J. Biol. Control, 15 (1): 59-62, 2001

Consumption, digestion and utilization of biopesticides treated tomato fruits by *Helicoverpa armigera* (Hübner)

P. M. PRAVEEN and N. DHANDAPANI
Department of Agricultural Entomology
Tamil Nadu Agricultural University
Coimbatore 641 003, Tamil Nadu, India
E-mail: pmpraveen2k@hotmail.com

ABSTRACT: Effect of biopesticides, *viz., Bacillus thuringiensis* subsp. *kurstaki,* nuclear polyhedrosis virus and neem formulation on consumption, digestion and utilisation of tomato fruits by the fruit borer, *Helicoverpa armigera* (Hübner) was studied. In general food intake, faecal matter voided and weight gained by the larvae were lower in biopesticide treated fruits than in untreated ones. The total food consumed (0.008g), weight of faeces voided (0.0015g), larval weight gain (0.0018) and feeding period (1.25 days) were the lowest in *B.t.* @ 0.5g/lit. whereas, it was 1.6582g, 0.9404g, 0.271g and 10.83 days in untreated check, respectively. The consumption index (CI) was lowest in *B.t.* @ 0.25g/lit (0.098). Growth rate (GR), approximate digestibility (AD), efficiency of conversion of ingested food to body substance (ECI) and Efficiency of Conversion of Digested food to body matter (ECD) were also worked out and discussed.

KEY WORDS: Biopesticides, *Helicoverpa armigera*, tomato, utilization

Studies on the consumption, digestion and utilization of food plants by insects are important both from fundamental and applied points of view. They provide information on the quantitative loss brought about by the pests. Consumption indices can also be taken as indirect measurements of the relative susceptibilities of crops to pest infestation. Studies on Indian insects along this line are very few (Shyamala *et al.*, 1960; Prem kumar *et al.*, 1977; Dhandapani and Balasubramanian, 1980; Dhandapani, 1986). Particularly, studies are very limited (Galande and Ajri, 1997) on utilization of food by insects after biopesticide treatments. Generally mortality of insects occurs with biopesticide treatments only after a few hours. Hence the present study was undertaken to find out the indices relating to the consumption and utilization of tomato fruits treated with biopesticides by *Helicoverpa armigera* (Hübner) an important fruit borer which can cause direct marketable yield loss ranging from 20 to 60 per cent in various seasons (Manjunath *et al.*, 1970; Bhatnagar *et al.*, 1981; Tewari and Krishnamoorthy, 1984; Lal and Lal, 1996).

MATERIALS AND METHODS

Fresh tomato fruits of uniform size from the field were treated with the biopesticides (Table 1) of selected concentrations using hand atomiser. Biopesticide concentrations were selected in such a way to study their effect on food utilization. Distilled water was sprayed for untreated check. The treated fruits were shade dried for 10 minutes and transferred to disposable cups (6x5cm) at the rate of one fruit per cup. The larvae of uniform

age (third instar) and size (70-90mg) reared on the same host and starved for 6 hours were released on the tomato fruits individually to avoid cannibalism, covered with muslin cloth and secured tightly with rubber band. The experiment was conducted under room temperature (25±2°C) at Department of Entomology, Tamil Nadu Agricultural University, Coimbatore, during June, 2000. The observations on quantity of food consumed, excreta voided and the weight gained by the caterpillars from third instar to death/ pupation were determined on fresh weight basis. Each treatment was replicated thrice using ten larvae per replication. The mean weight of the insects was calculated by summing up the initial and final weights determined every day and dividing by the number of weighings. All the indices relating to the consumption, digestion and utilization of tomato fruits were calculated according to Waldbauer (1968).

1. Consumption index

$$CI = F/TA$$

F- Fresh or dry weight of food eaten

T- Duration of feeding period

A- Mean fresh or dry weight of animal during feeding period

2. Growth rate

$$GR = G/TA$$

G- Fresh or dry weight of animal

T- duration of feeding period (days)

A- mean fresh or dry weight of animal during feeding period

3. Efficiency of conversion of ingested food to body substance (ECI) or gross efficiency

$$ECI = \frac{\text{Weight gained}}{\text{Weight of food ingested}} \times 100$$

4. Approximate digestibility (AD)

$$AD = \frac{\text{Weight of food ingested} - \text{Weight of faeces}}{\text{Weight of food ingested}} \times 100$$

5. Efficiency of conversion of digested food (ECD) or net efficiency

$$ECD = \frac{\text{Weight gained}}{\text{Weight of food ingested} - \text{Weight of faeces}} \times 100$$

RESULTS AND DISCUSSION

Food consumption

The total food consumed and different consumption indices are presented in Table 1. The food consumed was more in untreated check (1.658mg) followed by those treated with Econeem @ 0.25 ml/lit (1.334mg) and *Ha*NPV @ 0.75×10^9 POB/lit (1.138mg). The lowest consumption of tomato fruits was noticed in fruits treated with *Bacillus thuringiensis* subsp. *kurstaki* (*B.t.*). This might have been due to the action of *B.t.* as stomach poison causing death quickly compared to other biopesticides (Adang, 1991). The same trend was observed for the weight of faeces voided and the larval weight gained. The Consumption Index (CI) of *H. armigera* was found to be more for the larvae fed on NPV (1.007 and 1.215 at 0.75×10^9 POB/lit and 0.5×10^9 POB/lit, respectively) treated tomato fruits followed by the larvae fed on Econeem (0.957 at 0.25ml/lit and 0.694 at 0.5ml/lit) treated fruits. This might be due to the variation in feeding period.

Growth rate

Growth rate (GR) was higher for the larvae fed on *Ha*NPV treated fruits at the rate of 0.5×10^9 POB/lit. The lowest GR was observed in *B. t.* treatment. This might be due to the faster growth under prolonged diseased condition than normal ones (Galande and Ajri, 1997).

Approximate digestibility

Approximate digestibility (AD) taken as the index of digestibility is presented in Table 2. The AD was significantly highest in *B. t.* @ 0.5g/lit (81.57%) compared to other treatments. The AD in untreated check was 44.16 per cent, whereas it was the lowest in *Ha*NPV treated fruits at the rate of $0.5x10^9$ POB/lit (43.66%). This might be due to the increased feeding periods in other treatments compared to *B. t.* treatment (Chandra *et al.*, 1999; Gujar *et al.*, 2000).

Utilization of food

Efficiency of conversion of ingested food (ECI) or gross efficiency

The larvae feeding on *B. t.* were found to have the highest gross efficiency (26.14% and 22.35% at 0.25g/lit and 0.5g/lit, respectively, compared to other treatments. The lowest ECI was recorded in untreated check (16.33%). The treatments *Ha*NPV and neem at two different doses were on par with each other.

Efficiency of conversion of digested food (ECD) or net efficiency

The ECD was higher in NPV (42.47% at $0.75x10^9$ POB/lit and 45.70 % at $0.5x10^9$ POB/lit) and Econeem (40.11% and 46.82% at 0.25ml/lit and 0.5ml/lit, respectively) treatments and was lower in *B.t.* @ 0.5 g/lit (27.0%). When a larva is subjected to any stress condition, the rate of ECD will be faster than the normal ones. So the high ECD observed might have been due to faster growth of the larvae (Soo and Fraenkel, 1966).

Table 1. Consumption and utilization of biopesticide treated tomato fruits by *H. armigera* larvae

Treatment	*Total food consumed larva (gm)	Weight of faeces voided/ larva (gm)	Larval weight gain/ larva (gm)	Feeding period (days)	Consumption Index (CI)	Growth rate (GR)	AD (%)	ECI (%)	ECD (%)
B.t. @0.25g/lit	0.0080	0.004	0.0026	1.43	0.098	0.030	57.57	26.14	37.08
B.t. @0.5g/lit	0.0080	0.0015	0.0018	1.25	0.123	0.027	81.57	22.35	27.00
*Ha*NPV@ $0.75x10^9$ POB/lit	1.1378	0.6053	0.2096	6.83	1.007	0.185	46.68	19.66	42.47
*Ha*NPV @$0.5x10^9$POB/lit	1.0003	0.5634	0.1983	6.06	1.215	0.278	43.66	19.83	45.70
Econeem @ 0.25ml/lit	1.3343	0.7419	0.2380	8.33	0.957	0.132	44.45	18.99	40.11
Econeem@0.5 ml/lit	1.0040	0.5486	0.2130	7.40	0.694	0.147	45.44	21.24	46.82
Untreated check	1.6582	0.9404	0.2710	10.83	0.548	0.089	44.16	16.33	36.71
CD (P=0.01)					0.545	0.024	12.07	3.655	6.085

The results of the present studies revealed that the larvae were able to digest and utilize the biopesticide treated plant parts for their growth and development for few days. Therefore, chances are more for the later instar larvae to escape from death. Hence, it is necessary to quicken the mortality by way of increasing the dose or through addition of adjuvants or through integrating different methods of pest management along with biopesticides.

ACKNOWLEDGEMENTS

The authors are thankful to Drs. N. Sathaiah and J. S. Kennedy, Department of Entomology for their valuable suggestions in conducting the experiment. The help rendered by K. Vanitha and C. M. Senthil Kumar, is greatly acknowledged.

REFERENCES

Adang, M. J. 1991. *Bacillus thuringiensis* insecticidal crystal proteins: Gene structure, action and utilization, pp. 3-24. In: K. Maramorosch (Ed.). *Biotechnology for biological control of pests and vectors*. CRC Press, Boca Raton.

Bhatnagar, V. S., Lateef, S. S., Sithanantham, S., Pawar, C. S. and Reed, W. 1981. Research on *Heliothis* at ICRISAT. In: *Proceedings of International Workshop on Heliothis management*, 15-20 Nov., 1981, ICRISAT, Patancheru, Andhra Pradesh, India. pp. 385-395.

Chandra, A., Kaushik, N. C. and Gupta, G. P. 1999. Studies of *Bacillus thuringiensis* on growth and development of *Helicoverpa armigera* Hubner. *Annals of Plant Protection Sciences*, 7(2): 154-158.

Dhandapani, N. 1986. Consumption, digestion and utilization of bhendi varieties by *Earias vittella* Fab. *Madras Agricultural Journal*, **73**(12): 676-678.

Dhandapani, N. and Balasubramanian, M. 1980. Consumption and utilisation of different food plants by *Helicoverpa armigera* (Hbn.) (Noctuidae: Lepidoptera). *Entomon*, **5**(2): 99-103.

Galande, S. M. and Ajri, D. S. 1997. Consumption, digestion and utilisation of sunflower leaves by *Helicoverpa armigera* (Hubner) treated with nuclear polyhedrosis virus. *Journal of Biological Control*, **11**: 11-16.

Gujar, G. T., Vinay, K. and Kumari, A. 2000. Bioactivity of *Bacillus thuringiensis* against the American bollworm, *Helicoverpa armigera* (Hubner). *Annals of Plant Protection Sciences*, **8**(2): 125-131.

Lal, O. P. and Lal, S. K. 1996. Failure of control measures against *Helicoverpa armigera* infesting tomato in heavy pesticidal application areas in Delhi and satellite towns in western UP and Haryana. *Journal of Entomological Research*, **20**(4): 355-364.

Manjunath, T. M., Phalak, V. R. and Subramaniyan, S. 1970. First record of egg parasites of *Heliothis armigera* Hb. (Lepidoptera: Noctuidae) in India. *Commonwealth Institute of Biological Control Technical Bulletin*, **13**: 111-115.

Prem Kumar, M., Dale, D. and Nair, M. R. G. K. 1977. Consumption, digestion and utilisation of food by larvae of *Spodoptera litura* F. (Lepidoptera: Noctuidae). *Entomon*, **2**: 7-10.

Shyamala, M. B., Sharda, K., Bhat, M. G. and Bhat, J. V. 1960. Chloromycetin in the nutrition of the silkworm *Bombyx mori* L. II. Influence on digestion and utilisation of protein, fat and minerals. *Journal of Insect Physiology*, **2**: 229-234.

Soo, H. C. F. and Fraenkel, G. 1966. The consumption, digestion and utilisation of food plants by a polyphagous insect, *Prodenia eridania* (Cramer). *Journal of Insect Physiology*, **12**: 711-730.

Tewari, G. C. and Krishnamoorthy, P. N. 1984. Yield loss in tomato caused by fruit borer. *Indian Journal of Agricultural Sciences*, **54**: 341-343.

Waldbauer, G. P. 1968. The consumption and utilization of food by insects. *Advances in Insect Physiology*, **5**: 229-288.