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Photoperiodic response on the development of *Petalocephala* (Cicadellidae: Ledrinae) sp. on *Azadirachta indica*

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ABSTRACT

Photoperiodism refers to the biological response of the organism to changes in the duration of light and darkness in a day. The experiment was performed on *Petalocephala* to study the effect of photoperiod on it. Experiment performed with help of neem leaves on which insect was found. Our results suggest that using 16h of light promotes the development of *Petalocephala* by reducing the time duration from 8.98±0.09to3.060±0.16days.

KEYWORDS: Photoperiod, *Petalocephala*, development, Neem.

INTRODUCTION

Leafhoppers comprise a diverse group of insects worldwide, total over20,000 species. Both young nymphs and mature adults sustain themselves by extracting plant juices. through puncturing the underside of leaves.

The impact of fluctuating weather conditions on agriculture is profoundly significant(Dhaliwalet.al.,2004).Photoperiod among insects regulates wide array of physiological phenomena including the initiation and cessation of

diapauses(Kogure,1933,Baker1935),

seasonalvariation(Marcovitch,1923),growthrates(Saunders,1972),migrationpatterns(Dingle,1974),Coloration(MacLeod,1967), Sexualbehavior(Perez,Verdier,andPener,1971),Sexratios(HoelscherandVinson,1971),Reproductivecapacity(Atwal,1955),Susceptibiliytoinsecticides(FernandezandRandalph,1966),andrecoveryfromthermalstress(Pittendrigh,1961).

An insect expanded their habitats into regions with distinct winters at higher latitudes, photoperiodic response evolved repeatedly. Substantial evidence indicates that the majority if not all photoperiodic mechanisms stem from the underlying circadian system. This concept was initially introduced around 75 years ago by Erwin Bunning, a German plant physiologist (Bunning,1936).

Temperature can influence the photoperiodic time measurement system and initiation of diapauses through various mechanisms for instance, temperature fluctuation can modify the critical day length (Circadian Day Length) at which 50% of the female population enters diapauses (Saunders and Gilbert,1990).Various studies have explored circadian-based models concerning the insect photoperiodic mechanism. For instance, Pittendrigh (1972) proposes potential theoretical frameworks for photoperiodic induction, drawing from Bunning's overarching hypothesis. These frameworks, such as the 'internal coincidence' and 'external coincidence' models, have been discussed in prior literature (Vaz Nunes & Saunders, 1999; Saunders, 2002, 2011).

The internal coincidence model suggests the involvement of separate 'dawn' and 'dusk' oscillators, with seasonal variations in photoperiod perceived through changes in their phase relationships as day or night lengths alter. Light's role in this model is primarily seen as entrainment. Conversely, external coincidence theory posits a single oscillator synchronized by the light-dark cycle, ensuring that a specific light-sensitive phase (referred to as the photo-inducible phase, is) occurs during the latter portion of the night (Pittendrigh & Minis, 1964; Pittendrigh, 1966). During long autumn nights, falls in darkness, triggering diapause, whereas in short summer nights, the dawn phase extends backward to illuminate, thus prompting continuous or no diapause

development. Here, light serves two functions: entraining the circadian

oscillation(s) to the light cycle and regulating no diapause or diapause pathways through illumination or lack thereof during the photo-inducible phase.

The control of diapause through photoperiod is significant not just in terms of fundamental biological understanding, but also in practical entomology. Understanding the life cycles and environmental responses of pests or endangered species is vital for managing them effectively or aiding in their conservation efforts, with photoperiodism playing a key role in regulating these processes (Grevstad et.al. 2022; Grevstad and Coop 2015; Kumar et.al. 2015; Lindestad et.al. 2019; Nielsen et.al. 2016; Peffers et.al. 2021; Pollard et. al.,2019).

Inducing diapause can be advantageous for extending shelf life and reducing the expenses associated with maintaining a colony continuously. However, effectively managing diapause within a program requires understanding the environmental signals that trigger the onset and end of diapause (Ichikawa et al., 2020; Li et al., 2018). Artificial light at night (ALAN) presents a significant challenge in urban areas, disrupting physiological functions and behaviors in birds, mammals, and even humans (Stevenson et al., 2015). ALAN also interferes with insect photoperiodic responses and disrupts local adaptations (Fyie et al., 2021; Mukai et al., 2021; van Gefen et al., 2014; Westby and Medley, 2020).

Insect photoperiodism comprises various physiological components (outlined below). This review delves into our existing understanding of the physiological and molecular mechanisms of certain components, such as the photoperiodic time measurement system, photoreceptors, and circadian clocks, with a particular focus on models concerning photoperiodic time measurement.

Material and methods

The effect of day length on the nymph development period was studied by caging 10 nymphs of the same age inside the caged Neem jars to establish the effect of photoperiod on the nymphs of *Petalocephala* sp. collected from different Neem trees present at Isabella Thoburn College, Lucknow (80.88°E longitude and 26.75°N latitude) were studied inside controlled environment rooms with a mean (SD) temperature of 26.49±0.57ºC at different photoperiods.

Fifty newly molted second instar nymphs were taken for the experiment. Out of which 10 instars were introduced in each plastic caged Neem leaf with 5 leaves for each replica. To prevent the leaves from dryness a piece of oasis was kept inside the jars. The leaves were renewed every day and daily observations were made on the nymph development durations until the third instars emerged. And rearing them under photoperiods of 16hr, 12hr, and 8hr at 26.49 ± 0.57°C.The nymphs were given fresh leaves each day till the last day of the experiment and observed daily for the total second instar nymph duration.

Fig1: Tree from where Neem leaves Were collected

Fig2: Microscope under which *Petalocephala* Sp. Was observed.

Fig3: Experimental set-up

RESULTS

We found a significant effect of photoperiod on the development of nymphs of*Petalocephala* sp. (F=542.2, p< 0.001). Across all photoperiods tested, the developmental time of the nymphal stage at a mean temperature of 26.08◦C and photoperiod of L8:16D with a mean of 8.98±0.09 days was significantly higher than at photoperiod of L16:D8 and L12:D12. The mean duration of development under photoperiod L16:D8 and L12:D12 are 3.060±0.16 and 4.360±0.10 respectively.

Fig4: *Petalocephala* sp. Observed Under microscope

Fig5: *Petalocephala* sp. Found on Neem leaves

Table1. ANNOVA TABLE

ANOVA Table	SS	df	MS
Treatment (between columns)	96.80	2	48.40
Individual (between rows)	0.2333	4	0.05833
Residual (random)	0.7387	8	0.09233
Total	97.77	14	

DATA ANALYSIS

The obtained data were analyzed using GraphPad Prism 5 software. The mean of the total duration was estimated and calculated by using a one-way ANOVA test to determine the effect of photoperiod on the total development duration of nymphs.

DISCUSSION:

Photoperiodism refers to an adaptive mechanism employed by organisms to gauge the length of daylight and predict approaching seasons. This allows them, or their offspring, to synchronize their development and physiological processes with environmental fluctuations. Researchers have extensively examined these physiological mechanisms to grasp insect life cycles, control pest populations, protect temperature changes such as pulses or steps,

endangered species, and facilitate the cultivation of beneficial insects(Shin G. Goto,2022).

The impact of temperature on triggering diapause and the photoperiodic mechanism is investigated through various conditions. These encompass constant temperature settings, temperature fluctuations, periodic

combination with concurrent light-dark cycles (LD), or under conditions of continuous darkness (DD) or constant light (LL).

Photoperiodism was initially observed in plants a hundred years ago by Garner and Allard in 1920. Shortly after, in 1923, it was identified in the strawberry root aphid Aphis forbesi by Marcovitch.

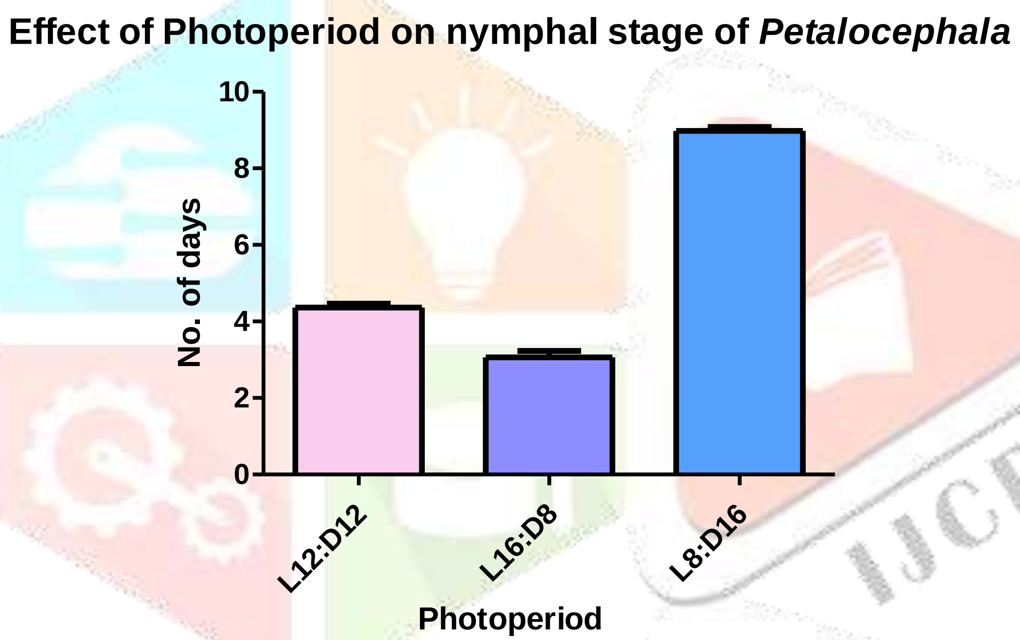
The model insect, Drosophila melanogaster, may also show photoperiodic responses in female ovarian development, male spermatogenesis and accessory gland development, energy resource accumulation, and gene expression (Kubrak et al. 2016; Saunders et al. 1989).

Several methods, such as surgical ablation, covering with paints that prevent light penetration, supplemental illumination, and transplantation of the cultured organ, have been used to identify the photoreceptive organ responsible for photoperiodism (Goto et al. 2010).

Arthropods use opsins as photoreceptive molecules to receive light (Van Der Kooi et al. 2021). Opsins generally exhibit a narrow range of spectral sensitivity; however, each species possesses multiple opsins with distinct spectral classes that enable them to receive the light of a broad range of wavelengths.

In cricket species *Dianemobius nigrofasciatus* and the blow fly *Protophormiaterra enovae*, studies conducted by Shiga and Numata in 1996 and 1997 demonstrated that surgically removing the compound eyes of adults inhibited their ability to respond to photoperiodic cues, thereby affecting the regulation of embryonic and adult diapause.

Research into the molecular mechanism governing circadian behavior has predominantly centered on *Drosophila melanogaster*(Patke et al., 2020).



Graph showing Effect of Photoperiod on nymphal stage of *Petalocephala*

*C*ONCLUSION

In conclusion the experiment was performed to analyze effect of photoperiodic response on the development of *Petalocephala* (Cicadellidae:Ledrinae) sp. on *Azadirachta indica.* all photoperiod tests the developmental times of the nymph's stages of *Petalocephala* sp. (F=542.2, $p < 0.001$). at mean temperature of 26.08 degree temperature and photoperiod of L8;16 D with a mean of 8.98± 0.09 days was higher than at photoperiod of L16:D8 and L12:D12.

The mean duration of development under photoperiod L16:D8 and L12:D12 are 3.060 ±0.16 and 4.360±0.10 respectively.

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