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Seasonal monitoring of two *Bactrocera Species* using methyl eugenol traps on guava orchards in Hyderabad district

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Abstract: : An experiment was performed during consecutive three years (2011-2014) on the seasonal monitoring of fruit flies (*B. zonata* and *B. dorsalis*) using methyl eugenol traps at different heights in guava orchards. The pheromone traps baited with lure toxicant mixture (95% methyl eugenol + Thiodan insecticide) were installed at surface (T_1), 1 m (T_2), 2m height (T_3) and 3 m (T_4). The effect of different heights of methyl eugenol pheromone traps on the male-adult *B. zonata* and *B. dorsalis* catches was statistically significant ($P<0.05$); and the fruit fly catches in traps varied significantly during 12 months of the year ($P<0.05$). The pest catches differed significantly ($P<0.05$) during the years of study (2011-2014); while the interactive effect of years and treatments were non-significant ($P>0.05$). The highest *B. zonata* catches (1428.4±260.04) were monitored in traps installed at 2m height; while the monthly *B. zonata* trap catches simultaneously decreased to 1340.5±230.02, 1185.4±202.56 and 1177.3±210.23 at trap heights of 0 m (surface), 1 m and 3 m, respectively. The average monthly trap catches of *B. zonata* were 1282.90±287.55. The maximum monthly *B. dorsalis* catches (7.34±0.70) were found in traps installed at 2m height; while the monthly *B. dorsalis* trap catches decreased to 6.29±0.60, 4.96±0.49 and 4.67±0.48 when the traps were installed at 0 m (surface), 1 m and 3 m heights, respectively. The average monthly trap catches of *B. dorsalis* were 5.81±0.55. It was concluded that the methyl eugenol pheromone traps were most effective when installed at 2 m height; while traps installed at 1 m and 3 m height could not catch *B. zonata* and *B. dorsalis* more than the surface installed traps. The *B. zonata* starts its rapid development from the month of May and sustains upto the month of September with certain fluctuation.

Keywords: *Bactrocera zonata, B. dorsalis,* methyl eugenol pheromone traps, trap height

1. INTRODUCTION

The insect pests belonging to numerous species attack and damage the fruits (Ali *et al.* 2010). Among them the fruit flies are the serious pests of fruits. They are light yellow to blackish in colour (Suhail *et al.*, 2000). In additional to causing direct losses in the yield and marketability, they pose as significant threats to quarantine security and thus to international trade in fruits and fresh vegetables world-wide (Joomaye *et al*., 2000). Fruit flies losses in Pakistan were estimated in 200 million dollars annually at farm level. The use of cover insecticide sprays against fruit flies is wide spread and increasing. Small farmers suffer more than large ones, through limited access to plant protection methods such as insecticides (John *et al.,* 1997). Peach fruit fly *B. zonata* Saunders and oriental fruit fly *B. dorsalis* (Hendel) are the most serious polyphagous insect pests. These attack a large host range of fruits and vegetables hosts; such as mango, peach, fig, guava, citrus, tomato and apple (Fletcher, 1987). *B. zonata* is widespread in south Asia from Pakistan, India and Sri Lanka to Southeast Asian countries such as Thailand, Laos, Vietnam and Indonesia (White and Elson-Harris, 1992). This pest is active throughout the year (Kapoor 1993 and Hsu and Feng, 2000). Regarding this pest and its control inadequate work has been done in Pakistan particularly from Sindh.

There are different types of traps that are used to catch insects. Some common traps that are often used to catch insects are: sticky traps, light traps and pheromone traps (Campbell *et al.* 1992). Campbell *et al.* (1992) found that pheromone was more effective for catching insect pests and pheromone trap catches increased during early stages of the insect night periods. Malik *et al.* (2003) installed pheromone traps against sucking complex and fruit flies 1.5 m from the ground in okra strongly suggested the use of pheromone over pesticides against the crop insect pests. In view of the facts stated above, the present experiment was conducted on seasonal monitoring of fruit flies (*Bactrocera zonata* and *B. dorsalis*) on guava in Hyderabad District using methyl eugenol traps at different heights.

2. MATERIAL AND METHODS

This study was conducted at the experimental farm and fruit fly rearing laboratories of Nuclear Institute of Agriculture, Tandojam (NIA). The experiments were conducted on an area of six acres of guava orchard at NIA Tandojam, District Hyderabad. The adult populations of fruit flies were recorded weekly through pheromone trap baited with lure toxicant mixture (95 % methyl eugenol + 5 % thiodan insecticide). The experiment was conducted to observe

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the fruit fly catches by hanging fruit fly traps at different heights on guava trees. There were four treatments i. e. pheromone traps installed on ground surface (T1), 1 meter (T2), 2 meters (T3) and 3 meter heights (T4). The experiment was replicated five times. The pheromone traps were replenished after one month to keep fresh chemical for attraction of the fruit flies. Killed male flies in traps were counted and species were identified at weekly interval. Due to the smell of lure traps, male flies were attracted in the traps and were killed due to insecticide Thiodan. The impacts of different treatments on parasitoid, fruit fly and pest management practices will be compared using computer software. All the tests for a significant difference to separate means will be done at $P \leq 0.05$.

3. RESULTS

Male adult *B. zonata* catches in methyl eugenol pheromone traps installed at various heights in guava orchard at NIA Tandojam

The effect of different heights of methyl eugenol pheromone traps (treatments) on the male-adult *B. zonata* catches was statistically significant ($P<0.05$); and the *B. zonata* catches in traps varied significantly during 12 months of the year ($P<0.05$). The pest catches differed significantly ($P<0.05$) during the years of study (2011-2014); while the interactive effect of years and treatments were non-significant ($P>0.05$). The treatment effect showed that highest monthly *B. zonata* catches (1428.4± 260.04) were monitored in traps installed at 2m height (T_3); while the monthly *B. zonata* trap catches simultaneously decreased to 1340.5±230.02, 1185.4±202.56 and 1177.3± 210.23 at trap heights of 0 m (surface, T_1), 1 m (T_2) and 3 m (T_4), respectively. The average monthly trap catches of *B. zonata* were 1282.90±287.55 and the methyl eugenol pheromone traps were most effective when installed at 2 m height; while traps installed at 1 m and 3 m height could not catch *B. zonata* male adults more than the surface installed traps **(Table 1 a and b).**

The record of three years monthly male-adult monitoring of *B. zonata* shows that the insect population was higher in the months of July (3861.1±224.50) and August (3483.6±168.22); while a significant reduction in the trap catches was observed in the months of June (2493.53±92.102), September (2005.3±187.50), October (1368.3± 255.66) and May (1190.8±2.15). A declining trend in the *B. zonata* trap catches was observed for the months of Novembe (254.6±27.55), April (243.1±1.22), December (174.6±3.15), March (132.3±1.17) and January (121.6±0.58); while the least trap catches were observed in the month of February (66.0±1.11). The *B. zonata* starts its rapid development from the month of May and sustains upto the month of September with certain fluctuation. This indicates that there is linear association of *B. zonata* population with the temperature, when its sky-high population was recorded during May to September; while the population declined in the months of low temperature **(Table 1 a).**

The male-adult *B. zonata* catches fluctuated significantly ($P<0.05$) during the three years of study, and the higher insect population was monitored in the year 2012-13 (1341.6±380.15) compared to 2013-14 (1293.±357.15) and 2011-12 (1214.1±377.59). During the years of study 2011-12, 2012-13 and 2013-14, the mean temperature was 32.82, 33.50 and 33.27ºC, suggesting a linear relationship of temperature with the insect population buildup **(Table1b).** The treatment×month×year inetractive effect indicated that the highest *B. zonata* monthly population on average was 4717.1±599.42 in the month of July 2012 when the methyl eugenol pheromone traps were installed at 2 m height (T_3); while the minimum insect population of 61.15±1.11 was monitored in the month of February 2011 at 3 m trap height (T_4)

Male adult *B. dorsalis* catches in methyl eugenol pheromone traps installed at various heights in guava orchard at NIA Tandojam

The influence of different heights of methyl eugenol pheromone traps (treatments) on the male-adult *B. dorsalis* catches was statistically significant ($P<0.05$); and the *B. dorsalis* catches in traps differed significantly during 12 months of the year ($P<0.05$). The *B. dorsalis* catches also differed significantly ($P<0.05$) for the years of study (2011-2014); while the non-significant ($P>0.05$) effect of treatment×month×year interaction was observed. The effect of trap height showed that maximum monthly *B. dorsalis* catches (7.34±0.70) were found in traps installed at 2m height (T_3); while the monthly *B. dorsalis* trap catches decreased to 6.29±0.60, 4.96±0.49 and 4.67±0.48 when the traps were installed at 0 m (surface, T_1), 1 m (T_2) and 3 m (T_4) heights, respectively. The average monthly trap catches of *B. dorsalis* were 5.81±0.55 and the methyl eugenol pheromone traps installed at 2 m height were more effective to trap *B. dorsalis*; while traps heights of 1 m and 3 m traped lesser *B. dorsalis* population than traps installed at surface.

Monthly *B. dorsalis* monitoring indicated that the pest population was higher in the months of June (11.78±0.55), July (10.43±1.81), August (9.06±0.88) and May (8.72±0.47); while a significant reduction in the trap catches was observed in the months of September (5.83±0.44), March (5.81±0.82) and April (5.42± 0.55). A decline in the *B. dorsalis* trap catches was noted in the months of December(2.86±0.47),

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Table 1 (a) Male adult population of *Bactrocera zonata* through methyl eugenol traps at different heights in NIA guava orchard during different months of the year 2011-2014.

Month	Yrs	T1= Surface	T2= 1 meter height	T3= 2 meter height	T4= 3 meter height	Mean±SE	Overall mean
Jun	1st	2321..15±358..23l-r	2343..10±195.46l-r	2614..80±224.82j-p	2160.0±243..15 o-t	2359..8±94..303 e-f	2493..53 ±92.102 c
	2nd	2564..9±342..20 j-p	2589..1±175..22 j-p	2889.4±201..89 h-n	2386..8±210.44 l-q	2607..5±104..22 e	
	3rd	2472..0±350..22 l-p	2495.4±184..36 k-p	2784..8±216..11 i-o	2300.4±225..8 m-s	2513..1±100.44 e	
Jul	1st	3735..64±789.61c-f	3234..56±282.44f-j	4268..84±613.1abc	3377..0±503..83 e-i	3654..0±230.46 b-c	3861..1 ±224..50 a
	2nd	4127..9±725..15 a-d	3574..2±248..27 c-h	4717..1±599.42 a	3731..6±488..36 c-f	4037.7±254..66 a	
	3rd	3978..5±750..22 b-e	3444..8±273..55 d-i	4546..3±601..22 ab	3596..5±496..3 c-h	3891..5±245.44 ab	
Aug	1st	3444.4±473..85d-i	3007..35±624.1g-m	3714.70±472.73c-g	3020..55±371.73g-l	3296..80±172..37 d	3483..6 ±168..22 b
	2nd	3806..1±421.41 c-f	3323..1±603..22 e-i	4104.7±410..85 a-d	3337.7±317..22 e-i	3642. 9±190.4 bcd	
	3rd	3668..3±455..20 c-g	3202..8±618.45 f-k	3956..2±452..3 b-e	3216..9±352..14 f-j	3511..0±183..56 cd	
Sep	1st	1571..36±242.17tuv	1593.76±176.47s-v	2347.44±130..51l-r	2078..56±140.60o-t	1897..80±190.14g	2005..3 ±187..50 d
	2nd	1736.4±228..10q-v	1761..1±138..29q-v	2593..9±114..25j-p	2296..8±114..29n-s	2097..0±210..10 f-g	
	3rd	1673..5±235..99rv	1697.4±159.42q-v	2500..0±125..32k-p	2213.7±132..55n-t	2021..1±202.49f-g	
Oct	1st	1996.40±336..37pu	1231.15±94..62 vw	1211..60±82..6 vw	741.15±47.70 wxy	1295..1±259.77 h	1368..5 ±255.66 e
	2nd	2206..0±315..20 n-t	1360.4±73..26uvw	1338..8±61.25uvw	819.0±38..22 wx	1431..1±287..03 h	
	3rd	2126..2±328.45 o-t	1311..2±83..55uvw	1290.4±71.5uvw	789.3±41.22 wx	1379..3±276..66 h	
Nov	1st	326..95±24..28 xy	239.10±13.08 xy	213..20 ±16.08 xy	184..55 ±16.08 xy	240..95 ±30.75 i	254.6 ±27.55 f
	2nd	361..3±17.19 xy	264..2±8..99 xy	235..5±11..25 xy	203..9±11..22 xy	266..2±34.00 i	
	3rd	348..2±21.10 xy	254.6±11.22 xy	227.0±17.45 xy	196.5±15.88 xy	256.6±32.76 i	
Dec	1st	167.04 ±2.72 xy	159.60 ±1.70 xy	174.88 ±2.85 xy	159.40 ±1.80 xy	165.23 ±3.67 i	174.6 ±3.15 f
	2nd	184.6±1.89 xy	176.4±0.96 xy	193.2±1.96 xy	176.1±1.15 xy	182.6±4.05 i	
	3rd	177.9±2.10 xy	170.0±1.18 xy	186.2±2.18 xy	169.8±1..68 xy	176.0±3.89 i	
Jan	1st	114.80±1.41 xy	114.25±2.05 xy	117.05±1.44 xy	114.05±1.05 xy	115.04±0.68 i	121.6 ±0.58 f
	2nd	126.9±1.14 xy	126.2±1.93 xy	129.3±1.05 xy	126.0±0.99 xy	127.1±0.75 i	
	3rd	122.3±1.29 xy	121.7±2.00 xy	124.7±1.25 xy	121.5±1.01 xy	122.5±0.73 i	
Feb	1st	61.80 ±1..04 l y	61.40±0..88 l y	65.60 ±1.34 y	61.15 ±1.11 y	62.48 ±1.04 i	66.0 ±1.11 f
	2nd	68.3±0.85 y	67.8±0.28 y	72.5±1.04 y	67.6±0.99 y	69.0±1.15 i	
	3rd	65.8±0.99 y	65.4±0.73 y	69.9±1.23 y	65.1±1.03 y	66.5±1.12 i	
Mar	1st	126.16 ±1.17 xy	124.24 ±0.92 xy	127.96 ±1.67 xy	122.72 ±0.91 xy	125.27 ±1.13 i	132.4 ±1.17 f
	2nd	139.4±0.97 xy	137.3±0.48 xy	141.4±1.07 xy	135.5±0.22 xy	138.4±1..27 i	
	3rd	134.4±1.08 xy	132.3±0..84 xy	136.3±1.53 xy	130.7±0.45 xy	133.4±1..22 i	
Apr	1st	231.25 ±0.67 xy	228.80 ±0.57 xy	232.60 ±1.56 xy	227.45 ±0.32 xy	230.02 ±1.16 i	243.1 ±1.22 f
	2nd	255.5±0.24 xy	252.8±0.37 xy	257.0±1.12 xy	251.3±0.10 xy	254.2±1.28 i	
	3rd	246.3±0.39 xy	243.7±0.48 xy	247.7±1.43 xy	242.2±0.28 xy	245.0±1..24 i	
May	1st	1127..0 ±1.09 vw	1124.5 ±0.83 vw	1132..6 ±1.31 vw	1123.7 ±0.57 vw	1127..00 ±2.01 h	1190..8 ±2.15 e
	2nd	1245.3±0.97 vw	1242.6±0.43 vw	1251.5±1.10 vw	1241.7±0.27 vw	1245.3±2.21 h	
	3rd	1200..2±1.01 vw	1197..6±0.75 vw	1206..2±1.26 vw	1196.7±0.48 vw	1200..2±2.14 h	

	Treatments (T)	Months (M)	Year	Y x T
SE±	60.076	104.06	52.028	104.06
LSD 0.05	118.00	204.38	102.19	204.38
LSD 0.01	155.26	268.93	134.46	268.93
F-value	8.34	352.86	3.06	0.91
P-value	0.0000	0.0000	0.0477	0.8400

Table 1(b) Interactive effect of treatments × years on adult population of *Bactrocera zonata* through methyl eugenol traps at different heights in NIA guava orchard during different months of the year 2011-2014.

Year x treatments	T1= Surface	T2= 1 meter height	T3= 2 meter height	T4= 3 meter height	Mean±SE
1st	1268.7±387..68 b-e	1121..8±341..37 e	1351..8±438..29 a-d	1114..2±354..32 e	1214.1±377.59 b
2nd	1401..9±382..55 abc	1239..6±344.15 b-e	1493.7±440..22 a	1231.2±357..21 cde	1341.6±380.15 a
3rd	1351.1±384..21 a-d	1194.7±338.10 de	1439..6±428.18 ab	1186..6±342..58 de	1293..0±357.15 ab
Mean±SE	1340.5±230..03 a	1185.4±202.56 b	1428.4±260..04 a	1177.3±210..23 b	1282..9±287.55

October (2.84±0.18), January (2.59±0.44) and February (2.31±0.19); while the least *B. dorsalis* trap catches were observed in the month of November (2.13±0.55). The *B. dorsalis* starts flaring up in May and reached its peak population in the month of June. The *B. dorsalis* is basically the mango fruit fly and as the results suggested, its population was more associated with the mango season rather to associate its population with the abiotic factors. The effect of years indicated that the male-adult *B. dorsalis* catches fluctuated significantly ($P<0.05$) during the years of study, and the higher insect population was traped in the year 2012-13 (5.93±0.68) compared to 2013-14 (5.88±0.50) and 2011-12 (5.62±0.58). During the years 2011-12, 2012-13 and 2013-14, the mean temperature was 32.82, 33.50 and 33.27ºC, suggested that temperature also influenced the population buildup of *B. dorsalis*.The treatment×month×year ineraction indicated that the highest monthly *B. dorsalis* population on average was 13.87±0.05 in the month of June 2012 when the methyl eugenol pheromone traps were installed at 2 m height (T_3); while the minimum *B. dorsalis* population of 1.70±0.22 and 1.70±0.05 was monitored equally in the months of November 2011 and February 2012 at 3 m trap height (T_4), respectively.

Table 2(a) Male adult population of *Bactrocera dorsalis* through methyl eugenol traps at different heights in NIA guava orchard during different months of the year 2011-2014.

Month	Yrs	T1= Surface	T2= 1 meter height	T3= 2 meter height	T4= 3 meter height	Mean ± SE	Overall mean for months
Jun	1st	11.60±0.16 e-i	10.90±0.10 g-j	13.15±0.16 b-e	10.00 ±0.07 i-k	11.41±0.66 ab	11.78
	2nd	12.23±0.06 c-g	11.50±0.05 e-i	13.87±0.05 abc	10.49±0.02 h-k	12.02±0.71 a	±
	3rd	12.14±0.11 d-h	11.40±0.07 f-i	13.76±0.11 a-d	10.40±0.05 i-k	11.93± 0.70 a	0.55 a
Jul	1st	12.32±1.62 c-g	7.68±0.81 n-q	14.36±1.55 ab	6.00±1.09 p-r	10.09±1.95 c	10.43
	2nd	12.99±1.10 b-f	8.10±0.21 m-r	15.50±1.10 a	6.33±0.96 p-r	10.73±2.12 bc	±
	3rd	12.89±1.28 b-f	8.03±0.39 m-r	15.02±1.38 a	6.28±1.05 p-r	10.56±2.04 c	1.81 b
Aug	1st	9.55±1.69 j-n	6.75±1.32 p-r	10.95±0.63 g-j	7.80±0.96 n-q	8.76±0.93 d	9.06
	2nd	10.07±1.10 i-k	7.12±0.15 n-q	11.55±0.21 e-i	8.22±0.15 m-q	9.24±0.98 d	±
	3rd	9.99±1.38 i-l	7.06±0.28 n-q	11.46±0.46 f-i	8.16±0.47 m-r	9.17±0.97 d	0.88 c
Sep	1st	4.52±0.52 r-t	4.04±0.63 r-t	7.44±0.66 n-q	6.56±0.87 p-r	5.64±0.81 e	5.83
	2nd	4.77±0.25 r-t	4.26±0.25 r-t	7.85±0.18 n-q	6.92±0.22 p-r	5.95±0.85 e	±
	3rd	4.73±0.35 r-t	4.23±0.38 r-t	7.78±0.29 n-q	6.86±0.47 p-r	5.90±0.84 e	0.44 d
Oct	1st	3.75±0.38 s-u	2.40±0.30 u-y	3.05±0.33 s-u	1.80±0.18 z	2.75±0.41 fg	2.84
	2nd	3.95±0.10 s-u	2.53±0.15 u-y	3.21±0.19 s-u	1.89±0.03 z	2.90±0.44 f	±
	3rd	3.92±0.29 s-u	2.51±0.27 u-y	3.19±0.28 s-u	1.88±0.14 z	2.87±0.43 fg	0.18 e
Nov	1st	2.75±0.45 u-y	2.05±0.18 u-y	1.75±0.22 z	1.70±0.22 z	2.06±0.24 g	2.13
	2nd	2.90±0.20 u-y	2.16±0.02 u-y	1.84±0.10 z	1.79±0.11 z	2.17±0.25 fg	±
	3rd	2.88±0.38 u-y	2.14±0.17 u-y	1.83±0.19 z	1.78±0.17 z	2.15±0.25 fg	0.55 f
Dec	1st	2.92±0.08 u-y	2.24±0.07 u-y	4.12±0.08 r-t	1.80±0.06 z	2.77±0.50 fg	2.86
	2nd	3.08±0.01 s-u	2.36±0.01 u-y	4.34±0.01 r-t	1.90±0.01 z	2.92±0.53 f	±
	3rd	3.05±0.05 s-u	2.34±0.05 u-y	4.31±0.05 r-t	1.88±0.04 z	2.89±0.52 f	0.47 e
Jan	1st	2.50±0.11 u-y	1.95±0.14 z	3.75±0.20 s-u	1.85±0.06 z	2.51±0.43 fg	2.59
	2nd	2.63±0.03 u-y	2.05±0.03 u-y	3.95±0.10 s-u	1.95±0.01 z	2.65±0.46fg	±
	3rd	2.61±0.09 u-y	2.03±0.11 u-y	3.92±0.17 s-u	1.93±0.03 z	2.62± 0.45 fg	0.44 ef
Feb	1st	2.40±0.10 u-y	2.05±0.09 u-y	2.80±0.18 u-y	1.70±0.05 z	2.23±0.23 fg	2.31
	2nd	2.53±0.03 u-y	2.16±0.01 u-y	2.95±0.05 u-y	1.79±0.01 z	2.36±0.24 fg	±
	3rd	2.51±0.07 u-y	2.14±0.07 u-y	2.93±0.14 u-y	1.77±0.03 z	2.34±0.24 fg	0.19 f
Mar	1st	5.88±0.13 q-r	5.12±0.13 q-r	7.00±0.00 n-q	4.48±0.04 r-t	5.62±0.54 e	5.81
	2nd	6.20±0.04 p-r	5.40±0.03 q-r	7.39±0.00 n-q	4.72±0.01 r-t	5.93±0.57 e	±
	3rd	6.15±0.08 p-r	5.35±0.07 q-r	7.33±0.00 n-q	4.68±0.03 r-t	5.88±0.56 e	0.82 d
Apr	1st	5.90±0.40 q-r	4.50±0.55 r-t	7.25±0.53 n-q	3.35±0.41 s-u	5.25±0.84 e	5.42
	2nd	6.22±0.14 p-r	4.74±0.11 r-t	7.65±0.15 n-q	3.53±0.11 s-u	5.53±0.89 e	±
	3rd	6.17±0.35 p-r	4.71±0.35 r-t	7.59±0.35 n-q	3.50±0.28 s-u	5.49±0.88 e	0.55 d
May	1st	8.95±0.14 k-p	7.90±0.06 n-q	9.60±0.15 j-m	7.30±0.09 n-q	8.43±0.51 d	8.72
	2nd	9.44±0.03 d-o	8.33±0.01 l-q	10.13±0.03 i-k	7.70±0.02 n-q	8.90±0.54 d	±
	3rd	9.36±0.10 j-o	8.26±0.03 m-q	10.04±0.09 i-k	7.64±0.05 n-q	8.83±0.53 d	0.47 c

	Treatments (T)	Months (M)	Year	Y x T
SE±	0.1408	0.2438	0.1219	0.2438
LSD 0.05	0.2765	0.4789	0.2394	0.4789
LSD 0.01	0.3638	0.6301	0.3151	0.6301
F-value	154.26	397.23	3.71	1.51
P-value	0.0000	0.0000	0.0250	0.231

Table 2(b) Interactive effect of treatments × years on adult population of *Bactrocera dorsalis* through methyl eugenol traps at different heights in NIA guava orchard during different months of the year 2011-2014

Year x treatments	T1= Surface	T2= 1 meter height	T3= 2 meter height	T4= 3 meter height	Mean±SE
1st	6.08±0.47 b	4.79±0.15 cd	7.10±0.83 a	4.52±0.44 d	5.62±0.58 b
2nd	6.42±0.22 b	5.06±0.29 c	7.49±0.49 a	4.77±0.73 cd	5.93±0.68 a
3rd	6.37±0.17 b	5.02±0.11 c	7.43±0.27 a	4.73±0.57 cd	5.88±0.50 a
Mean±SE	6.29±0.60 b	4.96±0.49 c	7.34±0.70 a	4.67±0.48 d	5.81±0.55

4. DISCUSSION

During the present finding it was observed that *B. zonata* starts its rapid development from the month of May and sustains upto the month of September with certain fluctuation. This indicates that there is linear association of *B. zonata* population with the temperature, when its sky-high population was recorded during May to September; while the population declined in the months of low temperature. Saafan *et al* (2000) reported that during the period from May to August the *Bactrocera zonata* populations were higher than the remaining months of the year. Sewoosunkur Gopaul *et al* (2000) used pheromone traps to capture fruit flies and found that *Bactrocera zonata* catches were mostly associated with the trap height and more catches were found when traps were installed at certain heights as compared to surface installation of the trap.

Beside this, White *et al*. (2000) found that oriental fruit fly *B. dorsalis* population was relatively lower than the population of peach fruit fly *B. zonata* with respect to their monitoring by different trap types and installation pattern. Jeuffrault *et al* (2000) concluded that since its first detection in 1991, the peach fly, *Bactrocera zonata*, has been subject to surveillance by a trapping network and control by the male annihilation technique and spot spraying that have prevented its full establishment. Since the beginning of 2000, a more significant control has been organized in the north of the island (Reunion) in a well defined zone of establishment. A range of control methods have been used to prevent the spread of the fly to agricultural areas. Anjum Suhail *et al* (2000) found that 4 pheromone (methyl eugenol) traps were best for controlling fruit flies with minimum damage of 1.5% and 4.15% in July and August, respectively. The investigations on seasonal activity showed that the population of *Dacus zonatus* [*Bactrocera zonata*] was higher than that of *Dacus dorsalis* [*Bactrocera dorsalis*] throughout the activity season in 1997. The highest male population of *Dacus* spp. was observed in first week of July. Fourteen days interval application was found to be more effective than monthly applications. From another study, Divender Gupta and Ranjeet Bhatia (2000) reported that the fruit fly (*Bactrocera dorsalis* and *B. zonata*) population was monitored using eugenol trap with 0.1% methyl and 0.25% malathion per trap in mango and guava orchards. However, the study carried out by Abraham Verghese and Jayanthi (2001) developed methyl eugenol trap for attracting *Bactrocera dorsalis*, *B. zonata*, *B. correcta* and *B. affinis* for a period of one month. The collected flies were dry, which facilitated easy taxonomic identification. Likewise, Sarada *et al* (2001) used traps as attractants for many fruit flies.

Similarly Satarkar *et al* (2009) also reported that *Bactrocera* fruit flies population attracted to methyl eugenol-baited traps, viz. *B. dorsalis*, *B. caryeae*, *B. zonata*, *B. affinis* and *B. correcta*, followed the negative binomial distribution pattern and was highly aggregated or clumped. Dale and Patel (2010) studied peak fly population coincided with the fruiting season of guava. Presently we agreed on this. These findings are further supported by White *et al*. (2000) who found that oriental fruit fly *B. dorsalis* population was relatively lower than the population of peach fruit fly *B. zonata* with respect to their monitoring by different trap types and installation pattern. Similarly, Suhail *et al* (2000) suggests that 4 pheromone (methyl eugenol) traps were best for controlling fruit flies with minimum damage of 1.5% and 4.15% in July and August, respectively. In a simila investigation, Gupta and Bhatia (2000) found that the fruit fly *B. zonata* population was trapped using eugenol trap in guava orchards and there was a significant positive correlation between the trap catch and maximum and minimum temperatures during both the years for both the hosts.

5. CONCLUSIONS

It could be concluded that methyl eugenol pheromone traps were most effective when installed at 2 m height; while traps installed at 1 m and 3 m height could not catch *B. zonata* and *B. dorsalis* more than the surface installed traps. The *B. zonata* starts its rapid development from the month of May and sustains upto the month of September; while *B. dorsalis* starts flaring up in May and reached its peak population in the month of June.The *B. dorsalis* is basically the mango fruit fly and its population was more associated with the mango season rather to associate its population with the abiotic factors. Generally the *B. zonata* population was markedly higher than the population of *B. dorsalis.*

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