FIELD AND LABORATORY STUDIES ON INFESTATION OF IMMATURE MANGO FRUITS BY THE PEACH FRUIT FLY, BACTROCERA ZONARA (SAUNDERS)

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Abstract

The peach fruit fly, *Bactrocerazonata*, is one of the fruit flies thatattack mango fruits during maturity and ripening stages causing significant damage. This paper iscontribution for evaluation the role of dropped immature fruits as host of *B. zonata* through sampling dropped mango fruits of different varieties at different stages of maturity in different types of mango cultivations. Also, the study was extended to find an interpretation via laboratory investigation the ability of *B. zonata* females for egg laying on immature mango fruits after abscission for different periods (5, 10 and 15 days) comparing with freshly harvested fruits correlating with biochemical and physical fruit changes after abscission. The results indicated that the immature fruits that on the tree were free of infestation, while the infestation was observed on that were sampled under the trees. Percentages of infestation during the 1stseason (2014) for the early and mid-ripen season varieties were 7.83 and 9.14%, respectively and during the 2nd season(2015) were 5.18 and5.52%, respectively. The mean no. of obtained pupae/ infested fruit were 7.54 and 12.16 pupae/infested fruit, respectively, and 7.25 and 8.10 pupae / infested fruit, respectively during the second season(2015).The sampled immature fruits of late ripen varieties were free of infestation during the two season. The dropped immature mango fruits were firstly observed to be infested during the 4th week of May and the 1st week of June during the two seasons, respectively. The obtained data revealed that, the immature infestation percentages of early and mid-ripening season varieties were lower in comparison with those sampled during maturity and ripening stages. The laboratory study ensured the preference of *B. zonata* females for egg laying on the fruits that were abscised for 5, 10 and 15 days in percentages of 26.67, 46.67 and 53.33%, respectively, the pupation percentages were 80.85, 87.33 and 89.47%, respectively, adult emergence percentages were 63.16, 65.59 and 72.18%, respectively, while, the durations of total immature stages that reared on the mentioned abscised fruits were, 18.20, 16.98 and 16.79 days, respectively. The fruit phenological changes including increasing of total soluble sugars, total soluble solids(T.S.S), also reduction of fruit juice acidity and fruit firmness factor may be play an important role in susceptibility of dropped immature mango fruits to the peach fruit fly attacks. Removal of such fruit becomes a necessity for avoiding such risk, also, attention should be paid for following and monitoring the fruit flies status in early times (after fruits setting) instead of later periods during June or July.

INTRODUCION

Egypt has excellent potential for the development of a very prosperous mango (*Mangifera indica* L.) industry. Egypt produces a significant amount of this fruit close to excellent markets, especially the Arab and European markets. The peach fruit fly, *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) is one of the most destructive fruit flies that attacking mango fruits, the larvae feed on the pulp of ripe fruits formingtunnels inside them causing a great damage and make fruits unfavorable for marketing and exportation(Saafan, *et. al.,* 2006 and Amin, 2008).

The majority of fruit flies are thought to only oviposit into ripe fruits (Allwood, 1997).The mature and ripen fruits are preferable for the females of fruit fly, who usually choose only mature fruits to lay their eggs (Sarwar *et. al*., 2014).The green mangoes of Tommy Atkines and Keitt varieties throughout 3 years of field sampling fruits were not infested by the Caribbean fruit fly, *Anastrepha suspense* (Peña, *et. al.,* 2006).

However, Gikonyo *et. al*., (2003) reported that wild females of*Ceratitiscosyra* (Walker) were more attracted to and laid preferentially on greencolouredimmature and turning mangoes than on ripe and yellow mangoes in the naturalenvironment. Also, the very young mangoes, after abscission couldhost *Bactrocerainvadens* Drew, Tsuruta& White larvae very early in the season (Vayssières *et. al*., 2008).

Immature mangoes are distinguished from mature mangoes in that they do not ripe after harvest (Reid, 1992), immature mangoes have a whitish flesh, lack juiciness, and have a sour flavor. Some agricultural practices including over-irrigation, fertilization or mechanical fractions cause falling or dropping premature mango fruits from trees.

In Egypt, no studies were reported to determine if immature mango fruits could represent a risk for the peach fruit fly. The present study was contributed for evaluating the role of dropped immature fruits as host of *B. zonata* through sampling dropped mango fruits of different varieties at different stages of maturity in different types of mango cultivations. Moreover, searching the effect of some biochemical changes of immature fruits after abscission on the completion the life cycle of *B. zonata* to confirm the field studies.

MATERIALS AND METHODS

A- Field studies:

1.The selected experimental orchards:

This study was conducted at the period from the 1st week of May until the end of August throughout two successive seasons, 2014 and 2015 at Fayoum governorate in two types of mango cultivations:

1.1 .The mixed-host orchards:

The 1st site is located in Ibshway (Senro) district, Fayoum governorate with total cultivated area of 100feddans including mango, guava, mandarin and pear. Mango trees occupied about 75% of total cultivated area, Balady varietieswere the most abundant commercial varieties occupying about 30 feddans, followed by Timor, Sediqqe and Owusi varieties (≤ 10 fedanns for each of them), while, the varieties Hendi, Golek, Armanios and Zebdia varied in their cultivated areas (≤ 5 fedanns each).The site 2nd is located atFayoum (Al-Daly) district with total cultivated area of 50 feddans including mango, mandarin and Valencia orange. Mango trees occupied about 70% of total cultivated area, Sediqqe variety was the most abundant commercial varieties occupying about 20 feddans, followed by Balady and Timor varieties (10 feddans for each of them),while, the varieties Zebdia, Owusi, Keit and Kent differed in their cultivated areas (≤5 fedanns for each of them).

1.2 . The mango aggregated orchards:

The 1st site is located in Ibshway (Abo-ksah) district with total cultivated area of 100 feddans, Balady variety was the most abundant commercial varieties occupying about 50 feddans, followed by Timor,Owusi, Sediqqe and Zebdia varieties (40feddans), while, the late ripen varieties, Keitand Kent were cultivated in areas ≤ 5 fedanns for each of them. The site 2nd is located in Fayoum (Beni-Saleh) district with total cultivated area of 80 feddans, Balady variety was the most abundant commercial varieties occupying about 40 feddans, followed by Timor, Owusi, and Hendi varieties (35feddans), while, the variety Sediqqe, cultivated in area ≤5 fedanns.

2. Monitoring of *B. zonata* populations*:*

For monitoring the males of *B. zonata*, six Jackson sticky traps were used for each experimental site. The traps were baited with methyl eugenol as a male lure of *B. zonata* males and technical malathion as a toxicant agent at a ratio of (4:1), respectively. The traps were hanged at a height of approx., 1.75-2.50 m. and distributed evenly in the tested orchards. Traps were inspected weekly with replacing the sheets and replenished with the mentioned attractant by injecting the cotton wick using medical syringe. The attracted males were counted and the mean catch per trap per day "CTD" was calculated.

3.Sampling of mango fruits:

Depending upon mango harvesting season in Middle Egypt region (including Fayoum governorate),mango fruits are assumed to be harvested in July until September (Yahia, 1999). Therefore, the mango fruits were classified into 3 categories; firstly, the fruits of early ripening varieties that could be seasonally harvested during July, including Balady, Hendi, Golek and Armanios; secondly, the mid-ripening varieties that could be harvested during August including, Balady, Timor,

Sediqqe, Zebdia and Owusi; while, the fruits of last category are assumed to be harvested during September and October, including Keit and Kent varieties.

Throughout the two studied successive seasons (2014 and 2015), for each variety of mango trees, 5 trees were selected and 40 fruits at least representing the cardinal directions of the trees, preferably immature, were weekly inspected. The mentioned fruits were marked to avoid replication of examination. A fruit was considered damaged when a fly ovipuncture or watery spot was visible (Vayssiéres *et. al*., 2009). The infestation percent damage was determined as ratio of number of infested fruits per total of inspected fruits.

At the period from the 1st week of May till the 3rd week of July, the fallen mango fruit during the successive developmental stages including immaturity, maturity and ripen stages were weekly collected, classified according to their varieties and brought to the laboratory in plastic bags. The fruits were incubated in plastic containers above a layer of sterilized sand (10 cm). After 3-5 days, the fruits were inspected for assessing infestation percentage, the non-infested fruits were removed. After pupation, the pupae were obtained from sand by sieving counted, and kept in Petri dishes. The emerged adult fruit flies were counted and identified to peach fruit fly or Mediterranean fruit fly (if found).

B- Laboratory studies :

During the 3rd week of May, 60fruits of immature mango (*var*. Sediqqe) were pickedand bagged to avoid any infestation. The fruits were grouped whereas twentyfruits were placed over a layer of sand on plastic containers for durations of 5, 10 and 15 days under room temperature (26±3.0C°) to allow following biochemical changes. In addition, five fresh harvested immature fruits were picked to determine some chemical characteristics.

1-Fruit infestation by laboratory reared *B. zonata* flies

The studies were conducted in the laboratory to determine the ability of *B. Zonata* for depositing eggs inside fruits at different stages of immaturity. Ten fruits were included 5 freshly harvested fruits and 5 fruits that were kept as mentioned above for 5, 10 and 15 days, these fruits were exposed for 2 hrs to 200 fertile females of *B. zonata* reared on cage (40 X 40 X 40 cm) in 3 respective times. Hence, the exposed fruits were removed, separated and transferred on smaller plastic containers supplied with a layer of sand to receive pupae and stored under laboratory conditions. The infestation, pupation and emergence percentages were calculated. Also, durations of egg-larval, pupal and total immature stage were estimated for the individuals of each infested fruit.

2. Determination of some chemical constituents of fruit:

Five fruits of each group that were kept under room temperature for 5, 10 and 15 days apart of the tree were transferred to the Central Laboratory of Chemical,

Biological and Microbiological Unit, Horticulture Research Institute, Agriculture Research Center (ARC) to determine some chemical phonological characteristics. The assessed chemical characteristics included total soluble sugars, T.S.S. (Total soluble solids % of the fruit juice), Total acidity (TA), fruit moisture (water content %) and fruit firmness.

For assessing total soluble sugar, a known weight of the dried ground sample was taken to extract soluble sugars and boiled in 100 ml. of 70% neutral ethanol for 6-8 hrs under reflux. The extract was filtered and the ethanol was removed by vacuum distillation. The residue was clarified by the leading and deluding method as described before. The last solution was filtered, completed to a known volume and subjected for colorimetric determination (expressed as glucose) of total soluble sugars and reducing ones (Tanaka *et. al.,* 1975).

Total acidity as gm of unhydrous citric acid was determined and estimated per 100ml fruit juice, for assessing water content of fruits, the fresh fruits were weighted, then oven dried at 70 ˚C until constant weight and average fruit fresh and dry weights (gm) was determined (A.O.A.C., 1990).Fruit juice total soluble solids percentage (T.S.S. %) was determined using Carl Zeiss® hand refract meter. Fruit firmness was determined by using Penetrometer (fruit pressure tester, mango model), Model FT327.

C : Statistical anaylsis :

The statistical analysis was done as one way ANOVA and means separated was conducted by using L.S.D. at the probability of 5% (Costat, 1990).

RESULTS AND DISCUSSION

A- Population monitoring:

Fig.(I) shows the population of *B. zonata* on two different types of mango tree cultivations at Fayoum governorate during two successive seasons 2014 and 2015, particuerly the period from May to the end of August, coinciding devolpmental stages of mango fruits.

For the 1st season (2014),the data illustrated in Fig. (1) shows various densities of *B. zonata* population in the mentioned two types of mango cultivations. The mixed fruit cultivation was more attractive for *B. zonata*. The trend of *B. Zonata* CTD values started with 0.67 and 2.00 flies/trap/day on the 1st week of May for the aggregated mango orchards and the mixed-hosts orchard, respectively. The highest CTD value was recorded on the mango aggregated orchards (13.67 flies / trap / week) on the 5th week of July, while the highest CTD on the mixed-hosts cultivation was 18.67 flies / trap / week on the 3rd week of August, respectively.

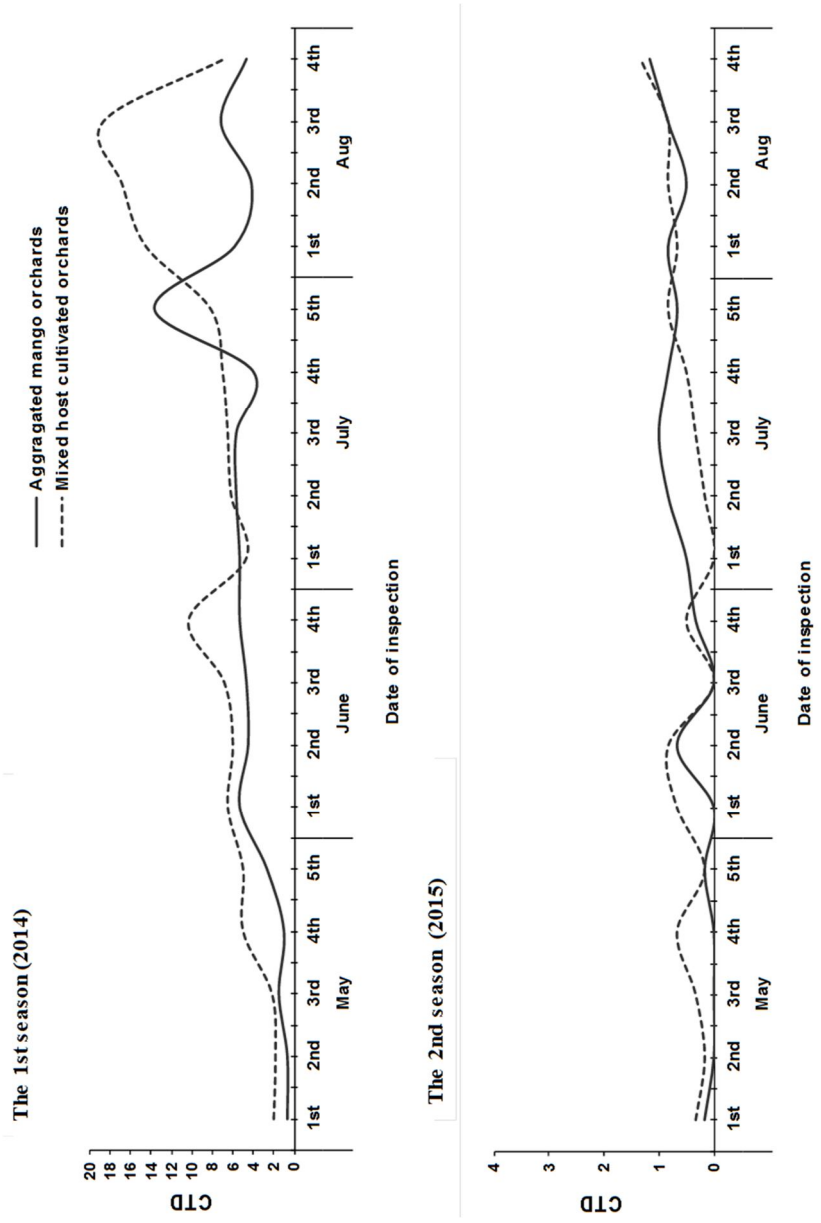

Fig. 1. Captured mean weekly flies of *B. zonata* in different types of mango orchards (the mixed-host and the mango aggregated orchards) at Fayoum Governorate during two seasons 2014 and 2015.

For the 2nd season (2015), the abundance of *B. zonata* population was relatively lower when compared with the previous season. Efforts of the National Area Fruit Flies Eradication Program may be suppressed the

population of *B. zonata* through applications of male annihilation technique. However, *B. zonata* was more abundant on the mixed-hosts fruit cultivations than the other type. The trend of CTD values started with 0.17 and 0.33 fly/trap/day on the 1st week of May for the aggregated mango orchards and the mixed-hosts orchard that containing mango, respectively. Notably, on the aggregated mango orchards, the traps indicated the absence of *B. zonata* males during some weeks of May and June coinciding with mango fruit immaturity. Applications of male annihilation technique that were carried out bythe National Area Fruit Flies Eradication Program may be the main responsible for such absence of *B. zonata* male flies. The highest mean of CTD values was observed on the mixed-hosts orchards that containing mango (1.17 flies/trap/day) on the 4th week of August, On the mixed-host orchards, the highest CTD value was observed (1.33 flies / trap / week) on the 4th week of August.

With a careful view, *B. zonata* had somewhat the same tend of population fluctuations during the two study seasons. *B. zonata* density was higher in the 1st season (2014) than that on the 2ndseason (2015). Previous results indicted the impact role of hosts diversity and availability such as peach, apricot, mandarin and Valencia orange which its fruits are available in ripening stage earlier than mango fruits. Such host range may support the *B. zonata* flies to rebuild new generations (Saafan *et. al.*, 2006, Amin, 2008, and Amin & Saafan 2013). The emerged flies from the mentioned fruits maybe are supposed to attack mango fruits available for infestation as possible. Drew and Hooper (1983) stated that females with mature ovaries tend to remain or very near fruiting host plants so long as the fruit is acceptable for egg laying. If the plants are non-host or hosts with low quality fruit, the mature females either arrive in low numbers and/or emigrate rather rabidly.

B- Infestation percentages of *B. zonata*:

Concerning the infestation percentages, the field observations revealed that, all the inspected immature fruits that were on the tree were found to be free of infestation by *B. zonata* during all the studied period of the two seasons. The collected immature mango of fallen fruits that sampled from the orchards of the aggregated mango, only were not infested by *B. zonata* during all the studied two seasons. Besides, absence of fruit flies infestation symptoms, no emerged adults were recorded from all samples of various varieties during immaturity stage. While, the

other sampled immature fruits that were collected from mixed-hosts orchards varied as shown in Table (1).

1-The 1st season (2014):

Data of Table (1) indicates that mean infestation percent of immature mango fruits of early ripening varieties that collected under the trees were with 7.83%,while, the mentioned varieties differed in their infestation rates by *B. zonata*. Balady varieties were the most infested fruits (8.58%) followed by Hendi (6.56%), Golek (5.58%) and Armanios (4.17%)varieties.

The mean no. of obtained pupae/fruit infested early immature fruits was 7.54, while, the highest mean no. of obtained pupae/ infested fruit was for Armanios variety (18.00 pupae / infested fruit), and the lowest one was observed obtaining from Balady varieties (6.69 pupae/ infested fruit). The emergence percentage of the early ripen varieties ranged72.73 – 88.89%. This data may explain the relationship between sensitivity of different mango varieties to infestation with *B. zonata* and consequently the number of attracted flies into traps. Concerning the maturity and ripening stages of early ripen varieties; all the mango varieties were observed to increase in their infestation levels. It should be notable that the mean no. of obtained pupae was higher than that recorded during immaturity stage. Data in Table (2) revealed that, immature mango fruits were observed to be infested during the 4th week of May excepting Golek fruits variety which was infested during the 5th week of May.

Concerning the mid-season ripening mango varieties, the mean infestation percent was 9.14%, Balady fruits recorded the highest infestation (12.79%), followed by Sediqqe, Timor and Zebdia (9.68, 7.14 and 6.67% respectively), while Owusi immature fruits were free of infestation (Table 1). The mean no. of obtained pupae/infested fruit was 12.16, Sediqqe fruits produced the highest mean no. of pupae (13.67 pupae/infested fruit). Routinely, the infestation % of mid-season ripening varieties increased during maturity and ripening stages. Subsequently, the mean no. of obtained pupae increased for all varieties comparatively to that obtained during immaturity stage.

Table (2) revealed that the start of infestation of immature mango fruits of some Balady varieties and Sediqqe varieties (mid-season ripening varieties) were observed during the 5th week of May. The sampled fruits of Keitt and Kent as late ripening varieties were observed to be absolutely free of infestation.

Table 1. Mean infestation % of dropped immature mango fruits of different varieties by *B. zonata*, mean no. of obtained pupae/ infested fruit and emergence % at Fayoum governorate during seasons of 2014 and 2015.

Season	Ripening season status	Variety	Immaturity stage					Maturity stage					Ripening stage				
			No. of collected fruits	No. of infested fruits	Infestation %	Mean no. of obtained pupae/ infested fruit	Emergence %	No. of collected fruits	No. of infested fruits	Infestation %	Mean no. of obtained pupae/ infested fruit	Emergence %	No. of collected fruits	No. of infested fruits	Infestation %	Mean no. of obtained pupae/ infested fruit	Emergence %
2014	Early ripening	Balady	373	32	8.58	6.69	73.83	92	22	23.91	17.27	76.32	48	39	81.25	13.33	83.65
		Hendi	122	8	6.56	9.25	78.38	28	6	21.43	15.50	84.95	15	12	80.00	17.92	89.30
		Golek	17	1	5.88	11.00	72.73	18	4	22.22	14.25	85.96	-	-	-	-	-
		Aromanis	24	1	4.17	18.00	88.89	18	6	33.33	23.17	92.09	-	-	-	-	-
		Total	536	42	7.83	7.54	75.71	156	38	24.36	17.60	81.61	63	51	80.95	14.41	85.31
	Mid-ripening	Balady	172	22	12.79	12.36	82.35	48	22	45.83	15.23	83.58	32	29	90.63	12.76	87.84
		Timor	84	6	7.14	11.33	80.88	27	8	29.63	14.38	76.52	18	13	72.22	14.15	88.04
		Sediqqi	62	6	9.68	13.67	79.27	15	4	26.67	23.75	87.37	18	14	77.78	16.29	86.84
		Zebdia	45	3	6.67	9.33	78.57	30	13	43.33	16.92	80.91	12	11	91.67	19.82	76.15
		Owusi	42	0	0.00	-	-	15	3	20.00	14.33	86.05	15	8	53.33	14.63	95.73
		Total	405	37	9.14	12.16	81.33	135	50	37.03	16.16	82.43	98	75	76.53	14.89	86.21
	Late ripening	Keit	27	0	0.00	-	-	27	0	0.00	-	-	-	-	-	-	-
		Kent	15	0	0.00	-	-	15	0	0.00	-	-	-	-	-	-	-
		Total	42	0	0.00	–	–	42	0	0.00			-	-	-	-	-
2015	Early ripening	Balady	280	17	6.07	6.47	74.55	48	7	14.58	15.71	85.45	62	17	27.42	10.12	90.12
		Hendi	136	5	3.68	8.60	72.09	33	5	15.15	14.40	88.89	28	5	17.86	16.60	86.75
		Golek	30	1	3.33	7.00	71.43	22	3	13.64	13.67	87.80	-	-	-	-	-
		Aromanis	17	1	5.88	14.00	78.57	12	4	33.33	13.75	83.64	-	-	-	-	-
		Total	463	24	5.18	7.25	74.14	115	19	16.52	14.63	86.33	90	22	24.44	11.59	89.02
	Mid-ripening	Balady	142	11	7.75	8.36	72.83	75	13	17.33	8.46	85.45	60	11	18.33	19.82	88.99
		Timor	72	3	4.17	9.33	67.86	35	5	14.29	12.40	90.32	27	6	22.22	16.17	95.88
		Sediqqi	48	3	6.25	6.67	75.00	24	3	12.50	18.33	87.27	18	3	16.67	18.33	76.36
		Zebdia	38	1	2.63	8.00	62.50	25	2	8.00	12.00	79.17	18	5	27.78	13.80	79.71
		Owusi	62	2	3.23	7.00	71.43	30	5	16.67	9.60	91.67	15	5	33.33	11.40	84.21
		Total	362	20	5.52	8.10	71.60	189	28	14.82	10.68	87.29	138	30	21.74	16.53	87.10
	Late ripening	Keit	40	0	0.00	-	-	18	0	0.00	-	-	-	-	-	-	-
		Kent	28	0	0.00	-	-	18	0	0.00	-	-	-	-	-	-	-
		Total	68	0	0.00	-	-	36	0	0.00	-	-	-	-	-	-	-

2- The 2nd season (2015):

The percentage of infestation of immature mango fruits of early ripening varieties by *B. zonata*, was 5.18% (Table 1). Regarding the varieties infestations, Baladyvarieties were the most infested (6.07%) followed by Armanios (5.88%), Hendi (3.68%) and Golek(3.33%) varieties. The mean no. of obtained pupae /infested fruit was 7.25, the highest mean no. of pupae/ infested fruit was obtained from Armanios variety (14.00 pupae / infested fruit), while the lowest one was observed from Balady varieties (6.47 pupae/ infested fruit). The emergence percentage ranged between 71.43 – 78.57%.

Concerning the maturity and ripening stages of early ripening varieties, all the mango varieties were observed to increase in their infestation levels. It should be notable that the men no. of obtained pupae was higher than that recorded during immaturity stage. Data in Table (2) revealed that immature mango fruits of Balady and Armanios varieties were observed to be infested during the 1st week of June.

Table 2. Date of infestation of dropped immature fruits of some mango varieties at Fayoum governorate during the two successive seasons 2014 and 2015.

Season	Varieties		May			June				July		
			3rd	4th	5th	1st	2nd	3rd	4th	1st	2nd	3rd
2014	Earlyripening	Balady	—	+	+	+						
		Hendi	—	+	+	+						
		Golek	—	—	+	+						
		Aromanis	—	+	+	+						
	Mid-season ripening	Balady	—	—	+	+	+					
		Timor	—	—	—	+	+					
		Sediqqi	—	—	+	+	+					
		Zebdia	—	—	—	—	+	+				
		Owusi	—	—	—	—	—	+	+			
	Lateripening	Keitt	—	—	—	—	—	—	—	—	—	—
		Kent	—	—	—	—	—	—	—	—	—	—
2015	Earlyripening	Balady	—	—	—	+	+					
		Hendi	—	—	—	—	+	+	+			
		Golek	—	—	—	—	+	+	+			
		Aromanis	—	—	—	+	+	+				
	Mid-season ripening	Balady	—	—	—	—	+					
		Timor	—	—	—	—	—	+	+			
		Sediqqi	—	—	—	—	+	+				
		Zebdia	—	—	—	—	—	—	+			
		Owusi	—	—	—	—	—	—	+			
	Late ripening	Keitt	—	—	—	—	—	—	—	—	—	—
		Kent	—	—	—	—	—	—	—	—	—	—

— Sampled fruits are not infested by *B. zonata*+Sampled fruits are infested by *B. zonata*

Among the mid-season ripening mango varieties, someBalady fruits recorded the highest infestation (7.75%), followed by Sediqqe (6.25%), Timor(4.17), Owusi(3.23), and Zebdia (2.63%).The mean no. of obtained pupae/infested fruit was 12.16,while, Timor fruits produced the highest mean no. of pupae (9.33 pupae/infested fruit). During maturity and ripening stages, subsequently, the infestation rates and the mean no. of obtained pupae increased for all varieties comparatively to that obtained during immaturity stage. The start of infestation of mid-season ripening mango fruits of Balady and Sediqqe varieties was observed during the 2nd week of June (Table 2), while, in Timor, infestation started on the 3rd week of June and in case of Zebdia and Owusi, the infestation started at the 4th week of June. The sampled fruits of Keitt and Kent as late ripening varieties were observed to be absolutely free of infestation.

Generally, the obtained results indicated that the infestation % of immature mango fruits may increase under higher levels of population density of *B. zonata*, the reduction of infestation of the 2nd season (2015) maybe due to low population density of *B. zonata* when compared with 1st season (2014), particularly, correlated by mixed-host cultivations which supporting the favorable conditions for overlapping *B. zonata* generations. The levels of infestation depend on the surrounding host plants and agro-ecological conditions of the locality (Sarwar *et. al.*, 2014).The mean numbers of pupae of *B. zonata* obtained from mature and ripe fruits of mango were higher than those obtained from immature fruits, thus indicating success of *B. zonata* immature stages to complete their life cycle.

The non-infestation of immature fruits on the tree may due to the contraction of immature fruit against female ovipositor stings.As soon as this occurs, latex leaks from the punctured wounds could be observed on the skin of fruit(Sarwar*et. al.*,2014).Differences among cultivars were suggested to be caused by differences in toxic chemicals, nutrients, or resin ducts (Peña & Moyhuddin, 1997).The green mangoes (Tommy Atkines and Keitt varieties) throughout 3 years of field sampling fruits were not infested by the Caribbean fruit fly, *A.suspensa* (Peña *et. al.,* 2006).

All dropped immature fruits of sampled varieties can be infested by the *B. zonata* excluding some late ripening varieties, thus is interpreted by availability of other early and mid-season ripening mango varieties as a mature and ripen status which are preferable for the females of fruit fly that usually choose only mature fruits to lay their eggs (Sarwar *et. al.*,2014). Also, the mature mangoes served as abetter substrate for development of the Caribbean fruit fly, *A. suspense* (Hennessey & Schnell, 2001).

The obtained results are in agreement with those previously stated by Vayssières *et. al*., 2008 and Diatta, *et. al.,* 2013 who revealed that, the immature abscised fruits of mango could host*B. Invadens* larvae very early in the season beside infesting green and ripe host fruits. Also, immature mangoes supported from 2-59% of the emergence of *A. suspense* compared with mature fruits (Hennessey & Schnell 2001).Moreover, in certain cases, some immature young fruits are also attacked, which may fall to ground from the host tree (Sarwar *et. al*., 2014).

B-Laboratory studies:

1-Infestability of *B. zonata*

As shown in Table (3), under forced infestation, the freshly harvested fruits during immaturity stage were not infested by the fertile females of *B. zonata* comparing to those fruits that exposed in same time.While, the abscised immature fruits were infested in various percentages, the fruits that were abscised for 15 and 10 days were significantly the highest ones (53.33 and 46.67 %, respectively), while, the fruits that abscised for 5 days were the lowest one (26.67%).The mean numbers of pupae of *B. zonata* obtained from the fruits that were abscised for 15 and 10days fruits of mango (16.63and 15.14pupae per fruit, respectively)were significantly higher than those obtained from green fruits (11.75 pupae per fruit).

As shown in Fig. (2), the egg-larval stage varied significantly in durations when rearing on the different stages of abscessed immature mango fruits under room temperature. The egg-larval stage averaged 9.12, 9.24 and 10.38 days, while the pupal stage averaged 7.67, 7.74 and 7.82days, with total duration of 16.79, 16.98 and 18.20 days for the immature mango fruits that abscised for 15, 10 and 5 days, respectively. In the same manner, the pupation percentages were significantly differed, whereas averaged89.47, 87.73 and 80.85% for the immature mango that abscised fruits for 15, 10 and 5 days, respectively. The percentages of emergence were significantly differed for the immature mango fruits that detached for 15, 10 and 5 days averaging 72.18, 65.59 and 63.16 days, respectively.

Table 3.Infestability of caged *B. zonata* females for egg laying on freshly harvested fruits and abscised immature fruits for 5,10 and 15 days.

Immature fruits status		No. of exposed fruits	No. of infested fruits	Infestation %	Mean no. of obtained pupae/ infested fruit	Pupation %	Emergence %
After 5 days	Freshly harvested fruits	15	0	00.00	-	-	-
	Abscised fruits	15	4	26.67b	11.75b	80.85b	63.16b
After 10 days	Freshly harvested fruits	15	0	00.00	-	-	-
	Abscised fruits	15	7	46.67a	15.14a	87.73a	65.59b
After 15 days	Freshly harvested fruits	15	0	00.00	-	-	-
	Abscised fruits	15	8	53.33a	16.63a	89.47a	72.18a

Means followed by the same latter vertically are insignificantly varied.

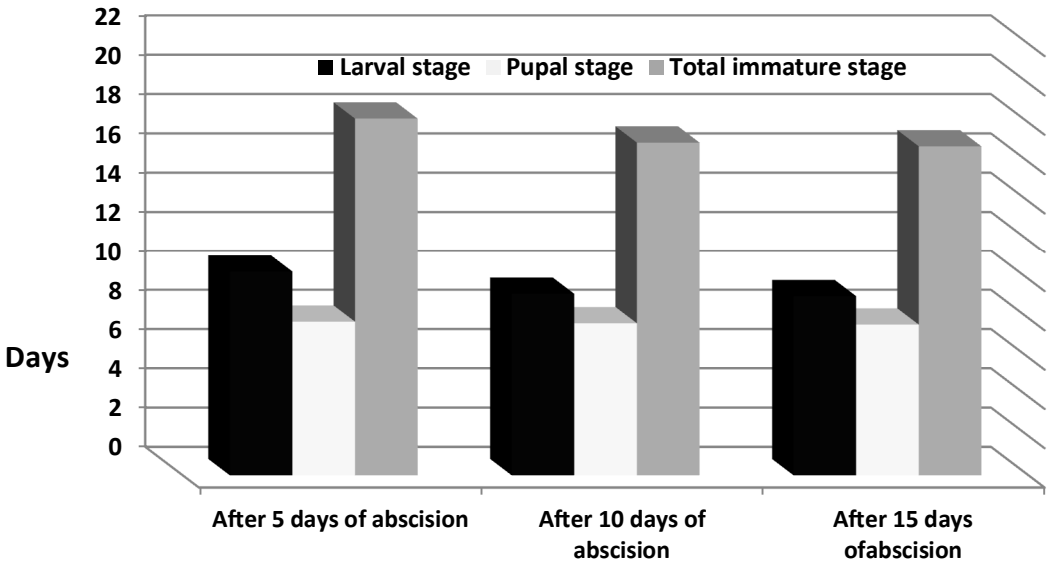

Fig. 2. Durations of *B. zonata* immature stages rearing on the abscised immature mango fruits under room temperature .

2-Chemical changes of abscised fruits:

Table (4) presents the changes of most important biochemical characteristics that may be mainly involved during maturity and ripening stages of mango fruits including, total soluble sugars, T.S.S, TA, fruit moisture (water content%) and fruit firmness. The total sugars increased gradually in significance from 2.01 g/100g at the immature harvested fruits to the highest one 3.79 g/100g for the fruits that picked tree for 15 days. TSS increases slightly at the mature-green stage.

T.S.S content of mango gradually increased gradually from 3.70% in the freshly harvested fruits to highest one 5.60 % for fruits that picked from trees for 10 days. Quintana *et. al*., 1984 reported that TSS of mango increased gradually up to maturity. TA of freshly harvested mango decreased from 0.26% to 0.11 % in fruits that picked from tree for 10 days. In general, young fruit contain more acids, that declined throughout maturation until ripening due to their conversion to sugars (gluconeogenesis).

Table 4. Fruit characteristics of immature mango fruits including freshly harvested fruits and abscised fruits for 5, 10 and 15 days under room temperature .

The fruit status	Total sugars (g/100g)	T.S.S %	Moisture %	Acidity %	Firmness Lb/inch^2
Freshly harvested fruits	2.01 c	3.70 c	82.96b	0.26 a	35.80 a
After 5 days of abscission	3.19b	5.50 b	85.42ab	0.19 b	33.80b
After 10 days of abscission	3.32 b	5.60 a	86.16a	0.12 c	32.00bc
After 15 days of abscission	3.79 a	5.80ab	87.89 a	0.11 c	31.80 c

Means followed by the same latter vertically are insignificantly varied.

Fruit firmness declined from 35.80 Lb/inch^{2}in the freshly harvested fruits to 31.80 Lb/inch^{2}in the fruits that detached for 15 day s(Table 4). Changes in average firmness were also correlated with changes in acidity and T.S.S of the fruit during ripening (Mizrach *et. al*., (1997).The change of water content was not effective comparatively to other factors, however, significant variations were observed among the fruits of the three treatments. Moisture percentage of different varieties significantly differed and reported more than 80% in all varieties for the harvested mango fruits after 10, 13, 16 and 19 weeks after flowering in all stages of fruit development (Ueda *et. al*., 2000).

To understand the ability of *B. zonata* females for egg laying on abscised immature fruits, in same time its failure to attack the immature fruits that either on the trees or that freshly harvested and that were exposed on the rearing cages, fruit firmness may be play an important role for facilitation the penetration of female ovipositor through fruit skin. The fruits that abscised for 15 days of tree had the lowest mean of fruit firmness; also, they were the most infested fruits. In other words, the gradual decline of fruit firmness correlated in positively with *B. zonata* infestation. Also, the freshly harvested fruits that had the highest mean of fruit firmness were not infested in all respective exposing comparing to others abscised fruits. Changes in average firmness were also correlated with changes in acidity and T.S.S of the fruit during ripening (Mizrach *et. al*., (1997). Cell wall degradation is the

major factor that causes softening of several fruits. Fruit firmness played an important role in oviposition strategies of female *Anastrepha ludens* (Loew), that laying larger egg clutches into unripe fruit than ripe fruit (Diaz-Fleischer & Aluja, 2003).

Commonly, the biochemical changes of abscised immature fruits may support the *B. zonata* individuals to complete its life cycle on the abscised immature fruits. Rattanapun *et. al*., 2009 indicated that the changes in total soluble solids, T.S.S, and skin toughness correlate with changing host use across the ripening stages of two mango varieties when infested by *B. dorsails*. Therefore, the physical change in skin texture and fruit firmness reflects the biochemical changes of starch accumulation, T. S. S, reduction of acidity.

The obtained results are so similar to that reported by Diatta*et.al*., 2013 who indicated that, the lowest mean numbers of *B. invadens*, pupae were obtained from green fruits on fruit species belonging to three families and many more pupae were counted in mature fruits. In addition, the mango fruit fly *Ceratitis cosyra* (Walker),was attracted to and oviposited preferentially on immature and mature green than ripe yellow mango fruits in the field (Gikonyo *et. al*., 2003).Contrary to them, Peña *et. al.,* 2006 revealed that the green mango fruits of "Keitt" variety showed a very low rate of larval emergence of the Caribbean fruit fly, *A. suspense* under very high fly population pressure under laboratory cage infestation, thus, indicating the fruits are poor host conditionally.

It could be concluded that, success of *B. zonata* for infesting and completing its life cycle through dropped immature mango fruits saves an advantage for *B. zonata* to increase its population under field conditions. The infestation rate of abscised immature mango fruits is seemed to be affected by some factors including the availability of mixed-host orchards, higher density of fly population and the longevity of fruit abscission under trees. The mixed-host orchards especially those containing early ripe mango varieties present a favorable environment that can support strongly *B. Zonata* fertile females under absence of suitable host in ripe stage before the mangoes reach the turning stage. The phonological changes including chemical and physiological changes could be considered the major factors that play an important role in susceptibility of dropped immature mango fruits to fruit fly attacks. Removal of such fruit becomes necessary for avoiding such risk. Also, attention should be paid for following and monitoring the fruit flies status in early times (1st week of May at least) instead of later periods during June or July.

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دراسات حقلية ومعملية على إصابة ثمار المانجو غير مكتملة النموبذبابة ثمار الخوخ

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تعتبر ذبابة ثمار الخوخ واحدة من اخطر انواع ذباب الفاكهة على ثمار المانجو في مرحلتي اكتمال النمو و النضج، حيث تسبب لها خسائر شديدة. وتهدف هذة الدراسة الى القاء الضوء على اصابة ثمار المانجو غير مكتملة النمو بذبابة ثمار الخوخ وذلك من خلال التقدير الحقلي وجمع عينات اسبوعياً للثمار غير مكتملة النموذلك في مزارع المانجو المجمعة ومزارع الفاكهة مختلطة العوائل والتي تحتوي على اشجار المانجو. كذلك امتدت الدراسة لتقدم تفسيراً لذلك من خلال تقييم معملي لقدرة اناث ذبابة الخوخ والمرباة معملياً على اصابة ثمار المانجو غير مكتملة النمو والتي تم قطفها ووضعها تحت درجة حرارة الغرفة لمدة ٥ و ١٠ و١٥ يوم مقارنة بثمار غير مكتملة النمو حديثة القطف ، وربطها مع التغيرات البيوكيمائية والفيزيائية للثمار المحضنة. وقد أكدت النتائج خلو الثمار التي على الاشجار من الاصابة، وتم تسجيل الاصابة للثمار غير مكتملة النمو من تلك المجموعة من أسفل الاشجار في مزارع الفاكهة مختلطة العوائل. وكانت نسب الاصابة للموسم الأول من الدراسة (٢٠١٤) للاصناف مبكرة ومتوسطة النضج ٧,٨٣و ٩,١٤ % وفي الموسم الثاني (٢٠١٥) كانت ٥,١٨ و ٥,٥٢% على الترتيب. وكان متوسط عدد العذارى /ثمرة مصابة ٧,٥٤ و ١٢,١٦ عذراء / ثمرة مصابة للموسم الاول وللموسم الثاني ٧,٢٥ و ٨,١٠عذراء / ثمرة على الترتيب ، ويشار الى خلو ثمار الاصناف المتأخرة النضج (الكيت والكنت) من الاصابة خلال عامي الدراسة.وبدأت إصابة ثمار المانجو غير مكتملة النمو في الاسبوع الثالث من شهر مايو والاسبوع الأول من شهر يونيو لموسمي الدراسة على الترتيب. وأكدت النتائج على أن نسب الاصابة للاصناف المبكرة والمتوسطة النضج كانت أقل من مثيلاتها في مرحلتي اكتمال النمو والنضج. وفي الدراسة المعملية فضلت اناث ذبابة الخوخ وضع البيض في الثمار المحضنة لمدد ٥ و ١٠ و ١٥ يوم بنسب ٢٦,٦٧ و ٤٦,٦٧ و ٥٣,٣٣ % بنسب تعذير ٨٠,٨٥ و٨٧,٧٣ و٨٩,٤٧ % و نسبة خروج للحشرات الكاملة ٦٣,١٦ و٦٥,٥٩ و ٧٢,١٨%، في حين كانت مدد الاطوار غير كاملة١٨,٢٠و ١٦,٩٨ و ١٦,٧٩ يوم على الترتيب. وأكدت الدراسة المعملية على أن التغير في بعض الصفات الكيماوية والفيزيائية مثل ازدياد كمية السكريات الكلية الذائبة ونسبة المواد الصلبة الذائبة الكلية والانخفاض في درجة الحموضة علاوة على التغير الملحوظ في درجة صلابة الثمرة نتيجة انفصال الثمار عن الاشجار تساعد في زيادة حساسية تلك الثمار للاصابة بعد سقوطها أسفل الأشجار وتوصى الدراسة بضرورة متابعة تعداد ذباب الفاكهة و الاستعداد لجمع الثمار من بعد مرحلة العقد بدلاً من الانتظار لشهري يونيو ويوليو.