Research Article

A CASE STUDY OF CHINESE CITRUS FLY (*BACTROCERA MINAX* ENDERLIN) (DIPTERA: TEPHRITIDAE) PUPAE IN SINDHULI DISTRICT, NEPAL

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ABSTRACT

A case study was conducted in the Sweet Orange Superzone, Sindhuli to study the sex ratio and mortality of Chinese citrus fly (*Bactocera minax* Enderlin) pupae. The Chinese citrus fly infestation rates on the orchard was taken as treatment i.e. 0-20% fruit infestation, 21-40% fruit infestation, 41-60% fruit infestation, 61-80% fruit infestation and 81-100% fruit infestation. The pupal density was found directly proportional to the rate of orchard infestation with the highest 35.67 pupae per square meter in 81-100% fruit infested orchards. The average pupal mortality was found to be 30.06% and was found to be directly proportional to the level of fruit infestation by the fruit fly maggots. The adult emergence rate was statistically at par on the highly infestation orchard than those of partially infested orchard. The emerged adult's sex ratio was found to be mixed and was not statistically at par for all the different fruit infestation levels and was found to be 0.91.

Key words: *Bactocera minax, emergence, pupal mortality, sex ratio, sweet orange*

INTRODUCTION

Citriculture is an emerging sector in the world, which is also, equally important in Nepal. There is huge demand of fruit in domestic and international market (Adhikari and GC, 2020). Among fruits, citrus is one of the high value crops in mid hills of Nepalwith the fruit production of about 0.22 million tons (NCDP, 2015/16). Sweet Orange (*Citrus sinensis* Osbeck, Family: Rutaceae) are native to southern China or northeast India. They contain vitamin C, pectin, essential oils and are rich in sugar. Its peels are used in making marmalades, juice, sherbets, cordials etc. are important processed products. The flesh or pulp of the fruit is typically juicy and sweet, divided into 10 to 14 segments (although there are seedless varieties) and ranges in color from yellow to orange red (Ayer and Shrestha, 2018).

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Sindhuli district has a potential for successful cultivation of sweet orange (Junar) in terms of climatic condition and unique topography. Good yield of Junar has often led to emergence of various insects feeding on its plant and fruits. Among them, Chinese citrus fly (CCF) (*Bactrocera minax* Enderlin) has been the important insect feeding on the fruit and thus creating heavy fruit loss in farmers' Junar orchards. Chinese citrus fly is one of the emerging pests for the citrus growers in Nepal (Adhikari *et al*., 2020). The Chinese citrus fly, *Bactrocera minax* (Enderlein) (Diptera: Tephritidae) being univoltine and having larval host range restricted in wildand cultivated citrus species (Allwood *et al*.,1999) is the most destructive pest of citrus which can cause 100% fruit loss in severe situations. This pest is also occurring in Bhutan, northwest India and Nepal (Xia *et al*., 2018).The objective of the case study was to find out the pupal density with respect to damage extent on the orchard, pupal mortality and sex ratio of *B. minax*.

MATERIALS AND METHODS

The case study was carried out at Golanjor Rural Municipality under Junar Superzone, Khaniyakharka, Sindhuli in Completely Randomized Design (CRD) with five treatments (T1=0-20% fruit infestation, T2=21-40% fruit infestation, T3=41-60% fruit infestation, T4=61-80% fruit infestation and T5=81- 100% fruit infestation) with four replications. The pupae were collected from 0-25 cm soil depth from a quadrant of 1×1 m^2 according to the treatment and kept in respective jar with sandy clay soil from the place where pupae were collected. The plastic jar measuring 5 cm in diameter and 8 cm in height were used. Soil was filled upto 7 cm height of the rearing jar. The pupae were collected from single quadrant at the site i.e. according to the treatment. Altogether the pupae were collected from 20 different quadrants during February and March 2019. The exact numbers of pupae were kept in the jar according to the treatments as those were found in the sampled quadrant. Then, the plastic jar/containers were covered with net to prevent escape of emerged adults. The number of fly emergence was observed and recorded in every 5 days interval after the first emergence of the fly, for sex ratio male and female population was recorded by observing the morphological appearance and the pupal mortality was recorded and calculated after taking the final data of adult emergence. The pupae failed in adult emergence at the time of final data recording were considered as dead.

$$\text{Sex ratio} = \frac{\text{Population of adult male emerged}}{\text{Population of adult female emerged}} \times 100$$

$$\text{Pupal Mortality} = \frac{\text{Total number of dead pupae}}{\text{Total number of pupae tested}} \times 100$$

The final data was recorded in MS-Excel and analyzed using the ANOVA procedure described by Gomez and Gomez (1984) and MS-Excel whenever necessary. The Duncan's Multiple Range Test (DMRT) was used to compare the difference of the means.

RESULTS AND DISCUSSION

Pupal density

The average number of pupa was found to be directly proportional to the damage done by the maggots in the sweet orange orchard, i.e. 7.67, 11.00, 14.33, 19.33 and 35.67 for 1-20% fruit Infestation, 21-40% fruit Infestation, 41-60% fruit Infestation, 61-80% fruit Infestation and 81-100% fruit Infestation respectively (Table 1).

Table 1. Average number of pupae on different level of orchard infestation

Treatment	Description	Average pupal population/ treatment (No.)
T1	0-20% fruit infestation	7.67
T2	21-40% fruit infestation	11.00
T3	41-60% fruit infestation	14.33
T4	61-80% fruit infestation	19.33
T5	81- 100% fruit infestation	35.67

Pupal mortality

Among the 336 pupae tested for survival in the plastic jar, 101 of them died. The mortality rate of the pupae was directly proportional to the damage threshold in the orchard caused by the maggot's i.e. 17.24%, 21.74%, 19.30%, 31.08%, 40.00% for 1-20% fruit infestation, 21-40% fruit infestation, 41-60% fruit infestation, 61-80% fruit infestation and 81-100% fruit infestation, respectively. The higher mortality rate in highly infested orchard was probably due to overcrowding of larvae before going to pupation and other management factors. According to Mia *et al.* (2007),predation and climatic factors contribute to pupal mortality whereas, soil borne pathogens caused no mortality. Similarly, different findings have shown that the larval and pupal mortality increases with increase in soil moisture level and depends directly on duration of treatment (Li *et al*., 2019). The pupal mortality was found to be varied with different soil type with higher mortality rates in clayey soil and less in sandy and loamy soils. Overall the mortality rate of the pupae was 30.06% in the experiment conducted (Fig. 1).

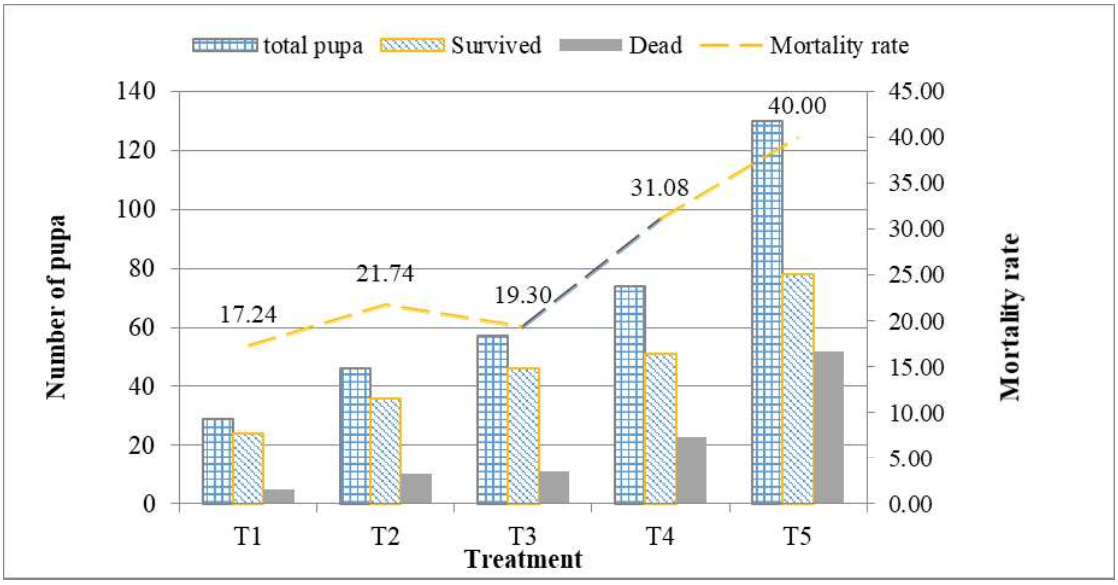

Fig. 1: No. of total pupa, survived pupa, dead pupa and percentage mortality of the pupa among different treatments

Adult emergence and sex ratio

The total emergence rate of adult Chinese citrus fruit fly in 81-100% fruit infestation (19.50) was found significant with 0-20% fruit infestation (6) and 21-40% fruit infestation (9). There was no significant difference in 41-60% fruit infestation (11) and 61-80% fruit infestation (12.75) (Table 2).

Table 2. Total emergence rate of *B. minax* adult fly

Treatments	0-20% fruit infestation	21-40% fruit infestation	41-60% fruit infestation	61-80% fruit infestation	81-100% fruit infestation
Mean	6^{b}	9^{b}	11^{ab}	12.75^{ab}	19.50^{a}
SE±	1.73	1.08	1.23	0.48	5.52

The sex ratio of emerged adult fruit fly was found to be mixed with 1, 0.80, 0.84, 0.89 and 1.0 for 1-20% fruit infestation, 21-40% fruit infestation, 41-60% fruit infestation, 61-80% fruit infestation and 81-100% fruit infestation respectively. The sex ratio was found to be 0.91 in overall adult emergence (Fig. 2). As of the result stated by Dorji *et al*. (2006) the emergence of adults and sex ratio pattern of male and female had no any significant differences. Similarly the larval and pupal mortality can be increased and the adult

emergence can be minimized by increasing the soil moisture content and immersing the larvae (Li *et al*., 2019).

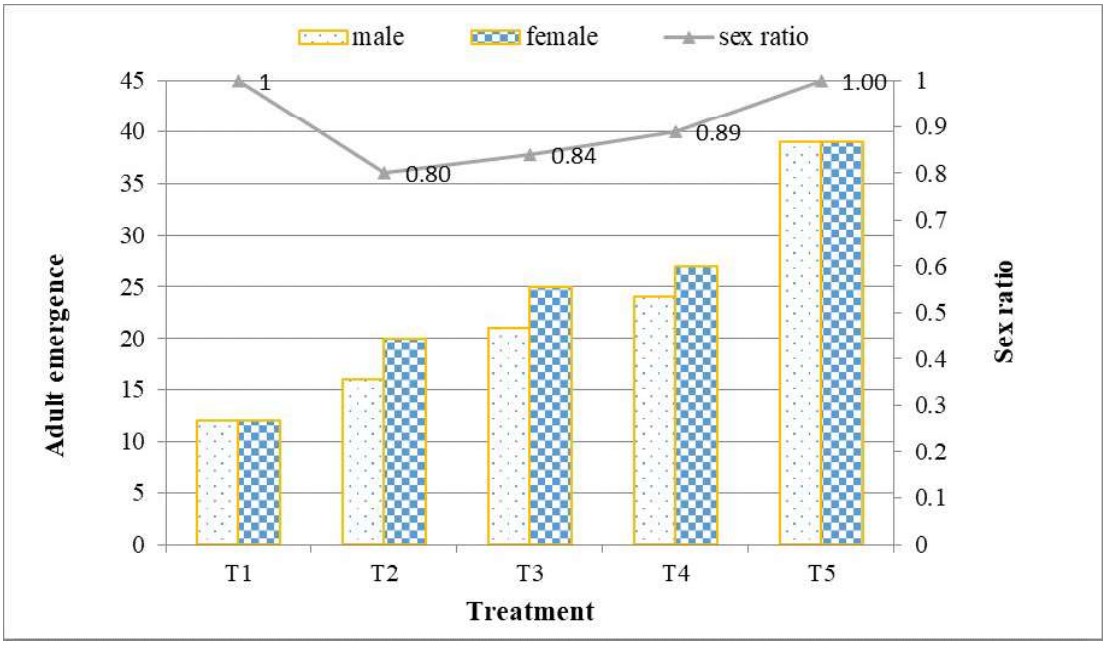

Fig 2: Adult male and female emergence and sex ratio of adult fruit flies in different treatment

CONCLUSION

It is concluded from this case study that the pupal density and pupal mortality is directly proportional with fruit loss caused by the Chinese citrus fly. The emerged adult's sex ratio of the pest is not significantly related to the population density and the extent of fruit loss and was found to be variable. The low emergence of adult from the pupae was also affected by the management factors like tillage, deep burying, soil type, soil moisture, etc in the citrus orchard. Further research on mortality of pupae on different soil texture and soil moisture can be carried out.

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