NITROGENOUS FERTILIZATION AFFECTS LEAF CONSUMPTION AND UTILIZATION BY PLUTELLA XYLOSTELLA LINN (LEPIDOPTERA: PLUTELLIDAE)

G. M. BANSODE* AND M. S. PUROHIT
N. M. College of Agriculture, Navsari Agricultural University Navsari, 396 450 (Gujrat)
e-mail: ganeshban@rediffmail.com

INTRODUCTION
Nitrogen is a mineral nutrient required by all organisms, being the main component of the body, the genetic code and the metabolism (Scriber, 1984; Simpson and Raubenheimer, 1993; Simpson et al., 1995). Fertilizer application to enrich soil increases not only the nitrogen content of crops but also plant consumption by insects (Tingey and Singh, 1980). Since, nitrogen contents of phytophagous insects are several times higher than those of plants and because food is the only source of water and nitrogen for most insects, feeding on plants with good accumulation of nitrogen and water is obligatory for herbivorous insects (Scriber, 1977). The consumption and utilization of food in insects facilitate the understanding of the adaptability of insects to the environment.

Insects that feed on diets or host plants high in N generally have greater growth rates, higher efficiency of conversion of ingested food and shorter developmental times as reported by Chen et al. (2004) on Choristoneura occidentalis, Carnevalli et al. (1990) on Spodoptera frugiperda and Setamous et al. (1993) on Sesamia calamistis. Therefore, the existing knowledge on the relationship between host plant nitrogen and food utilization in herbivorous insects is not conclusive. Insect-host relationships can be better understood by knowing the rate of food consumption, its digestibility and conversion of food eaten to body tissue. However, similar line of work on diamondback moth (Plutella Xylostella) is not attended. The present study therefore examines the influence of different N fertilization on leaf consumption and utilization by Plutella xylostella.

MATERIALS AND METHODS
The experiment was laid out at Department of Entomology, N. M. College of Agriculture, Navsari, Gujarat in a completely randomized design (CRD) with four levels of nitrogenous fertilizers (N₁ - 160 kg N/ha, N₂ - 80 kg N/ha, N₃ - 40 kg N/ha and N₄ - no fertilizers) replicated five times. The cauliflower leaves collected from plot applied with different fertilizer regime were brought to laboratory and cut in to 5 x 5cm piece. These pieces were placed singly in to the petridish and single first instar larva obtained from insect culture released in each petridish. For each replication, ten larvae were released. Treatment wise fresh foods were supplied to the larvae until pupation. The weight of individual full grown larva as well as pupa was taken with electronic balance. The observations on the following growth parameters were recorded.

ABSTRACT
Food consumption and utilization influence metabolism, enzyme synthesis, nutrient storage and other activities. The nutritional ecology of the Plutella xylostella was studied using nitrogenous fertilized leaves as the source of food. In order to have a detailed picture of food utilization, daily measurement of food ingested, faeces produced and weight gain by larva were recorded. The results revealed that amount of food ingested and consumption index were increased proportionally with the increasing level of N applied to host plants. The amount of food ingested was increased gradually with advancement of age, while consumption of food had decreased with advancement of age. Approximate digestibility, efficiency of conversion of ingested food and efficiency of conversion of digested food increased in younger larvae and declined with the advancement of age.
Weight of food ingested
Was calculated by subtracting the weight of leftover food from the amount of food introduced.

Consumption index (C.I.)
Was calculated by formula proposed by Waldbauer (1968).

$$ C.I. = \frac{\text{Wt. gained by insect}}{\text{Wt. of food ingested}} \times 100 $$

Approximate digestibility (A.D.)
Was calculated by formula proposed by Waldbauer (1968).

$$ A.D. = \frac{\text{Wt. gained by insect}}{\text{Wt. of food ingested}} \times 100 $$

Efficiency of conversion of digested food (E.C.I.)
was calculated by following formula proposed by Waldbauer (1968).

$$ E.C.I. = \frac{\text{Wt. gained by insect}}{\text{Wt. of food ingested}} \times 100 $$

Efficiency of conversion of digested food (E.C.D.)
The efficiency with which digested food is converted to body substance was calculated from following formula proposed by Waldbauer (1968).

$$ E.C.D. = \frac{\text{Wt. gained by insect}}{\text{Wt. of food ingested}} \times 100 $$

RESULTS AND DISCUSSION
The weight of the food ingested differed significantly P value among the treatments at all 4 days of observation (Table 1). Significantly higher food ingested by 5 days old larva was recorded in treatment $N_1 (33.73mg)$ followed by in treatment $N_2 (32.00mg)$ and $N_3 (30.54mg)$. In untreated food, consumption was significantly less (30.03mg). Though, the quantity of food consumption increased with the advancement of age, the trend in food ingested remained same by 6, 7 and 8 days (full grown) old larva. Full-grown larvae consumed higher quantity (75.48 mg) of food and it differed significantly from $N_2 (62.05mg)$ and $N_3 (61.19mg)$. The quantity of food ingested by larva was significantly lower (54.12mg) when fed with food obtained from $N_3$ regime.

From the above results, it is seen that amount of food ingested increased proportionally with the increasing level of N applied to host plants. The result also showed that amount of food ingested was increased gradually with advancement of age.

The data recorded for 5 days old larvae showed that significantly higher C.I. (Table 1) was observed in treatment $N_1 (1.56)$ and it was at par with treatment $N_2 (1.54)$ and $N_3 (1.46)$. However, lower C.I. was observed in treatment $N_3 (1.44)$ which did not differ statistically from treatment $N_1$. The C.I. due to different nitrogen levels in 6 days old larva was significantly higher in $N_1 (1.62)$ and it was at par with $N_2 (1.54)$. The other two treatments recorded lower C.I. and differed significantly P value from the above treatment.

The C.I. due to different N levels had decline with advancement of age. However, trend of influence of N levels on C.I. of 7 days old larva remained similar as in previous case. The C.I. of full-grown larva was significantly higher in $N_1$ treatment (1.46) and it was at par with treatment $N_2 (1.39)$ and $N_3 (1.38)$. However, lower C.I. was observed in $N_2 (1.31)$.

The consumption index, which is used to determine the capacity to consume food in relation to their body weight also influenced by N levels and increased gradually with increasing N levels. Though, the capacity of consumption of food had decreased with advancement of age, the significant influence of N level in C.I. continued up to the full grown stage. Dandapani and Balasubramanian (1980) stated that the consumption index decreased with an increase in age in Heliothis armigera Hubner (Noctuidae).

Approximate digestibility (Table 2) differed significantly among the treatments in 5 days old larva. It was significantly higher in $N_1 (49.54\%)$ and was at par with $N_2 (48.45\%)$ and $N_3 (47.40\%)$. $N_3$ recorded significantly lower (45.07\%) A.D. In general, the A.D. of 6 days old larva had increased in all treatments. However, the difference among the treatments was significant, wherein $N_1$ gave higher A.D. (51.84\%), but it was at par with $N_2 (51.55\%)$ and $N_3 (51.40\%)$. A.D. of 7 days old larva and full grown larva did not differ significantly and it was almost equal in all the treatments. The data further showed the gradual decline in A.D. from 6 days onwards and the extent of reduction was between 20 to 25 per cent of full grown larva.

Approximate digestibility, which indicates utilization of food by diamondback moth larva, was also significantly influenced by levels of nitrogen supplied to food plants, but only in 5 and 6 days old larva. The capacity of utilization of food by younger larva increased with increasing the levels of nitrogen supplied to host plant increased. In subsequent larval stages, nitrogen levels did not exert any effect on A.D., which declined in general. The increasing A.D. in younger larva is associated with chewing off small pieces of leaf or selective feeding than the older age larva, which fed on large piece of leaf containing indigestible fibres that contribute to decline in A.D.

Digestibility is affected by nutritional deficiency or imbalanced diet, high content of crude fiber or deficiency of water in food (Waldbauer, 1964). The higher assimilation efficiency or approximate digestibility is certainly a racial character, as higher food intake does not necessarily result in higher digestibility (Magdum et al., 1996).

The E.C.I. of 5 days old larva (Table 2) showed significant difference due to N level fertilization to host plant. Treatment $N_1$, $N_2$ and $N_3$ recorded 18.12, 18.74 and 19.32 per cent E.C.I. respectively and they differed significantly from $N_0$ (15.04\%). The E.C.I. due to different N levels had increased in the 6 days old larva. However, the trend of influence of N levels on E.C.I. remained similar as it was found in 5 days old larva. The E.C.I. of 7 and 8 days old larva did not influenced by different nitrogen regime. The gradual reduction in E.C.I.
was also noticed in all the treatments, which was to the tune of 50 per cent in full-grown larvae compared to E.C.I. of 6 days old larvae.

E.C.I. denotes the ability of insects to utilize ingested food for its development. In all the treatments, the E.C.I. of latter age larvae was found to be reduced to some extent as compared to early stage larvae. The results showed that the food treated with higher N level (N$_1$) efficiently utilized by younger (5 and 6 days old) diamondback moth larvae than the other N levels and untreated food.

E.C.D. recorded in 5, 6, 7 and 8 days old larvae (Table 3) showed significant influence of treatments only in 5 days old larvae. Wherein N$_2$, (38.80%), N$_3$, (38.67%) and N$_4$, (38.13%) gave equal effect on E.C.D. of 5 days old larvae. Thereafter, E.C.D. started declining from 33.25 to 27.30 per cent in N$_p$, 38.13 to 27.73 per cent in N$_1$, 38.87 to 28.70 per cent in N$_2$, 38.80 to 28.84 per cent in N$_3$, with the advancement of age without significant difference due to treatments.

The efficiency with which digested food is converted to body substance (E.C.D) also significantly influenced by N levels only in 5 days old larvae. The N level had no influence on E.C.D. of older and full-grown larvae and declined with the advancement of age. However, comparatively higher E.C.D. was recorded in larvae fed with leaves having higher nitrogen level. Waldbauer (1964) reported that higher the food intake tends to mobilize the gut contents faster and provide less time for enzyme activity and food absorption making digestive efficiency poor.

Hence, it is proved that as the nitrogen levels increased, foliage become more digestible and efficiency of ingested and digested food also increased in early age larvae. Muthukrishnan and Selvan (1993) reported that higher nitrogenous fertilization doses were correlated with increased consumption and utilization of leaf by *Porthesia scintillans*. The declining in efficiency of conversion of ingested and digested food in older larvae, observed in present investigation is supported by Montgomery (1982) who found that declining food nitrogen utilization efficiency with age of gypsy moth larvae fed on food with high nitrogen content. Similarly, analysis of nitrogen in the faeces showed that *H. armigera* larvae in latter stage had lower rate of N intake and utilization than the 2nd and 3rd instar larvae (Wu et al., 1988). Furthermore, Slansky and Scriber (1985) analyzed the results of several hundreds of experiments on 25 insect species and found that the rates and efficiencies of host plants utilization in penultimate and final larval instars declined with decreases in plant nitrogen.

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**REFERENCES**


