Original Research Article

Screening of cucurbits germplasm for antixenosis basis of resistance against fruit flies, *Bactrocera*spp. (Diptera: Tephritidae)

ABSTRACT

*Varietal screening of cucurbit germplasm for their relative resistance/ susceptibility against fruit flies, Bactrocera**spp**. infestation was done at field trial laid under All India Coordinated Research Project (AICRP)on Vegetables in the Vegetable Experimental Farm, Faculty of Horticulture, SKUAST-K, Shalimar during khariefseason, 2021 in different cucurbit crops i.e. Bottle gourd, Bitter gourd, Ridge gourd ,Muskmelon and Cucumber.Various antixenotic traits including pubescence on fruit, fruit shape, color of fruits, rind thickness, flesh thickness, fruit toughness, fruit length and diameter, depth and number of ribswere studied on fifty-four varieties/genotypes of different cucurbit crops to assess their relative resistance/susceptibility to fruit flies.The cucurbit genotypes with maximum rind thickness, Pubescence, fruit toughness had least fruit flies infestation; and had significant influence in imparting resistance against fruit flies; however, shape, size and color of the cucurbit fruits were not of much significance in conferring resistance to fruit flies infestation.*

Key words: Antixenosis, cucurbits germplasm, *Bactrocera*species, Rind thickness, Fruit toughnes

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 (reference with two or three authors from the last five years). Vegetables is a gastronomic nutritional word which is usually referred to different part of a plant that are used in human diet, such as leaves, fruits, roots, sprouts and young trunks (reference with two or three authors from the last five

years). Vegetables are valuable in maintaining alkaline reserve of the body and are valued mainly for their high carbohydrate, vitamins and mineral contents (Robinson, 1990).After China, India is the world's second largest producer of vegetables, accounting for around 10 per cent of total global production, the acreage and production of vegetable crops is 10.35 million hectares and 191.77 million metric tons, respectively(Anonymous, 2020). According to the United Nations Food and Agriculture Organization (FAO), 3100 calories per head per day on the average were available in the developed countries contrary to this in the developing countries, per head per day availability of calories was 2200(Patil, 2020).Cucurbits are an important group of vegetables belonging to family Cucurbitaceae. Cucurbits show many biologic properties such as antioxidant, antimicrobial, ant diabetic, anti-inflammatory, and anticancer activity. They are a source of polyphenols, tannins and cucurbitacins and can be used as a potential treatment for stomach and intestinal disorders. (Rolnik, 2022). The dipteran family Tephritidae consists of over 4000 species, of which nearly 700 species belong to Dacine fruit flies (Fletcher, 1987).Nearly 250 species are of economic importance, and are distributed widely in temperate, sub-tropical, and tropical regions of the world (Christenson and Foote, 1960). The fruit flies of the family Tephritidae are well-known pests of fruits and vegetables throughout the world. Fruit flies are responsible to cause more than 60 per cent crop losses in major cucurbit crops (Manoj*et al.,* 2017).Plants are generally exposed to a variety of biotic and abiotic factors that may alter their genotypic and/or phenotypic properties resulting in expression of different mechanisms of resistance, to pest attack (Gogi*et al*., 2010; Haldhar*et al.,* 2013). Such mechanisms of plant resistance have been effectively used against insect pests in many field and horticultural crops (Dhillon*et al.,* 2005; Gogi*et al.,* 2010). Mechanisms of resistance in plants are either constitutive or induced and are grouped into three main categories: antixenosis, antibiosis and tolerance.Antixenosisrefers to the potential plant characteristics/traits, either allelochemical or morphological, that impart or alters insect behavior towards the host preference (Moslem *et al.,* 2011)

MATERIALS AND METHODS

A total 23 varieties and 31 genotype of Bottle gourd, Bitter gourd, Ridge gourd, Muskmelon and Cucumber weretransplanted at Vegetable Experimental Farm, SKUAST, Kashmir, Shalimar

during *Kharief,* 2021; to determine a relationship between fruit morphological characters and their relative susceptibility/resistance to *Bactrocera*species. The morphological traits of different cucurbit crops of each genotype/variety were thoroughly examined under natural infestation conditions to assess their impact in conferring susceptibility/resistance to fruit flies infestation. The crop was sown with three replicates (blocks) for each varieties/genotypes in a randomized block design. Three fruits each of the different cucurbit varieties/genotypes were thoroughly examined to record data on the morphological traits (rind thickness, flesh thickness, fruit diameter) using Vernier Caliper. Fruittoughness was assessed using penetrometer (Model: FT 327- 3-27 lbs.). The fruit length in different cucurbit genotype/ varieties was measured from peduncle end of fruit to the blossom scar point with help of measuring scaleand expressed in centimetre.The diameter of each cucurbit fruit was measured from center of fruit to different points with the help of Vernier caliper**.** Depth of ribs was measured by cutting the fruits longitudinally, and ribs depth was measured on two opposite sides and then averaged. All the fruits used for observation on depth of ribs were also used for measuring the skin thickness. Intensity of ribs was measured by counting the number of ribs in one cm^2area. The total yield for all the screened genotypes/ varieties was recorded by adding the weight of healthy fruits in each picking, to assess the impact of different antixenotic traits in conferring resistance against fruit flies and optimizing the total yields.

RESULTS AND DISCUSSION:

In total 23 varieties and 31 genotype of Bottle gourd, Bitter gourd, Ridgegourd,MuskmelonandCucumberwerescreenedfortheirrelativesusceptibility/resistance against different *Bactrocera*species. The morphological characters *viz.* a*viz.* rind thick, fruit toughness, pubescence, flesh thickness, number and depth of ribs inhibit fruit flies oviposition and less larval infestation. In bottle gourd, the varieties (BOG-HYB-6, BOG-VAR-6, BOG-HYB-7,BOG-HYB- 3) with greater rind thickness, fruit toughness and dense pubescence had least fruit flies infestation; whereas, the germplasm (BOG-VAR-3, BOG-VAR-1, BOG-HYB-1) with minimum rind thickness and fruit toughness, less fruit pubescence had maximum fruit flies infestation. The highest fruit flies infestation as 36.0, 30.33 and 28.10 per cent was in BOG-VAR-3, BOG-VAR-4, BOG-VAR-1, though lowest infestation was recorded in BOG-HYB-

6(13.33 per cent). Though, fruit length and breadth were not of much significance; green colored fruits were much preferred for oviposition in comparison to light green colored (Table 1). In Bitter gourd, the genotype BIT HYB- 7 had maximum rind thickness and fruit toughness; higher number and depth of ribs; followed by BIT HYB- 5, BIT HYB- 9; had least fruit flies infestation, this could be attributed to less oviposition due to hard fruit epicarp and depth/density of ribs and consequently higher fruit yields. The highly infested genotype (BIT-HYB-2, BIT-HYB-.8) had thin skin, less fruit toughness, sparsely distributed ribs.Though, shape and color of fruit had not much significance in population buildup of the pest (Table 2).Similarly, in Ridge gourd, the genotype VRRG-6had maximum rind thickness (4.44 mm) and fruit toughness (9.73 kg/cm^2) had least fruit flies infestation (18.33 per cent).The higher infestation in genotypes (VRRG - 25-16, VRRG - 18-17-1, VRRG -1-16as 40.99, 36.0, 35.33 per cent could possibly be due to least rind thickness, fruit toughness and less depth and density of ribs which led to higher oviposition. However, light green colored fruits were much preferred for fruit flies oviposition in comparisonto green colored; though fruits shape was not of much significance (Table 3).InMuskmelon,genotypeF1 LHM-MASTI had maximum rind thickness, followed by Kajri, Madhuras, Shivaji, Khusbo. The least fruit infestation (14.74 per cent)in genotype F1 LHM-MASTI and consequently higher yieldshad could be attributed to maximum rind thicknessand fruit toughness, thoughfruit length and breadth didn‘t had much significance in conferring resistance against fruit flies. However, the varieties Muskmelon Madhuras had highest fruit flies infestation (33.41 per cent), followed Muskmelon Madhuri 2, Shivaji, Khusboo exhibited fruit morphological traits- rind thickness, fruit toughness on a lower side and subsequent less fruit yields. In all the Musk melon genotypes, the shape and color of the fruits were of least significance in conferring resistance (Table 4). In Cucumber, thevarieties Kheera Prasad 40hadmaximum rind thickness, fruit toughness and least fruit flies infestation; however, NSC-Kheera had highest fruit infestation which could be attributed to minimum rind thickness, fruit toughness and less fruit yield. The size, shape and color of the fruit in all the cucumber genotypes were not of much significance in conferring resistance against fruit flies (Table 5)Thepresentfindingsaremoreorlessin accordance with Panday *et al.*,(2009), who too reported *B. cucurbitae*as the most serious and damaging pest of cucurbits amongst which bitter gourd is

highly preferred; the authors also observed that size and shape of bitter gourd fruits inhibit fruit flies oviposition and infestation. Manbharhaldar*et al*.(2015) too opined that mechanisms of resistance is greatly influenced with various antixenotic traits like pubescence, fruit toughness, rind thickness, flesh thickness, days to first harvest and fruit diameter Similarly, Manoj *et al*.(2017) reported less tissue firmness in crop snake gourd in comparison to bottle gourd was more preferred for fruit flies oviposition. The authors further revealed that more hairs 16.6 per microscopic field in bottle gourd as compared to minimum hair of 1.4 per microscopic field in highly preferred snakegourd indicated more susceptibility and damage. The results are further in consonance with findings of

Navdeep *et al*.(2020);who evaluated different plant characters of bottlegourd genotype for their influence on various yield characters and fruit infestation; the authors opined that fruit rind thickness (mm), fruit flesh thickness(mm), average fruit weight ,days to first flower, fruit length (cm), fruit girth (cm)etc. had significant impact on oviposition and fruit flies infestation. However, Gaddam*et al*(2022) and Sajja*et al*(2022) too reported that different plant traits significantly confer susceptibility/resistance to fruit flies infestation and consequently influence fruit yield and fruit yield and quality.

REFERENCES:

- Anonymous 2020.Department of Agriculture, Government of India. Annual report of estimated area and production of vegetable crops in India, pp. 1-2**:**
- Christenson LD and Foote RH. 1960. Biology of fruit flies. *Annual Review of Entomology***5**: 171-192
- Dhillon, M. K., Singh, R., Naresh, J. S. and Sharma, N. K. 2005. Influence of physico- chemical traits of bitter gourd, *Momordicacharantia* L. on larval density and resistance to melon fruit fly *Bactoceracucurbitae*(Coquillet). Journal of Applied Entomology, 129 (7): 393-396.
- Fletcher BS. 1987. The biology of Dacine fruit flies. *Annual Review of Entomology***32**: 115-144.
- Gaddam,T.A.R.,Bahadur,V.andTopno,S.E.,2022.Performance of bottle gourd (Lagenariasiceraria L.) varieties in Prayagrajagro-climatic conditions.*The Pharma Innovation Journal*, 11(6): 456-60.
- Gogi, M. D., Ashfaq, M., Arif, M. J. and Khan, M. A. 2010. Bio-physical bases of antixenotic mechanism of resistance in bitter-gourd (*Momordicacharantia* L., Cucurbitacae) against melon fruit fly, *Bactroceracucurbitae* (Coquillett)(Diptera: Tephritidae). *Pakistan Journal of Botany* **42**(2): 1251-1266.
- Manbharhaldar, S.M; Choudhary; B.R.andBhargava,Rakesh. 2015.Antixenoticresistance traits of muskmelon(*Cucumis melo*) against fruit fly *(Bactroceracucurbitae*(Coquillett) in arid region of India.*Phytoparasitica* 41: 41: 473-78
- Manoj, Sridharan, C. S. and Awasthi, N. S. 2017.Varying infestation of fruit fly, *Bactroceracucurbitae*(Coquillett) in different cucurbit crops.*Journal of Entomology and Zoology Studies* 5(53): 1419-1421.
- Moslem, B., Alireza, A., Shahriyar, A., Saeid, M., Ramin, R., 2011. Evaluation of resistance of cucumber cultivars to the vegetable leaf miner (Liriomyzasativae Blanchard) (Diptera: Agromyzidae) in greenhouse. *Chil. J. Agric. Res.* 7, 395–400
- Navdeep, S. and Harpal, S. 2020. Evaluation of bottle gourd

[*Lagenariamsiceraria*(Molina) Standl.] genotypes for various growth and yield characters. *Asian Journal of Horticulture* 1**5**(1):.4-6.

- Patil, P. D. 2020. Level of consumption of nutrients among tribal population in Satpuda Mountain region of Jalgaon district (MS). *International Journal of Advanced Research* **6(**9): 415-418
- Panday, A. K., Rai, P. N. A. and Kumar, A. 2009.Screening of some bitter gourd varieties/germplasm on the basis of some biological and biometrical parameters of melon fruit fly (*Bactroceracucurbitae*Coquillett).*Vegetable Science* **36**(3) **3**99-400.
- Robinson, D. S. 1990. Food biochemistry and nutritional value.Longman Scientific and Technical Publisher, NewYork. USA
- Rolnik, A. and Olas, B. 2022.A Review of the Effect of Preparations from Vegetables of the Asteraceae Family and Cucurbitaceae Family on the Cardiovascular System and Its Diseases.*Nutrients* 1**4**(17): 3601
- Sajja, V., Vijay Bahadur,Anita Kerketta and Deepanshu 2022. Performance of bottle gourd (*Lagenaria siceraria* L.) hybrid genotypes in Prayagraj agro-climatic conditions.*The Pharma Journal;* Vol 11(5): 2328-2333.

Table 1: Morphological character of bottle gourd genotypes/varieties in relation to infestation of *Bactroceracucurbitae*

Bottle gourd genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm²)	Fruit length (cm)	Fruit Diameter (cm)	Pubescence on fruit	Days to first fruit harvest	Total Yield (q/ha)	Shape of fruit	Color of fruit
BOG- HYB-1	**24.99**	**2.25**	**92.11**	**2.30**	44.69	9.71	**10.00**	77.85	**141.15**	Elongate	Lightgreen
BOG-HYB-2	18.44	2.88	66.15	3.20	40.15	6.78	13.10	74.80	211.2	Elongate	Lightgreen
.BOG-HYB-3	19.66	4.40	85.81	3.52	43.49	9.24	15.05	75.00	169.87	Elongate	Lightgreen
BOG-HYB-5	20.66	2.76	71.79	3.00	42.51	6.43	17.12	71.30	143.57	Elongate	Lightgreen
BOG-HYB-6	**13.33**	**5.39**	**58.00**	**5.36**	35.64	5.90	**19.20**	66.95	290.15	Elongate	Lightgreen
.BOG-HYB-7	18.88	3.73	79.89	3.26	43.04	8.38	11.50	76.13	168.11	Elongate	Lightgreen
BOG-VAR-1	28.10	1.77	68.33	2.93	28.80	6.21	9.00	76.20	175.0	Elongate	Green
BOG- VAR-2	20.99	3.10	77.10	5.20	22.35	7.42	12.90	74.48	190.5	Elongate	Green
BOG- VAR-3	**36.00**	**1.60**	**84.20**	**2.49**	32.50	8.52	**8.90**	81.24	169.5	Elongate	Green
BOG- VAR-4	30.33	2.58	69.69	3.83	20.29	6.73	13.20	75.79	180.4	Elongate	Green
BOG- nVAR-5	27.22	2.40	64.00	3.60	25.73	7.17	11.70	70.03	188.5	Elongate	Green
BOG– VAR-6	**18.99**	**3.44**	**52.64**	**6.30**	19.20	4.27	**16.60**	77.87	**193.6**	Elongate	Green
SE(d)	------	0.30	3.74	0.19	2.14	1.08	0.95				
C.D.	-------	0.62	7.80	0.40	4.48	2.26	1.99				

Table 2: Morphological character of Bitter gourd genotypes/varieties in relation to infestation of *Bactroceracucurbitae*

Bitter gourd genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm²)	Fruit length (cm)	Fruit Diameter (cm)	Depth of ribs	No of ribs	Days to first fruit harvest	Total Yield (q/ha)	Shape of fruit	Color of fruit
BIT-HYB-1	26.55	5.00	4.30	7.11	14.30	3.32	0.91	15.10	72.80	94.89	spindal	Green
BIT-HYB-2	**28.99**	**3.00**	**5.25**	**5.16**	21.00	4.85	**0.22**	**12.22**	70.50	90.52	spindal	Green
BIT-HYB-3	22.77	5.05	4.25	8.64	15.88	3.98	3.22	15.02	71.55	95.66	Spindal	Lightorange
BIT-HYB-4	24.33	3.11	4.35	6.42	17.25	4.83	0.58	12.50	73.22	92.75	Spindal	Green
BIT-HYB-5	22.44	4.03	5.10	7.12	17.00	4.75	0.60	20.40	75.62	108.39	Spindal	Green
BIT-HYB-7	**18.66**	**5.11**	**3.96**	**9.73**	13.40	3.25	**7.00**	**24.22**	73.81	109.76	spindal	Green
.BIT-HYB-8	28.10	3.03	4.12	8.80	16.86	3.93	6.00	19.00	69.08	106.55	Spindal	Green
.BIT-HYB-9	22.88	4.00	4.11	8.11	20.26	3.88	3.00	22.87	70.00	101.42	Spindal	Lightorange
SE(d)		0.34	0.22	0.67	0.83	0.27	0.31	1.14				
C.D.		0.73	0.48	1.46	1.80	0.58	0.68	2.48				

Table 3: Morphological character of Ridge gourd genotypes/varieties in relation to infestation of *Bactroceracucurbitae*

Ridge gourd genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm²)	Fruit length (cm)	Fruit Diameter (cm)	Depth of ribs	No of ribs	Days to first fruit harvest	Total Yield (q/ha)	Shape of fruit	Color of fruit
.VRRG-12-17	32.66	1.92	2.41	6.81	23.67	4.66	2.53	8.66	52.35	125.35	Cylindrical	Green
VRRG-25-16	**40.99**	**1.42**	**5.03**	**5.64**	28.76	19.72	**1.33**	**6.33**	55.33	120.3	Cylindrical	Lightgreen
.VRRG-18-17-1	36.00	1.90	2.60	7.67	26.19	4.77	2.55	7.30	56.04	142.94	Cylindrical	Green
VRRG-18-17-2	28.00	1.66	2.30	5.95	20.56	4.38	2.02	8.31	51.00	137.24	Cylindrical	Green
VRRG-1-16	35.33	1.64	2.90	8.67	28.73	4.60	2.00	7.66	**57.00**	**130.16**	Cylindrical	Green
VRRG-6	**18.33**	**4.44**	**2.25**	**9.73**	19.33	4.13	**2.76**	**8.33**	46.44	147.26	Cylindrical	Green
VRRG-181	30.00	1.94	2.44	8.33	22.50	4.70	1.66	7.32	50.00	134.62	Cylindrical	Green
VRRG-35-16	28.33	1.62	2.65	7.30	20.77	4.96	2.38	7.33	44..26	127.09	Cylindrical	Green
KASHI- SHIVANI	26.66	1.97	2.73	6.57	25.67	4.73	1.53	7.67	52.07	143.43	Cylindrical	Green
SE(d)		0.14	0.28	0.54	2.12	7.48	0.24	1.17				
C.D		0.31	0.60	1.16	4.53	0.25	0.52	N/A				

Table 4: Morphological character of Musk melon genotypes/varieties in relation to infestation of *Bactroceracucurbitae*

Musk melon genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm²)	Fruit length (cm)	Fruit Diameter (cm)	Days to first fruit harvest	Total Yield (q/ha)	Shape of fruit	Color of fruit
TIPU-50	27.16	0.30	25.93	6.73	12.06	19.07	80.26	24.83	Round	Light green
F1 HYBRIDVS-8989	24.33	0.34	24.11	7.82	16.04	11.77	85.68	28.75	Round	Light green
. F1 LHM-MUNNA	26.33	0.29	30.43	8.44	19.12	13.07	83.25	25.23	Round	Light yellow
LHM-MEHAK	27.07	0.15	26.18	5.30	13.02	9.04	86.65	28.95	Round	Light green
F1LHM-MEDHA	22.66	0.19	22.88	7.11	18.33	12.25	84.89	21.59	Round	Green
F1 LHM-MASTI	**14.74**	**4.50**	**20.00**	**8.67**	12.00	9.73	74.92	38.33	Round	Light green
MAHIMAs	24.74	0.16	21.34	5.09	18.29	14.43	84.21	32.56	Round	Green
MUSKMELONMADHURI2	**32.24**	**0.13**	**36.90**	**4.11**	20.43	11.04	78.75	19.11	Round	Green
F1RASEELA	27.24	0.14	31.22	7.18	14.22	10.67	84.27	22.81	Round	Green
KHUSBOO	28.65	3.00	34.90	5.23	15.55	17.00	75.25	28.50	Round	Light green
SARASMUSKMELON	25.24	2.00	29.60	6.03	11.33	13.11	65.75	31.50	Round	Green
MUSKMELON MADHURAS	**33.41**	**1.00**	**35.70**	**5.10**	19.00	19.35	68.50	25.70	Round	Lightyellow
.SHIVAJI	29.66	3.11	36.60	6.53	14.80	13.53	70.40	32.50	Round	Lightyellow
KAJRI	**18.41**	**4.00**	**27.50**	**7.26**	11.20	12.00	62.50	34.20	Round	LightGreen
.MADHURAS	25.26	3.50	29.90	5.53	15.33	18.00	63.25	30.20	Round	Lightyellow
SE(d)		0.06	0.39	0.10	1.84	1.50				
C.D.		0.13	0.80	0.22	3.80	3.10				

Table 5: Morphological character of Cucumber genotypes/varieties in relation to infestation of *Bactroceracucurbitae*

Cucumber genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm²)	Fruit length (cm)	Fruit Diameter (cm)	Days to first fruit harvest	Total Yield (q/ha)	Shape of fruit	Color of fruit
Kheera super-40	26.22	0.74	1.83	11.30	16.31	3.45	47.33	107.41	Round long	Light green
Jagadamba-12	30.66	0.77	1.40	9.93	18.56	2.58	53.52	106.03	Round long	Light green
NSC- Kheera	**37.99**	**0.69**	**1.99**	**9.50**	22.60	4.58	56.59	**101.13**	Round long	Light green
USL-45	29.77	0.76	1. 36	10.60	17.60	3.99	52.32	110.84	Obovoid	Light green
Dharwad-Green	24.10	0.71	1.29	10.98	14.20	3.13	44.08	102.98	Round long	Light green
.S-3	24.33	0.80	1.42	10.00	16.26	3.72	48.04	108.78	Round long	Light green
Selection-3	27.88	0.75	1.57	9.66	20.32	3.09	49.38	103.59	Round long	Light green
PusaBarkha	25.22	0.78	1.62	11.16	19.72	3.69	52.32	121.50	Round long	Light green
Cucumber Jagadamba	24.88	0.79	1.73	10.20	17.23	2.67	47.09	108.66	Round long	Light green
Kheera Prasad-40	**19.77**	**0.83**	**1.27**	**11.46**	13.55	2.00	48.05	**122.41**	Round long	Light green
SE(d)		0.15	0.29	1.04	1.17	0.27				
C.D.		0.02	0.06	0.96	2.47	0.58				