

Variations in Developmental Biology and Morphometrics of Diamondback Moth, *Plutella xylostella* (Lepidoptera: Yponomeutidae) Collected From Different Geographic Areas of North India

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Abstract A laboratory study was conducted to find out the variations in the developmental biology and morphometrics of diamondback moth, *Plutella xylostella* (Lepidoptera : Yponomeutidae) collected from five different geographic regions viz., Hisar (800 feet), Kangra (2200 feet), Solan (4200 feet), Theog (7500 feet) and Kinnaur (9000 feet) at $25\pm 1^{\circ}\text{C}$ on cauliflower. The observations on the morphometric study revealed that length and breadth of eggs was found to be maximum (0.52 and 0.34 mm) in case of Kangra population, whereas it was minimum (0.46 and 0.28 mm) in Hisar population. Wing expanse was maximum (13.25 and 14.95 mm) in Kinnaur population and minimum (12.05 and 13.15 mm) in Solan population. Significant differences were observed in developmental period for the population of different geographical regions. The total developmental period was maximum (17.03 days) for the Kangra population while it was minimum (14.65 days) for the Kinnaur population and was significantly different from each other. This

study will play a significant role to device the region specific management strategy against this pest.

Keywords Developmental biology, Morphometric, Diamondback moth, Geographic regions, Variations.

Introduction

The diamondback moth, *Plutella xylostella* (L.) (Lepidoptera : Yponomeutidae) is one of the most destructive pest of cultivated cruciferous vegetables throughout the world [1—4]. It was reported for the first time in India by Fletcher [5]. In India, the infestation leads to 30-100% loss of the crop [6]. From Himachal Pradesh, this pest was reported on cruciferous crops in temperate regions where cabbage and cauliflower are grown [7]. Due to differences in various agroclimatic factors, this insect responds differently on different host plants, temperature and climates. Collecting such information will be helpful for us to understand the variations of population dynamics in different regions so the we can develop suitable management strategies [8].

This study was made to compare the differences in the developmental biology and morphometrics between the different geographic populations that were reared on the same host plant and at the same tem-

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Table 1. Localities from where *Plutella xylostella* was collected.

Locality	State	Altitude (feet)
Hisar (Haryana)	Haryana	800
Jaach (Kangra)	Himachal Pradesh	2200
Chambaghat (Solan)	Himachal Pradesh	4200
Theog (Shimla)	Himachal Pradesh	7500
Kalpa (Kinnaur)	Himachal Pradesh	9000

perature which would help us to develop the better management strategies for the different region.

Materials and Methods

Sampling

Larvae and pupae of *P. xylostella* were collected manually from five different localities of different altitudes (Table 1) from the farmer's fields at each location and were immediately placed in plastic jar (20 cm × 15 cm), top of which was covered with muslin cloth with leaves of cauliflower inside the container as food to the developing larvae these were further reared under laboratory conditions as per the method described under.

Rearing of the test insect

Collected samples of *Plutella xylostella* were reared in cages of size of 30×34×24 cm with glass pan on three sides. Fresh leaves of cauliflower with their petiole dipped in glass vials (7 cm × 1.5 cm) were kept inside these cages and the larvae so collected were shifted to these leaves and allowed to develop up to

adults. The adult thus emerged were fed with 10% sugar syrup. The culture of the test insect collected from each locality was maintained under laboratory conditions at temperature of $25 \pm 1^\circ\text{C}$ in BOD incubator throughout the period of study.

Developmental biology

Developmental period of *P. xylostella* collected from five different localities were determined at $25 \pm 1^\circ\text{C}$ in BOD incubator by keeping five pair of male and female in glass chimney (20 cm × 15 cm) provided with 10% sugar syrup in cotton swab and were allowed for egg lying. A batch of 100 eggs of so obtained was taken for developmental study for each locality and was replicated five times. The eggs being checked daily and the daily emerged larvae were recorded. Regular checking of eggs was continued until all eggs either hatched or collapsed.

Developmental time of larvae and pupae was observed in the growth chamber at similar conditions provided to eggs. On hatching, the neonate larvae (12 hour old) were transferred with the help of camel's hair brush to the petri plates (diameter 9.5 cm) containing cauliflower leaves. The leaves were changed periodically as and when exhausted. Observations on duration of different instars were recorded daily under microscope. Experiment was replicated five times with 20 larvae/replication. The pupae formed in each replication were kept separately inside the incubator at $25 \pm 1^\circ\text{C}$. The number of days for which the insect remained in the pupal stage till emergence of adults of the diamondback was counted as pupal period. Simultaneously the longevity of male and female was recorded for each locality.

Table 2. Comparative analysis of biological parameters of *P. xylostella* collected from five different geographical regions.

Localities	Biological parameters					Adult longevity (days)	
	Incubation period (days) (Mean ± SE)	Larval period (days) (Mean ± SE)	Pupal period (days) (Mean ± SE)	Total developmental period (days) (Mean ± SE)	(Mean ± SE)		
					Male	Female	
Hisar	4.10 ± 0.05	7.52 ± 0.16	5.74 ± 0.11	16.95 ± 0.10	22.20 ± 1.03	17.10 ± 0.81	
Kangra	3.80 ± 0.11	8.36 ± 0.13	5.40 ± 0.10	17.03 ± 0.28	17.60 ± 0.45	11.66 ± 0.62	
Solan	3.14 ± 0.05	7.66 ± 0.14	4.61 ± 0.22	15.30 ± 0.32	17.70 ± 0.78	12.70 ± 0.98	
Theog	3.37 ± 0.08	8.21 ± 0.23	4.63 ± 0.15	15.58 ± 0.30	15.20 ± 0.82	9.40 ± 0.40	
Kinnaur	3.08 ± 0.06	7.12 ± 0.07	4.70 ± 0.10	14.65 ± 0.17	14.70 ± 0.93	10.80 ± 0.60	
CD				0.76	2.38	1.91	

Table 3. Comparative analysis of length of different stages of *P. xylostella* collected from five different geographical regions.

Stage	Hisar	Length (mm) Mean \pm SE				CD	
		Kangra	Solan	Theog	Kinnaur		
Pupa	Egg	0.46 \pm 0.0 ^b	0.52 \pm 0.01 ^a	0.46 \pm 0.14 ^b	0.48 \pm 0.25 ^{ab}	0.037	
	Internal	5.24 \pm 0.07 ^b	5.62 \pm 0.13 ^a	5.90 \pm 0.15 ^a	5.80 \pm 0.08 ^a	0.279	
	Cocoon	8.24 \pm 0.10	8.31 \pm 0.08	8.20 \pm 0.14	8.35 \pm 0.23	8.40 \pm 0.14	NS
Adult	Male	5.15 \pm 0.170 ^b	4.90 \pm 0.180 ^b	5.0 \pm 0.10 ^b	5.65 \pm 0.150 ^a	5.10 \pm 0.066 ^b	0.419
	Female	5.0 \pm 0.099 ^b	5.10 \pm 0.180 ^b	5.15 \pm 0.15 ^b	5.75 \pm 0.134 ^a	5.65 \pm 0.150 ^a	0.415

Morphometrics of different stages

Morphometric of the eggs, pupae and adults of *P. xylostella* for each locality was taken by using microscope.

Results and Discussion

Developmental biology

The incubation period for Hisar, Kangra, Solan, Theog and Kinnaur population was found to be 4.10, 3.80, 3.37, 3.14 and 3.08 days, respectively and the duration of larval period for the respective populations was found to be 7.52, 8.36, 7.66, 8.21 and 7.12 days. The ecotype of the Kangra populations had the longest larval period followed by those of the Theog, Solan, Hisar and Kinnaur populations, respectively. The total developmental period among the five ecotypes was the longest for the Kangra ecotype (17.03 days) followed by Hisar (16.95 days), Theog (15.59 days), Solan (15.30 days) and Kinnaur (14.65 days) ecotypes. The developmental period of the Kinnaur population was significantly shorter than those observed in the populations collected from other localities. These results are more or less in line with the other workers who compared the total developmental period among eight different ecotypes of *P. xylostella* in India and found significant variation [9]. A study conducted in China also reported the variations in the developmental stages of diamondback moth collected from five different geographic regions [8]. These differences can be attributed to acclimatization, thermal responses of insects along a gradient of latitude [10, 11] and larval food [12–14] thus this indicates the differences among the population from different geographical regions.

The longevity of male and female adults revealed that males of the Hisar ecotype survived for longer duration (22.20 days) as compared to Solan (17.70 days) and Kangra (17.60 days) ecotypes. The adult males of the Theog (15.20 days) and Kinnaur (14.70 days) ecotypes. The adult males of the Theog (15.20 days) and Kinnaur (14.70 days) ecotypes survived significantly for shorter period. In case of the female also, the Hisar ecotype lived longer (17.10 days) followed by Solan (12.70 days) and Kangra (11.66 days) ecotypes. The duration of the female longevity was significantly shorter in Kinnaur (10.80 days) and Theog (9.40 days) populations (Table 2). These studies revealed that there were marked variations in the longevity of the adults of the diamondback moth collected from the five different localities. Variations among the adult male and female longevity from different ecotypes were also reported in the diamondback moth by other workers in India and China [8, 9].

Morphometrics of different stages of *P. xylostella* for different geographical regions

The mean length of the eggs of the diamondback moth collected from five ecotypes viz. Hisar, Kangra, Solan, Theog and Kinnaur was 0.46, 0.52, 0.46, 0.48 and 0.47 mm respectively revealing thereby that, the Kangra population was significantly higher (0.52 mm) than populations from the other geographical regions (Table 3), whereas the breadth was significantly more for the Kangra, Kinnaur and Theog ecotypes than Hisar and Solan ecotypes. The length of the pupa (internal) was significantly at par with the Kinnaur, Solan and Theog ecotypes but differed from those of the Kangra and Hisar ecotypes.

Table 4. Comparative analysis of breadth of different developmental stages of *P. xylostella* collected from five different geographical regions.

Stage		Length (mm) Mean \pm SE					CD
		Hisar	Kangra	Solan	Theog	Kinnaur	
Pupa	Egg	0.46 \pm 0.0 ^b	0.52 \pm 0.01 ^a	0.46 \pm 0.14 ^b	0.48 \pm 0.25 ^{ab}	0.47 \pm 0.07 ^b	0.037
	Internal	5.24 \pm 0.07 ^b	5.62 \pm 0.13 ^a	5.90 \pm 0.15 ^a	5.80 \pm 0.08 ^a	5.80 \pm 0.1 ^a	0.279
	Cocoon	8.24 \pm 0.10	8.31 \pm 0.08	8.20 \pm 0.14	8.35 \pm 0.23	8.40 \pm 0.14	NS
Adult	Male	5.15 \pm 0.170 ^b	4.90 \pm 0.180 ^b	5.0 \pm 0.10 ^b	5.65 \pm 0.150 ^a	5.10 \pm 0.066 ^b	0.419
	Female	5.0 \pm 0.099 ^b	5.10 \pm 0.180 ^b	5.15 \pm 0.15 ^b	5.75 \pm 0.134 ^a	5.65 \pm 0.150 ^a	0.415

Body length of the adult male of the diamond-back moth from Theog was significantly higher (5.65 mm) than other ecotypes whereas the wing expanse for the Kinnaur (13.25 mm) and Theog (13.10 mm) populations was higher than the other geographic ecotypes (Tables 3 and 4). There were significant differences in the female wing expanse among different ecotypes while the body length of the Kinnaur and Theog ecotypes was more than the population from other regions. The micro morphological variations among the diamondback moth collected from five different localities were also observed [15].

Intraspecific morphological variations in the green bug, mosquitoes [16, 17] and larval, pupal and adults of the *Helicoverpa armigera* in cotton [18] which were collected from different geographic regions were reported.

Conclusion

On the basis of present investigation it is concluded that there were significant variation in the developmental biology among populations of *P. xylostella* from different geographical regions. Variations in biological parameters and morphometric characters of populations collected from different regions indicate formation of region specific ecotypes of the test insect. This information will be helpful in formulating region specific management strategies against this pest.

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