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Monitoring of melon fruit fly (*Bactrocera cucurbitae*) Col. (Diptera: Tephritidae) in relation to weather parameters

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Abstract

The present study on monitoring of melon fruit fly in relation to weather parameters was conducted in the farmers field at three locations viz., Bommankatte, Basavnagangur and Abbalgere using Barrix cue-lure trap during *Rabi* 2016-17. Monitoring of melon fruit fly revealed that the initial incidence of the melon fruit fly population begins from the flowering stage of ridge gourd and peak incidence coincides with the peak fruiting period of the crop. At peak fruiting period highest trap catches of 28.40 fruit flies/trap/week were recorded in mid-March (11th standard week of 2017) at Abbalgere, However at Bommankatte and Basavanagangur peak trap catches of 21.40 and 22.20 fruit flies/trap/week were recorded, respectively from ninth standard week of 2017 during peak fruiting period. The incidence of melon fruit fly from three locations showed significant positive correlation with maximum and minimum temperature. Whereas, afternoon relative humidity and rainfall had significant negative correlation with melon fruit fly incidence from all three locations. The incidence of melon fruit fly was influenced to an extent of 83.60, 67.50 and 85.90 percent from the respective locations by all the weather parameters together.

Keywords: *Bactrocera cucurbitae*, (Diptera: Tephritidae), weather parameters

1. Introduction

Ridge gourd [*Luffa acutangula* (L.) Roxb.] belongs to genus *Luffa* of Cucurbitaceous family and has a chromosome number $2n = 26$ and is native to India. Tender fruits are green in colour, which are used in soups and curries or as a cooked vegetable. In India, ridge gourd is cultivated in an area of 10,037 hectares with a production of 3,16,925 tons and 31.6 tons/hectare productivity^[3]. In Karnataka, the crop is grown in an area of 4970 hectares with a production of 42856 tons and productivity of 8.62 tons/hectare^[2]. Insect pests are the major constraint for increasing the production and productivity of ridge gourd crop. *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) affects as much as 0.44 lakh metric ton fruits in ridge gourd and render an annual loss of 21.80 crore rupees in India^[23]. Damage caused by melon fruit flies depends mostly on the prevailing climatic conditions and the diversity of hosts in a particular agro ecosystem. Therefore, monitoring pest population in relation to weather parameters which helps in determining appropriate time of action and suitable method of management. It is one of the most important information necessary for formulating IPM strategy to manage melon fruit flies. Keeping this in mind, the present study on monitoring of melon fruit fly in relation to weather parameters was carried.

2. Materials and methods

In order to monitor melon fruit fly, *Bactrocera cucurbitae* and to work out their correlation with prevailing weather parameters, an experiment was conducted in the farmers field at three locations viz., Bommankatte, Basavanagangur and Abbalgere villages of the Shivamogga district during *Rabi* season of 2016-17. Seeds of ridge gourd hybrid Naga were sown in the main field of 2000 sq. m area with a spacing of 0.95m × 1.5m, between the rows and plants, respectively. The crop was raised by adopting a recommended package of practices except for the plant protection measures. Commercial cue-lure trap, Barrix catchTM traps were used for monitoring. Five traps were set up in the field and care was taken to maintain a distance of 300 m² between the traps to avoid the trap interference effect. In order to monitor fruit flies in ridge gourd, observations on a number of fruit flies trapped in each trap were recorded at weekly intervals from one week after germination and mean trap catches were calculated for every week throughout the cropping season.

The influence of weather factors on trap catches of fruit flies were studied by using the data collected from Agro-met Advisory Unit of the University of Agricultural and Horticultural Sciences, Shivamogga.

Correlation and Regression study was made between weekly trap catches of fruit flies and mean weather parameters like maximum temperature, minimum temperature, morning and afternoon relative humidity and rainfall for every standard week.

3. Results

3.1 Monitoring of melon fruit fly on ridge gourd at Bommankatte village, Shivamogga

The present study was conducted in the farmers field at Bommankatte, Shivamogga during *Rabi* 2016-17 using Barrix traps. The pheromone trap was operated in the ridge gourd field throughout its cropping period *i.e.*, from 50th SW (Standard Week) of 2016 to 11th SW of 2017.

The incidence of melon fruit fly, *Bactrocera cucurbitae* commenced during the third week of January 2017 (3rd standard week) at 45 days after sowing when the crop was in flowering stage with mean trap catches of 1.60 fruit flies/trap/week, the population increased rapidly reaching its peak with mean trap catches of 21.40 fruit flies/trap/week during the first week of March (9th standard week) when the crop was at the maximum fruiting period. Thereafter, the trap catches of *B. cucurbitae* declined gradually and the lowest mean trap catches of 3.60 fruit flies/trap/week during the third week of March (11th standard week) when the crop was the last harvest (Table 1).

3.2 Correlation and regression between melon fruit fly population with weather parameters at Bommankatte, Shivamogga

Studies were made to find out the relationship between trap catches of *B. cucurbitae* and weather parameters such as maximum and minimum temperature, rainfall, morning and afternoon relative humidity.

Correlation between *Bactrocera cucurbitae* and weather parameters showed significant positive correlation with maximum ($r = 0.754$) and minimum ($r = 0.637$) temperature. Whereas, positive non-significant relationship with morning relative humidity ($r = 0.159$) and negative relationship with afternoon relative humidity ($r = -0.179$) and rainfall ($r = -0.274$) was observed (Table 2).

Table 3: Multiple regression equation between weather parameters and incidence of melon fruit fly, *Bactrocera cucurbitae* during *Rabi* season 2016-17 at Bommankatte on ridge gourd

Weather parameters	Regression model	R ²
Maximum temperature (x ₁)	Y = -86.076 + (2.758)x ₁	0.568
Minimum temperature (x ₂)	Y = -23.204 + (1.793)x ₂	0.406
Morning relative humidity (x ₃)	Y = -3.695 + (0.130)x ₃	0.025
Evening relative humidity (x ₄)	Y = 10.596 + (-0.130)x ₄	0.032
Rainfall (x ₅)	Y = 6.609 + (-1.413)x ₅	0.075
Overall parameters	Y = -28.608 + 0.452x ₁ + 1.745x ₂ - 0.213x ₃ + 0.137x ₄ - 0.404x ₅	0.836*

Y = mean trap catches of fruit flies per week, R² = coefficient of determination, * = multiple correlation coefficient

3.3 Monitoring of melon fruit fly species on ridge gourd at Basavanagangur, Shivamogga

This study was conducted in the farmers field at Basavanagangur, Shivamogga during *Rabi* 2016-17. Barrix traps were installed during 50th SW 2016 and observations were recorded up to 11th SW 2017.

Here, the appearance of the melon fruit fly population was recorded for the second week of January 2017 (3rd standard week) when the crop was at flowering stage with mean trap

Table 1: Incidence of melon fruit fly, *Bactrocera cucurbitae* during *Rabi* season 2016-17 in ridge gourd at Bommankatte, Shivamogga.

Crop stage	Standard week	Mean trap catches of fruit flies per week
Vegetative stage	50	0.00
	51	0.00
	52	0.00
	1	0.00
Flower initiation to 1 st picking	2	0.00
	3	1.60
	4	3.20
Harvesting stage	5	7.20
	6	8.40
	7	12.60
	8	16.40
	9	21.40
	10	8.80
	11	3.60

Number of observation = 14 Standard weeks

Table 2: Correlation co-efficient between weather parameters and incidence of melon fruit fly, *Bactrocera cucurbitae* during *Rabi* season 2016-17 at Bommankatte on ridge gourd.

Weather parameters	Mean weekly trap catches
Maximum temperature	0.754*
Minimum temperature	0.637*
Morning relative humidity (RH I)	0.159 ^{NS}
Evening relative humidity (RH II)	-0.179 ^{NS}
RF (Rain fall)	-0.274 ^{NS}

n = 12, Table 'r' values at 5% is 0.53, Table 'r' values at 1% is 0.66, * = significant at 5%, NS = Non-significant

The multiple linear regression analysis estimated between melon fruit fly on ridge gourd and the weather parameters, in *Rabi* maximum temperature influenced 56.80 percent over fruit fly incidence, minimum temperature influenced 40.60 percent, morning and afternoon relative humidity influenced 2.50 percent and 3.20 percent, respectively. The rainfall influenced to an extent of 7.50 percent over fruit fly incidence. All the weather factors together influenced the trap catches to an extent of 83.60 percent (Table 3). The multiple linear regression model fitted was $Y = -77.413 + 1.426x_1 + 1.280x_2 + 0.225x_3 - 0.031x_4 - 1.202x_5$. Where, x₁ = Maximum temperature, x₂ = Minimum temperature, x₃ = Morning relative humidity, x₄ = Afternoon relative humidity and x₅ = Rainfall.

catches of 0.60 fruit flies/trap/week. The peak incidence with mean trap catches of 22.20 fruit flies/trap/week observed during the first week of March (9th standard week) when the crop was at the maximum fruiting period. Later, the incidence of melon fruit fly started to decline and the lowest mean trap catches of 2.40 fruit flies/trap/week were recorded during the third week of March (11th standard week) when the crop was at final harvest (Table 4).

3.4 Correlation and regression between melon fruit fly population with weather parameters at Basavanagangur, Shivamogga

Correlation between *Bactrocera cucurbitae* and weather parameters showed significant positive correlation with

maximum ($r= 0.726$) and minimum ($r= 0.628$) temperature. Whereas, positive non-significant relationship with morning relative humidity ($r= 0.146$) and negative relationship with afternoon relative humidity ($r= -0.193$) and rainfall ($r= -0.295$) was observed (Table 5).

Table 4: Incidence of melon fruit fly, *Bactrocera cucurbitae* during Rabi season 2016-17 in ridge gourd at Basavanagangur, Shivamogga.

Crop stage	Standard week	Mean trap catches of fruit flies per week
Vegetative stage	50	0.00
	51	0.00
	52	0.00
Flower initiation to 1 st picking	1	0.00
	2	0.60
	3	2.20
Harvesting stage	4	3.80
	5	7.20
	6	8.20
	7	13.00
	8	16.20
	9	22.20
	10	9.60
	11	2.40

Number of observation = 14 Standard weeks

Table 5: Correlation co-efficient between weather parameters and incidence of melon fruit fly, *Bactrocera cucurbitae* during Rabi season 2016-17 at Basavanagangur on ridge gourd.

Weather parameters	Mean weekly trap catches
Maximum temperature	0.726*
Minimum temperature	0.628*
Morning relative humidity (RH I)	0.146 ^{NS}
Evening relative humidity (RH II)	-0.193 ^{NS}
RF(Rain fall)	-0.295 ^{NS}

n = 12, Table 'r' values at 5% is 0.53, Table 'r' values at 1% is 0.66, * = significant at 5%, NS = Non significant

The multiple linear regression analysis revealed that independent variables like maximum temperature, minimum

temperature, morning relative humidity, afternoon relative humidity and rainfall found impact on dependent variable *B. cucurbitae* population. The fruit fly population mainly depends on two factors i.e., maximum temperature (52.70 percent) and minimum temperature (39.40 percent) whereas morning relative humidity (2.10 percent) and afternoon relative humidity (3.70 percent) had lower influence as compared to rainfall (8.70 percent). All the weather factors together influenced the trap catches to an extent of 67.50 percent (Table 6). The multiple linear regression model fitted was $Y = -71.745 + 1.187x_1 + 1.415x_2 + 0.237x_3 - 0.046x_4 - 1.428x_5$.

Table 6: Multiple regression equation between weather parameters and incidence of melon fruit fly, *Bactrocera cucurbitae* during Rabi season 2016-17 at Basavanagangur on ridge gourd

Weather parameters	Regression model	R ²
Maximum temperature (x ₁)	$Y = -84.164 + (2.705)x_1$	0.527
Minimum temperature (x ₂)	$Y = -23.154 + (1.799)x_2$	0.394
Morning relative humidity (x ₃)	$Y = -2.875 + (0.121)x_3$	0.021
Evening relative humidity (x ₄)	$Y = 11.201 + (-0.143)x_4$	0.037
Rainfall (x ₅)	$Y = 6.831 + (-1.551)x_5$	0.087
Overall parameters	$Y = -71.745 + 1.187x_1 + 1.415x_2 + 0.237x_3 - 0.046x_4 - 1.428x_5$	0.675

Y = mean trap catches of fruit flies per week, R² = coefficient of determination, * = multiple correlation coefficient

3.5 Monitoring of melon fruit fly species on ridge gourd at Abbalgere, Shivamogga

The population monitoring study was also conducted in a farmer's field at Abbalgere, Shivamogga during Rabi 2016-17. The Barrix traps were operated in the ridge gourd field from 52nd SW of 2016 to 13th SW of 2017.

The activity of melon fruit fly was recorded initially in the last week of January 2017 (4th standard week) with mean trap catches of 0.6 fruit flies/trap/week then the population increased with slight fluctuation. The highest incidence with mean trap catches of 28.40 fruit flies/trap/week was noticed during mid-March (11th standard week) when the crop was with maximum fruits, afterwards the population started to decline. When the crop was at final picking stage the lower fruit fly incidence was recorded with mean trap catches of 6.80 fruit flies/trap/week (13th standard week) (Table 7).

Table 7: Incidence of melon fruit fly, *Bactrocera cucurbitae* during Rabi season 2016-17 on ridge gourd at Abbalgere, Shivamogga.

Crop stage	Standard week	Mean trap catches of fruit flies per week
Vegetative stage	52	0.00
	1	0.00
	2	0.00
Flower initiation to 1 st picking	3	0.00
	4	0.60
	5	2.40
Harvesting stage	6	5.20
	7	9.60
	8	12.20
	9	18.20
	10	24.00
	11	28.40
	12	12.00
	13	6.80

Number of observation = 14 Standard weeks

3.6 Correlation and regression between melon fruit fly populations with weather parameters at Abbalgere, Shivamogga

Correlation coefficient values showed significantly positive correlation between trap catches with maximum temperature

($r = 0.772^*$) and minimum temperature ($r = 0.663^*$). The morning relative humidity ($r = 0.168$) showed non-significant positive correlation, whereas afternoon relative humidity ($r = -0.165$) and rainfall ($r = -0.269$) had non-significant negative correlation with the trap catches (Table 8).

Table 8: Correlation co-efficient between weather parameters and incidence of melon fruit fly, *Bactrocera cucurbitae* during Rabi season 2016-17 at Abbalgere on ridge gourd.

Weather parameters	Mean weekly trap catches
Maximum temperature	0.772*
Minimum temperature	0.663*
Morning relative humidity (RH I)	0.168 ^{NS}
Evening relative humidity (RH II)	-0.165 ^{NS}
RF(Rain fall)	-0.269 ^{NS}

n = 12 and Table 'r' values at 5% is 0.53, Table 'r' values at 1% is 0.66,

* = significant at 5%, NS = Non-significant

The multiple linear regression analysis was estimated between melon fruit fly population with the weather parameters. It was found that the maximum temperature influenced 59.60 percent over fruit fly incidence, minimum temperature influenced 43.90 percent, either morning RH or afternoon RH does not have much influence, however rainfall influenced

7.20 percent on fruit fly population. All the weather factors together influenced the trap catches to an extent of 85.90 percent (Table 9). Obtained multiple linear regression model fitted was $Y = -110.262 + 2.039x_1 + 1.810x_2 + 0.306x_3 - 0.015x_4 - 1.723x_5$.

Table 9: Multiple regression equation between weather parameters and incidence of melon fruit fly, *Bactrocera cucurbitae* during Rabi season 2016-17 at Abbalgere on ridge gourd

Weather parameters	Regression model	R ²
Maximum temperature	$Y = -120.78 + (3.874)x_1$	0.596
Minimum temperature	$Y = -33.028 + (2.556)x_2$	0.439
Morning relative humidity	$Y = -5.381 + (0.188)x_3$	0.028
Evening relative humidity	$Y = 14.401 + (-0.164)x_4$	0.027
Rainfall	$Y = 9.425 + (-1.901)x_5$	0.072
Overall parameters	$Y = -110.262 + 2.039x_1 + 1.810x_2 + 0.306x_3 - 0.015x_4 - 1.723x_5$	0.859 [#]

Y = mean trap catches of fruit flies per week, R² = coefficient of determination,

[#] = multiple correlation coefficient

4. Discussion

4.1 Monitoring of melon fruit fly, *Bactrocera cucurbitae* in ridge gourd

Population monitoring of any pest species is a prime requisite to understand the behavior of pests in different cropping stages for developing forecasting model and to derive effective management strategies. In the present study, monitoring of melon fruit fly, *B. cucurbitae* was studied during Rabi 2016-2017 at three locations. Population of melon fruit fly widely fluctuated from very low to peak level in all the three locations depending on the stage of the crop and weather conditions (Figure 1).

The initial population of melon fruit fly was observed at

flowering stage on the 3rd standard week (SW). The peak population of fruit flies was observed when the fruits were at peak fruiting period i.e., 7th to 10th SW. Highest population was recorded when the crop reaches its maximum fruiting period during 9th SW and subsequently the population was gradually declined. This may be due to closure of the crop period at Bommanakatte and Basavanagangur. These results agree with the findings of Fazlullah *et al.* (2015)^[7] who observed that fruit fly population was maximum at before the ripening time and afterwards decreased towards the end of the cropping season. Mazomenos *et al.* (2001)^[16] also reported that the fruit fly population trended to decrease later in the cropping season.

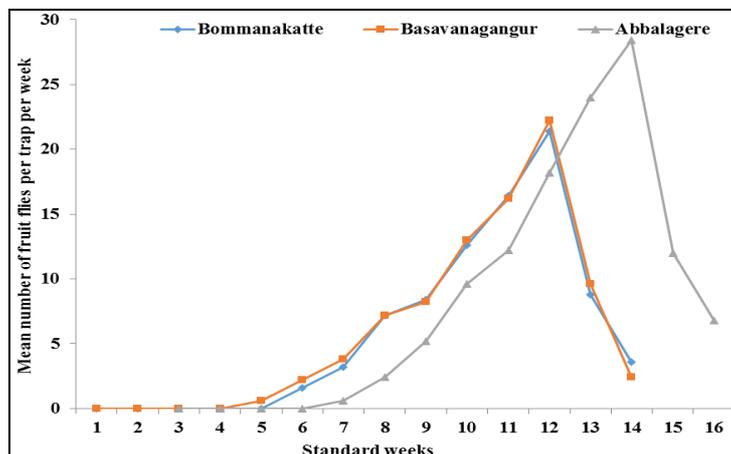


Fig 1: Monitoring of melon fruit fly, *Bactrocera cucurbitae* on ridge gourd at three locations during Rabi 2016-17

The results of the current study agreed with the findings of Sushilkumar *et al.* (1997)^[21] who observed the peak activity of fruit flies coinciding with the fruiting period of crop. Alim *et al.* (2012)^[11] reported that the population of melon fruit flies increased with the ripening of fruits. Jalaluddin *et al.* (2001)^[11] found that fruit ripening played an important role in regulating the *B. correcta* population.

Highest fruit fly population was recorded at Abbalgere compared to Bommankatte and Basavanagangur. This might be due to higher temperature at Abbalgere, where fruit fly population increases with temperature. These results are in close relation to the findings of Lee *et al.* (1992)^[15] who reported that high temperature and long photoperiod influenced the activity and abundance of *B. cucurbitae*.

Gupta and Verma (1992)^[9], Khan *et al.* (1993)^[12] and Raguvanshi *et al.* (2010)^[18] also reported that the activity of *B. cucurbitae* was more in mid-March month compared to February months. Borah (1993)^[6] also found highest infestation by *B. cucurbitae* during summer compared to *Rabi* season.

Present findings are also endorsed by the earlier findings of Patnaik *et al.* (2004)^[17], Banerji *et al.* (2005)^[4], Shivaya and Kumar (2008)^[19], Laskar and Chatterjee (2010)^[14] and Lanjar *et al.* (2013)^[13].

4.2 Relationship between weather parameters and the incidence of melon fruit fly *Bactrocera cucurbitae* in ridge gourd

It is clear from the analysis of Barrix trap capture data that all the weather parameters contributed significantly towards increasing or decreasing melon fruit fly population dynamics.

At all the three locations, the incidence level of *B. cucurbitae* had a significant positive correlation with maximum temperature and minimum temperature. The trap catches were influenced to an extent of 52.70 to 59.60 percent and 39.40 to 43.90 percent by maximum temperature and minimum temperature, respectively in all the three different locations.

It is clearly observed that fruit fly population was very low (0.60 to 5.20 fruit flies/ trap/week) when maximum temperature was ranged between 30 to 33°C and minimum temperature ranged from 12 to 17°C. The population level increased gradually (9.6 to 28.40 fruit flies /trap/week) when maximum temperature ranged between 33 to 35°C minimum temperature ranged from 16 to 21° C. This might be the reason for significant positive correlation of population with temperature variation.

In the present study, rain fall and afternoon relative humidity showed non-significant negative correlation with melon fly incidence in cucumber and they influenced to an extent of 7.20 to 8.70 percent and 2.70 to 3.70 percent, respectively. These results are in close agreement with findings of Vignesh (2015)^[22] who recorded significant positive correlation with maximum and minimum temperature whereas non-significant negative correlations with rain fall.

However, Laskar and Chatterjee (2010)^[14] and Banerji *et al.* (2005)^[4] found that the incidence of melon fruit fly had positive correlation with minimum temperature, morning relative humidity and rainfall. Present findings are also endorsed by the earlier findings of Hasyim *et al.* (2008)^[10], Shivayya and Kumar (2008)^[19] and Raguvanshi *et al.* (2010)^[18]. Ganie *et al.* (2013)^[8] reported that the maximum temperature was positively correlated with the population of melon fruit flies.

Cummulative of all the weather parameters had influenced to an extent of 67.50 to 83.60 percent of the fruit fly population.

Similarly, Barma *et al.* (2013)^[5] also found that the population of *B. cucurbitae* was influenced by all weather parameters to an extent of 76.20 percent.

5. Conclusion

The experiment conducted in the farmers field at three locations *viz.*, Bommankatte, Basavanagangur and Abbalgere villages of the Shivamogga district during *Rabi* season of 2016-17 on monitoring of melon fruit fly in relation to weather parameters. It was found that the incidence of melon fruit fly, *Bactrocera cucurbitae* was higher during the months of mid-March to April than in January to February.

The weather parameters *viz.*, maximum and minimum temperature had greater influence on population fluctuation.

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