Screening of guava (*Psidium guajava* L) varieties against fruit fly, *Bactrocera* spp in southwest Haryana

AARTI[1], RAM KARAN GAUR[2] and SUNITA YADAV[1]

[1]Department of Entomology, CCS Haryana Agricultural University
Hisar 125004 Haryana, India
[2]ICAR – Krishi Vigyan Kendra, CCS HAU, Rohtak 124001 Haryana, India
Email for correspondence: drramkaran1965@gmail.com

 Received: 08.12.2022/Accepted: 20.01.2023

ABSRACT

The number of maggots per infested fruit and fruit fly infestation differ from variety to variety. In the present study on screening of guava varieties against fruit fly, *Bactrocera* spp, out of six guava varieties, the maximum number of maggots 12.20/infested fruit and maximum infestation of 75.00 per cent were recorded in Banarasi Surkha and minimum number of maggots 9.80/infested fruit and minimum infestation 45.00 per cent were recorded in Desi germplasm. The variety Banarasi Surkha recorded highest fruit weight (169.2 g) and TSS (13.20°Brix) and lowest firmness (6.20 kg/cm^2), acidity (0.36%) and total phenol content (196 mg/100 g FW). Allahbadi Safeda had maximum size (5.40 cm × 6.80 cm). Hisar Surkha had highest pH (3.72) and vitamin C (186.40 mg/100 g) content. Desi germplasm had highest firmness (7.62 kg/cm^2), acidity (0.52%) and total phenols (289 mg/100 g FW) and lowest fruit weight (132.2 g), size (4.34 cm × 5.80 cm), TSS (11.60 Brix) and vitamin C (121.24 mg/100 g) content. Lowest pH was observed in Hisar Safeda (3.35). Higher number of maggots per fruit and fruit fly infestation were recorded in the varieties/germplasms Banarasi Surkha and L-49. Fruit infestation had a positive correlation with fruit weight (r = 0.857), TSS (r = 0.984) and vitamin C (r = 0.849) and negative correlation with fruit firmness (r = –0.992), acidity (r = –0.987) and total phenolic content (r = –0.959).

Keywords: Guava; varieties; fruit fly; maggots; infestation

INRODUCTION

India is the second largest producer of fruits in the world after China. It has become a challenge for this country not only to feed its own population but also to export fruits and vegetables to various developed countries. The climacteric fruit guava, *Psidium guajava* L, originated in tropical America has been cultivated widely in many countries in the world. It is considered as the most important fruit of the family Myrtaceae. Guava is the fourth most widely grown fruit crop in India. In fiscal year 2022, volume of guava produced in India is estimated to have amounted to 4.92 million metric tonnes. The cultivation area of guava was about 315 thousand hectares in the country in 2022 (Minhas 2022). The fruit is a rich source of nutrition as it is a major source of vitamin A, B and C (Anita et al 2012). It also contains good amount of pectin, calcium and phosphorus with a characteristic flavour. The fruit quality is superior in winter rather than rainy season and for this reason, rainy season crop is avoided in some areas to fetch better yield in winter season. Guava fruit can be consumed as fresh or in processed form. The fruit is processed in number of products like jellies, jam and nectar. When a guava orchard is established in large area, the pest also gets gradually established in the orchard which in turn creates a serious threat to the crop, the main reason behind the low production of crop in spite of growing in the vast area. Sarwar (2006) identified major insect species of guava which include scale insect, fruit fly, redbanded thrips, mealy bug, mite, stink bug, guava moth and guava whitefly. Fruit fly is the most destructive pest of the genus *Bactrocera* and it infests 62 species of plants belonging 30 families, many of which are commercially important (Kunprom et al 2015). Guava is one of the most attacked fruits in India by the fruit fly species *Bactrocera dorsalis* and *B zonatus*. The damage due

to this pest sometime reaches to the extent of crop failure during the rainy season. Delayed harvesting makes it vulnerable to the attack of fruit flies. Therefore, the present study was carried out to generate information on relative susceptibility of promising varieties of guava in order to aid in taking precise management decisions and their implementation in tackling the insect pest problems in guava.

MATERIAL and METHODS

The investigations on varietal/germplasm screening against fruit fly were carried out under field conditions in the guava orchard of CCS Haryana Agricultural University, Regional Research Station, Bawal, Haryana located in the low rainfall zone of southwestern Haryana (28.1° N, 76.5° E and 266 m amsl) during 2020-21. The soil of the region is light-textured, loamy and of low water holding capacity. Six prominent varieties/germplasms (Lucknow-49, Banarasi Surkha, Allahabadi Safeda, Hisar Surkha, Hisar Safeda and Desi) planted in the research farm at a spacing of 20 ft x 20 ft were selected and kept free from pesticides application during the course of the study. The experiment was replicated thrice. Averages of per cent infested fruits in respect of each variety/germplasm were worked out.

The experiment was started in June 2020 and continued till the month of December 2020. Various fruit physical parameters such as weight, size, firmness, shape and colour and biochemical traits such as pH, total soluble solids (TSS), acidity, total phenols and ascorbic acid (vitamin C) were recorded on ten semi-ripe fruits from each germplasm/variety. A hand refractometer was used to determine the TSS. Standard techniques were used to determine ascorbic acid and acidity. The data were statistically analyzed. The association between fruit fly infestation and physical and biochemical traits was investigated.

The per cent fruit damage was also calculated by counting fruits bearing pinhole damage/ovipositional marks and brown spots. Infestation symptoms of different fruit flies are similar, therefore, it was difficult to distinguish among themselves. Therefore, the infestation percentage was estimated for all fruit flies together. The infestation damage was determined as ratio of the number of infested fruits and total of inspected fruits.

RESULTS and DISCUSSION

Larval population of *Bactrocera* spp and infestation in different guava varieties/germplasms

The number of maggots of *Bactrocera* spp per infested fruit and fruit fly infestation differed from germplasm to germplasm (Table1). Out of six guava varieties/germplasms, the maximum mean number of maggots per infested fruit (12.20) and infestation (75.00%) were recorded in variety Banarasi Surkha followed by L-49 with 12.00 maggots per infested fruit and 70.00 per cent infestation. Minimum number of maggots per infested fruit (9.80) and infestation (45.00%) were recorded in Desi germplasm. The results of the present study are almost similar to the findings of Devi et al (2018) who observed the maximum number of oviposition marks of oriental fruit fly on Hisar Surkha (19 oviposition marks/5 fruits) followed by Banarasi Surkha and Allahabad Safeda (16 oviposition marks/5 fruits each) and Punjab Pink (15 oviposition marks/5 fruits), whereas, minimum in Lalit (8 oviposition marks/5 fruits). The work of Jalaludin et al (1998) also support the results of the present study who recorded 66.7 and 55.7 per cent fruit fly infestation in Allahabadi Safeda and Local respectively and reported Lucknow-49 as susceptible to fruit fly attack.

Relationship of fruit fly, *Bactrocera* spp infestation with physical traits of guava fruit

The data pertaining to relationship of fruit fly infestation with physical traits of guava fruit are given in Table 2.

Fruit weight: Differences were also noticed in fruit infestation with regard to fruit weight. The fruit weight was highest in Banarasi Surkha (169.2 g) and lowest in Desi (132.2 g) having fruit infestation 75.0 and 45.0 per cent respectively. Singh et al (2013) reported 144.58 g fruit weight of Hisar Surkha under Uttar Pradesh condition. A positive correlation of fruit infestation with fruit weight ($r = 0.857$) (Table 3) was also observed in the study which means heavier fruits exhibited greater fruit infestation as compared to lighter fruits which could be attributed to the availability of sufficient food material in large and heavy fruits, affording opportunities for adequate feeding and survival of the maggots.

Fruit size: A greater amount of variation was noticed in the fruit size of different varieties/germplasms. During the study, it was noticed that fruit size was

Table 1. Larval population of *Bactrocera* spp and infestation in different guava varieties/germplasms

Variety/germplasm	Average number of maggots/infested fruit	Average fruit fly infestation (%)
L-49	12.00	70.00
Allahabadi Safeda	11.20	60.00
Hisar Surkha	11.80	65.00
Hisar Safeda	10.60	50.00
Banarasi Surkha	12.20	75.00
Desi	9.80	45.00

Table 2. Relationship of fruit fly infestation with physical traits of guava fruit

Variety	Average fruit fly infestation (%)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit firmness (kg/cm^2)	Fruit shape	Fruit colour
L-49	70.00	158.3	5.20	6.32	6.41	Round	Yellowish green
Allahabadi Safeda	60.00	167.9	5.40	6.80	6.76	Globose	Greenish yellow
Hisar Surkha	65.00	163.4	5.97	6.42	6.43	Round	Yellow with red dots
Hisar Safeda	50.00	160.6	5.13	6.01	7.23	Round	Yellowish green
Banarasi Surkha	75.00	169.2	5.83	6.16	6.20	Oblong	Yellowish green
Desi	45.00	132.2	4.34	5.80	7.62	Sub-globose	Yellowish green

highest in the variety/germplasm Hisar Surkha (5.97 cm × 6.42 cm) and lowest in Desi (4.34 cm × 5.80 cm) having fruit infestation of 65.00 and 45.00 per cent respectively. Banarasi Surkha with highest fruit infestation (75.00%) had fruit size of 5.83 cm × 6.16 cm. Present findings are supported by the work of Khan et al (2019) who reported significant variation in fruit size in terms of fruit length and diameter among different cultivars viz Lucknow 49 and Allahabad Safeda.

Fruit firmness: The results reveal that fruit firmness was maximum in germplasm Desi (7.62 kg/cm^2) and minimum in the Banarasi Surkha (6.20 kg/cm^2) having fruit infestation to the tune of 45.0 and 75.0 per cent respectively. The correlation analysis between fruit fly infestation and fruit firmness revealed that fruit fly infestation had significant negative correlation (r = –0.992) (Table 3) with fruit firmness that provided resistance against fruit fly. Follett (2009) also observed that infestation rate increased with decreasing fruit firmness. Louzeiro et al (2020) found that firmness of infested fruits was lower in comparison to non-infested fruits.

Fruit shape: The fruits of the selected guava varieties/ germplasms exhibited four distinct shapes viz oblong, globose, round and sub-globose. Higher infestation was recorded in the variety/germplasm having oblong fruits ie Banarasi Surkha followed by L-49 having round fruits and minimum in Desi having sub-globose fruits.

Fruit colour: The fruits of selected guava varieties/ germplasms exhibited three different colours viz greenish yellow, yellowish green and yellow with red dots. Out of the six varieties, four were of yellowish green colour namely L-49, Hisar Safeda, Banarasi Surkha and Desi with fruit infestation of 70.00, 50.00, 75.00 and 45.00 per cent respectively. Allahabadi Safeda was greenish yellow and Hisar Surkha was yellow with red dots fruit colour and had fruit infestation of 60.00 and 65.00 per cent respectively.

Relationship of fruit fly infestation with biochemical traits of guava fruit: The data on relationship of fruit fly infestation with biochemical traits of guava fruit are given in Table 4.

pH: Highest pH was observed in Hisar Surkha (3.72) followed by Allahabadi Safeda (3.65) with fruit infestation of 65.0 and 60.0 per cent respectively. The lowest pH was found in Hisar Safeda (3.35) followed by Banarasi Surkha (3.44) having fruit infestation of 50.0 and 75.0 per cent respectively. Earlier Yusof (1989) observed pH from 3.89 to 4.1 in different guava varieties.

Table 3. Correlation between fruit fly infestation and physical traits of guava fruit

Physiological factor	Correlation
Fruit weight (g)	r = .857*
Fruit length (cm)	r = .700NS
Fruit breadth (cm)	r = .536NS
Fruit firmness (kg/cm^2)	r = –.992**

*Significant at 5% level of significance, **Significant at 1% level of significance, NS = Non-significant

Table 4. Relationship of fruit fly infestation with various biochemical traits of guava fruit

Variety	Average fruit infestation(%)	pH	TSS (°Brix)	Acidity (%)	Phenols (mg/100 g fruit)	Vitamin C (mg/100 g pulp)
L-49	70.00	3.63	13.00	0.38	224	153.43
Allahabadi Safeda	60.00	3.65	12.60	0.44	257	171.43
Hisar Surkha	65.00	3.72	12.90	0.40	239	186.40
Hisar Safeda	50.00	3.35	12.40	0.48	270	150.13
Banarasi Surkha	75.00	3.44	13.20	0.36	196	182.32
Desi	45.00	3.63	11.60	0.52	289	121.24

Total soluble solids: The TSS content was highest in Banarasi Surkha (13.20°Brix) which had maximum fruit infestation (75.0%) followed by L-49 which had 13.00°Brix TSS and 70.00 per cent fruit infestation. Lowest TSS content (11.60°Brix) was observed in Desi which also had minimum fruit infestation (45.00%).

Acidity: Highest acidity (0.52%) was recorded in Desi followed by Hisar Safeda (0.48%) and Allahabadi Safeda (0.44%) having infestations 45.00, 50.00 and 60.00 per cent respectively. The lowest acidity (0.36%) was noticed in Banarasi Surkha followed by L-49 (0.38%) and Hisar Surkha (0.40%) having fruit infestation of 75.00, 70.00 and 65.00 per cent respectively.

Total phenols: Total phenolic content was highest in Desi (289 mg/100 g FW) followed by Hisar Safeda (270 mg/100 g FW) and Allahabadi Safeda (257 mg/100 g fruit) and lowest in Banarasi Surkha (196 mg/100 g fruit). It was found that the variety/germplasm Desi with minimum infestation (45.00%) had highest quantity of total phenols (289 mg/100 g fruit) and Banarasi Surkha with maximum infestation (75.00%) had lowest content (196 mg/100 g fruit).

Vitamin C: Maximum vitamin C content was recorded in Hisar Surkha (186.40 mg/100 g) followed by Banarasi Surkha (182.32 mg/100 g) and Allahabadi Safeda (171.42 mg/100 g) having fruit fly infestation of 65.00, 75.00 and 60.00 per cent respectively and minimum in Desi (121.24 mg/100 g) having lowest fruit infestation of 45.00 per cent. The study conducted by Yusof (1989) observed that the vitamin C varied from 40.00 to 180.00 mg/100 g in guava varieties.

The correlation analysis study between pH and fruit fly infestation revealed a non-significant correlation (Table 5). A positive and significant correlation (r = 0.984) was exhibited between fruit fly infestation and fruit TSS which could be due to the reason that major portion of TSS is constituted of solids which contribute towards sweetness and in turn attract fruit flies. A negative correlation (r = –0.987) was recorded between fruit fly infestation and fruit acidity. Thus the germplasm like Desi had high acidity value and suffered lower fruit fly infestation. Vitamin C content was positively correlated (r = 0.849) with fruit infestation while total phenolic content had significant and negative correlation (r = –0.959).

Galli et al (2019) in multivariate analysis suggested that fruit infestation was inversely related to skin colour, firmness, soluble solids and titrable acidity of guava fruits. Jalaluddin and Sadakathulla (1999) observed that high levels of vitamin C, total soluble solids and total phenols in guava fruits were the factors contributing to resistance against fruit fly infestation. Reddy and Vasugi (2008) also made similar observations while examining certain wild species of guava against

Table 5. Correlation of fruit fly infestation with biochemical traits of guava fruit

Biochemical factor	Correlation
pH	r = .010^{NS}
Total soluble solids	r = .984**
Acidity	r = –.987**
Total phenols	r = –.959**
Vitamin C	r = .849*

*Significant at 5% level of significance, **Significant at 1% level of significance, NS = Non-significant

fruit fly. They reported that TSS and total sugars were positively correlated with fruit fly infestation while acidity was negatively correlated.

CONCLUSION

On the basis of the results, it is concluded that no single factor governed the infestation of fruit fly independently and the extent of infestation was an outcome of the contribution of all the factors together. Reduced fruit infestation could be due to antibiosis mechanisms of host plant resistance and the results postulated that physical and biochemical fruit parameters could contribute to these resistance mechanisms. Out of six guava varieties/germplasms none of them was found resistant against fruit flies. However, Desi (seedling) germplasm had minimum (45.0%) and Banarasi Surkha (75.0%) had highest infestation.

REFERENCES

Anita M, Sivaram V and Jayaramappa KV 2012. Influence of bee attractants on pollination and yield parameters in guava (*Psidium guajava* L). International Journal of Plant Reproductive Biology **4(1):** 41-46.

Devi M, Singh NV, Yadav GS, Sharma JR and Yadav J 2018. Screening of guava cultivars against different insect pests in agroclimatic condition of Haryana. Journal of Entomology and Zoology Studies **6(2):** 857-859.

Follett PA 2009. Puncture resistance in Sharwil avocado to oriental fruit fly and Mediterranean fruit fly (Diptera: Tephritidae) oviposition. Journal of Economic Entomology **102(3):** 921-926.

Galli JA, de A Palharini MC, Torres EMJ, Michelotto MD, Fischer IH, de A Bertani RM and Martins ALM 2019. Correlation between the infestation index of *Anastrepha* spp (Diptera: Tephritidae) and the physico-chemical properties of guava fruits. Acta Horticulturae **1256:** 435-440.

Jalaluddin SM and Sadakathulla S 1999. Development and survival of *Bactrocera correcta* (Bezzi) (Diptera: Tephritidae) on selected guava cultivars. Pest Management in Horticultural Ecosystems **5(1):** 24-27.

Jalaluddin SM, Katarajan K and Sadakathulla S 1998. Relative resistance of guava germplasm to guava fruit fly, *Bactrocera correcta* (Bezzi). Abstract, Fifth International Symposium on Fruit Flies of Economic Importance, 1-5 June 1998, Penang, Malaysia, pp 167.

Khan AA, Das A and Sarkar SK 2019. Profiling of fruit physico-chemical attributes of some promising guava (*Psidium guajava* L) cultivars under the new alluvial zone of West Bengal. Journal of Pharmacognosy and Phytochemistry **8(5):** 588-592.

Kunprom C, Sopaladawan PN and Pramual P 2015. Population genetics and demographic history of guava fruit fly *Bactrocera correcta* (Diptera: Tephritidae) in northeastern Thailand. European Journal of Entomology **112(2):** 227-264.

Louzeiro LRF, de Souza-Filho MF, Raga A and Schmidt FL 2020. Relationship between fruit fly (Diptera: Tephritidae) infestation and the physico-chemical changes in fresh fruits. African Journal of Agricultural Research **15(1):** 122-133.

Minhas A 2022. Production volume of guava in India FY 2015-2022. Statista , 2 August 2022.

Reddy PVR and Vasugi C 2008. Resistance to fruit fly, *Bactrocera dorsalis* (Hendel) and tea mosquito bug, *Helopeltis antonii* (Sign) in certain wild *Psidium* species. Journal of Horticultural Sciences **3(1):** 79-81.

Sarwar M 2006. Occurrence of insect pests on guava (*Psidium guajava*) tree. Pakistan Journal of Zoology **38(3):** 197-200.

Singh S, Singh S and Singh J 2013. Evaluation of guava (*Psidium guajava* L) cultivars under eastern UP conditions. Annals of Horticulture **6(2):** 392-394.

Yusof S 1989. Physico-chemical characteristics of some guava varieties in Malaysia. Acta Horticulturae **269:** 301-306.