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The effects of photoperiod and nutrient variety on preadult developmental time of *Plodia interpunctella* (Lepidoptera: Pyralidae)

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Abstract
Plodia interpunctella (hubner) the Indian meal moth was used in this research. İn our study were examined effects of photoperiod and nutrient variety on the preadult developmental time of *Plodia interpunctella*. Experiments were carried out in laboratory conditions with the temperature of 26 ± 1 ° C and 60% moisture proportion. Corn flour and bran were used for *P. interpuncella* as nutrient.
For the photoperiods, five photoperiods were studied as following; CD (continuous daylight), CD (continuous darkness), 18L:6D (18 hours of daylight, 6 hours of darkness) 12L:12D (12 hours of daylight, 12 hours of darkness) 6L:18D (6 hours of daylight, 18 hours of darkness) regimes.. In our study, shortest preadult developmental time is in CL photoperiod condition. we found developmental time of the Indian meal moth was significantly influenced by the different diets and photoperiod. *P. İnterpunctella* develop fastest as pre-adults under CLcycles compared to short day lengths corn flour is the most efficient nutrient compared to all conditions. As the daylight period increases, preadult developmental time decreases. As the daylight increases at different photoperiods, development period become shorter. Development of both nutritient was fastest under CL cycles.

Keywords: photoperiod, nutrient variety, *Plodia interpunctella*

Introduction
The Indian meal moth, *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae), is known as a major pest during the processing and storage of dried fruits. It can infest a variety of products and is perhaps the most economically important insect pest of processed food (Phillips *et al*., 2000 ; Rees, 2004; Mohandas *et al*, 2007; Nasirian *et al*, 2014) [23, 16, 21]
Developmental and physiological processes of insects can be affected by different factors such as temperature, humidity, photoperiod and the quality as well as the quantity of food (Na and Ryoo, 2000; Musa and Ren, 2005; Bouayad *et al*., 2008) [19, 17, 5]. Photoperiod and food variety are vital for the development and viability of harmful.(Shojaaddini *et al*., 2005) [28].
Photoperiod affects many activities such as hatching or pup for living creatures, sex ratio, length of life and nutrition activities (Macedo *et al*., 2003; Saunders and Bertossa, 2011; Workman *et al*., 2011; Fonken *et al*., 2012; Saunders,2014) [15, 33, 7, 27]. Many insect species develop at different rates under short- and long-day lengths; some develop faster under short days, whereas others under long days (Saunders, 2002) [25].
For the animal life, not only the daylight and darkness periods but also nutrient variety have importance. Photoperiod start and end periods change make significant changes in physiology of insects. This fact is vital for the living creatures' life regarding the biological activities such as life time and yield. (Allemand *et al*., 1973; Hartman *et al*., 2001; Yacobovitch *et al*., 2004) [1, 8, 34]. It is stated by different researchers that food influenced development speed and length of life insects by modifying metabolic activity.
The purpose of this study is to assess the photoperiod and food dependent change of preadult devepomental of *P. İnterpunctella* adults raised under different photoperiod. It is expected that the data obtained will fill in the blanks about the photoperiod and nutrient quality in insects. Our research which combines effects of photoperiod and food.

Materıals and Methods
Plodia interpunctella (hubner) the Indian meal moth was used in this research. İn our study were examined effects of photoperiod and nutrient variety on the preadult developmental time of *Plodia interpunctella*.

Experiments were carried out in laboratory conditions with the temperature of 26 ± 1 ° C and 60% moisture proportion. Corn flour and bran were used for *P. interpuncella* as nutrient. For the photoperiods, five photoperiods were studied as following; CD (continuous daylight), CD (continuous darkness), 18L:6D (18 hours of daylight, 6 hours of darkness) 12L:12D (12 hours of daylight, 12 hours of darkness) 6L:18D (6 hours of daylight, 18 hours of darkness) regimes.. Illumination was done with 40 W fluorescent bulbs in different photoperiod regimes. The trial which was dark all the time was conducted in incubator, while the others were conducted in rooms the light of which were adjusted with photoperiod light.

Insects were placed in glass jars appropriately prepared in two separate nutrient hitches with five photoperiods. During the larval period of insects, folded pieces of papers were put into the jars so that they could easily reach the pup phase. In the trials, firstly, on the same day matured insects were separated. All jars were preserved for the proper photoperiod and food environment.. The day insects were observed to come out was calculated as the pre-adult developmental time. In each trial, 30 individuals were used while calculating pre-adult developmental time. When the adults began to form in trial containers, adults which came out every day were grouped according to their sexes and their numbers were specified. At least three generations produced insects were used for the certain photoperiods and food related researches.

Data Analysis

Statistical analysis was executed using SPSS 15.0 statistical software One Way Analysis of Variance (ANOVA) was used for the comparison of more than two groups. Averages were assessed by using tukey Test, when the test results were significant. The significance levels of the results obtained from this test were assessed by using 'Tukey' test. 0.05 reliability was used in the assessments.

Results

Table 1: The Effects of Photoperiod and Nutrient Variety on Preadult developmental Time of *Plodia İnterpunctella* (Lepidoptera: Pyralidae)

	Preadult Developmental Tıme	
	Corn flour	**bran**
Photoperiod	**¹Ort±S.H.**	
CL	37.33±1.20 Ab	42.00±0.57 Bb
18L:6D	39.33±0.33 Aab	41.33±0.33 Bb
12L:12D	41.00±1.15 Aab	43.33±0.88 Aab
6L:18D	42.33±0.33 Aa	46.33±0.88 Ba
CD	41.66±0.88 Aa	46.00±0.57 Ba

Average of 3 repeated of processes each with 30 beings

Difference between the averages shown at the same column with lowercase is negligible. p>0.05

Difference between the averages shown at the same line with same nutrients and big letters is negligible. p>0.05

As shown in table 1, corn flour is the most efficient nutrient compared to all conditions. As the daylight period increases, preadult developmental time decreases..When we analyze the results, of preadult developmental time CL and 18L:18D was found very close to each other in both nutrients.

As shown in table 1, in general, as the duration of illumination decrease, preadult developmental time increases. During CD (continuous darkness), developmental time 41,66 days in corn flour whereas, during CL it became 37.33 days. During CD (continuous darkness), developmental time 46 days in bran whereas, during CL it became 42 days During CD (continuous darkness), developmental time 41,66 days in corn flour whereas, it became 46 days in bran. There has been no big difference regarding the preadult developmental time lifetime if we compare CL with 18L,6A and 6L,18D with CD.

As shown in table 1 as the daylight increases at different photoperiods, development period become shorter. Development of both nutritient was fastest under CL cycles.

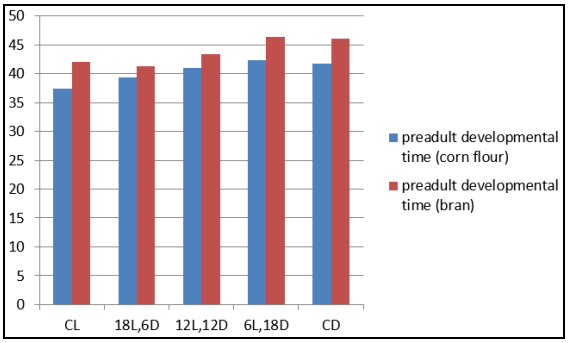

Fig 1: The Effects of Photoperiod and Nutrient Variety on Preadult developmental Time of *Plodia İnterpunctella* (Lepidoptera: Pyralidae)

As shown in figüre 1 as the daylight increases at different photoperiods, development period become shorter. Development of both nutritient was fastest under CL cycles.

Discussion

Photoperiod affects many activities such as hatching or pup for living creatures, sex ratio, length of life and nutrition activities. (Watanabe, 2000 Denlinger, 2002; Niva and Takeda, 2003; Macedo *et al*., 2003; Saunders and Bertossa, 2011; Workman *et al*., 2011; Fonken *et al*., 2012) [32, 6, 22, 15, 26, 33, 7]. In a study by Hossain *et al*., (2016) [9], which was conducted with *Dermestus maculatus* using 3 different photoperiods (24:D, 24L, 12L:12D), it was found that development period shortened based on darkness. In a study they conducted with *Spodotera litura* (12L:12D, 0L:24D, and 24L:0D), Subala and Shivekumar (2017) [29] found that butterflies, lived longer and consumed food the most under dark conditions.

Diversity of the composition of both types of nutrients is caused by different nutritional elements that they provide to larvae and adults. Because nutrition affecs metabolism.(Olson and Andow, 1998 Kaspi *et al*. 2002) [30, 11]. Özer (1957) [31], stated that *P. Interpunctella* prefers water-contented products and plants, and Kıvan and Karsavuran (1991) [12] stated that this insect evolve faster in water content. In our study, corn flour is the most developed and efficient in all photoperiods. In a study with *P. interpunctella* as the daylight increases at different photoperiods, development period become shorter and rate of survival increases in long photoperiods, they determined that there are differences in larval duration and lifelong in raw and roasted pistachios (Shojaaddını *et al*., 2005) [28]. Kikukawa and Masaki (1984) [13] analyzed the effect of light and dark phases on this insects' biology and also effect of photoperiod change on *P. interpunctella*.in their another study, in cases where different photoperiods were changed within one or two days intervals, it is analyzed that there are differences regarding the insects' development (Kikukawa *et al*.,2008) [14]. The biology of *P. interpunctella* on various diets has been studied by several researchers. Arbogast (2007) evaluated the development of *P. interpunctella* immature stages under different temperature, humidity and dietary conditions. Bouayad *et al*. (2008) [5] studied the effect of four diets (wheat flour, dates, sorghum and barely) on the postembryonic development of this insect, and reported the shortest developmental time for the larvae reared on wheat flour. In our study, shortest preadult developmental time is in CL photoperiod condition. we found developmental time of the Indian meal moth was significantly influenced by the different diets and photoperiod. *P. İnterpunctella* develop fastest as pre-adults under CLcycles compared to short day lengths.

In this study, some differences have been detected between different photoperiods and nutritient especially for some groups. This case shows us that daylight and nutritient change can affect the insects' metabolism. As the brain affected by photoperiod, there has been some changes analyzed in insects' endocrine status.

Similar daylight daily periods show close results, which means they have similar effects on the activities such as nutrient, reproduction, aging, metabolism. Our results show constant light is more efficient; especially the difference is more obvious on CL and CD. Different results especially for developmental time taken according to different photoperiod and nutritient, shows us that, insect metabolism is affected by photoperiod.

From the obtained results it can be understood that for the upbringing and production of *P. Interpunctella,* one must pay attention both nutrients and also daylight.

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