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Life Cycle of the Diamondback Moth *Plutella xylostella* L. (Lepidoptera: Plutellidae), in Broccoli and Cauliflower under Laboratory Conditions

Ciclo Biológico de la Palomilla Dorso de Diamante *Plutella xylostella* L., en Brócoli y Coliflor bajo condiciones de Laboratorio

Huaripata, C.[1*]; Sánchez, G.[1]

*Corresponding author: cesar.huaripata@gmail.com

Abstract

This research aimed to determine the biological cycle of *Plutella xylostella* (DBM), raised in broccoli var. Calabrese and cauliflower var. Snowball in laboratory conditions averaging 76.1 ° F and 65% RH. The mating of the moths was carried out in one-liter plastic containers and the postures were incubated inside 200 ml polypropylene cups, both covered with nets. To provide suitable food for larvae the plants were cultivated under cover to avoid infestation with pests. Fresh leaves were used to feed the larvae until pupation. The results were analyzed with the nonparametric statistical test of Kruskal-Wallis. The following biological parameters were obtained, reared with broccoli and cauliflower leaves respectively: incubation period 3 days; larval period 9.76 and 9.69 days; pupal period 5.1 and 5.3 days; biological cycle 19.5 and 19.9 days and 175 and 187 eggs as the capacity of oviposition of mated females. These results do not show significant statistical differences of the moth's biological cycle between the two host plants.

Key words: *Plutella xylostella, DBM, life cycle, Brassicaceae, broccoli, cauliflower.*

Resumen

Esta investigación tuvo como objetivo determinar el ciclo biológico de *Plutella xylostella* (PDD), criada en brócoli var. Calabrese y coliflor var. Snowball bajo condiciones de laboratorio promediando 76.1 ° F y 65% de HR. El apareamiento de las polillas se realizó en recipientes de plástico de un litro y las posturas se incubaron dentro de vasos de polipropileno de 200 ml, ambos cubiertos con redes. Para proporcionar alimento adecuado para las larvas, las plantas se cultivaron bajo cubierta para evitar la infestación con plagas. Se usaron hojas frescas para alimentar a las larvas hasta la pupación. Los resultados se analizaron con la prueba estadística no paramétrica de Kruskal-Wallis. Se obtuvieron los siguientes parámetros biológicos de PDD, criadas con brócoli y hojas de coliflor respectivamente: período de incubación 3 días; período larval 9,76 y 9,69 días; periodo pupal 5.1 y 5.3 días; ciclo biológico 19.5 y 19.9 días; 175 y 187 huevos como la capacidad de oviposición de hembras apareadas. Estos resultados no muestran diferencias estadísticas significativas del ciclo biológico de la polilla entre las dos plantas hospedadoras.

Palabras clave: *Plutella xylostella*, *PDD, ciclo biológico, Brassicaceae, brócoli, coliflor.*

Introduction

Vegetables, and within them Brassicaceae family, are very appreciated in human feeding due to its high nutritional and medicinal value, mainly for its properties in cancer prevention (Cohen, Kristal & Stanford, 2000; Keck & Finley, 2004). The chemo-protective effect of these vegetables is due to their high content of glucosinolates, anticancer substances that are responsible for detoxification (Lampe & Peterson, 2002).

Climatic conditions in Peru allow the growth of several species in the Brassicaceae; all of them are attacked by insect pests., (Sánchez & Vergara, 2014) cite *Brevicoryne brassicae* L., *Hellula phidilealis* Walk., *Leptophobia aripa* Boisduval, and *Plutella xylostella* L. The last one is considered the main pest; it is known as "Diamondback Moth", a cosmopolitan species with Mediterranean origin

[1]Klaus Raven Büller Entomological Museum (KRBEM), Universidad Nacional Agraria La Molina (UNALM)

(Lingappa, Basavanagoud, Kulkarni, Patil, & Kambrekar, 2004)

P. xylostella, is the key pest in tropical areas, given the numerous generations per year and the absence of effective natural enemies (García-Morató, 2000); this species reduces yields and product quality, especially in summer due to high infestation (Sánchez & Vergara, 2014). Due to the importance of this pest, the objective was to determine the biological cycle of *Plutella xylostella* L., in broccoli (*Brassica oleraceae* var. *italika*) Plenck, and in cauliflower (*Brassica oleraceae* var. *botrytis*) L. The results will provide important data for a better integrated pest management of Diamondback Moth in Peru.

Materials and Methods

This study was conducted in the laboratory of the Entomology Museum "Klaus Raven Büller" (MEKRB) of the Universidad Nacional Agraria La Molina (UNALM), from March to August 2013. All the rearing work was conducted under controlled conditions, averaged at 76.1 °F of temperature and 65.1% RH. In order to obtain more reliable data, the rearing was carried out until reaching three generations of *P. xylostella*.

Outside MEKRB, an area covered with canvas and tulle was installed, inside which pots were placed with broccoli (*Brassica oleracea* var. *italika*, Calabrese variety) and cauliflower (*Brassica oleracea* var. *botrytis*, Snowball variety), in order to provide fresh leaves, free of insect's pest and (Figure 1a and 1b). For each variety, twenty clay pots of four kg capacity were used, the pots were filled with 50% agricultural soil and 50% compost. To ensure the fertility and good development of the plants, two plants were placed per pot.

Fifty adults of *P. xylostella* were collected from an agricultural field located in the district of Carabayllo (Lima, Peru). These specimens were taken to the MEKRB Laboratory where they were conditioned in two five-liter glass jars, on the bottom of which paper towel and fresh "broccoli" leaves were placed, as an oviposition substrate. Twenty moths were placed in each bottle; to ensure a proper gas exchange, the opening of these containers was covered with nets secured with rubber bands. For the mass rearing, the leaves containing eggs of *P. xylostella* were extracted, and then transferred to Petri dishes of 15 cm in diameter x 1.5 cm in height. The larvae that emerged were fed broccoli leaves until their pupal stage. The pupae were placed individually in polypropylene containers of seven cm in diameter, five cm in diameter and four cm in height. Once the adults emerged, they were used as breeding stock for this research.

Adult breeding and egg production

For mating, twenty polypropylene containers of one-liter capacity were used (twelve cm in their highest diameter, nine cm in their lowest diameter and thirteen cm in height)

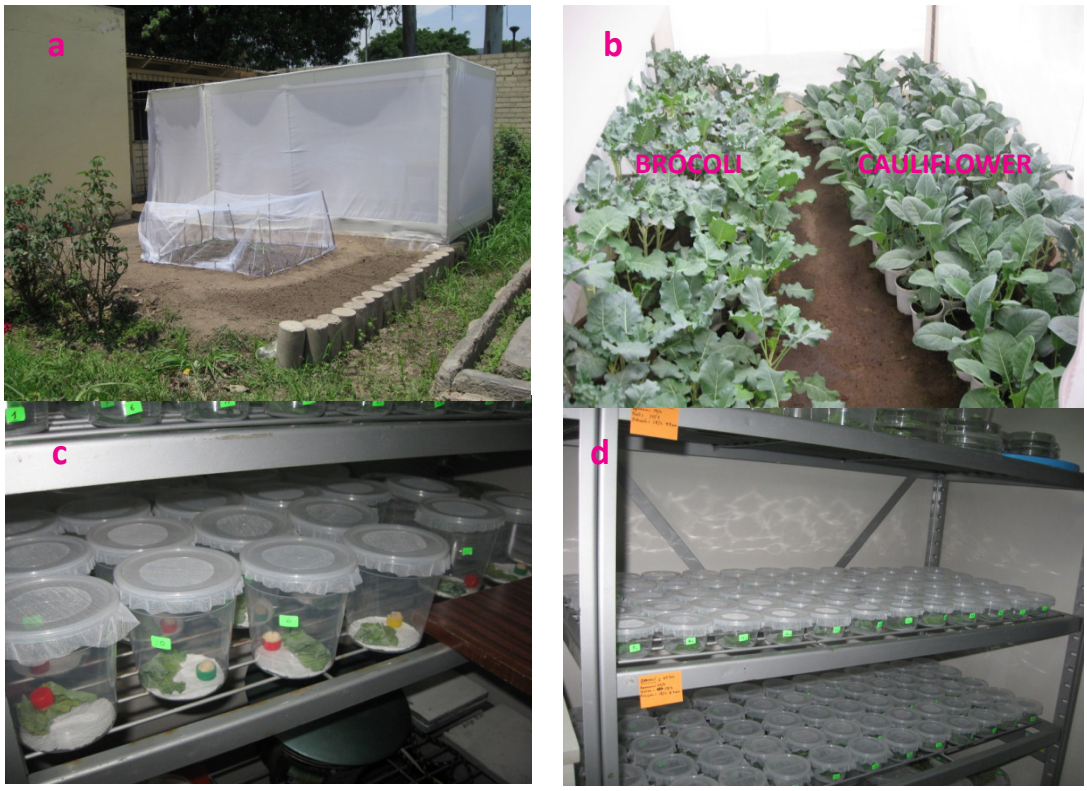

Figure 1. a) Plant material under cover (nursery and transplant); b) Plants of broccoli (Calabrese variety) and cauliflower (Var. Snowball); c) Mating containers; d) Rearing containers.

(Figure 1c). Each container was covered with net to favor gas exchange. At the bottom of each container was placed paper towel, a container of two cm in diameter x one cm high, with diluted honey for adult feeding, and broccoli or cauliflower leaves for oviposition; a pair of adults of *P. xylostella* was placed inside each container. Of these containers, ten were used for the study in broccoli and ten for cauliflower.

Individual breeding of eggs

The eggs were removed from the mating containers, and these with the help of the marten hair brush, were individually placed in polypropylene rearing containers of seven cm in their highest diameter, five cm in their lowest diameter and four cm in height and covered with net at the top (Figure 1d). Each rearing container was conditioned with paper towel moistened in the bottom and a fraction of leaf of broccoli or cauliflower according to the case for the hatching and feeding of the larva. Sixty rearing containers were used for broccoli research and sixty for cauliflower, material that was used to determine the biological parameters of *P. xylostella*.

Once the rearing was started, eggs, larvae, and pupae were observed daily until adults were obtained. The incubation, larval, pupal, biological cycle length and oviposition capacity were recorded.

The results were analyzed using the nonparametric statistical test of Kruskall-Wallis, statistical analyzes were performed using the SPSS 19 Statistics software.

Results

In broccoli leaves, *P. xylostella* recorded an incubation period of 3 days, incubation period did not have significant differences between the three generations (Kruskal - Wallis test: X2 = 0.00, with GL = 2 and $p \geq 0.05$); the larval stage was 9.76 days with a range of 8 to 11 days, the duration of this period fed broccoli leaves had significant differences between the three generations (Kruskal - Wallis test: X2 = 9.56, with GL = 2 and $p \geq 0.05$); the pupal stage was: 5.13 days, with a range of 4 to 7 days, had significant differences between the three generations (Kruskal-Wallis test: X2 = 7.19, with GL = 2 and $p \geq 0.05$); the biological cycle was 19.4 days; with a range of 16.8 to 21.8 days, there were no significant differences between the three generations (Kruskal-Wallis test: X2 = 0.96, with GL = 2 and $p \geq 0.05$). The oviposition capacity was 187 eggs, with a range of 53 to 336 eggs, according to the analysis, there were no significant differences between the three generations (Kruskal-Wallis test: X2 = 2.98, with GL = 2 and $p \geq 0.05$) (Table 1).

In leaves of cauliflower, *P. xylostella* recorded an incubation period of 3 days, incubation period did not have significant differences between the three generations (Kruskal - Wallis test: X2 = 0.00, with GL = 2 and $p \geq 0.05$); the larval stage was 9.69 days with a range of 8 to 12 days, there were significant differences between the three generations (Kruskal-Wallis test: X2 = 8.39, with GL = 2 and $p \geq 0.05$); the pupal stage was 5.29 days with a range of 4 to 7 days, there were significant differences between the three generations (Kruskal-Wallis test: X2 = 21.45, with

Table 1. *Average of biological parameters of Plutella xylostella L., during three successive generations (G) in broccoli, under laboratory conditions. March - August 2013. La Molina, Lima - Peru.*

Broccoli	Incubation period	Larval period	Pupal period	Biological period	Oviposition capacity
G - I	3a	9.62a	5.28a	19.48a	171.7a
G - II	3a	9.64a	4.98ab	19.38a	171.3a
G - III	3a	10.02b	5.14a	19.63a	216.7a
Average	**3**	**9.76**	**5.13**	**19.49**	**187**

Table 2. *Average of biological parameters of Plutella xylostella L., during three successive generations (G) in cauliflower, under laboratory conditions. March - August 2013. La Molina, Lima - Peru.*

Cauliflower	Incubation period	Larval period	Pupal period	Biological period	Oviposition capacity
G - I	3a	9.62a	5.38ab	19.87a	160.1a
G - II	3a	9.92b	4.94a	19.8a	173.5a
G - III	3a	9.52a	5.58ab	19.97a	191.4a
Average	**3**	**9.69**	**5.3**	**19.88**	**175**

GL = 2 and p <0.05); the biological cycle was 19.8 days with a range of 17.8 to 22.2 days, there were no significant differences between the three generations (Kruskal-Wallis test: X2 = 0.9, with GL = 2 and p ≥ 0.05). The oviposition capacity was 175 eggs with a range of 72 to 286 eggs, according to the analysis, there were no significant differences between the three generations (Kruskal-Wallis test: X2 = 1.26, with GL = 2 and p ≥ 0.05) (Table 2).

Discussion

In this study, the incubation period was three days, both in broccoli and in cauliflower. These results are similar to those obtained by (Hasanshahi et al., 2014) in three varieties of cauliflower; also, (Fernández & Alvarez, 1988) recorded 2.9 days in cabbage (*Brassica oleracea* var. *capitata*) and (Ebrahimi, Talebi, Fathipour, & Zamani, 2008) recorded 3 days in rapeseed cultivars (*Brassica napus* L.)

The larval period showed similar results for both cauliflower and broccoli (9.76 and 9.69 days respectively). These results coincide with those obtained by (Niu, Li, Li, & Liu, 2013), 9.6 days in cauliflower, however, other researchers recorded different values for this parameter. These values range from 6.64 days (25 °C) (Saeed, Sayyed, Shad, & Zaka, 2010) to 11.09 days (23.5 °C) (Sarnthoy, Keinmeesuke, Sinchaisri, & Nakasuji, 1989). This variation may be due to differences in many factors under which these studies were carried out, such as the cultivar used and the strain of *P. xylostella* used, which, according to (Sarnthoy et al., 1989), shows variable results.

The pupal period recorded in broccoli and cauliflower (5.13 and 5.3 days respectively) was very similar for both varieties. The range of values recorded by other researchers varies from 3.86 in cauliflower (Golizadeh, Kamali, Fathipour, & Abbasipour, 2009) to 5.89 in broccoli and 6.0 days in cauliflower (Syed & Abro, 2003). This variation would be a function of the same variables that affect the duration of the larval status mentioned above.

In broccoli the biological cycle of *P. xylostella* was 19.49 days and in cauliflower it was 19.88 days. These slight differences are not significant, since in all the previous parameters there were no wide differences.

In broccoli, the oviposition capacity of *P. xylostella* was 187 eggs, and in cauliflower it was 175 eggs. These values do not differ significantly.

Conclusions

In broccoli leaves, the duration of the biological cycle of *P. xylostella* was 19.4 days, the egg state lasted 3 days, the larva 9.76 days, the pupa 5.13 days and the oviposition capacity was 187 eggs on average.

In cauliflower leaves, the duration of the biological cycle of *P. xylostella* was 19.8 days, the egg state lasted 3 days, the larva 9.69 days, pupa 5. 3 days and the capacity of oviposition was 175 eggs on average.

There are no significant differences between the biological parameters of *P. xylostella* bred in both broccoli and cauliflower.

In Peru, it is the first study of *P. xylostella* in these species broccoli and cauliflower.

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