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Seasonal incidence and effectiveness of various spray baits against fruit fly, *Bactrocera cucurbitae* Coquillet on cucumber

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Abstract
Studies on seasonal incidence and evaluation of effectiveness of various spray baits against fruit fly *B. cucurbitae* coquillet on cucumber were undertaken at PG farm of Department of Agricultural Entomology, MPKV, Rahuri during late *kharif* season of 2019. The peak incidence of 55 fruit flies/trap/week was recorded in 41st SMW.

The maximum (31.40% and 30.40%) fruit fly infestation on number and weight basis respectively was also recorded in 41stSMW.The fruit fly infestation started decreasing after 44thSMW due to maturity of crop. The correlation studies of fruit flies/trap/week, fruit fly infestation on number and weight basis was found non-significant with maximum and minimum temperatures, morning and evening relative humidity, wind velocity and rainfall.

The incidence of fruit fly was significantly less in various spray baits used in comparison with untreated control. The mean observation taken 10 days after spraying clearly indicate that the spray bait prepared from molasses, tulsi leaf extract, jaggery, sugar, NSE, protein hydrolysate and cucumber pulp were found promising in reducing the infestation of cucumber fruit fly *B. cucurbitae*.

The cucumber yield ranged from 11.10 to 12.60 tonn/ha. Sugar spray bait treatment recorded highest (12.60 tona/ha) followed by tulasi leaf extract (12.15 tona/ha) and molasses (12.03 tona/ha). The highest (1:11.81) ICBR was recorded in the spray bait treatment prepared from molasses and followed by sugar (1:11.54).

Keywords: *Bactrocera cucurbitae*

Introduction
Vegetables contain vitamins, proteins, fibres and other elements of biological value hence are the most important integral part of balance diet of human being. They are very rich and comparatively much cheaper source of body building element and calories yielding from food. Vegetables are called as "protective food" as their consumption prevents several deficiency and disorders, which help in maintaining the physical health of the human being. The Indian Council of Medical Research (ICMR) suggested that an average man with vegetarian or non-vegetarian food habit needs to consume 125 gm leafy vegetables, 100 gm roots and tubers and 75 gm other vegetables in our daily diet.

India is producing around 187.47 million tonnes vegetables annually which are the second largest producer of vegetables in the world after china. The area under vegetable production in India is around 10.43 million hectors with a productivity of 17.90 t/ha. Uttar Pradesh is the leading vegetable producing state in India with annual production of 28.62 million tonnes, which contribute 15.27 percent share. In Maharashtra the annual production of vegetables was 11.61 million tonnes and contribute 6.19 percent share in India (Anonymous, 2019) [4].

The family Tephritidae (true fruit flies) is one of the largest, most diversified and fascinating acalypterate families of Diptera which includes more than 4200 known species arranged in 471 genera (Norrbom *et al.*, 1998) [17]. Tephritids (hereafter referred to as fruit flies) are distributed throughout the tropical, subtropical and temperate regions of the world (Christenson and Foote, 1960) [7] (Aluja *et al.*, 1996) [3] (Armstrong and Jang, 1997) [5], but the greatest diversity of species occurs in the tropical regions (Wang, 1996) [24] (Norrbom *et al.*, 1998) [17]. About 392 species have been recorded in India (Kapoor, 1993) [14].

Damage caused by fruit flies to various fruit and vegetable crops has been estimated up to 100 percent (Dhillon *et al.*, 2005a) [8]. (Philippe *et al.*, 2010) [18]. In midhill conditions of Himachal Pradesh Gupta and Verma (1982) [13] observed about 80 percent fruit fly infestation on cucumber and bottle gourd, 60 percent on bitter gourd and 50 percent on sponge gourd.

The fruit flies of the family Tephritidae are well-known pests of fruits and vegetables throughout the world. The devastating effects that fruit flies inflict to the horticultural industry worldwide, and the transboundary nature of the problem, have placed fruit flies on top of the world's list of key insect pests (Enkerlin, 2003) [10]. The melon fruit fly, *Bactrocera cucurbitae*, the most serious of them all, causes severe damage to cucurbits and is geographically distributed throughout the tropics and subtropics of the world (Drew, 1992) [9].

B. cucurbitae is native to Southeast Asia, but has now widespread in different parts of Africa, the Middle East and Hawaii (Back and Pemberton, 1917) [6] (Fletcher, 1987) [11], India, Bangladesh, Pakistan, Nepal, Srilanka, China, New Guinea, Philippines, Mariana, Australia (Narayanan and Batra, 1960) [16], Egypt, Kenya and Tanzania (Weems and Heppner,2001) [25]. It has more than 81 plant species as its host, but the family Cucurbitaceae is most preferred (Allwood *et al.*, 1999) [2], though it also attacks non-cucurbit vegetables, grain legumes and other fruits (Dhillon *et al.*, 2005a) [8].

Material and method

During the course of the present investigation the field experiments were planned with an objective on seasonal incidence and evaluation of different spray baits for management of fruit fly on cucumber during *kharif* 2019 at the farm of Post Graduate Institute, Department of Agril. Entomology, MPKV, Rahuri.

Method of recording observation Seasonal incidence

Weekly observations on seasonal incidence of cucumber fruit fly were recorded from fruiting to till last harvesting in each Meteorological week.

The incidence of fruit fly was estimated on the basis of percent fruit infestation from fruit formation to last picking. The percent infestation of fruit was worked out on number and weight basis. The infestation of fruits was calculated by picking fruits of marketable size at five days interval. The fruits of cucumber were examined and all fruits with fly punctures and healthy appearance were harvested. Infested and healthy fruits were weighted and counted separately and percentage of fruits damage on number and weight basis were worked out by the following formula.

$$\% \text{ Pest infestation (number basis)} = \frac{\text{No. of damaged fruits}}{\text{Total no. of fruits}} \times 100$$

$$\% \text{ Pest infestation (weight basis)} = \frac{\text{Weight of damaged fruits}}{\text{Total no. of fruits}} \times 100$$

Efficacy of different spray baits

Fruit damage due to fruit fly (*B. cucurbitae)* was recorded at harvest by observing fruits per plot. Marketable sized fruits were harvested at 5 days interval in each treatment. Percent fruit infestation due to fruit fly before treatment and five days after treatment was recorded. The healthy and infested fruits were sorted out separately after each picking. The percentage of infested fruits and marketable fruit yield on number and weight basis in each treatment was worked out to assess the effect of treatments during the entire cropping seasons. At each fruit picking, the healthy and infested fruits were sorted out separately, weighed and noted. The percent infestation was worked out by using the following formula.

$$\% \text{ Pest infestation (number basis)} = \frac{\text{No. of damaged fruits}}{\text{Total no. of fruits}} \times 100$$

$$\% \text{ Pest infestation (weight basis)} = \frac{\text{Weight of damaged fruits}}{\text{Total no. of fruits}} \times 100$$

Data on Meteorological Parameters

To study the influence of abiotic factors (meteorological parameters) on seasonal incidence of pests, the meteorological data on maximum temperature (T max.), minimum temperature (T min.), relative humidity during morning (RH I) and evening (RH II) hours, rainfall (mm) and wind velocity were obtained from the Agricultural Meteorological Observatory, Water management project MPKV, Rahuri, for the period of August 2019 to October 2019.

Statistical Analysis

Statistical analysis of the data was carried out on percent fruit damage obtained from field experiment. The data on per cent damaged fruits were transformed into arcsine values to reduce the variation in different treatments and then subjected to statistical analysis. The significance of treatments was assessed by determining critical difference (CD) at 5% level of significance.

Results and Discussions

Seasonal Incidence of Cucumber Fruit Fly

Seasonal incidence of cucumber fruit fly and the influence of thermo hygro parameters *viz.*, Temperature (maximum and minimum), relative humidity (morning and evening), wind velocity and rainfall on infestation of fruit fly was assessed and presented in Table 1.

The infestation of fruit fly was started in 37th SMW with population of 10 fruit flies per trap per week. The higher level of infestation was noticed from 38th SMW when fruit setting was started.

The peak incidence of 55 fruit flies per trap per week was recorded in 41st SMW. The maximum (31.41% and 30.4%) fruit fly infestation on number and weight basis respectively was also recorded in 41st SMW. The fruit fly infestation started decreasing after 44th SMW due to maturity of crop.

The studies revealed that the correlation of number of fruit flies per trap per week with maximum temperature (+0.205), minimum temperature (+0.016), morning relative humidity (+0.105) and rainfall (0.240) were found positively non-significant where as it was found negatively non-significant with evening relative humidity (-0.422) and wind velocity (-0.631). The negative non-significant correlation exist between percent fruit infestation on number basis with minimum temperature (-0.158), morning relative humidity (-0.198), evening relative humidity(-0.375) and wind velocity (-0.653) while positive non-significant correlation was observed with maximum temperature (0.136) and rainfall (0.266).

Percent fruit fly infestation on weight basis was found negatively non-significant correlation with minimum temperature (-0.156), morning relative humidity (-0.187), evening relative humidity (-0.366) and wind velocity (-0.648) while positive non-significant correlation was observed with maximum temperature (0.128) and rainfall (0.274).

The present findings are more or less in confirmly with Ghule *et al.* (2014) [12]. Only the difference in correlation with temperature might be due to the change in season.

Vignesh and Viraktamath (2015) [23] also observed similar results who reported positive correlation with minimum temperature (r =0.388) and morning (r =0.372) and evening relative humidity(r =0.427).

The non-significant correlation of fruit fly infestation observed with abiotic factors during present investigation is also in confirmation with Shinde *et al.* (2018) [20].

Mean fruit fly infestation on cucumber on number basis after three sprays

The data presented in Table 3 revealed that the mean percent fruit infestation after five days of imposing all three spray bait treatments by cucumber fruit fly on number basis ranged from 22.76 to 28.89% in treated plots as against 48.52 percent fruit infestation in untreated control. All the treatments were statistically significantly superior over untreated control. The lowest (22.76%) percent fruit infestation on number basis was observed in spray bait prepared by using molasses however it was at par with spray bait prepared by using tulasi leaf extract (23.44%), jaggery (23.52%), NSE (26.57%), sugar (27.13%), protein hydrolysate (28.60%) and cucumber pulp (28.89%).

It is observed from the data presented in Table 3 revealed that the mean percent fruit infestation by cucumber fruit fly on number basis at ten days after imposing all three spray bait treatments were significantly superior over untreated control. The spray bait with molasses was found lowest (25.24%) percent fruit infestation by cucumber fruit fly on number basis however it was at par with spray bait prepared from Tulasi leaf extract (26.35%), Jaggery (26.42%), NSE (29.67%), Sugar (30.07%) and Protein hydrolysate (31.54%).

The general trend of field efficacy of the treatments under study against cucumber fruit fly on number basis indicated as spray bait prepared from Molasses >Tulasi leaf extract > Jaggery > NSE > Sugar > Protein hydrolysate > cucumber pulp.

Mean fruit fly infestation on cucumber on weight basis after three sprays

The data presented in Table 4 revealed that the mean after five days of imposing all three spray bait treatments the percent fruit infestation by cucumber fruit fly on weight basis ranged from 18.46 to 29.83% in treated plots as against 48.1 percent fruit infestation in untreated control. All the treatments were statistically significantly superior over untreated control. The lowest (18.46%) percent fruit infestation on weight basis was observed in spray bait prepared by using molasses however it was at par with spray bait prepared by using tulasi leaf extract (21.60%), jaggery (21.63%) and Sugar (24.40%).

It is observed from the data presented in Table 4 revealed that the mean percent fruit infestation by cucumber fruit fly on weight basis at ten days after imposing all three spray bait treatments were significantly superior over untreated control. The spray bait with molasses was found lowest (21.11%) percent fruit infestation by cucumber fruit fly on weight basis however it was at par with spray bait prepared from tulasi leaf extract (24.62%), jaggery (24.71%) and Sugar (27.38%).

The general trend of effectiveness of various spray baits under study against percent fruit infestation by cucumber fruit fly on weight basis indicated as spray bait prepared from Molasses >Tulasi leaf extract > Jaggery > Sugar > NSE > Protein hydrolysate > cucumber pulp.

The results are in confirmly with that of Gupta and Verma (1982) [13] and Liu and Hwang (2000) [15] who reported that spray bait prepared using molasses was more effective than others.

Singh and Singh (1998) [21] reported that NSKE is effective against *B. cucurbitae* which are in confirmation with present findings. The present findings are similar with Sunil *et al.* (2016) [22] who reported the effectiveness of deltamethrin 2.8 EC + Jaggery bait as effective treatment against *B. cucurbitae*.

Ros *et al.* (2003) [19] reported that the hydrolysed protein was the best attractant against *B. oleae*. In present findings also protein hydrolysate was found effective.

Abhilash *et al.* (2018) [1] reported that among botanicals NSE 5% was effective, in present investigation also NSE is also one of the better treatment.

Effect of various spray bait treatments on yield of cucumber with percent increase over control

It could be seen from the Table 5 that all the treatments are significantly superior and recorded higher yield over untreated control.

The data further revealed that significantly highest gross yield (12.60 tonn/ha) was recorded in spray bait prepared from sugar and was found at par with tulasi leaf extract (12.15 tonn/ha), molasses (12.03 tonn/ha), NSE (11.64 tonn/ha), jaggery (11.40 tonn/ha), cucumber pulp (11.25 tonn/ha) and Protein hydrolysate (11.10 tonn/ha). However, all the treatments were significantly superior over untreated plot which recorded (9.75tonn/ha) fruit yield of cucumber.

The percent increase in yield over control in all the treatments varied from 13.84 to 29.23 percent. Sugar (29.23%) recorded the highest percent increase in yield over control.

Table 1: Seasonal incidence of *B. cucurbitae* on cucumber during *Kharif*, 2019

Met. Week	No. of fruit flies/trap/ week	Fruit fly infestation (%) on no. basis	Fruit fly infestation (%) on weight basis	Temperature (0C)		Relative humidity (%)		Wind velocity (Km/hr)	Rain (mm)
				Max.	Min.	Morn.	Even.		
37	10	0	0	28.8	22.5	78	68	2	1.3
38	19	0	0	29.8	21.7	89	71	4	4.2
39	35	28.13	27.5	30.2	21.9	83	67	3	4.9
40	43	29.77	28.93	31.1	21.1	80	59	1	6.1
41	55	31.41	30.4	31.7	24.1	77	50	0	7.1
42	42	27.35	26.42	28.2	18.6	81	68	1.4	52.4
43	38	26.58	26.1	25.7	20.8	87	79	1.3	141.8
44	25	24.22	23.22	30.4	21	54	58	1.1	4

Table 2: Correlation of weather parameters with no. of fruit flies/trap/week and fruit fly infestation (%) on no. and weight basis by fruit fly *B. cucurbitae* on cucumber during *Kharif*- 2019

Sr. No.	Weather parameters	No. of fruit flies/ trap/week	Fruit fly infestation (%) on no. basis	Fruit fly infestation (%) on weight basis
1.	Max. Temperature (0C)	0.205	0.136	0.128
2.	Min. Temperature (0C)	0.016	- 0.158	- 0.156
3.	Mor. Relative humidity (%)	0.105	- 0.198	- 0.187
4.	Eve. Relative humidity (%)	- 0.422	- 0.375	- 0.366
5.	Wind velocity(Km/hr)	- 0.631	- 0.653	- 0.648
6.	Rain(mm)	0.240	0.266	0.274

Table 3: Mean effectiveness of various spray baits against fruit fly on cucumber (Number basis) cumulative of three sprays

Treatment No.	Treatment name	Dose/lit	Per cent Fruit infestation	
			5 DAS	10 DAS
T1	Tulasi leaf extract	20 g	23.44(28.92)	26.35(30.85)
T2	Jaggery	20 g	23.52(28.98)	26.42(30.91)
T3	Protein hydrolysate	20 g	28.60(32.16)	31.54(34.03)
T4	Sugar	20 g	27.13(31.26)	30.07(33.23)
T5	Molasses (fermented)	20 g	22.76(28.43)	25.24(30.11)
T6	Cucumber pulp	20 g	28.89(32.56)	32.33(34.56)
T7	NSE	5%	26.57(30.97)	29.67(32.95)
T8	Untreated Control	--	48.52(44.18)	51.75(46.11)
	S.E.		1.45	1.39
	C.D.		4.39	4.22

Table 4: Mean effectiveness of various spray baits against fruit fly on cucumber (Weight basis) cumulative of three sprays

Treatment No.	Treatment name	Dose/lit	Per cent Fruit infestation	
			5 DAS	10 DAS
T1	Tulasi leaf extract	20 g	21.60(27.67)	24.62(29.72)
T2	Jaggery	20 g	21.63(27.63)	24.71(29.74)
T3	Protein hydrolysate	20 g	27.24(31.35)	30.11(33.20)
T4	Sugar	20 g	24.40(29.51)	27.38(31.48)
T5	Molasses (fermented)	20 g	18.46(25.44)	21.11(27.54)
T6	Cucumber pulp	20 g	29.83(33.09)	32.87(34.96)
T7	NSE	5%	26.50(31.11)	29.91(33.07)
T8	Untreated Control	--	48.10(43.92)	51.26(45.72)
	S.E.		1.36	1.31
	C.D.		4.14	3.98

Table 5: Effect of various spray baits on yield of cucumber

Treatment No.	Treatment name	Dose/lit	Cucumber yield (kg/plot)	Cucumber yield (tonn/ha)	Per cent increase in yield
T1	Tulasi leaf extract	20 g	4.86	12.15	24.61
T2	Jaggery	20 g	4.56	11.40	16.92
T3	Protein hydrolysate	20 g	4.44	11.10	13.84
T4	Sugar	20 g	5.04	12.60	29.23
T5	Molasses (fermented)	20 g	4.81	12.03	23.38
T6	Cucumber pulp	20 g	4.50	11.25	15.38
T7	NSE	5%	4.65	11.64	19.38
T8	Untreated Control	--	3.90	9.75	0
SE			0.033	--	--
C.D. at 5%			0.10	--	--

Conclusion

1. During *Kharif* 2019 fruit fly catches/trap/week ranged from 10 to 55. The per cent fruit infestation ranged from 24.22 to 31.41% on number basis during crop growth period. The percent fruit infestation ranged from 23.22 to 30.4% on weight basis during crop growth period.
2. Surveillance of fruit fly on cucumber and their correlation with weather parameters may assist to develop the suitable forecasting and forewarning model which minimize crop loss and optimize pest control leading to reduction of cost of cultivation.
3. Pooled data of percent fruit infestation on number basis during *Kharif*2019, that treatment molasses showed lowest percent fruit infestation (24.00%) and it was at par with treatments tulasi leaf extract (24.89%). However, maximum fruit damage (30.61%) was recorded on treatment cucumber pulp, which was least effective among all treatments.
4. Pooled data of percent fruit infestation on weight basis during *Kharif* 2019, that treatment molasses showed lowest percent fruit infestation (19.78%) and it was at par with treatments tulasi leaf extract (23.11%). However,

maximum fruit damage (31.35%) was recorded on treatment cucumber pulp, which was least effective among all treatments.

5. Spray bait treatment *i.e.* molasses and tulasi leaf extract proved to be most suitable for minimizing fruit damage on cucumber crop and producing good fruit yield to get maximum economic benefits.

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