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Population Monitoring and Larval Infestation of Fruit Flies in Important Cucurbit Crops in Kashmir

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ABSTRACT: Population monitoring of fruit flies, *Bactrocera* spp. (Diptera: Tephritidae) was carried at Vegetable Experimental Farm, Faculty of Horticulture, SKUAST, Shalimar during 2021-22. Larval infestation on different cucurbit crops i.e. Bottlegourd, Bittergourd, Ridgegourd, Muskmelon and Cucumber was assessed from a month of crop transplanting till final harvest. Adult fruit flies were monitored from 28th to 43rd SW; the trap catch got initiated from 28th SW as 2.2 fruit flies adults per trap which gradually increased in subsequent weeks till it peaked to maximum catch of 23.6 adults per trap in 37th SW; and thereafter decreased in succeeding weeks. The larval count of *Bactrocera cucurbitae*, *B. dorsalis, B. scutellaris* in different cucurbit crops started from 2nd week of August (34th SW), and gradually increased in successive weeks till first fortnight of September (37th SW). In different cucurbit crops, the larval population was in the range of 16.66-22.55 larvae per fruit.

Keywords: Monitoring, Larval infestation, *Bactrocera* species, Cucurbits, Fruit harvest.

INTRODUCTION

The vegetables form an essential component of the human diet especially in India and in some Southeast Asian countries where sizable population basically consists of vegetarians. Vegetables are valuable in maintaining alkaline reserve of the body and are valued mainly for their high carbohydrate, vitamins and mineral contents (Robinson, 1990). Vitamins are organic compounds occurring in natural food especially in vegetables either as such or as utilizable precursor. They are needed for maintenance of skin, mucous membrane, bones, teeth, hair vision and reproduction; and are also involved in blood clotting, normal functioning of nervous system and endocrine glands and are also needed for metabolism of macromolecules (Chatterjea and Shinde 1998). Cucurbits are an important group of vegetables belonging to family Cucurbitaceae. They are well known for their nutritional and medicinal values, and as potential sources of crop diversity. Cucurbits show many biologic properties such as antioxidant, antimicrobial, antidiabetic, anti-inflammatory, and anticancer activity. Cucurbits are a source of polyphenols, tannins and cucurbitacins and can be used as a potential treatment for stomach and intestinal disorders (Rolnik and Olas 2022). 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). Fruit flies are responsible to cause more than 60 per cent crop losses in major cucurbit crops (Manoj *et al.*, 2017). *Bactrocera cucurbitae* feeds on more than 81 plant species, but it prefers the Cucurbitaceous family (Allwood *et al*., 1999); and also feeds on non-cucurbit vegetables, cereal legumes, and other fruits (Dhillon *et al*., 2005). The population monitoring of various fruit flies species is imperative to design the different management strategies for its effective control.

MATERIAL AND METHODS

Population monitoring of fruit flies was done at Vegetable Experimental Farm, SKUAST, Kashmir, Shalimar during the *Kharif*, season, 2021. Fruit fly traps containing Cue lure, chemically 4-(p-acetoxyphenyl)-2-butanone, alongwith wax dispensers fitted in bottle and bucket trap; fixed at equidistance from 45 days of crop sowing/transplanting, coinciding with initiation of flowering were used for monitoring the adult fruit flies population in different cucurbits crops. The observations on fruit flies male adults collected in the traps were recorded at weekly intervals till the final harvest of the crop, the pheromone lures were changed at weekly intervals. The fruit flies larval population was recorded from different genotype/ varieties infesting cucurbit crops bittergourd, bottlegourd, ridgegourd, muskmelon and cucumber till the final crop harvest. During different fruit harvests, three fruits from each genotype/varieties in respective cucurbit crops were randomly selected cut open and number of maggots was counted. Each such cucurbit fruit served as one replicate and mean larval population per fruit per genotype/ variety was calculated.

RESULTS AND DISCUSSION

The adult fruit flies monitored in different cucurbit crops using Cuelure and wax dispenser at Vegetable Experimental Farm, SKUAST-K, Shalimar revealed trapping of three fruit flies species namely, *Bactrocera cucurbitae*, *Bactrocera scutellaris* and *Bactrocera dorsalis* during the pest monitoring beginning forty five days of crop transplanting till end of September. *B. cucurbitae* was predominant fruit flies species in comparison to *B. scutellaris* and *B. dorsalis*. The first catch of adult fruit flies initiated in 28th SW as 2.2 fruit flies/ trap with corresponding maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and rainfall of 30.4 C, 17.98 C, 76.26 per cent, 44.14 per cent and 7.54 mm, respectively. Thereafter, the adult flies trap catch more or less gradually increased in successive weeks and maximized to 23.6 flies/ trap during 37th SW; the Tephritid trap catch gradually declined and was minimum of 9.40 /trap during the 43rd SW corresponding to last week of October (Table 1). The present findings are corroborated by the work of Liu and Lin (1992) who reported Cue lure as the most attractive mixture for luring males of both *B. cucurbitae* and *B. dorsalis* as compared to methyl eugenol. Similarly, Maharjan *et al.* (2015) while studying the population dynamics of *B. cucurbitae*, *B. scutellaris* and *B. caudate* in cucurbit crops; reported that *B. cucurbitae* was predominant species and had higher infestation and damage in comparison to other species two species. The significantly higher population densities dominance of *B. cucurbitae* during population monitoring in different cucurbit crops was also observed by Abro *et al*. (2017) The highest and lowest catch of 23.6 and 1.60 flies /trap during the present studies finds support from the work of Manoj *et al.* (2017) who too recorded maximum catch of *B. cucurbitae* as 10.25 adult /trap/day as against minimum catches of 2.5 adult/trap/day. The peak activity of *B. cucurbitae* in third week of September till last week of October with a distinct peak in the last week of September, coinciding with the fruiting season of cucurbits (Sawai *et al.,* 2019) is inconsonance with the present findings.

The larval population in Bottle gourd genotype/varieties, started from the ending July, and gradually increased in successive weeks. The mean fruit flies larval infestation for all the fruit harvests revealed the highest count of 16.66 larvae/fruit in genotype BOG-HYB-1; whereas, in bottle gourd variety BOG-VAR-3, maximum larval count was 15.25/fruit. However, the minimum larval population of 7.58 and 11.66 larvae/fruit was in genotype BOG-HYB-6 and BOG-VAR-6, respectively (Table 2). In another cucurbit crop bitter gourd, the larval population at first fruit harvest during ending August (35th SW) was 2.71/ fruit in BIT - HYB-1 which gradually increased in subsequent weeks till it peaked to maximum larval count of 4.30 larvae/fruit in second fortnight of September (37th SW).

In almost all the genotype, the larval population gradually increased in successive fruit harvests. The maximum mean fruit flies larval population for all the fruit harvests was 5.94 larvae/fruit in genotype BIT-HYB-2. However, the minimum larval population of 1.46/fruit was computed in genotype BIT-HYB-7 (Table 3). Though, in all the Ridge gourd genotype/ varieties, the larval population of *Bactrocera* species gradually increased in successive fruit harvests and peaked to maximum population at 39th SW. In all the five fruit harvests from 33rd to 39th SW at weekly intervals, VRRG-25-16 had maximum larval count of 13.20 larvae/fruit. However, the minimum larval population of 8.33 larvae/fruit was recorded in genotype VRRG-6 (Table 4). In muskmelon**,** the mean fruit flies species larval population for all the fruit harvests was highest as 12.58 larvae/fruit in genotype Muskmelon-Madhuri-2; whereas, in variety Muskmelon-Madhur as maximum count was 18.50 larvae/ fruit. However, the minimum larval population of 7.50 and 9.91 larvae/fruit was observed in genotype F1-LHM-Masti and variety Kajri, respectively (Table 5). However, all the ten Cucumber varieties were field screened for the larval infestation during three fruit harvest at 34th, 36th and 37th SW. The highest mean fruit flies larval population for all the fruit harvests was 22.55 larvae/fruit in variety NSC-Kheera. However, the minimum larval population of 12.44/fruit was in variety Kheera-Prasad-40 (Table 6).

The results on larval population in different cucurbit germplasm revealed the highest larval count during the 37th and 39th SW. Among all the Cucurbit crops, Cucumber had maximum population count as 22.55 larvae/plant; and minimum population of 1.46 larvae/ plant in Bitter gourd. The Bitter gourd and Ridge gourd had least larval population of *Bactrocera* species; this could possibly be due to depth and density of ribs, and also due to presence of certain secondary metabolites which prevented the female oviposition. However, the cucurbit crop Bottle gourd had less larval population in comparison to Muskmelon and Cucumber; which could be attributed to dense hairs/pubescence and hard and thick fruit rind. Though, the present findings are more or less in concurrence with the observations of Virendra *et al*. (2010); while screening different genotype of bitter gourd against melon fruit fly reported maximum maggots per fruit as 9.24 and minimum as 3.01, which is slightly more than the count of 5.94 and 1.46 larvae/ fruit during present investigations; the difference could be due to varietal difference and varied climatic conditions. The highest larval count of 5.94/ fruit is in close proximity to 5.65 larvae per fruit as reported by Sharma and Kumar (2016). The results are further supported by the findings of Nath *et al*. (2017); Manikandan *et al*. (2021) who too reported fruit flies larval count in the range of 2.59 to 8.13 and 1.29-6.57 larvae per fruit, respectively, in bitter gourd, which is in close proximity to the present findings.

Table 1: Pheromone Monitoring of fruit flies in Cucurbit genotype/varieties at Vegetable Experimental Farm, SKUAST-K, and Shalimar during 2021.

Date of adult fruit flies catch/(Standard Week)	No. of adult fruit flies/ trap	Max Temp(0°C)	Min temp (0°C)	Max RH(%)	Min RH(%)	Rainfall (mm)
28SW(9-15 July)	2.2(1.48)	30.04	17.98	76.28	44.14	7.54
29SW(16-22 July)	1.6(1.26)	28.70	18.01	82.14	55.00	9.40
30SW(23-29 July)	3.2(1.78)	31.22	19.77	77.85	59.71	2.25
31SMW(30-5, Aug)	8.4(2.89)	29.80	17.48	82.85	60.0	13.25
32SW(6-12, Aug)	9.2(3.03)	29.20	13.60	79.50	46.70	1.0
33SW(13-19, Aug)	11.4(3.37)	29.28	13.61	79.57	46.71	1.0
34SW(20-26, Aug)	13.4(3.66)	32.53	15.51	74.57	40.42	0
35SW(27-2, Aug)	17.0(4.12)	29.22	13.50	75.14	44.57	0.51
36SW (3-9, Sep)	15.4 (3.92)	31.12	14.94	74.14	44.57	0
37 SW(10-16, Sep)	23.6 (4.85)	26.64	13.55	83.71	58.71	14.08
38SW (17-23, Sep)	18.4 (4.28)	29.92	14.57	80.42	49.0	5.57
39SW(24-30, Sep)	19.0 (4.35)	30.35	12.50	88.14	45.85	0.
40SW (1-7, Oct)	16.8 (4.09)	27.42	10.92	89.57	55.71	1.67
41SW (8-14, Oct)	13.2 (3.63)	23.50	6.70	88.71	69.14	1.94
42SW (15-21, Oct)	10.00 (3.16)	21.21	6.42	87.85	69.00	3.74
43SW (22-28, Oct)	9.40 (3.06)	15.00	3.25	89.16	79.50	10.3
SE(d)	**0.04**					
CD(p=0.05)	**0.09**					

Table 2: Fruit flies larval count on different bottlegourd genotypes/varieties a t Experimental Vegetable Farm, SKUAST-K, Shalimar during 2021.

Name of Crop (Genotypes/ varieties) Bottle Gourd	Mean Number of fruit flies larvae per fruit				Cumulative mean fruit flies larvae per fruit
	1st Fruit harvest (34SW)	2nd Fruit harvest (35 SW)	3rd Fruit harvest (36 SW)	4th Fruit harvest (37SW)	
	Number of larvae/fruit				
BOG-HYB-1	15.00 (4.00)	16.33 (4.16)	17.33 (4.28)	18.00 (4.35)	16.66 (4.20)
BOG-HYB-2	10.67 (3.41)	11.33(3.51)	11.00(3.46)	13.00(3.73)	11.50(3.53)
BOG-HYB-3	13.33(3.78)	14.00(3.87)	14.33(3.91)	16.67(4.19)	14.58(3.94)
BOG-HYB-5	14.67(3.95)	15.00(3.99)	16.33(4.16)	17.33(4.27)	15.83(4.04)
BOG-HYB-6	6.00 (2.64)	6.67(2.76)	8.67(3.10)	9.00(3.15)	7.58(2.92)
BOG-HYB-7	14.00 (3.87)	14.33(3.91)	15.33(4.04)	16.65(4.17)	15.08 (4.00)
BOG-VAR-1	11.33(3.51)	12.00(3.60)	14.66 (3.95)	14.67 (3.83)	12.92 (3.72)
BOG-VAR-2	14.00 (3.87)	14.00 (3.71)	15.67 (4.08)	16.67 (4.19)	15.16 (4.01)
BOG-VAR-3	13.00 (3.74)	14.33 (3.91)	16.67 (4.11)	17.00(4.22)	15.25(4.03)
BOG-VAR-4	10.67(3.41)	11.33(3.51)	13.62(3.82)	15.00 (3.99)	12.65(3.69)
BOG-VAR-5	10.67 (3.41)	11.33 (3.61)	13.62 (3.82)	15.00 (3.99)	12,65 (3.69)
BOG–VAR-6	10.47 (3.38)	11.66 (3.61	12.66 (3.69)	13.66 (3.73)	11.86 (3.58)
SE(d)	0.06	0.09	0.06	0.17	0.13
C.D. (p=0.05)	**0.13**	**0.19**	**0.14**	**0.35**	**0.27**

*Each value is mean of three replications

Table 3: Fruit flies larval count on different bittergourd genotypes/varieties at Experimental Vegetable Farm, SKUAST-K, and Shalimar during 2021.

Name of Crop/ Genotypes Bitter Gourd	1st fruit harvest (35SW)	2nd fruit harvest (36 SW)	3rd fruit harvest (37SW)	Cumulative mean no of larvae per fruit
	Number of larvae/fruit			
BIT-HYB-1	2.71 (1.92)	2.90 (1.97)	4.30(2.30)	3.29 (2.04)
BIT-HYB-2	5.14 (2.47)	6.30 (2.70)	6.40 (2.72)	5.94 (2.63)
BIT-HYB-3	1.91 (1.70)	2.40 (1.84)	2.70 (1.92)	2.33 (1.81)
BIT-HYB-4	2.37 (1.83)	2.43 (1.85)	3.43 (2.10)	2.74 (1.92)
BIT-HYB-5	2.87 (1.96)	3.26 (2.06)	3.80 (2.18)	3.30 (2.06)
BIT-HYB-7	1.51 (1.58)	1.23 (1.49)	1.66 (1.62)	1.46 (1.55)
BIT-HYB-8	2.54 (1.80)	2.63 (1.90)	1.66 (1.62)	1.46 (1.55)
BIT-HYB-9	1.71 (1,64)	2.36 (1.83)	2.60 (1.89)	2.22 (1.78)
SE(d)	0.07	0.08	0.08	0.17
C.D.(p=0.05)	**0.12**	**0.17**	**0.37**	**0.38**

*Each value is mean of three replications

Table 4: Fruit flies larval count on different Ridge gourd genotypes/varieties at Experimental Vegetable Farm, SKUAST-K, Shalimar during 2021.

Name of Crop (Genotypes/varieties) Ridge Gourd	1st Fruit harvest (33 SW)	2nd Fruit harvest (34SW)	3rd Fruit harvest (36SW)	4th Fruitharvest (37SW)	5th Fruit harvest (39SW)	Cumulative mean no. Of larvae per fruit
Number of larvae/fruit						
VRRG-12-17	10.0 (3.31)	11.0 (3.46)	11.33 (3.51)	12.0 (3.60)	13.33 (3.78)	11.53 (3.53)
VRRG-25-16	10.33 (3.36)	11.67 (3.55)	13.86 (3.85)	14.33 (3.91)	15.67 (4.08)	13.20 (3.76)
VRRG-18-17-2	7/67 (2.94)	8,33 (3.05)	8.67 (3.10)	9.00 (3.15)	10.00 (3.31)	8.73 (3.11)
VRRG-1-16	11.33 (3.51)	11.66 (3.55)	13.0 (3.74)	14.67 (3.95)	15.0 (3.99)	13.13 (3.76)
VRRG-6	6.00 (2.64)	7.00 (2.82)	8.33 (3.05)	9.66 (3.26)	10.67 (3.41)	8.33 (3.04)
VRRG-181	7.00 (2.82)	9.33 (3.21)	11.66 (3.55)	12.67 (3.69)	13.00 (3.74)	10.73 (3.41)
VRRG-35-16	9.00 (3.16)	10.67 (3.41)	11.67 (3.55)	12.33 (3.63)	15.33 (4.04)	11.88 (3.58)
KASHI-SHIVANI	8.00 (2.99)	9.00 (3.16)	9.67 (3.26)	10.33 (3.36)	11.33 (3.51)	9.66 (3.25)
SE(d)	0.10	0.12	0.08	0.12	0.09	0.20
C.D.(p=0.05)	**0.23**	**0.26**	**0.18**	**0.27**	**0.20**	**0.43**

*Each value is mean of three replications

Table 5: Fruit flies larval count on different Muskmelon genotypes/varieties at Experimental Vegetable Farm, SKUAST-K, Shalimar during 2021.

Name of Crop (Genotypes/varieties) Muskmelon	1st Fruit harvest (34SW)	2nd Fruit harvest (36SW)	3rd Fruit harvest (37SW)	4th Fruit harvest (39SW)	Cumulative mean no. of larvae per fruit
Number of larvae/fruit					
TIPU-50	8.66 (3.10)	9.33 (3.21)	12,67 (3.68)	13.00 (3.73)	11.16 (3.45)
F1HYBRIDVS-8989	6.00 (2.64)	8.33 (3.05)	10.33 (3.36)	12.67 (3.69)	8.83 (3.12)
F1 LHM-MUNNA.	6.33 (2.70)	6.66 (2.76)	8.00 (2.99)	9.67 (3.26)	7.58 (2.91)
LHM-MEHAK	7.00 (2.82)	7.33 (2.88)	9.67 (3.26)	11.33 (3.50)	9.33 (3.20)
F1LHM-MEDHA	7.33 (2.88)	7.67 (2.94)	10.00 (3.31)	12.66 (3.69)	9.41 (3.21)
F1LHM-MASTI	5.33 (2.51)	6.00 (2.64)	7.66 (2.93)	9.67 (3.26)	7.50 (2.90)
MAHIMAs	6.11 (2.20)	6.64 (2.73)	8.67 (3.10)	10.67 (3.41)	7.91(2.97)
MADHURI2	8.00 (2.99)	10.33 (3.36)	15.33 (4.04)	17.67 (4.31)	12.58 (3.67)
.F1RASEELA	7.33 (2.88)	9.67 (3.26)	11.66 (3.78)	13.33 (3.78)	10.49 (3.38)
KHUSBOO	9.00 (3.16)	11.33 (3.50)	13.66 (3.74)	15.67 (4.08)	12.25 (3.63)
SARAS MUSKMELON	10.66 (3.41)	12.0 (3.60)	11.33 (3.50)	13.67 (3.82)	11.91 (3.58)
MUSKMELON MADHURAS	16.00 (4.12)	18.33 (4.39)	19.00 (4.47)	20.67 (4.65)	18.50 (4.41)
.SHIVAJI	12.00 (3.60)	18233 (3.64)	16.66 (4.20)	17.33 (4.28)	14.58 (3.94)
KAJRI	8.66 (3.10)	10.33 (3.36)	9.67 (3.26)	11.00 (3.46)	9.91 (3.29)
MADHURAS	11.66 (3.55)	13.66 (3.82)	11.33 (3.50)	18.88 (4.45)	13.83 (3.75)
SE(d)	0.09	0.14	0.11	0.12	0.21
C.D(p=0.05)	**0.20**	**0.29**	**0.24**	**0.26**	**0.44**

*Each value is mean of three replication

Table 6: Fruit fly larval count on different Cucumber varieties at Experimental Vegetable Farm, SKUAST-K, Shalimar during 2021.

Name of Crop/varieties Cucumber	1st fruit harvest (34SW)	2nd fruit harvest (36SW)	3rd fruit harvest (37SW)	Cumulative mean no. of larvae per fruit
Number of larvae/fruit				
KHEERASUPER-40	11.67(3.55)	13.00(3.74)	14.67 (3.95)	12.55(3.67)
JAGADAMBA-12	13.33(3.78)	10.00 (3.31)	15.66 (4.08)	12.99(3.73)
NSC-KHEERA	20.33 (4.61)	22.99(4.89)	24.67 (5.06)	22.55(4.85)
USL-45	11.00 (3.46)	14.33(3.91)	16.66 (4.20)	13.99(3.86)
DHARWAD-GREEN	17.66 (4.31)	16.76(4.20)	19.33 (5.50)	17.88 (4.34)
S-3	17.67 (4.33)	18.00 (4.35)	20.33 (4.61)	18.66 (4.43)
SELECTION-3	12.67 (3.69)	13.33 (3.78)	12.66 (3.69)	13.55(3.81)
PUSABARKHA	18.00(4.35)	19.67 (4.54)	21.66 (4.76)	19.77(4.55)
CUCUMBER JAGADAMBA	19.67(4.54)	18.33 (4.39)	20.00 (4.58)	19.33 (4.50)
KHEERA-PRASAD-40	10.33(3.36)	12.33 (3.64)	12.66 (3.69)	12.44(3.66)
SE(d)	0.09	0.10	0.08	0.15
C.D.(p=0.05)	**0.19**	**0.21**	**0.18**	**0.33**

*Each value is mean of three replications

CONCLUSIONS

After monitoring the cucurbits by using different lures, three species of *Bactrocera* were reported *viz.*, *Bactrocera cucurbitae* (predominant), *Bactrocera scutellaris* and *Bactrocera dorsalis*. The larval population in Bottle gourd genotype/varieties, started from the ending July, and gradually increased in successive weeks. The mean fruit flies larval infestation for all the fruit harvests revealed the highest count of 16.66 larvae/fruit in genotype BOG-HYB-1. The larval population in different cucurbit germplasm revealed the highest larval count during the 37th and 39th SW. Among all the Cucurbit crops, Cucumber had maximum population count as 22.55 larvae/plant; and minimum population of 1.46 larvae/ plant in Bitter gourd.

FUTURE SCOPE

The use of synthetic insecticides will be continued due to limited information of alternative insect pest management practices. The effective public extension services, government policies, and farmer education are important to expand the use of viral insecticides as well as for further development in the production and use of these insecticides. In addition, introducing and evaluating commercial available baculoviruses bio-insecticides need to be practiced.

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Conflict of Interest. None.

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