Int. J. Biol. Res., 2(2): 97-100, 2014.

HORIZONTAL AND VERTICAL LIFE TABLES AND SURVIVORSHIP CURVES OF COTTON LEAFHOPPER *AMRASCA DEVASTANS* (DISTANT) (HOMOPTERA: CICADELLIDAE) AND THE DISTRIBUTION OF MORTALITY WITH AGE.

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ABSTRACT

Horizontal (age-specific) and vertical (time-specific) life tables and survivorship curves of cotton leafhopper *Amrasca devastans* (Distant) (Homoptera: Cicadellidae) is presented following Slobodkin (1962), Southwood, 1978) in lab and in the field at Karachi university campus respectively. The most vulnerable stages of its life cycle are recognized. The mortality per 1000 (q_x) was high among 1st and 2nd instars and drastically decreased in later stages of development. The mortality per 1000 (q_x) in laboratory specimen 200 among 1st instar and was 250 among 2nd instar. In the field the mortality per1000 (q_x) was 554 among 1st instar and was 164 among 2nd instar. Both types of survivorship curves apparently resembled type III & IV of Slobodkin (1962) with heaviest mortality occurred at early stages of life cycle.

KEYWORD: Life table, Survivorship curve, Mortality, Cotton leaf hopper Homoptera: Cicadellidae.

INTRODUCTION

Cotton is the leading cash crop giving foundation to the economy of Pakistan. Cotton leaf hopper *Amrasca devastans* (Distant) is among most common sucking insect pest that completes several generations during the season. All the stages of its life cycle are capable to suck plant sap by their piercing and sucking type of mouth parts and may spread virus or other disease producing pathogens. In almost all cases the leaf hoppers start its activity with the emergence of seedlings and establish its population with growth of crop. A life table is a convenient format for describing the mortality schedule of a population. Richards (1940) and Deevey (1947) were the first to focus attention on the importance of life table approaches in population studies of animal ecology, in economic entomology and in insect control. Southwood *et al.* (1972) constructed the life table for *Aedes aegypti.* Ahmad (1988) discusses the significance of inferences drawn from life table data in integrated pest management (IPM). The "survivorship curves" is the graphical representation of the fall off of numbers with time in a given age (lx), is plotted against the age "x". The shapes of the curve describes the distribution of mortality with age. Slobodkin (1962) described four types of survivorship curves. Mortality is one of the four key parameters that drive population changes. The object of the present work is to find out comprehensive knowledge about the life cycle and population dynamic, highlighting most vulnerable stage at which the pest population is found to be weaker and fragile to face environmental stress. The knowledge of such information help to seek better, economical and safer management strategies of above mentioned pest, which may be helpful in constructing a strong foundation, and to significantly improve the efficiency and sustainability of insect pests management systems for this cosmopolitan pest in Pakistan.

MATERIALS AND METHODS

For the construction of for horizontal life table the counted number of 1st instar larvae of cotton leaf hopper was released in different petridishes and were provided with leaves of alternate host plants *Abelmoschus esculentus* (L.) Moench. The proportions of individuals surviving from 1st instar to adult were counted from day to day. The immatures dying in a particular age group "d_x" were calculated, subtracting the number entering into the next age group, from the value of that age group. The life expectancy "e_X" of each instar was calculated by dividing the T_X (total number of animals x age units beyond the age x,) with l_X (the number surviving at the beginning of age class (i.e. T_X / l_x), whereas, the mortality rate in one group "q_X" per thousand was calculated by dividing the value of "d_X" by "l_X" and multiplying it by 1000, using the above data the survivorship curves were plotted, following Slobodkin (1962).

For the construction vertical survivor ship curve the specimens were collected from the local field of *Abelmoschus esculentus* at Karachi University campus measuring 12 x 4 feet for each field. On each sampling date one to two persons worked for one hour usually before sunset on every 5th day. The samples were taken from randomly selected leaves and stems of 8 to 10 plants from top to bottom. Both nymphs and adults of cotton leaf hopper were recorded by using leaf turn method following Ellsworth *et al.* (1995) and Naranjo *et al.* (1996) in addition searching method was also adopted following Johnson and Mellanby (1942) and Nelson *et al.* (1957). The variations in different physical factors like mean maximum temperature, mean minimum temperature and mean % humidity were recorded as shown in Table 3.

RESULTS

Age specific and time specific life budgets of *A. devastans* (Tables 1 and 2) and horizontal survivorship curves (Fig: 1A & B) apparently resembled 3rd or 4th types of Slobodkin (1962) in which the mortality was found to be increased with age. Age specific life table showed the mortality rate per 1000 (q_x) was 200 among 1st instar and was 250 among 2nd instar. Time specific life table showed the mortality rate per1000 (q_x) was 554 among 1st instar and was 164 among 2nd instar. Both types of survivorship curves apparently resembled type III & IV of Slobodkin (1962) with heaviest mortality occurred at early stages of life cycle. The low mortality rate among late instars probably showed their better adaptability to climatic and physical stress.

Table 1. Age specific life table of *A. devastans* in laboratory.

X	l_x	d_x	L_x	T_x	e_x	$1000q_x$
1st	1000	200	900	3980	3.98	200
2nd	800	200	700	3080	3.85	250
3rd	600	80	660	2380	3.96	133
4th	720	20	710	1720	2.38	27.7
5th	700	20	680	1010	1.4	28.5
Adult	660	660	330	330	0.5	1000

Table 2. Time specific life table of *A. devastans* in field.

X	l_x	d_x	L_x	T_x	e_x	$1000q_x$
1st	465	258	336	1022.5	2.19	554.8
2nd	207	34	190	686.5	3.3	164
3rd	173	18	164	496.5	2.86	104
4th	155	24	143	332.5	2.14	154
5th	131	07	127.5	189.5	1.4	53
Adult	124	124	62	62	0.5	1000

Table 3. Standard means error of various physical factors at 95% C.I.

Physical factors	Mean ± SE	95.0 % C.I
Maximum Mean Temperature	34.333 ± 0.211	(33.791, 34.875)
Minimum Mean Temperature	26.000 ± 0.258	(25.336, 26.664)
Means % Humidity	60.00 ± 1.69	(55.65, 64.35)

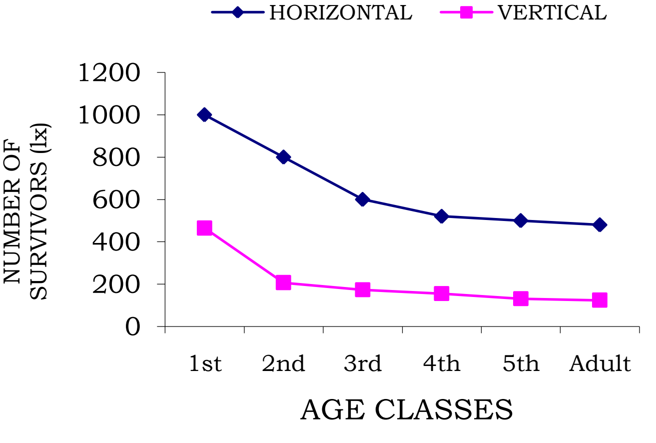

Fig. 1. Comparative survivorship curves of *Amrasca devastans* (Distant) in laboratory and in field.

DISCUSSION

The present finding is found to be in agreement with the finding of Richard (1940) he reported the successive reductions in the population of an insect throughout a single generation. Sisli and Bosgelmez (1973 a, b) in different sub sp. of *N. viridula* (L) also reported heavy mortality in immature stages, which appears to confirm the present conclusion. Ahmad (1978) in his life budget studies on *Schoenobius incertulas* (walker) also reported that the young larvae I+II and middle stage (qx=540X603) were more vulnerable to disturbance and die when removed from their natural tillers but the later stages were more adaptable and even tolerated the disturbance when removed from them. Similarly Ahmad *et al.* (1979) in their age specific life table studies of *Shoenobius incurtulas* (Walker) they also reported maximum mean percent mortality in the 1st (I+II) and middle (III+ IV) stages and no mortality in the last (IV+V) larval stage. In the present work maximum mortality was observed among 1st, 2nd and 3rd instars of *A. devastans* that become decreased during later stage of life cycle probably because they are more adaptable and tolerant to disturbance than the immature. The difference between the present and the findings of Ahmad and Mohammad (1982) might be associated with different pests or different host plant. They described in their horizontal life budget of *Lestonocoris karachiesis* on *Barleria prionotis* L. The survivorship curves plotted were slightly modified type I and II of Slobodkin (1962).

Ahmad (1983b) confirmed his earlier results (Ahmad, 1983a) through the field data with better natural conditions and reported the heaviest mortality in the egg stage after which the mortality rate decreased regularly, which appears to be in agreement with the present findings.

Ahmed & Zaidi (1985) also estimated high mortality rate in field as compared to laboratory data in survivorship study of *Dysdercus koegnii* (F) and concluded the highest population in August and the highest mortality in the initial stages of the life cycle. In the present study highest mortality also appeared in the initial stages of life cycle.

Ahmad and Onder (1990) constructed survivorship curves of *Trichophora* bugs from laboratory and field data which were almost the 4th type of Slobodkin (1962) in which the mortality in the earliest stage of the life cycle i.e. egg stage was the highest but in the immature stages the mortality rate appeared to be fairly consistent making almost a straight line. The survivorship curves of *A. devastans* constructed from the field data appeared to be a slight deviation from the above finding largely might be due to omitting the “egg stage” in present study. The egg and early instars probably are more vulnerable to biotic and abiotic factors in the field and showed high mortality rate as compared to later stages of life cycle which were found to be more adaptable and more tolerant to the climatic changes.

Thirakhupt & Araya (1992) drew the survivorship curve of the bird cherry-oat aphid, *Rhopalosiphum padi* (L.), and English grain aphid, *Sitobion avenae* (F.), from the laboratory data. The survivorship curves for *R. padi and S. avenae in* single or mixed colonies were similar to the Type I of general survivorship curve. The mortality was somewhat constant until the individuals reached the post reproductive stage and then increased sharply (about 7 wk for *R. padi and* 9 wk for *S. avenae)*, but showed different survivorship pattern in the field, because of the influence of climatic conditions, natural enemies and migration. In the present investigation the constructed survivorship curves were type (IV) and (III) of Slobodkin (1962) with some deviations, which was more dominant in the field data influence of climatic conditions, natural enemies and migration are taken into consideration in present study. Ahmad *et al.* (1995) studied the biology and population dynamics of legume bug *Piezodorus hybneri* (Gmelin) and reported that the egg stage appears to be the most vulnerable stage followed by 1st immature stage (q_x = 250.0 & 133.33 respectively). In the present findings high mortality was also noticed among immature stages i.e. 1st, 2nd and 3rd, (q_x = 200.0 & 250 respectively).

Ge F *et al.* (2003) in their comparative study on population dynamics & natural life table of *Helicoverpa armigera*, cotton boll worm in northern China and southern China recorded higher mortality in its egg stages to the second instar and lower after 3rd instar . In the present findings the 1st, 2nd instars of leaf hoppers were found to be most vulnerable with higher mortality rate than the older stages and the field data also showed even higher mortality as compared to laboratory observation.

Ali and Rizvi (2010) described the effect of various temperature on the age and stage specific life table of *coocinela septemounctata* (Coleoptera : coccinellidae) and concluded the expectancy of life exhibited a continuous decline with advancement of age in present finding heavy mortality observed in early stages with low expectancy of life the difference might be due to diffence in experimental species.

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(Received July 2013; Accepted July 2014)