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EFFECT OF DIFFERENT LEVEL OF NITROGENOUS FERTILIZER ON LARVAL AND POST LARVAL DEVELOPMENT OF *PLUTELLA XYLOSTELLA* (LINN.) INFESTING CAULIFLOWER

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ABSTRACT
Nitrogen is one of the most critical chemical elements for plant and herbivores, profoundly influencing development and reproduction. The larval and post larval development of the diamondback moth, *Plutella xylostella* (Lepidoptera: Pluttelidae), were studied in relation to varying N fertilization levels (160, 80, 40 and 0 kg N/Ha.) in cauliflower (*Brassica oleracea* var. *botrytis* L.). The results showed that diamondback moth larvae grew faster gradually when fed with the increasing dose of N fertilization to host plant. However, the upper two levels of N *i.e.* 80 and 160 kg N/ha did show significant effect on larval development period and it did not influence the adult stage.

INTRODUCTION

Nitrogen, fundamental for amino acid and protein synthesis in any biological system, constitutes around 0.5–5% of plant tissue and 10% of animal tissue (Mattson, 1980) and is considered to be frequently limiting for both plants and their consumers (McNeill and Southwood, 1978; Mattson, 1980). The food ingested and digested by the insect must fulfill its nutritional requirements for normal growth and development to occur. Many studies have shown a positive effect on herbivore density or performance (growth, development and fecundity) when plant nutrient status is enhanced through N fertilization. However, a substantial number of studies have also found negative effects or no effects (Scriber and Slansky, 1981; Blua and Toscano, 1994; Bethke *et al*., 1998; Casey and Raupp, 1999). Thus, a definitive pattern on the response of herbivores to host quality cannot be concluded for all species (Cisneros and Godfrey, 2001)

Farmers are habituated to apply excessive dose of fertilizers especially in the form of nitrogen in all crops including cauliflower, without knowing its effect on the enhancement of insect incidence. Earlier, few workers studied the effect of nitrogenous fertilization of host plant on growth and development of *Choristoneura occidentalis* (Brewer *et al*., 1985), *Spodoptera frugiperda* (Carnevalli *et al*., 1990) *Helicoverpa armigera* (Purohit and Deshpande, 1991) and *Sesamia calamistis* (Setamous *et al*., 1993). Study of the effects of host plant nutrition on the biology of insects is important in understanding host suitability of plant infesting insect species.

To date, the relationship between host plant nitrogen fertilization and performance of insects and mites that feed on plant sap has been studied in great detail. No research has been conducted to evaluate the effect of nitrogen level in cauliflower plants on the biology of *P. xylostella*. Knowledge of influence of nitrogenous fertilization to host plants on growth and development may play role in formulating the IPM strategy for DBM management. The objective of this study was to quantify the effect of nitrogen fertilization of cauliflower on the larval, pupal developmental duration, adult longevity and fecundity of *P. xylostella*.

MATERIALS AND METHODS

The experiment was laid out at Department of Entomology, N. M. College of Agriculture, Navsari. The experiment was laid out in a completely randomized design (CRD) with four levels of nitrogenous fertilizers (N_3-160 kg N/ha, N_2-80 kg N/ha, N_1-40 kg N/ha and N_o- 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 pertidish. For each replication, ten larvae were released. Treatment wise fresh foods were supplied to the larvae until pupation. The number of days from hatching till pupation taken by each larva was counted to record larval period. The development period for pupae was also recorded. The weight of individual full grown larva as well as pupa was taken with electronic balance. The adults emerged were paired

Table 1: Effect of nitrogen levels on development period of *P. xylostella*

Treatments	Duration (days)		't' value in comparison to N_0	
	Larva	Pupa	Larva	Pupa
N_0 (No fertilizer)	8.97 ± 1.29	4.24 ± 1.34	-	-
N_1 (40Kg N/ha)	8.79 ± 1.21	4.05 ± 1.23	0.67	0.68
N_2 (80Kg N/ha)	8.44 ± 1.14	3.95 ± 1.22	2*	0.93
N_3 (160Kg N/ha)	8.32 ± 1.12	3.79 ± 1.41	2.54*	1.45

*Significant at 5% level

Table 2: Effect of nitrogen levels on weight of *P. xylostella* (larva and pupa)

Treatment	Larval weight (mg)				Pupal weight (mg)
	Days old larvae				
	5	***6***	***7***	***8***	
N_0 (No fertilizer)	21.00 b	29.00 b	36.00 c	41.98 c	38.70 c
N_1 (40Kg N/ha)	21.00 b	30.00 b	38.00 b	45.00 b	41.76 b
N_2 (80Kg N/ha)	21.20 b	30.40 b	38.80 b	46.00 b	43.60 b
N_3 (160Kg N/ha)	22.04 a	32.50 a	42.00 a	51.00 a	48.20 a
S.Em +	0.27	0.73	0.60	0.72	3.62
C.D. 5%	0.82	2.19	1.79	2.15	2.55
C.V.%	2.87	5.35	3.45	3.49	4.42

separately until death. From recorded data, average male, female longevity and fecundity were calculated. T test was used for larval development period, longevity and fecundity.

RESULTS AND DISCUSSION

Effect of N levels on larval and pupal period

The data presented in Table 1 indicated that the development period of diamondback moth larvae was significantly influenced by levels of nitrogen supplied to food. The number of days required to complete entire larval stage was significantly less (8.32±1.12 days) in N_3 compared to other treatments. The average number of days required to complete larval stage were 8.44 ± 1.14, 8.79 ± 1.21 and 8.97 ± 1.29 days in N_2, N_1 and N_0, respectively, wherein only the former treatment showed the significant effect on larval development period. The results of present work showed that diamondback moth larvae grew faster gradually when fed with the increasing dose of N fertilization to host plant. However, the upper two levels of N *i.e.* 80 and 160 kg N/ha did show significant effect on larval development period. Xia *et al*. (1997) reported that increasing nitrogenous fertilizer rate to host plant reduced the larval period of *H. armigera*. Similarly, Solange *et al*. (2006) reported that greater nitrogen concentration on plants did not affect *Heliconius erato phyllis* larval survival, but led to a reduction in larval development time and increased adult size.

The mechanisms by which N fertilization increases *P. xylostella* larval growth and modifies larval feeding preference are unknown. It is possible that the variable N applications shifted the balance of the plant's protein to carbohydrate ratio (P: C), or reduced levels of plant defensive compounds, or a combination of the two. An appropriate P: C ratio is important for growth and development of many phytophagous insects. (Simpson and Raubenheimer, 1993; Bede *et al*., 2007).

Pupal period varied from 3.79 ± 1.41 to 4.24 ± 1.34 days due to different levels of N fertilization to host plant. However, it did not differ significantly from each other. Comparatively least pupal period was recorded in treatment N_3 (3.79 ± 1.41 days) followed by N_2 (3.95 ± 1.22 days), N_1 (4.05 ± 1.23 days) and N_0 (4.24 ± 1.34 days).The pupal development period was not significantly affected by nitrogen levels was observed in present investigation is supported by Setamous *et al*. (1993) who reported that pupal period of *Sesamia calamistis* was not affected by plant nitrogen. However Carnevalli *et al*. (1990) studied the effect of nitrogen on *Spodoptera frugiperda* and reported that pupal period was longest in treatment without nitrogen.

Effect of N levels on weight of larva and pupa

The data presented in Table 2 showed that larval weight of 5, 6, 7 and 8 days (full-grown) old larvae differed significantly among different nitrogen levels. Significantly higher larval weight of 5 days old larvae was recorded in N_3 treatment (22.04mg) followed by N_2 (21.20mg), N_1 (21.00mg) and N_0 (21.00mg). Similar trend of different level of N on larval weight was recorded in 6 days old larvae. The data recorded for 7 days old larvae showed that significantly higher weight was gained by N_3 (42.00 mg). The other two treatments gained higher weight over N_0 (36.00 mg) were N_2 (38.80 mg) and N_1 (38.00 mg) and both were at par with each other. The data further indicated that the similar trend of weight gained by full-grown larva was recorded wherein, N_3 gained significantly higher weight (51.00 mg) over all other treatments. The average weight of larva was 46.00 and 45.00 mg in the N_2 and N_1 treatment, respectively and was at par with each other. The weight gained by 5, 6, 7 days old and full grown larvae significantly increased with increasing nitrogen dose to host plant. The full grown larva gained 25 per cent more weight (51.00mg) in N_3 than the weight gained in N_0 treatment (41.98mg). Thus, application of higher dose of N to host plant showed very clear impact on the growth and development of *P. xylostella* larva. Soldaat and Vrieling (1992) reported that larval weight of *Tyria jacobaeae* positively correlated with nitrogen concentration of food plant.

The data on the pupal weight of diamondback moth were also significantly affected by N levels. Treatment N_3 resulted in higher pupal weight (48.2mg) followed by N_2 (43.60mg) and N_1 (41.76mg). The least weight of pupae (38.70mg) was observed in N_0 treatment. The pattern of weight gained by pupa due to different treatments was almost similar to that of weight gain by larvae. This result is in concurrence with the finding of Wheeler *et al*. (1998), who reported that male and female *Spodoptera pectinicornis* pupal biomass were significantly greater when larvae were fed leaves from high nitrogen fertilized plant. While Brewer *et al*. (1986) reported that pupal weight of *Choristoneura occidentalis* was significantly greater for larvae reared on white fir with mid range foliage nitrogen level.

Effect of N levels on longevity and fecundity of diamondback moth

The data pertaining to effect of N levels on longevity of diamondback moth (Table 3) showed that longevity of male and female did not influence by levels of nitrogen supplied to host plant. However, data showed that longevity of both male and female was slightly higher in treatment of N levels

Table 3: Effect of nitrogen levels on longevity and fecundity of *P. xylostella*

Treat.	Duration (days)		't' value in comparison to N_0		Eggsper female	't' value in comparison to No
	Male	Female	Male	Female		
$N_{0\ (No\ fertilizer)}$	4.4 ± 0.51	7.27 ± 0.70	-	-	128.2 ± 24.53	-
$N_{1\ (40Kg\ N/ha)}$	4.6 ± 0.82	7.33 ± 0.62	0.80	0.26	132.33 ± 19.58	0.52
$N_{2\ (80Kg\ N/ha)}$	4.73 ± 0.70	7.40 ± 0.63	1.5	0.54	137.00 ± 23.19	1.02
$N_{3\ (160Kg\ N/ha)}$	4.80 ± 0.68	7.60 ± 0.63	1.86	1.37	137.67 ± 19.52	1.20
			NS	NS	NS	NS

compared to unfertilized regime. Similarly the fecundity of diamondback moth (Table 3) did not differ significantly among the treatments. But numerically higher fecundity was observed in treatment N3 (137.67 ± 19.52 eggs/ female) followed by N2 (137.00 ± 23.19 eggs/ female), N1 (132.33 ± 19.58 eggs/ female) and N-0 (128.2 ± 24.53 eggs/ female).

The longevity (male and female) and fecundity of diamondback moth did not influenced by level of nitrogen supplied to food plant. However, the present result is in contrast with that obtained by Setamous *et al*. (1993), who reported that longevity and fecundity of *Sesamia calamistis* increased with increasing nitrogen dose to host plant, while Brewer *et al*. (1986) reported that number of eggs and total mass of egg produced by *Choristoneura occidentalis* female were lowest at high and low extreme of foliar nitrogen level. Several previous studies have examined the effects of insect herbivores on host plant nutrient levels, in particular nitrogen (Fischer and Fiedler, 2000; Chau and Heinz, 2006), but nitrogen content alone does not always explain the ovipositional preferences of females, particularly crucifer specialists such as *P. xylostella* that rely on additional stimuli. In *P. xylostella*, sulphur-deficient plants were less attractive for egg deposition than those growing in soils that received the maximum application of sulphur fertilizer (Gupta and Thorsteinson, 1960; Marazzi *et al*., 2004). Oviposition was significantly higher on *Brassica* species growing in soil enriched with sulphur than those growing in soil deficient in sulphur (Gupta and Thorsteinson, 1960).

Many plant-defensive allelochemicals have been reported to be decreased by N addition (Stout *et al*., 1998; Schmelz *et al*., 2003; Prudic *et al*., 2005), so it is possible that some elements of preference are attributable to changes in plant defensive capacity. These qualitative and quantitative attributes may be malleable by varying N fertilization and may further modify the herbivore–plant interactions.

Thus, it seems that the influence of N supplied to host plant on growth and development continued only upto immature stages of diamondback moth. It did not reflect in adult stage.

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