



# Screening of Cucurbits Germplasm for Antixenosis Basis of Resistance against Fruit Flies, *Bactrocera* spp. (Diptera: Tephritidae)

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## 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 kharif season, 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 ribs were studied on fifty-four varieties/genotypes of different cucurbit crops to assess their relative resistance/susceptibility to fruit flies. The cucurbit genotypes

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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.

**Keywords:** *Antixenosis; cucurbits germplasm; Bactrocera species; rind thickness; fruit toughness.*

## 1. 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 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 [1]. Vegetables are valuable in maintaining alkaline reserve of the body and are valued mainly for their high carbohydrate, vitamins and mineral contents [2]. 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 [3]. 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 [4]. Cucurbits are an important group of vegetables belonging to family Cucurbitaceae. Cucurbits show many biologic properties such as antioxidant, antimicrobial, antidiabetic, 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 [5]. The dipteran family Tephritidae consists of over 4000 species, of which nearly 700 species belong to Dacine fruit flies [6]. Nearly 250 species are of economic importance, and are distributed widely in temperate, sub-tropical, and tropical regions of the world [7]. 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 [8]. 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 [9,10]. Such mechanisms of plant resistance have been

effectively used against insect pests in many field and horticultural crops [9,11]. Mechanisms of resistance in plants are either constitutive or induced and are grouped into three main categories: antixenosis, antibiosis and tolerance. Antixenosis refers to the potential plant characteristics/trait, either allelochemical or morphological, that impart or alters insect behavior towards the host preference [12].

## 2. MATERIALS AND METHODS

A total 23 varieties and 31 genotype of Bottle gourd, Bitter gourd, Ridge gourd, Muskmelon and Cucumber were transplanted at Vegetable Experimental Farm, SKUAST, Kashmir, Shalimar during *Kharif*, 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. Fruit toughness 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 scale and 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<sup>2</sup> area. 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.

### 3. RESULTS AND DISCUSSION

In total 23 varieties and 31 genotype of Bottle gourd, Bitter gourd, Ridge gourd, Muskmelon and Cucumber were screened for their relative susceptibility/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-6 had maximum rind thickness (4.44 mm) and fruit toughness (9.73 kg/cm<sup>2</sup>) had least fruit flies infestation (18.33 per cent). The higher infestation in genotypes (VRRG-25-16, VRRG-18-17-1, VRRG-1-16) as 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 comparison to green colored; though fruits shape was not of much significance (Table 3). In Muskmelon, genotype F1 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 yields had could be attributed to maximum rind thickness and fruit toughness, though fruit 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, the varieties Kheera Prasad 40 had maximum 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). The present findings are more or less in accordance with Panday et al. [13], 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. [14] 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. [8] 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. [15] who evaluated different plant characters of bottle gourd 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. [16] and Sajja et al. [17] too reported that different plant traits significantly confer susceptibility/resistance to fruit flies infestation and consequently influence fruit yield and fruit yield and quality.

**Table 1. Morphological character of bottle gourd genotypes/varieties in relation to infestation of *Bactrocera cucurbitae***

Bottle gourd genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm <sup>2</sup> )	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
<b>SE(d)</b>		<b>0.30</b>	<b>3.74</b>	<b>0.19</b>	<b>2.14</b>	<b>1.08</b>	<b>0.95</b>				
<b>C.D.</b>		<b>0.62</b>	<b>7.80</b>	<b>0.40</b>	<b>4.48</b>	<b>2.26</b>	<b>1.99</b>				

**Table 2. Morphological character of Bitter gourd genotypes/varieties in relation to infestation of *Bactrocera cucurbitae***

Bitter gourd genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm <sup>2</sup> )	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
<b>SE(d)</b>		<b>0.34</b>	<b>0.22</b>	<b>0.67</b>	<b>0.83</b>	<b>0.27</b>	<b>0.31</b>	<b>1.14</b>				
<b>C.D.</b>		<b>0.73</b>	<b>0.48</b>	<b>1.46</b>	<b>1.80</b>	<b>0.58</b>	<b>0.68</b>	<b>2.48</b>				

**Table 3. Morphological character of Ridge gourd genotypes/varieties in relation to infestation of *Bactrocera cucurbitae***

Ridge gourd genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm <sup>2</sup> )	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
<b>SE(d)</b>		0.14	0.28	0.54	2.12	7.48	0.24	1.17				
<b>C.D</b>		0.31	0.60	1.16	4.53	0.25	0.52	N/A				

**Table 4. Morphological character of Muskmelon genotypes/varieties in relation to infestation of *Bactrocera cucurbitae***

Musk melon genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm <sup>2</sup> )	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	68.5	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
<b>SE(d)</b>		0.06	0.39	0.10	1.84	1.50				
<b>C.D.</b>		0.13	0.80	0.22	3.80	3.10				

**Table 5. Morphological character of Cucumber genotypes/varieties in relation to infestation of *Bactrocera cucurbitae***

Cucumber genotypes /varieties	Infestation on Number Basis	Rind thickness (mm)	Flesh thickness (mm)	Fruit Toughness (Kg/cm <sup>2</sup> )	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	24.88	0.79	1.73	10.20	17.23	2.67	47.09	108.66	Round long	Light green
Jagadamba										
Kheera Prasad-40	19.77	0.83	1.27	11.46	13.55	2.00	48.05	122.41	Round long	Light green
<b>SE(d)</b>		0.15	0.29	1.04	1.17	0.27				
<b>C.D.</b>		0.02	0.06	0.96	2.47	0.58				

#### 4. CONCLUSION

A total of fifty four cucurbit germplasm of crop Bottle gourd, Bitter gourd, Ridge gourd, Muskmelon and Cucumber were screened against fruit flies under natural infestation conditions. 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. The cucurbit varieties/ genotypes with greater rind thickness, fruit toughness and dense pubescence had least fruit flies infestation; whereas, the germplasm with minimum rind thickness and fruit toughness, less pubescence had maximum fruit fly infestation. However, the other morphological fruit traits as fruit length and breadth were not of much significance; though, green colored fruits were much preferred for oviposition in comparison to light green colored.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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