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Research Article

GROWTH PARAMETER INDICES OF CUT WORM LARVA *Spodoptera litura* (Fab.) ON VARIOUS HOST PLANTS

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Abstract- An experiment was conducted to find the effect of five host plants *viz.,* chickpea, castor, chillies, mulberry and parthenium, on the consumption, growth, digestibility and conversion efficiency of ingested and digested food of *Spodoptera litura* (Fab.) larva at the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during 2012. Among the plants tested, food consumption and excretion was found high in castor. Average consumption index of *S. litura* grown in chickpea, mulberry, parthenium, chillies and castor were found to be 3.889, 3.343, 3.262, 2.825 and 3.079 respectively. Higher growth rate was found when larva was fed with chickpea (0.474) and the least being 0.450 in castor. Early instar larva fed with chickpea was found to have higher digestibility (90.811) and it was least in weed plant, parthenium (88.110). Late instar larva of *S. litura* fed with chick pea was found to convert 7.452% of ingested food into its body mass whereas it was only 5.087% when fed in castor. The efficiency of conversion of digested food of *S. litura* larva fed with chickpea was least at early instars (12.450) whereas it was the highest during the late instars (7.994). Chickpea with highest average consumption index, growth rate and digestibility was found to be the best host plant. Further, efficiency of conversion of ingested and digested food of late instar larva was also found high in chickpea.

Keywords- *Host plants, Food, Consumption, Utilization, S. litura*

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Introduction

The leaf caterpillar, *Spodoptera litura* (Fab.) is a phytophagous insect of polyphagous nature, damaging numerous field and horticultural crops. Though it is commonly known as the tobacco caterpillar / cut worm, it is reported to have more than 120 host plants including field crops, vegetables, ornamental plants and weeds which cover over 40 families [1-4]. Although it had been a sporadic pest of tobacco for many years, it has been gradually becoming a very important insect pest in the recent past in many other crops [5,6]. The pest causes economic losses of crops from 26 to 100 per cent based on the crop stage and its infestation level in the field [7,8]. The main crop species attacked by *S. litura* in the tropics are cotton, groundnut, pulses, maize, rice, castor, soybean, sunflower, jute, tobacco, lucerne, flax, colocasia, tea and vegetables like brassica, capsicum, cucurbits, bean, potato, sweet potato, tomato, brinjal, greens, banana etc.

Host plant is a key determinant of the establishment, growth, survival and fecundity of herbivorous insects. Though many host plants were reported for *S. litura*, every host does not support the pest in the same way. There have been a number of studies on the biological parameters of *S. litura* on different host plants under different environmental conditions, particularly in India [9,10], Pakistan [11], China [12,13], Korea [14, 15] and other Asian countries [16,17] where *S. litura* has been an important pest on various crops. But the larval survival and pupation rate were reported to vary greatly on different host plants, ranging from 100 per cent on *Ricinus communis* L. to 44.3 per cent on ground nut [18]. The developmental period was the longest in tobacco followed by sweet potato, cowpea and Chinese cabbage [19]. The larval development was significantly decreased to 15.5 days when fed on cabbage compared with cowpea (19.5 d) and alligator weed (20.2 d) [20].

Many studies concluded a significant difference in larval feeding, growth, food consumption pattern and utilisation by *S. litura* larva when fed with different host plants. Thus, there is some nutrient or essential component in the food it takes, which supports the insect for its preference, growth and survival. The host plant that support pest and make it to attain maturity in a short duration may be regarded as the best but it should have made insect healthier also. Consumption of food is one such criteria of a healthy larva but it is not enough to consume food but should have contributed to its growth rate. Finding the digestibility is a criterion to know the food consumed, get digested or not *i.e* utilised or not. Here also, the process of food utilisation does not end with digestion but absorption and conversion of absorbed nutrients into body matter which can be analysed by calculating the efficiency of conversion of ingested/ digested food.

If a host plant attracts an insect to feed on it by presenting itself as a preferred host and also gives nutrients for digestion and utilisation of it into its body mass can be regarded as the best host plant for successful survival of the pest. Studies on effect of host plants on the biology of insect are important in understanding host suitability of plant infesting insect species. This also forms the basis for an important management technique known as trap crop strategy. Keeping these aspects in view, an investigation was made to know the host preference and food consumption and utilisation of *S. litura* in five different plants *viz*., chickpea (*Cicer arietinum* L.), castor (*Ricinus communis* L.), chillies (*Capsicum annuum* L.), mulberry (*Morus alba* L.) and parthenium (*Parthenium hysterophorus* L.).

Materials and Methods

Investigations were conducted at the Insectory of Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during 2012 to find

the host preference, food consumption and utilization of leaf caterpillar *S. litura* in five different host plants under ambient room temperature. *S. litura* egg masses were originally collected from castor plant and laboratory reared larva was used for the studies. Four days after hatching, larvae were weighed (ten larva) using an electronic balance and transferred in five different containers having five different pre weighed host plants *viz*., chickpea, castor, chillies, mulberry and parthenium. Ten replications were maintained for each treatment and the host plants were grown in pots without any chemical sprays.

Observations on food consumption and excretion

The larvae were allowed to feed on different host plants for four days. On fourth day of feeding (eighth day of emergence) observations were made on the quantity of food consumed, excreta voided and the weight gained by larvae using an electronic balance. Then larvae were given with fresh and pre weighed food of different host plants. The growth and nutritional indices were determined using standard formulae. Again larvae were allowed to feed for another three days in their respective host plants. On third day (eleventh day of emergence) observations on the above said parameters were taken and growth and nutritional indices were calculated. On the 18th day of emergence all larvae were found to become pupa. The weight of pupa formed from the larvae, fed with different host plants were weighed individually using an electronic balance.

Indices used for calculation and analysis

Various indices of food consumption and utilization were calculated as proposed by [21] and as followed by many authors such as [22-24] for different insects. The different indices used for calculating of consumption and utilization of food by *S. lutura* larva in different hosts are as follow:

A. Consumption index (CI) = $\frac{\text{Weight of food consumed}}{\text{Duration of feeding period (days) x Mean larval weight during the feeding period}}$

B. Growth rate (GR) = $\frac{\text{Fresh or dry weight of animal}}{\text{Duration of feeding period (days) x Mean larval weight during the feeding period}}$

C. Approximate digestibility (AD) = $\frac{\text{Weight of food ingested – Weight of faeces}}{\text{Weight of food ingested}} \times 100$

D. Efficiency of conversion of ingested food into body matter (ECI) = $\frac{\text{Weight gained by the larva during feeding period}}{\text{Weight of food consumed}} \times 100$

E. Efficiency of conversion of digested food in to body matter (ECD) = $\frac{\text{Weight gained during feeding period}}{\text{Weight of food ingested – Weight of faeces}} \times 100$

Statistical Analysis

The raw data were subjected to statistical analysis. Standard error was calculated for original values and given in the respective tables. The values are further subjected to analysis of variance (ANOVA) using completely randomised design (CRD). The mean values of treatments were then separated by least significant difference (LSD) using AGRES software in ANOVA package for researchers, version 7.01, Pascal Intl. Software Solutions.

Results and Discussion

Body mass of *S. litura* reared in different hosts

The weight gained by *S. litura* larvae fed with different host plants is given in [Fig-1]. Weight of ten larva of *S. litura* fed in castor on fourth day of emergence was 0.138 g which was increased to 4.426 g on eighth day and further to 7.250 g on the eleventh day when it reaches sixth instar. The weed plant, parthenium also supported the growth of *S. litura* and thus the larva reached 3.326 and 6.660 g on eighth and eleventh days, respectively from 0.1258 g when it was four-day old. The body weight of the larva reared in chickpea was the least of all hosts tested. The weight of single larva of *S. litura* reared in castor on fourth day of emergence was 0.014 g which was increased to 0.725 g on the eleventh day when it reaches the sixth instar. The present study revealed a difference in pupal weight with a range of 0.42 to 0.50 g when larval stage was fed with different host plants. But [10] reported pupal development and pupal weight will not be affected by host plants on which their larvae fed. Other reports showed difference in pupal weight when larva reared in different hosts [19].

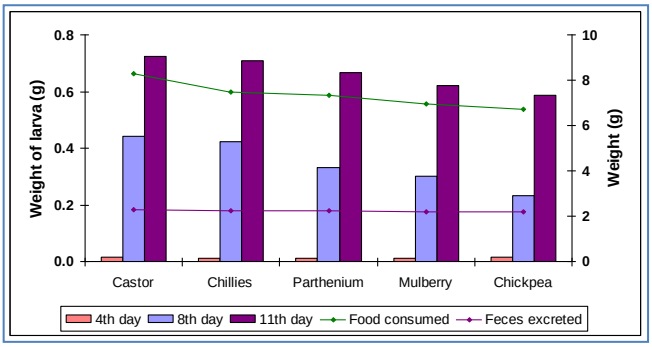

Fig-1 Growth of *S. litura* larva, its consumption and defecation in different host plants

Food consumption and excretion in *S. litura* reared in different hosts

The food consumed by larva of *S. litura* for four days (fourth to eighth day of emergence) was about 1.937, 2.732, 2.221, 2.111, and 1.912 of chickpea, castor, chillies, parthenium, and mulberry respectively [Table-1]. Among the five host plants, food consumption in castor was found to be high *i.e*, 2.732 and 5.543 g for early and late instar larva, respectively. Food consumption was the lowest in mulberry and chickpea which recorded 1.912 and 1.937 for early instar larva, which were not significantly different with each other. Earlier, [25] also attributed that food consumption in castor as high and mint as the lowest when studied with five different host plants.

Like food consumption, the amount of excretion was also more in larvae reared on castor *i.e.* 0.291 and 0.496 g for early and late instar larva, respectively measured on eight and eleventh day of emergence, which is significantly higher than the other treatments. The weight of feaces of the early instar larva grown in parthenium was found to be more than of chillies, even though the weight of food consumed in parthenium was found lesser than chillies. The amount of excretion of late instar larva measured on eleventh day was 0.32, 0.496, 0.465, 0.436 and 0.353 when reared in chickpea, castor, chillies, parthenium, and mulberry respectively.

Food utilization in *S. litura* reared in different hosts

The food utilization in *S. litura* larva reared in different hosts was analyzed using various indices *viz.,* consumption index, growth rate, approximate digestibility, efficiency of conversion of ingested food and efficiency of conversion of digested food and the details of these indices are given below.

Consumption Index

The food consumed by *S. litura* reared in different host plants was found to vary from 1.912 to 2.732 g per larva in the early instars and 4.764 to 5.543 g per larva in its later instars. The mean weight of the larva was found to be high when reared in castor (0.228 g) followed by chillies (0.217 g) and the least being in the chick pea (0.124 g) at its early instars. The same trend was noticed in the late instar larva also where heavier larvae were measured in castor followed by chillies,

parthenium, mulberry and chickpea. The consumption index of early instar larva of *S. litura* reared in chick pea was the highest (3.905) followed by parthenium (3.050), mulberry (3.044) castor (2.995) and chillies (2.558). The consumption index of the later instar larva grown in chickpea, mulberry, parthenium, castor and chillies were found to be 3.873, 3.642, 3.474, 3.163, 3.093 respectively [Table-1]. In an experiment conducted by [25] with five host plants *viz*., castor, cotton, tomato, mint and cabbage the highest consumption of food and weight gain was observed in larvae fed on castor. The relative consumption rates were reported highest when the larvae fed on sweet potato (3.90), followed by that on cowpea (3.16), then on Chinese cabbage (2.28), and the lowest on tobacco was attributed by [19]. In the present study, the consumption index which is the ratio of food consumption and mean weight of animal, revealed chickpea as the best host with the highest consumption index of (3.905) followed by parthenium (3.050), mulberry (3.044) castor (2.995) and chillies (2.558) for early instars. The consumption index of the later instar larva grown in chickpea was again the highest (3.873) among the five host plants tested.

Table-1 *Consumption index of Spodoptera litura in different host plants*

Hosts	Early instar (upto 8 days)				Late instar				Average Consumption Index (CI)
	Weight of food consumed (g)	Mean weight of larva (g)	Duration of feeding (days)	Consumption Index	Weight of food consumed (g)	Mean weight of larva (g)	Duration of feeding (days)	Consumption Index	
Chickpea	1.937^{c}	0.124^{c}	4	3.905	4.764^{c}	0.410^{cd}	3	3.873	3.889
Castor	2.732^{a}	0.228^{a}	4	2.995	5.543^{a}	0.584^{a}	3	3.163	3.079
Chilly	2.221^{b}	0.217^{a}	4	2.558	5.244^{b}	0.565^{ab}	3	3.093	2.825
Mulberry	1.912^{c}	0.157^{b}	4	3.044	5.037^{bc}	0.461^{c}	3	3.642	3.343
Parthenium	2.111^{b}	0.173^{b}	4	3.050	5.201^{b}	0.499^{b}	3	3.474	3.262
CD at 0.05	0.167	0.020			0.279	0.073^{d}			

In a column means followed by a common letter are not significantly different at *P* = 0.05 by LSD

Growth Rate

The weight of the larva was also found to differ when reared in different host plants. Mean weight of larva fed with chickpea, castor, chillies, mulberry and parthenium for four days were found to be 1.23, 0.228, 0.217, 0.157 and 0.173 respectively. The data recorded on eighth day of emergence showed that heavier larva was obtained when it was fed with castor, weighing 0.443 g and smaller one being of that of chickpea (0.233 g) [Table-2]. The weight of eleven day old larvae grown with castor was found to be 0.725 g, where as it was 0.588 g when grown in chickpea. The eleven-day old larva grown in chillies, parthenium and mulberry were found to be of 0.708, 0.666 and 0.620 g by weight, respectively.

The growth rate of early instar larva recorded on eighth day of emergence was found to be 0.486 for the larva grown with castor and chillies and 0.481 for parthenium and mulberry where as it was 0.470 for chickpea. In case of late instars, the growth rate was found to be high in chickpea (0.478) followed by mulberry (0.448) and parthenium (0.445). The growth of late instar larva grown in castor was the least among the five hosts studied being 0.414 followed by chillies (0.418). The overall growth rate was high for larva grown in chickpea (0.474) followed by mulberry (0.465) and the least being for castor (0.450).

Table-2 *Growth rate of Spodoptera litura reared in different host plants*

Hosts	Early instar (upto 8 days)				Late instar				Average Growth rate
	Final weight of larva (g)	Mean weight of larva (g)*	Duration of feeding (days)	Growth rate	Final weight of larva (g)	Mean weight of larva (g)*	Duration of feeding (days)	Growth rate	
Chickpea	0.233^{c}	0.123± 0.002	4	0.470	0.588^{c}	0.410± 0.018	3	0.478	0.474
Castor	0.443^{a}	0.228± 0.009	4	0.486	0.725^{a}	0.584± 0.031	3	0.414	0.450
Chilly	0.422^{a}	0.217± 0.004	4	0.486	0.708^{a}	0.565± 0.028	3	0.418	0.452
Mulberry	0.302^{b}	0.157± 0.009	4	0.481	0.620^{bc}	0.461± 0.020	3	0.448	0.465
Parthenium	0.333^{b}	0.173± 0.009	4	0.481	0.666^{ab}	0.499± 0.026	3	0.445	0.463
CD at 0.05	**0.059**				**0.064**				

In a column means followed by a common letter are not significantly different at *P* = 0.05 by LSD;* Weight in grams ± standard error

Approximate Digestibility

The approximate digestibility as measured on eighth day of emergence varies from 89.348 to 90.811 for the early instar larva of *S. litura* grown in different host plants. The approximate digestibility of early instar larva was found to be high when fed with chickpea (90.811) followed by mulberry (90.220) and the least being for parthenium (88.110) [Table-3]. The approximate digestibility ranges form 91.052 to 93.220 for eleven day old *S. litura* larva reared in different host plants. The approximate digestibility of early instar larva was found to be high when fed with chickpea (90.811) followed by mulberry (90.220) and the least being for parthenium (88.110). Parthenium as a weed plant may produce some anti-nutritional compounds which makes it least digestible among the five host plants tested. The approximate digestibility of castor was found to be the least for later instar larva of *S. litura* which recorded 91.052 The mean approximate digestibility of different host plants of *S. litura* larva was found to have a ranged from 90.200 to 92.015. The mean approximate digestibility of the larva fed with parthenium was found to be the least among the five host plants studied which recorded 89.863 showing parthenium as the least preferred host and chickpea being the highly preferred and nutritional host plant [Table-3]. The approximate digestibility of *S.litura* larva fed on ground nut was found to be 94.09 [26], whereas it was 74.78, 66.51, 25.49 and 29.76 in Chinese cabbage, cowpea, sweet potato and tobacco respectively [19].

Table-3 *Approximate digestibility of Spodoptera litura larva fed on different host plants*

Hosts	Early instar (upto 8 days)			Late instar			Mean Approximate Digestibility (AD)
	Weight of the food ingested (g)*	Weight of faeces (g)	Approximate Digestibility	Weight of the food ingested (g)*	Weight of faeces (g)	Approximate Digestibility	
Chickpea	1.937±0.061	0.178^{c}	90.811	4.764±0.159	0.323^{c}	93.220	92.015
Castor	2.732±0.054	0.291^{a}	89.348	5.543±0.104	0.496^{a}	91.052	90.200
Chilly	2.221±0.081	0.226^{b}	89.824	5.244±0.031	0.465^{ab}	91.133	90.478
Mulberry	1.912±0.057	0.187^{c}	90.220	5.037±0.087	0.353^{c}	92.992	91.606
Parthenium	2.111±0.060	0.251^{b}	88.110	5.201±0.056	0.436^{b}	91.617	89.863
CD at 0.05		0.033			0.051		

In a column means followed by a common letter are not significantly different at *P* = 0.05 by LSD; * Weight in grams ± standard error

Efficiency of Conversion of Ingested Food

Food conversion efficiencies on different host plants vary considerably in *S.litura* larvae [1, 25]. The efficiency of conversion of ingested food to body mass in the early instar larvae of *S. litura* is also found to vary from 11.306 to 18.460 when fed with different host plants [Table-4]. It was found that eight day old larva could able to convert 11.306% of food to its body mass in chickpea which was found to be the least among the plants tested. The efficiency of conversion of ingested food in early instar larva was found to be more in chillies (18.460) followed by castor (15.703), parthenium (15.159) and mulberry (15.115). The late instar larva was found to convert the ingested food to its body mass to a maximum in chickpea (7.452) followed by parthenium (6.403) and mulberry (6.313). In an experiment with five host plants plants *viz*., castor, cotton, tomato, mint and cabbage, mint alone did not report to support optimum larval growth because of low digestibility and low efficiency of conversion of digested food to body [25]. The conversion efficiency of *S. litura* larva reared in tobacco as the highest (29.75) whereas sweet potato as the lowest (8.34) and for banana it was 16.56 [19].

Table-4 *Efficiency of conversion of ingested and digested food in S. litura larva*

Hosts	Early instar (upto 8 days)					Late instar				
	Weight gained by the larva (g)	Weight of the food ingested (g)	Weight of faeces (g)*	Efficiency of Conversion of Ingested Food	Efficiency of Conversion of Digested Food	Weight gained by the larva (g)	Weight of the food ingested (g)	Weight of faeces (g)*	Efficiency of Conversion of Ingested Food	Efficiency of Conversion of Digested Food
Chickpea	0.219	1.937	0.178±0.009	11.306	12.450	0.355	4.764	0.323±0.011	7.452	7.994
Castor	0.429	2.732	0.291±0.013	15.703	17.575	0.282	5.543	0.496±0.024	5.087	5.587
Chilly	0.410	2.221	0.226±0.012	18.460	20.551	0.285	5.244	0.465±0.021	5.435	5.964
Mulberry	0.289	1.912	0.187±0.011	15.115	16.754	0.318	5.037	0.353±0.014	6.313	6.789
Parthenium	0.320	2.111	0.251±0.014	15.159	17.204	0.333	5.201	0.436±0.017	6.403	6.988

*** Weight in grams ± standard error**

Efficiency of Conversion of Digested Food

The efficiency of conversion of digested food into body matter in early instar *S. litura* larva reared in different host plant revealed, chillies as the best host plant which supported the highest conversion efficiency (20.551) followed by castor (17.575) and parthenium (17.204) but significantly lower than that of chillies. This may be the reason that *S. litura* is reported as a major pest of chillies by [27-29]. The conversion efficiency of late instar larva of *S. litura* fed with chickpea was the highest (7.994) followed by mulberry (6.789) and parthenium (6.988). The overall efficiency of conversion of ingested or digested food into body matter was high in late instar larva grown in chickpea.

Conclusion

The host plants affected all the growth parameters studied in the test insect, *S. litura*. Chickpea, with the highest average consumption index, growth rate and digestibility was found to be the best host plant. Highest consumption and excretion was recorded with castor. The approximate digestibility was the low in the weed plant parthenium. Though the consumption rate was high in castor, efficiency of conversion of digested food was the least, suggesting less nutritious. However, the conversion efficiency of ingested and digested food in chickpea was the least in early instar larva but the highest in late instars. So chickpea can be considered as the best host plant for the successful survival of the pest and it can be selected as the host plant for conducting laboratory experiments with *S. litura.*

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Abbreviations:

ANOVA- Analysis of Variance,
CRD- Completely Randomized Design
LSD - Least Significant Difference
CI- Consumption index
GR- Growth rate
AD- Approximate digestibility
ECI- Efficiency of conversion of ingested food into body matter
ECD- Efficiency of conversion of digested food in to body matter

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest: None declared

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