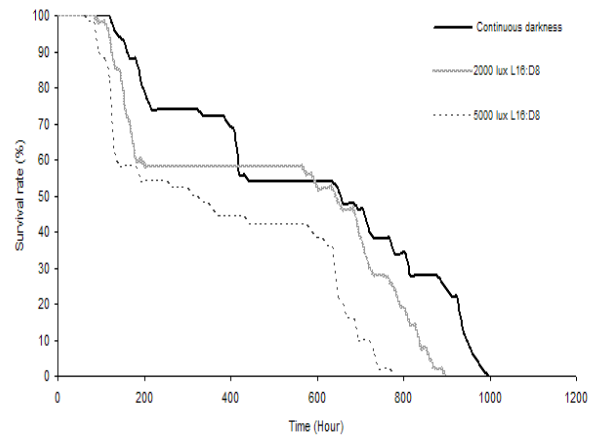


Fig. 2. Survival curves of *Venturia canescens*.

The egg numbers of *V. canescens* was significantly affected by photoperiod and light intensity ($F = 32.27$, $df = 2$, $P < 0.001$) (Fig. 3). The average egg numbers of the parasitoid was found as 193.02 ± 4.45 , 172.70 ± 4.80 , and 133.92 ± 6.40 in continuous darkness, 2000 and 5000 lux, respectively.

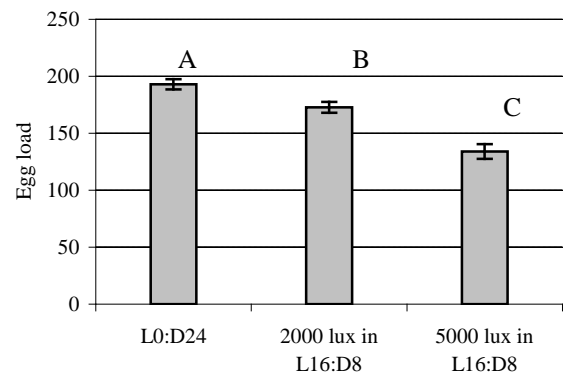


Fig. 3. The effect of photoperiod and light intensity on the number of mature eggs (egg load) of *Venturia canescens*. Bars with the same letter are not significantly different ($P < 0.05$; Duncan). Bars show the standard error of mean. Experiments were conducted with 50 samples for each treatment.

DISCUSSION

The maximum average longevity was found to be 583.92 ± 43.46 hours in continuous darkness (Figs. 1, 2). Changing light condition from continuous darkness to 2000 lux light intensity did not significantly affect the longevity of the parasitoid. However, increasing light intensity from 2000 lux to 5000 lux significantly decreased the longevity of the parasitoid. This may arise from the parasitoids displaying more activity in high light intensity conditions than in low light intensity and darkness conditions. From this, we can assume that the parasitoid uses its energy more effectively, in darkness than in day time, thus ensuring longevity.

The egg numbers of the parasitoid was found to be significantly higher in continuous darkness than in 2000 and 5000 lux light intensities (Fig. 3). In addition to this, increasing light intensity from 2000 to 5000 lux significantly decreased the fecundity of the parasitoid (22.45%). This result is similar to the results for longevity and related to the increased activity of parasitoids in the day time. Energy which could be used for egg production is used for general body activity in day time and high light intensity.

Limited studies have concentrated on photoperiod and light intensity in order to maximize the longevity and fecundity of natural enemies. It was noted that some entomophagous insects are nocturnal, e.g. certain Ichneumonidae (Gauld and Huddleston, 1976); Vespidae, Pompilidae and Rhopalosomatidae (Gauld and Bolton, 1988). However, *V. canescens* is a diurnal parasitoid, and one study is available on effect of different photoperiods on the longevity. Ozkan (2004) indicated that changing from continuous darkness to 2000 lux light intensity in L16:D8 did not significantly affect the longevity of the parasitoid, however, the author did not test 5000 lux light intensity. It was notified that diurnal variation in activity obviously needs to be taken into account in fecundity experiments (Jervis and Copland, 1996). Most natural enemy species will show strong diurnal peaks of behavioural activity, foraging being mainly confined to the photophase, as in many parasitoids and some carabid beetles (Ekbom, 1982; Luff, 1978; Ruberson *et al.*, 1988). Valdivirene *et al.* (2002) indicated that photoperiod affected longevity of *Orius insidiosus* (Say) (Hemiptera:

Anthocoridae), which is an important predator of thrips. Longevity varied from 77.1 days, at photoperiod L10:D14, to 40.1 days at photoperiod L9:D15. The same authors also showed that photoperiod could affect the reproduction of this insect. In the parasitoid *Ooencyrtus kuvanae* (Howard) (Hymenoptera: Encyrtidae), the photoperiod experienced at adult eclosion influenced both longevity and the rate of progeny production. Short-day conditions resulted in females producing fewer progeny but living longer (Weseloh, 1986).

The intensity of light has an important influence on the biology and behaviour of most insects (Jervis and Copland, 1996). High light intensity seems to increase the general activity of natural enemies. For example adults of beetle *Cryptoleamus montrouzieri* Muls (Coleoptera: Coccinellidae) spend a greater proportion of their time walking and make more attempts to fly in bright light than under dim light conditions (Heidari and Copland, 1989). These authors also noted that light intensity and quality may also influence the close range perception of hosts, and therefore suggested that care be taken in fecundity experiments to provide sufficient light for normal activity. In our experiment, changing photoperiod from L0:D24 to L16:D8, and increasing the light intensity increased the parasitoid's general activity, and this situation caused a decrease on the longevity and egg load of the parasitoid. This is a usual result, as it is notified that longer day length are known to shorten parasitoid longevity, and decrease its lifetime fecundity (Jervis and Copland, 1996).

As a conclusion, continuous darkness may be accepted as appropriate condition to maximize the longevity and fecundity of *V. canescens*. The results of this experiment should be taken into serious consideration when rearing and releasing the parasitoid. Maximum fecundity and long life could result in significantly increased progeny production, which may improve the applications in biological control programs. The use of darkness should also have a major economic impact on the rearing and/or the mass production of the parasitoid, as the use of numerous fluorescent lights will not be necessary. Dark conditions will allow a saving on fixed and operational costs of the rearing.

ACKNOWLEDGEMENTS

We are grateful to Prof Dr Frantisek Marec (Biological Centre, ASCR Institute of Entomology Department of Genetics Branisovska 31CZ-370 05 Ceske Budejovice Czech Republic) for critically proofreading the manuscript. The authors also thanks to The Scientific and Technical Research Council of Turkey for the support.

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(Received 22 May 2007, revised 29 August 2007)