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Effect of Host Plant on Biological Parameters of *Plutella xylostella* Under Laboratory Condition

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Abstract: Different *Brassica* vegetable crops and oil seed *Brassica* crops were applied to observe the biological parameters of *Plutella xylostella* under laboratory condition. The larval, pupal duration, pupal mass, percent larval pupating, percent survival to adult and fecundity were recorded. The shortest larval and pupal period was recorded on *Brassica camelina* and *Eurica sativus*, and the longest larval and pupal period was recorded on cabbage *Brassica oleracea* var. *capitata* and *Brassica oleracea* var. *botrytis*. Percent larvae pupating varied significantly, and percent survival to adult stage was also varied significantly. The highest survival rate was found on cauliflower *Brassica oleracea* var. *botrytis*. Pupal mass on different host plants varied significantly, the lowest on *Brassica napus* and the highest was on *E. sativus*. The highest fecundity was observed on rocked seed fed female. Nitrogen content of different host plant leaves were also varied considerably and had obviously correlative with the pupal mass and the fecundity.

Key words: *Plutella xylostella*; host plants; biology

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The diamond back moth *Plutella xylostella* (L.) (Lepidoptera: Plutillidae) is the most destructive insect of Cruciferous plants through out the world, and has been recorded from at least 128 countries or territories of the world^[1,2]. *P. xylostella*, is particularly wide-spread in South-East Asia due to the rapid turnover of generations (14–20 generations per year as compared with 2–7 generations in the temperate regions) under sub-tropical and tropical climatic conditions^[3]. Abro et. al.^[4] have found *P. xylostella* feeds only on plants of Cruciferae. Many of the plants of this family are cultivated as vegetables and oil seed crops. Numerous Crucifer plants not consumed by man, are considered weeds, are also consumed by *P. xylostella*, when its favoured hosts are absent and crucial link in maintaining *P. xylostella* populations^[2]. Glucosinolate such as sinigrin, sinlbin and glucosinolate provide specific feeding stimulates, while glucosinolate or its metabo-

lites, allylthiocyanates act as oviposition stimulants^[5,6].

Brassica vegetables especially cabbage *Brassica oleracea* var. *capitata*, cauliflower. *B. oleracea* var. *botrytis* and radish, *Raphanus sativus* are important crops of Sindh, Pakistan. The climate of southern Sindh (Hyderabad and Karachi regions) in mild and Cruciferous vegetables are almost grown through out the year around towns and cities by small scale farmers. *P. xylostella* has become a very serious problem and causes great economic loss to farmers. Present paper deals with the effect of biological parameters measured on different host species in detached leaf bioassay in Pakistan.

1 Material and method

Studies were carried out at the department of Entomology, Sindh Agriculture University Tandojam, Pakistan. Different *Brassica* vegetable crops and oil seed *Brassica*

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crops used in this study were *B. camelina*, *B. carinata*, *B. napus*, *B. alba*, *B. campestris*, *B. oleracea* var. *capitata*, *B. oleracea* var. *botrytis*, *Eurica sativus*, *Raphanus sativus*. *Brassica* crops were sown in completely randomized block design on ridges, oil seed crops were sown in a completely randomized block design with from 10 to 15 meter long rows for each crop during 1998. Leaves of different host plants were harvested from the field, leaf discs from each plant were kept in petridishes ($d=10.0$ cm) seperately and 10 newly hatched neonate larvae (10.0 hours old) were introduced with fine camel hair brush in to each petridish. This experiment was replicated five times. Biological parameters studies were larval and pupal duration, pupal mass, percent larval pupating, percent survival to adult and fecundity. Fresh food was provided to larvae and old food removed daily till pupation. One day after pupation pupal mass was recorded on electrical balance (Ohaus, Galay, 160). Pupal mass was recorded at random, of 25 to 30 for each host plant. At adult emergence, percent survival was recorded on various host plants. After adult emergence, one male and one female were paired and kept in a glass chimney ($h=17.0$ cm) with basal and upper openings as 7 and 8 cm diameter respectively for egg laying. A petridish ($d=10$ cm) was placed at the basal end of glass chimney and upper opening was covered with a muslin cloth tied with rubber band. A small leaf of cauliflower was kept in a beverage bottle lid impregnated on to cotton wool for provided to adults as a food. There were five replications per host plants obser-

vation on egg laying was recorded daily till the end of oviposition and death of females.

To determine the nitrogen content of different host plant leaves, samples of fully expanded full grown leaves weighting 500 g were harvested per treatment at random from experimental area. Plant leaves were harvested along with their petioles, samples were dissected in oven (Memmert, Germany) at 60 degree centigrade, then grounded into fine powder. The samples were digested with nitric acid and perchloric acid^[7]. Total nitrogen was determined by Kjeldahl method^[7] at the department of Soil Science Sindh Agriculture University Tandojam, Pakistan.

2 Result

2.1 Biological parameters of *Plutella xylostella* on different host species

The result (table 1) showed that the host plant species significantly ($F=27.93$, $d=9.18$, $P<0.001$) affected the larval development of *P. xylostella*. The shortest larval and pupal period was recorded as 10.47 and 8.28 days on *B. camelina* and *Eurica sativus* respectively, while the longest larval and pupal period was recorded on cabbage *B. oleracea* var. *capitata* and *B. oleracea* var. *botrytis*. Percent larvae pupating varied significantly ($F=45.21$, $df=9$, $P<0.01$) on different host species. Similarly percent survival to adult stage was also significantly ($F=45.21$, $df=9$, $P<0.01$) and ranged between 62% to 88%. The highest survival was found on cauliflower.

Tab. 1 Biological parameters of *Plutella xylostella* measured on different host species in a detached leaf bioassay¹⁾

host species	larval duration/d	rate of larval pupating/%	pupal duration/d	rate of survival to adult/%
<i>Brassica camelina</i>	10.47±0.16a	68.0±0.58a	8.50±0.21a	62.0±0.58a
<i>Brassica napus</i> var. <i>canola</i>	11.32±0.14bc	74.3±1.20b	8.71±0.18a	74.3±1.20bc
<i>Brassica carinata</i>	10.65±0.14a	80.7±0.33c	8.79±0.21a	68.0±0.33ab
<i>Brassica campestris</i>	10.62±0.11a	80.7±2.18c	8.51±0.23a	76.30±2.18cd
<i>Brassica alba</i>	10.80±0.11a	90.7±2.18d	8.65±0.13a	84.0±2.18e
<i>Brassica oleracea</i> var. <i>capitata</i>	11.64±0.13cd	88.0±2.18d	9.33±0.18a	82.0±2.18de
<i>Brassica oleracea</i> var. <i>botrytis</i>	12.11±0.11e	88.7±0.58d	9.36±0.13a	84.7±0.58e
<i>Brassica napus</i>	11.84±0.11e	90.0±0.18d	9.36±0.23a	88.0±2.18e
<i>Eurica sativus</i>	11.22±0.08b	90.0±2.85d	8.28±0.14a	84.0±2.18e
<i>Raphanus sativus</i>	11.80±0.15de	70.7±2.20ab	8.94±0.24a	70.0±2.20bc

1) Mean±SE followed by the same letter within a column are not significantly different from each other ($P<0.05$; LSD method)

2.2 Effect of host plant nitrogen content on pupal mass and fecundity of *Plutella xylostella*

The results of host plant nitrogen content, pupal mass and fecundity of *Plutella xylostella* were listed in Table 2.

The percent nitrogen content of different host plants varied considerably and it ranged between 3.47% and 4.84%. Pupal mass of *P. xylostella* developing on different hosts also varied significantly ($F=150.0$, $df=9$, P

<0.01). The lowest pupal mass was recorded (5.68 mg) on *B. napus*, while the highest (7.54 mg) on *E. sativus* (rocket seed). The linear regression formula, $Y=4.0927+0.6505N$ ($R^2=0.4772$), was given out between average pupal mass of *P. xylostella* and percent nitrogen content of host plants after test. N and Y meant percent nitrogen content of host plants and pupal mass of *P. xylostella* respectively.

Tab. 2 Effect of host plant nitrogen content on pupal mass and fecundity of *Plutella xylostella* under laboratory¹⁾

host species	nitrogen/ %	pupal mass/ mg	fecundity per female/ eggs
<i>Brassica camelina</i>	3.67	6.60±0.24b	112.33±41.03a
<i>Brassica napus</i> var. <i>canola</i>	3.47	5.68±0.20b	
<i>Brassica carinata</i>	4.0	6.54±0.25b	88.67±25.49a
<i>Brassica compestris</i>	4.81	6.66±0.20b	
<i>Brassica alba</i>	3.78	6.94±0.22bc	108.75±27.26a
<i>Brassica oleracea</i> var. <i>capitata</i>	3.64	6.78±0.15b	
<i>Brassica oleracea</i> var. <i>botrytis</i>	3.66	6.50±0.17b	80.25±3.14a
<i>Brassica napus</i>	4.64	7.18±0.22c	
<i>Eurica sativus</i>	4.84	7.54±0.19d	165.50±13.74a
<i>Raphanus sativus</i>	4.34	7.15±0.21c	

1) Mean±SE followed by the same letter within a column are not significantly different from each other ($P<0.05$; LSD method)

The correlation studies carried out between percent nitrogen content and fecundity revealed a highly significant ($P<0.05$) respectively. The lowest fecundity was recorded (80.25 eggs) on *Brassica oleracea* var. *botrytis*. The highest fecundity was also recorded from rocket seed *Eurica sativus* fed female which was 165.5 eggs/female. The linear regression model was built up as follow: $Y=-118.5740+57.5625N$ ($R^2=0.7330$). In that model N meant percent nitrogen content of host plants, and Y was fecundity of *P. xylostella* female.

Fecundity per female of *P. xylostella* was obviously different when they emerged from different mass pupae. The lowest fecundity was recorded (80.25 eggs) when average pupal mass was 6.50 mg on *Brassica oleracea* var. *botrytis* while the highest fecundity 165.5 eggs / female when average pupal mass was 7.54 mg on *Eurica sativa*. The linear regression equation was revealed as follow: $Y=-379.420+71.881X$ ($R^2=0.8904$). In that model Y and X meant fecundity per female and pupal mass of *P. xylostella* respectively.

3 Conclusion and discussion

Adult longevity varies considerably depending upon

many factors such as adult food^[8,9], for example, Hasanein^[10] reported average life span of males and females *P. xylostella*, 6.3 to 15.4 and 5.7 to 10.3 days respectively. Ho^[11] observed that mated males and females lived for an average of 16.5 and 15.4 days respectively.

In the present study, cauliflower and cabbage were found to be better hosts for *P. xylostella* completing larval period in short time compared with other hosts. Chand, et al^[12] noted that *P. xylostella* attached all the Cruciferous plants it exhibited a marked preference for cauliflower and cabbage. These two plants possess fleshy succulent leaves that provide both olfactory and gustatory stimuli. Ramchandran et. al.^[13] also found significant differences in biological parameters of *P. xylostella* feeding on different *Brassica* spp. leaves. Present studies also show the highest *P. xylostella* survival when fed on cauliflower followed by cabbage, almost similar observation are recorded by other workers^[14,15]. A correlation carried out between pupal mass and fecundity regression equation indicated that *P. xylostella* fecundity increased at a rate of 71.88 and 85.61 eggs for each milligram increase in pupal mass. Yamada and Umeya^[16] concluded that fecundity was determined by pupal size. Williams^[17] observed that the corre-

lation between pupal mass and fecundity was greater than that between pupal length and fecundity in *Chilo sacchariphagus*.

A correlation between nitrogen content of leaves and fecundity gave a highly significant correlation ($r=0.856$) value. The nitrogen concentration present in host plants is frequently a key factor in determining the growth and survival of herbivores^[18]. Increased level of plant nitrogen may have beneficial nutritional effects on insects. In present study correlation studies between percent nitrogen and pupal mass and percent nitrogen content and fecundity of insects showed a significant positive relationship. Pupal mass percent nitrogen content of leaves regression analysis indicated that *P. xylostella* pupal mass increased at a rate of 0.658 mg for each percent increase in nitrogen content of host leaves. Similarly regression analysis of percent nitrogen content and fecundity of *P. xylostella*, showed that every percent nitrogen content of leaves contributed 57.60 eggs to the fecundity of females. There are studies reported in literature which confirm and support these findings, for example, van Emden et. al.^[19] found that the fecundity of *Brevicoryne persicae* varied greatly and was correlated with total soluble nitrogen in *Brassica* sprout leaves of the same age. The growth, reproduction and survival of phytophagous insects are positively correlated with nitrogen content in their food^[18,20]. The tissue of the cruciferous plants characteristically contain one or more of a group of substances called the mustard oil of alkyl isothiocyanates, sinigrin, one of the alkyl isothiocyanates, and a constituent of some of the host plants of *P. xylostella* furnishes a specific and potent stimulus which is presence of suitable nutrients induces sustained feeding in insects^[21]. Similarly these glucosinolates also provide necessary oviposition stimuli to the females *P. xylostella*^[6]. The growth and development of *P. xylostella* varied considerably on different host plants in present study which may be due to presence of nutritional and phagostimulant factors in the most appropriate ratio for optimal growth and development of *P. xylostella* in some of its host plants compared with others.

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寄主植物对小菜蛾实验种群生物学参数的影响

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摘要: 实验观察了小菜蛾取食不同种白菜和油菜的主要生物学参数, 包括幼虫、蛹的历期、蛹质量、化蛹率、羽化率和雌虫产卵量。结果表明: (1) 取食苔菜(*Brassica camelina*) 幼虫历期最短, 取食花椰菜(*B. oleracea* var. *botrytis*) 幼虫历期最长; (2) 取食不同蔬菜化蛹率变化明显, 其中以白芥(*Brassica alba*) 最高达 90.7%, 羽化率变化很大, 以欧州油菜(*Brassica napus*) 最高达 84%; (3) 蛹质量也因寄主不同而异, 取食蔬菜 *B. napus* 最低为 5.68 mg, 取食香花芥菜(*E. sativus*) 最高为 7.54 mg; (4) 取食香花芥菜雌虫产卵量最高为 165.50 粒; (5) 蛹质量和寄主含氮量, 产卵量和寄主含氮量, 产卵量和蛹质量分别相关性显著, 并建立了回归方程分别为: $Y = 4.0927 + 0.6505N$, $Y = -118.5740 + 57.5625N$ 和 $Y = -379.420 + 71.881X$ 。

关键词: 小菜蛾; 寄主植物; 生物学

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简讯

2001 年度《华南农业大学学报》优秀论文评选揭晓

2002 年华南农业大学对 2001 年度刊登在《华南农业大学学报》的论文进行了优秀论文评选, 在本次评选活动中, 共评选出了 5 篇优秀论文, 由学校给予物质和精神的奖励。本次获奖名单如下(排名不分先后):

1. 陈雄辉, 万邦惠, 陆燕鹏, 彭海峰, 梁克勤, 赵静. 光温敏核不育水稻异交结实潜力的研究. 2001, 22(1): 1—4.
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