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Growth Rate Studies of Diamondback Moth, *Plutella xylostella* in Different Geographical Regions of North India

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A B S T R A C T

The diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae), is cosmopolitan in its geographical distribution, occurring in all major crucifer growing regions of world. The larva skeletonize the leaves and ultimately affecting the plant growth and rendering it unfit for further use. Since the science changes with topographical source, hereditary strategies, for example, the relative rate of regular choice and hereditary separation ought to be utilized to investigate the geological variation of diamondback moth. Fertility table summarizes the information on biological performance of a species. The analysis revealed the variation among four populations of *P. xylostella*. Saharanpur population had maximum intrinsic rate of increase r_m, followed by Pantnagar and Delhi whereas, the least value of r_m was observed in the Hisar population. On comparing fertility parameters of different populations, it was found that the Theog population was the most prolific among all the populations while the Hisar population was the least amongst all the populations.

Introduction

The diamondback moth, *Plutella xylostella* (L.), in India and throughout world is the most catastrophic pest of vegetable crops belonging to family brassicaceae (Niu *et al.*, 2013; Kianpour *et al.*, 2014). The first instar larvae mine in the leaf and the subsequent instars feed on the leaf and skeletonize it ultimately affecting the plant growth and rendering it unfit for further use. In India, its infestation leads to 30-100% loss of the cole crops (Ahmed *et al.*, 2009). It is estimated that 4 to 5 billion USD every year was wasted due to management cost and yield losses around the world (Furlong *et al.*, 2013). There is differences in the biological activities of the diamondback moth when fed on different host plants (Zhang *et al.*, 2012; Niu *et al.*, 2014) and on different climatic conditions and temperatures (Liu *et al.*, 2003; Golizadeh *et al.*, 2007), there is a less literature pertaining on intra-specific variations of *P. xylostella* when reared on the same host plant (Pan *et al.*, 2014). Gathering this data will be useful to understand the population variations in different areas with the goal that develop suitable management techniques (Ram *et al.*, 2016). In view of the above, the present study was conducted to understand genetic variation of diamondback moth.

Materials and Methods

Host plant

Cauliflower seeds were shown in the open field at the experimental farm of the department of Entomology, Dr Yashwant Singh Parmar university of Horticulture and Forestry (Nauni, Solan, HP, India). Transplanting was done after 4 weeks, when the plants had 4-5 leaves, individually in open field for use in the following experiments.

Sampling

Larvae, pupae and adults from four different geographical areas of North India viz. Hisar (Haryana), Delhi (UT), Pantnagar (Uttarakhand) and Saharnpur (Uttar Pradesh) of different altitudes (Table 1) from the cauliflower and cabbage fields at each location were collected manually and were immediately placed in plastic jar (20 cm × 10 cm), top of which was covered with muslin cloth with leaves of cauliflower inside the container as food to the developing larvae.

About 9-10 generations of *P. xylostella* adults were reared on the same cauliflower variety in the laboratory. The adults thus emerged were fed with 10% sugar syrup in cotton swab and were provided with fresh cauliflower leaves for egg laying. Male-female pairs were placed in cages of size of 36×34×24 cm with glass pan on three sides in order to get the same aged eggs of test insect. Fresh leaves of cauliflower with their petiole dipped in glass vials (7cm x 1.5cm) were kept inside these cages. The cauliflower leaves were removed from the rearing cage after 12 h, eggs were moved individually into a petri dish that contained a cauliflower leaf (around 25 cm^2). Until pupation the larvae were raised in the petri dish, and the pupae were transferred to rearing cage. To check sex ratio, female fecundity and adult longevity the emerged adults were reared as described above till all females and males died. The culture of the test insect collected from each locality was maintained under laboratory conditions at room temperature (25±1^oC) throughout the period of study.

Life-table study

Life-fertility study were conducted in a growth chamber [25± 1^0C, 65 % RH with a photoperiod of 14:10 (L: D) h]. The observation on egg hatching was daily recorded, and the numbers of hatched were recorded until either the eggs hatched or the eggs crumbled. Freshly hatched larvae from the stock culture were transferred into a petri dish containing cauliflower leaves. New leaves were placed daily in place of old leaves until the larvae died or pupated. Daily observation was taken on larval, pupal, and adult stages until development was complete. To differentiate different larval instars exuviae were used. Single pair was kept in a plastic drum with a 4–5 leaf cauliflower leaves for mating. The adults were fed on cotton swab with 10 % honey solution regularly. Cauliflower leaves were replaced with new leaves daily, and eggs deposited on each plant and drum walls were collected with the help of camel hair brush and recorded daily until the female died. The data is so collected used for calculating the intrinsic rate of increase (rm), mean generation time (T), finite rate increase (λ), doubling time (DT) and net reproductive rate (Ro).

Results and Discussion

Results Life fertility parameters of different *P. xylostella* populations have been represented in Table 2. Newly hatched egg which survive to age x marked as lx and the peak value of mx demonstrated a quick increment to the maximum, and a more clearly characterized could be recognized in

the beginning of adult emergence (Figures 1, 2, 3 and 4). The data reveals that there were observable differences in the different populations with respect to their life fertility parameters. The gross reproductive rate (GRR) was highest in the Saharanpur population (170.68 female eggs per female) and minimum was for Pantnagar 123.58. The net reproductive rate (Ro) followed almost similar trend as the Saharanpur population had highest value of Ro followed by Pantnagar and Hisar i.e. 76.41, 63.25 and 62.74females produced per generation, respectively. The Delhi population had the least Ro value (56.31females produced per generation). The approximate generation time (Tc) varied from 19.58 days in Saharanpur population to 22.63 days in Hisar population. The Gross fecundity (Mx) was highest for Saharnpur population (316.13 eggs per female) and least Mx was observed in the Delhi population i.e. 223.44 eggs per female. The innate capacity for increase (rc) was highest in the Saharanpur and Hisar population had lowest rc value. The intrinsic rate of natural increase (rm) was calculated from rc values for different populations. Similarly highest value of rm value was observed in the Saharanpur. The least value of rm was observed in the Hisar population. On comparing fertility parameters of *P. xylostella* of different populations, it was found that the Saharanpur population was the most prolific among all the populations while the Hisar population was the least prolific as revealed by the minimum value of the true intrinsic rate of increase amongst all the populations. The true generation time (T) and Doubling time (DT) were minimum for Saharanpur population and maximum for Hisar population. Weekly multiplication rate (WM) was observed to be the highest for the Sharanpur population (5.07 days) and least for Hisar population (3.75 days).

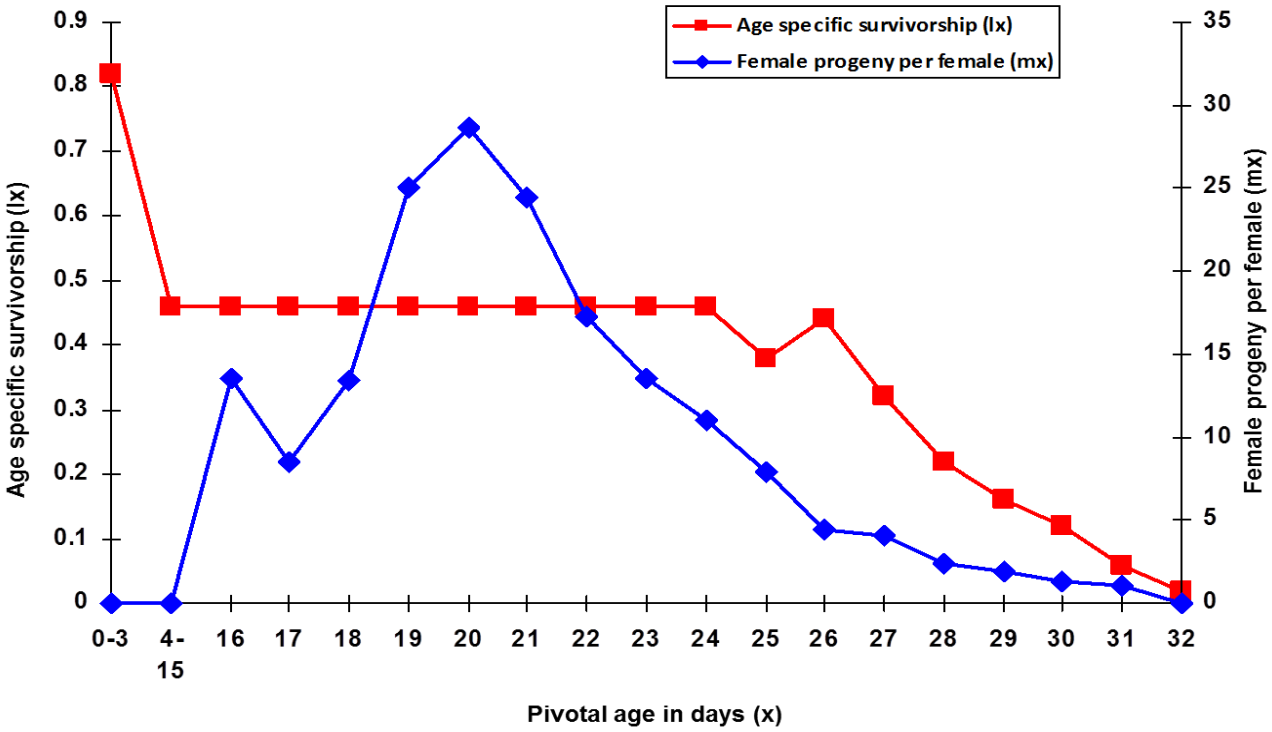

Fig. 1. Age specific survival and fecundity for *P. xylostella* collected from Sharanpur

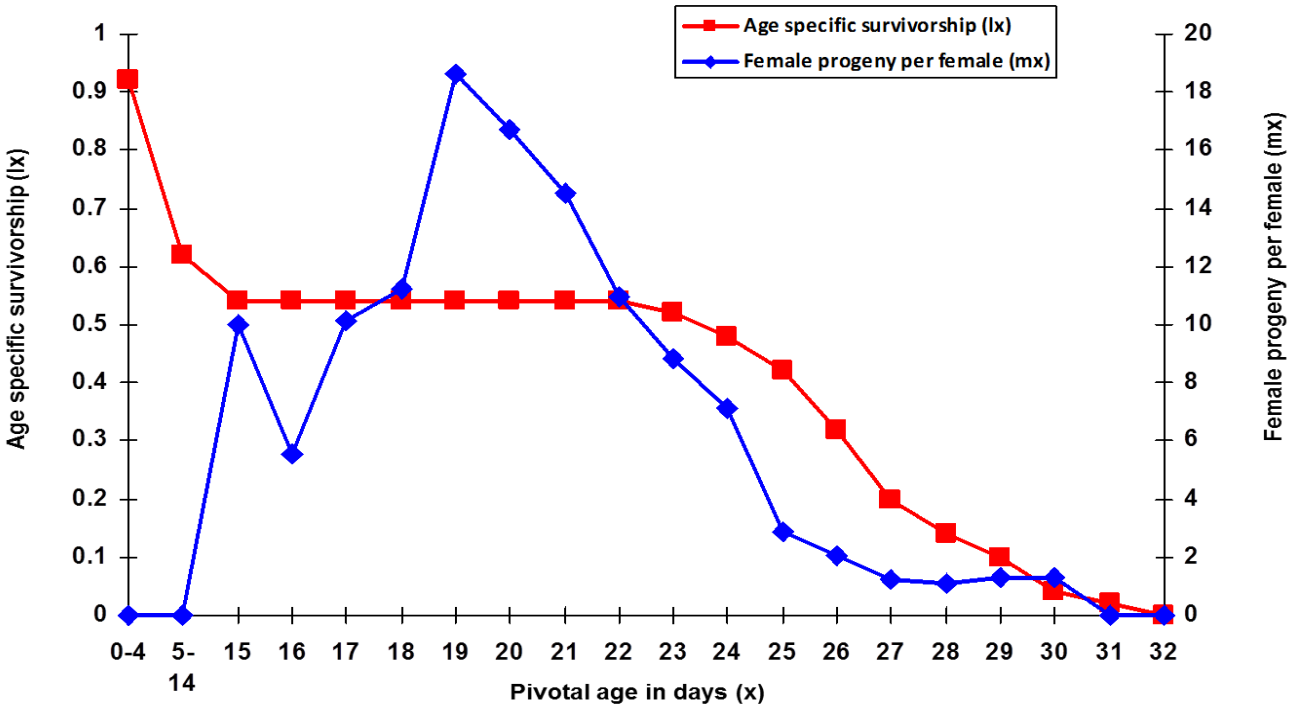

Fig. 2. Age specific survival and fecundity for *P. xylostella* collected from Pantnagar

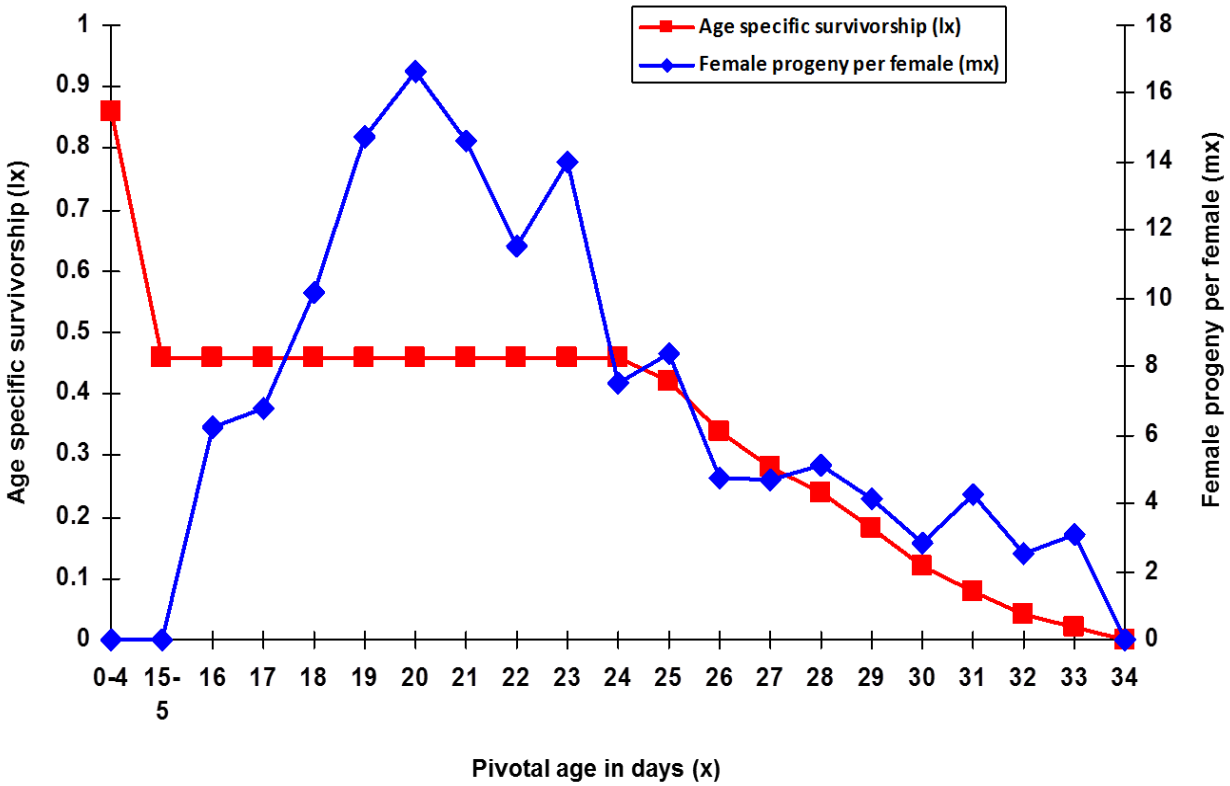

Fig. 3. Age specific survival and fecundity for *P. xylostella* collected from for Delhi population

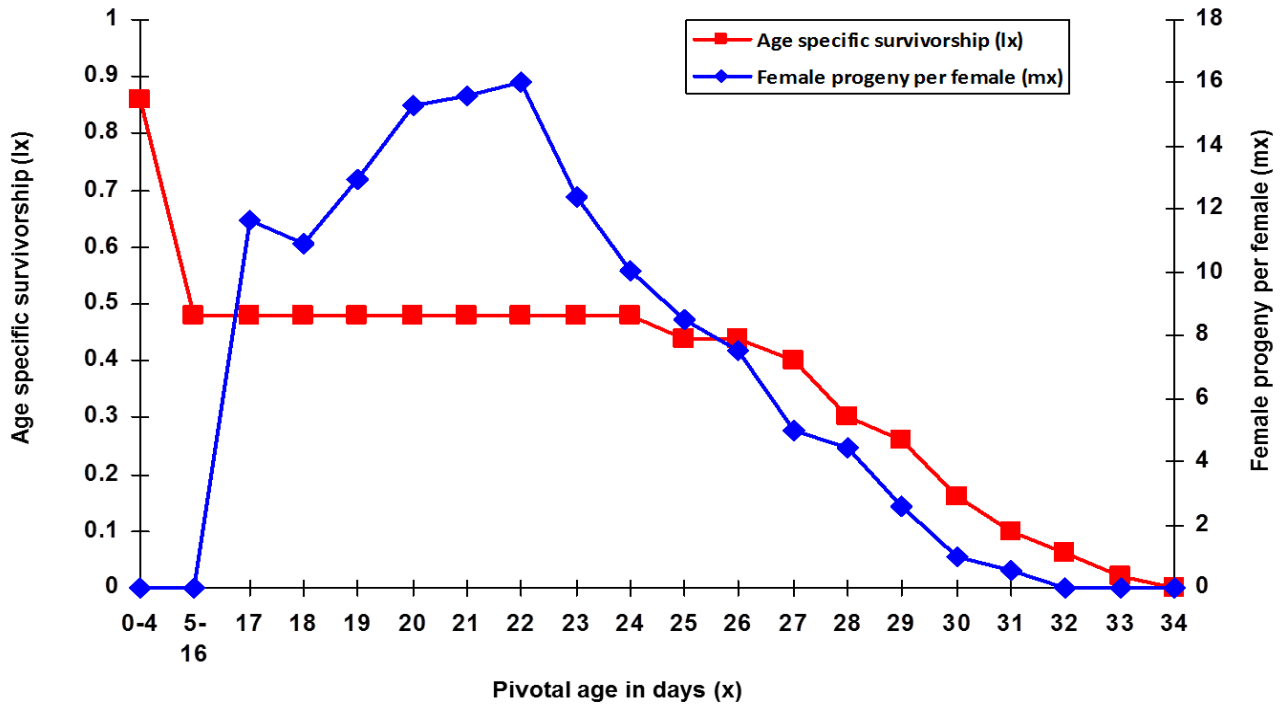

Fig. 4. Age specific survival and fecundity for *P. xylostella* collected from Hisar

Table.1 Sampling localities of *Plutella xylostella*

Locality	Altitude (feet)
Sharanpur (Uttar Pradesh)	885
Pantnagar(Uttarakhand)	764
Delhi (UT)	709
Hisar(Haryana)	705

Table.2 Comparative life table parameters of different populations of *Plutella xylostella*

	Fertility parameters of DBM in the indicated population			
Parameters	**Saharanpur**	**Pantnagar**	**Delhi**	**Hisar**
Gross reproductive rate (GRR)	178.68	123.58	142.06	140.47
Net reproductive rate (R_0)	76.41	63.25	56.31	62.74
Approximate generation time (T_c)	19.58	19.75	21.34	22.63
Innate capacity for increase (r_c)	0.221	0.210	0.189	0.183
Intrinsic rate of natural increase (r_m)	0.232	0.218	0.195	0.189
True generation time (T)	18.69	19.02	20.67	21.90
Finite rate of increase (λ)	1.26	1.24	1.22	1.21
Doubling time (DT)	2.99	3.18	3.56	3.67
Weekly multiplication rate (WM)	5.07	4.60	4.92	3.75
Gross fecundity (M_x)	316.13	223.44	251.33	259.33

These differences can be attributed to thermal adaptations to different geographical areas. The acclimatization of the pest population from distinct geographical areas may also be the reason for such differences. So it seems reasonable to speculate that the differences among the populations may be associated with their adaptation to their respective local climatic conditions. There is a difference in development (from neonate to adult) in the test insect when reared on different temperature (Golizadeh *et al.,* 2007). Other than environmental variability are vital components for nearby adjusting among allopatric areas and biological difference has been found along latitudinal gradient (Lee and Michall-Old, 2011). Since *P. xylostella*is exceptionally tolerant to various insecticides and it has been discovered that resistance is area specific, being identified with the host plants, social practices, insecticide application example and advancements in various geological areas (Mohan and Gujar, 2003). So learning of contrasts in *P. xylostella* population diverse geological areas could give understanding into population progression and be utilized adequately for precisely anticipating *P. xylostella* population advancement in various locations keeping in mind the end goal to choose techniques and basic planning for management as reported by Pan *et al.,* (2014) while studying such phenomenon in *P. xylostella* from five different geographical locations in China. Similar results were recorded for *P. xylostella* by Ram *et al.,* (2016), who reported difference in rm value in the five populations of diamondback moth collected from different regions having different altitudes viz. Hisar, Kangra, Solan, Theog and Kinnaur. The r_m value was found to be maximum (0.222 female progeny/female/day) for the Kangra, whereas for the Kinnaur, Theog, Solan and Hisar population it was 0.203, 0.202, 0.182 and 0.151 female progeny/female/day. Natural rate of increase (rm) would reflect many factors, for example, fertility, survival rate, and generation time. These qualities would satisfactorily summarize the physiological characteristics of a species in connection to its ability to multiply. To assess the performance of an insect, it would be a most suitable parameter (Southwood and Henderson, 2009). Since the biology fluctuates with land source, hereditary techniques, the relative rate of natural determination and hereditary separation ought to be utilized to investigate the topographical variation of *P. xylostella*.

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