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Field life-tables and key mortality factors of important lepidopterous pests of soybean

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Abstract
Present investigation were carried out at the laboratory Department of Entomology, RCA, Udaipur during kharif 2014 and 2015. Life table studies of S. litura on soybean reported that the mortality in egg stages during both the year kharif 2014 and 2015 was due to infertility and unavailability in eggs respectively. The mortality factors in younger larvae (I to III instar) during 2014 and 2015 was due to Braconids, respectively. The cumulative mortality factors in larvae from IV to VI instars during both the years 2014 and 2015 was 54 per cent and 69 per cent due to, N. rileyi, unknown reasons, tachinid fly and disease respectively. Life table studies of semilooper on soybean revealed that the mortality in egg stages during both the year kharif 2014 and 2015 was due to unknown reasons and infertility in eggs respectively. The mortality factors in younger larvae (I to III instar) during 2014 and 2015 was due to parasitization and Braconids, respectively. The cumulative mortality factors in larvae from IV to VI instars during 2014 and 2015 were 54 per cent and 67 per cent due to tachinid fly dispersion, predation, unknown reasons, and disease respectively.

Keywords: *S. litura*, Braconids, semilooper, and instars

Introduction
Soybean [*Glycine max* (L.) Merril] is an important leguminous crop (Leguminosae, sub-family Papilionoaceae) and is the world's largest source of high quality protein (42%) feed and the second largest source of edible oil (20%). Soybean has innumerable possibilities of not only improving agriculture, but also supporting industries; hence, it is known as the "Golden Bean" of the 20th century.

Soya protein possesses an excellent combination of major essential amino acids like leucine in which most of the cereals are deficient. In addition it is a rich source of vitamin B complex, thiamine (11mg/g), riboflavin (34mg/g), methionine, threonine, soluble phosphates and sulphur. Sprouted soybean contains vitamin C, vitamin A, vitamin E (a natural antioxidant) and its byproduct soya milk contains 20 fold higher iron as compared to cow milk (1.3mg/100 ml). Soybean meal is used as protein supplement in diet, cattle and poultry feed.

The feasibility of growing soybean with minimum inputs and management led to the rapid expansion in area and production with the result that India now ranks 4th in terms of soybean cultivation and 5th in terms of soybean production after USA, Brazil, Argentina and China. In India, soybean is mainly grown in the states of Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh, Chhattisgarh, Nagaland and Gujarat as a rainfed crop during the *kharif* season. Soybean occupies 42 per cent of India's total oilseeds and 25 per cent of edible oil production. The total production of soybean during 2014-15 was 103.73 lakh MT from an area of 109.10 lakh hectares with productivity of 951 kg ha^{-1}.In Rajasthan area under soybean is 10.24 lakh ha and production 7.86 lakh tones.

The low productivity of soybean both at national and state level is attributed to abiotic and biotic stresses like drought, weeds, insect pests and diseases. Among these, insect pests often pose a serious threat to soybean production by increasing cost of cultivation and impairing quality of the produce in many ways (Singh *et al.*, 2000) [3].

The luxuriant crop growth, soft and succulent foliage attract many insects and provides unlimited source of food, space and shelter. Soybean is reported to be attacked by more than 380 species of insects in many parts of the world (Luckmann, 1971) [1]. In early seventies about a dozen minor insect pests were recorded on soybean in India, while in 1997 this number has increased to an alarming figure of 270, besides 4 other invertebrates and 10 vertebrates (Singh 1999) [2].

Life-tables and key mortality factors such as predators, parasitoids and pathogen infection are important tools for their management. To study the pest population dynamics, life tables and key mortality factors are useful in management of pests of soybean. Location specific studies

to find out incidence of major insect pests and extent of damage are more important. There is an urgent need to find out eco safe, effective and economically viable techniques by using some newer insecticides, botanicals and use of neem derivatives or neem product.

Material and Methods

The experiment was carried out at the laboratory Department of Entomology, RCA, Udaipur during kharif 2014 and 2015. The first appearance of eggs or larvae of lepidopterous pests infesting soybean were recorded by visiting the field frequently. After hatching of the eggs the larvae were reared on soybean till pupation in plastic boxes of 5 x 5 x 5cm size. The rearing of this culture were consistently made in laboratory till the disappearance of pests on respective food plants in the field. This culture was considered as a check culture for further studies.

Five quadrats (2.25 X 2.00 m) of soybean were observed twice in every meteorological week. All the plants from each quadrant were carefully examined for the presence of larvae and pupae of lepidopterous pests. The observations were made on the mortality of larvae and pupae of lepidopterous pests infesting soybean by parasitoids, entomopathogens and unknown reasons. An interval of 4 to 6 days was provided before sampling of eggs of next generation after the mean adult emergence of previous generation. This period was considered for completion of oviposition by the moths of previous generation.

Methods of regarding observations

Eggs

The eggs collected from the field were brought to the laboratory and reared till hatching or emergence of any parasitoid adults. The observations were made on the per cent natural mortality of eggs, number of the eggs hatching into the larvae, per cent parasitization in eggs.

Larvae

The larvae collected from the field were brought to the laboratory and reared on soybean leaves till pupation and mortality due to biotic factors, survival rate of each instar and unknown caused were recorded separately.

Pupae

For pupae, the observations were made on the number of matured larvae released for pupation from field and per cent mortality/survival rate of pupae, factors responsible for pupal mortality, per cent adult emergence and pupal period were recorded separately.

Adult

In adults, observations were made on the adult longevity of male and female, sex ratio, survival rate.

Results and Discussion

Table1: Stage dependent life table of *Spodoptera litura* on soybean (Average of 5 quadrants *Kharif* 2014)

Stage	Initial No. insects	No. of Deaths	Mortality factor/s	Mortality (d)	Survival(s)	K value (- log $_e$ (s))
Egg	540	190	infertility	0.35	0.65	-0.43
Larvae I – III	100	22	Braconids	0.22	0.78	-0.24
Larvae IV – VI	78	19	*N. rileyi*	0.24	0.76	-0.27
Larvae IV – VI	59	14	unknown	0.23	0.77	-0.26
Larvae IV – VI	45	10	Tachinid fly	0.22	0.78	-0.24
Pre-pupae	35	11	dessication	0.31	0.69	-0.37
Pupae	24	09	Malformed pupae	0.37	0.63	0.46
Pupae	15	08	Pupal deformity	0.53	0.47	0.75
Adults	07*	-	-	-	-	-
Adult male	04	-	-	-	-	-
Adult female	03	-	-	-	-	-

The data is presented in table (1) represents that the initial number of eggs taken was 540 the mortality in egg stage was 0.35 per cent due to infertility in eggs. The mortality factors in larvae from I to III instar was 0.22 per cent due to *Braconids.* The recorded male to female ratio was 1.3:1. The cumulative mortality in larvae from IV –VI instars was 54 per cent due to *Noumeriya rileyi*, unknown reasons and *Tachinid fly*.

Table 2: Stage dependent life table of *Spodoptera litura* on soybean (Average of 5 quadrants *Kharif* 2015)

Stage	Initial No. insects	No. of Deaths	Mortality factor/s	Mortality (d)	Survival(s)	K value (- log $_e$ (s))
Egg	510	186	unviability	0.36	0.64	-0.45
Larvae I – III	100	38	Braconids	0.38	0.62	-0.48
Larvae IV – VI	62	18	unknown	0.29	0.71	-0.34
Larvae IV – VI	42	15	tachinid fly	0.35	0.65	-0.43
Larvae IV – VI	27	09	disease	0.33	0.67	-0.40
Pre-pupae	18	06	dessication	0.33	0.67	-0.40
Pupae	12	04	Pupal deformity	0.33	0.67	-0.40
Pupae	08	04	Adult not emerged	0.50	0.50	-0.69
Adults	04		-	-	-	-
Adult male	02	-	-	-	-	-
Adult female	02	-	-	-	-	-

The data is presented in table (2) represents that the initial number of eggs taken was 510 the mortality in egg stage was 0.36 per cent due to unviability in eggs. The mortality factors in larvae from I to III instar was 0.38 per cent due to *Braconids.* The recorded male to female ratio was 1:1. The cumulative mortality in larvae from IV –VI instars was 69 per cent due to unknown reasons, *Tachinid fly* and disease.

Table 3: Stage dependent life table of semilooper on soybean (Average of 5 quadrants *Kharif* 2014)

Stage	Initial No. insects	No. of Deaths	Mortality factor/s	Mortality (d)	Survival(s)	K value (- log $_e$ (s))
Egg	90	38	unknown	0.42	0.58	-0.54
Larvae I – III	50	08	parasitized	0.16	0.84	-0.17
Larvae IV – VI	42	09	*Tachinid fly*	0.21	0.79	-0.24
Larvae IV – VI	33	06	dispersion	0.18	0.82	-0.19
Larvae IV – VI	27	08	predation	0.29	0.71	-0.34
Pre-pupae	19	05	Incomplete pupation	0.26	0.74	-0.30
Pupae	14	06	Unsuccessful emergence	0.42	0.58	-0.54
Pupae	08	03	Pupal deformity	0.37	0.63	-0.46
Adults	05	-	-	-	-	-
Adult male	02	-	-	-	-	-
Adult female	03	-	-	-	-	-

The data is presented in table (3) represents that the initial number of eggs taken was 90. The mortality in egg stage was 0.42 per cent due to unknown reasons. The mortality factors in larvae from I to III instar was 0.16 per cent due to *parasitization.* The recorded male to female ratio was 1:1.5. The cumulative mortality in larvae from IV –VI instars was 54 per cent due to *tachinid fly*, dispersion and predation.

Table 4: Stage dependent life table of semilooper on soybean (Average of 5 quadrants *Kharif* 2015)

Stage	Initial No. insects	No. of Deaths	Mortality factor/s	Mortality (d)	Survival(s)	K value (- log $_e$ (s))
Egg	80	26	infertility	0.32	0.68	-0.38
Larvae I – III	50	12	Braconids	0.24	0.76	-0.27
Larvae IV – VI	38	09	tachinid fly	0.23	0.77	-0.26
Larvae IV – VI	29	10	unknown	0.34	0.66	-0.54
Larvae IV – VI	19	07	dispersion	0.36	0.64	-0.45
Pre-pupae	12	04	Malformed pupae	0.33	0.67	-0.40
Pupae	08	03	Pupal deformity	0.37	0.63	-0.46
Pupae	05	03	Adults not emerged	0.60	0.40	-0.92
Adults	02	-	-	-	-	-
Adult male	01	-	-	-	-	-
Adult female	01	-	-	-	-	-

The data is presented in table (4) represents that the initial number of eggs taken was 80. The mortality in egg stage was 0.32 per cent due to infertility in eggs. The mortality factors in larvae from I to III instar was 0.24 per cent due to *Braconids.* The recorded male to female ratio was 1:1. The cumulative mortality in larvae from IV –VI instars was 67 per cent due to unknown reasons, *tachinid fly* and disease.

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