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Article

Oviposition Preference and Larvae Feeding of Diamondback Moth (*Plutella xylostella* Linn.) on Several Species of Brassicaceae Family Crops

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ABSTRACT

Diamondback moth (*P. xylostella*) is a major pest of Brassicaceae crops. This study investigates host plant preferences of *P. xylostella* and their impact on larval growth across five Brassicaceae species (cabbage, green mustard, cauliflower, kale, and kailan). This experimental using a Completely Randomized Design (CRD) with five replications, we assessed oviposition behavior and larval growth efficiency. The research was conducted at the Agrotechnology Laboratory, Faculty of Agriculture, University of Jember. Our findings reveal that *P. xylostella* preferred kale (B. oleracea var. sabellica) for oviposition (19 eggs on average), followed by green mustard, cabbage, kailan, and cauliflower. Analysis of the efficiency of conversion of food (ECI and ECD) were highest in larvae fed on kailan leaves, suggesting enhanced larval development (ECI = 0.1966, ECD = 0.2074). These findings suggest that kale could be used as a trap crop in integrated pest management (IPM) strategies to mitigate damage on economically important Brassicaceae crops.

INTRODUCTION

The diamondback moth, *Plutella xylostella*, is a highly prevalent and destructive pest that significantly impacts Brassicaceae crops worldwide (Fathipour & Mirhosseini, 2017; Furlong et al., 2013). *P. xylostella* poses a serious threat to agricultural production due to its ability to infest and damage a wide range of Brassicaceae species. The larvae of *P. xylostella* have developed mechanisms to bypass the natural defenses of these plants, allowing them to feed extensively on foliage. As a result, their feeding activity leads to severe yield losses, with reported reductions exceeding 90% in Indonesia and other Asian countries (Saeed et al., 2010; Zalucki et al., 2012).

P. xylostella utilizes the abundant glucosinolates in Brassicaceae plants as host cues (Hamilton et al., 2005). Some studies have reported that *P. xylostella* thrives better on cabbage (*Brassica oleracea var. capitate*) compared to other Brassicaceae plants (Asmoro & Winasa, 2021; Fukatine et al., 2023). However, other studies have indicated that *P. xylostella* is more attracted to oviposit on *Barbarea vulgaris* (Badenes-Perez et al., 2004). On the other hand, Brassicaceae plants have undergone extensive varietal development, including kale (*Brassica oleracea var. sabellica*) and kailan (*Brassica oleracea alboglabra*). The increasing resistance to insecticides and concerns about environmental and human health have stimulated greater interest in alternative pest management techniques such as trap cropping (Banks & Ekbom, 1999). For instance, Indian mustard (*Brassica juncea L. Czern*) and Chinese cabbage (*Brassica oleracea L. var acephalla*) are among the most commonly proposed trap crops for *P. xylostella* (Åsman, 2002; Mitchell et al., 2000).

Factors influencing *P. xylostella* preference include volatile compounds and nutritional content of Brassicaceae plants. In addition to plant volatiles, *P. xylostella* relies on vision and mechanoreception for host recognition and oviposition (Spencer et al., 1999). *P. xylostella* has also been shown to prefer ovipositing on glossy green leaves with a thin waxy layer compared to lighter-colored leaves with a thick waxy layer (Justus et al., 2000; Ulmer et al., 2002). Therefore, understanding the oviposition preferences of *P. xylostella* across different Brassicaceae species is essential for optimizing trap cropping strategies. This study aimed to determine *P. xylostella* preference in Brassicaceae plants regarding adult oviposition and larval feeding behavior. The results of this study can be considered in the management of *P. xylostella*, including the development of alternative trap crops in integrated pest management to reduce infestations in economically valuable Brassicaceae crops.

MATERIALS AND METHODS

Time and Place

The research was conducted from May to August 2023 at the Green House Kusuma Faculty of Agriculture and Agrotechnology Laboratory, Faculty of Agriculture, University of Jember.

P. xylostella rearing

P. xylostella was reared by collecting larvae from the field and rearing them in jars. Rearing conditions at temperature 25 ± 2°C, humidity 70% and light condition 12L:12D photoperiod. The larvae were fed fresh cabbage leaves, which were replaced daily. Larvae entering the pupal stage, indicated by reduced feeding and movement, were transferred to rearing boxes. Pupae that emerged as adults were fed 10% honey solution dripped onto cotton. Adults were allowed to copulate and oviposit on cabbage leaves. Eggs were transferred to jars covered with mesh and provided with fresh cabbage leaves for larval feeding. The insects used as test insects were the second generation (F2).

Plants Preparation

The plants to be used were cabbage, cauliflower, green mustard, kale, and kailan. Plant test preparation started with seeding, planting, and maintenance. The best plants 25 days after transplanting with uniform growth with had approximately 6-8 leaves and no infestation of pests or diseases were selected as test plants.

Experimental Design

This study employed a Completely Randomized Design with five treatments, each replicated five times. A total of 5 pairs of adult *P. xylostella* were introduced into the experimental cages, with each plant species receiving one pairs per replicate. The treatments used were:

P1 = Cabbage plant, variety Green Coronet

P2 = Green mustard plant, variety Shinta

P3 = Cauliflower plant, variety TM Kiran
P4 = Kale plant, variety Nero Di Toscana
P5 = Kailan plant, variety Full White

Oviposition Preference

Oviposition preference was assessed through a choice test involving five different host plant species placed in a cage measuring (50x30x75) cm as illustrated (Figure 1). A pair of adult *P. xylostella* was introduced into the cage. The number of eggs on each plant species and their position on the plant (upper and lower leaf surfaces, and other parts) were recorded at the end of the experiment.

Leaf Nutrient Index

Leaf discs with a diameter of 8 cm from the test plants were weighed using an analytical balance and then provided to the larvae. Larvae were weighed and then allowed to feed on the test plant leaves. After 24 hours, the remaining leaves were discarded and not included in the calculation and replaced with new leaves. Feces produced at the end of each day were collected and weighed. Larval weight was recorded at the end of the experiment when the larvae became adult. The nutrient index is calculated using the formula as used in the research of Xu et al. (2016) bellow:

$$\text{Efficiency of conversion of ingested food (ECI)} = \frac{100\ P}{E}$$

$$\text{Efficiency of conversion of digested food (ECD)} = \frac{100\ P}{E-F}$$

Notes:
P = Insect weight gain
E = Weight of food eaten
F = Weight of feces produced

Data Analysis

Data analysis using ANOVA (Analysis of Variance). If the results of the ANOVA analysis show significantly different, further tests are carried out using the DMRT (Duncan Multiple Range Test) method with an error rate of 5%.

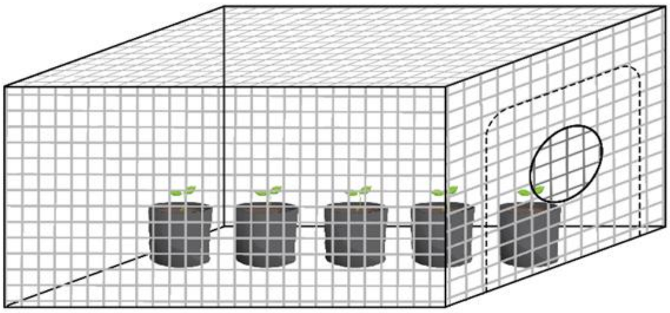

Figure 1. Experimental cages illustration

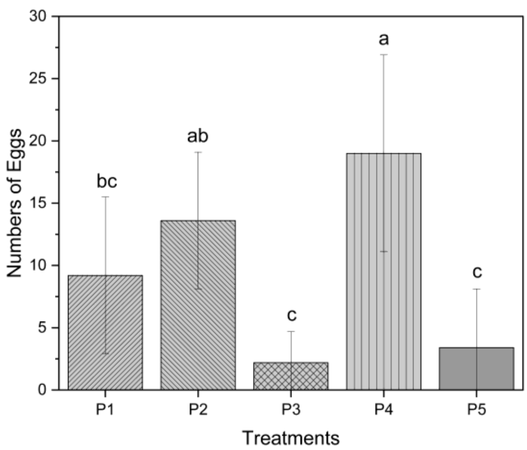

Figure 2. The average number of eggs laid by adult *P. xylostella*

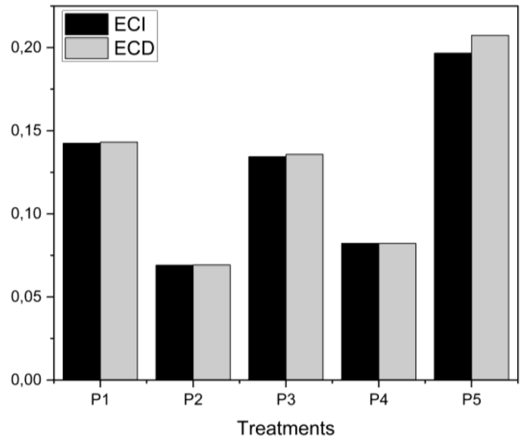

Figure 3. Nutrition index of *P. xylostella* larvae

RESULTS AND DISCUSSION

Oviposition Preference

The highest average number of eggs was found on kale plants (19 eggs), followed by green mustard (13.6 eggs), cabbage (9.2 eggs), kailan (3.4 eggs), and cauliflower (2.2 eggs) (Figure 2). Statistical analysis showed significant differences among the five Brassicaceae plant treatments. The highest number of eggs was found on kale plants, likely due to the physical characteristics of kale that influence insect oviposition. Host plant quality affects the development of *P. xylostella* (Ramzan et al., 2021). The rough and corrugated leaf surface facilitated *P. xylostella* adults to perch on kale plants when laying eggs and helped to retain eggs on the plant surface, preventing them from falling off. Thus, the morphology of the host plant has a significant influence on *P. xylostella* oviposition (Andrahennadi & Gillott, 1998). These findings align with previous reports indicating that leaf surface structure and secondary metabolites influence oviposition choice in *P. xylostella* (Ang et al., 2016; Silva & Furlong, 2012).

Based on observations of cabbage, green mustard, cauliflower, kale, and kailan plants, female *P. xylostella* preferred to oviposit on the undersides of leaves. Charleston & Kfir (2000) indicates that the wax layer on the upper surface of the leaves interferes with the oviposition process. For *P. xylostella* oviposition, the role of physical factors of the host plant is very important (Andrahennadi & Gillott, 1998). Leaf or stem surfaces are preferred as oviposition sites, especially on leaves that have more grooves (Herlinda et al., 2004; Ulmer et al., 2002). Under normal conditions, female *P. xylostella* can produce 100 to 200 eggs (Ahmed et al., 2022), whereas in this study, female *P. xylostella* produced an average of only 9.48 eggs. This is likely due to a decrease in female *P. xylostella* fecundity during the rearing process, leading to reduced lifespan and fewer eggs produced by the insects. This condition may be influenced by environmental factors in laboratory rearing, which are different from their natural habitat.

Leaf Nutrient Index

The Efficiency of Conversion of Ingested Food (ECI) and Efficiency of Conversion of Digested Food (ECD) values were higher in larvae-fed kale leaves (ECI = 0.1966, ECD = 0.2074) compared to those fed green mustard leaves (ECI = 0.0691, ECD = 0.0693) (Figure 3). This is related to the higher oxygen consumption or higher energy consumption during larval digestion of food. ECI and ECD indicate the physiological efficiency of insects in assimilating consumed and digested food for growth and development (Hemati et al., 2012).

The higher ECI and ECD values of kale compared to cabbage, cauliflower, kale, and green mustard indicate that kale is the best feed for *P. xylostella*. Kailan may provide an optimal combination of nutrient availability, digestibility, and lower plant defenses, leading to improved feeding efficiency as well as higher ECI and ECD values for *P. xylostella*. This suggests that a higher amount of food consumed leads to more body mass conversion and is directly proportional to the increase in larval weight of *P.*

xylostella. Wang et al. (2023) reported that *Spodoptera frugiperda* had high ECI and ECD values on cotton compared to corn, wheat, soybean, and tomato. This suggests that the high values on cotton make cotton a more favorable plant for *P. xylostella* larvae based on its nutrition. Conversely, feed with low ECI and ECD values indicates that the feed is not suitable for *P. xylostella*. H. armigera larvae had low ECI and ECD on Meshkin tomato indicating the plant was not suitable for its development (Hemati et al., 2012). Low feed consumption causes a reduction in the conversion of feed into biomass, thereby reducing the efficiency of conversion of consumed feed and this can affect larval weight.

CONCLUSION

This study confirms that kale has potential as a *P. xylostella* trap plant based on oviposition preference. Kailan is the most suitable food for *P. xylostella* larvae based on larval growth efficiency. These findings suggest in designing integrated pest management (IPM) strategies, such as selecting Brassicaceae plants for intercropping or as a trap crops. Future studies should explore field validation and chemical analyses of host plant volatiles influencing oviposition behavior.

AUTHORS CONTRIBUTIONS

WM and W designed the research. WM supervised all the processes, and NM collected the data. NM and MU analyzed the data. WM and MU wrote the manuscript. All the authors have read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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