

## Original Research Article

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## Influence of Weather Factors on the Occurrence, Population Fluctuation and Species Diversity of Fruit Flies in Snake Gourd Ecosystem

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### ABSTRACT

Snake gourd, *Trichosanthes anguina* L., in the family of cucurbitaceae is the most important tropical and sub-tropical vegetable, which contains lots of medicinal properties that cure people from blood pressure, heart disease, rheumatism and psoriasis. Fruit flies (Tephritidae: Diptera) are polphagous pest and widely distributed in subtropical, tropical and temperate regions of the world. Melon fruit fly, *Zeugodacus cucurbitae* Coquillett is the serious pest of all cucurbitaceous vegetable and reduces the yield of a crop. Adult flies create oviposition punctures on the fruit rind and hatched maggots from the eggs feed on the pulp portion of the fruit. The maggot feeding leads to reduce the marketability and unfit for human consumption. The intensity of the infestation of fruit fly is closely related with the weather parameters and species diversity in the particular location. To overcome the yield losses, there is a need for monitoring of pest species in relation with meteorological factors which helps to determine the management practices. To assess the seasonal occurrence, fluctuation and its species diversity the field experiment was conducted at farmer's field at Kumaravadi village, Tiruchirappalli during *kharif* and *rabi* season 2019-20. The fruit fly species of *Z. cucurbitae*, *Z. gavisus* and *B. vishnu* were trapped in cue lure baited traps and the species *viz.*, *B. dorsalis*, *B. zonata* and *B. correcta* species were trapped in methyl eugenol traps and the species were taxonomically categorized. The maximum population was noticed and trapped in 35<sup>th</sup> Standard Meteorological Week (SMW) i.e., 25.80 fruit flies/trap in *kharif* and 10<sup>th</sup> SMW (12.3 fruit flies/trap) in *rabi*. On comparing the weather parameters relative humidity and rainfall shows negative correlation and other factors are positively correlated with the trap catches in both the seasons.

#### Keywords

Snake gourd, Fruit fly, Occurrence, Species diversity, Cue lure, Methyl eugenol

#### Article Info

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### Introduction

Cucurbits are the most important summer vegetables in the family cucurbitaceae and grown throughout the year except winter

season. In India, vegetable crops are cultivated in an area of 10100 ha with the productivity of 185883 MT (Anonymous, 2019). Snake gourd (*Trichosanthes anguina* L, 2n = 22) is an annual climber originated

from India. It is also known as serpent gourd, viper gourd, club gourd, snake squash, chichinda, padwal and pudalangai in the southern states of India (Deepa Devi, 2017). The fruit contains essential nutrients like vitamin C (30.5%), manganese (12.5%), vitamin B6 (11.3%), vitamin A (9.8%), magnesium (6.7%), iron (5.7%) and calcium (6.7%) for human diet. It acts as a traditional medicine and eliminates the toxins from the body by stimulate the liver and increases urination in human body (Mathew *et al.*, 2019). In Tamil Nadu, snake gourd is cultivated in a total area of 1439 ha with a production of 35,411 tonnes and productivity of 17.66 t/ha. The crop is mainly attacked by melon fruit fly, *Zeugodacus cucurbitae* Coquillett and causes varied yield losses from 30 to 60% depends on the season and cucurbit species/varieties (Dhillon *et al.*, 2005). Adult female prefers to lay eggs inside the pulp portion of the fruit up to 2 to 4 mm deep by making ovipositional punctures on the fruit rind and the eggs emerged as maggots. Apart from fruit, they also lay eggs in corolla and stem region of a plant and also feed flowers (Narayanan, 1953). Infested fruit starts to decay by the action of saprophytic organisms like bacteria and fungi turns to rotten, deformed, and unfit for human consumption (Nasiruddin *et al.*, 2004). Use of insecticides for the control of fruit fly is detrimental to consumers and environment also increases the cost of production, there is a need for alternative method that could be ecofriendly and effective (Neupane, 2000). Pheromone technology is viable option for the management as well as monitoring of fruit flies. Cue-lure (4-(*p*-acetoxyphenyl)-2-butanone) and Methyl eugenol (4-allyl-1,2-dimethoxy benzene carboxylate) were the highly attractive kairomone compound for *Zeugodacus cucurbitae* and *Bactrocera dorsalis*, respectively (Hardy, 1979). Field sanitation along with use of traps is the best alternative method of low cost,

environmentally safe and high specificity for fruit fly management (Sureshbabu and Viraktamath, 2003). The fruit fly damage is varied depends upon the favourable climatic factors and wide diversity of host plants in the particular region. Therefore, it compels the understanding of its behavior with its existing environmental system. Keeping this in view, the present investigation was made to explore the occurrence, fluctuation and its diversity in snake gourd ecosystem.

## Materials and Methods

The field experiment on the assessment of seasonal occurrence and diversity of fruit flies in relation to abiotic factors in snake gourd ecosystem was carried out during 2019-20, in the farmer's field of Kumaravadi village, Vaiyampatti block of Trichirappalli District located between 10<sup>0</sup>32'N latitude and 78<sup>0</sup>18'E longitude at an altitude of 219m above the sea level.

The experiment was conducted by following standard meteorological weeks and the periodical observations were taken at weekly interval. The trap catches were properly preserved and subjected to taxonomical identification and categorization.

The parapheromone attractants *viz.*, cue lure [4, (p-acetoxyphenyl)-2-butanone]] and methyl eugenol (4-allyl-1, 2-dimethoxy benzene carboxylate) were used for monitoring and trapping of fruit flies. A simple bottle trap device with lost cost material was used in the experiment for regular monitoring on the incidence and diversity of fruit flies in the field. Cylindrical disposed plastic water bottle having 10 cm diameter and 25 cm height with a screw lid was used as a trapping material. The bottles were cut open in a three square (1.5 cm x 1.5 cm) shaped entry slits with evenly spaced 10 cm below from the lid with the help of folding

knife. A small hole was made in the centre portion of the lid for the use of hanging of cotton wick. A cotton thread was tied above the lid and half portion was inserted inside the bottle.

The attractant lures were prepared by mixing the commercially available laboratory grade cue lure or methyl eugenol, ethanol along with insecticide malathion 50 EC at the ratio of 6:4:2. A cotton wick (2.5 x 1 cm) was saturated in the lure for 24 h and hung inside the bottle trap near the entry hole. Bottle trap was placed in the snake gourd ecosystem at 1.5 m height for monitoring and trapping of fruit flies. The traps were monitored at weekly interval and trapped fruit flies were collected for identification using the taxonomical keys of David and Ramani (2011). The cotton wicks were replaced at weekly intervals for continuous monitoring to record the data on seasonal incidence of different species of fruit flies in snake gourd.

The meteorological parameters *viz.*, maximum temperature, minimum temperature, relative humidity and rainfall during the experimental period were collected from NASA ARC POWER website. The weather parameters were summarized into weekly averages and correlated with trapped adults of fruit flies to assess its season oriented changes in its population dynamics.

## Results and Discussion

There was a significant and clear variation on the fruit fly species trapped in two different lures. In cue lure traps, the species *viz.* *Zeugodacus cucurbitae* (Coquillett), *Zeugodacus gavisus* (Munro) and *Bactrocera vishnu* (Drew and Handcock) were recorded. In methyl eugenol traps, *Bactrocera dorsalis* (Hendel), *Bactrocera zonata* (Saunders) and *Bactrocera correcta* (Bezzi) were identified from the collected trapped specimens.

## Fruit fly incidence during *kharif* 2019

In *kharif* season, maximum of *Zeugodacus cucurbitae* species was recorded on 45<sup>th</sup> Standard Meteorological Week (SMW) *i.e.*, 9.7 fruit flies/ trap followed by 44<sup>th</sup> SMW (9.6 fruit flies/trap) and the minimum trapping was recorded on 48<sup>th</sup> SMW (3.6 fruit flies/trap) (Table 1). The data was significantly coincides with the finding of Raghuvashini *et al.*, (2012), who reported peak activity of melon fruit fly occurs during 43 SMW (115/trap) in Agricultural research farm, Varanasi during 2003-2004. *Zeugodacus gavisus* species was more on 35<sup>th</sup> SMW and minimum on 48<sup>th</sup> SMW. *B. vishnu* species was recorded only a low population in 35<sup>th</sup>, 38<sup>th</sup>, 39<sup>th</sup> and 47<sup>th</sup> SMW. Likewise, Wen (1985) also recorded two peaks of *Z. cucurbitae* during August- October and May-June months in Southern Taiwan. Total number of fruit flies was maximum on 35<sup>th</sup> (14.20 fruit flies/trap) and minimum on 48<sup>th</sup> SMW (3.90 fruit flies/trap) in cue lure baited traps. Total number of fruit flies trapped was higher in 43<sup>rd</sup> SMW then population decreased upto 39<sup>th</sup> SMW. The number was again increased (11.0 fruit flies/trap) and attain a second peak at 44<sup>th</sup> and 45<sup>th</sup> SMW.

In methyl eugenol traps, the maximum trapping were noticed on 35<sup>th</sup> SMW (25.80 fruit flies/trap) followed by 37<sup>th</sup> SMW (13.30 fruit flies/trap) and minimum number of fruit flies was recorded on 44<sup>th</sup> SMW (3.90 fruit flies/trap). *B. dorsalis* trapping was more in 35<sup>th</sup> SMW (22.3 fruit flies/trap) and low in 44<sup>th</sup> SMW (3.6 fruit flies/trap). The population was maximum on August month and starts declining till November months. Uddin *et al.*, (2016) also documented peak activity of *B. dorsalis* population was recorded only on May-August months during the fruit ripening stages in mango ecosystem. *B. zonata* was recorded as maximum on 35<sup>th</sup> SMW (2.3 fruit flies/trap) followed by 37<sup>th</sup>

and 42<sup>nd</sup> SMW (1.3 fruit flies/trap). *B. correcta* species was more in 35<sup>th</sup> SMW (1.2 fruit flies/trap). The abundance of *Bactrocera* spp. in the month of August observed in this investigation is well supported by the findings of Vignesh *et al.*, 2020, that the peak incidence of fruit flies i.e., 56.50 numbers/trap during the month of August'17 in mango orchards (Fig. 1).

### Fruit fly incidence during *rabi* 2020

During *rabi* season, *Z. cucurbitae* trap catches were more on 10<sup>th</sup> SMW (10.6 fruit flies/trap) followed by 9<sup>th</sup> SMW (9.3 fruit flies/trap) and minimum catches on 3<sup>rd</sup> SMW (3.3 fruit flies/trap). *Z. gavisus* species was more in 3<sup>rd</sup>, 6<sup>th</sup> and 8<sup>th</sup> SMW (1.0 fruit flies/trap). In case of another species *B. Vishnu*, it was more in 6<sup>th</sup> and 9<sup>th</sup> SMW (1.3 fruit flies/trap) (Table 2). Total number of fruit flies was maximum in 10<sup>th</sup> SMW (12.00 fruit flies/trap) followed by 9<sup>th</sup> SMW (11.30 fruit flies/trap) and low population was recorded on 5<sup>th</sup> SMW (4.20 fruit flies/trap) in cue lure traps. Singh and Naik (2006) showed similar result as melon fruit fly population was low during January and increases gradually and attains peak in March, then slowly declines in bitter melon during 2006.

But in methyl eugenol traps, the maximum population recorded in 10<sup>th</sup> SMW (12.30 fruit flies/trap) followed by 8<sup>th</sup> (11.9 fruit flies/trap) and 9<sup>th</sup> SMW (11.6 fruit flies/trap), minimum population recorded on 5<sup>th</sup> SMW (7.20 fruit flies/trap). *B. dorsalis* was more on 9<sup>th</sup> SMW (10.3 fruit flies/trap) and minimum on 3<sup>rd</sup> SMW (5.3 fruit flies/trap). The population was increased gradually from 5<sup>th</sup> SMW to 9<sup>th</sup> SMW in *B. dorsalis*. Nagaraj *et al.*, (2014) also found the mango fruit fly population was maximum (1.2 fruit flies/trap) during last week of February (9<sup>th</sup> SMW) then gradually declined till last week of March. *B. zonata* was noticed more in 3<sup>rd</sup> SMW (1.6

fruit flies/trap). *B. correcta* was high in 8<sup>th</sup> SMW (1.3 fruit flies/trap). The peak activity of fruit fly registered during March- June was coincides with the fruiting period of the crop (Sushil Kumar *et al.*, 1997; Sarada *et al.*, 2001) (Fig. 2).

### Role of abiotic factors on trapping of fruit flies during *kharif* and *rabi* season

The impact of abiotic factors *viz.*, temperature, relative humidity, rainfall and wind speed on the fruit fly incidence were related by correlation analysis and correlation co-efficient was derived. In *kharif* season, maximum temperature ( $r= 0.334$ ), minimum temperature ( $r= 0.558$ ), maximum wind speed ( $r= 0.183$ ), minimum wind speed ( $r= 0.198$ ) were positively correlated with trap catches. Rainfall ( $r= -0.346$ ) and relative humidity ( $r= -0.443$ ) showed negatively correlated with cue lure trap catches (Table 3). All the weather parameters like maximum temperature, minimum temperature, relative humidity, rainfall, maximum wind speed and minimum wind speed are non significant to fruit fly catches. The present finding is in tune with Dubale *et al.*, (2018) on ridge gourd in Konkan region during *kharif* season of 2017. But in methyl eugenol traps, maximum temperature ( $r= 0.693$ ), minimum temperature ( $r= 0.835$ ), maximum wind speed ( $r= 0.550$ ), minimum wind speed ( $r= 0.684$ ) have significantly positive correlated, but relative humidity ( $r= -0.744$ ) and rainfall ( $r= -0.419$ ) have negative correlation with fruit fly catches.

In *rabi* season, the weather parameters maximum temperature ( $r= 0.849$ ), minimum temperature ( $r= 0.924$ ) and maximum wind speed ( $r= 0.448$ ) were positively correlated, relative humidity ( $r= -0.850$ ), minimum wind speed ( $r= -0.064$ ) and rainfall ( $r= -0.301$ ) was negatively correlated to trap catches in cue lure traps (Table 4).

**Table.1** Species diversity and abundance of fruit fly in trap catches during *Kharif* 2019

2019 SMW*	Date	Cue lure			Total	Methyl eugenol			Total
		<i>Z. cucurbitae</i>	<i>Z. gavisus</i>	<i>B. vishnu</i>		<i>B. dorsalis</i>	<i>B. zonata</i>	<i>B. correcta</i>	
35	27Aug-02 Sep	8.3	5.3	0.6	14.2	22.3	2.3	1.2	25.8
36	03 Sep-09 Sep	7.0	2.0	-	9.0	6.6	0.6	0.3	7.5
37	10 Sep-16 Sep	6.3	1.3	-	7.6	12.0	1.3	-	13.3
38	17 Sep-23 Sep	6.3	1.9	0.3	8.5	5.6	-	0.3	5.9
39	24 Sep-30 Sep	5.6	2.6	0.3	8.5	7.0	0.6	-	7.6
40	01 Oct-07 Oct	7.0	2.3	-	9.3	6.3	0.3	0.3	6.9
41	08 Oct-14 Oct	4.6	2.0	-	6.6	7.3	0.6	-	7.9
42	15 Oct-21 Oct	7.3	0.6	-	7.9	5.6	1.3	0.3	7.2
43	22 Oct- 28 Oct	6.3	1.3	-	7.6	6.6	-	0.6	7.2
44	29 Oct- 04 Nov	9.6	1.6	-	11.2	3.6	0.3	-	3.9
45	05 Nov- 11 Nov	9.7	1.3	-	11.0	5.0	-	0.6	5.6
46	12 Nov- 18 Nov	8.3	2.0	-	10.3	5.6	0.6	-	6.2
47	19 Nov- 25 Nov	4.0	1.6	0.3	5.90	7.0	-	-	7.0
48	26 Nov- 02 Dec	3.6	0.3	-	3.90	5.0	-	0.3	5.3

\*Standard Meteorological Week (SMW)

**Table.2** Species diversity and abundance of fruit fly in trap catches during *rabi* 2020

2020 SMW	Date	Cue lure			Total	Methyl eugenol			Total
		<i>Z. cucurbitae</i>	<i>Z. gavisus</i>	<i>B. vishnu</i>		<i>B. dorsalis</i>	<i>B. zonata</i>	<i>B. correcta</i>	
3	15Jan-21 Jan	3.3	1.0	-	4.3	5.3	1.6	0.6	7.6
4	22 Jan- 28 Jan	4.6	0.6	1.0	6.3	6.6	0.6	0.3	7.5
5	29 Jan-04 Feb	3.6	-	0.6	4.2	5.6	1.0	0.6	7.2
6	05Feb- 11 Feb	5.6	1.0	1.3	8.0	7.3	0.6	0.3	8.2
7	12Feb- 18 Feb	5.0	0.6	1.0	6.6	8.3	0.6	0.6	9.5
8	19Feb- 25 Feb	7.0	1.0	0.3	8.3	9.6	1.0	1.3	11.9
9	26 Feb- 04 Ma	9.3	0.6	1.3	11.3	10.3	1.3	-	11.6
10	05Mar-11Mar	10.6	0.6	0.6	12.0	10.0	1.3	1.0	12.3

\*Standard Meteorological Week (SMW)

**Table.3** Correlation between weather parameters and fruit fly trap catches during *kharif* 2019

2019 SMW	CL catches (No. of insects/trap)	ME trap catches (No. of insects/trap)	Temperature (°C)		Relative Humidity (%)	Rain fall (mm)	Wind speed	
			Max	Min			Max	Min
35	14.2	25.8	35.91	25.02	56.98	0.28	5.31	1.95
36	9.0	7.5	34.73	23.48	65.13	0.75	5.18	1.29
37	7.6	13.3	34.13	23.75	66.32	6.27	3.02	0.74
38	8.5	5.9	33.58	23.45	70.09	5.74	2.79	1.07
39	8.5	7.6	30.57	23.44	79.27	7.97	2.85	0.68
40	9.3	6.9	31.17	23.07	77.71	4.93	2.23	0.44
41	6.6	7.9	31.17	23.38	78.57	4.01	1.96	0.48
42	7.9	7.2	29.07	23.28	86.37	13.17	2.45	0.38
43	7.6	7.2	28.39	22.63	87.34	10.31	2.20	0.54
44	11.2	3.9	27.58	22.70	87.57	10.88	2.91	0.36
45	11.0	5.6	29.49	22.83	84.88	3.32	1.58	0.22
46	10.3	6.2	29.53	22.39	86.98	2.64	2.94	0.79
47	5.9	7.0	29.21	22.31	87.60	2.40	3.59	0.90
48	3.9	5.3	28.98	22.16	88.53	9.18	3.95	1.18
Correlation		CL	<b>0.334</b>	<b>0.558</b>	<b>-0.443</b>	<b>-0.346</b>	<b>0.183</b>	<b>0.198</b>
		ME	<b>0.693</b>	<b>0.835</b>	<b>-0.744</b>	<b>-0.419</b>	<b>0.550</b>	<b>0.684</b>

\*Standard Meteorological Week (SMW)

**Table.4** Correlation between weather parameters and fruit fly trap catches during *rabi* 2020

2020 SMW	CL catch (No. of insects/trap)	ME catch (No. of insects/trap)	Temperature (°C)		Relative Humidity (%)	Rain fall (mm)	Wind speed	
			Max	Min			Max	Min
3	4.3	7.6	31.04	19.11	74.67	0.43	3.50	0.88
4	6.3	7.5	32.11	18.80	68.73	0.001	3.49	0.92
5	4.2	7.2	33.17	19.59	65.62	0.002	3.20	0.48
6	8.0	8.2	33.57	20.64	62.13	0.025	3.79	0.67
7	6.6	9.5	34.85	19.50	57.69	0.014	3.53	0.91
8	8.3	11.9	34.38	20.46	61.35	0.178	4.29	1.16
9	11.3	11.6	35.29	22.73	55.49	0.065	3.23	0.59
10	12.0	12.3	37.83	23.94	51.96	0.042	4.20	0.74
Correlation		CL	<b>0.849</b>	<b>0.924</b>	<b>-0.850</b>	<b>-0.301</b>	<b>0.448</b>	<b>-0.064</b>
		ME	<b>0.832</b>	<b>0.803</b>	<b>-0.801</b>	<b>-0.070</b>	<b>0.591</b>	<b>0.233</b>

\*Standard Meteorological Week (SMW)

Fig.1 Weather parameter relationship with fruit fly catches during *kharif* 2019

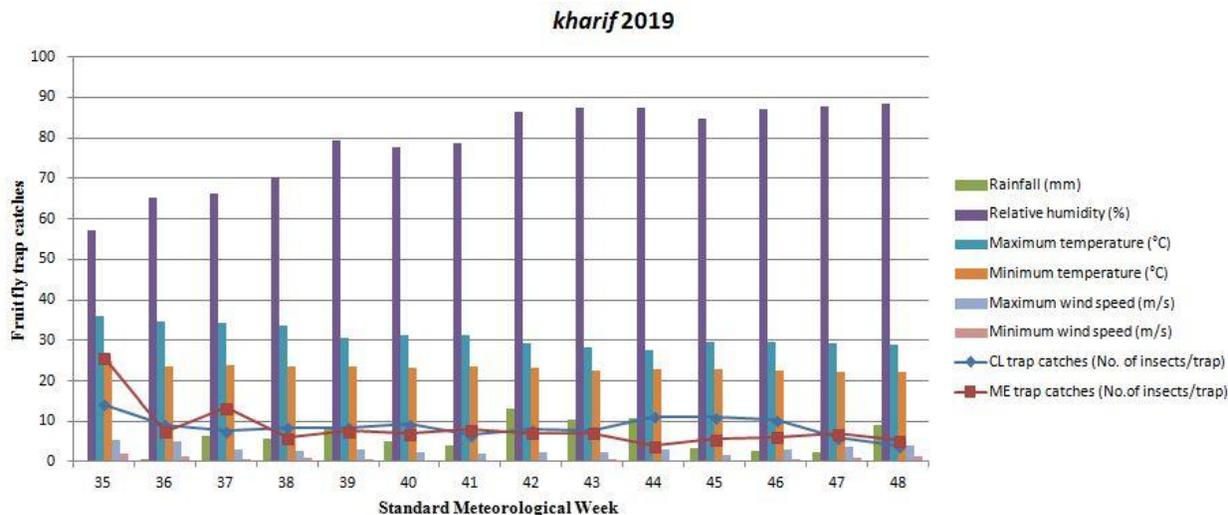
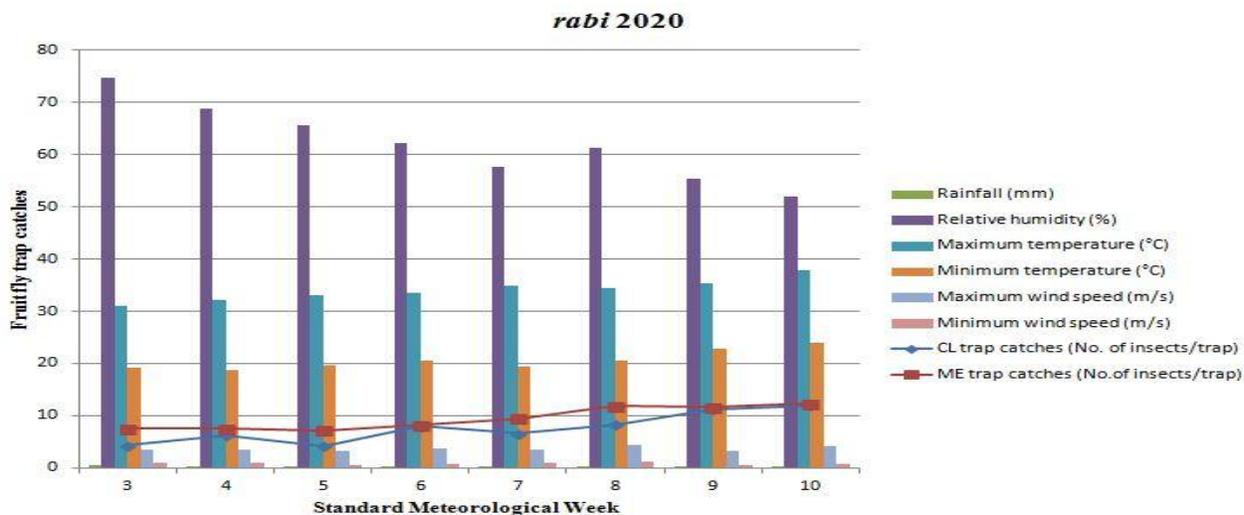


Fig.2 Weather parameter relationship with fruit fly catches during *rabi* 2020



The result was similar with Ghule *et al.*, (2014) fruit fly incidence had positive correlated with maximum temperature ( $r = +0.870$ ), minimum temperature ( $r = +0.730$ ) but had negatively correlated with relative humidity ( $r = -0.738$ ) in cucumber. Abhilash *et al.*, (2017) also endowed peak activity of melon fruit fly was recorded on 9<sup>th</sup> week during fruiting stage in Bommankatte and Basavanaganur villages of the Shivamogga district during 2016-17 in ridge gourd cropping system. The fruit fly catches shown

significant positive correlation with maximum and minimum temperature, whereas, relative humidity and rainfall showed the negative correlation with melon fruit fly incidence in the two locations. Maximum temperature ( $r=0.832$ ), minimum temperature ( $r=0.803$ ), maximum wind speed ( $r=0.591$ ) and minimum wind speed ( $r=0.233$ ) were positive correlation but relative humidity ( $r=-0.801$ ), rainfall ( $r=-0.070$ ) were negatively correlated with trap catches in methyl eugenol traps. The positively correlation of temperature and

negative impact of rainfall and relative humidity over the occurrence of fruit flies in snake gourd ecosystem is also strengthened by the finding of Vignesh *et al.*, 2020, concluded that the influence of external weather parameters on the population of fruit flies shows that rainfall and humidity declines the fruit fly population, whereas the temperature tends to increase the population of fruit flies.

In conclusion, fruit fly incidence and fruit damage is mainly depends on the abiotic factor and species diversity in the cropping area. In Snake gourd ecosystem, the species like *Z. cucurbitae*, *Z. gavisus* and *B. vishnu* species recorded in cue lure traps and *B. dorsalis*, *B. zonata* and *B. correcta* species trapped in methyl eugenol baited traps. The results of the present findings indicated that *Z. cucurbitae* population was dominated during November month (45<sup>th</sup> SMW) and last week of August (35<sup>th</sup> SMW) in *kharif* and first week of March (10<sup>th</sup> SMW) in *rabi* season. *B. dorsalis* species was maximum during last week of August (35<sup>th</sup> SMW) in *kharif* and first week of March (10<sup>th</sup> SMW) in *rabi* season. The weather parameters, relative humidity and rainfall had negative correlation with fruit fly catches and other parameters showed positive correlation in both cue lure and methyl eugenol traps. Through this finding, farmers can be advised and forewarn to initiate control measures in the early fruiting stage for effective management of fruit fly. The farmers can also be advised for installation of para pheromone traps without any synthetic insecticide use towards a safer environment and eco-friendly management approach.

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