

# POPULATION FLUCTUATION OF ADULT MALES OF THE FRUIT FLY, *Bactrocera tau* Walker (DIPTERA: TEPHRITIDAE) IN PASSION FRUIT ORCHARDS IN RELATION TO ABIOTIC FACTORS AND SANITATION

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## ABSTRACT

Fruit fly (*Bactrocera tau*) is the most destructive pest on some fruits in Indonesia. Monitoring of the pest population is essential as one of the procedures in the IPM concept. The study aimed to investigate the seasonal fluctuation of adult males of *B. tau* and their damage on passion fruits in relation to abiotic factors. The research was done by a survey method on three plots of passion fruit orchards in Alahan Panjang, West Sumatra, Indonesia from March to December 2005. In plot 1 the farmer practiced sanitation by removing damaged fruits and weeds from the orchard. In the plots 2 and 3 no sanitation was practiced. Each plot was 1 ha in size. The parameters observed were density of adult male *B. tau* and climatic factors (rainfall per day, number of rainy days, and average day temperature). Empty mineral water bottle traps were used to catch adult males of *B. tau*. Each plot had 16 traps set up with cue lure as fruit fly attractant. Each trap was baited with 3 ml cue lure on a cotton wick (1 cm diameter). The cotton wick was rebaited at 2-week intervals. The traps were placed on host plants about 1.5 m above the ground. Trapped flies were collected every two weeks and counted. The data were analyzed by correlation analysis. The results revealed that the number of male *B. tau* in three orchards showed a similar fluctuation during the study period with a major peak in July. The lower numbers of flies captured in plot 1 (with sanitation) compared to the two other plots (without sanitation) were consistent with a lower percentage of damaged fruits in the plot 1 compared to the other two. The percentage of damaged fruits gradually decreased over time to about 20% in plot 1 which is lower than that in the other two plots (30-40%). The number of fruit flies captured with cue lure baited traps correlated positively with all three abiotic factors studied. The seasonal fluctuation of the fruit fly population and the damage to the fruits are necessary to be studied as a procedure in IPM for controlling *B. tau*.

[**Keywords:** *Bactrocera tau*, passion fruit, population fluctuation, abiotic factors]

## INTRODUCTION

Passion fruit (*Passiflora edulis*) is the best known of the fruits of *Passiflora* species. It is a member of a large group of climbing herbs and shrubs native to tropical America, Southeast Asia, and Australia.

Passion fruit is regarded to be of significant socio-economic importance in Alahan Panjang, West Sumatra, Indonesia. In this region, this crop occupies an area of approximately 500 ha. The plants are flowering and fruiting almost continuously throughout the year with the peak periods in August to December and March to May. The fruit losses caused by insect pests, particularly by the fruit fly (*Bactrocera tau*), is estimated as high as 40% of the production (Hasyim *et al.* 2004). In general, the yield loss due to fruit flies varies between 30-100% depending on the fruit species and season (Dhillon *et al.* 2005). Fruit infestation by melon fruit fly in bitter melon has been reported to vary from 41 to 89% (Gupta and Verma 1978; Rabindranath and Pillai 1986).

Tephritids in the genus of *Bactrocera* are of particular concern throughout much of Asia and Australia, where they constitute a significant threat to agricultural resources (Nagappan *et al.* 1971; Fletcher 1987; Han *et al.* 1994; Belas 1996; White 1996; Kinnear *et al.* 1998; Kim *et al.* 1999; Cohen and Yuval 2000). Nearly 440 species are distributed primarily in tropical Asia, the South Pacific, and Australia (White and Elson-Harris 1992; Singh *et al.* 2000).

Fruit flies are one of the most serious insect pests on horticultural crops throughout the tropical and subtropical regions (Allwood and Drew 1996; Aluja *et al.* 1996; Armstrong and Jang 1997; Hasyim *et al.* 2004; Hasyim *et al.* 2006). They damage fruits and vegetables by laying eggs under the skin. The eggs hatch into larvae feeding in the decaying flesh of the fruits or vegetables. Infected fruits and vegetables quickly become rotten and inedible or drop to the ground prematurely, thus causing considerable losses in production (Hollingsworth *et al.* 1997).

Fruit flies can successfully be managed over local area by fruit bagging, field sanitation, protein bait, annihilation technique, growing fly resistant genotypes, augmentation of biological control, and

insecticides (Akhtaruzzaman *et al.* 1999; Singh *et al.* 2000; Dhillon *et al.* 2005). The phenology and population dynamics of fruit flies have been studied extensively in the tropics and to a lesser extend in temperate areas lying within the northern, colder areas of its current geographical distribution (Bateman 1972; Harris *et al.* 1993; Hedstrom 1993; Dhillon *et al.* 2005).

Most of the studies conducted in the tropics deal primarily with adult trapping in different habitats although some also examine the effect of host fruit on population dynamics (Harris and Lee 1986; 1987; Harris *et al.* 1989; Liquido *et al.* 1989; Eskafi and Kolbe 1990; Harris and Olalquiga 1991; Harris *et al.* 1993). These studies generally concluded that there is a positive correlation between cue lure or methyl eugenol trap catches and weather conditions (such as rainfall and humidity) and host fruit availability (Christenson and Foote 1960; Tan and Muney 1994; Papadopoulos *et al.* 2001).

The present study aimed to assess the seasonal fluctuation of male *B. tau* in passion fruit orchards in Alahan Panjang, West Sumatra, Indonesia. Previous research showed that this species is the major problem in passion fruit in the area. Understanding the seasonal fluctuation of the fruit fly population and the damage to the fruits may contribute to the improved management for the pest.

## MATERIALS AND METHODS

The study was conducted from March 2005 to December 2005 in three passion fruit orchards in Alahan Panjang, West Sumatra, Indonesia (850 m above sea level). The research was done by a survey method on three plots of passion fruit orchards. The spiraling upward of passion fruit trees were propped up by loft. In the plot 1 the farmer practiced sanitation by removing damaged fruits and weeds from the orchard. In the other two orchards (plot 2 and 3) no sanitation was practiced. Each plot was 1 ha in size. The parameters observed were number of adult male *B. tau* captured in traps and climate factors (rainfall per day, number of rainy days, and average day temperature). The climate data were collected at meteorological station located 350 m of the experimental farm. The climate in this area is characterized by wet and rainy conditions.

Monitoring of adult population of *B. tau* was done in three orchards. For field trapping, modified clear traps made from mineral water bottles (Steiner *et al.* 1965) baited with 0.5 ml cue lure were hung on passiflora shrubs (Fig. 1). Sixteen traps were distribut-



Fig. 1. The trap type used to catch adult male fruit flies.

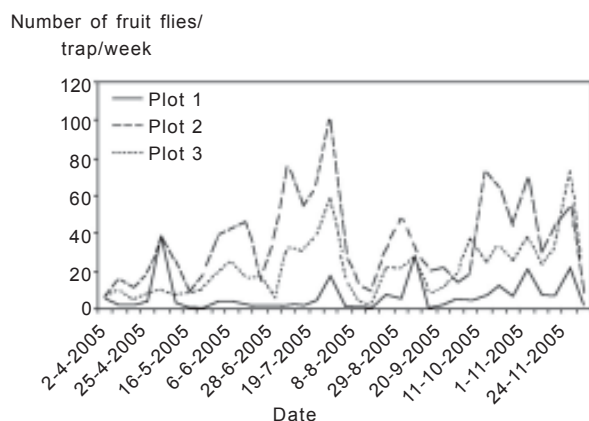
ed in the border of each orchard (25 m distance between traps). Every week the number of fruit flies per trap was counted and new traps were put out in the field. To determine the seasonal pattern of fruit fly infestation, extensive fruit sampling was conducted per month.

The data were analyzed by correlation analysis ( $P < 0.05$ ). The analysis was continued by using regression ( $P < 0.05$ ) if there is a correlation among those factors (GenStat 2005). To choose the most fitted regression model, the regression models were tested. The regression model showing the highest  $R^2$  was chosen as the fitted model. All calculations were performed using the statistical program of SPSS 2000.

## RESULTS AND DISCUSSION

### The Seasonal Fluctuation of Male *B. tau*

The seasonal fluctuation of trap catches of male *B. tau* in three passion fruit orchards in Alahan Panjang, West Sumatra, Indonesia showed a similar pattern during the study period with a major peak in July (Fig. 2). The population density in plot 1 was lower compared to that in the other two plots, because



**Fig. 2.** Seasonal pattern of *Bactrocera tau* male adults captured by trapping in passion fruit orchards in Alahan Panjang, West Sumatra, Indonesia.

farmer in the plot 1 removed all fallen fruits from the field by completely burying them in the soil.

Vijayasegaran (1985) reported that orchard sanitation by collecting and destructing all unwanted fruits on the trees and on the ground contributes significantly to reducing the fruit fly population. Collection and destruction of fallen, damaged, over-ripe, and excess ripe fruits are strongly recommended to reduce resident populations of fruit flies in all kind of fruit host. In Hawaii, papaws left on the ground act as a major breeding site for oriental fruit fly (*B. dorsalis*) and melon fly (*B. cucurbitae*) (Liquido *et al.* 1995). To eliminate or reduce this resident population reservoir, crop sanitation should be an essential component of melon fly and oriental fruit fly management in papaw orchards in Hawaii (Harris *et al.* 1993). In some areas of China, *B. minax*, a highly destructive pest on citrus, is successfully controlled by large-scale, area wide destruction of fallen fruits in orchards and villages (Yang 1991). Burying damaged fruit 0.50 m deep in the soil prevents adult fly exclusion and reduces the population (Klungness *et al.* 2005).

On the other two orchards without sanitation, the population of male *B. tau* was higher than that in plot 1 (with sanitation). This phenomenon indicated that sanitation has a significant contribution to reducing fruit fly population.

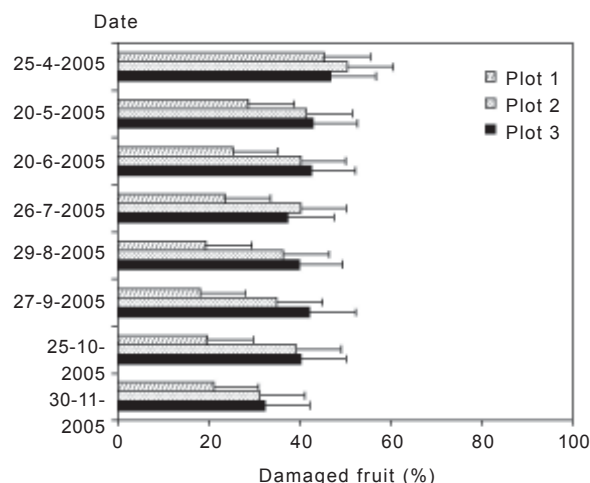
### The Relationship between Fruit Fly Population and Fruit Damage

The lower number of fruit flies captured in plot 1 (with sanitation) compared to the two plots without sanitation is consistent with a lower percentage of damaged fruits in this plot compared to the other two

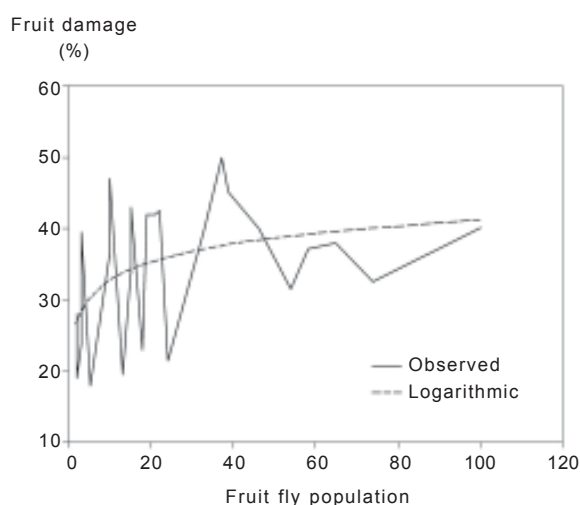
(Fig. 3). The percentage of damaged fruits gradually decreased to about 20% in the plot 1 which is lower than that in the other two plots (30-40%). Similar results were reported by Yang (1991) that *B. citri*, a serious pest of citrus in China, was successfully controlled by orchard sanitation.

Klungness *et al.* (2005) also reported that the most effective method in melon fruit fly management was by using field sanitation. To break the reproduction cycle and population increase, growers need to remove all unharvested fruits or vegetables from a field by completely burying them deep into the soil.

The regression analysis showed that there is a positive relationship between fruit fly population and damaged fruit (Fig. 4). The regression model fit to this



**Fig. 3.** Percentage of fruit infestation (with standard deviation) by fruit flies in passion fruit orchards in Alahan Panjang, West Sumatra, Indonesia.



**Fig. 4.** The regression between fruit fly population and percentage of fruit damaged in passion fruit orchards in Alahan Panjang, West Sumatra, Indonesia.



relationship is logarithmic indicated by equation  $Y = 24.338 + 3.654 \log X$ ,  $R^2 = 0.194$  ( $P = 0.031$ ).

### The Relationship between Abiotic Factors and Fruit Fly Population

The correlation analysis of weather factors and fruit fly trapping showed that all abiotic factors (rainfall, rainy days and temperatures) correlated significantly with the number of fruit flies trapped with cue lure (Table 1). Rainfall and rainy days had positive and highly significant correlation with fruit flies caught per trap. Temperature also correlated positively and significantly with the number of fruit flies caught per trap. It suggests that during high rainfall and high temperature periods (July), farmers should pay extraattention to sanitation.

Similar result was reported by Mahmood *et al.* (2002) who showed a positive correlation between rainfall and *Dacus zonatus* trapping in peach orchards in Pakistan. All the weather factors, when computed together, contributed maximum towards population fluctuation (Qureshi *et al.* 1992). Su (1984) and Shukla and Prasad (1985) reported that there was a significant and positive correlation between temperature and fruit flies caught per trap. In China, daily average temperature of 18°C was probably the threshold temperature required for the flies to undertake long-range dispersal, which partially explained the start of the fruit fly season in May each year on this high plateau (Liu and Yeh 1982).

### CONCLUSION

Sanitation resulted in low number of fruit flies and damaged fruits in passion fruit orchards in Alahan Panjang, West Sumatra, Indonesia. The percentage of damaged fruits gradually decreased to about 20% in the plot with sanitation which is lower than that in the plots without sanitation. Rainfall, number of rainy days, and temperature positively correlated with the number of adult male *Bactrocera tau* captured.

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**Table 1. The correlation between abiotic factors and number of adult male *Bactrocera tau* trapped with cue lure.**

Abiotic factors	Mean	Correlation	Regression equation	R <sup>2</sup>
Rainfall (mm)	49.53	0.689**	$Y = 7.55 + 0.41x - 0.001x^2$	0.53
No. of rainy (days)	4.13	0.611**	$Y = 7.36 + 2.19x + 0.16x^2$	0.38
Temperature (°C)	21.22	0.346*	$Y = 6575 - 633.6x + 15.3x^2$	0.23

\*\*Highly significant at 1% level of significance

\*Significant at 5% level of significance

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