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LIFE TABLE ANALYSIS AND EXTENT OF DAMAGE CAUSED BY *SPODOPTERA EXIGUA* (NOCTUIDAE: LEPIDOPTERA), A SERIOUS PEST

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ABSTRACT

Agriculture is the baseline for uplift of economic sources for any country. But every year many hectares of the cropland area are damaged by herbivore insects. Among these herbivore insects, *Spodoptera exigua* is a serious pest of agricultural land. It damages almost 90 plant species. In the present study analysis of each life stage of *S. exigua* was carried out by providing four host plants namely, Cauliflower, Cabbage, Brassica and Turnip. Experiment was conducted at 20 ±5˚C temperature, 60±5 relative humidity and 16:8 light and dark duration. Total food consumption was 14.01 ± 0.61 g on cauliflower, 11.65±0.07g on Cabbage, 5.41±0.19 on Brassica and 4.92±0.5 on turnip. Maximum larval duration was also recorded on cauliflower (14.00±0.47 days). The longest pupal duration was recorded for the larvae fed on turnip (14.00±0.82 days). Overall cauliflower was significantly preferred food ($p<0.001$) for *S. exigua*. The current study is a prerequisite for establishing effective control measure against this serious pest.

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INTRODUCTION

Beside many factors that are causing food losses, lepidopteran pests are one of them. The agriculture sector is the most important economic hub of any country as it provides food security, employment and brings economic profit to any country (Azam and Shafique, 2017). But many insect pests are competing with human beings for food resources and among them larval stages of Lepidoptera are most pronounced (Oerke and Dehne, 2004). Larvae of Lepidoptera called as caterpillar have chewing mouth parts and eat gregariously almost every part of plant (Krenn, 2010). *Spodoptera exigua* (Lepidoptera: Noctuidae) is commonly known as beet armyworm and has gained much importance due to its poly-phytophagous behavior. It is a cosmopolitan pest of many tropical, subtropical and south Asian regions (Dáder*et al*., 2020; Elvira *et al.,* 2010; Zheng *et al.,* 2000). 35 plant families and approximately 170 plant species are infested by this pest (Hafeez *et al.,* 2022; Bragard *et al.,* 2019; Mardani-Talaei *et al*., 2014). This insect pest species was originated in South Asia, but its outbreaks and economic damages has been spread in Africa, Asia, America and Europe. Due to its migratory behavior the infestation rate and damage capacity has worsen in many countries including Pakistan (Wang *et al.,* 2022; Saeed, 2010). Diversity, spatio-temporal population dynamics, distribution and density of *S. exigua* is influenced by the availability of suitable host plant (Babu and Singh, 2021; Saeed *et al.,* 2017). Host plant species have influence on biological, developmental and ecological susceptibilities of insect pests. This relationship between *S. exigua* and its potential extent of causing damage on host plants provide fundamental knowledge for devising impactful pest control measures (Nurkomar *et al.,* 2023; Mookiah *et al.,*

2022; Peterson *et al.,* 2016; Khaliq *et al.,* 2014). The suitability of host plant for insect pest depends upon the capability of completing its life stages on that specific host plant (Rajesh Chowdary *et al.,* 2024). To determine the relationship between plant and herbivorous insects, quantitative analysis of food consumption by phytophagous insects is very important. Effective rearing methodology of insects can provide significant knowledge about rate of host plant consumption, plant infestation rate and extent of damage caused by the insect pest. All this knowledge will be valuable for designing effective control measures against herbivory insects (Greenberg *et al.,* 2001). The present study aims to evaluate the feeding efficacy and magnitude of damage caused by *S. exigua* in agro-ecosystem of selected regions.

MATERIALS AND METHOD

Insect Collection

Egg masses and first instars of *S. exigua* were brought to Pest control laboratory of University of Agriculture Faisalabad. Egg masses were identified by the presence of clusters of rounded dirty white eggs.

Insect Rearing

Egg and first instar stages of *S. exigua* were kept in insect rearing glass cages with measurement of 30 × 30 × 32 cm. each box has wooden boundaries and proper two windows covered with fine net for proper ventilation. In each cage 5 specimens were kept and provided with pre weigh crop plant as diets. Thus 4 cages were used for all the four diets viz., cabbage, cauliflower, brassica and turnip with three replicates and 1 control group for each plant. A total of 15 cages were used in the experiment. In control group the same food was placed without larvae to calculate the evaporative loss. After 24 hours the remaining food and excreta were removed and again provided with fresh pre weigh food. Remaining food and the food placed as control group was also weighed. Feeding efficiency was determined by calculating the difference between initially provided food, water loss due to evaporation in control group and remaining food (Khosravi *et al.,* 2010).

The same practice was done regularly until all larvae converted into pupae. At the pupal stage larvae stopped feeding and enclosed in a puparium. All pupae were weighed. By dividing mean pupal weight and mean food consumption, feeding index was calculated (Shen *et al*., 2006).

Adult Emergence

When adults emerged from pupae, they were shifted to another box to check the longevity adults were provided with cotton balls soaked in 20% honey solution and fresh flowers.

Experimental Conditions

For whole experiment environmental conditions were kept same i.e., 20±5˚C temperature, 60±5 relative humidity and 16:8 light and dark duration.

Statistical Analysis

Food consumption by larvae on each host plant and mean ± SD was calculated on MS Excel 2013. While one way analysis of variance (ANOVA) was applied to observe the level of significance in feeding efficacy and per day food consumption of larvae.

RESULTS AND DISCUSSION

Per Day Food Consumption

Table 1 indicates the food consumption rate on each day by *S. exigua* larvae. It was maximum 1.48± 0.06 g on 12th day for cauliflower. For cabbage maximum food was consumed on 10th day (1.29± 0.01 g) while for brassica and turnip maximum consumption was on 8th day (0.85 ± 0.03 g) and on 7th day (0.7 ± 0.05 g).

Average Per Day Consumption

Maximum average consumption by *S. exigua* was on cauliflower (1 ± 0.01 g) and least average consumption was for brassica (0.54 ±0.05 g) (Table 1).

Total Consumption

Figure 1 represents that the most preferred diet for *S. exigua* was cauliflower (14.01 ± 0.61 g total consumption) while turnip was least preferred (4.92 ± 0.5g total consumption). On cabbage and brassica total food consumption was 11.65± 0.07g and 5.41± 0.19 g. Table (2) also indicated that cauliflower was significantly preferred diet with $p< 0.00$.

Pupal Weight

The larvae fed on turnip exhibited lowest pupal weight 0.12 ± 0.02 g while the larvae that consume cauliflower showed maximum pupal weight (0.43 ± 0.05g) (Figure 2).

Percentage of Adult Emergence

Adult emergence percentage was 70 for cauliflower, 65 for cabbage and 55 for turnip and brassica (Table 3).

Table 1. Food consumption on four host plants (Cauliflower, Cabbage, Brassica and Turnip) by *S. exigua*.

Days	Cauliflower(g) Mean ± SD	cabbage(g) Mean ± SD	Brassica(g) Mean ± SD	Turnip(g) Mean ± SD
1	0.4±0.08	0.47±0.05	0.27±0.04	0.33±0.05
2	0.54±0.07	0.63±0.05	0.38±0.01	0.5±0.08
3	0.68±0.02	0.82±0.06	0.42±0.01	0.59±0.08
4	0.74±0.02	0.97±0.01	0.56±0.01	0.63±1.51
5	0.89±0.04	1±0.01	0.62±0.01	0.66±0.08
6	1.14±0.03	1.08±0.02	0.68±0.03	0.65±0.07
7	1.22±0.03	1.12±0.02	0.73±0.03	0.70±0.05
8	1.26±0.04	1.19±0.01	0.85±0.03	0.51±0.01
9	1.31±0.02	1.25±0.03	0.63±0.10	0.35±0.06
10	1.36±0.04	1.29±0.01	0.41±0.10	
11	1.41±0.02	1±0.08		
12	1.48±0.06	0.67±0.13		
13	1.03±0.13			
14	0.53±0.13			
Total consumption(g)	14.01±0.16a	11.65±0.07b	5.41±0.19c	4.92±0.5c
Per day consumption(g)	1.00a	0.97b	0.54c	0.55c
Pupal weight(g)	0.43	0.31	0.21	0.12
Feeding index	0.03a	0.03a	0.04a	0.02b

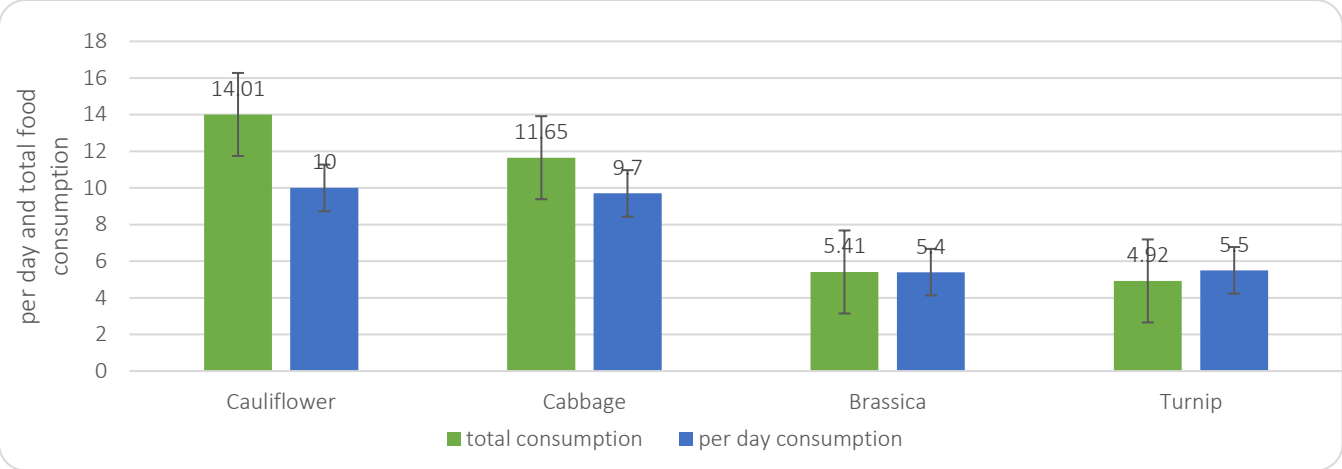
Table 2. Analysis of variance (ANOVA) for feeding efficiency and per day food consumption of *S. exigua* on four crops.

Source	DF	SS	MS	F	P
Total consumption(g)	3	184.94	61.65	624.02	0.001**
Error	8	0.79	0.10		
Total	11	185.73			
Per day consumption(g)	3	0.53	0.178	131.74	0.001**
Error	8	0.01	0.01		
Total	11	0.54			

**significant results.

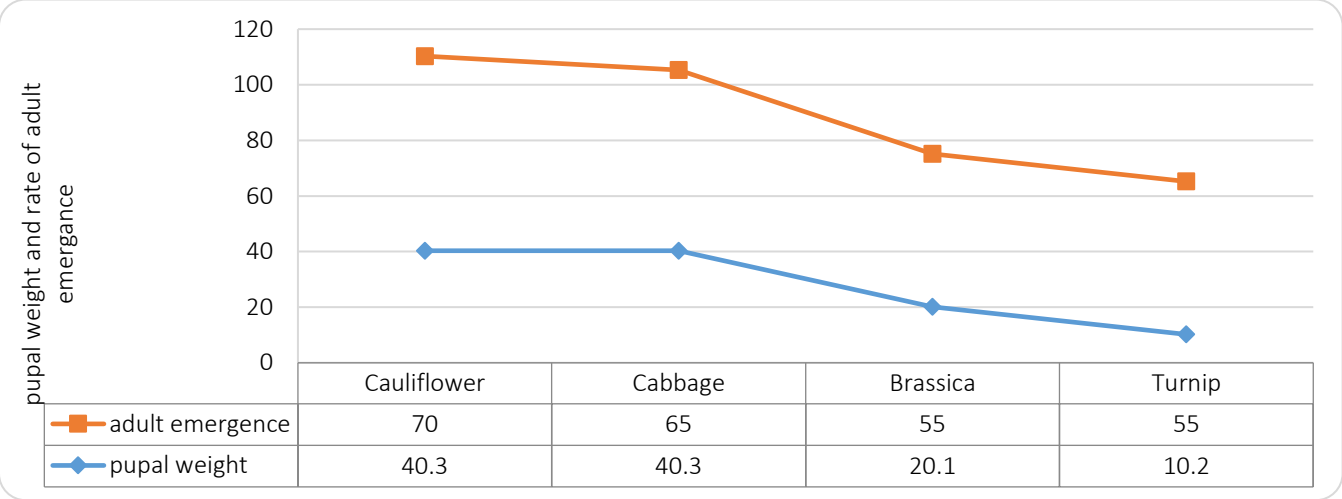
Table 3. Mean duration and mean length of each life stage of *S. exigua* recorded on four crops.

Life cycle	Cauliflower	Cabbage	Brassica	Turnip
Larval Duration(days)	14.00±0.47a	12.33±1.70b	9.50±0.50c	9.00±0.00c
Length(mm)	35.40±0.00a	32.40±0.10b	28.30±0.47c	15.73±0.46d
Pupal Duration(days)	9.00±0.82b	10.00±0.05b	13.30±0.94a	14.00±0.82a
Length(mm)	18.33±0.47a	17.33±0.47a	15.57±0.49b	15.40±0.43b
Adult Duration(days)	4.33±0.47a	4.00±0.81a	4.33±1.25a	4.00±0.00a
Length(mm)	26.00±0.47a	24.67±0.82b	23.00±0.82b	21.33±1.25c
Total duration(days)	27.33±9.93a	26.33±9.45a	26.83±9.62a	27.00±9.88a
% emergence	70a	65b	55c	55c



*Per day consumption is multiplied by 10 to make the relationship visible.

Figure 1. Total food consumption (g) and per day food consumption (g) rate on Four all four crops by *S. exigua.*



	Cauliflower	Cabbage	Brassica	Turnip
adult emergence	70	65	55	55
pupal weight	40.3	40.3	20.1	10.2

Pupal weight is multiplied with 10 to make it visible.

Figure 2. Pupal weight and percentage of adult emergence of *S. exigua* on four host plants.

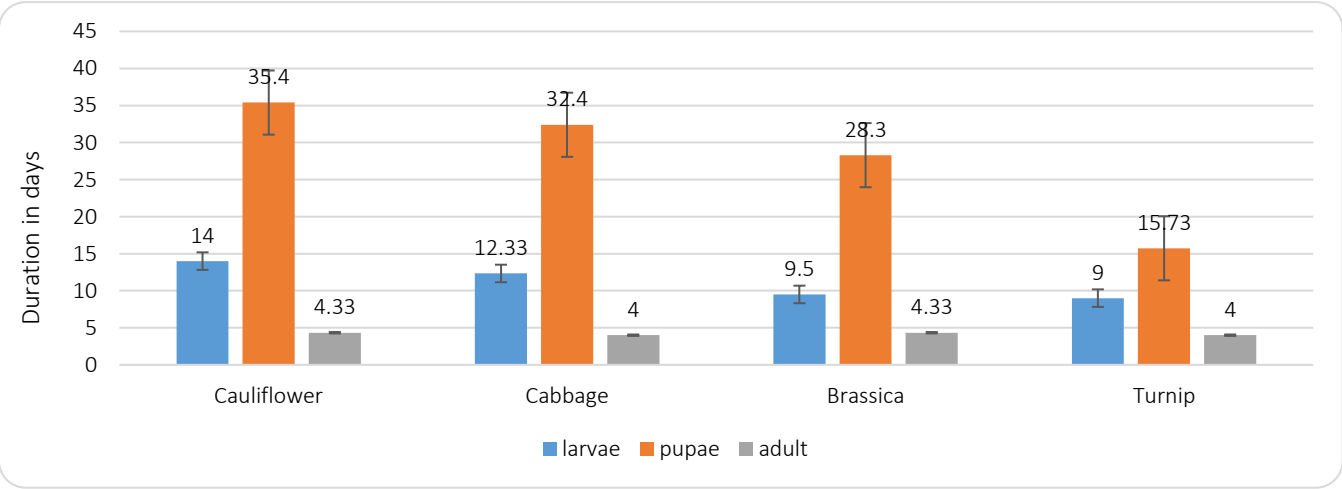


Figure 3. Larval, pupal and adult duration (in days) of *S. exigua* on four crops.

Longevity of each Life Stage

Maximum larval duration was 14.00 ± 0.47 days on cauliflower and 9.00 ±0.00 days being minimum duration on turnip. Least pupal duration was attained by the larvae that fed on cauliflower (9.00 ± 0.82 days) while on turnip maximum pupal duration was recorded (14.00 ±0.82 days). Adult longevity was recorded maximum on cauliflower (4.33 ± 0.47 days) and brassica (4.33 ± 1.25 days) while on cabbage and turnip adult duration was 4.00 ±0.18 days and 4.00 ±0.00 days, respectively (Figure 3).

Mean Body Length of each Stage

Least larval length was attained by the larvae that fed on turnip (15.73 ±0.46 mm) while maximum larval length was recorded for cauliflower (35.4 ±0.00 mm). Similarly maximum pupal length was also found on cauliflower 18.33±0.47mm. Adult body length was 23.00 ±0.81 mm, 26.00 ±0.47 mm, 24.67±0.82 mm and 21.33±1.22 mm for brassica, cauliflower, cabbage and turnip, respectively (Table 3).

In the present study different life parameters like larval duration, pupal length, adult longevity and feeding efficiency of *S. exigua* was evaluated by providing Cauliflower, Cabbage, Brassica and turnip as natural diet. (Azidah and Sofian, (2006a); Azidah and Sofian, (2006b); Azidah and Sofian, (2007) has also conducted similar kind of research to study the effect of host plant on life cycle of *S. exigua*. Mehrkhoua *et al., (*2012) also conducted a study to analyze the life cycle and feeding habits of *S. exigua* for different cultivar of Soybeans. In the present study cauliflower was the most preferred natural host plant for larvae of *S. exigua*. Idris and Emelia, (2001); Naseri *et al.,* (2009) reported that different life stages are correlated with provided host plants. Larval length was also maximum on cauliflower and minimum on turnip as it was least consumed diet. Larval duration and pupal period also correlated with feed preference. These nutritive components and various metabolites present in host plants cause the variation in developmental patterns (Faheem *et al,* 2021). As cauliflower was much consumed food, larval duration was also maximum on this and pupal duration was shortest for cauliflower Abdullah *et al.,* (2017) and Sivapragasam and Syed (2001) reported same kind of results. The shortest pupal duration on cauliflower is due to the nutritive components of this host plant. Biological parameters of insect population are influenced by the nutritional components gained by host plant in larval stages. Particularly the lepidopteran larvae that consume nutrient rich host plants exhibit rapid growth rate and complete the life cycle as compared to those larvae that feed on less nutritional host plants (Nurkomar *et al.,* 2023; Wang *et al.,* 2022). While turnip was the least preferred diet so larval duration was minimum and pupal duration was maximum on turnip. Similarly adult emergence and adult longevity were also related with consumed diet (Idris and Leong, 2001). Larvae that fed more food attain longer adult life and vice versa. Exploration about life table analysis and pest behavior about plant consumption is a prerequisite step towards pest control management (Jallow and Matsumura, 2001). Current study provides a baseline knowledge about larval duration, food consumption rate, pupal period and adult longevity of *S. exigua* on natural host plant. The estimation of crop loss due to *S. exigua* and growth patterns of different host plants has worth value to make effective pest control strategies.

CONCLUSIONS

To control polyphagous insect pests, a comprehensive study about the life cycle of pest and preferred host plants can provide fundamental knowledge to control this pest.

CONFLICT OF INTEREST

The authors declared that they have no conflict of interest.

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