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Occurrence of Fruit Flies (Diptera: Tephritidae) in Fruit Orchards from Myanmar

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미얀마 과수원에서 과실파리 발생에 관한 연구

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ABSTRACT: Population of fruit flies was monitored by using methyl eugenol trap during 2010-2011 in Yezin, Myanmar. Population numbers were analyzed with meteorological factors including rainfall, temperature, relative humidity and duration of sunshine. Samples of mango, guava, and jujube fruits were collected from orchards. The fruits were kept in containers so that the species of flies infesting the fruit could be identified when the adult insects emerged and to assess damage caused by fruit flies. Regression analyses indicated that populations of fruit flies were observed to be positively correlative with rainfall, minimum temperature and relative humidity, and negatively correlative with the duration of sunshine. Eleven species of fruit flies, *Bactrocera arecae*, *B. carambolae*, *B. correcta*, *B. dorsalis*, *B. kandiensis*, *B. latilineola*, *B. malaysiensis*, *B. neocognata*, *B. raiensis*, *B. verbascifoliae*, and *Carpomya vesuvina*, were identified. *B. correcta* and *B. dorsalis* were the most abundant and accounted for 29.3% and 28.6% of total emerged adults in the different fruit samples. The highest percentage of fruit damage was observed on guava (59±15.4), followed by mango (35.5±12.1) while the lowest was recorded on jujube (18.5±7.9).

Key words: Fruit flies, Population fluctuation, Climatic factors, Host fruits, Damage

초 록: 2010년부터 2011년까지 미얀마 예진 지역의 과수원에서 methyl eugenol trap을 이용하여 과수원 해충인 과실파리에 대한 발생빈도와 피해정도에 대한 연구를 수행하였다. 망고, 구아바, 대추나무를 대상으로 과실파리의 발생 정도를 알아보고 아울러 강수량, 온도, 습도, 일조시간 등 발생과 기후적요인과의 상호관계 등을 분석하였다. 그 결과 회귀분석에서 강수, 최저온도 그리고 상대습도는 과실파리의 발생에 긍정적인 영향을 주었고 반면에 일조량은 발생을 억제하는 요인으로 작용하였다. 그리고 *Bactrocera arecae*, *B. carambolae*, *B. correcta*, *B. dorsalis*, *B. kandiensis*, *B. latilineola*, *B. malaysiensis*, *B. neocognata*, *B. raiensis*, *B. verbascifoliae*와 *Carpomya vesuvina* 등, 모두 11종의 과실파리가 조사되었고, 그 중 *B. correcta*와 *B. dorsalis*가 29.3%와 28.6%로 많은 개체수를 나타내었다. 구아바가 가장 피해가 심했고(59±15.4), 다음은 망고였으며(35.5±12.1), 반면에 대추에서 가장 낮은 비율을 보였다(18.5±7.9).

검색어: 과실파리, 개체군변동, 기후요인, 기주, 피해

True fruit flies (Diptera: Tephritidae) belong to approximately 4,500 species distributed over most of the world and are among the most economically important pests that attack soft fruits worldwide (White and Elson-Harris, 1992; Tan and Nishida, 1998). The genus *Bactrocera* is the most economically significant with about 40 species considered to be important pests. Most of the major pests belonging to this genus are from the Oriental and Australasian regions (White and Elson-Harris, 1992). Most fruit

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fly species are polyphagus, very mobile, and can effectively search for food and oviposition sites. This combination of attributes makes the insects very successful at colonizing new areas, achieving large populations relatively quickly, and causing enormous losses (Allwood, 1997). They are prevalent from the fruit setting times through harvest. Population of fruit flies is affected by mating behavior, oviposition behavior, dispersal, nutrition, moisture, temperature, light and competitions (Kitto, 1983).

Morris and Waterhouse (1998) reported that fruit flies are the primary pests that damage mangoes, citrus, guavas, and cashews in Myanmar. Drew and Hancock (1994) reported that Oriental fruit fly complex can be regarded as economic pest in Myanmar. *Bactrocera caudata*, *B. correcta* (guava fruit fly), *B. cucurbitae* (melon fly), *B. dorsalis* (Oriental fruit fly), *B. dorsalis* complex, *B. tau*, *B. tuberculata*, and *B. zonata* (peach fruit fly) have been reported in Myanmar (CABI, 2007). In many countries, fruit flies are the cause of tremendous losses in fruit production and impose limits on the export market (Aluja and Mangan, 2008). In Malaysia, fruit flies are the major obstacle for developing the fruit industry (Singh, 1991). Other countries like Thailand, Indonesia, India, Taiwan, and China are facing similar problems. The objectives of the current study were to monitor the incidence of fruit fly and to evaluate the species richness of fruit flies in the Yezin area of Myanmar.

Materials and Methods

Study area

The experiments were conducted at Yezin Agricultural University (15° 52′ N and 96° 07′ E) and orchard farm of Department of Agricultural Research (19° 51′ N and 96° 07′ E) in Yezin from April 2010 to March 2011. The experimental orchards cultivated mainly with different varieties of mango and guava, and the orchards also contained citrus, jujube, banana, papaya and vegetables like tomato, okra, cucumber and eggplant. Major cultivated fruits like different varieties of mango grown in this study region were severely infested by Oriental fruit fly, *B. dorsalis*.

Population fluctuations of fruit flies

Methyl eugonol is highly attractive papapheromone for males of economically important fruit flies species in this area, the population density of fruit flies in the experimental fields was monitored by using methyl eugenol (ME) traps. Traps were handmade and constructed based on stenier trap. Twelve traps were suspended from the branches of fruit trees, 1.5~2 m above soil surface, and separated from each other by more than 50 m. Since methyl eugenol is highly attractive parapheromone for males of the fruit flies, adult male flies were captured in traps. The captures in each trap were counted daily, and methyl eugenol was replenished for a weekly basis. The meteorological data such as temperature (minimum – maximum), rainfall, duration of sunshine and relative humidity (RH) were recorded from meteorological station of Department of Agricultural Research in Yezin.

Fruits sampling

Every week, two kg of mango (*Mangifera indica*, Anarcardiaceae), guava (*Psidium guajava*, Myrtacea), or jujube (*Zizyphus jujuba*, Rhamnaceae) fruits were sampled from orchards. The collected fruits were preserved separately in plastic containers filled with a layer of damp sand for pupation. Fruits were maintained in these containers for 2-3 weeks, and sand was sieved to collect the mature larvae and pupae. The collected mature larvae and pupae were maintained in plastic containers (15 × 13 × 12 cm) under room temperature until the adults emerged. The openings of the containers were covered with muslin cloth. Newly emerged adults were given sugar water (20% sucrose) in the plastic containers for several days to allow mature and full color development. The adults were then identified to species levels using identification keys (Ichinohe and Kaneda, 1992) and Lucid keys (Lawson et al., 2003). The abundance of each fruit fly species was estimated as the proportion of the total adult of each fruit fly species and the total adult collected of all fruit fly species. Percentage of damage was determined as ratio of number of infested fruits per total of collected fruits; while the infestation indices were expressed as mean number of pupae per fruit and per weight of collected fruits.

Data Analysis

Using Excel program, regression and correlation analysis

(P<0.05) was used to calculate between adult captured and four climatic factors: temperature, rainfall, sunshine hours and relative humidity by the procedures outlined by Gomez and Gomez (1984).

Results and Discussion

Population fluctuation

The number of fruit flies trapped with methyl eugenol varied with receiving rainfall in 2010-2011 was shown in Fig. 1. The incidence of fruit flies was observed throughout the study period. The highest number (403.3 flies/trap/week) was observed on May 26 and the lowest (18.3 flies/trap/week) on February 22. At the beginning of study, the population was very low (21.2~77.2 flies/trap/week) and no rainfall was obtained at those periods. After that it noticeably increased and reached the highest peak (403.3 flies/trap/week) by first heavy rain (145 mm) at the end of May. The higher populations (126.2-320.2 flies/trap/week) was observed from June to mid July. These maximum catches coincided with ripening of mango fruits. Mwatawala et al. (2006) indicated that mango orchards present high numbers of fruit flies during their fruiting season. Ye (2001) reported that the area planted with fruit trees and the fruiting period can all affect from oriental fruit fly. Agarwal and Kumar (1999) studied the maximum populations of peach fruit fly, *Bactrocera zonata*, were observed during the third week of June (357.0 flies/trap) in India. The finding of present investigation is in agreement with the results of Makhmoor and Singh (1998) who reported that peak population (170.66 males/trap/week) of oriental fruit fly, *Bactrocera dorsalis* was observed in July in India.

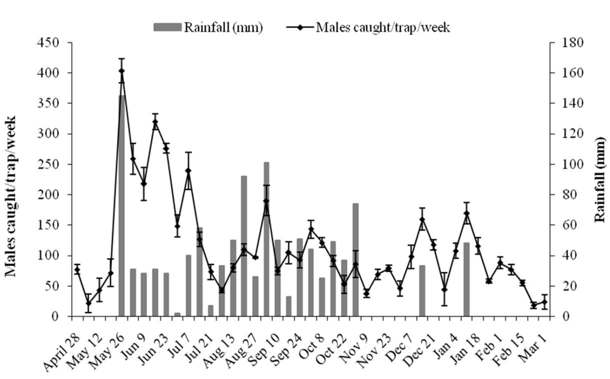

Fig. 1. Population fluctuation of fruit flies caught in relation to rainfall (mm) in 2010-2011.

Thereafter population was decreased (42.5 flies/trap/week) on August 6. Then it was noted that the population was started increasing again and obtained high number of fruit flies (109.8 flies/trap/week) on August 20, (190.25 flies/trap/week) on September 3, (143.3 flies/trap/week) on October 1 by receiving higher amount of rainfall of 92 mm, 101 mm and 44 mm, respectively. Mahmood and Mishkatullah (2007) claimed that the maximum population of *Bactrocera* species was recorded in August. Similar result was reported by the finding of Gillani et al. (2002) who stated that *Dacus dorsalis* appeared in the field in April and attained maximum population in August. These high fruit flies catches coincided with guava fruiting season. It was noted that rainfall has a strong influence on incidence of fruit flies. Amice and Sales (1997) reported that the influence of abiotic factors (such as temperature and rainfall) is closely related with fly population dynamics. Khan et al. (2003) also studied that the weather factors showed significant contribution towards population fluctuation and among them, rainfall appeared as the most important factor for population fluctuation of fruit flies. Chen et al. (2006) underlined that rainfall was the strongest one among all the climatic factors.

Lower numbers of fruit flies were monitored from at the end to October and November. It was probably because of lack of availability of hosts. Then it started increasing at the beginning of December as jujube fruit started ripening. There were two peaks during jujube season, the first peak (159.5 flies/trap/week) was observed on December 14 and the second one (169.3 flies/trap/week) on January 11 and these were coincided with unexpected rain (33 and 48 mm). So it was noted that host availability is one of the important aspects of population fluctuation of fruit flies. Papadopoulos (1999) stated that the main factor affecting population build up of fruit flies in the tropics is fruit abundance and availability. Drew and Hooper (1983) also reported that host availability and abundance of cultivated fruits (mangos, guavas) are important factors which determine popu lation fluctuations of *Bactrocera* species.

Correlation with abiotic factors

The positive significant relationship (Pr < 0.001) was observed between the mean number of fruit flies and rainfall (r = 0.57)

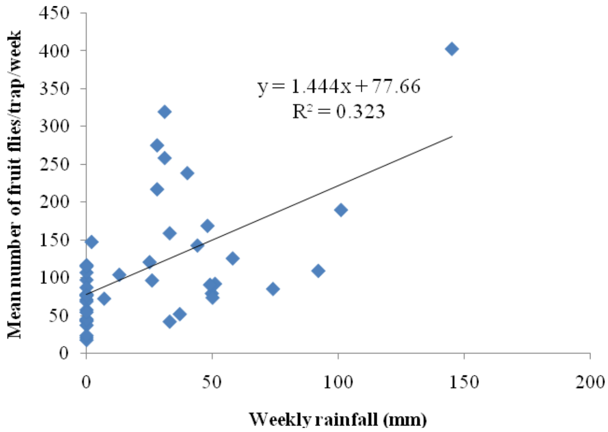

Fig. 2. Relationship between number of fruit flies and rainfall (mm) in 2010-2011.

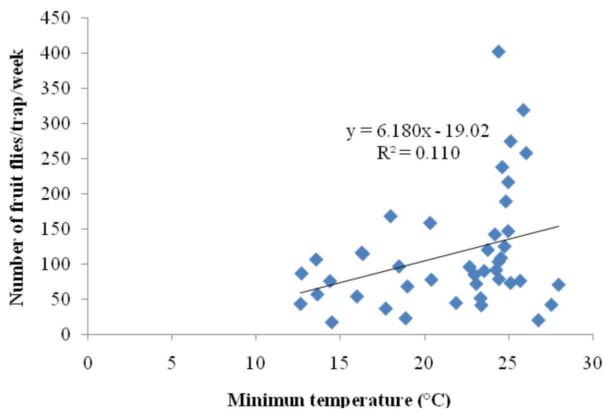

Fig. 3. Relationship between number of fruit flies and minimum temperature (℃) in 2010-2011.

(Fig. 2). The linear regression equation (y = 1.444x + 77.66) showed that fruit fly population increased at a rate of 1.44 fly with an increasing 1 mm rainfall between the range of 0 to 145 mm. Sarada et al. (2001) observed that fruit fly population of *Bactrocera* sp. had positive correlation with rainfall. The present study was corroborated with Hasyim et al. (2008) who reported that rainfall and rainy days had positive and highly significant correlation with fruit flies caught per trap. Their findings are agreed with the report of Jalaluddin et al. (2001) who stated that weekly catch of *B. correcta* have significant positive correlation with rainfall (r = 0.2364) in guava orchard. The finding of the present investigation is in agreement with the reports of the previous studies by Su (1984), Shukla and Prasad (1985), Gupta et al. (1990), Paw et al. (1991), Agarwal and Kumar (1999) and Ingoley et al. (2002).

Minimum temperature was found to be a positively correlated

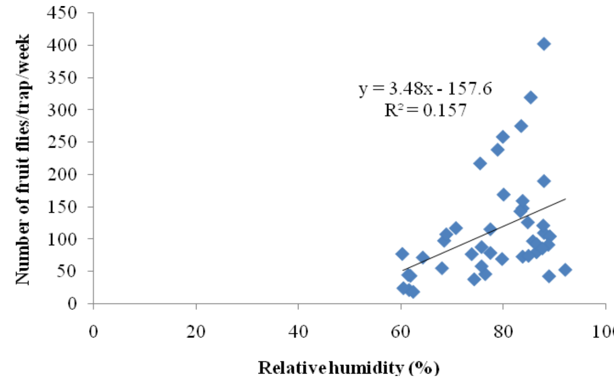

Fig. 4. Relationship between number of fruit flies and relative humidity (%) in 2010-2011.

(Pr = 0.04, r = 0.33) to insects count (Fig. 3) while no correlation was found between population of insects trapped and maximum temperature and mean temperature. Positive relationship with minimum temperatures was recorded in India on the oriental fruit fly, *B. dorsalis* (Kannan and Venugopala Rao, 2006). The current result agreed with the finding of Sarada et al. (2001) who observed that fruit fly population of *Bactrocera* sp. had positive correlation with minimum temperature and positive non-significant correlation with maximum temperature. Similar findings had been reported by Verghese and Sudhadevi (1998) and Gupta and Bhatia (2000) who pointed out a positive correlation of *B. dorsalis* population with minimum temperature. Jalaluddin et al. (2001) recorded the same positive correlation with minimum temperature with the guava fruit fly, *B. correcta*.

The significant positive relationship (Pr = 0.02, r = 0.40) was examined between the mean number of fruit fly and relative humidity (Fig. 4). Chen and Ye (2007) reported that monthly air relatively humidity was positively and significantly correlative with monthly population fluctuation of fruit flies between April and November. Hasyim et al. (2008) also claimed the number of fruit flies captured with cue-lure baited traps correlated positively with humidity. The result of present study also are similar to observation of Ranjitha and Viraktamath (2006) who detected that there was a high significant positive correlation between trap catches of *B. dorsalis* and morning relative humidity and afternoon relative humidity. Similar observations with regard to positive and significant correlation between relative humidity and fly activity have been reported that by earlier workers; Murthy and Regupathy (1992) and Boscan and Godoy (1989).

The negative and significant relationship ($Pr < 0.001$, r = 0.57)

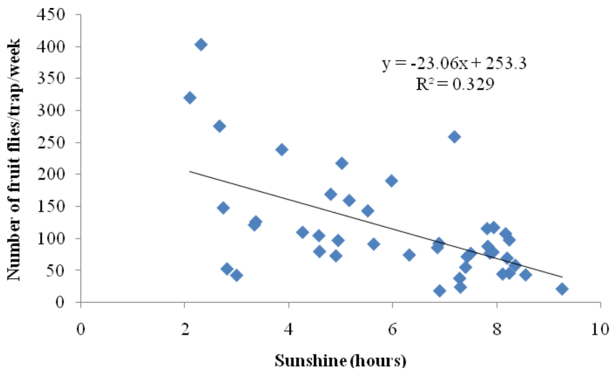

Fig. 5. Relationship between number of fruit flies and duration of sunshine (hours) in 2010-2011.

Table 1. Percentage of fruit flies species emerged from mango, guava and jujube in Yezin area, Myanmar, mean number of pupae recorded per kg fruit and per fruit, and damage

	Mango		Guava		Jujube	
	Total	%	Total	%	Total	%
B. arecae	7	5	17	10	-	-
B. carambolae	13	9	9	5	14	12
B. dorsalis	44	29	55	32	27	23
B. kandiensis	21	14	12	7	-	-
B. latilineola	6	4	-	-	-	-
B. malaysiaseinsis	6	4	6	4	-	-
B. neocognata	3	2	24	14	-	-
B. raiensis	6	4	-	-	-	-
B. verbascifoliae	12	8	3	2	9	8
B. correcta	33	22	45	26	51	43
C. vesuvina	-	-	-	-	18	15

was observed between the mean number of fruit fly and the duration of sunshine (Fig. 5). The duration of sunshine correlated negatively with fly incidence which indicated that sunnier the day, less was the fly activity. It might be like that during sunny days the flies prefer to congregate below the leaf surface or under the shade of vegetation. The result of the present study was agreed with the observation of Laskar and Chatterjee (2010) who exhibited that total sunshine hour per day influence negatively on adult melon fly incidence. Shukla and Prasad (1985) also reported that the peak trap catches of *B. dorsalis* had a negative correlation with average number of day light hours. Chen and Ye (2007) expressed that there was a significant negative correlation between monthly population fluctuation and monthly duration of sunshine (r = -0.72). Murthy and Regupathy (1992) also stated that incidence of moring fruit fly, *Gitona* sp. was negatively correlated with the duration of sunshine. Their results are in agreement with record of Jalaluddin et al. (2001) who stated that weekly mean the duration of sunshine had low negative correlation with the catch.

Fruit flies species and their abundance

A total of 441 adult fruit flies emerged from 489 pupae from all samples of mango, guava and jujube fruits collected in the present study. Eleven fruit fly species were identified from the fruits collected *B. arecae*, *B. carambolae*, *B. correcta*, *B. dorsalis*, *B. kandiensis*, *B. latilineola*, *B. malaysiensis*, *B. neocognata*, *B. raiensis*, *B. verbascifoliae*, and *Carpomya vesuvina.* Among these, *B. correcta* and *B. dorsalis* were the most abundant in the different fruit samples and *B. latilineola* and *B. raiensis* had the lowest proportion of emerged adults. Mango was infested by ten species and the most abundant species in mango was *B. dorsalis.* Guava was infested with eight species and *B. dorsalis* was also the most abundant species in guava. Five of the observed species emerged and the most abundant species that infested jujubes was *B. correcta* (Table 1). *B. arecae*, *B. carambolae*, *B. dorsalis*, *B. kandiensis*, *B. latilineola*, *B. malaysiensis*, *B. neocognata*, *B. raiensis*, and *B. verbascifoliae* belong to sibling species of the *B. dorsalis* complex. *C. vesuvina* was only found in jujubes. Four species (*B. carambolae*, *B. correcta, B. dorsalis and B. verbascifoliae*) were found in all fruit samples confirming their polyphagus nature. Among them, *B. dorsalis* and *B. correcta* emerged in high number showing their competitive ability. Waterhouse (1993) reported oriental fruit fly (*B. dorsalis*) as one of the five most important pests of agriculture in South East Asia. *B. dorsalis* is highly polyphagous, being able to infest more than 300 host plants from 40 families and mango is the most commonly attacked (Haramoto and Bess, 1970; Vargas et al., 1984; Smith, 1989; Clarke et al., 2005). This was confirmed by Morris and Waterhouse (1998) reported that *B. dorsalis* is a very widespread and an important guava pest in Myanmar. Similarly, guava fruit fly, *B. correcta* is one of the most destructive pests in the genus *Bactrocera* (Wang, 1996) and widely distributed throughout most countries of south East Asia (Drew and Raghu, 2002). The fly is polyphagous with wide range of tropical and subtropical fruits and melons belonging to 30 plant families (Maynard et al., 2004). In Vietnam and central to northern Thailand, serious infestation by this fly causes great loss in fruit and vegetable production (Drew and Raghu, 2002). This study confirms that serious pests; *B. dorsalis* and *B. correcta* are well established in the study region.

The level of fruit fly damaged fruits ranged from 18.5 to 59%. The highest percentage of fruit damage was observed on guava (59±15.4), followed by mango (35.5±12.1) while the lowest was recorded on jujube (18.5±7.9). Number of pupae per kg fruit was highest on guava (15.5±4.8) and mango (15±7.2) compared to jujube (10.75±5.3). Similarly the number of pupae per fruit was also greatest on mango (3.5±1.7) and guava (3.25±1.5) and the lowest on jujube (0.5±0.3). The number of pupae per kg was higher in the hosts with highest percentage of damage. Guava and mango were the most preferred and damaged host fruits, because they have already been cited as fruit flies most infested hosts (Newell and Haramoto, 1968; Vargas et al., 1983; White and Elson-Harris, 1992; Drew and Hancock, 1994; Lawson et al., 2003).

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