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SHORT NOTE

COMPARATIVE LIFE TABLE STUDIES OF DIAMONDBACK MOTH, *Plutella xylostella* (Linnaeus) ON CABBAGE

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Cabbage, *Brassica oleracea* var. *capitata* is one of the most important vegetables of India. It is attacked by a number of insect pests and the diamondback moth (DBM), *Plutella xylostella* (Linnaeus) (Lepidoptera : Yponomeutidae) inflict severe damage to the crop by defoliation causing yields loss up to 44.6 percent (Krishnaiah, 1980). Many cabbage growers use IPM-neem seed kernel extract spray, trap crop, etc. The extracts from neem seed and kernel have provided good control of DBM on cabbage (Sannaveerappanavar *et al.*, 1997). It is therefore, desirable to develop an integrated pest management (IPM) system, which is less dependent on synthetic insecticides. Jalali *et al.* (2001), in the choice study for most suitable Trichogrammatid species to promote as a key component in the IPM for DBM has reported *Trichogrammatoidea bactrae* Nagaraja as the most important species. In order to develop an effective strategy for the management of DBM, construction of its life table is indispensable as it determines the expectation of life, understands population dynamics of the pest and also for evaluating natural enemy action in influencing pest population densities.

In the present study, the influence of *T. bactrae*, Neemarin 1500 (0.15% - Azadirachtin EC) and Dichlorvos 76% EC on the life expectancy of *P. xylostella* was compared to understand the role of these agents in the population dynamics of the *P. xylostella*.

Larvae and pupae of *P. xylostella* collected from cabbage field were reared in the laboratory at Project Directorate of Biological Control, Bangalore and the F_1 generation grown on potted cabbage was used for the experiment. Five pairs of the freshly emerged adults were kept in insect rearing cage (30 cm^3) containing 50% diluted honey solution and water swabs as adult feed. Cabbage leaf was kept for moths to lay eggs and was changed daily until all the females died. Number of eggs laid on each day was counted and kept in a plastic container (15 x 10 cm) covered with double layered black muslin cloth. The number of larvae hatched out of each day's egg laying was recorded regularly. Growing larvae were transferred to fresh cabbage leaf as and when required for the completion of developmental period. Pupae were collected into the glass vials (15 x 3 cm) and kept for adult emergence. The female population obtained from each day's egg laying was considered for construction of fertility and life tables. The experiment was repeated for five times.

The experiment was conducted in the laboratory at 26 ± 2°C and 65 ± 5% RH.

The age specific survival (l_x) and fecundity (m_x) at each pivotal age (x) were worked out daily for the entire reproductive period to prepare fertility and life table statistics as outlined by Southwood (1978). The factors considered were net reproductive rate (R_o) = $\Sigma l_x m_x$, approximate duration of generation (T_c) = $\Sigma x l_x m_x$, approximate intrinsic rate of increase (r_c) = $\log_e R_o / T_c$, precise intrinsic rate of increase (r_m) = $e^{-rm} x l_x m_x = 1$, precise generation time (T) = $\log_e R_o / m$, finite rate of increase (λ) = antilog$_e r_m$, weekly multiplication rate = $(\lambda)^7$, number of estimated females in F_2 = $(R_o)^2$ and doubling time (DT) = $\log_e 2 / r_m$.

To study the effect of different treatments on stage mortality, four treatments viz., T_1 = release of *T. bactrae* @ 30 eggs per 1 female; T_2 = spray of dichlorvos @ 0.05%; T_3 = spray of Neemarin @ 1500 ppm; T_4 = untreated control were imposed. For T_1, cabbage leaf bouquet was kept in the insect-rearing cage (30 cm^3) having 5 pairs of moths for egg laying. After 24 hours, eggs were counted and exposed to *T. bactrae* @ 30 eggs : 1 female / cage. The host egg density and parasitoid release ratio was based on the studies of Jalali *et al.* (2001). This process was repeated till all females died. Each day's exposure was kept separately to count the number of eggs parasitized and to record larval hatching. The mortality in egg, larval and pupal stages was recorded. In treatments T_2 (treatment with insecticide – Dichlorvos) and T_3 (treatment with neem seed kernel – Neemarin), cabbage plants were sprayed with Dichlorvos (@ 0.05%) and Neemarin (@ 1500 ppm) once in three days under net house conditions and allowed them to dry. Adults were released on the treated leaves for egg laying and experimental detail and observations recorded were as described above.

The life table was prepared considering the following aspects (Southwood, 1978). The aspects considered were – x = stage interval at which sample was taken, lx = the number living at the beginning of the stage noted in the column x, dx = the number dead within the age interval stated in the column x, dxF = the mortality factor responsible for dx, 100qx = percentage apparent mortality and 100dx/n = number killed as percentage mortality based upon the number of eggs in the beginning. All lx and dx values represent the number of individuals per sample.

The experiment was conducted in the laboratory at 26 ± 2°C and 65 ± 5% RH.

The results on adult moth daily survival and fecundity of DBM (age-specific) studied under untreated condition presented in Table 1 indicated that the oviposition of the *P. xylostella* commenced on 21st day of pivotal age (egg stage to adult emergence and egg laying) and continued up to 33rd day. The fecundity rate (m_x) was observed to increase steadily from 5.0 (on 21st day) to 16.00 eggs (on 23rd day). The female laid greater number of eggs during first six days of its life span. The first female moth died on 25th day of pivotal age and all females died by 35th day (Table 1). The net reproductive rate (R_o) was 66 progenies during its life span of 29.7 days (Table 1). The precise generation time (T) was determined as 23.00 days. The capacity of increase in number (r_m) of female moth was found to be 0.18, whereas the daily finite rate of increase (l) was 1.19 female. The weekly multiplication rate of female moth population was 3.38 and its population doubled in 3.85 days. Therefore, the hypothetical F_2 female population $(R_o)^2$ was estimated as 4356.00

The mean generation time (T_c) of DBM in the present study is in conformity with the result of Hemchandra and Singh (2003), while the net reproductive rate (R_o) is at variance with their findings. This variation may be attributed to difference in climatic conditions and host plant as they used cauliflower in their study. Similar to the present study, Justin *et al.* (2000) recorded reproductive survival rate of 16 days.

The comparative study of the influence of different factors on the life table of DBM

Table 1. Age specific fecundity, longevity and life table statistics of *P. xylostella* on cabbage (26 ± 2°C and 65 ± 5%RH)

Age of ♀ moth (x)	Longevity of ♀ moth (l_x)	Fecundity rate (m_x)	l_xm_x	xl_xm_x
1-19	Immature stages (Egg to adult emergence)			
20	Pre oviposition period			
21	1.0	5.0	5.0	105.0
22	1.0	11.0	11.0	242.0
23	1.0	16.0	16.0	368.0
24	1.0	14.0	14.0	336.0
25	0.8	4.0	3.2	80.0
26	0.8	5.0	4.0	104.0
27	0.8	3.0	2.4	64.8
28	0.8	3.0	2.4	67.2
29	0.8	2.0	1.6	46.4
30	0.8	3.0	2.4	72.0
31	0.8	3.0	2.4	74.4
32	0.8	1.0	0.8	25.6
33	0.8	1.0	0.8	26.4
34	0.4	0.0	0.0	0.0
35	0.0	0.0	0.0	0.0
			$\sum$ = 66.0	$\sum$ = 1958.8

Particulars	Statistical values
R_o = Net production rate	66.0 eggs
T_c = Approximate duration of generation	29.7 days
r_c = Approximate intrinsic rate increase	0.1 females
r_m = Precise intrinsic rate of increase	0.2 females
T = Precise generation time	23.0 days
λ = Finite rate of increase	1.2 females/day
WMR=Weekly multiplication rate	3.4 females
DT=Doubling time	3.9 days
$(R_o)^2$ = Number of estimated females in F_2	4356.0 females

Table 2. Life table for *P. xylostella* on cabbage under untreated and treated conditions (26 ± 2°C and 65 ± 5% RH)

Developmental stage (x)	No. surviving in x (lx)	Factors responsible for dx	No. dying in x (dx)	% apparent mortality (100 q/x)	% real mortality (100 dx/n)	Generation mortality (%)	Generation survival (%)
T. bactrae							
Egg	654.0	Unknown	230.0	35.2	35.2	97.1	2.9
	424.0	Parasitism	240.0	56.6	36.6		
Immature larvae	184.0	Unknown	153.0	83.1	23.4		
Mature larvae	31.0	Unknown	7.0	22.5	1.1		
Pupae	24.0	Unknown	5.0	20.8	0.8		
Adult	19.0						
Dichlorvos							
Egg	595.0	Unknown	208.0	34.9	34.9	99.3	0.7
	387.0	Insecticide	332.0	85.8	55.8		
Immature larvae	55.0	Unknown	48.0	87.2	8.1		
Mature larvae	7.0	Unknown	1.0	14.3	0.2		
Pupae	6.0	Unknown	2.0	33.4	0.3		
Adult	4.0						
Neemarin							
Egg	396.0	Unknown	138.0	34.8	34.8	99.0	1.0
	258.0	Neem application	238.0	92.2	60.1		
Immature larvae	20.0	Unknown	15.0	75.0	3.8		
Mature larvae	5.0	Unknown	1.0	20.0	0.3		
Pupae	4.0	Unknown	0.0	0.0	0.0		
Adult	4.0						
Control							
Egg	635.0	Unknown	222.0	34.9	34.9	87.5	12.5
Immature larvae	413.0	Unknown	310.0	75.1	48.8		
Mature larvae	103.0	Unknown	16.0	15.5	2.5		
Pupae	87.0	Unknown	8.0	9.1	1.3		
Adult	79.0						

(Table 2) revealed that the survival rate of the pest from egg to adult emergence was highest in untreated condition and lowest in dichlorvos treatment. Maximum percentage of apparent and real mortality was observed during egg stage in treated conditions while it was maximum during immature larval stage in untreated conditions. Neemarin treatment caused maximum percent real mortality of eggs (60.1%) followed by dichlorvos (55.8%) and *T. bactrae* (36.6%). The generation mortality based on the different developmental stages of DBM was estimated as 99.3 for dichlorvos, 99.0 for neemarin and 97.1 per cent for *T. bactrae* compared to 87.5% due to unknown factors with their corresponding generation survival of 0.7, 1.0, 2.9 and 12.5 percent, respectively.

The results of the present study revealed that either the release of *T. bactrae* (@ 1 female / 30 eggs / 30 cm^3, (which converts @ 1,00,000/ha) or spray of neemarin (@1500 ppm) were comparable with the spray of insecticide – dichlorvos. Effective control of *P. xylostella* is possible when treated at egg stage and *T. bactrae*, a potential egg parasitoid can be used as a component of IPM package especially in the cabbage ecosystem.

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REFERENCES

Hemchandra, O. and Singh, T. K. 2003. Life table, rate of increase and stable-age distribution of *Plutella xylostella* (Linnaeus) on Cauliflower. *Annals of Plant Protection Sciences,* **11**: 269-273.

Jalali, S. K., Singh, S. P. and Venkatesan, T. 2001. Choice of suitable Trichogrammatid species for suppression of diamondback moth, *Plutella xylostella* (Linnaeus) (Lepidoptera : Yponomeutidae) on cabbage. *Shashpa,* **8** : 161-166.

Justin, C.G.L., Kumar, M. G. and Swamiappan, M. 2000. Life table studies of the diamond back moth, *Plutella xylostella* (L.) on cauliflower, cabbage and mustard. *Madras Agricultural Journal,* **87** : 206-210.

Krishnaiah, K. 1980. Methodology for assessing crop losses due to pests of vegetables. In: Assessment of Crop Loss due to Pests and Diseases. (Eds.: Govindu, H.C., Veeresh, G.K., Walker, T.T. and Jenkyn., J.F.), University of Agricultural Sciences, Technical Series No. **33** : pp. 359-369.

Sannaveerappanavar, V. T., Viraktamath, C. A. and Puttaswamy, 1997. Management of insecticide resistant diamond back moth, *Plutella xylostella* (L.) on cabbage using neem seed kernel extract and other novel insecticides. *Karnataka Journal of Agricultural Sciences,* **10** : 886-888.

Southwood, T. R. E. 1978. Ecological Methods with particular reference to the study of insect populations. 2nd edition. Chapman and Hall, London, 524 pp.

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