Research Article

Life table studies of three mango hopper species in field conditions

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Abstract

Mango is a fruit-producing tropical tree belonging to the flowering plant genus *Mangifera*, cultivated mostly for their edible fruit. Most of these species are found in nature as wild mangoes. The present study was conducted in the Horticultural Garden, Sindh Agriculture University, Tandojam, Pakistan. Life table studies revealed that the surviving fraction (S_x) in the egg stage of *Amritodus atkinsoni*, *Idioscopus clypealis*, and *Idioscopus niveosparsus*, was calculated as 0.94, 0.95, and 0.97; Mortality survival ratio (MSR) were 0.07, 0.05, and 0.04 and Indispensable mortality (IM) were 65, 49 and 35. Similarly, the S_x in nymphs of all three hopper species were calculated as 0.942, 0.954, and 0.964; MSR were 0.062, 0.048, and 0.036 and IM were 48.8, 39.8, and 31.0, respectively. The k-value from egg to 5th instar nymph of *A. atkinsoni* ranged (0.01-0.03), *I. clypealis* (0.02-0.03), and *I. niveosparsus* (0.01-0.02). It is concluded that mortality, apparent mortality, mortality, survival ratio, and indispensable mortality were highest in egg, 3rd, and 4th instars of *I. clypealis*. However, the maximum K-value was recorded among egg, 3rd, and 4th instars, respectively. In the case of *A. atkinsoni* with a variation in k- value that was maximum in 3rd and 4th instars. Life table studies of *I. niveosparsus* revealed that maximum apparent mortality, survival fraction ratio, and indispensable mortality were noted in the 4th instar. Whereas the maximum k-value was recorded in egg, 3rd, 4th, and 5th instar nymphs. The total K-value was highest in the case of *I. clypealis* followed by *A. atkinsoni* and *I. niveosparsus*, respectively.

Keywords: *Amritodus atkinsoni*; *Idioscopus clypealis*; *Idioscopus niveosparsus*; Life table

Introduction

Mango (*Mangifera indica* L) most delicious fruit in the world. This fruit is the most favored of the subcontinent and designated as king of all fruits. It is ranked as mostly due to its better flavor, pleasant taste, and possess massive nutritional worth, containing vitamins A and C. It has been cultivated in South Asia for the last four thousand years [1]. Presently this fruit is commercially grown in the subtropical regions mainly Pakistan, India, and Bangladesh. The Asian countries

contribute 77%, Americas and African shares for 13 and 9%, in mango production, respectively [2]. Therefore, mango production is adversely affected when insect species cause damage from nursery raising to its harvesting. Nearly three hundred plant feeder's insects have been recorded to ravage the mango orchard in different areas of the world [3]. Amongst these insect pests about more than twelve species are considered major insect pests, which are responsible to cause heavy yield loss in mango fruit [4]. Tara *et al.* [5]

reported that mango plants are adversely affected by various sucking insects. The majority of mango hoppers species like *I. clypealis*, *A. atkinsoni*, and *I. neviosparsus* are considered major insect pests. Both nymphs and adults of mango hoppers damage to new flushes, leaves, and inflorescences of mango plants [6-8]. Patel *et al.* [3] reported that nymphs and adults of the hoppers making a pinhole in the tender shoots, inflorescences, and leaves suck the sap from it, which causes the absence of flower-bearing and falling of immature fruits, and cause a reduction in yield. Hoppers were also responsible to promote sooty molds, that cause fungal disease on the lower side of leaves, branches, and fruits in moist weather. Within few days of the attack, the whole leaf becomes blackish that restricts the photosynthetic movement in plants. This injury is denoted as a honeydew disease. More than 50% of crop losses have been recorded due to severely infested trees. Mango hopper species (*I. clypealis*, *I. niveosparsus* and *A. atkinsoni*) have great impact due to their long-term flight on panicles and leaves, respectively [9]. Similarly, [7] observed both *A. atkinsoni* and *I. niveosparsus* on the upper portions of mango trees at different times of the year. Mango hoppers were settled on the crop during the vegetative and reproductive phases. The highest occurrence was observed during the blossom phase of the crop after which the insects traveled to cracks and crevices of the trunk [10]. Various studies were conducted by Anitha *et al.* [11] on the impact of abiotic factors on the occurrence of the hopper and its management practices by using agro-chemicals in the mango field. However, there is a basic need to conduct a comprehensive study to determine the impact of environmental factors on different life stages of mango hoppers.

Materials and methods

This research was carried out in Horticultural Garden, Sindh Agriculture University, Tandojam. Three years old mango plants were brought into the field

and planted in the pits prepared, during its flowering stage to record the life table of the mango hopper. For this purpose, newly hatched (1000) eggs of each of three mango hopper spp. were kept separately on inflorescence. Then mango plant was caged into a wooden frame of five feet width and five feet height which was covered with a green muslin cloth to prevent the in and out movement of any living organism, it was done to just decrease the error in data to be recorded throughout the observation period. Thereafter, the observations were recorded on several surviving eggs, nymphs, and adults of mango leafhopper carefully with the help of magnifying glasses, camel brush, and Ariel net. The life table was constructed according to the formula described by [12].

x = Stage of the insect

l_x = Number surviving at the beginning of the stage x

dx = Mortality during the stage indicated in the column x

$100q_x$ = Apparent mortality

S_x = Survival fraction

MSR = Mortality survival ratio

IM = Indispensable mortality

L_x = Log

K-value = Killing value

The data calculated through the above assumptions were used for computing various life parameters as given below:

Apparent mortality (100q)

It gives the information on x number dying as a percentage of number entering that stage and was calculated by using the formula;

$$\text{Apparent Mortality} = [d / l] \times 100 \text{ Survival Fraction } (S_x)$$

The data obtained on apparent mortality was used for the calculation of the stage-specific survival fraction (S_x) of each stage by using the equation;

$$S_x \text{ of particular stage} = [l_x \text{ of subsequent stage}] / [l_x \text{ of particular stage}]$$

Mortality survivor ratio (MSR)

It is the increase in population that would

have occurred if the mortality in the stage, in question had not occurred and was calculated as follows;

MSR of particular stage = [Mortality in particular stage]/ [1x of subsequent stage]

Indispensable mortality (IM)

This type of mortality would not be there in case the factor (s) causing it is not allowed to operate. However, the subsequent mortality factors operate. The equation is;

IM = [Number of adults emerged] x [M.S.R. of particular stage]

K-values

It is the key factor, which is primarily responsible for increase or decrease in number from one generation to another and was computed as the difference between the successive values for "Log l_x ". However, the x total generation mortality was calculated by adding the k values of different development stages of the insect, which is designated/ indicated as "K" [13, 14].

$K = k_E + k_{N1} + k_{N2} + k_{N3} + k_{N4} + k_{N5}$
 Where, $k_E + k_{N1} + k_{N2} + k_{N3} + k_{N4}$ and k_{N5} are the k-values at the egg and nymphal stages of 1st, 2nd, 3rd, 4th, and 5th instar of mango hoppers.

Results and discussion

The results presented in (Table 1). indicated the stage-specific life table experiments of mango hopper species, under field conditions. The following results were achieved after the completion of observations.

Surviving fraction (Sx)

The outcome described in (Table 1). initiated that survival fraction in maximum counts was 0.94 *I. clypealis* while the maximum counts for *A. atkinsoni* for same were 0.95 whereas the maximum figure in this regard pertained with *I. nevioparsus* was also observed that uppermost Survival fraction (Sx) was calculated 0.98 in first instar of *I. nevioparsus*, whereas *A. atkinsoni* had 0.97 and *I. clypealis* 0.96 during 1st instar. In the same way highest

survival fraction for 2nd moulting period was 0.97 for *A. atkinsoni* and 0.96 for *I. nevioparsus* but the counts were distinct for *I. clypealis* which were 0.95. The 3rd instar observation revealed that maximum survival fraction recorded *I. nevioparsus* 0.96 *A. atkinsoni* 0.94 and *I. clypealis* 0.93 after the completion of 3rd instar insect stepped in 4th instar in this instar the peak survival fraction recorded for mango hopper species was *I. nevioparsus* 0.94 *A. atkinsoni* 0.93 and *I. clypealis* 0.93. In this way, the 5th instar maximum survival fraction calculation was *I. nevioparsus* 0.95 *A. atkinsoni* 0.94 and *I. clypealis* 0.94. Hence it was observed that the maximum survival fraction was noted for mango hopper species *I. nevioparsus* during 1st, 3rd, 4th, and 5th instar while the highest survival fraction during 2nd instar was recorded in *A. atkinsoni*. Whereas the lowest population of survival fraction was recorded in *I. clypealis* during 1st, 2nd, and 3rd instar while the 4th and 5th *atkinsoni* and *I. clypealis* which was 0.93.

Apparent motility (100 qx)

Peak outcome of apparent mortality for egg stage of the hopper was recorded in *I. clypealis* which was 6.5 % followed by *A. atkinsoni* 4.9 % and *I. nevioparsus* 3.5 % mortality. For the period of 1st instar the maximum mortality calculated in *I. clypealis* was 3.85 % while the lowest record was for *A. atkinsoni* 3.26 % and *I. nevioparsus* 2.18 % mortality. Apparent mortality for 2nd instar calculation revealed that maximum mortality has occurred in *I. clypealis* 5.01 % although lowest mortality counts were 3.92 % In *I. nevioparsus* and death percentage for *A. atkinsoni* in this instar was 3.04 %. 3rd instar mortality peak was recorded at 7.26 % in *I. clypealis* followed by 5.61% in *A. atkinsoni* and 3.64 % in *I. nevioparsus*. The same procedure for mortality counts also continued during the 4th instar, the maximum mortality percentage for this instar was 7.45 % in *I. clypealis*, while the lowest mortality recorded was 7.13 % in *A. atkinsoni* followed by 5.48 % in *I. nevioparsus*.

Highest mortality in the 5th instar was calculated in 5.73 % *I. clypealis* followed by *A. atkinsoni* 5.63 % and *I. nevioparsus* 5.10 %. These results revealed that the highest mortality percentage throughout the observation was in *I. clypealis*, which

happened in all instars. Although the lowest mortality percentage during 1st, 3rd, 4th and 5th instar was counted in *I. nevioparsus* whereas the minimum mortality percentage for 2nd instar was recorded in *A. atkinsoni*.

Table 1. Life table of mango hopper species on inflorescences of the mango plant in field conditions

Stage (x)	No. surviving at the beginning of stage (lx)	No. dying in each stage (dx)	Apparent mortality (100qx)	Survival fraction (Sx)	Mortality survivor ratio (MSR)	Indispensable mortality (IM)	Log (lx)	k-Value
<i>Idioscopus clypealis</i>								
Eggs	1000	65	6.50	0.94	0.07	65.00	3.00	0.03
1 st instar	935	36	3.85	0.96	0.04	36.00	2.97	0.02
2 nd instar	899	45	5.01	0.95	0.05	45.00	2.95	0.02
3 rd instar	854	62	7.26	0.93	0.08	62.00	2.93	0.03
4 th instar	792	59	7.45	0.93	0.08	59.00	2.90	0.03
5 th instar	733	42	5.73	0.94	0.06	42.00	2.87	0.03
Adults	691	691	100.00				2.84	
								0.16
<i>Amritodus atkinsoni</i>								
Egg	1000	49	4.90	0.95	0.05	49.00	3.00	0.02
1 st instar	951	31	3.26	0.97	0.03	31.00	2.98	0.01
2 nd instar	920	28	3.04	0.97	0.03	28.00	2.96	0.01
3 rd instar	892	50	5.61	0.94	0.06	50.00	2.95	0.03
4 th instar	842	53	6.29	0.94	0.07	53.00	2.93	0.03
5 th instar	789	37	4.69	0.95	0.05	37.00	2.90	0.02
Adults	752	738	98.14				2.88	
								0.12
<i>Idioscopus niveoparsus</i>								
Eggs	1000	35	3.50	0.97	0.04	35.00	3.00	0.02
1 st instar	965	21	2.18	0.98	0.02	21.00	2.98	0.01
2 nd instar	944	24	2.54	0.97	0.03	24.00	2.97	0.01
3 rd instar	920	33	3.59	0.96	0.04	33.00	2.96	0.02
4 th instar	887	46	5.19	0.95	0.05	46.00	2.95	0.02
5 th instar	841	31	3.69	0.96	0.04	31.00	2.92	0.02
Adults	810	781	96.42				2.91	
								0.09

Mortality survival ratio (MSR)

The given data in (Table 1). shows that the maximum mortality survival ratio of egg stage was found at 0.07 in hopper species *I. clypealis* whereas, the minimum mortality survival ratio was 0.05 calculated in *A. atkinsoni* and 0.04 calculated for *I. nevioparsus*. Data counts show that the highest MSR during 1st instar stage of the hopper belongs to 0.04 in *I. clypealis*

followed by *A. atkinsoni* (0.03) and *I. nevioparsus* (0.02). Data revealed for 2nd instar the maximum MSR was 0.05 for *I. clypealis* and the lowest was *I. nevioparsus* 0.04 and *A. atkinsoni* 0.03. The Highest MSR during 3rd instar of the mango hopper was found in *A. atkinsoni* 0.08 although the lowest MSR counts were 0.06 in 0.04 in *A. atkinsoni* and *I. nevioparsus*. Calculated data shows that *I.*

clypealis and *A. atkinsoni* had the same MSR which was 0.08 while *A. atkinsoni* stands with the lowest MSR of 0.06. Just like the 4th instar, the MSR recorded for the 5th instar was the same for *I. clypealis* and *A. atkinsoni* which were counted as 0.06 while *I. nevioparsus* reported with the lowest MSR 0.05.

Indispensable mortality (IM)

While the recording of Indispensable mortality (IM) was observed which showed that the maximum (IM) in egg stage was (65) in *I. clypealis* the factor of mortality was infertility, whereas the same factor was recorded and calculated in *A. atkinsoni* which was (49) eggs, whereas the lowest number of eggs were (35) recorded in *I. nevioparsus*. The highest mortality during 1st instar revealed (36) in *I. clypealis*, although it was less in *A. atkinsoni* with (31) nymphs the mortality for this stage counted (21) nymphs in *I. nevioparsus*.

Mortality during 2nd nymphal instar indicated maximum numbers (45) in *I. clypealis* followed by (37) and (28) in *I. nevioparsus* and *A. atkinsoni* respectively. Peak numbers of mortality occurred throughout 3rd nymphal stage was (62) for *I. clypealis* while the lower and lowest was recorded as (50) and (33) for *A. atkinsoni* and *I. nevioparsus* respectively. Mortality all over the 4th molting stage was (60) in *A. atkinsoni* followed by *I. clypealis* (59) nymphs and minimum was (51) in *I. nevioparsus*. Mortality that occurred within the 5th nymphal stage was highest in *A. atkinsoni* with (44) nymphs pursued by *I. clypealis* and *I. nevioparsus* with the same mortality was seen (42).

k-value

The result shows that the minimum k-value during the egg stage was recorded at 0.02 in *A. atkinsoni* and *I. nevioparsus*, while the maximum was recorded in *I. clypealis*. 0.01. Similarly, k-value was calculated as minimum during 1st nymphal instar for it was once again *A. atkinsoni* as well *I. nevioparsus* whereas the highest was 0.02 pertained with *I. clypealis*. The 2nd moulting stage revealed that maximum k-

value was counted as in *I. clypealis* and *I. nevioparsus* while the lowest k-value 0.01 was in *A. atkinsoni*. 3rd instar described the lowest k-value 0.02 of *A. atkinsoni* although the maximum was in both of the rest of mango hopper species. 0.03 k- value was recorded for all of three mango hopper species throughout the 4th immature stage. 5th instar revealed that *A. atkinsoni* and *I. clypealis* both were with peak k-value which was 0.03 but the k-value of *I. nevioparsus* was 0.02 which was lowest.

The outcome of the present investigation describes that the non-significant mortality and apparent mortality, mortality survival ratio, and indispensable mortality were highest in egg, 3rd, and 4th instars of *I. clypealis* whereas survival fraction was recorded non-significant for all life stages. However, maximum non- significant K-value were recorded among egg, 3rd, and 4th instars, respectively. Almost the same trend of life table data was recorded in the case of *A. atkinsoni* with a variation in k- value that was maximum in 3rd and 4th instars. Life table studies of *I. nevioparsus* revealed that maximum apparent mortality, survival fraction ratio, and indispensable mortality was note in the 4th instar. Whereas non-significant maximum k-value was recorded in egg, 3rd, 4th, and 5th instar nymphs. The total K-value was highest in the case of *I. clypealis* followed by *A. atkinsoni* and *I. nevioparsus*. Almost the same results were seen in the experiment conducted by various researchers. [15] revealed the same results during life table studies of cotton mealybug. They revealed that the highest killing rate was recorded in 1st instar, whereas the maximum survivorship was seen in the 3rd instars and pupae along with overall k-value (0.35). [16] examined at the highest MSR figures in the pre-pupal (0.04) and pupal stages (0.06), whereas the lowest (0.01) mortality was seen in the coccinellid species. Similarly, [17] described the overall “K” in all subsequent stages were seen at maximum (0.2676) and minimum (0.1079) levels. [18] reported that the quality of host

plant food influenced the fecundity of herbivorous insects were determined in the individual and the population scale. The nutritional quality of plants significantly influences insect survival, growth, and egg-laying capacity [19]. Due to nutrient deficiency in host plants that adversely affected survival, body size, and development rate of the species. Whereas, the findings of [20] also endorsed to the [21] that population dynamics of plant-feeding insects can be significantly influenced by heterogeneousness in the quality of the plant. The natality and mortality of plant feeders were adversely affected by changing parameters that occur inside the plants such as survivor, growth, and fecundity. Similarly, [12] and [22] reported the highest death rate in Indian mustard followed by yellow Sarson, gobhi Sarson, and cauliflower in all life stages of *P. brassicae* due to an imbalance of the nutritional cycle of host plants. The highest survival fractions were observed at the immature stage of development on the cabbage as compared to other cole crops [23]. Shahjahan *et al.* [24] reported apparent mortality (100qx) was maximum (11.11) for pupa and minimum (5.00) was during 3rd instar of *Chrysoperla carnea* fed on *Planococcus citrimealy* on the citrus plant.

Conclusion

It is concluded that mortality, apparent mortality, mortality, survival ratio, and indispensable mortality were highest in egg, 3rd, and 4th instars of *I. clypealis*. However, the maximum K-value was recorded among egg, 3rd, and 4th instars, respectively. In the case of *A. atkinsoni* with a variation in k- value that was maximum in 3rd and 4th instars. Life table studies of *I. neviosparsus* revealed that maximum apparent mortality, survival fraction ratio, and indispensable mortality was noted in the 4th instar. Whereas the maximum k-value was recorded in egg, 3rd, 4th, and 5th instar nymphs. The total K-value was highest in the case of *I. clypealis* followed by *A. atkinsoni* and *I.*

neviosparsus, respectively.

Author's contributions

Conceived and designed the experiments: RRH Awan, Performed the experiments: RRH Awan & AG Lanjar, Analyzed the data: RRH Awan, AG Lanjar & A Bukero, contributed materials/ analysis/ tools: A Bukero & IA Nizamani, Wrote the paper: RRH Awan & A Bukero.

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